U. S. Department of the Interior

U. S. Geological Survey

GLOBAL VOLCANIC EARTHQUAKE SWARM DATABASE 1979-1989

by

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Open-File Report 96-69

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1996

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Introduction

Earthquake swarms are pervasive at volcanoes, but have seldom been studied systematically. Most swarms that are described in the literature are those that occurred in association with eruptions; indeed, earthquake swarms are the most reliable method of forecasting eruptions. For the purpose of this report, a swarm is defined as many earthquakes of the same size occurring in a small volume. Swarms are different in these two ways from a mainshock-aftershock sequence or a foreshock-mainshock-aftershock sequence (fig. 1). Swarms are especially common in volcanic areas.

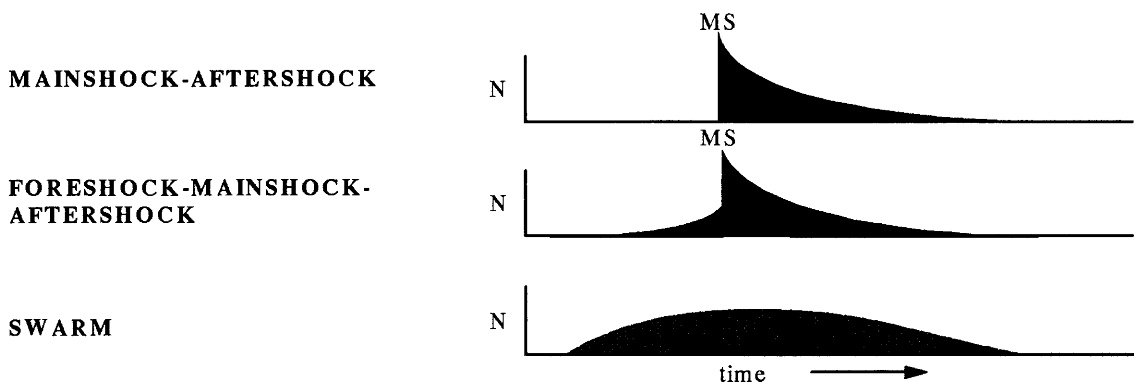

Figure 1. The number of events (N) per unit time versus time is schematically shown for the three types of earthquake sequences. The mainshock (MS) indicates the sharp increase in rate for the upper two distributions.

Because swarms are such a common and important phenomenon, we undertook a systematic and comprehensive study of swarms at volcanoes using modern commercially available database software. We term the result the Global Volcanic Earthquake Swarm Database (GVESD). This report describes the database and how it is structured, and gives preliminary results of a study of swarm durations based on 11 years of data as reported in the *Bulletin of Volcanic Eruptions* (BVE) of the Volcanological Society of Japan.

We chose BVE as our primary data source for several reasons. First, it contains data on many swarms that were never reported in the open literature. This is because most papers report eruptions, and swarms are included only if they were associated with eruptions. In other words, the open literature is biased in favor of eruptions, whereas BVE more fully reports a variety of activity during times of no eruptions. Second, BVE is prepared once per year, which gives investigators the opportunity to summarize data on a broad time scale. Monthly reports, such as the Smithsonian Institution Global Volcanism Network Bulletin, often focus more narrowly on the necessarily short (one month) time scale. Third, BVE is organized by time, so the 1980 issue, for example, contains data on many volcanoes for 1980. This makes it easy to select a sample which includes known large (or small) eruptions, whereas the open literature often has a significant delay between an event and the report. Fourth, BVE data are organized systematically, which greatly aids the preparation of data for entry into the electronic database. Fifth, the BVE includes a section devoted to miscellaneous information. The miscellaneous information section includes many reports of seismic activity at volcanoes that were not in eruption that year. Finally, BVE includes a supplement, which is used to provide additional information on previous years' activity. This systematic updating provides an additional element of quality control which is not found in most standard reports.

In spite of the generally high quality of BVE data, there are a number of limitations in those data as well as in the very nature of the problem we have chosen for study. In many respects this has been an exercise in the study of messy data. We have been faced with the difficult task of converting the judgments and measurements of many other scientists, which are often reported in words, into numerical data. We have thus been faced with a myriad of decisions and have struggled to maintain consistency and high quality control. A most basic decision is the start time of an earthquake swarm. In most cases this has been reported by a remote observer, but the units vary widely from "10:23 on July 24" to "late July." In some cases we have had to read data from a graph or histogram, so we have had to decide whether a factor of 2 or 3 increase above background marks the onset of a swarm. The sections below on the structure of the database provide many examples of such decisions.

It was our initial intention to perform a full multi-parametric study of the database. However, it quickly became apparent that durations of earthquake swarms were the most widely reported parameter whereas many other parameters were poorly reported (e.g., energy, cumulative seismic energy release, detection threshold, b-values). Thus we have focused our initial efforts on understanding the distribution of the swarm duration with respect to eruptive activity.

Database Structure and Description

The GVESD consists of three main tables: a volcano table (VOLCAT), a volcanic earthquake swarm table (SWARMCAT), and an eruption table (ERUPTCAT). The volcano table contains general information on 149 volcanoes active between 1979-1989. This table also serves as the parent table for the rest of the database. A sample record of the volcano and swarm table is shown in figure 2.

KUSATSU-SHIRANE Honshu-Japan 36.62N 138.55E *VOTW num.*:0803-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2176 m *Edifice relief :* 500 m
Range of eruptive products: andesite

SWARM DATE: 82/10/22 ±0.5 Dur. (days): 1.5 ±1 Type:1aq Event type(s):VE,t Grade : B

Max. Magnitude:	# EQ total : 23	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.): 6	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling : Y
		Magnification : 5 K	Geothermal : Y

Key phrase: Prior to eruptions, frequency of volcanic earthquakes increased on Oct. 22 (23 events).

The exact time of occurrence of these phreatic explosions was not well known. However, at 08:55 (JST) continuous volcanic tremors (amplitude = 0.2 um), possibly due to eruptive activity, commenced and was recorded at 1.1 km NE of Yugama crater and the amplitude became 5 um through about 11:00. Then, the amplitude of continuous volcanic tremors decreased; 1 um after 12:30, 0.3 um after 00:00 on Oct. 27, 0.1 um after 16:15 and stopped at 01:24 on Oct. 30.
Prior to eruptions, the frequency of volcanic earthquakes increased on Oct. 22 (23 events) and one volcanic tremor was recorded. Volcanic earthquakes swarmed from 21:45 (Oct. 26) to 07:38 (Oct. 27) but frequency suddenly decreased after that.
Figs: seismic activity before and after phreatic explosion of Oct. 26.
BVE No. 22, p. 47-50.

Figure 2. An example record from the Global Volcanic Earthquake Swarm Database. The top box shows the information contained in the volcano table. The middle portion shows one swarm record from the swarm table. The bottom portion shows text excerpted from the original reports.

Volcano Table

The volcano name, geographical region, latitude, longitude, and volcano number used within the database are drawn directly from *Volcanoes of the World Data File 1992*, an update of *Volcanoes of the World* (Simkin and others, 1981; Simkin and Siebert, 1994). The *Volcanoes of the World Data File* was expanded to include the volcano elevation, edifice height, morphology, compositional range of erupted products, tectonic framework, and a short geologic summary of each volcano (time is local unless otherwise stated). This supplemental information was taken from the *List of the World Active Volcanoes*, a special issue of the BVE, (Katsui and others, 1971), and *Volcanoes of North America*, (Wood and Kienle, 1990).

Earthquake Swarm Table

The volcanic earthquake swarm table holds over 600 records containing summary information related to each swarm and includes the dates of occurrence, durations, and the uncertainties in these measurements. Other parameters related to swarms such as the swarm type (see definitions below), the event type, the magnitude and intensity of the largest shock, the number of felt and unfelt events, and a short summary of the seismic instrumentation are included with each swarm record. This summary information is supplemented with an extended field that contains text excerpted from the original reports. A reference list is included with each record. See figure 2 for an example.

Eruption Table

The eruption table contains summaries of over 160 eruptions associated with well-documented earthquake swarms. It includes information pertaining to eruptive activity, such as dates of activity, eruption intensity (Volcano Explosivity Index), and character of the eruption. This information is drawn from the BVE and the Smithsonian Institution's Global Volcanism Program eruption data file. The eruption table does not include all eruptions that occurred during the time period covered by the database.

The following sections contain detailed descriptions of parameters in each of the above tables.

VOLCAT Organization and Parameter Description

The conventions for the volcano name, geographical region, latitude, longitude, and volcano number used within the GVESD are the same as in the *Volcanoes of the World* (Simkin, and others, 1981). The order of presentation is by geographic region and follows the organization of the *Catalog of Active Volcanoes of the World, IAVCEI, 1951- present.* Table 1 shows the regional organization, the number of swarm records in each region, and the starting page for each region in the GVESD. Table 2 is an alphabetical listing of the volcanoes, the number of swarm records at each volcano, the volcano number, and the page number in the GVESD.

Table 1. Regional Organization

	Region	*Number of swarm records*	*Number of volcanoes*	*Page*
1	Mediterranean	26	4	1
2	Africa and the Red Sea	5	1	14
3	Arabia and the Indian Ocean	28	1	17
4	New Zealand, Kermadec, Tonga, and Samoa	26	5	27
5	Melanesia	81	7	42
6	Indonesia	38	24	80
7	Philippines	26	6	111
8	Japan, Taiwan, and Marianas	138	25	122
9	Kurile Islands	4	4	195
10	Kamchatka	26	4	200
11	Aleutian Islands and Alaska	41	9	213
12	Western North America	40	5	232
13	Hawaiian Islands and Pacific Ocean	104	6	252
14	Central America	23	14	286
15	South America	16	6	307
16	West Indies	7	4	319
17	Iceland and Jan Mayen	8	5	326
18	Atlantic Ocean	2	1	331
19	Antarctica	2	2	332

Table 2. List of Volcanoes in the GVESD

Volcano Name	Number	Recs.	Page	Volcano Name	Number	Recs.	Page
ADAGDAK	1101-112	1	214	ILI BOLENG	0604-22=	4	99
AGUNG	0604-02=	1	96	ILIWERUNG	0604-25=	1	100
AKITA-KOMAGA-TAKE	0803-23=	2	159	IVAN GROZNY	0900-07=	1	195
ALAID	0900-39=	1	199	IWAKI	0803-27=	1	160
AMBRYM	0507-04=	1	78	IWO-JIMA	0804-12=	1	178
ANAK RANAKAH	0604-071	3	98	IZU-TOBU	0803-01=	2	141
ANIAKCHAK	1102-09-	1	225	KARKAR	0501-03=	9	48
API SIAU	0607-02=	4	108	KELUT	0603-28=	1	89
ASAMA	0803-11=	10	146	KICK-'EM-JENNY	1600-16=	1	325
ASO	0802-11=	17	134	KILAUEA	1302-01-	95	253
AUGUSTINE	1103-01-	5	226	KIRISHIMA	0802-09=	9	128
BAGANA	0505-02=	13	74	KLIUCHEVSKOI	1000-26=	15	204
BANDA API	0605-09=	3	102	KOMAGA-TAKE	0805-02=	2	81
BANDAI	0803-16=	3	157	KOZU-SHIMA	0804-03=	1	176
BATUR	0604-01=	1	95	KRAFLA	1703-08=	6	328
BEERENBERG	1706-01=	1	330	KRAKATAU	0602-00=	2	82
BEZYMIANNY	1000-25=	7	201	KUSATSU-SHIRANE	0803-12=	11	150
BROMO	0603-31=	1	91	LAMONGAN	0603-32=	2	92
BULUSAN	0703-01=	11	114	LANGILA	0502-01=	16	53
CAMPI FLEGREI	0101-01=	6	1	LASCAR	1505-10=	1	315
CANLAON	0702-02=	8	111	LASSEN PEAK	1203-08-	1	243
CHICHON, EL	1401-12=	1	290	LIAMUIGA, MT.	1600-03=	1	319
CHIKURACHKI	0900-36=	1	197	LOIHI SEAMOUNT	1302-00-	3	252
COLIMA VOLCANIC COMP.	1401-04=	4	286	LOKON-EMPUNG	0606-10=	3	106
COLO [UNA UNA]	0606-01=	1	104	LONG ISLAND	0501-05=	1	51
CONCEPCION	1404-12=	1	305	LONG VALLEY	1203-14-	17	244
DECEPTION ISLAND	1900-03=	1	333	LONQUIMAY	1507-10=	1	317
DIENG VOLCANIC COMPL.	0603-20=	1	86	MACDONALD	1303-07-	3	284
DON JOAO DE CASTRO BANK	1802-07=	2	331	MAHAWU	0606-11=	1	107
DUTTON, MT.	1102-011	1	216	MAKIAN	0608-07=	1	110
EBEKO	0900-38=	1	198	MALINAO	0703-04=	1	119
EREBUS, MOUNT	1900-02=	3	332	MANAM	0501-02=	17	42
ETNA	0101-06=	18	8	MARAPI	0601-14=	3	81
FOURNAISE, PITON DE LA	0303-02=	28	17	MARU-YAMA	0805-061	3	191
FUEGO	1402-09=	1	296	MASAYA	1404-10=	2	304
FUJI	0803-03=	1	142	MAUNA LOA	1302-02=	6	278
GALUNGGUNG	0603-14=	2	84	MAYON	0703-03=	3	118
GAMALAMA	0608-06=	2	109	ME-AKAN	0805-07=	6	192
GARELOI	1101-07=	1	213	MEDICINE LAKE	1203-02-	1	242
GORELY	1000-07=	2	200	MEHETIA	1303-06-	1	283
GRIMSVOTN	1703-01=	1	327	MERAPI	0603-25=	5	87
GUAGUA PICHINCHA	1502-02=	3	313	MIYAKE-JIMA	0804-04=	1	177
HAKKODA GROUP	0803-28=	1	161	MOMOTOMBO	1404-09=	1	303
HAROHARO COMPLEX	0401-05=	1	30	NASU	0803-15=	5	154
HEKLA	1702-07=	1	326	NEGRA, SIERRA	1503-05=	1	314
HOOD, MOUNT	1202-01-	1	241	NII-JIMA	0804-02=	2	175
IJEN	0603-35=	1	94	NIUAFO'OU	0405-11=	1	41

Table 2 continued. List of Volcanoes in the GVESD

Volcano Name	Number	Recs.	Page	Volcano Name	Number	Recs.	Page
NORIKURA	0803-06=	1	145	SOPUTAN	0606-03=	3	105
NYAMURAGIRA	0203-02=	7	14	SORIK MARAPI	0601-12=	3	80
NYOS, LAKE	0204-003	1	16	SOUFRIERE GUADELOUPE	1600-06=	1	320
OKMOK	1101-29-	1	215	SOUFRIERE ST. VINCENT	1600-15=	1	324
ON-TAKE	0803-04=	5	143	SPURR	1103-04-	1	231
OSHIMA	0804-01=	33	162	ST. HELENS, MT.	1201-05-	27	323
PACAYA	1402-11=	5	297	STROMBOLI	0101-04=	5	3
PAGAN, NORTH	0804-17=	1	180	SUWANOSE-JIMA	0802-03=	1	122
PARICUTIN	1401-06=	1	288	TAAL	0703-07=	3	120
PATATES, MORNE	1600-11=	4	321	TACANA	1401-13=	4	291
PAVLOF	1102-03-	21	217	TANGKUBAN PARAHU	0603-09=	3	83
PELEE, MONTAGNE	1600-12=	1	323	TARAWERA	0401-06=	1	31
PINATUBO, MT.	0703-083	1	121	TARUMAI	0805-04=	3	186
POPOCATEPETL	1401-09=	1	289	TEAHITIA	1303-03-	4	281
RABAUL	0502-14=	19	67	TECAPA	1403-08=	1	299
RAUNG	0603-34=	1	93	TELICA	1404-04=	2	302
REDOUBT	1103-03-	9	228	TOKACHI	0805-05=	9	187
RINCON DE LA VIEJA	1405-02=	1	306	TOLIMA	1501-03=	1	316
RUAPEHU	0401-10=	22	32	TUPUNGATITO	1507-01=	2	58
RUIZ	1501-02=	10	307	ULAWUN	0502-12=	25	52
RUMBLE III	0401-13-	1	40	UMBOI	0501-06=	1	179
SAKURA-JIMA	0802-08=	13	123	UNNAMED SUBMARINE	0804-14*	1	131
SAN CRISTOBAL	1404-02=	1	301	UNZEN	0802-10=	6	182
SAN MIGUEL	1403-10=	4	300	USU	0805-03=	8	224
SANGEANG API	0604-05=	2	97	VENIAMINOF	1102-07-	2	318
SANTA MARIA	1402-03=	5	294	VILLARRICA	1507-12=	1	304
SARYCHEV PEAK	0900-24=	1	196	VULCANO	0101-05=	6	5
SEMERU	0603-30=	4	90	WHITE ISLAND	0401-04=	7	26
SHIVELUCH	1000-27=	7	210	YASUR	0507-10=	1	79
SIRUNG	0604-27=	1	101	YELLOWSTONE	1205-01-	1	251
SLAMET	0603-18=	1	85				

Morphology, Tectonic Framework, Elevation, and Edifice Relief

The morphology or volcano type is drawn from the *List of the World Active Volcanoes* (Katsui and others, 1971). Table 3 is a list of the morphologies and the abbreviations used in the VOLCAT table. The majority of swarm records in the GVESD occur at stratovolcanoes and shield volcanoes, with the remainder from calderas, submarine, and compound volcanoes. There are more than twice as many swarm reports from stratovolcanoes as from shield volcanoes.

Table 3. Volcano Morphology

Morphology abbreviation	Volcano morphology	Total number of swarm records	Number of swarm records with duration specified
S	strato or composite	321	267
Sh	shield	137	130
S,Cald	strato with caldera	63	53
S,D	strato with lava dome	57	43
Cald	caldera	49	35
Cald,S	caldera with strato	33	21
S,Sh	strato on a shield	22	21
C	compound or complex	19	12
D	lava dome	17	15
Sub	submarine	17	12
S,CL	strato with crater lake	9	6
	unknown	8	7
Sh,Cald	shield with caldera	3	2
CC	cinder cone	2	2
CC,C	cinder cone in caldera	1	0
LF	lava field (flows)	1	1
S,So	strato with somma	1	1
Sh, D	shield with dome	1	1

The tectonic framework field refers to the regional tectonic setting. We define three general regimes; convergent, divergent, and hot spot. When detailed information is available, we subdivide the tectonic regimes by the type of crust involved. Table 4 shows a summary of the abbreviations used in the GVESD for the tectonic framework. The majority of swarm records occur at volcanoes in convergent margins followed by oceanic hot spots and divergent margins.

Table 4. Tectonic Framework

Tectonic framework abbreviation	Tectonic framework	Total number of swarm records	Number of swarm records with duration specified
C	Convergent (arc)	241	196
CM	Convergent Continental Margin	175	146
HO	Oceanic Hot Spot	133	127
CO	Convergent Intraoceanic	44	41
CM?	Uncert. Convergent Continental Margin	38	28
C?	Uncert. Convergent (arc)	29	28
DRC?	Uncert. Divergent Rift Continental	17	13
DM	Divergent Mid Ocean Ridge	12	11
CO?	Uncert. Convergent Intraoceanic	9	7
DRC	Divergent Rift Continental	8	5
HC	Continental Hot Spot	1	0

The elevation data are drawn from both the *Volcanoes of the World* (Simkin and others, 1981) and the *Catalog of Active Volcanoes of the World IAVCEI, 1951- present*. Elevations are in meters above sea level at the volcano's highest point. When more than one elevation value is given (e.g., multiple peaks within a massif) the highest value is recorded. The edifice relief or "height over the regional base" is a coarse measurement the volcano's size. Edifice relief values were extracted from *List of the World Active Volcanoes* (Katsui and others, 1971) for most areas and *The Volcanoes of North America* (Wood and Kienle, 1990) for North America.

Range of Erupted Products

The range of eruptive products field is intended to give a rough idea of the silica content of the magmas erupted at each volcano. We divided this field into six categories; basalt (B), basaltic andesite (BA), andesite (A), dacite (D), rhyodacite (RD) and rhyolite (R). For example, for a volcano that has erupted basalt and dacite, the eruptive product range field is coded as B,D or 'basalt and dacite'. The silica ranges, abbreviations, and the number of cases within each field are shown in table 5. Over half of the swarm records are from volcanoes with basaltic to andesitic composition. The majority of these data were extracted from Katsui and others (1971) for areas outside North America, Motyka and others (1993) for Alaska, and Wood and Kienle (1990) for the contiguous U.S. and Canada. For selected individual eruptions we recorded silica content of the erupted products. The eruption table (see below) holds these data for eruptions with well-studied swarms. The silica content data for the individual eruptions are primarily drawn from the BVE.

Table 5. Erupted Products

Erupted products abbreviation	*% Si02*	*Lower bound*	*Upper bound*	*Erupted products*	*Total number of swarm records*	*Number of swarm records with duration specified*
B	46.5	41	52	basalt	256	220
B,BA	50	41	55	basalt to basaltic andesite	61	59
B,A	52.8	41	63	basalt to andesite	88	63
BA	53.5	52	55	basaltic andesite	1	1
B,D	55.3	41	65	basalt to dacite	0	0
BA,A	56.3	52	63	basaltic andesite to andesite	8	7
B,RD	57	41	70	basalt to rhyodacite	0	0
BA,D	58.8	52	65	basaltic andesite to dacite	0	0
A	59	55	63	andesite	199	157
B,R	59.3	41	74	basalt to rhyolite	27	19
BA,RD	61	52	70	basaltic andesite to rhyodacite	0	0
A,D	61.5	55	65	andesite to dacite	58	51
BA,R	63	52	74	basaltic andesite to rhyolite	1	1
A,RD	63.3	55	70	andesite to rhyodacite	0	0
D	64	63	65	dacite	0	0
A,R	65.5	55	74	andesite to rhyolite	2	2
D,RD	65.8	63	70	dacite to rhyodacite	0	0
RD	67.5	65	70	rhyodacite	0	0
D,R	68	63	74	dacite to rhyolite	0	0
RD,R	69.8	65	74	rhyodacite to rhyoloite	0	0
R	72	70	74	rhyolite	3	3

SiO2 values from: Cox et al., (1979), The interpretation of igneous rocks, George Allen and Unwin, London.

SWARMCAT Organization and Parameter Description

For each volcano, one or more earthquake swarm records are linked to the volcano table's records. The swarm records are linked through the *Volcanoes of the World* catalog-number. Each swarm record is composed of: a header of key fields; a body of swarm, instrumental, and other geophysical parameters; a variable length section containing report excerpts; and references. Three fields are used to ensure that every earthquake swarm record is unique. These fields are called the key fields, and are the volcano catalog-number, the swarm start date, and the swarm type. Every swarm record has a unique value of these three combined fields.

Swarm Dates, Durations and Uncertainties

The start date of a swarm in most cases originates directly from the BVE reports. Typically the beginning of a swarm is described as an increase in the number earthquakes reported per day (see swarm duration definition below). Gradual increases in seismicity, problems in network coverage, a high detection threshold, and the lack of a clear definition of when a swarm begins (or ends) are all problems with determining the start time and duration of a swarm. Often these difficulties lead to reports that describe the onset of a swarm in imprecise terms. In order to track these problems a field was added to capture the uncertainties in these measurements. A typical swarm report may read: "Seismicity increased in the middle of November to about 60 events per day. However, there was a decline to 5-20 per day in late December" (Bagana volcano, BVE, 1985, no. 25, p. 20). This swarm was entered into the GVESD as beginning on 85/11/15 ± 5 days, with a duration of 40 ± 10 days. Table 6 describes the uncertainty values used in several common situations.

Table 6. Reporting Uncertainties

Dates reported	*Uncertainty assigned:*
minute	0
hour	+/-0.02 day
day	+/-0.5 day
week	+/-3.5 days
month	+/-15 days

Date modifiers	*Within a month (e.g. "mid" Jan.)*	*Within a year (e.g. "mid" 1980)*
"early"	5 Jan. +/- 5 days	1 Mar. 1980 +/- 60 days
"mid"	15 Jan. +/- 5 days	1 Jul. 1980 +/- 60 days
"late"	25 Jan. +/- 5 days	1 Nov. 1980 +/- 60 days

Some reports in the BVE include vague descriptions or occurrences of seismicity that cannot be easily classified. We use one place holding record per year to incorporate this information into the GVESD. Place holder records are delimited using the start date, the uncertainty, and the key phrase fields (see below). The start date is 'year'/7/1 with an uncertainty of ± 183 days for a place holding record. The key phrase field also contains the text; "place holder for 'year'..." to set these records apart. These are examples of our solutions to the problem of coding highly variable reports into quantitative form.

Definition of a Swarm and Swarm Duration

Earthquake swarms are generally defined as a sequence of events closely clustered in time and space without a single outstanding shock (Mogi, 1963). Our working definition follows Mogi's outline and also requires a significant increase in the rate of local volcanic earthquakes above the background rate. We take volcanic earthquakes to be of any type, for example A, B, (Minakami, 1960), high frequency, low frequency, short period, long period, (Koyanagi, and others, 1987), volcano tectonic, (Latter, 1981), explosion events, etc., but they must occur within an arbitrary near distance to the volcano (typically < 15 km). We do not identify a significant increase over the background rate in a strict statistical sense, but accept the experience and point of view of each reporter. In other words, if the reporter feels that an increase in seismicity is significant enough to report, then we include that report as a swarm record along with a quality modifier. We also do not consider seismic crises (peak seismicity rates within a swarm), obvious mainshock-aftershock sequences, and tremor episodes as swarms. These "non-swarm" seismic sequences are recorded in the GVESD and are delimited in a separate field (QC field explained below).

This working definition was developed through the systematic examination of over 600 swarms. One single fixed definition or algorithm might be preferable, but is not feasible due to the widely varying qualities and formats of the data. Future studies would greatly benefit from standardized reporting and the strict application of an algorithm to distinguish the starts, ends and durations of swarms.

Swarm Type

We grouped volcanic earthquake swarms according to their temporal relationship to eruptive activity. The swarm types are schematically summarized in figure 3. The main categories are: swarms that precede (Type I), or accompany (Type II) eruptive activity, and those not associated with eruptive activity (Type III). There are a few reported cases of eruptions occurring without a detectable increase in seismicity. These eruptions are included in the database and are identified as Type IV. Roman numerals are used throughout the discussion of swarm type, while Arabic numerals are used in the database for compactness.

Type I, or precursory swarms (46% of the GVESD records), were further divided into 4 sub-types (I a, I b, I c, and I d) according to when the swarm ends in relation to the eruptive activity. Type I a are swarms that begin and end before the eruption commences (for example, 1989 precursory swarm at Izu-Tobu). Type I b are swarms that begin before the eruption and end coincident with the start of the eruption (for example Asama, 1983). Type I c are swarms that begin before the eruption, continue through the duration of the eruption, and end as the eruption ends (for example Oshima, 1987). Type I d swarms begin before the eruption and end after the eruption has ceased (for example Soufriere de Guadeloupe, 1976).

Type II swarms, those accompanying eruptions (15% of the GVESD records), are separated into three sub-types (II a, II b, II c). Type II a swarms begin and end with the eruption. Type II b swarms begin with the eruption and then continue after the cessation of the eruption. Type II c is reserved for swarms that occur during an extended eruption (e.g., the continuing eruption of Kilauea).

Type III swarms are not associated with eruptions (39% of the GVESD records). To separate this category from swarms of Type I a, the time period between the end of the swarm and the next eruption was measured. This quiescent duration is generally less than 10 days with no cases greater than 3 months. Using this observation 100 days is used as a cut-off to separate Type III from Type I a. Post-eruption swarms are also included in Type III category.

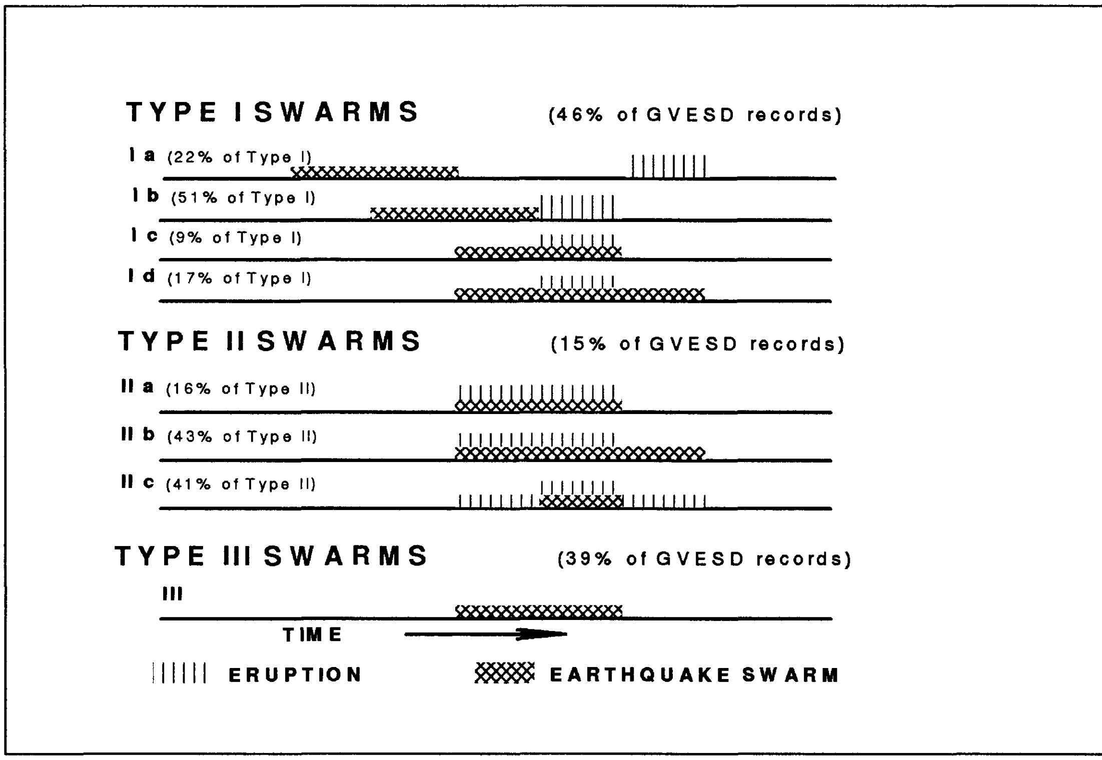

Figure 3. Schematic diagram of the temporal relation between volcanic earthquake swarms and eruptive activity. The stippled boxes represent the earthquake swarms. The vertically striped boxes represent the eruptions.

Event Types

In order to further describe the nature of the seismicity that makes up a swarm we added an event type(s) field. Table 7 shows a list of the events types found in the GVESD. Within any swarm there maybe one or more types of seismic event recorded. The event type field attempts to reflect this complexity by listing (in the order of occurrence, if reported) all the event types that occurred during the swarm. Some swarms are defined and reported by event type. At Kilauea, for example, swarms are reported by location and event type. We separated swarms reported at this level of detail into individual swarm records. Most reports do not provide this level of detail. Therefore, most swarm records contain many different event types. Table 7 lists the event types we have defined, with their abbreviations and the numbers of swarm records in which each was used.

Table 7. **Event Types**

Event type abbreviation	*Event type*	*Number of cases*
A	A-type	24
B	B-type	82
C	C-type	6
E	explosion	16
Felt	felt earthquake	11
G	gas	2
HF	high frequency	23
LF	low frequency	36
LP	long period	49
M	mixed frequency	1
MF	medium frequecy	1
mseis	micro-seism	1
reg	regional earthquake	1
S	surface	15
SP	short period	39
SV	shallow volcanic	10
Tect	tectonic	7
t	tremor	60
tor	tornillo	2
VE	volcanic earthquake	56
VT	volcano tectonic	37

Quality Grades (QC)

We assign an overall quality grade (QC) to each swarm record. The quality grade is intended to be a qualitative statement of the reliability of the report and the swarm record. We assigned quality grades of A through C to each swarm record. The first two grade levels, A and B primarily reflect the report data source. A QC grade of A is given to swarm records that are taken from the primary reviewed literature or from data to which we have primary access. We assume that swarm records derived from these sources are the most dependable. QC grades of B are assigned to swarm records extracted from reports in the BVE. This QC grade level makes up a majority of the records in the GVESD. The C grade is not a reflection of the data source, but is given to records where there is some question about whether the seismicity constitutes a swarm. Mainshock-aftershock sequences, seismic crises, and vague reports of seismic activity are given a QC grade of C. A parallel grading system is used for tremor episodes. Tremor episodes are delimited from true earthquake swarms by using a lower case QC grade (e.g., a, b, and c).

Approximately 15% (93 records) of the swarm records in the GVESD are derived from the reviewed literature or locally available data (A-QC). Over half (327 records) of the records were drawn from the BVE (B-QC). A quarter (148 records) of the records are questionable swarms and therefore given a C-QC grade. Tremor episodes comprise about 8% (50 records) of the GVESD.

Maximum Magnitude, Intensity, and Depth

The maximum magnitude field contains the magnitude of the largest shock within each swarm. Over one fourth (168 cases) of the swarm records contain the magnitude of the largest shock in the swarm. We added a magnitude scale field to qualify the type of magnitude reported (e.g., M_L,

m_b, M_{JMA}, etc.). A specific magnitude scale is reported with the maximum magnitude in only 6% of the swarm records.

The maximum intensity field records the felt intensity of the largest shock of the swarm. Another field holds the distance between the observer and the active vent. Intensity is reported in about 10% (67 records) of the swarm records, while the distance to the active vent is reported in only one half of these cases. We have recorded all the intensities in the GVESD using the Modified Mercalli (MM) scale. When an intensity is given in a different scale (e.g., JMA or Rossi-Forel) we assign a MM intensity to the value. Where differing intensity scales overlap, the greater MM value is used. For example, the JMA grade 1 spans MM1 to MM3, so a JMA grade 1 is given a MM3. A table of the intensity scales, from Newhall and Dzurizin (1988), is shown in Appendix A.

The depth field is a measure of the mean depth of the swarm. The depth field is supplemented with another field to express the range of depths where the earthquakes are located. The mean depth is recorded in 16% (103 records) of the swarm records. Figure 4 shows the distribution of the mean depth of volcanic earthquake swarms recorded in the GVESD. Volcanic earthquakes are generally shallower than their tectonic counterparts.

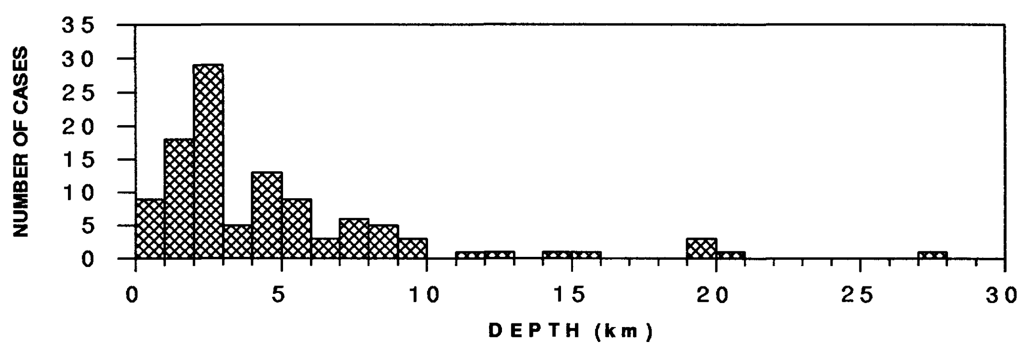

Figure 4. The mean depth of volcanic earthquake swarms.

Cumulative Energy, Energy Release Rate, and Repose

The cumulative energy and the energy release rate fields were included to use a standard measure for comparison with eruption parameters. In practice, the energy parameters are rarely reported (only 2% of the swarm records). This is most disappointing; with a homogenous data set the energy field could prove to be an interesting parameter to compare with eruptive activity. Energy has obvious physical relevance. The energy values and rates are reported in Joules and Joules per day, respectively.

The repose field refers to the eruption repose period. The eruption repose period is here defined as the period of time between the end of the last eruption to the beginning of the next eruption. This field is reported in 20% of the swarm records (127 cases).

Earthquake Counts and Magnitude Detection Threshold

The total number of earthquakes and the number of felt earthquakes are reported in nearly one half of the GVESD records (268 records). The total number and number of felt earthquakes are recorded in the "# EQ total" and "# felt total " fields respectively. The number of reported earthquakes in a swarm is sensitive to the magnitude detection threshold of the local network. The magnitude detection threshold is recorded in a separate field. The detection threshold is reported in about a fourth of the swarm records. Where sufficient information about the network is available the detection threshold was estimated. When reported, the distance from the felt observations to the active vent is included in the comments field.

Seismograph Information

The seismograph section of SWARMCAT is devoted to a summary of the seismic instrumentation at each volcano. The summary includes the type of seismometer, the distance between the nearest station and the active vent, the number of components, the natural period, and the magnification. The seismograph field indicates if the instruments are permanent or temporary stations. The distance (in kilometers) between the nearest station and the active vent is recorded in the distance to vent field. The seismograph and distance fields are commonly reported and are recorded in 84% (530 cases) of the swarm records. The type and component fields describe the type and the number of components in the instrument. We also record the natural period (in seconds) and the magnification at the natural period when available. The natural period and the magnification fields are reported in about 60% (369 cases) of the swarm records.

Previous Swarms and Other Reported Information

The previous swarms field is intended to determine whether or not there is a basis for comparison of a database swarm with other, earlier swarms. The OTHER REPORTED INFORMATION section of the SWARMCAT table provides a quick reference to other reported phenomenon. It was created to be a starting point to build or link other databases. The fields are either filled with 'Y' (yes), 'N' (no), or blank (no information reported). A 'Y' or 'N' in any of the field means some information regarding that parameter was reported. If the parameter was observed and either changed or no information on change was given, then a 'Y' is indicated. For example, a report may state "tilt measurements were conducted," this information is recorded as a 'Y' in the deformation field even though it is not clear if any tilt occurred. A 'N' or no in any field represents a negative result was reported. If, for example, a report explicitly states "no migration of earthquake hypocenters was observed" the migration field will be filled with a 'N.' The details of seismological observations are included in the comment field. For non-seismological observations details can be found in the references section of the record.

Volcanic tremor is the most commonly reported observation followed by reports on ground deformation or tilt. Table 8 shows the number of positive and negative cases reported for each field. The fields are mostly self-explanatory, but a few need some further explanation. The Geothermal field refers to any temperature measurement conducted near the volcano. This includes fumaroles, crater lakes, or hot springs. As stated above, Migration refers to the migration of earthquake hypocenters. The EQ (earthquake) families field refers to earthquakes with nearly identical waveforms, also known as multiplets. The Rumbling field describes audible observations made at the volcano.

Table 8. Other Reported Observations

Parameter	*number of observations*	
	yes	*no*
Tremor	340	10
Deformation	255	1
Magnetic	108	0
Geothermal	89	0
Gravity	60	0
Rumbling	47	0
Migration	42	0
EQ families	36	0
Focal mechanism	8	0

References, Comment and Key Phrase fields

The references used to compile the swarm records are listed at the bottom of each record. The first reference in the list is the primary data source, unless otherwise noted. The other references of seismological interest are included with the BVE reports. The comment field is above the reference field within the swarm record. This variable length field contains text excerpted from the original reports. If the report includes pertinent figures a short note is added in the comment field. The Key phrase field is a one or two line summary of the comment field and gives the essence of the report from which the numerical data were derived.

ERUPTCAT Organization and Parameter Description

The eruption table (ERUPTCAT) contains basic descriptive parameters for 170 eruptions. The task of systematically compiling a complete database of eruption parameters for all eruptions (occurring during the time period covered by the GVESD) is beyond the scope of this study. We selected a set of eruptions that were preceded by well-reported swarms. From these eruptions, data were collected and entered into the eruption table. The eruption parameters chosen are, the start date, the volume of erupted material, the height of the eruption plume, an estimate of the silica content of the erupted products, and the Volcanic Explosivity Index (VEI).The ERUPTCAT table is shown below as table 9. The eruptions are listed in chronological order (grouped by year), beginning and ending with a few eruptions outside the time period systematically covered by the GVESD.

Table 9. ERUPTCAT

Volcano		Bulletin of Volcanic Eruptions Eruption data							VOTW Eruption data				SWARMCAT Swarm data			
Number	Name	start		volume			plume	SiO2	start	T	L	VEI	start	type	dur.	Mmax
0805-03=	Usu								10/7/25	6		2	10/7/22	1bq	4	Ms 5.1
0802-08=	Sakura-Jima								14/1/12	8	9	4	14/1/10	1b	2	Ms 5.2
1401-06=	Paricutin								43/2/20	9	8	4	43/1/7	1b	45	M 4.5
0802-08=	Sakura-Jima								55/10/13			3 *	55/4/20	1aq	175	
1000-25=	Bezymianny								55/10/22	9		5 *	55/10/11	1b	172	M 4.4
1000-27=	Sheveluch								64/11/12	8		4 +	64/11/2	1b	10	M 4.9
1503-05=	Negra, Sierra	79/11/13		g			14		79/11/13			3	79/11/13	1c?	2	M 4.8
1302-01-	Kilauea	80/3/11							80/3/11			0	80/3/10	1c?	1.25	M 4.2
1201-05-	St. Helens, Mount	80/5/18		g	4.0E+8		22	64	80/3/27	9	5	5 *	80/3/20	1d	59	ML 5.1
0502-12=	Ulawun	80/10/6		g				64	80/10/6	7		3	80/10/3	1b?	3	
1201-05-	St. Helens, Mount	80/7/22		g	5.0E+7		20	52	80/3/27			3 #	80/7/22	1b	0.5	M 2.0
1201-05-	St. Helens, Mount	80/10/19	1	m		1.2E+6		64	80/3/27			3 #	80/10/4	1b	11	M 2.8
1102-03-	Pavlof	80/11/8		m?			8	50	80/11/8	6		3 ^	80/11/6	1d	80	M 2.3
1201-05-	St. Helens, Mount	80/12/27	1	m		1.6E+6		63	80/3/27			1 #	80/12/24	1b	2	
0303-02=	Piton de la Fournaise	81/2/3		m		1.6E+7		48	81/2/3		7	2	81/1/21	1b	13	
1201-05-	St. Helens, Mount	81/2/5	1	m		3.6E+6		62	80/3/27			1 #	81/2/2	1b	3	
0805-04=	Tarumai	81/2/27		l	4.0E+2				81/2/27	2		0	80/11/15	1cq	240	
0101-06=	Etna	81/3/17		g		3.0E+7	0.3	48	81/3/17	5	6	1	81/3/12	1aq	6	
1201-05-	St. Helens, Mount	81/4/10	1	m		4.1E+6		62	80/3/27			1 #	81/4/5	1b	5	
0703-01=	Bulusan	81/4/27							81/4/9			3 #	81/4/20	1b	8	
0900-39=	Alaid	81/4/27					12		81/4/27	8		4 *	81/4/26	1b	6	M 3.5
0804-17=	Pagan, North	81/5/15		g	3.6E+7	4.3E+7	20	52	81/5/15	8	7	4 *	81/4/1	1b	45	M 4.0
1201-05-	St. Helens, Mount	81/6/18	1	m		4.1E+6		62	80/3/27			1 #	81/6/13	1b	5	
1502-02=	Guagua Pichincha	81/8/31		l	5.0E+3		1	64	81/8/31	4		1 ^	81/8/15	1b	15	
1201-05-	St. Helens, Mount	81/9/6		m		3.9E+6		62	80/3/27			1 #	81/8/30	1b	8	
1102-03-	Pavlof	81/9/25		m	7.5E+6		10.5		81/9/25	7	6	3	81/9/25	1d	96	M 2.3
1201-05-	St. Helens, Mount	81/10/30	1	m		3.6E+6		62	80/3/27			1 #	81/10/24	1b	7	
0203-02=	Nyamuragira	81/12/25		g			5	56	81/12/25	7	7	3	81/12/25	1b	0.13	M 1.3
1404-04=	Telica	82/2/12		m			4.3		81/11/25			2 ^	82/1/15	1cq	27	M 3.0
1201-05-	St. Helens, Mount	82/3/18		m		3.4E+6		62	80/3/27		6	3 #	82/2/24	1b	22	
1303-03-	Teahitia	82/3/25							82/3/16			0	82/3/14	1c	39	M 4.0
1401-12=	Chichon, El	82/3/28		g	5.0E+8		25	59	82/3/28	9		5 *	82/3/1	1bq	28	Md 4.0
0803-11=	Asama	82/4/26		m			0.5	59	82/4/26			2	82/1/15	1aq	15	
1302-01-	Kilauea	82/4/30		m		5.0E+5	0.05	49	82/4/30		5	0	82/4/30	1c?	0.16	
1201-05-	St. Helens, Mount	82/5/14	1	m		2.7E+6		63	80/3/27				82/5/6	1b	8	
1201-05-	St. Helens, Mount	82/8/18	1	m		4.6E+6		63	80/3/27				82/7/27	1b	21	
1302-01-	Kilauea	82/9/25		m		3.0E+6	0.07	49	82/9/25		6	1 ^	82/9/25	1aq	1.6	
1404-10=	Masaya	82/10/7		ml					65/10/10			1 ^	82/10/7	1d	1.5	M 2.3
0803-12=	Kusatsu-Shirane	82/10/26		l			0.1	59	82/10/26			1	82/10/22	1aq	1.5	
0804-12=	Iwo-Jima	82/11/28		l					82/11/28			1	82/11/25	1aq	5	
1302-01-	Kilauea	83/1/3		g		1.4E+7		49	83/1/3		7	1 ^	83/1/1	1aq	6	
1201-05-	St. Helens, Mount	83/2/2		g		1.4E+7	6	63	80/3/27		7	2 #	83/1/20	1b	13	
0101-06=	Etna	83/3/28		g	1.5E+6	1.0E+8	0.1	48	83/3/28	5	8	1	83/1/22	1b?	53	
0803-11=	Asama	83/4/8		m	1.3E+4		0.6	59	83/4/8			2	83/3/17	1aq	7	
1703-01=	Grimsvotn	83/5/28		m			3.5	49	83/5/28			2	83/5/28	1aq	0.39	M 4.0
0606-01=	Una Una	83/7/23		g			14		83/7/18			4 *	83/7/4	1c	24	M 4.6
1302-01-	Kilauea	83/7/25		m		9.0E+6		49	83/1/3			1 #	83/7/5	1b	16	
0803-12=	Kusatsu-Shirane	83/7/26		l			0.2	59	83/7/26			1	83/7/19	1aq	5	
0603-09=	Tangkuban Parahu	83/9/14							83/9/14			1	83/9/5	1bq	10	
0804-04=	Miyake-Jima	83/10/4			4.7E+6	6.0E+6			83/10/3	6	6	3	83/10/3	1b	0.06	
0502-12=	Ulawun	83/11/6		l			2	47	83/11/6			1	83/1/25	1aq	285	
1102-03-	Palvof	83/11/14		l					83/11/14	7		3	83/11/5	1d	29	M 2.3
1302-01-	Kilauea	83/11/30		m		8.0E+6		49	83/1/3			1 #	83/11/24	1aq	1	
0303-02=	Piton de la Fournaise	83/12/4		m		8.0E+6		48	83/12/4		7	2	83/11/20	1b	14	
0803-12=	Kusatsu-Shirane	83/12/21		l			0.3	59	83/7/26			1	83/12/18	1c	2	

Table 9 continued. ERUPTCAT

Volcano		Bulletin of Volcanic Eruptions Eruption data						VOTW Eruption data				SWARMCAT Swarm data			
Number	Name	start	volume			plume	SiO2	start	T	L	VEI	start	type	dur.	Mmax
1302-01-	Kilauea	84/1/20	g		1.0E+7		49	83/1/3			1 #	83/12/30	1aq	2	
1000-25=	Bezymianny	84/2/5	m			5		84/2/5	7		3 ^	84/1/15	1d	20	K 6.5
1302-01-	Kilauea	84/2/14	m		8.0E+6		49	83/1/3			1 #	84/2/5	1a	4	
1302-01-	Kilauea	84/3/3	g		1.2E+7		49	83/1/3			1 #	84/2/24	1a	7	
1302-01-	Kilauea	84/3/16	g		1.0E+7		49	83/1/3			1 #	84/3/16	1a	8	
1302-02=	Mauna Loa	84/3/25	g		2.2E+8	0.05	51	84/3/25		8	0	84/3/24	1d	120	M 4.0
1302-01-	Kilauea	84/4/18	g		2.4E+7		49	83/1/3			1 #	84/4/10	1b	10	
1302-01-	Kilauea	84/5/16	m		2.0E+6		49	83/1/3			1 #	84/5/7	1b	8	
1302-01-	Kilauea	84/6/7	m		6.0E+6		49	83/1/3			1 #	84/6/1	1a	5	
0603-25=	Merapi	84/6/15	g	8.8E+6		6	54	72/10/6			3 *	84/6/7	1b	8	
1302-01-	Kilauea	84/6/30	m		5.7E+6		49	83/1/3			1 #	84/6/17	1b	12	
1302-01-	Kilauea	84/7/28	m		9.5E+6		49	83/1/3			1 #	84/7/17	1b	11	
1302-01-	Kilauea	84/8/19	g		1.2E+7		49	83/1/3			1 #	84/8/7	1b	12	
0606-03=	Soputan	84/8/31	m			6	59	84/5/24		7	3 ^	84/8/6	1aq	19	
1302-01-	Kilauea	84/9/19	g		1.1E+7		49	83/1/3			1 #	84/9/1	1b	20	
1000-25=	Bezymianny	84/10/12	g			3.5		84/2/5	7		3 ^	84/10/12	1d	23	K 6.0
1302-01-	Kilauea	84/11/2	m		6.6E+6		49	83/1/3			1 #	84/10/2	1b	29	
1302-01-	Kilauea	84/11/20	m		8.4E+6		49	83/1/3			1 #	84/11/11	1b	9	
1302-01-	Kilauea	84/12/3	g		1.3E+7		49	83/1/3			1 #	84/11/23	1b	9	
0502-12=	Ulawun	84/12/30	l			2	47	84/12/30		5	1	84/12/24	1c	29	
1302-01-	Kilauea	85/1/3	g		1.3E+7		49	83/1/3			1 #	84/12/24	1b	11	
1706-01=	Beerenberg	85/1/6 2	m	8.0E+5	6.2E+6	1		85/1/6			2	85/1/4	1b	2	
1302-01-	Kilauea	85/2/4	g		1.4E+7		49	83/1/3			1 #	85/1/16	1b	20	
0702-02=	Canlaon	85/3/13	l			0.7		85/3/13			1	85/3/13	1bq	0.19	
1302-01-	Kilauea	85/3/13	g		1.9E+7		49	83/1/3			1 #	85/2/28	1b	14	
1302-01-	Kilauea	85/3/13	g		1.9E+7		49	83/1/3			1 #	85/3/14	1b	2	
0403-11=	Niuafo'ou	85/3/21	l	1.0E+2			54	85/3/21	2		0	85/3/21	1?	0.13	ML 2.4
1302-01-	Kilauea	85/4/21	g		1.6E+7		49	83/1/3			1 ^	85/3/27	1b	27	
0606-03=	Soputan	85/5/19	m	5.0E+6		5		85/5/19	6		2	85/3/15	1bq	65	M 5.6
0401-10=	Ruapehu	85/5/25	l					85/5/21			1	85/5/20	1d	12	ML 2.4
1302-01-	Kilauea	85/6/12	m		7.9E+6		49	83/1/3			1 #	85/5/10	1b	35	
0303-02=	Piton de la Fournaise	85/6/14	m		1.0E+6		49	85/6/14		8	1	85/5/15	1b	29	M 1.0
0805-05=	Tokachi-Dake	85/6/19	l			0.1		85/6/19			1	85/6/12	1bq	7	M 4.4
1302-01-	Kilauea	85/7/6	g		1.1E+7		49	83/1/3			1 #	85/6/21	1b	19	
1302-01-	Kilauea	85/7/26	m		7.2E+6		49	83/1/3			1 #	85/7/4	1b	13	
0604-05=	Sangeang Api	85/7/30	m	5.0E+6		6.5	47	85/7/30		7	3 *	85/4/29	1b	90	
0303-02=	Piton de la Fournaise	85/8/5	m		4.0E+6		48	85/6/14			1	85/8/5	1c	0.13	
1302-01-	Kilauea	85/9/2	g		1.2E+7		49	83/1/3			1 #	85/8/14	1b	18	
0303-02=	Piton de la Fournaise	85/9/6	g		1.7E+7		49	85/6/14			1	85/9/6	1b	0.05	
1302-01-	Kilauea	85/9/24	g		1.5E+7		49	83/1/3			1 #	85/9/10	1b	15	
1302-01-	Kilauea	85/10/21	g		1.5E+7		49	83/1/3			1 #	85/10/5	1b	16	
1302-01-	Kilauea	85/11/13	g		1.4E+7		49	83/1/3			1 #	85/10/30	1b	14	
1501-02=	Ruiz, Nevado del	85/11/13	g	4.3E+7				85/9/11	7		3 ^	84/11/13	1a	360	M 4.0
0603-09=	Tangkuban Parahu	85/11/15	l			0.2		85/11/15			1	85/4/15	1bq	210	
0502-12=	Ulawun	85/11/20	m	7.5E+6	2.0E+6	8	49	85/11/17	6	6	3 *	85/11/12	1cq	10	
0303-02=	Piton de la Fournaise	85/12/2	m		1.0E+6		49	85/6/14			1 #	85/12/2	1b	0.01	
0303-02=	Piton de la Fournaise	85/12/29	m		7.0E+6	0.15	49	85/6/14			1 #	85/12/25	1c	4	
1302-01-	Kilauea	86/1/1	g		1.2E+7		49	83/1/3			1 #	85/11/26	1a	32	
1302-01-	Kilauea	86/1/27	g		1.4E+7		49	83/1/3			1 #	86/1/19	1b	10	
1302-01-	Kilauea	86/2/22	g		1.2E+7		49	83/1/3			1 #	86/2/8	1b	16	
0303-02=	Piton de la Fournaise	86/3/19	g		2.0E+6			85/6/14			1 #	86/2/11	1a?	1.5	M 2.0
1302-01-	Kilauea	86/3/22	g		1.0E+7		49	83/1/3			1 #	86/3/7	1a	9	
1103-01-	Augustine	86/3/27	m			12	61	86/3/27	8		4 ?	86/2/10	1b	45	ML 2.1
0702-02=	Canlaon	86/3/30	l			0.7		87/3/30			1	87/3/1	1b	64	
1302-01-	Kilauea	86/4/13	g		1.2E+7		49	83/1/3			1 #	86/4/6	1b	8	

Table 9 continued. ERUPTCAT

Volcano		Bulletin of Volcanic Eruptions Eruption data							VOTW Eruption data					SWARMCAT Swarm data			
Number	Name	start		volume			plume	SiO2	start	T	L	VEI		start	type	dur.	Mmax
1302-01-	Kilauea	86/5/7		m		9.4E+6		49	83/1/3			1	#	86/4/27	1b	11	
1401-13=	Tacana	86/5/8		l			1		86/5/8			1		86/5/7	1b	2.5	ML 5.0
1401-13=	Tacana	86/5/8		l			1		86/5/8			1	?	85/12/15	1a?	72	
1302-01-	Kilauea	86/6/2		m		9.8E+6		49	83/1/3			1	#	86/5/21	1b	12	
0702-02=	Canlaon	86/6/22		m	1.4E+5		4		86/6/3	5		2		86/6/14	1b	8	
1302-01-	Kilauea	86/6/26		m		8.8E+6		49	83/1/3			1	#	86/6/18	1b	8	
0601-12=	Sorik Marapi	86/7/5		l	6.7E+2		0.7		86/7/5	2		1		86/7/4	1c	8	
0203-02=	Nyamuragira	86/7/16		g	5.0E+6	6.0E+7	0.25	45	86/7/16	7	7	2		86/7/16	1b	0.54	
1302-01-	Kilauea	86/7/18		m		6.0E+6		49	83/1/3			1	#	86/7/9	1b	10	
1501-02=	Ruiz, Nevado del	86/7/20					4		85/9/11			2		86/7/20	1b	0.29	
1501-02=	Ruiz, Nevado del	86/7/20		l			4		85/9/11			2		86/7/5	1a?	5	
0603-20=	Dieng	86/8/6		l			0.3		86/8/6			1		86/4/15	1aq	45	
0303-02=	Piton de la Fournaise	86/11/12		m		3.0E+5		49	85/6/14			1	#	86/11/12	1b	0.04	
1102-03-	Pavlof	86/11/16							86/4/16		6	3	^	86/4/7	1d	16	M 2
0804-01=	O-Shima	86/11/21		g	2.5E+7	2.2E+7	16	55	86/11/15	7	7	3	^	86/11/21	1c	9	M 6
0604-22=	Ili Boleng	86/11/24		m			1		86/5/28			1		86/11/14	1b	10	
0303-02=	Piton de la Fournaise	86/11/26		m		3.0E+5		48	85/6/14			1	#	86/11/17	1aq	9	M 3
1000-26=	Klyuchevskoy	86/11/27							86/11/27		7	3	^	87/12/27	1d?	10	Ks 9
0303-02=	Piton de la Fournaise	86/12/18			2.0E+6	m		48.9	85/6/14			1	#	86/12/2	1b	6	
0303-02=	Piton de la Fournaise	86/12/30						48.9	85/6/14			1	#	86/12/29	1b	1.5	M 2.0
0303-02=	Piton de la Fournaise	87/1/6		m		1.1E+6		49	85/6/14			1	#	87/1/6	1b	1.3	Md 1.0
1000-26=	Klyuchevskoy	87/2/23		l				53	86/11/27		7	3	^	87/2/20	1c	14	
1501-02=	Ruiz, Nevado del	87/6/9		l					85/9/11			2	?	87/5/21	1a	1.5	M 2.0
0303-02=	Piton de la Fournaise	87/6/13							85/6/14		8	1		87/6/8	1a	4	M 2.7
0303-02=	Piton de la Fournaise	87/7/19		m		1.0E+6		49	85/6/14			1	#	87/7/11	1b	8	
1501-02=	Ruiz, Nevado del	87/8/10		l					85/9/11	7		3	^	87/7/31	1a	1.5	
0401-10=	Ruapehu	87/8/24		l					87/8/24			1		87/8/18	1b	6	ML 2.0
0604-22=	Ili Boleng	87/10/2		l			0.3		87/10/2			1		87/6/20	1a	5	
0303-02=	Piton de la Fournaise	87/11/6		m		1.6E+6		49	85/6/14			1		87/11/3	1b	3	
0804-01=	O-Shima	87/11/16					4.3		87/11/16	4		3	^	87/9/15	1c	64	
0303-02=	Piton de la Fournaise	87/11/30		g		1.0E+7		49	85/6/14			1	#	87/11/29	1b	1.5	
0203-02=	Nyamuragira	87/12/30		m		3.0E+6		45	87/12/30	6	6	1		87/11/1	1b	30	
0604-071	Anak Ranakah	88/1/3		l			1.5		87/12/28	7	6	3	*	87/12/30	1b	5	
0805-07=	Me-Akan	88/1/5							88/1/5			1		87/9/9	1a	105	
1000-26=	Klyuchevskoy	88/1/20		g		3.4E+7		47	86/11/27			2		88/1/19	1b	12	
0303-02=	Piton de la Fournaise	88/2/7		m		8.0E+6		49	85/6/14			1	#	88/2/4	1b	3	
0608-06=	Gamalama	88/2/12		l			2		88/2/12			2		88/1/5	1bq	28	
0703-01=	Bulusan	88/2/20		m	3.2E+4		1.5		88/2/20	4		2		88/1/20	1b	30	
0605-09=	Banda Api	88/5/9		m	3.2E+4	6.0E+6	3.5		88/5/9		6	3	?	88/4/20	1b	18	M 3.7
0702-02=	Canlaon	88/6/21		l			1		88/6/21			1		88/5/6	1b	45	
0608-07=	Kie Besi	88/7/29		g			10		88/7/29			3		88/7/20	1b	9	
0303-02=	Piton de la Fournaise	88/12/14		m		8.0E+6		48	85/6/14			1		88/12/14	1b	0.16	
1507-10=	Lonquimay	88/12/27		m			5.5	58	88/12/25	8	8	3	^	88/12/7	1b	18	M 4.6
0502-12=	Ulawun	89/1/1					2	47	89/1/1			2		88/10/5	1c	66	
1000-26=	Klyuchevskoy	89/1/1					0.2	47	86/11/27			2		89/1/1	1c	16	
0900-24=	Sarychev Peak	89/1/13							89/1/13			1	?	89/1/5	1b	7	
1402-11=	Pacaya, Volcan de	89/3/7					3		65/7/4			3	^	89/2/25	1b	10	
0803-01=	Izu-Tobu	89/7/13						71	89/7/13	5		1		89/6/30	1aq	11	M 5.5
1000-26=	Klyuchevskoy	89/7/30					3	47	86/11/27			2	?	89/7/22	1bq	8	
0101-06=	Etna	89/9/11						47	89/9/11		7	2		89/8/17	1aq	9	
1103-03-	Redoubt	89/12/14	*3*	m	4.4E+5		10	61	89/12/14			2	#	89/12/13	1b	0.95	ML 2.0
1103-03-	Redoubt	90/1/2	*3*	g	2.5E+7		12	61	89/12/14		7	3	#	89/12/26	1b	7	
0603-28=	Kelut	90/2/10		m			12		90/2/10	8		4		89/11/15	1a	90	Md 2.0
1103-03-	Redoubt	90/2/15	*3*	m	5.6E+6		10	61	89/12/14		7	2	#	90/2/12	1b	3.42	
1103-03-	Redoubt	90/3/14	*3*	m	1.2E+6		12	61	89/12/14		7	2	#	90/3/13	1b	1.42	

Table 9 continued. ERUPTCAT

Volcano		*Bulletin of Volcanic Eruptions Eruption data*							*VOTW Eruption data*				*SWARMCAT Swarm data*			
Number	*Name*	*start*		*volume*			*plume*	*SiO2*	*start*	*T*	*L*	*VEI*	*start*	*type*	*dur.*	*Mmax*
1103-03-	Redoubt	90/3/23	*3*	m	3.8E+5		10	61	89/12/14		7	2 #	90/3/22	1b	1.42	
1103-03-	Redoubt	90/3/29	*3*	m	1.1E+6			61	89/12/14		7	1 #	90/3/28	1b	1.17	
1103-03-	Redoubt	90/4/6	*3*	m	5.2E+5		9	61	89/12/14		7	2 #	90/4/6	1b	0.54	
1103-03-	Redoubt	90/4/14	*3*	m	8.5E+5		10	61	89/12/14		7	2 #	90/4/15	1b	0.13	ML 1.7
0802-10=	Unzen	90/11/17		l			0.3		90/11/17	6	8	1	89/11/21	1a?	3	M 3.7
0703-083	Pinatubo	91/6/12		g	3.0E+9		40		91/4/2	10		6 *	91/4/2	1b	70	ML 4.3
1103-05-	Spurr		*4*		5.0E+7		14.5	57	92/6/27	7		4 ^	91/8/15	1bq	180	ML 1.7
1401-09=	Popocatepetl			m		1.4E+6	1		94/12/21			2	94/10/15	1b	60	M 2.9

1 Swanson, D. A. and R. T. Holcomb (1989)
2 BVE No. 26 (1986)
3 Scott and McGimsey (1994)
4 Alaska Volcano Observatory staff (1993)
Symbols are explained in the text.

Data Sources

The ERUPTCAT table is composed of three sections. The first section is eruption data drawn from the *Bulletin of Volcanic Eruptions* (BVE). The second section is eruption data drawn from *Volcanoes of the World second edition* (VOTW). The third section is the associated swarm data preceding each eruption drawn from the SWARMCAT table. The BVE section of the table includes the eruption start date, erupted volume, plume height, and silica content. The VOTW section also includes the start date, tephra and lava volumes, and adds the VEI for each eruption. The third section shows the precursory swarm parameters including the swarm start date, type, duration, and the magnitude of the largest earthquake preceding the eruption.

Both the BVE and VOTW data are listed because the two data sources differ in some respects. The BVE section describes all of the eruptions that were preceded by the well-reported swarms. In the VOTW directory, in many cases, these eruptions have been grouped as an eruptive phase of a longer eruptive sequence. For example, all the eruptions at Mount St. Helens between 1980 and 1986 are considered as one eruptive sequence in the VOTW directory. The BVE describes these as individual phases. All of the data listed in the BVE section are drawn from the BVE covering that year, unless an italic numeral (e.g., *1*) is listed following the start date. The italic numeral points to a reference used to complete or supplement data for that eruption or eruptive phase.

Erupted Volume, Plume Height, Silica Content, and the VEI

The BVE classifies the size or intensity of an eruption into three categories: Little (l), medium (m), and great (g) according to the bulk volume of erupted material. The BVE uses the following correlation between them:

$$(l) <1x10^4 m^3, (m)\ 1x10^4 \text{ to } 1x10^7 m^3, (g) >1x10^7 m^3 .$$

This field gives an estimate of the size of the eruption when no estimate of the erupted volume is available. This one letter size code is recorded in the first column of the volume field. The next two columns of volume field are the bulk tephra and lava volumes in cubic meters. If a range of values are reported the average is recorded.

The plume field records the maximum height in kilometers of the eruption cloud above the crater. The SiO2 field records the silica content of the main erupted product. The silica content values are taken directly from the BVE reports. In many cases, silica values are explicitly stated while others are derived from reported rock names.

The VOTW section of the ERUPTCAT table is directly extracted from the Smithsonian Institution's Global Volcanism Program eruption data file. The start date, tephra and lava volume, and the VEI are listed. The following field descriptions are from the Global Volcanism Program eruption data file.

The eruptive volume is broken into two fields, tephra (*T*) and lava (*L*). The volume is an order of magnitude value in cubic meters (e.g., 8 = >10 to the 8th power cubic meters = >100,000,000 m^3 = >0.1 km^3, 9 = >1 km^3, etc.). The tephra volume is a bulk volume, not dense rock equivalent.

The VEI is a 0-8 scale of explosive magnitude. An asterisk (*) follows the maximum VEI of an eruption for which additional VEI values have been assigned for specific phases. We have added a "pound sign" (#) to these specific phases where we have estimated the VEI. A "plus" (+) following VEIs greater than 4 identifies eruptions in the upper third of that VEI range. A "^" accompanies those eruptions early in a region's historical record that have been upgraded by 1 VEI unit, as explained in *Volcanoes of the World* and Newhall & Self (1982).

The parameters of the third section of the ERUPTCAT table are described in the SWARMCAT organization and parameter description section of this report.

Preliminary Results

Swarm Duration

The duration of a volcanic earthquake swarm was found to be the most commonly reported parameter. The database contains 385 swarm duration records with high quality grades. The distribution of swarm durations is shown in Figure 5. The durations vary from very short, intense swarms lasting only a few hours, such as those reported at Piton de la Fournaise and Kilauea, to swarms lasting a few years, such as the activity recorded at Long Valley Caldera and Usu (Usu at 1682 days is the longest swarm in the database). The distribution of durations is nearly log-normal with a geometric mean of 5.5 days, a median of 7 days and a mode of 2 days. The $\log_{10}$ transformed duration distribution was tested for normality using the Kolmogorov-Smirnov test (Rock, 1988). The test showed that the distribution was not normal. The duration distribution is skewed to the left. In other words, there is an excess of shorter swarms.

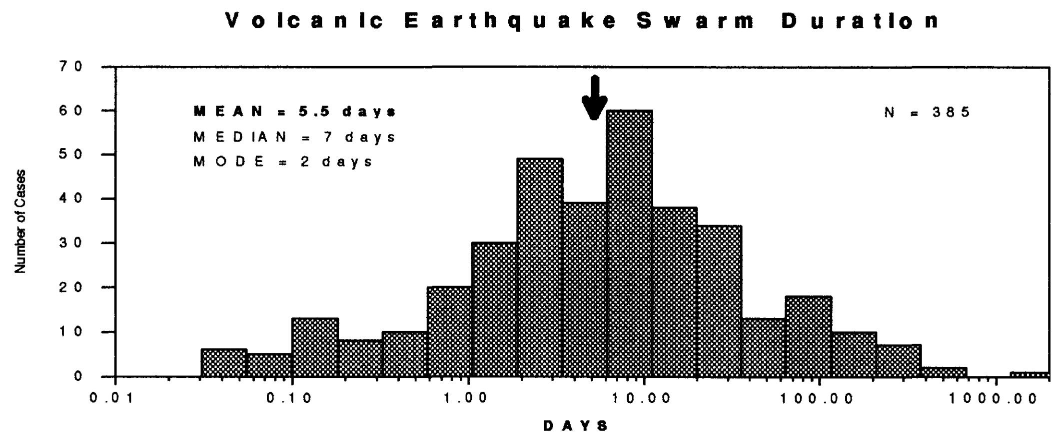

Figure 5. Histogram of the durations of 385 volcanic earthquake swarms. The horizontal axis is logarithmic. The data indicate a log-normal distribution (with a slight skew toward shorter durations) with a geometric mean of 5.5 days (marked with a bold arrow), a median of 7 days, and a mode of 2 days.

Swarm durations were then separated based on their relationship to eruptive activity: those which preceded eruptions (Type I) and those not associated with eruptions (Type III). The durations of Type I swarms tended to be longer than Type III swarms (fig. 6). The geometric mean durations were 8 and 3.5 days, respectively. The means of the duration distributions were found to be significantly different from one another, in other words the durations of each swarm type are drawn from different parent populations. The $\log_{10}$ transformed duration distributions for the two swarm types were again tested for normality. We found that the Type I swarm duration distribution is again not log-normal, while the Type III distribution is log-normal. As with the combined distributions, the Type I duration distribution is skewed towards shorter durations.

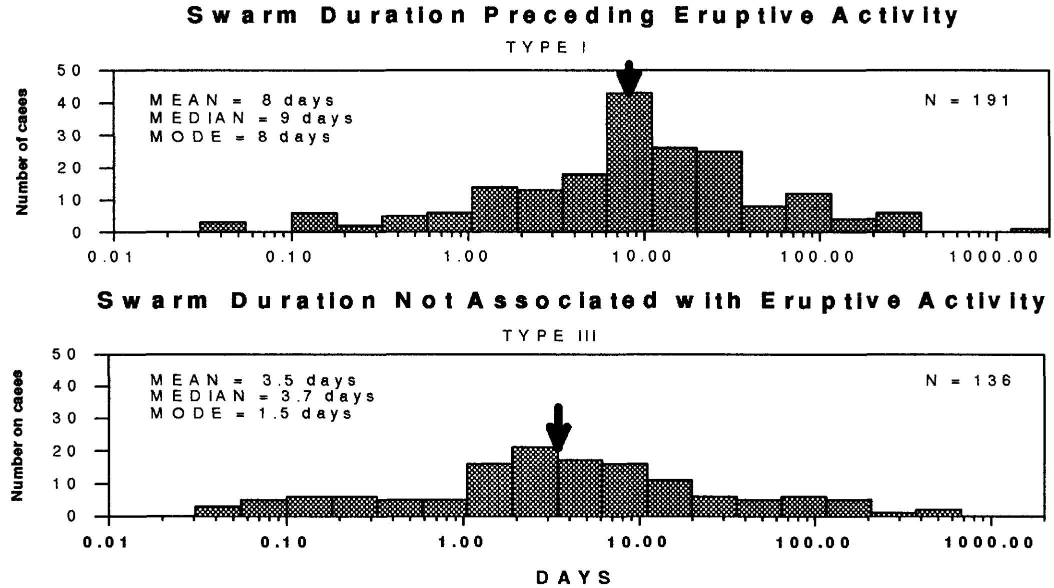

Figure 6. Comparison of the distribution of 191 earthquake swarm durations that precede eruptive activity (Type I) and 136 durations that are not associated with eruptive activity (Type III). The Type I swarm duration distribution is nearly log-normal, while the Type III distribution is log-normal. As with the combined distributions, the Type I duration distribution is skewed to the left. The geometric means are 8 and 3.5 days (marked with bold arrows), the medians 9 and 3.7 days, and the modes 8 and 1.5 days for Type I and III swarms respectively.

Earthquake Magnitude

Apart from swarm duration the next most commonly and reliably reported parameter is the magnitude of the largest shock (M_{max}). The database contains 113 magnitude records with high quality grades. The M_{max} values range from 0.5 to 6.2. The largest events in the database, M_s6.2 at Miyake-jima in 1983 and M6.0 at Oshima in 1986, occurred during large fissure eruptions. A M5.6 event at Soputan in 1985 is the largest event preceding an eruption in the database. The largest events occurring without a following eruption are a M_{JMA}5.7 at Unzen in 1984 and a M6.2 in Long Valley Caldera in 1980.

Although many magnitude scales are used in reporting these events, only the Russian energy class measurements were converted for comparison. The Russian energy scale K_s was converted to M using: $M = (K_s - 4.6)/1.5$; where M is the magnitude determined from surface waves; K_s is the mean energy class determined as the arithmetical mean from short-period S-waves of several stations (Gorelchik, 1989).

The mean of the M_{max} distribution for precursory swarms (Type I) is not significantly different from the mean for swarms not associated with eruptions (Type III) (fig. 7). The mean M_{max} is 3.2 for both precursory or Type I swarms and for non-precursory or Type III swarms. The Type I distribution is slightly more spread out than the Type III. The standard deviations of the distributions are 1.3 and 1.0 for Type I and Type III swarm respectively.

The eruptive character is used to divide Type I swarms into two groups. The shaded bars of the top histogram of figure 7 show events that preceded central vent eruptions, while the open bars are from swarms that preceded eccentric (flank) or radial fissure eruptions. With two exceptions, the eccentric and radial fissure eruptions are preceded by larger shocks than central vent eruptions.

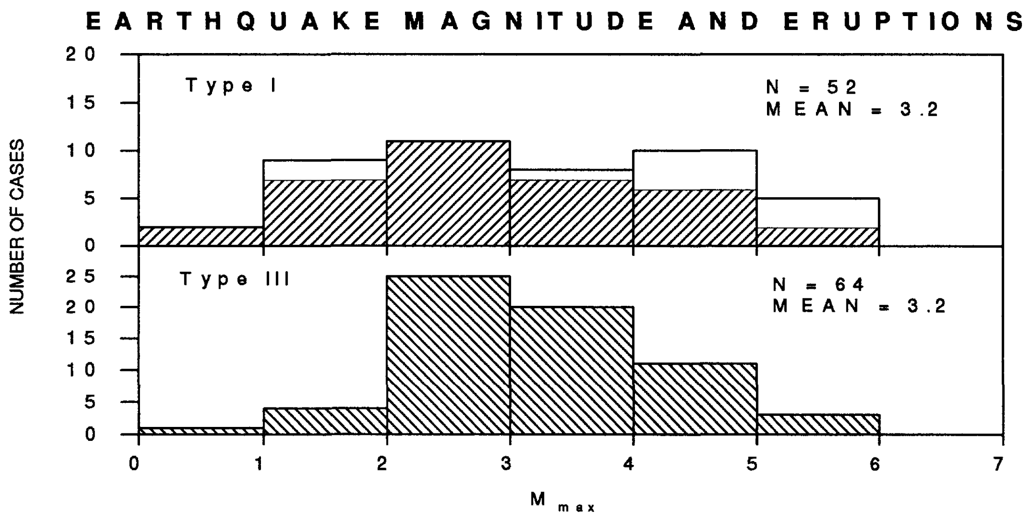

Figure 7. Comparison of the distribution of magnitude of the largest shock (M_{max}) within 53 swarms that precede eruptive activity (Type I) and 64 swarms that are not associated with eruptive activity (Type III). The striped bars are events that preceded central vent eruptions, while the open bars are from swarms that preceded eccentric (flank) or radial fissure eruptions. The M_{max} values plotted on the abscissa are the upper bound (inclusive) of each interval.

Data Limitations and Discussion

The observation that the mean duration of swarms that precede eruptions is about twice as long as swarms that are not associated with eruptions may be due to: 1) reporting bias, 2) mis-indentification of small tectonic mainshock-aftershock sequences as swarms, or 3) different time scales for the processes involved with transport of magma to the surface, when compared with intrusion or other transient forcing phenomena (tidal, barometric pressure fluctuations, seasonal ocean-loading, etc.).

Reporting bias is a possible source of error which must be considered when interpreting these results. The database was compiled primarily from the BVE where the emphasis is the reporting of eruptions. Therefore, there may be a tendency more frequently to report seismic activity associated closely with eruptions as opposed to swarms that occur at volcanoes with little or no historic activity. Furthermore, if an eruption occurs, the reporter may examine the preceding seismicity more rigorously, and perhaps include a longer period of time as the precursory seismicity.

The mean magnitude for the largest shocks in volcanic areas is about M3, based on data from 113 swarms at 61 volcanoes in the GVESD. Using aftershock decay parameters given by Reasenberg and Jones (1989) for tectonic earthquakes in southern California, the duration of an aftershock sequence following a M3 is about half a day and for a M4, 3.5 days. Thus, the durations of a small mainshock-aftershock sequences are similar to the mean duration of Type III swarms. In areas where the magnitudes are not available or not reliable, small tectonic earthquakes and their aftershocks may be reported as swarms.

The above problems of reporting bias and mis-identification are certainly factors in some of the reports. However, we believe that given a large sample size, these effects will not unduly bias the general result. With these limitations in mind, we can speculate that differing earthquake swarm durations are due to several suites of physical processes operating at different time scales. For example, the ascent of magma to the surface may express itself in longer lasting swarms, while intrusions or failed eruptions are manifested by shorter swarms. Other factors not directly associated with the movement of magma may also lead to shorter duration sequences of earthquakes. Volcanic and geothermal areas have been shown to be sensitive to small strains. Such strains can be generated by earth and ocean tidal stresses (Rydelek and others, 1988; McNutt and Beavan, 1981; Klein, 1976), body and surface waves from regional or teleseimic earthquakes (Hill et al., 1993), seasonal ocean-loading (McNutt and Beavan, 1987), or changes in barometric pressure (Rinehart, 1980).

Volcanic earthquake swarms, unlike tectonic mainshock-aftershock sequences, do not release the majority of seismic energy in the largest earthquake of sequence. Swarms, by definition, have one or more shocks of similar magnitude. Therefore, the seismic energy released during a swarm is spread over a longer period of time than tectonic mainshock-aftershock sequences. The difference in swarm duration distributions suggests that duration is more likely to reflect future eruptive activity than the magnitude of the largest event within a given swarm.

Improvements and Future Work

In designing this project we hoped to cast a wide net over seismological phenomena occurring at volcanoes. We found that the net had many holes; only very few parameters are frequently reported in the literature. Filling in the blanks of this current version of the database would be highly desirable. We believe that much of this data exists, but was never published. The next step is to contact the individual reporters and begin collecting this primary data.

The database would be improved by the addition of new high quality records. The number and quality of case studies on volcanic earthquake swarms have been steadily improving as more volcanoes are becoming monitored. The addition of the most recent swarms (occurring after 1989) will be given priority over the cases studied before 1979.

Along with the addition of more records, each record could be expanded to included summary figures such as; seismicity rate, time-depth, time-magnitude, earthquake location, and example seismograms. The database software that we are currently using does support fields that contain digital images. Future versions of the GVESD will incorporate these figures.

Future work with the GVESD will explore more fully the relationship between swarm parameters (such as the duration, M_{max}, and event types) and specific eruption parameters such as the Volcanic Explosivity Index, chemistry of the erupted products, eruption repose, volcano edifice height, etc. We are developing a generic volcanic earthquake swarm model which will provide a conceptual framework to interpret sequences or swarms of volcanic earthquakes which involve several different types of events. The GVESD will provide the data to explore the succession of particular event types within swarms and their durations.

Acknowledgments

We thank J. Lahr and C. Nye for providing helpful comments and suggestions which improved this report. We also thank L. Siebert for providing an advance of copy of the second edition of *Volcanoes of the World*. This work was supported by the Alaska Volcano Observatory under the US Geological Survey Volcano Hazards and Geothermal Studies Program, and by additional funds from the State of Alaska.

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Appendix A

<table>
<tr><th>ROSS-FOREL</th><th>MODIFIED MERCALLI</th><th>MSK (GEOFIAN)</th><th>JMA</th></tr>
<tr><td rowspan="3">1</td><td rowspan="2">1</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">2</td><td rowspan="5">1</td></tr>
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<tr><td rowspan="4">10</td><td>10</td><td rowspan="2">10</td></tr>
<tr><td rowspan="2">11</td><td rowspan="3">7</td></tr>
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<tr><td>12</td><td>12</td></tr>
</table>

from Newhall and Dzurisin (1988)

Mediterranean

CAMPI FLEGREI Italy

40.83N 14.14 E *VOTW num.*:0101-01=

Morphology: caldera *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 458 m *Edifice relief* : 650 m
Range of eruptive products:

SWARM DATE: 83/10/13 ±0.5 Dur. (days): 0.21 ±0.02 Type:3 Event type(s): Grade : B

Max. Magnitude: 3.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 250
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration : Y
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Change in seismic activity first noted Nov. 82. On Oct. 13 swarm of 250 events in 5 hours

Change in seismic activity first noted Nov. 82.
M3 earthquake in Mar. 83, uplift reached max. 5 mm/day in Oct. 83 seismicity trended with uplift. M4 earthquake on Oct. 4. On Oct. 13 swarm of 250 events in 5 hours max. M3.
Seismic network of 22 vertical machines. (for data analysis techniques see BVE No 23 p 55-56.)
Earthquakes of higher magnitude restricted in area (Solfatara field mean depth = 3 km). Figs: hypo. maps and daily number of earthquakes with strain release.
BVE No. 23, p. 55-56.

SWARM DATE: 84/4/1 ±0 Dur. (days): 0.21 ±0 Type:3 Event type(s): Grade : B

Max. Magnitude: 3.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 499
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: On Mar. 14 M4.0 on Apr. 1 a swarm of 499 events between 03:30 - 08:00

On Mar. 9 M3.9 earthquake, on Mar. 14 M4.0 and on Apr. 1 a swarm of 499 events between 03:30 - 08:00 with max. M= 3.0. On Apr. 3 a M3.5. From Jun.-Sept. 1984 10 events (M3.2-3.9) recorded. Figs: epicenter map and strain release.
BVE No. 24, p. 61-62.

SWARM DATE: 84/11/4 ±3 Dur. (days): 25 ±5 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increases in Nov.1984, in first week. Swarm lasted thur Nov. 1984

New increases in Nov.1984, in first week a M2.7 earthquake. On Nov. 8 events of M3.2, 3.2, 2.8, and 3.3 recorded in the Gulf of Pozzuoli. On Nov. 10 a M2.9 and Nov. 11 a M3.1. Swarm lasted through Nov. 1984 with other M2.0-3.1 events along with the uplift.
On Dec. 8 a M3.8 occurred after this seismicity decreased. Figs: epicenter map and strain release.

BVE No. 24, p. 61-62.

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1985

Since Jan. 1985, there has been no dectectable seismic activity at Campi Flegrei. The last M4 earthquake occurred in Dec. 1984.
BVE No. 26, p. 90.

CAMPI FLEGREI Italy		40.83 N 14.14 E *VOTW num.*:0101-01=
Morphology: caldera	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 458 m	*Edifice relief :* 650 m	
Range of eruptive products:		

SWARM DATE: 89/4/3 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: 2.2
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total : 82
\# Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Most significant was represented by the swarm of Apr. 3 when 82 shocks were recorded with max. ML2.2

In 1989, a ground uplift of about 8 cm was recorded from Mar. 14 to Jun. 10. In coincidence with the new upward ground motion phase, a total 316 seismic events were recorded. The most significant was represented by the swarm of Apr. 3 when 82 shocks were recorded with max. ML 2.2 and the foci located in the Solfatara area.

BVE No. 29, p. 90.

Communication from : G. Ricciardi, Observatorio Vesuviano, Via A. Manzoni 249,80138 Napoli, Italy.

SWARM DATE: 89/6/15 ±15 Dur. (days): 15 ±15 Type:3 Event type(s): Grade : C

Max. Magnitude: 2.7
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total : 174
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Activity occured in June when 174 events, 75 of which crossed instrumental threshold, were recorded.

The activity occured in June when 174 events, 75 of which crossed instrumental threshold, were recorded. The max. M2.7 took place on June 6 and was located in the Solfatara area which actually appeared to be the most active seismic area during this final upward bradyseism phase.

BVE No. 29, p. 90.

Communication from : G. Ricciardi, Observatorio Vesuviano, Via A. Manzoni 249,80138 Napoli, Italy.

STROMBOLI Italy 38.79N 15.21 E *VOTW num.*:0101-04=
Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 926 m *Edifice relief :* 2700 m
Range of eruptive products: basalt

SWARM DATE: 83/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: temporary
Max. Intensity: MM at # Felt total : Dist. to vent: 0.14 km
Depth (km): ± b-value : Type: Mark L4C
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1983.

Mirco-tremor =35um/s at 0.15km from vent.

BVE No. 23, p. 7.

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph:
Max. Intensity: MM at # Felt total : 0 Dist. to vent:
Depth (km): ± b-value : Type:
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1985.

Unfelt shocks and micro-tremors: recorded

BVE No. 26, p 1.

SWARM DATE: 85/11/18 ± Dur. (days): 18 ± Type:1? Event type(s): Grade : C

Max. Magnitude: 2.9 # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : 1 Dist. to vent: 1.8 km
Depth (km): ± b-value : Type: Geotech S-13
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: One shock felt (on Nov. 18) 18 days before the eruption. M2.9

Unfelt shocks: recorded.

BVE No. 25, p. 7-8.

SWARM DATE: 88/6/10 ±5 Dur. (days): 52 ±5 Type:1dq Event type(s):E Grade : C

Max. Magnitude: 2.5 # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : 1 Dist. to vent: 1.8 km
Depth (km): ± b-value : Type: Geotech S-13
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Seismic activity, which was essentially related to the Strombolian explosions

Seismic activity, which was essentially related to the Strombolian explosions, had marked fluctuations in the daily number of events through the year (Fig. 1-2 in BVE No. 28). In particular, July activity was characterized by the large number of high amplitude shocks, though their magnitude was always lower than 2.5.
The strongest explosion, which was felt by the inhabitants of the island, was recorded at the Ginostra station and by all the seismographs of the Aeolian Islands Seismic Network. The phenomenon was followed by a temporary decrease in the number of shocks which had their minimum in the first days of September.

BVE No. 28, p. 1-4.

STROMBOLI Italy		38.79N 15.21 E	*VOTW num.*:0101-04=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin	
Elevation above m.s.l. : 926 m	*Edifice relief :* 2700 m		
Range of eruptive products: basalt			

SWARM DATE: 89/3/7 ± Dur. (days): ± Type:2a? Event type(s):E Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.8 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Geotech S-13	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 1 K	Geothermal :	

Key phrase: Place holder for 1989.

Four powerful explosive sequences occurred on March 7, 20, 26, and April 3. The seismic traces of these phenomena had durations ranging between 3 and 11 minutes The seismic record also showed that several explosions were accompanied by tremors with a relatively high amplitude which slowly vanished with time. Figure of temporal distribution of seismic shocks p. 9 of BVE No 29.

BVE No. 29, p. 7-9.

Falsaperla, S., Montalto, A., Spampinato, S. (1989): Analysis of seismic data concerning explosive sequences on Stromboli volcano in 1989. Bull. G. N. V., 1, 249-258. Smithsonian Institution (1990): Bull. GVN vol 15, no 8, 13-14; no 9, 13.

VULCANO Italy

38.40 N 14.96 E *VOTW num.*:0101-05=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 500 m *Edifice relief :* 1500 m
Range of eruptive products: basalt to rhyolite

SWARM DATE: 85/4/15 ±15 Dur. (days): 120 ±15 Type:3 Event type(s): Grade : B

Max. Magnitude: 2.5
Max. Intensity: MM at
Depth (km): 1 ±1
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A micro-earthquake swarm occurred between Apr. and Aug.

A micro-earthquake swarm occurred between Apr. and Aug. 1985 at Vulcano. It consisted of shallow (less than 2 km deep) shocks mainly localized in the northern part of the isle, around the VCR station (Fig. 1, BVE No. 25, p. 57), where the most recent volcanic structures are present. The epicenters appear quite dispersed so that it is not possible to correlate seismic activity with a specific structural system.
The swarm peaked in May with about 18 events per day (Fig. 2a BVE), although the occurrence frequency of the most energetic shocks reached a maximum in Jul. (Fig. 2b BVE). Since May a more pronounced dispersion of the epicenters was observed with respect to the VCR area, together with an increase of the focal depth. During the whole sequence, magnitude was always less than 2.5 and the seismic stations which detected the activity were only those located on the Lipari - Vulcano islands. A cluster of tectonic events with maximum magnitude 2.7 was localized very near to Vulcano (<10 km) a fortnight before the swarm.
The waveform analysis indicates that the events were due to both fracturing and degassing phenomena.
Low-frequency and irregular waveform earthquakes were lacking. That may be interpreted as a preliminary indication that no fracturing phenomenon occurred near the magma and significant variations of the magma level may be excluded.

BVE No. 25, p. 57.
Communication from: S. Falsaperla and G. Neri, Istitut. Internazionale di Vulcanologia, V. le Regina Margherita, 6 - 95123 Catania, Italy.

SWARM DATE: 86/12/20 ±3 Dur. (days): 190 ±10 Type:3 Event type(s): Grade : C

Max. Magnitude: 3.7
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration is taken off figure (BVE No. 27, p 81)

Seismic activity increased in Dec., leading to a peak in mid-July 1987.

BVE No. 26, p. 79.
BVE No. 27, p. 81.

VULCANO Italy 38.40N 14.96 E *VOTW num.*:0101-05=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 500 m *Edifice relief :* 1500 m
Range of eruptive products: basalt to rhyolite

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1987.

A slight increase in the hourly occurrence frequency of the local seismic events recorded at the VCR station on the island of Vulcano was observed in the last few months of 1986. A similar tendency had been present during 1987 with a maximum which was reached in the middle of July (Fig. 2, BVE No. 27, p.81). In spite of the high number of shocks recorded at VCR, which is located very close to the most recent volcanic apparatus of the island, the energy release associated with this phenomenon seems to have been quite low and the mechanism of generation did not show any change, being related to both fracturing and degassing processes. By the end of July the occurrence frequency returned to quite low levels, although little fluctuations were present. As a deep drilling was carried out very close to the seismic station for geothermal investigations, a gap exists in the data set between 9 February and 5 May. During this time and in the whole examined period the tectonic seismicity in the island and in an area 40 km wide around it was quite low and the magnitude did not exceed 3.7.
fig: station map

BVE No. 27, p. 81.

SWARM DATE: 88/8/9 ±0.5 Dur. (days): 5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: 2.5	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): 2 ±2	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: A seismic swarm started on Aug. 9 (first phase deep foci up to 4 km)

A seismic swarm started on Aug. 9 after a progressive increment in the number of the local shocks from Aug. 6. The phenomenon, recorded at all the stations on Vulcano of the Aeolian Island Seismic Network, had a spatial evolution characterized by two phases: in the first one, from 9 to 14 of Aug. the events were located in the southern part of the island and had quite "deep" foci (up to 4 km). During the second phase, which lasted in September, the shocks mainly occurred in the northern part (Gran Cratere) of Vulcano and had shallow foci (<= 1.5 km). The maximum magnitude, reached during the first phase of the swarm, was 2.5, but due to the relevant number of shocks with magnitude >= 1.8, the energy release associated with the swarm was quite high in comparison to previous similar episodes recorded in the last 10 years. In addition to this, the tectonic activity in an area of about 30 km around Vulcano was characterized, between Mar. and Jun., by a large number of earthquakes with maximum magnitude 4, located at SW of the island. Fig: earthquake counts for 1988 and Jul. 1 -Sep 30.

BVE No. 28, p. 88.

SWARM DATE: 88/8/17 ±0.5 Dur. (days): 27 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): .7 ±.7	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Duration taken from figure on p 88 BVE (second phase shallow foci <=1.5 km depth)

See Aug. 8, 1988 for additional comments.

BVE No. 28, p. 88.

VULCANO Italy		38.40 N 14.96 E *VOTW num.*:0101-05=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 500 m	*Edifice relief :* 1500 m	
Range of eruptive products: basalt to rhyolite		

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: 2.5	# EQ total : 18	Seismograph:	Tremor :	Migration :
Max. Intensity: MM at	# Felt total : 0	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Place holder for 1989

No anomalous seismic phenomenon was recorded throughout the year. At station VCR 18 tectonic earthquakes with magnitude < 2.5 and origin in an area of 30 km around the island. Fig: seismicity rates. BVE No. 29, p. 91.

BVE No. 29, p. 91.

S. Falsaperla, Istituto Internazionale, Piazza Roma 2, 95123 Catania, Italy

ETNA Italy — 37.73N 15.00 E — *VOTW num.*:0101-06=

Morphology: strato or composite — *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3290 m — *Edifice relief :* 2300 m
Range of eruptive products: basalt

SWARM DATE: 79/8/3 ±0.5 Dur. (days): 4 ±1 Type: Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.3
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 2 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Series of shocks on 3rd and 6th of Aug.

Series of shocks on 3rd and 6th of Aug. felt and unfelt shocks were recorded.

BVE No. 19, p. 10-11.

SWARM DATE: 80/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1980.

Felt, and unfelt shocks: occurred. Micro-tremor: occurred.

BVE No. 20, p. 10-11.

SWARM DATE: 81/3/12 ±0.5 Dur. (days): 6 ±1 Type:1aq Event type(s):B Grade : A

Max. Magnitude:
Max. Intensity: MM IV at
Depth (km): ±
Detection threshold:1.3
Cum. energy release:

EQ total : 1350
Felt total : 6
b-value : 2.5
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity : Y
Magnetic : Y
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Duration from fig. in Gresta and Patane

Fore-running phenomena (except for N. flank erupt. Mar. 1)
Unfelt: occurred
Micro-tremors: occurred, increase in ground temp: occurred.
Fore-running phenomena for N flank eruption (Mar. 17-23, 1981)
Felt: occurred, freq. = 3/day, from 2 days prior
Micro-tremors: recorded, 3 day duration
Increase in ground Temp: occurred, tilt observed from 1 month prior.

Gresta, S. and Patane, G., Variation of b values before the Etnean eruption of March 1981, PAGEOPH, vol. 121, no. 2, 1983.
BVE No. 21, p. 10-13.

ETNA Italy		37.73N 15.00 E *VOTW num.*:0101-06=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 3290 m	*Edifice relief :* 2300 m	
Range of eruptive products: basalt		

SWARM DATE: 83/1/22 ±0.5 Dur. (days): 53 ±2 Type:**1b?** Event type(s):B Grade : **A**

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total : 650	Seismograph: permanent		
Max. Intensity: MM III at	# Felt total :	Dist. to vent: 2 km	Tremor : Y	Migration :
		Type: Willmore	Deformation : Y	Focal mech:
Depth (km): 6 ±9	b-value : 1.4	Component : Z	Gravity : Y	EQ families :
Detection threshold:1.3	Repose (yr.):	Natural period : 1 s	Magnetic : Y	Rumbling :
Cum. energy release:	Previous swarms : Y	Magnification : 4 K	Geothermal :	

Key phrase: Duration from: Gresta and Patane 1983. Mar. 26, 27, 1983 violent seismic crisis preceded opening on S. flank of eruptive fissure on Mar. 28.

Mar. 26, 27 1983 violent seismic crisis preceded opening on S. flank of eruptive fissure on Mar. 28.
Felt shocks: from 2 days prior to 3/28 eruptivity, MM 3.3
Unfelt shocks: from 2 days prior.
3 day duration of micro-tremors.

Gresta, S. and Patane, G., Changes in b value before the Etnean eruption of March-August 1983, PAGEOPH, vol. 121, 5/6, 1983.
Patane, G., et al., Seismic activity preceding the 1983 eruption of Mt. Etna, Bull. Volcanol., vol. 47-4 (2), 1984
BVE No. 23, p. 8-10.

SWARM DATE: 84/4/27 ± Dur. (days): 0 ± Type:4 Event type(s): Grade : **A**

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor :	Migration :
		Type: Willmore	Deformation :	Focal mech:
Depth (km): ±	b-value :	Component : Z	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Natural period : 1 s	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Magnification : 4 K	Geothermal :	

Key phrase: An eruption strated at a summit vent (SE crater) on Apr. 27, and was not preceded by a seismic crisis.

An eruption strated at a summit vent (SE crater) on Apr. 27, and was not preceded by a seismic crisis, contrary to what was observed for many recent flank eruptions.

Gresta. S. et al., The October 1984 seismic crisis at Mount Etna. Part I : Space-time evolution of the events, Annales Geophysicae, 1987, 5B, (6), 671-680.

ETNA Italy 37.73N 15.00 E *VOTW num.*:0101-06=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3290 m *Edifice relief* : 2300 m
Range of eruptive products: basalt

SWARM DATE: 84/10/16 ±1 Dur. (days): 15 ±1 Type:1e Event type(s): Grade : A

Max. Magnitude: M 4.2
Max. Intensity: MM at
Depth (km): 10 ±10
Detection threshold: 2.0
Cum. energy release: 4.0e+11 J

EQ total : 271
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic : Y
Geothermal : Y
Migration :
Focal mech: Y
EQ families :
Rumbling :

Key phrase: Duration from: table 8 in Gasperini, P. et al. (1992)

A sharp increase in the number of earthquakes started in the afternoon of Oct. 16 and was followed by relatively still period (in the morning of Oct. 17). The greatest number of the shocks was concentrated in a second time span (Oct. 17 08:00-Oct. 18 12:00) which ended with the occurrence of a M4.2 event on the northeastern side of the volcano. A third shock M4.2 shock located on the eastern flank seriously damaged the village of Zafferana Etnea (Oct. 19 17:43). The following time evolution of the crisis does not show particular peaks in the earthquake frequency, even after an another strong event (M3.9 Oct. 25 at 01:11) occurred on the eastern flank. For all the considered period a set of about 500 (well located) events [rms<0.5 s, erh < 3 km, erz < 5 km]. Detailed descriptions of six "sub-periods" are given in the Gresta 1987 reference.

Gasperini, P. et al., Time and space clusting of Etna volcano earthquakes during the period May 1983-February 1987, JVGR, 52 (1992) 297-307.
Gresta. S. et al., The October 1984 seismic crisis at Mount Etna. Part I : Space-time evolution of the events, Annales Geophysicae, 1987, 5B, (6), 671-680.
BVE No. 24, p. 8-9.

SWARM DATE: 85/3/12 ±0.25 Dur. (days): 0 ± Type:4 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 1.3
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 2 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Lava flow was emitted without any explosive or seismic activity.

Mar. 8 - Jul. lava eruptions on the S flank. Scant seismic info.

BVE No. 25, p. 8-10.

ETNA Italy 37.73N15.00 E *VOTW num.*:0101-06=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3290 m *Edifice relief :* 2300 m
Range of eruptive products: basalt

SWARM DATE: 85/12/22 ±0.5 Dur. (days): 31 ±1 Type:1d Event type(s):VT Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:3.0
Cum. energy release:

EQ total : 40
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration : N
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from table 9 in Gasperini (1992). On Dec. 25 preceded by a "seismic crisis" a fissure opened.

Felt and unfelt shocks occurred. No coherent spatial migration of the cluster has been found.

Gasperini, P. et al., Time and space clusting of Etna volcano earthquakes during the period May 1983-February 1987, JVGR, 52 (1992) 297-307.
BVE No. 25, p. 8-10.

SWARM DATE: 86/5/8 ±0.5 Dur. (days): 5 ±1 Type:1e Event type(s):VT Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:3.0
Cum. energy release:

EQ total : 14
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from table 9 in Gasperini (1992).

Felt shocks occurred; Unfelt and Microtremors were recorded. No coherent spatial migration of the cluster has been found.

Gasperini, P. et al., Time and space clustering of Etna volcano earthquakes during the period May 1983-February 1987, JVGR, 52 (1992) 297-307.
BVE No. 26, p. 3-5.

SWARM DATE: 86/10/2 ±0.5 Dur. (days): 10 ±1 Type:1e Event type(s):VT Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:3.0
Cum. energy release:

EQ total : 13
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: premanent
Dist. to vent: 2 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration : Y
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from table 9 in Gasperini (1992).

No coherent spatial migration of the the cluster has been found.

Gasperini, P. et al., Time and space clusting of Etna volcano earthquakes during the period May 1983-February 1987, JVGR, 52 (1992) 297-307.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 6 km
Type: Willmore
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1987

Felt shocks: occurred
Unfelt shocks: recorded
Micro-tremors: recorded
BVE No. 27, p. 2-3.

ETNA Italy

37.73N 15.00 E *VOTW num.*:0101-06=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3290 m *Edifice relief :* 2300 m
Range of eruptive products: basalt

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1988

During 1988 the seismicity been somewhat low. Higher frequency of the events occurred only in April (in particular) and June. The most energetic event was recorded on June 19. In the end of June an increase in amplitude of the micro-tremors was also recorded.

BVE No. 28, p. 2-4.

SWARM DATE: 89/7/27 ±0.5 Dur. (days):<1 ± Type:1a? Event type(s): Grade : B

Max. Magnitude: M 2.8
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.5
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type: Various
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarms with magnitudes more than 1 occurred on Jul. 27.

Events localized on the east flank in the first 3 months of the year M=3.5 on Jan. 29. Other significant events were observed except on May 6 and Jun. 28 ~M3. A deep event occurred on Jul. 8 (M=2.8) in side the Valle del Bove, was the beginning of a period of high seismicity. Swarms with magnitudes more than 1 occurred on Jul. 27 and on Aug. 3, and much shallower an Aug. 17-18, 21, and 26-28. No relevant seismic activity was observed until the beginning of eruptive activity from the SE crater. During the eruptive events a big swarm (events with >M3) was recorded on Sept. 23-24. Micro-seismic activity took place on Sept. 27 related to the opening of an eruptive fissure. Another swarm of shallow events observed after Sept. 30 related to the propagation of the final part of fracture towards SSE. The highest frequency of events Oct. 2 when the propagation of the fracture finished. No more signs of seismic activity, except for a seismic event on Dec. 9 (M=2.8) and a little swarm on Dec. 27.

BVE No. 29 p. 10-13.
Mastrolorenzo, G., Caltabiano, T., Kilburn CRJ, Romano R, Luongo, G. (1990): Eruptive patterns and magma ascent, Mt. Etna, Sicily. Poster IAVCEI International Volcanological Congress, Mainz.

SWARM DATE: 89/8/3 ±0.5 Dur. (days):<1 ± Type:1a? Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.5
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarms with magnitudes more than 1 occurred on Aug. 3

See Jul. 7 comments.

BVE No. 29 p. 10-13.
Mastrolorenzo, G., Caltabiano, T., Kilburn CRJ, Romano R, Luongo, G. (1990): Eruptive patterns and magma ascent, Mt. Etna, Sicily. Poster IAVCEI International Volcanological Congress, Mainz.

ETNA Italy

37.73N 15.00 E *VOTW num.*:0101-06=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3290 m *Edifice relief* : 2300 m
Range of eruptive products: basalt

SWARM DATE: 89/8/17 ±0.5 Dur. (days): 9 ±1 Type:1aq Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent	Tremor :	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:1.5	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Swarms with magnitudes more than 1 occurred on Aug. 17-18.

Swarms with magnitudes more than 1 occurred on July 27 and on Aug. 3, and much shallower an Aug. 17-18, 21, and 26-28. No relevant seismic activity was observed until the beginning of eruptive activity from the SE crater. See July 89 for further comments.

BVE No. 29 p. 10-13.

Mastrolorenzo, G., Caltabiano, T., Kilburn CRJ, Romano R, Luongo, G. (1990): Eruptive patterns and magma ascent, Mt. Etna, Sicily. Poster IAVCEI International Volcanological Congress, Mainz.

SWARM DATE: 89/9/23 ±0.5 Dur. (days): 2 ±0.5 Type:2a Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total : 10	Seismograph: permanent	Tremor :	Migration : Y
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): 20 ±5	b-value :	Type:	Gravity :	EQ families :
Detection threshold:1.5	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: A big swarm (events with M>3) was recorded on Sept. 23-24.

During the eruptive events a big swarm (tens of deep(>=15 km) events with M>3) was recorded on Sept. 23-24. See July 89 for comments.

BVE No. 29 p. 10-13.

Mastrolorenzo, G., Caltabiano, T., Kilburn CRJ, Romano R, Luongo, G. (1990): Eruptive patterns and magma ascent, Mt. Etna, Sicily. Poster IAVCEI International Volcanological Congress, Mainz.

Castellano, M., et al., Upward migration of seismic focii: A forerunner of the 1989 eruption of Mt. Etna (Italy), Bull. Volcanol. (1993) 55:357-361.

SWARM DATE: 89/9/30 ±0 Dur. (days): 3.5 ±0.5 Type:1e? Event type(s):VT Grade : A

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: ML2.5	# EQ total :	Seismograph:	Tremor :	Migration : Y
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech: Y
Depth (km): 5 ±5	b-value :	Type:	Gravity :	EQ families :
Detection threshold:1.5	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Duration from Ferrucci (1993)

Some hundreds of shallow (30 Sept.-3 Oct.) events were observed before the end of the eruption.

Ferrucci, F., et al., Mt. Etna: a model for the 1989 eruption, JVGR, 56 (1993) 35-56.

Castellano, M., et al., Upward migration of seismic foci: A forerunner of the 1989 eruption of Mt. Etna (Italy), Bull. Volcanol. (1993) 55:357-361.

SWARM DATE: 89/12/27 ±0.5 Dur. (days):<1 ± Type:3 Event type(s): Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent	Tremor :	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:1.5	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: A little swarm on Dec. 27.

See July 89 for comments.

BVE No. 29 p. 10-13.

Mastrolorenzo, G., Caltabiano, T., Kilburn CRJ, Romano R, Luongo, G. (1990): Eruptive patterns and magma ascent, Mt. Etna, Sicily. Poster IAVCEI International Volcanological Congress, Mainz.

Africa and the Red Sea

NYAMURAGIRA Africa-C		1.38 S 29.20 E	*VOTW num.*:0203-02=
Morphology: shield	*Tectonic framework:*	Divergent Rift Continental	
Elevation above m.s.l. : 3465 m	*Edifice relief :* 2005 m		
Range of eruptive products:			

SWARM DATE: 80/2/5 ±0 Dur. (days):>20 ± Type:2b? Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 95 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:2.3	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal :

Key phrase: From Feb. 2 to 25 Seismicity was recorded on temporary array.

A (confined to zone elongated southward from caldera) and B-type (confined to caldera around) events recorded at 3 stations at Katale (KTL), Bulengo (BLG) & Lubogo (LBG). Long period micro-tremors correlated with lava extrusion and preceded opening of new vent. Sharply decline after Feb. 22 announcing end of lava rise on Feb. 23. Formed new scoriae cone, =120m height.
Fig: Station map.
BVE No. 20, p. 13-14.

SWARM DATE: 81/12/25 ±0 Dur. (days): 0.13 ±0.02 Type:1b Event type(s):VE Grade : B

Max. Magnitude: 1.3	# EQ total : 20	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 100 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Volcanic earthquakes started to occur at 18:26 Dec. 25.

Short period Benioff seismographs at Lwiro 95 km S recorded tremor 3 hrs. prior to eruption. Volcanic earthquakes > 1.3 started to occur successively at 18:26 Dec. 25. Volcanic tremors increased rapidly at the same time.
BVE No. 21, p. 14-15.

SWARM DATE: 82/1/6 ± Dur. (days): ± Type:1d? Event type(s):t Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 100 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Benioff short period	Deformation : Y Focal mech:
Detection threshold:1.4	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: High mirco-earthquake activity occurred for long time near new cone after eruption.

Evening of Jan. 6,1982 a seismograph 1.2 km SSE recorded varying amplitude volcanic tremor originating from lava fountianing. Type of tremor changed with change in eruptivity from lava fountianing to Strombolian type (Tremor change = continuous to isolated). As eruption declined amplitudes of tremor decreased monotonically up to Jan. 14 when eruptivity ceased. High micro-earthquake activity occurred for long time near new cone after eruption. Fig: max. tremor ampl. variation.
BVE No. 22, p. 12-14.

SWARM DATE: 84/2/23 ±0.5 Dur. (days): 0.1 ±0.02 Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Katsushima short per	Deformation : Focal mech:
Detection threshold:0.8	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Place holder from tremor observations.

Tremor observed (continuous volcanic). It appeared that outburst took place 2-3 hrs. before fissure eruption. Figs: Max. ampl. tremor daily and hourly.
BVE No. 24, p. 10-11.

NYAMURAGIRA Africa-C		1.38 S 29.20 E	*VOTW num.*:0203-02=
Morphology: shield	*Tectonic framework:*	Divergent Rift Continental	
Elevation above m.s.l. : 3465 m	*Edifice relief :* 2005 m		
Range of eruptive products:			

SWARM DATE: 86/7/16 ±0.02 Dur. (days): 0.54 ±0.02 Type:1b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 100 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Benioff short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal : Y

Key phrase: A swarm of earthquakes preceded the eruption by 13 hours

Unfelt and micro-tremors: occurred 13 hours before the eruption, 60-100 events/hour. At the end of Jul. remarkable continuous seismic tremors were observed at 450 m from the vent. From the early morning of 18 Aug. the mode of eruption changed from the continuous lava fountaining to Strombolian type and the type of seismic tremors also changed from continuous to isolated ones. Then, the eruptions and the amplitude of the tremor decreased monotonously up to the early morning of 20 Aug.

BVE No. 26, p. 6-7.

SWARM DATE: 87/11/1 ±0.5 Dur. (days): 30 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 100 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Benioff short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: A gradual increase in the frequency of volcanic earthquakes occurred about one month before the eruption

no new seismic information in 1988 BVE - Felt shocks: none. Unfelt: recorded; A gradual increase in the frequency of volcanic earthquakes occurred about one month before the eruption (see BVE No. 27). fig. daily counts May 1987-May 1988.

BVE No. 27, p. 5-6.
BVE No. 28, p. 10.

SWARM DATE: 89/4/24 ±0 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total : 0	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Katsushima PK110	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): 1.33	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling : Y
		Magnification : 1 K	Geothermal :

Key phrase: Place holder tremor information in 1989.

On April 24, at 13:18(LCT), a fissure eruption started in the summit caldera (Figs. 4-1 and 2) after a dormancy of one year and four months. The eruption was clearly recognized by the appearance of continuous tremor on the seismograph at KTL (Fig. 4-2) and witnessed by habitants. The climax of the eruption was between 22:00 on April 29 and 04:50 on April 30. The max. amplitude of volcanic tremor was recorded during this climax. Station map on p. 18 of BVE No. 29.

BVE No. 29, p. 17-18.

NYOS, LAKE Africa-W		6.43 N 10.30 E *VOTW num.*:0204-003
Morphology: caldera	*Tectonic framework:*	Divergent Rift Continental
Elevation above m.s.l. :	*Edifice relief :*	
Range of eruptive products:		

SWARM DATE: 86/8/21 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling : Y
		Magnification :	Geothermal :

Key phrase: "Earth began to tremble. Water was agitated."

A series of rumbling sounds were heard from the lake. "Earth began to tremble. Water was agitated."

BVE No. 26, p. 8-10.

Arabia and the Indian Ocean

FOURNAISE, PITON DE LA	Indian O.-W	21.23S 55.71 E	*VOTW num.*:0303-02=	
Morphology: shield		*Tectonic framework:*	Oceanic Hot Spot	
Elevation above m.s.l. : 2631 m		*Edifice relief :*		
Range of eruptive products: basalt				

SWARM DATE: 81/1/21 ±0.5 Dur. (days): 13 ±1 Type:1b Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.3 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y	Focal mech:
Detection threshold:0.5	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 20 K	Geothermal :	

Key phrase: Eruption preceded by 13 days of sustained seismicity

Eruption preceded by 13 days of sustained seismicity and ground deformations. Unfelt: freq. = 5-100's per day from 13 day prior.

BVE No. 21, p. 16-17.

SWARM DATE: 83/11/20 ±0.5 Dur. (days): 14 ±1 Type:1b Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total : 50	Seismograph: permanent		
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): 2.25 ±.75	b-value :	Type: Mark L4C	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.): 2.58	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Dec 4, 1983 precursors limited to 2 weeks shallow (1.5-3 km depth) seismic crisis

Precursors include 2 weeks shallow (1.5-3 km) seismicity of <50 events. No long term increase of local seismicity (no long term deformation also) have preceded the eruption. Phase I and II outbreaks preceded by short (2.5 and 1.5 hrs.) swarms corresponding to magma intrusion. Some deformation measured with emplacements. Unfelt shocks: 1-10/day, S-P duration 1 sec. from 14 days prior. No tremors recorded.

BVE No. 23, p. 11-12.

SWARM DATE: 85/5/15 ±0.5 Dur. (days): 29 ±1 Type:1b Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: 1.0	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total : 0	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Begining on 15 May, several small earthquakes recorded. Seismic activity peaked on 8 June, and decreased to a low level on 13 June.

The earthquakes (M< 1) were recorded at depths of 1.5-2.5 km beneath the summit. Simultaneously, the summit dry-tilt stations began to show an inflationary pattern. The eruption began on 14 Jun. 16:04. The seismic events clustered at depths ranging from 1 to 2.5 km, beneath the same area as the center of inflation, at the NW of the main summit crater (Dolomieu). The shallowness and small lateral extension of the seismicity, and the short wavelength of the deformation showed that the focus of magmatic pressure was shallow and restricted to a small volume. The outbreak was preceded by an intrusive crisis less than one hour duration, characterized by strong seismic activity and by rapid deformation. The intrusion reached the surface along a SW-NE system of fissures in line with the epicentral zone.

BVE No. 25, p. 10-12

BVE No. 26, p. 75-76.

SEAN Bull. vol. 10, no. 5, p. 3-4, 1985.

FOUNDAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 85/8/5 ±0 Dur. (days): 0.13 ±0.02 Type:1c Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 200
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: On 5 Aug. at 22:50 a new intrusive seismic swarm began at shallow depth beneath the summit area and > 200 events were recorded in < 3 hours.

The eruption began 5 Aug. 23:40. ended 1 Sep. Seismic tremor lasted for 10 days at a very low level.

BVE No. 25, p. 10-12.
SEAN Bull. vol. 10, no. 7, p. 8-9, 1985.

SWARM DATE: 85/9/6 ±0 Dur. (days): 0.05 ±0.02 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 1 ±
Detection threshold:
Cum. energy release:

EQ total : 30
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A very short seismic crisis began on 6 Sep. at 1408. After events 3 fissures opened.

Similar to the Jun. and Aug. eruptive episodes, seismic events were center under Dolomieu and Soufriere, a 1 km depth.

BVE No. 25, p. 10-12.
SEAN Bull. vol. 10, no. 7, p. 8-9, 1985.

SWARM DATE: 85/12/2 ±0 Dur. (days): 0.01 ±0 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A very short seismic crisis occurred. For 17 minutes, very shallow low magnitude events occurred.

The events occurred under Dolomiew Crater at depths of 0.5-1.5 km. Then a 1.5 km fissure opened and lasted 28 hours. The volume of basalt emitted was very small.

BVE No. 25, p. 10-12.
SEAN Bull. vol. 10, no. 7, p. 8-9, 1985.

SWARM DATE: 85/12/25 ±0.5 Dur. (days): 4 ±1 Type:1c Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 2 ±1
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Since 25 Dec. some deeper events have occurred under the summit zone (1-3 km).

Since 25 Dec. some deeper events have occurred under the summit zone (1-3 km). On 28 Dec. the 2 strong events (20 s) were recorded on the whole seismic net (11 stations) followed by a few events on the 29th. During the evening of the 28th very small events were noticed at the summit station, followed by a very short crisis (18:36-18:50) and opening of fractures inside the Dolomieu crater (18:54-18:57).

BVE No. 25, p. 10-12.
SEAN Bull. vol. 10, no. 7, p. 8-9, 1985.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief* :
Range of eruptive products: basalt

SWARM DATE: 86/2/11 ±0.5 Dur. (days): 1.5 ±0.5 Type:1a? Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 3 ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4C
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation : Y
Gravity :
Magnetic : Y
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A short seismic crisis was recorded 11-12 Feb. with events located E of the summit at about 3 km depth.

BVE No. 26, p. 10-12.
Delorme, et al.; The March 1986 eruptive episodes at Piton de la Fournaise volcano. Jour. Volc. Geothermal Res., vol. 36, 1989
SEAN Bull. vol. 11, nos. 1,2,3,4,6,7,11,12

SWARM DATE: 86/3/17 ±0 Dur. (days): 0.06 ±0 Type:3i Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 3 ±1
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4C
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation : Y
Gravity :
Magnetic : Y
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A seismic crisis began at 21:17 with sudden increase in intensity after 22:46, ending at 23:16 without eruption.

In late Feb. and the first half of Mar. the volcano was quiet. On 17 Mar., intermediate depth events (2-4 km below sea level), located under the ESE flank. Interpreted as intrusive event.
BVE No. 26, p. 10-12.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 86/3/19 ±0 Dur. (days): 10 ±1 Type:1d Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor : Migration : Y
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification :	Geothermal :

Key phrase: Low magnitude events became dominate between 05:00 and 06:40, on 19 Mar. Seismicity continued until 29 Mar. 22:38 when a phreatic explosion occurred.

After the intrusive event of Mar. 17, the seismicity continued at shallow depth below the summit as well as at -2 to -5 km beneath the E flank, in the SE part of the Enclos Fouque caldera. Some events were recorded on the south edge of the caldera, indicating a SSE shifting of the micro-earthquakes. Low magnitude events, only detected by NTR station, became dominate between 05:00 and 06:40, on 19 Mar. At 06:40, a eruptive fissure opened and produced a small lava flow (10 e6m3). The eruption ended at 1560 19 Mar. The seismic crisis continued both at the summit and under the E flank. At 00:20, 20 Mar. a new 700 m long fissure opened. The intermediate depth seismicity ended after the opening of the vent but the seismic activity continued at a high level through 21-22 Mar. Only the southern most stations were saturated by continuous tremor due to the eruption. On 23 Mar. at 00:00, seismic activity increased at the summit zone. New cracks opened on the surface at 08:00 and at 17:00, a viscous and degassed lava poured out. On 28 Mar. 10:40, seismicity began very intense that it saturated all the summit stations. Seismicity continued till 29 Mar. 22:38 when a phreatic explosion occurred.

BVE No. 26, p. 10-12.

SWARM DATE: 86/6/5 ±5 Dur. (days): 40 ±5 Type:1b Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): 2.5 ±2.5	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification :	Geothermal :

Key phrase: During June and early July, seismic activity was semi-continuous.

During June and early July, seismic activity was semi-continuous with shallow events under the summit crater (1 to 5 per day) and infrequent deeper events (3-5 km) under the E flank. On 13 July, 18:10 after 2 summit seismic events, a new eruption started. Seismicity remained at low level between mid-July and mid-Sept. Shallow earthquake were registered until early Nov.

BVE No. 26, p. 10-12.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 86/7/9 ±0.5 Dur. (days): 1.5 ±0.5 Type:3i Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification :	Geothermal :

Key phrase: An intrusion not followed by an eruption occurred on July 9.

The 9th and 10th July 1985 intrusive and seismic crises: An intrusion not followed by an eruption occurred on July 9; it was the first event of this type observed at Piton de la Fournaise since the installation of the Volcanological Observatory in 1980. The seismicity and deformation patterns during this intrusive sequence were similar to those observed before all the outbreaks since 1980. The main seismic zone was beneath the central-to-south part of Dolomieu crater, but the deformation showed that the intrusion eventually migrated toward the east and stopped at a shallow depth, at about 1 km east of Dolomieu. As 9 July summit crisis was nearing to an end, a new crisis began on the east flank of the volcano on 10 July. It was the first seismic crisis observed in this area. It surpassed the previous summit seismic crises by two orders of magnitude in the number of earthquakes as well as the energy released. Initially, most hypocenters were concentrated at about 3 km at the E-NE of the summit and at depths of 2 to 5 km beneath sea level. Later, after the climax of the crisis, the hypocenter zone spread over the entire Grandes Pentes area. We suggest that this flank crisis corresponded to the release of compressional stresses accumulated in the central area of the volcano during the repeated intrusions that occurred over the last years.

BVE No. 26, p. 75-77.

SWARM DATE: 86/8/5 ±0 Dur. (days): 0.03 ±0 Type: Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification :	Geothermal :

Key phrase: A new intrusive seismic swarm began on 5 August (22:50) The eruption started at 23:40 (1 hour after the beginning of the seismic crisis)

5th August 1985 eruption

A new intrusive seismic swarm began on 5 August (22:50) at shallow depth beneath the Dolomieu Crater (same area as for the 14 June 1985 eruption). A sudden inflation (about 160 nrad) attacked the summit zone and the north flank of the volcano, corresponding to the emplacement of dikes into the north rift zone. The eruption started at 23:40 (local time)(i.e. 1 hour after the beginning of the seismic crisis) at the north base of the Central cone. Four fissures opened along an N 10 deg. orientation.

BVE No. 26, p. 75-77.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 86/9/6 ±0 Dur. (days): 0.05 ±0 Type:3? Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 1 ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4C
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: A very brief and shallow (about 1 km depth) seismic crisis began on 6 Sept. at 14:08

6th September 1985 eruption
A very brief and shallow (about 1 km depth) seismic crisis began on 6 Sept. at 14:08 after a small summit inflation (about 30 urads). Large ground movements were associated with dike emplacement beneath the east flank of the volcano. Three eruptive fissures opened at 15:20 (local time).

BVE No. 26, p. 75-77.

SWARM DATE: 86/11/12 ±0 Dur. (days): 0.04 ±0 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): .75 ±.25
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4C
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: An intense seismic crisis began on 12 Nov. at 11:50. An eruptive fissure broke at 12:48.

In early Nov., seismicity increased, at about 0.5 to 1 km beneath the Dolomieu. The eruption ended after one day.
BVE No. 26, p. 10-12.

SWARM DATE: 86/11/17 ±0.5 Dur. (days): 9 ±7 Type:1aq Event type(s): Grade : B

Max. Magnitude: 2.5
Max. Intensity: MM at
Depth (km): 2.25 ±1.25
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4C
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Activity remained unchanged at the low level until 17 Nov., leading to a shallow seismic crisis on 19-20 Nov. On 26 Nov. at 15:30, after 12 hours of seismic quiescence, a fracturing episode began.

Seismic activity remained unchanged at the low level until 17 Nov., when events >1.0 were noticed, 1.5 km depth below the E part of Dolomieu and leading to a shallow seismic crisis on 19-20 Nov. An avg. of 10-12 events per day were recorded at depth 1-2.2 km below the summit. During the night of 25 Nov. M 2.0 & 2.5 occurred beneath the Dolomieu at depth of 3-3.5 km below the summit. On 26 Nov. at 15:30, after 12 hours of seismic quiescence, a very shallow fracturing episode began.
BVE No. 26, p. 10-12.

SWARM DATE: 86/12/2 ±0.5 Dur. (days): 6 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 1.1 ±.4
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4C
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Low level until 2 Dec., when a new shallow seismic crisis began, a sharp increase on 6 Dec. at 06:35. At 07:03 a fissure opened.

Seismic activity continued at a low level until 2 Dec., when a new shallow seismic crisis began in the summit zone (0.7 to 1.5 km depth below the surface) with a sharp increase on 6 Dec. at 06:35. At 07:03 a fissure opened.
BVE No. 26, p. 10-12.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 86/12/29 ± Dur. (days): 1.5 ±0.5 Type:1b Event type(s): Grade : B

Max. Magnitude: 2.0
Max. Intensity: MM at
Depth (km): 2 ±1
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4C
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation : Y
Gravity :
Magnetic : Y
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: The seismicity increased on 28 Dec. which was followed by a short (18:36 to 18:50) summit crisis on 29 Dec.

29th December 1985 eruption
After a short eruptive phase of 3 Dec., a progressive summit inflation was recorded with an increase in rate between 19 and 27 Dec. Between 25 and 28 Dec. few seismic events (1 to 3 km depth) were registered under the summit zone. The seismicity increased on 28 Dec. with two strong events recorded on the whole seismic network and also with several small and shallow events, which were followed by a short (18:36 to 18:50) summit crisis on 29 Dec. The permanent summit inclinometer showed a sudden movement at 18:40 on the same day. At 18:52, fountaining began inside the Dolomieu summit.
BVE No. 26, p. 75-77.

SWARM DATE: 87/1/6 ±0 Dur. (days): 1.3 ±0 Type:1b Event type(s): Grade : B

Max. Magnitude: Md1.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 30
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic : Y
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A very weak seismic activity was detected from 08:52 on 6 Jan.

A very weak seismic activity was detected through the tremor from 08:52 on 6 Jan. About 30 summit events lasting less than 10 seconds were recorded until 12:00, together with a significant deformation of the northeastern area of the summit zone.
The intensity of the volcanic tremor progressively increased between 12:00 and 12:12, when a new eruptive fissure opened.
BVE No. 27, p. 7-9.

SWARM DATE: 87/6/2 ±0 Dur. (days): <1 ± Type:3i Event type(s):SP,LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 2 ±1
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic : Y
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: On 2 Jun. at 19:57 a seismic swarm occurred in the summit area without and eruptive event

Between mid-Feb. and the beginning of May, low but constant seismicity was detected in the central part of the volcano, with both short and long period events. Some of them were at shallow depth below the summit area, whereas some others were significantly deeper and located in the northern part of the volcano.
Seismicity slightly increased during the second week of May, mainly in the summit area at a depth about 1 to 3 km below the Dolomieu crater. Some deep events were also recorded below the Grandes Pentes area in the end of May. On 2 Jun. at 19:57 a seismic swarm occurred in the summit area without an eruptive event, though inclinometers showed only weak movements. This swarm was interpreted as the result of the emplacement of a shallow intrusion in the summit area.
BVE No. 27. p. 7-9.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 87/6/8 ±0 Dur. (days): 4 ±1 Type:1a Event type(s):LP Grade : C

Max. Magnitude: M 2.7
Max. Intensity: MM at
Depth (km): 1 ±1
Detection threshold:
Cum. energy release:

EQ total : 40
Felt total :
b-value :
Repose (yr.): .5
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: A new seismic crisis began at 18:28 on 8 Jun.

During the first week of Jun. the summit seismicity remained at a significant level with a daily rate of 4 to 6 events. A new seismic crisis began at 18:28 on 8 Jun., with a single shock located at a depth of 6 km M2.7 in the southeastern area of the Enclos caldera. This event was then followed from 05:09 on 9 Jun., by about 40 shocks located at a depth lower than 2 km, together with a clear inflation (~20 micro rad.)
On 10 Jun., volcanic tremor progressively appeared at the summit seismic stations (at 15:05) after a new inflation episode (~20 micro rad.) occurred during the night of 9 to 10 Jun.
While the summit inflation continued, as seen in the Soufriere inclinometer, and after some "long-period" seismic events, tremor suddenly increased as recorded by the overall seismic stations around 15:00 on 12 Jun., without noticeable changes of the sub-surface activity. At 09:15 on 13 Jun., explosions were heard in the summit area, and eye witnesses reported the occurrence of blue fumes.
BVE No. 27, p. 6-9.

SWARM DATE: 87/7/11 ±0.5 Dur. (days): 8 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Seismicity renewed in the beginning of Jul., and increased after 11 Jul. New eruptive fissures opened at 08:00 on 19 Jul.,

Seismicity renewed in the beginning of Jul., and increased after 11 Jul. in both summit and north flank areas. New eruptive fissures opened at 08:00 on 19 Jul., preceded by more than one hour superficial seismic crises.
Seismic activity remained at a high number of events recorded only by the stations close to the central crater. In this period, a noteworthy phase occurred on 12 Aug., when 13 seismic events located in the western part of the central cone occurred within 6 hours.Seismicity slightly decreased during Oct., with numerous superficial events recorded only by the Soufriere seismic stations.

BVE No. 27, p. 6-9.

SWARM DATE: 87/11/3 ±0.5 Dur. (days): 4 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 188
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L4
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: A new increase of seismic activity occurred on 3 Nov.

A new increase of seismic activity occurred on 3 Nov., with weak inflation of the northeastern edge of the Dolomieu crater. Ten summit events were recorded on 3 Nov. The number of events were 23 on 4 Nov., and 82 on 5 Nov. On 6 Nov., 73 events were recorded before 20:56, when a new intrusive crisis occurred. After a significant decrease of the tremor (though seismicity remained at a significant level), the second eruptive phase was recorded at 21:47 (three cracks opened leading to the emission of a small aa flow). Seismic activity strongly decreased after 23:30, but renewed in the central area in the following minutes.
At 00:40 on 7 Nov., a new increase of tremor indicated the third opening phase, whereas activity ceased on the former fissure systems.
Between 8 and 17 Nov., seismic activity remained in the summit area at a moderate level, with daily average of 5 to 6 events. It increased on the following days, especially after 21 Nov., with a daily avg. of 15 to 20 events located below the Dolomieu crater.
BVE No. 27. p. 6-9.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 87/11/29 ±0.5 Dur. (days): 1.5 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L4	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: The last seismic crisis of the year began on 29 Nov.

The last seismic crisis of the year began on 29 Nov. with the occurrence of very shallow shocks. From 06:30 on the next day, seismic events were located below the Dolomieu crater, with peak between 07:20 and 07:50, and a general inflation of the summit area was noted. Following the seismic and deformation data a fissure opened at the southern base of the central cone. The end of the eruption was characterized by a scarce activity, with interruption of tremor as long as for 30 minutes, together with a slight inflation of the summit and resuming tremor. Some of these modifications were likely to be related to modifications of the surface eruptive regime. After 7 days of low amplitude tremor, eruptive activity ceased on 1 Jan. 1988 at 14:00.

BVE No. 27, p. 6-9.

SWARM DATE: 88/2/4 ±1 Dur. (days): 3 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z & 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: A strong increase in seismicity began on Feb. 4, the eruption began on Feb. 7

A low but almost continuous seismicity with shallow foci localized below the Dolomieu summit crater was recorded throughout Jan., whereas no significant deformations were noticed. A strong increase in seismicity began on Feb. 4 after 2 deep events localized eastward of the central cone. A superficial seismic crisis roughly below the Soufriere station developed on Feb. 3, followed by a short but intense seismic crisis recorded between 20:32 and 22:20 on Feb. 7, with events localized below the southern rim of Dolomieu crater at a depth of less than 3 km. A day after Feb. 16, the seismic tremor became fluctuating whereas rhythmic explosions and weak flowing was observed at the vents. The tremor progressively decreased until Mar. 20 when a very low level was reached. A very moderate activity continued until Apr. 2 when tremor definitively stopped.

BVE No. 28, p. 11-14.

SWARM DATE: 88/4/20 ±0 Dur. (days): 0.02 ±0 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: On April 20 at 09:11, a seismic crisis began, the crisis lasted until 09:42 without eruption

Weak shallow seismicity renewed after the end of the tremor. Around Apr. 15, a summit inflation localized in the E part of the Dolomieu area was recorded by the permanent inclinometer network (about 20 urd at SOU inclinometer). On Apr. 20 at 09:11, a seismic crisis began with events located in the NE part of the summit, between 1 and 2 km below the surface. The crisis lasted until 09:42 without eruption or drastic change in deformation pattern.

BVE No. 28, p. 11-14.

FOURNAISE, PITON DE LA Indian O.-W 21.23S 55.71 E *VOTW num.*:0303-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l.: 2631 m *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 88/5/17 ±0.5 Dur. (days): 2 ±1 Type:3i Event type(s): Grade : C

Max. Magnitude: 2.0	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: A brief shallow seismic crisis began on May 18 at 04:02, with magnitudes not exceeding 2. Seismicity increased in late Aug., and on 31 at 15:23, deformation measurements documented the onset of a magma intrusion into the SE part of the Dolomieu crater.

After 3 weeks of minor shallow seismicity without significant deformation, two shallow magnitude 1.2 events were recorded on May 17 below the NE flank of the central cone at about 1 km depth. Then, a brief shallow seismic crisis began on the next morning (May 18) at 04:02, with magnitudes not exceeding 2. Events were localized below the northern rim of Dolomieu crater. During most of Aug., only weak seismicity in the summit area was detected. Seismicity increased in late Aug., and on 31 at 15:23, deformation measurements documented the onset of a magma intrusion into the SE part of the Dolomieu crater. During more than one month, very low but continuous tremor recorded at summit seismic stations indicated that the eruption was still continuing.

BVE No. 28, p. 11-14.

SWARM DATE: 88/12/14 ±0 Dur. (days): 0.16 ±0 Type:1b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: On Dec. 14 at 08:30, a seismic crisis began. The seismic crisis continued until 12:20.

Seismicity remained weak until November 12, when 25 minutes of low energy summit seismicity was recorded without associated deformation. Since then, discrete shallow events had increased in the summit area. On Dec. 14 at 08:30, a seismic crisis began including both shallow and deeper events below the central area. Most of them were located under the N rim of Dolomieu crater. The seismic crisis continued until 12:20, when low-frequency tremor appeared on seismograph of the summit seismic station (SFR). At l3:06, an eruptive fissure opened. The onset of the eruption, was at l3:06, followed by 40 minutes 1 Hz tremor. During the following days, a significant number of discrete seismic events accompanied vigorous tremor. Most seismic events were limited to the summit zone, but some were detected in the N part of the caldera. Eruptive activity stopped suddenly on Dec. 29 at 10:15. Since then, seismic activity has progressively resumed.

BVE No. 28, p. 11-14.

New Zealand, Kermadec, Tonga, and Samoa

WHITE ISLAND New Zealand

37.52S 177.18E *VOTW num.*:0401-04=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 321 m *Edifice relief :* 770 m
Range of eruptive products: andesite

SWARM DATE: 81/7/1 ±183 Dur. (days): ± Type: Event type(s):B,t,HF,E Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.2 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1981.

Jan. 1981 seismic activity characterized by low-medium frequency volcanic tremor and sequences of wide band eruption earthquakes. Seismic activity changed in Feb. 1981 with almost no tremor and increase in low freq. B-type events ~ 30 per day. During Mar-Aug. activity remained at low level. B-type activity predominated with only weak tremor and high frequency tectonic events were < 10 day.

BVE No. 21, p. 18-19.

SWARM DATE: 82/7/1 ±183 Dur. (days): 4 ±1 Type:1d Event type(s):B,VT Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1982

On 1 Jul. at 14:13 wide band earthquake sequence with peak to peak amplitude exceeding full scale deflection was recorded about 50 km SSW. An eruption accompanied the earthquakes. By 15:17 seismograph declined to 2-3 mm peak to peak, low frequency tremor like activity 2 smaller wide band earthquake sequences recorded on 3 Jul. 02:34 and 5 Jul. 04:24.

Between Jun. 2 and Jul. 5 low frequency B-type events declined in daily number. Only on Jun. 24, 28, 30 were there > 20 per day (max. 37 on Jun. 28) as compared to Feb. 27-Jun. 2 when number of event often ≥ 150 per day. All very small.

High frequency seismic events (volcano tectonic) numbered < 3 per day after Jun. 2. On Jun. 21-22, 4 medium frequency events were recorded. Tremor-like activity recorded on Jun. 18, 19, 30 and Jul. 2, 3, 4 1982.

BVE No. 22, p. 20.

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type:3 Event type(s):LF Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal : Y

Key phrase: Place holder for 1985.

Deflation of the Donald Mound area continues, together with a trend of generally declining temperatures, both in fumarole gas discharges and at depth. These trends have continued despite the reappearance of low frequency large amplitude earthquakes on the White Island seismic records.

BVE No. 25, p. 57.

Immediate Report, White Island Ground Inspection 13 Nov. 1985. Report compiled by I.A. Nairn. N.Z. Geological Survey, P.O. Box 499, Rotorua, New Zealand

WHITE ISLAND New Zealand 37.52S 177.18E *VOTW num.*:0401-04=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 321 m *Edifice relief :* 770 m
Range of eruptive products: andesite

SWARM DATE: 86/1/13 ±1 Dur. (days): 21 ±1 Type:1b? Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.9 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L-4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification :	Geothermal : Y

Key phrase: A new vent was observed on 3 Feb. after three weeks of volcanic tremor and B-type earthquakes.

Unfelt and micro-tremors: occurred.

BVE No. 26, p. 13.

SWARM DATE: 86/11/25 ±1 Dur. (days): 60 ±2 Type:1b Event type(s):B,E Grade : C

Max. Magnitude:	# EQ total : 1800	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L-4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal : Y

Key phrase: Unfelt shocks recorded 30 per day from ? 2 months before the eruption on Jan. 25, 1987.

On 2 Mar., the M6.3 Edgecumbe earthquake occurred centered 50 km to south of White Island. Although the number of local B-type earthquakes declined before the Edgecumbe earthquake and increased after it, no significant effects were noted on White Island eruptions.
Eruptive activity peaked between 13 and 22 May. During this period, moderate amplitude, medium frequency tremor dominated the seismic records. After 12 May the rate of occurrence of E-type eruption earthquakes sequences increased; 22 being recorded by 25 May.
Following this peak of eruptive activity, B-type earthquakes reappeared and E-type occurred most days until 11 Jun. About 30 Aug., E-type events reappeared on the seismic records. Frequently the volcanic tremor stopped at the time of an E-type event and gradually recommenced a few hours later. A relatively large phreatic eruption (with accompaning E-type event) at 10:15 ST on 7 Sept. was observed.
No volcanic tremor occurred during a relatively intense period of E-type activity in early Sept..

BVE No 27, p. 9-11.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.8 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Mark L-4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1988.

Unfelt shocks occurred

BVE No. 28, p. 14-15.

WHITE ISLAND New Zealand 37.52S 177.18E *VOTW num.*:0401-04=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 321 m *Edifice relief :* 770 m
Range of eruptive products: andesite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type:1c Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1989.

Unfelt shocks: occurred.

BVE No. 29, p. 19-20

HAROHARO COMPLEX New Zealand 38.09S 176.51E *VOTW num.*:0401-05=

Morphology: *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products:

SWARM DATE: 82/9/23 ±0.5 Dur. (days): 6 ±1 Type:3 Event type(s):LF Grade : B

Max. Magnitude: M 4.1
Max. Intensity: MM IV at
Depth (km): 6 ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation : Y
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A series of shallow earthquakes Sep. 23-29, 1982 a few km SE of Haroharo dome.

A series of shallow earthquakes Sept. 23-29, 1982 a few km SE of Haroharo dome.
Earthquakes > 2.5: Time 14:02 M3.4, 14:20 M4.1, 14:23 M4.1, 14:29 M2.6, 14:40 M3.2, 14:52 M3.0, 18:06 M2.9. Observers noted low frequency and large amplitude of felt shocks. Hypocenter for Sept. 27 event 5 km SE of dome at 2 km depth. this area coincides with surface faulting and geothermal activity. Epicenters of Sept. 23 estimated at 6 km from Sept. 27 event. Slow propagation of energy from earthquake and low frequency of felt shocks may indicate magma generated activity with roof rocks (J.H. Latter) No volcanic tremors recorded with this swarm.
BVE No. 22, p. 96.

TARAWERA New Zealand 38.23S 176.51E *VOTW num.*:0401-06=

Morphology: shield with dome *Tectonic framework:*
Elevation above m.s.l. : 1111 m *Edifice relief :* 750 m
Range of eruptive products: andesite

SWARM DATE: 87/11/16 ±0 Dur. (days): 0.17 ±0.02 Type:3 Event type(s):VT Grade : B

Max. Magnitude: ML3.8
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A short but intense sequence of earthquakes occurred in the lake Rotomahana area of the Tarawera Rift on 16 Nov. 1987.

A short but intense sequence of earthquakes occurred in the lake Rotomahana area of the Tarawera Rift on 16 Nov. 1987. The largest event (ML3.8) occurred at 18:35, in the middle of the sequence; events continued until about 20:00. A geodetic survey of the Lake Rotomahana strain monitoring pattern was completed about 20 minutes before the earthquake sequence commenced. Selected stations were reoccupied 3 days later but no significant co-seismic deformation was detected. All the earthquakes appeared to be of tectonic origin. Similar swarms were recorded 22-23 Feb. 1986 and in Feb. 1983.

BVE No. 27, p. 81.
Nairn, J. A., et al., (1986): Tarawera 1986 Eruption; in International Volcanological Congress Handbook, 1-9. Feb. 1986, p. 111-121.

RUAPEHU New Zealand

39.28S 175.57E *VOTW num.*:0401-10=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 2796 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

SWARM DATE: 80/1/27 ±0.5 Dur. (days): **15** ±1 Type: Event type(s):t,B,C Grade : **c**

Max. Magnitude: 3.5
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic : Y
Geothermal : Y
Migration :
Focal mech:
EQ families : Y
Rumbling :

Key phrase:Tremor was most marked between Jan. 27, and Feb. 11

Increase in crater lake (22-40 deg. C) Feb.-Mar 80 accompanied by small phreatomagmatic eruptions. Steady increase in the amount of energy radiated by tremor since 1976. This trend continued in 1980. Much of the tremor was of shallow origin and suggests intrusion of magma. Tremor was most marked between Jan. 27, and Feb. 11; Apr. 19 and May 14; Sept. 11 and Oct. 28; and form Dec. 19 to the end of the year. High frequency tremor (<0.5 km below lake) very conspicuous in Apr. and May accompanying increase in lake temp. Also clear in Jan Feb., Sept. -Oct. Largest quake of year accompanied eruption on Feb. 2. Low freq. events B-type and C-type in roof rock above so beneath lake. C-type not recorded before here. Unfelt: recorded see N.Z. Volc. Rec., No. 10.

BVE No. 20, p. 18-19.

SWARM DATE: 80/4/19 ±0.5 Dur. (days): **35** ±1 Type:1d Event type(s):t,B,C Grade : **c**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic : Y
Geothermal : Y
Migration :
Focal mech:
EQ families : Y
Rumbling :

Key phrase:Tremor was most marked between Apr. 19 and May 14.

See Jan 27, 1980 comments.

BVE No. 20, p. 18-19.

SWARM DATE: 80/9/11 ±0.5 Dur. (days): **47** ±1 Type: Event type(s):t Grade : **c**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic : Y
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase:Tremor was most marked between Sept. 11 and Oct. 28.

See Jan 27, 1980 comments

BVE No. 20, p. 18-19.

RUAPEHU New Zealand 39.28S 175.57E *VOTW num.*:0401-10=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 2796 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

<u>SWARM DATE:</u> 80/12/19 ± Dur. (days): 12 ± Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase:Tremor was most marked between Dec. 19 to the end of the year.

See comments for Jan 27, 1980

BVE No. 20, p. 18-19.

<u>SWARM DATE:</u> 81/9/7 ±0.5 Dur. (days):<1 ± Type:1aq Event type(s):C Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families : Y
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase:Sept. 7 swarm of 'roof rock' earthquakes began.

Volcanic tremor recorded and nearly continuous by Oct. 14, 1981. Unusual high frequency (3.5-5 Hz) interpreted as magma intrusions at shallow levels although lake heating did not begin until after Oct. 13, 1981.
After Oct. 28, normal declined although episodes of high frequency occurred on Oct. 28 Nov. 17-18, 1981 was major period of intrusion commenced climaxing on Nov. 28.
Seismic activity which had declined after Dec. 12 increased again on Dec. 22 when an observed eruption may have accompanied a M2.2 C-type earthquake.

BVE No. 21, p. 20-21.

<u>SWARM DATE:</u> 81/10/14 ±0.5 Dur. (days): 49 ±1 Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase:Tremor became strong and nearly continuous by Oct. 14, 1981. Seismic activity declined after 2 Dec.

Volcanic tremor had become common on the records after 2 Oct. Tremor became strong and nearly continuous by Oct. 14, 1981. Unusual high frequency (3.5-5 Hz) interpreted as magma intrusions at shallow levels although lake heating did not begin until after Oct. 13, 1981. Normal tremor declined on 28 Oct., although episodes of high frequency tremor occurred on that date, and also on 17 and 18 Nov. when the major period of shallow magma intrusion probably commenced, climaxing on 28 Nov.
Seismic activity which had declined after 2 Dec., increased again on 22 Dec. when an unobserved eruption may have occurred to accompany a magnitude 2.2 C-type earthquake.

BVE No. 21, p. 20-21.

RUAPEHU New Zealand

39.28S 175.57E *VOTW num.*:0401-10=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 2796 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

SWARM DATE: 81/12/22 ±0.5 Dur. (days):<1 ± Type:2a? Event type(s):C Grade : C

Max. Magnitude: M 2.2
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families : Y
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Dec. 22 when an unobserved eruption may had accompanied a M2.2 C-type earthquakes.

After Oct. 28, normal tremor declined although episodes of high freq. tremor occurred on Oct. 28, Nov. 17-18, 1981 was major period of intrusion commenced, climaxing on Nov. 28. Seismic activity which had declined after Dec. 12 increased again on Dec. 22 when an unobserved eruption may had accompanied a M 2.2 C-type earthquakes.
BVE No. 21, p. 20-21.

SWARM DATE: 82/1/14 ±0.5 Dur. (days): 16 ±1 Type:1d? Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: A high level of volcanic tremor recorded between 14-30 Jan. 1982.

Maximum frequency of 3 explosion per hour was reached by mid Jan. 1982.
A high level of volcanic tremor recorded between 14-30 Jan. 1982, subsequent secondary peaks reached 10-11 Feb., 11-16 Mar 1982. Subsequent episode of tremor, unaccompanied by eruptive activity occurred from 8 May - 11 Jun. and from mid Aug. to end of Sept. 1982.
BVE No. 22, p. 21-22.

SWARM DATE: 82/2/10 ±0.5 Dur. (days): 2 ±1 Type:1d? Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: A high level of volcanic tremor recorded between 10-11 Feb. 1982.

Maximum frequency of 3 explosion per hour was reached by mid Jan. 1982.
A high level of volcanic tremor recorded between 14-30 Jan. 1982, subsequent secondary peaks reached 10-11 Feb., 11-16 Mar 1982. Subsequent episode of tremor, unaccompanied by eruptive activity occurred from 8 May - 11 Jun. and from mid Aug. to end of Sept. 1982.
BVE No. 22, p. 21-22.

SWARM DATE: 82/3/11 ±0.5 Dur. (days): 5 ±1 Type:1d? Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: A high level of volcanic tremor recorded between 11-16 Mar 1982.

Maximum frequency of 3 explosion per hour was reached by mid Jan. 1982.
A high level of volcanic tremor recorded between 14-30 Jan. 1982, subsequent secondary peaks reached 10-11 Feb., 11-16 Mar 1982. Subsequent episode of tremor, unaccompanied by eruptive activity occurred from 8 May - 11 Jun. and from mid Aug. to end of Sept. 1982.
BVE No. 22, p. 21-22.

RUAPEHU New Zealand 39.28S 175.57E *VOTW num.*:0401-10=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin

Elevation above m.s.l. : 2796 m *Edifice relief :* 1500 m

Range of eruptive products: andesite

SWARM DATE: 82/5/28 ±0.5 Dur. (days): 23 ±1 Type:3 Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Episode of tremor, unaccompanied by eruptive activity occurred from 8 May - 11 Jun.

Maximum frequency of 3 explosion per hour was reached by mid Jan. 1982.
A high level of volcanic tremor recorded between 14-30 Jan. 1982, subsequent secondary peaks reached 10-11 Feb., 11-16 Mar 1982. Subsequent episode of tremor, unaccompanied by eruptive activity occurred from 8 May - 11 Jun. and from mid Aug. to end of Sept. 1982.
BVE No. 22, p. 21-22.

SWARM DATE: 82/8/15 ±5 Dur. (days): 40 ±10 Type:3 Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: Mark L4C
Component : Z
Natural period : .5 s
Magnification : 22 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Episode of tremor, unaccompanied by eruptive activity occurred from mid Aug. to end of Sept. 1982.

Maximum frequency of 3 explosion per hour was reached by mid Jan. 1982.
A high level of volcanic tremor recorded between 14-30 Jan. 1982, subsequent secondary peaks reached 10-11 Feb., 11-16 Mar 1982. Subsequent episode of tremor, unaccompanied by eruptive activity occurred from 8 May - 11 Jun. and from mid Aug. to end of Sept. 1982.
BVE No. 22, p. 21-22.

RUAPEHU New Zealand		39.28S 175.57E *VOTW num.*:0401-10=
Morphology: strato or composite	*Tectonic framework:*	Uncert. Convergent Continental Margin
Elevation above m.s.l. : 2796 m	*Edifice relief :* 1500 m	
Range of eruptive products: andesite		

SWARM DATE: 83/1/15 ±15 Dur. (days): 30 ±20 Type:3 Event type(s):B Grade : C

Max. Magnitude: ML3.1	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.75 km		Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: Mark L-4C		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	.5 s	Magnetic :	Rumbling :
		Magnification :	20 K	Geothermal :	

Key phrase: B-type earthquakes moderately high levels throughout Jan. and peaked Jan. 29. Activity rapidly declinced to a very low level 10-15 Feb.

Volcanic tremor and B-type earthquakes moderately high levels throughout Jan. and peaked Jan 29 with a B-type quake M2.9 at 0.5 km below the crater lake. Activity rapidly declined to a very low level 10-15 Feb. It remained low until 8:45 on Feb. 23 roof rock shock M2.1 trigger B-type earthquake sequence with ML 3.0 and 3.1 recorded.
A similar sequence of B-type earthquakes occurred on 6 Feb. at 23:56. The series of magnitude 3.0-3.1 events was again triggered by a high frequency roof rock shock, of magnitude 2.0. On 1 Mar. at 07:57, a third sequence of B-type events reached magnitude 2.9. Depths for the 1 Mar. events were estimated at 300-600 m below the crater lake.
Sequences of B-type earthquakes occurred every 2-4 days in late Feb. and Mar., but have been less frequent since then; only 2 B-type earthquake sequences were recorded 18 Apr.-15 May. Small shocks interpreted as tectonic, have occurred since 29 Apr. the largest has magnitude 1.8 on 5 May. There also have been occasional episodes of weak tremor.
BVE No. 23, p. 56.

SWARM DATE: 83/2/23 ±0.5 Dur. (days): 6 ±1 Type:3 Event type(s):C,B Grade : C

Max. Magnitude: ML3.1	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.75 km		Tremor :	Migration :
Depth (km): ±	b-value :	Type: Mark L-4C		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Z	Gravity :	EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period :	.5 s	Magnetic :	Rumbling :
		Magnification :	20 K	Geothermal :	

Key phrase: Feb. 23 roof rock shock M2.1 triggered B-type swarm.

Activity rapidly declined to a very low level 10-15 Feb. It remained low until 8:45 on Feb. 23 roof rock shock M2.1 trigger B-type earthquake sequence with ML 3.0 and 3.1 recorded.

BVE No. 23, p. 56-57.

RUAPEHU New Zealand 39.28S 175.57E *VOTW num.*:0401-10=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 2796 m *Edifice relief* : 1500 m
Range of eruptive products: andesite

SWARM DATE: 83/3/1 ±0 Dur. (days): ± Type:3 Event type(s):B Grade : C

Max. Magnitude: M 2.9	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.75 km	Tremor : / Migration :
Depth (km): .5 ±.1	b-value :	Type: Mark L-4C	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period : .5 s	Magnetic : / Rumbling :
		Magnification : 20 K	Geothermal :

Key phrase: On 1 Mar. at 07:57, a third sequence of B-type events.

On 1 Mar. at 07:57, a third sequence of B-type events reached magnitude 2.9. Depths for the 1 Mar. events were estimated at 300-600 m below the crater lake.
BVE No. 23, p. 56-57.

SWARM DATE: 85/5/20 ±1 Dur. (days): 12 ±0.5 Type:1d Event type(s):LF Grade : C

Max. Magnitude: ML2.4	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.75 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type: Mark L-4C	Deformation : / Focal mech:
Detection threshold:	Repose (yr.): 3	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : .5 s	Magnetic : / Rumbling :
		Magnification : 20 K	Geothermal :

Key phrase: Unfelt shocks: minor (max. ML2.2) 6 days before and larger (max. ML2.4) 8 days after small hydrothremal eruptions seen in crater lake.

Weak volcanic tremor 12-11 days before small hydro-thermal eruptions first seen. Duration 2 days period ~0.5 sec. Maximum radiated seismic energy per 6 hr period: 4 x10e+5 J (moderate to low level tremor).
BVE No. 25, p. 13.
SEAN Bull vol 10; no 5, p 3, no 6, p12-13, no 7, p 7-8, no 9, p 8, no 11, p 20, 1985
Latter, J H et al. (1987) : N.Z. Volcanological Record, no. 15, p 40-46.

SWARM DATE: 86/2/8 ± Dur. (days): ± Type:1e? Event type(s): Grade : C

Max. Magnitude: ML2.2	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM II at 0.7 km	# Felt total : 1	Dist. to vent: 0.7 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: Kinemetrics	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification : 22 K	Geothermal :

Key phrase: Unfelt shocks recorded no clear increase. Small earthquakes were recorded, largest event was ML 2.2 (14:13 on 8 Feb.)

Felt shock: at 22:58 or 23:01 NZDT (the place were the shock was felt, Dome Shelter, is generally unoccupied, hence it is not known whether other shocks in the sequence would have been felt) M-M II? at 0.7 km from the vent. Magnitude ML1.6 (22:58), 1.75 (23:01).
Unfelt shocks recorded, no clear increase. Frequency 10-15 per day, S-P = 1 second at 0.7 km from the vent.
BVE No. 26. p. 14.

SWARM DATE: 87/8/6 ±0.5 Dur. (days): 0.38 ±0.13 Type:3 Event type(s):HF Grade : B

Max. Magnitude: ML2.9	# EQ total : 80	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.75 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type: Mark L-4C	Deformation : Y / Focal mech:
Detection threshold: 1.4	Repose (yr.):	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y / Rumbling :
		Magnification : 20 K	Geothermal : Y

Key phrase: Aug. 6 a 6-12 hours swarm of 80 high frequency shocks occurred.

Largest volcanic earthquake during 1987, ML2.5 (B-Type?) 29 Jul. End of period of volcanic tremor 30 Jul. 6. Aug. 6 a 6-12 hours swarm of 80 high frequency shocks at superficial depth near Crater Lake Ruapehu. 6 Aug. ML 2.9 A-Type (HF) earthquake at depth 12 km. 11 Aug. weak volcanic tremor.
BVE No. 27, p. 11-12.

RUAPEHU New Zealand

39.28S 175.57E *VOTW num.*:0401-10=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 2796 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

SWARM DATE: 87/8/18 ±0.5 Dur. (days): 6 ±1 Type:1b Event type(s):B,C Grade : B

Max. Magnitude: ML2.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.4
Cum. energy release:

EQ total : 18
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.75 km
Type: Mark 4LC
Component : Z
Natural period : 1 s
Magnification : 20 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Unfelt shocks recorded from <= 3 per day >=ML1.4 from 6 days before the eruption.

The following volcanic earthquakes were probably correlated with the small phreatic eruptions 24-30 Aug.: 18 Aug. ML1.8 ?B/C-Type, 22 Aug. ML1.5 B/C-Type, 22 Aug. ML1.4 ?/C-Type, 22 Aug. ML 2.0 B/C-Type, 24 Aug. ML 1.7 B-Type, 24 Aug. ML 2.0 B/C-Type, 25 Aug. ML 1.7 B-Type.
Unfelt shocks recorded from <= 3 per day >=ML1.4 from 6 days before the eruption.
Micro-tremors recorded (weak volcanic tremor 11 Aug.) period ca. 0.4-0.8 sec. Energy : ca. 4 x10e+4 Joules per 6 hours.

BVE No. 27, p. 11-12.

SWARM DATE: 88/4/5 ±0.5 Dur. (days): 35 ±1 Type:1d Event type(s):t Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.75 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification : 20 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: Volcano seismicity, in particular volcanic tremor, increased; especially during April 5 to May 10

Volcano seismicity, in particular volcanic tremor, increased; especially during April 5 to May 10 when total daily energy values ranged 1e4 - 1e5 J. Felt shocks: 0 Unfelt shocks: <=3 per day. Mircotremors recorded; Volcanic tremor 4-10 x10e+4 J per 6 hrs
BVE No. 28, p. 15-16.

SWARM DATE: 88/12/8 ±0.5 Dur. (days): 0 ± Type:4 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.75 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification : 20 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: There was no precursory activity for the Dec. 8 eruption.

BVE No. 28, p. 15-16.

RUAPEHU New Zealand 39.28S 175.57E *VOTW num.*:0401-10=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 2796 m *Edifice relief* : 1500 m
Range of eruptive products: andesite

SWARM DATE: 89/1/27 ± Dur. (days): 130 ± Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total : 130	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.75 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 20 K	Geothermal : Y	

Key phrase: Place holder for tremor information. Tremors duration: ~130 days in total.

Unfelt shocks: Frequency <1/day Micro-tremors: recorded Volcanic tremors 1-100 x10e+4 J per 6 hrs. (variable)
Duration: ~130 days in total

BVE No 29, p. 20-21.

RUMBLE III **New Zealand** 35.74S 178.48E *VOTW num.*:0401-13-

Morphology: submarine *Tectonic framework:*
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products:

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1986

Sonar buoys dropped into the area detected bubbling noises, but no low frequency or pulsing noises (i.e. explosions).

BVE No. 26, p. 14-15.
SEAN Bull. vol. 11, no. 7, p. 15.

NIUAFO'OU Tonga-SW Pacific 15.60S 175.63W *VOTW num.*:0405-11=

Morphology: *Tectonic framework:*
Elevation above m.s.l. : 260 m *Edifice relief* :
Range of eruptive products:

SWARM DATE: 85/3/21 ±0.5 Dur. (days): 0.13 ±0.5 Type:1? Event type(s):felt Grade : B

Max. Magnitude:	# EQ total :	Seismograph: none	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM VII at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling : Y
		Magnification :	Geothermal :	

Key phrase: Felt at very short intervals from 20:50 to about 24:00 local time.

Unfelt unknown no seismometer near by.

BVE No. 25, p. 14.

Melanesia

MANAM New Guinea-NE of 4.10 S 145.06E *VOTW num.*:0501-02=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1830 m *Edifice relief* : 3100 m
Range of eruptive products: basalt

SWARM DATE: 79/7/1 ±183 Dur. (days): ± Type: Event type(s):B Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling : Y
Geothermal :

Key phrase: Place holder for 1979.

Most of Aug., activity died down by Aug. 24 and B-type level dropped to that of July. Activity was the same in Oct. as in Sept.
BVE No. 19, p. 19.

SWARM DATE: 80/5/15 ±15 Dur. (days): 20 ±10 Type:1d Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling : Y
Geothermal : Y

Key phrase: Intensified in May 4x normal corresponded with explosive activity in May

Seismic activity steady all year (intensified in May 4x normal) corresponded with explosive activity in May. Unfelt : recorded ~ 2000/day, B-type throughout the year. Steady change during year radial inflation ~ 5urad. at 4.5 km from vent.
BVE No. 20, p. 21-22.

SWARM DATE: 81/6/5 ±5 Dur. (days): 117 ±10 Type:1d Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling : Y
Geothermal :

Key phrase: From early June to late Sept. seismic amplitudes increased.

Noises accompanying the increased activity in Oct.-Dec. 1981 included strong rumblings, booming sharp detonations probably from S. crater. Seismicity of frequent B-type events or explosion events was steadily at a low level during 1st half of the year. Intensification from early Jun. 1981. Amplitude is double normal level in Aug.-Sept. 1981. Decline in late Sept. 1981 despite increase in eruptivity. Seismicity did not show a change until Dec. 1981. Increase again in Dec. 1981 to higher levels the Aug.-Sept. Character was B-type throughout the year. Tilt and visible activity clearly associated with seismicity.
Tiltmeters : register 2 urad radial inflation in Jan-Feb. 1981 followed by 3 urad deflation until Oct. 1980. Re-inflation of 3 urad in Jan-Dec. 1981.
Unfelt: frequency ~2000 B-type per day

BVE No. 21, p. 22-23.

MANAM **New Guinea-NE of** **4.10 S 145.06E** *VOTW num.*:0501-02=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1830 m *Edifice relief :* 3100 m
Range of eruptive products: basalt

SWARM DATE: 82/3/26 ±0.5 Dur. (days): 1 ±0.5 Type:1d Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling : Y
Geothermal :

Key phrase: Seismicity 20 times normal at eruption time (Mar 27).

Seismicity 20 times normal at eruption time (Mar 27). Before and after seismicity was discrete B-type earthquakes at 1 per minute, but for about 22 hours from the start of the eruption, discontinuous seismic tremor was recorded.
BVE No. 22, p. 23-25.

SWARM DATE: 82/3/27 ± Dur. (days): 0.92 ± Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling : Y
Geothermal :

Key phrase: For 22 hours after the start of the eruption discontinuous seismic tremor recorded.

For 22 hours after the start of the eruption discontinuous seismic tremor recorded. Seismicity was generally at a low level, although increased earthquake amplitudes were noted in conjunction with stronger explosive activity at Southern Crater in Mar., and at Main crater in Aug.-Sept. Daily rates of volcanic earthquake occurrence ranged from as little as 400 in late Mar. to over 4000 in Jan., Feb., and Apr. The average rate was about 2000 events per day.
BVE No. 22, p. 23-25.

SWARM DATE: 82/8/15 ±15 Dur. (days): 20 ±10 Type:1d Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total : 0
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling : Y
Geothermal :

Key phrase: Seismicity increased 2-3 x normal levels in Aug. 1982 as a response to eruptivity at main crater.

Seismicity increased 2-3 x normal level in Aug. 1982 as a response to eruptivity at main crater.
BVE No. 22, p. 23-25.

MANAM New Guinea-NE of 4.10 S 145.06E *VOTW num.*:0501-02=
Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1830 m *Edifice relief :* 3100 m
Range of eruptive products: basalt

SWARM DATE: 83/3/20 ±5 Dur. (days): 240 ±10 Type:1d Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 4.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Y Focal mech:
Detection threshold:1.6	Repose (yr.):	Component : Z	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 2.5 K	Geothermal :

Key phrase: Duration from BVE No. 23 figure.

Increase in seismicity in Apr. strong in May. Seismicity in general corresponded well with explosivity. Jun. 1983 peak seismic amplitude was 4 times normal. Curiously the daily rate of earthquakes peaked in Apr. at 3500 per day following a climb from rates of about 1200-2000 per day for Jan-Mar.
From early May to mid Oct. rates of earthquakes were 2800 per day to 2000 per day through late Oct. then back up to 2700 per day for late Oct.- mid Nov.Through Dec. it was 1700/day.
Amplitudes increased when frequency of events decreased in Oct. and were 2 times normal by end of Dec. Fig: Earthquake counts, seismic amplitude, and tilt.
BVE No. 23, p. 13-14.

SWARM DATE: 84/1/13 ±0.5 Dur. (days): 240 ±30 Type:1d Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 4.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Y Focal mech:
Detection threshold:1.6	Repose (yr.):	Component : Z	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 2.5 K	Geothermal :

Key phrase: After Jan. 13, B-type amplitude 6 normal. Duration from seismic amplitude fig.

After Jan. 13, B-type amplitude 6x normal. Tilt increase = 1urad. good correspondence between seismicity and eruptivity in Feb. Several cycles of waxing and waning seismicity over next 3 months. Unfelt: freq. ~ 2000 per day, S-P durations: B-type? Long trend duration Feb.-Aug. Several cycles of waxing and waning seismicity which were tentatively correlated with the solid earth tides, the maximum amplitude being recorded when the daily variation in earth tides was the greatest. The number of earthquakes per day showed a similar but less distinct relationship. Figs: Daily seismic ampl. 1983-1984.
BVE No 24, p. 16-17.

SWARM DATE: 85/3/4 ±0.5 Dur. (days): 20 ±1 Type:1c Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling : Y
		Magnification : 2.5 K	Geothermal :

Key phrase: From 4 to 24 March, the seismicity rose again.

With 2 urads of tilt inflation. Eruption character unknown. Explosions were heard on the 19th. Seismicity began declining in late March to reach non-eruptive levels by mid-April.
BVE No. 25, p. 14-15.

MANAM New Guinea-NE of   4.10 S 145.06E *VOTW num.*:0501-02=

Morphology: strato or composite   *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1830 m   *Edifice relief :* 3100 m
Range of eruptive products: basalt

SWARM DATE: 85/4/16 ±0.5 Dur. (days): 137 ±5 Type:1d Event type(s):B Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4.5 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 2.5 K	Geothermal :	

Key phrase: On April 16, the daily totals, of volcanic earthquakes rose markedly. Seismic amplitudes decreased gradually decresed and then stablilized in early Sept.

On April 16, the daily totals, of volcanic earthquakes rose markedly to about 1600-2000 and seismic amplitudes increased to about twice non-eruptive levels. Seismic amplitudes decreased gradually decresed and then stablilized in early Sept. just above non-eruptive level. The peak of seismic amplitudes occurred in mid-July.
BVE No. 25, p. 14-15.

SWARM DATE: 85/11/26 ±0.5 Dur. (days): 6 ±3 Type:1d Event type(s):B Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling : Y
		Magnification : 2.5 K	Geothermal :	

Key phrase: The seismicity increased slightly in number and in amplitude for a few days.

A slight increase in activity occurred again on Nov. 26, after a few minutes of a continuous deep roaring sounds and harmonic tremor, a thick brown cloud rose 1500 m above the South crater. The seismicity increased slightly in number and in amplitude for a few days before returning to a level just slightly above non-eruptive levels.
BVE No. 25, p. 14-15.

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s):B Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 4.5 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 2.5 K	Geothermal :	

Key phrase: Place holder for 1986.

Manam was at low inter-eruptive level of activity throughout 1986. Seismicity and tilt reflected this low level from Sept. 1985 until the end of 1986. The micro-seismicity remained at "normal", inter-eruptive level, with 1000 to 1700 B-type events of very low amplitude recorded daily. Daily totals of earthquakes declined steadily through 1986, reaching a minimum in Sept. then slowly increased again.
BVE No. 26, p. 15-16.

MANAM New Guinea-NE of 4.10 S 145.06E *VOTW num.*:0501-02=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)

Elevation above m.s.l. : 1830 m *Edifice relief :* 3100 m

Range of eruptive products: basalt

SWARM DATE: 87/1/18 ±0.5 Dur. (days): 37 ±1 Type:1d Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 68000
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling : Y

Key phrase: Seismicity increased steadily 18-31 Jan. Between 18 and 24 Feb. deep roaring was heard and seismic amplitudes increased slightly.

Seismicity dropped steadily from 1420 to 840 weak events per day 1-17 Jan. and increased steadily from 1010 to 1840 events per day 18-31 Jan. Between 18 and 24 Feb. deep roaring was heard and seismic amplitudes increased slightly. Mild strombolian eruptive activity began on 8 Mar.

Daily totals of volcanic earthquakes in Apr. were steady at 1500, and event amplitudes were about the same as in Mar. Seismic amplitudes remained steady through the month of May at the same level that has been recorded since Jan.

BVE No. 27, p. 12-14.

SWARM DATE: 87/6/10 ±0.5 Dur. (days): 14 ±1 Type:1aq Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Between 10 and 24 Jun., seismicity fluctuated at a moderate-high level before declining. Although there were visible and seismic indications of declining activity in late June, a sharp increase in activity took place on 30 June.

Between 10 and 24 Jun., seismicity fluctuated at a moderate-high level before declining. During the latter part of this period, lava ejections rose a few hundred meters and an ash column up to 500 m high above the summit. Although there were visible and seismic indications of declining activity in late June, a sharp increase in activity took place on 30 June. Seismicity began increasing in the morning and strombolian activity strengthened progressively. At 21:40, activity suddenly culminated in 2 exceptionally large ejections of lava the following day. A continuous eruption of a more than 2 km high ash column followed. Vivid lightning was observed.

BVE No. 27, p. 12-14.

SWARM DATE: 87/10/5 ±5 Dur. (days): ± Type:1e? Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling : Y

Key phrase: Place holder for Oct.-Dec. 1987. There was a marked, though moderate increase in the level of activity at the beginning of Oct.

Seismic activity declined sharply after the 30 June eruption and returned to the levels of late May by about 7 July. From 8 July until the end of the month, seismic activity was at a low level, similar to that recorded in Jan 1987. A low level of activity prevailed through Aug. and Sept. A moderately low level of seismicity continued with 1400-1500 sub-continuous, small amplitude, low-frequency events per day.

There was a marked, though moderate increase in the level of activity at the beginning of Oct. Seismic amplitudes began a progressive increase during the first week of Oct.

Seismicity showed no significant change, remaining at 1200-1400 B-type of small amplitude per day in Nov. In Dec. seismic amplitudes were stable at about twice non-eruptive levels and daily volcanic earthquakes totaled about 1400.

BVE No. 27, p. 12-14.

MANAM New Guinea-NE of 4.10 S 145.06E *VOTW num.*:0501-02=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1830 m *Edifice relief :* 3100 m
Range of eruptive products: basalt

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s):B Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1988.

Microseismicity remained at a steady low amplitude throughout the year, though the frequency of small B-type earthquakes decreased somewhat from 1300 - 1500 per day in Jan. to 1300 - 900 per day in Mar. and then ranged between 1200 and 700 per day during the rest of the year.

BVE No. 28, p.18.

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 2.5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1989 summary information.

A deflation and re-inflation of 1.5 ur occurred between mid-Mar. and mid May, then a progressive deflation of 2 ur followed until Jul., by which time the seismic activity was at its lowest. The seismicity showed a steady and 'normal' level of activity in both the number (900-1200/day) and amplitude (small) of the low frequency volcanic earthquakes recorded until mid-May. A decrease of activity took place thereafter and by Oct. only 300-500 events/day of very small amplitude were recorded. Instrument failure at the end of the year.

BVE No. 29, p. 21-22.

KARKAR **New Guinea-NE of** **4.65 S 145.96E** *VOTW num.*:0501-03=

Morphology: strato with caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1500 m *Edifice relief :* 3000 m
Range of eruptive products: andesite

SWARM DATE: 78/10/15 ±5 Dur. (days): 90 ±5 Type:**1bq** Event type(s):**felt**,B,t Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM III at 1.5 km	# Felt total :	Dist. to vent: 1.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: Rabual design	Deformation : Y	Focal mech:
Detection threshold: 1.0	Repose (yr.): 4	Component : Z	Gravity : Y	EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y	Rumbling :
		Magnification : 8 K	Geothermal : Y	

Key phrase: Felt shocks up 3 months prior.

B-type earthquakes, volcanic tremor, and localized surface heating to about 1000C in late 1978 were all indicative of an active body of magma close to the surface of the inner caldera.
Declining levels of seismicity from late Oct. 1978 onwards are taken as indications that the magma body had stabilized at a relatively shallow level.
Explosions began on 12 and 13 Jan 1979. Seismograms are characteristically banded caused by intervals of stronger and weaker tremor (see BVE No. 18, p. 19.). This banding is most noticeable for the pre-eruption period between Jul. and early Oct. 1978, but it is also quite pronounced for times during the eruption itself. this pattern of seismicity is similar to the regular eruption of some geysers, and it origin is interpreted as a cyclic interaction between a heat source (magma) and water.
Felt shocks up 3 months prior; frequency averaged from 5 per day (Nov. 1977) to 40 per day (Jul. 1978).
Micro-tremors observed; period ~ 0.25-0.5 sec.

BVE No. 19, p. 20-23.
McKee, C. O., et al., (1981): Fatal hydro-eruption of Karkar volcano in 1979: development of a maar-like crater, In: Cooke-Ravian Vol. of Volcanological Papers (ed. Johnson, R. W..) Geol. Sur. of Papua new Guinea Memoir 10, 63-84.

SWARM DATE: 81/8/15 ±15 Dur. (days): <30 ± Type:3 Event type(s):B,t Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Increases in B-type activity occurred in Aug. and Dec.1981

Throughout 1981 seismicity generally weak but temporary increases in B-type activity occurred in Aug. and Dec. 1981 along with brief period of tremor in Aug.-Sept. 1981. M6.3 (Oct. 4.1981) did not seem to correspond with any changes in the volcano.

BVE No. 21, p. 86.

KARKAR New Guinea-NE of 4.65 S 145.96E *VOTW num.*:0501-03=
Morphology: strato with caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1500 m *Edifice relief* : 3000 m
Range of eruptive products: andesite

SWARM DATE: 81/12/15 ±15 Dur. (days): <30 ± Type:3 Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increases in B-type activity occurred in Aug. and Dec. 1981

See Aug. 1981 for comments.
BVE No. 21, p. 86.

SWARM DATE: 82/6/15 ±15 Dur. (days): <180 ± Type:3 Event type(s):HF,B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: Increase in Jun. 1982 (200 small high frequency events per day) seismicity decreased steadily to < 50 events/day by Dec. 1982.

Activity through 1982 generally low decrease in numbers of B-type events and tremor.
100 B-type events per day with frequent episodes of tremor in early 1982 with exception to short increase in Jun. 1982 (200 small high frequency events per day) seismicity decreased steadily to < 50 events per day and infrequent episodes of tremor by Dec. 1982.
BVE No. 22, p. 97.

SWARM DATE: 83/1/15 ±15 Dur. (days): <30 ± Type:3 Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: Small numbers of low amplitude B-type earthquakes per day (highest up to 30 day in Jan. 1983)

Small numbers of low amplitude B-type earthquakes per day (highest up to 30 day in Jan., Apr. and Aug. 1983)
Tremor periods in between Apr. and Aug. 1983 typically 4 min. duration at 40 min. intervals.
BVE No. 23, p. 57.

SWARM DATE: 83/4/15 ±15 Dur. (days): <30 ± Type:3 Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Small numbers of low amplitude B-type earthquakes per day (highest up to 30 day in Apr. 1983)

Small numbers of low amplitude B-type earthquakes per day (highest up to 30 day in Jan., Apr. and Aug. 1983)
Tremor periods in between Apr. and Aug. 1983 typically 4 min. duration at 40 min. intervals.
BVE No. 23, p. 57.

KARKAR New Guinea-NE of 4.65 S 145.96E *VOTW num.*:0501-03=

Morphology: strato with caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1500 m *Edifice relief* : 3000 m
Range of eruptive products: andesite

SWARM DATE: 83/8/15 ±15 Dur. (days): <30 ± Type:3 Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Small numbers of low amplitude B-type earthquakes per day (highest up to 30 day Aug. 1983)

Small numbers of low amplitude B-type earthquakes per day (highest up to 30 day in Jan., Apr. and Aug. 1983) Tremor periods in between Apr. and Aug. 1983 typically 4 min. duration at 40 min. intervals.
BVE No. 23, p. 57.

SWARM DATE: 84/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM VII at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1984.

Volcano seismicity = 0-7 small amplitude events per day. A strong regional earthquakes (M6.5, 4 S 23', 145 E 52', depth 23 km) on Mar. 27 (MM VII resulted in landslides on walls of summit calderas). A 56 urad offset recorded but patterns of tilt before and after the earthquakes were flat.
BVE No. 24, p. 62.

SWARM DATE: 85/3/1 ±0.5 Dur. (days): 75 ±1 Type:3 Event type(s):LF Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: There was a steady increase in the numbers of low frequency events between the 1st and 9th; activity started to decrease on May 6th until it reached its pre-Mar. level by May 14.

In Mar. there was an increase in seismic activity at Karkar. There was a steady increase in the numbers of low frequency events between the 1st and 9th from less than 10 events per day to 70 events per day. The activity leveled off during the month but intensified on the 31st when about 150 events were recorded. A decline in seismic activity was evident in early Apr. and from the 7th to the 24th less then 10 events per day were recorded. However, on the 25th an increase of seismic activity again occurred. A peak in activity was reached on 5 May when 225 events were recorded, but activity started to decrease on the 6th until it reached its pre-Mar. level of less than 10 events per day on 14 May.
BVE No. 25, p. 57.
Communication from: B.Talai, Rabaul Volcanological Observatory, P.O. Box 386, Rabaul, Papua New Guinea

LONG ISLAND New Guinea-NE of 5.36 S 147.12E *VOTW num.*:0501-05=

Morphology: strato with caldera *Tectonic framework:* Convergent (arc)

Elevation above m.s.l. : 320 m *Edifice relief :* 2300 m

Range of eruptive products: basaltic andesite to andesite

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1985.

A seismograph operated on the western shore of Lake Wisdom on 10 Nov. and on Motmot from 11 to 13 Nov. recorded a few small local earthquakes, but their significance was uncertain.

BVE No. 25, p. 58.

Communication from: H.Patia, Rabaul Volcanological Observatory, P.O. Box 386, Rabaul, Papua New Guinea

UMBOI New Guinea-NE of 5.59 S 147.88E *VOTW num.*:0501-06=

Morphology: strato with caldera *Tectonic framework:*

Elevation above m.s.l. : 1495 m *Edifice relief :* 2400 m

Range of eruptive products:

SWARM DATE: 85/9/11 ±0.5 Dur. (days): 4 ±1 Type:3 Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 9
Felt total : 2
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS

Tremor :	Migration :
Deformation : Y	Focal mech:
Gravity :	EQ families :
Magnetic :	Rumbling :
Geothermal : Y	

Key phrase: Nine local earthquakes were recorded from 11-14 Sept.

Nine local earthquakes were recorded from 11-14 Sept., of which 2 were reportedly felt. These earthquakes are probably local to Umboi Island, but it is uncertain whether they are directly related to the volcano. The seismograph recordings indicate that earthquakes were continuing at a low level in mid-Sept.

BVE No. 25, p. 58.

P. Lowenstein, Rabaul Volcanological Observatory, P.O. Box 386, Rabaul, Papua New Guinea. From: SEAN Bulletin, vol. 10, 1985, no. 9, p. 6

LANGILA New Britain-SW Pac 5.53 S 148.42E *VOTW num.*:0502-01=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l.: 1189 m *Edifice relief :* 2400 m
Range of eruptive products: basalt

SWARM DATE: 80/1/19 ± Dur. (days): ± Type:2a? Event type(s):B Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II, RVO	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal :

Key phrase: Place holder for Jan 19 eruption. Vent forming eruption produced strong seismic event.

Vent forming eruption produced strong seismic event recorded 11km away Jan. 19. 1980. Unfelt: frequent B-type and occasional vulcanian shocks.
BVE No. 20, p. 24-25.

SWARM DATE: 80/10/25 ±5 Dur. (days): 20 ±5 Type:2a? Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II, RVO	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal :

Key phrase: Seismicity strengthened in late Oct with corresponding eruptive activity at both craters.

Unfelt: frequent B-type and occasional vulcanian shocks. Through the year seismicity was at low levels (occasional vulcanian explosions with B-type low intensity events).
Seismicity strengthened in late Oct. with corresponding eruptive activity at both craters. Intensity was 20 times normal at this time. Phase of effusive activity at crater 3 did not produce significantly stronger seismicity.
BVE No. 20, p. 24-25.

SWARM DATE: 81/6/5 ±5 Dur. (days): ± Type: Event type(s):E,t Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II, RVO	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal : Y

Key phrase: Place holder for 1981. In early Jun. 1981, large amplitude vulcanian explosion earthquake became common.

Seismicity at low levels for first 5 months of year with onset of explosive ash emission at crater 2 in early Jun. 1981, large amplitude vulcanian explosion earthquake became common. Periods of harmonic tremor (continuous) were associated with prolonged gas and tephra venting at crater 2 and presumed resonance effects in crater 2 lava conduit.
When crater 3 became more active in Oct. 1981 the seismicity was dominated by frequent, brief, small amplitude events consistent with observed Strombolian activity. Total number of events: uncertain, seismograph unoperational.
BVE No. 21, p. 24-25.

LANGILA New Britain-SW Pac		5.53 S 148.42E *VOTW num.*:0502-01=
Morphology: strato or composite	*Tectonic framework:* Convergent (arc)	
Elevation above m.s.l. : 1189 m	*Edifice relief :* 2400 m	
Range of eruptive products: basalt		

SWARM DATE: 82/1/11 ±0.5 Dur. (days): 12 ±1 Type:2a Event type(s):E Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MKII	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal :

Key phrase: From Jan. 11 up to 20 large explosion earthquakes accompanied vulcanian ash clouds recorded daily until Jan. 23.

Three swarms in 1982
From Jan. 11 up to 20 large explosion earthquakes accompanied vulcanian ash clouds recorded daily until Jan. 23.
Unfelt : recorded.

BVE No 22, p. 25-26.

SWARM DATE: 82/2/13 ±0.5 Dur. (days): 2 ±0.5 Type:2a? Event type(s):B Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II, RVO	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal :

Key phrase: Feb. 13-14 accompanying strongest explosions were sub-continuous B-type events

Feb. 13-14 accompanying strongest explosions were sub-continuous B-type events with several vulcanian explosion earthquakes per day.
Unfelt : recorded.
BVE No. 22, p. 25-26.

SWARM DATE: 82/5/5 ±0.5 Dur. (days): 4 ±1 Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal :

Key phrase: Place holder for continuous harmonic tremor on May 5-9.

May 5-9 Continuous harmonic tremor recorded at peak of Strombolian activity was gradually replaced with Strombolian earthquakes as vulcanian activity set in. Unfelt : recorded.
BVE No. 22, p. 25-26.

SWARM DATE: 83/7/5 ±5 Dur. (days): 7 ±5 Type: Event type(s):E,B,t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling : Y
		Magnification : 10 K	Geothermal :

Key phrase: Largest amplitude tremors recorded in the first week of July

Explosion quakes (0-5/day) and occasional period of harmonic tremor.
Jan and Feb. most violent explosions registered 9 km away as large amplitude event of period 1.3- 1.5 Hz, while eruptive activity generated discontinuous tremor. Explosions in May were followed by half hour periods of tremor and rumblings. Largest amplitude tremors recorded in the first week of July and early Aug.
Overall unfelt shocks : variable rates of Vulcanian explosion shocks and B-type events.
BVE No. 23, p.15-16.

LANGILA New Britain-SW Pac 5.53 S 148.42E *VOTW num.*:0502-01=
Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1189 m *Edifice relief :* 2400 m
Range of eruptive products: basalt

SWARM DATE: 83/8/5 ±5 Dur. (days): 5 ±5 Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling : Y
		Magnification : 10 K	Geothermal :

Key phrase: Largest amplitude tremors recorded in early Aug.

See Jul. 5, for additional comments.

BVE No. 22, p. 25-26.

SWARM DATE: 83/12/25 ±5 Dur. (days): 5 ± Type: Event type(s):t,E,B Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component :	Gravity : EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification : 10 K	Geothermal :

Key phrase: Place holder for 1983. Late Dec. saw long period of continuous harmonic tremor recorded.

Late Dec. saw long period of continuous harmonic tremor recorded which increased in amplitude at time of maximum activity.
Overall unfelt shocks : variable rates of Vulcanian explosion shocks and B-type events.

BVE No. 23, p. 15-16.

SWARM DATE: 84/7/1 ±183 Dur. (days): ± Type:1e Event type(s):E,B,t Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling : Y
		Magnification : 10 K	Geothermal :

Key phrase: Place holder for 1984.

The seismic station 10 km away recorded discontinuous tremor and large explosion earthquakes associated with the eruptive activity. This phase of stronger activity terminated with an explosion on 7 Feb. which sent an ash cloud to 3 km above crater 2. Eruptive activity subsided from late May and seismicity was at a very low level during this period and consisted of occasional small amplitude volcanic events. Unfelt : variable rates of Vulcanian shocks and B-type events.

BVE No. 24, p. 18.

SWARM DATE: 85/1/29 ±0.5 Dur. (days): 32 ±3 Type:1e Event type(s):LF Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: Duration from fig. BVE No. 25, p. 16. Througout Feb. there were many low-frequency earthquakes.

Seismicity from the volcano consisted of mostly low frequency events which were often associated with observed summit explosions. During periods of stronger activity, harmonic tremor, usually with a period of about 1 sec., was often recorded for durations of a few minutes to a few hours.
Throughout Feb. there were frequent explosions, up to 20 per day. during this period there ,were many low frequency earthquakes, and short durations of harmonic tremor (a few tens of minutes). Good fig. Daily numbers of LF and tremor durations.

BVE No. 25, p. 16-17

LANGILA New Britain-SW Pac 5.53 S 148.42E *VOTW num.*:0502-01=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1189 m *Edifice relief :* 2400 m
Range of eruptive products: basalt

SWARM DATE: 85/6/20 ±3 Dur. (days): 118 ±6 Type:1e Event type(s):LF Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: Duration picked from Daily count data in the BVE No. 25, p. 16.

See Jan. 29 for additional comments.

BVE No. 25, p. 16-17.

SWARM DATE: 86/1/15 ±15 Dur. (days): 45 ±15 Type:1e Event type(s):LF Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 10 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: Seismicity during (Jan.-Feb.) was moderate with up to 30 low-frequency earthquakes per day.

Seismicity during (Jan.-Feb.) was moderate with up to 30 low-frequency earthquakes per day. Most of these were associated with Vulcanian explosions. Periods of low-frequency tremor were also recorded in Jan. Two periods of high-frequency sub-continuous tremor-like signal were recorded in February (6th-11th and 21-25th) were possibly related to heavy rainfall.
Between the 7th and 29th May, seismicity was characterized by high frequency explosion earthquakes. Intervals of low frequency harmonic tremor were recorded during April.
The eruptive activity subsided rapidly at the end of May to a low level. Seismicity was at a low level and only a few volcanic earthquakes were recorded.

BVE No. 26, p. 16-17.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 10 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: Place holder 1987. A moderate increase in eruptive activity began the second week of Nov. seismicity showed no significant change.

Activity remained at a low level from Jan. through Apr. Seismic activity remained low. On Apr. 12, and explosion occurred and an ash cloud rose to 3 km above the volcano. A moderate increase in eruptive activity began the second week of Nov. seismicity showed no significant change.

BVE No. 27, p. 15.

LANGILA New Britain-SW Pac		5.53 S 148.42E	*VOTW num.*:0502-01=
Morphology: strato or composite	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 1189 m	*Edifice relief :* 2400 m		
Range of eruptive products: basalt			

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

				OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent			
Max. Intensity: MM at	# Felt total :	Dist. to vent:	10 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Willmore MK II		Deformation :	Focal mech:
Detection threshold:1.2	Repose (yr.):	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	4 K	Geothermal :	

Key phrase: Place holder for 1988. Seismic activity from late-July to December remained at a steady low level with only a few explosion earthquakes recorded.

Between March and early April seismicity remained at a relatively low level, although discrete explosion events were recorded. Seismic activity from late-July to December remained at a steady low level with only a few explosion earthquakes recorded.

BVE No. 28, p. 19-20.

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s):LF,E Grade :

				OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent			
Max. Intensity: MM at	# Felt total :	Dist. to vent:	10 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Willmore MK II		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	4 K	Geothermal :	

Key phrase: Place holder for 1989. More activity in April, Oct., and Dec. the average amplitude of the low frequency earthquake rose by a factor of 2-3 and these events merged into periods of sub-continuous tremor lasting several minutes.

Mild explosive activity was reflected by the seismicity which consisted of a few tens to ~300 low frequency earthquakes per day with occasional low frequency explosion events (0-10 per day). More activity in April, Oct., and Dec. the average amplitude of the low frequency earthquake rose by a factor of 2-3 and these events merged into periods of sub-continuous tremor lasting several minutes.

BVE No. 29, p. 22-23.

ULAWUN New Britain-SW Pac 5.05 S 151.33E *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2300 m *Edifice relief :* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 80/10/3 ±0.5 Dur. (days): 3 ±0.5 Type:1b? Event type(s):A Grade : B

Max. Magnitude:	# EQ total : 9	Seismograph: temporary		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 0	Dist. to vent:	11 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Willmore MKII		Deformation : Y	Focal mech:
Detection threshold:1.3	Repose (yr.): 2.4	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	10 K	Geothermal : Y	

Key phrase: Unfelt shocks recorded, frequency = 0-3 per day, from 3 days prior.

Unfelt shocks recorded, frequency = 0-3 per day, S-P durations = 1-2 sec. from 3 days prior. Micro tremor frequent but more on Oct. 6 1980.

BVE No. 20, p. 26-28.

SWARM DATE: 81/7/1 ±183 Dur. (days): ± Type: Event type(s):B Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	3 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Willmore MK II		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	1 K	Geothermal :	

Key phrase: Place holder for 1981.

Until Dec., seismicity was recorded at a site at the NW base of the volcano about 11 km from the summit. New instrumentation, from a seismometer midway up the SW flank of the volcano, was installed on 9 Dec., and revealed that the volcano-seismicity consisted of frequent small B-type volcanic events, numbering up to about 1000 per day.

BVE No. 21, p. 87.

SWARM DATE: 82/5/25 ±5 Dur. (days): 10 ±10 Type:3 Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph:		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:		Tremor :	Migration :
Depth (km): ±	b-value :	Type:		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :		Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :		Magnetic :	Rumbling :
		Magnification :		Geothermal :	

Key phrase: Seismic amplitude's increased in late May and reached peak of 3 times normal in early Jun. before returning to normal.

Between Jan. and early May seismicity was stable. Mid-May numbers and amplitudes of B-type events decreased markedly. Daily total 1000-5000 but dropped to as little as 30 in May. Seismic amplitudes increased again by the end of May and reached peak of 3 times normal in early Jun. before returning to normal. Seismic amplitudes began increasing again in Nov. then fell to 2 times normal in late Nov. and mid Dec. A marked decline was evident from mid Dec. but a slight increase was noted in late Dec. Most changes in gas emissions corresponded with changes in seismicity.

BVE No. 22, p. 97.

ULAWUN New Britain-SW Pac 5.05 S 151.33E *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l.: 2300 m *Edifice relief:* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 83/1/25 ±5 Dur. (days): 285 ±15 Type:1aq Event type(s):B Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.9
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.): 2.3
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Unfelt B-type shocks recorded from 10 months prior.

Variations in seismicity were recorded from May 1982, and in 1983, a series of seismic crises took place.
Late Jan. intermittent phreatic explosions were characterized by small amplitude, low frequency earthquakes or by periods of tremor. The amplitudes of volcanic earthquakes began to increase in mid-Aug. and late in the month, the earthquakes began to occur more frequently. Unfelt: up to 3000/day.
microtremors: duration ~200 hrs. total period ~ 0.5 sec.
Figs: Daily earthquake counts and relative seismic amplitude.
BVE No. 24, p. 19-20.

SWARM DATE: 83/3/21 ±0.5 Dur. (days): 1.58 ±0.02 Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic crises occurred on 21-23 Mar. (38 hrs.).

A series of seismic crises took place during 1983. Between Mar. and Jul., seismic crises occurred on 21-23 Mar. (38 hrs.), 10 Apr. (12 hrs.), 17 Apr. (18 hrs.), 19 May (10 hrs.), 10-11 Jun. (15 hrs.), 15 Jun. (7 hrs.), 16 Jun. (7 hrs.), 17-18 Jun. (17 hrs.), and 30 Jun.-2 Jul. (48 hrs.). the common feature of these crises was continuous tremor. some crises commenced with tremor while others developed from frequent discrete volcanic earthquakes. Usually, the crises ended with a change from continuous to discontinuous tremor followed by discrete earthquakes in declining frequency. A number of crises were proceeded by a seismic lull of several hours duration.
BVE No. 23, p. 57-58.

SWARM DATE: 83/4/7 ±0.5 Dur. (days): 22 ±1 Type:1a? Event type(s):A Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: In addition to the seismic crises, a spat of A-type events took place on 7, 11, 12, 15, 16, and 20-29 of April.

See Mar. 21, 1983 for additional comments.
BVE No. 23, p. 57-58.

SWARM DATE: 83/4/10 ±0.5 Dur. (days): 0.5 ±0.02 Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic crisis occurred on 10 Apr. (12 hrs.).

See Mar. 21, 1983 for additional comments.
BVE No. 23, p. 57-58.

ULAWUN New Britain-SW Pac 5.05 S 151.33E *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2300 m *Edifice relief :* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 83/4/17 ±0.5 Dur. (days): 0.75 ±0.02 Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 3 km
Depth (km): ± b-value : Type: Willmore MK II
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic crisis occurred on 17 Apr. (18 hrs.).

See Mar. 21, 1983 for additional comments.

BVE No. 23, p. 57-58.

SWARM DATE: 83/5/19 ±0.5 Dur. (days): 0.42 ±0.02 Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 3 km
Depth (km): ± b-value : Type: Willmore MK II
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic crisis occurred on 19 May (10 hrs.).

See Mar. 21, 1983 for additional comments.

BVE No. 23, p. 57-58.

SWARM DATE: 83/6/10 ±0.5 Dur. (days): 0.63 ±0.02 Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 3 km
Depth (km): ± b-value : Type: Willmore MK II
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic crisis occurred on 10-11 Jun. (15 hrs.).

See Mar. 21, 1983 for additional comments.

BVE No. 23, p. 57-58.

SWARM DATE: 83/6/15 ±0.5 Dur. (days): 0.29 ±0.02 Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 3 km
Depth (km): ± b-value : Type: Willmore MK II
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic crisis occurred on 15 Jun. (7 hrs.).

See Mar. 21, 1983 for additional comments.

BVE No. 23, p. 57-58.

SWARM DATE: 83/6/16 ±0.5 Dur. (days): 0.29 ±0.02 Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 3 km
Depth (km): ± b-value : Type: Willmore MK II
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic crisis occurred on 16 Jun. (7 hrs.).

See Mar. 21, 1983 for additional comments.

BVE No. 23, p. 57-58.

ULAWUN New Britain-SW Pac 5.05 S 151.33E *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l.: 2300 m *Edifice relief:* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 83/6/17 ±0.5 Dur. (days): 0.7 ±0.02 Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: A seismic crisis occurred on 17-18 Jun. (17 hrs).

See Mar. 21, 1983 for additional comments.

BVE No. 23, p. 57-58.

SWARM DATE: 83/6/30 ±0.5 Dur. (days): 2 ±0.02 Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: A seismic crisis occurred on 30 Jun.-2 Jul. (48 hrs.).

See Mar. 21, 1983 for additional comments.

BVE No. 23, p. 57-58.

SWARM DATE: 83/9/7 ±0.5 Dur. (days): 2 ±1 Type:2a? Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: Seismic amplitudes were 30-40 times normal on Sept. 7th, and 8th and seismicity characterized by irregular tremor produced by frequent explosions.

See Jan. 25, 1983 for additional comments.

BVE No. 24, p. 19-20.

ULAWUN **New Britain-SW Pac** 5.05 S 151.33E *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2300 m *Edifice relief :* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 83/11/3 ±0.5 Dur. (days): 6 ±1 Type: Event type(s):B Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A major seismic crisis began on 3 Nov. Seismic activity remained at high levels until the 8th when it rapidly declined to normal.

The pattern of declining activity ended abruptly when a new and major seismic crisis began on 3 Nov. Weak discontinuous tremor began at about 19:00 LT when frequent B-type volcanic earthquakes of large amplitude began to be recorded. This activity continued over the following two days, but at about 02:00 LT on the 6th, the earthquakes became continuous. A series of large earthquakes was recorded between 08:00 and 10:00 LT, and during this period observers near the base of the volcano reported dark emissions from the summit crater.
Seismic activity and the rate of summit emissions remained at high levels until the 8th when they rapidly declined to normal. At the peak of this crisis, over 3000 volcanic earthquakes per day were recorded.
BVE No. 23, p. 57-58.

SWARM DATE: 83/12/23 ±0.5 Dur. (days): 3 ±1 Type: Event type(s):B,t Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Another seismic crisis occurred in Dec., between the 23rd and 26th.

Another seismic crisis occurred in Dec., between the 23rd and 26th. A period of two hours of continuous, low amplitude harmonic tremor was recorded on 23rd, and was followed by further periods of low amplitude continuous and discontinuous tremor and numerous large B-type earthquakes. No changes to the normal white vapor emissions were noted during this crisis.
BVE No. 23, p. 57-58.

SWARM DATE: 84/8/15 ±5 Dur. (days): 25 ±5 Type:1d Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from fig. (BVE No. 24, p. 19)

The amplitude of volcanic earthquake began to increase in mid Aug. and late in the month began to occur more frequently. See Jan. 25, 1983 for addition comments.
BVE No. 24, p. 19-20.

ULAWUN New Britain-SW Pac 5.05 S 151.33E *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2300 m *Edifice relief :* 3000 m
Range of eruptive products: basalt to basaltic andesite

<u>SWARM DATE:</u> 84/12/24 ±0.5 Dur. (days): 29 ±1 Type:1c Event type(s):B Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: Duration from fig. (BVE No. 25, p. 18) Following ~6 days of increasing seismicity a new eruption comenced ~Dec. 30 1984

At the peak of seismicity (~1600 earthquakes per day with ampl. ~ 20 times normal levels) on 8 Jan. weak ejections of tephra. Good fig: Daily number of volcanic earthquakes and relative amplitude.

BVE No. 25, p. 17-19.

<u>SWARM DATE:</u> 85/11/12 ±0.5 Dur. (days): 10 ±0.5 Type:1cq Event type(s):B Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: Seismic activity began to increase on 12 Nov. After reaching a peak at ~08:00 on the 22nd seismicity suddenly declined & within 2 hours the eruption ended.

Seismic activity began to increase on 12 Nov. with the appearance of occasional small discrete 'B' type volcanic earthquakes. These increased in size and number over the following 3 days. Activity continued to increase over the following 2 days with the appearance of harmonic tremor at 16:00 LT on the 17 Nov. At 20:00 Strombolian activity confirmed. Good fig: Daily counts and relative seismic ampl.

BVE No. 25, p. 17-19.

<u>SWARM DATE:</u> 86/1/22 ± Dur. (days): 3 ±1 Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: Between the 22nd and 25th of Jan., 300-500 events per day were recorded.

Activity was generally at a low level at Ulawun during 1986, although following the Nov. 1985 eruption, seismicity was still somewhat elevated in Jan. 1986. In early Jan., 100-200 volcanic earthquakes were recorded daily, and between the 22nd and 25th, 300-500 events per day were recorded. However, from Feb. until the end of the year, daily earthquake totals were less than 100.

BVE No. 26, p. 79.

<u>SWARM DATE:</u> 86/5/10 ±0.5 Dur. (days): 0.13 ±0.02 Type:3 Event type(s):LF Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: On May 10, low frequency volcanic earthquakes and harmonic tremor were recorded for about 3 hours.

On May 10, low frequency volcanic earthquakes and harmonic tremor were recorded for about 3 hours, and on the 13th and 15th of May, bursts of tremor lasting a few minutes were recorded. Through the year, visible activity consisted of weak to moderate emissions of white vapor.

BVE No. 26, p. 79.

ULAWUN New Britain-SW Pac		5.05 S 151.33E	*VOTW num.*:0502-12=
Morphology: strato or composite	*Tectonic framework:* Convergent (arc)		
Elevation above m.s.l. : 2300 m	*Edifice relief :* 3000 m		
Range of eruptive products: basalt to basaltic andesite			

SWARM DATE: 87/12/18 ±0.5 Dur. (days): 8 ±1 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 2850	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: Willmore MK II	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: A somewhat irregular increase began on 18 Dec. and reached a peak of about 800 events per day on 23 and 24 Dec. Earthquakes then decreased steadily, stabilizing at about 350 events per day after 26 Dec.

The daily totals of volcanic earthquakes increased on 2 Dec. and averaged about 150 until 17 Dec. A further, but somewhat irregular increase began on 18 Dec. and reached a peak of about 800 events per day on 23 and 24 Dec. Earthquakes then decreased steadily, stabilizing at about 350 events per day after 26 Dec. The summit was obscured throughout most of the period of increased seismicity.

BVE No. 27, p. 81.

ULAWUN **New Britain-SW Pac** **5.05 S 151.33E** *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2300 m *Edifice relief :* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: Willmore MK II
Component : Z
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for supplementary seismic information in 1988.

The stronger seismic activity, which began in Nov. 1987, continued in 1988 and persisted until late Jun. 1988. Large fluctuations were recorded in daily totals of low frequency earthquakes, from as little as 10 to ~ 1800. The amplitudes of these events was as much as 10 times normal (inter-eruptive) levels. In addition, periods of sub-continuous, irregular tremor were recorded. Typically, these periods of tremor lasted 1-3 hours an were interspersed with intervals of seismic quiet of similar duration.
From July until early Oct. seismicity was at a low level. No tremor was recorded and daily totals of low frequency earthquakes were less than 50.
Seismicity appeared to show a correlation with rainfall. The first half of the year (stronger seismicity) had been wet, while the period Jul.-Sept. (lower seismicity) was dry. When the wet-season started in early Oct., seismicity increased again. Between Oct. 5 and 25, higher daily totals of low frequency earthquakes were recorded, up to 575. Amplitudes of these events remained small. On Oct. 26, periods of low amplitude tremor lasting 1-2 hours began to be recorded. At the same time, accompanying low frequency earthquakes became stronger, and more frequent.
For the remainder of the year, the seismic records were characterized by bands of low amplitude tremor (BVE Fig. M2-I). These periods of tremor lasted 1-2 hours and the daily average number of tremor periods was 9 in Nov. and 8 in Dec. Daily totals of low frequency earthquakes peaked at 1055 on Nov. 19, and then following a decline increased again in the last week of Dec.
The pattern of periodic intervals of seismic tremor is reminiscent of the seismicity recorded for about 6 months before the 1979 eruption at Karkar Island. In that case, the "banded" seismicity was attributed to periodic subterranean hydrothermal activity similar to the activity of geysers (McKee et al., 1981). The correlation of seismicity with rainfall at Ulawun in 1988 is indicative of a hydrothermal source. (Information from: C. McKee, Rabaul Volcanological Observatory, P.O. Box 386, Rabaul, Papua New Guinea).

BVE No. 28, p. 88-89.
McKee, C.O. et al. (1981): Fatal hydro-eruption of Karkar volcano in 1979: development of a maar-like crater. In: R. W. Johnson (Editor), Cooke-Ravian Volume of Volcanological Papers. Geol. Surv. Papua New Guinea, Memoir 10, p. 63-84.

ULAWUN New Britain-SW Pac 5.05 S 151.33E *VOTW num.*:0502-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)

Elevation above m.s.l. : 2300 m *Edifice relief :* 3000 m

Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 88/10/5 ±0.5 Dur. (days): 66 ±1 Type:1c Event type(s):LF Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: Precursory seismicity started on Oct. 5, 1988, There were no more phases of eruption after Mar. 22. In 1989 seismicity declined irregularly.

The precursory seismicity started on Oct. 5, 1988, when daily totals of low freq. earthquakes began increasing. From Oct. 26, periods of low ampl. tremor lasting 1-2 hours began to be recorded. At the same time, accompanying low freq. earthquakes became stronger and more frequent. Through Nov. and Dec. the average daily number of tremor periods was 9 and 8 respectively. The final phase of precursory seismicity was a progressive increase in the daily totals of low freq. earthquakes through the last week of Dec. 1988. This increase coincided with a period of heavy rain fall.

Seismicity was stable at low levels through most of Feb. but began increasing late in the month and in early March was coincident with a period of heavy rain fall.

Seismicity subsided relatively from March 6-8 but returned to a moderately high level between March 8 and 15, though with a change in pattern; the tremor periods were replaced with a succession of discrete, emergent events. Following another period of strong rainfall (March 15) the moderately strong vapor plume was ash-laden (gray) until March 22. Seismicity showed a different response; it suddenly died out from medium intensity to virtually nothing on Mar. 17, after a period of strong tremor lasting ~10 min. Subsequently intensifying progressively until Mar. 20 when it rapidly rose from med. to high, but dropped suddenly to nil on Mar. 22

There were no more phases of eruption after March 22. In 1989 seismicity declined irregularly.

Unfelt shocks freq.: 575-1055/day for 66 days

Micro tremors: duration ca. 990 hours started Oct. 26,1988 ca. 15 hours per day, period ~0.5 sec.

BVE No. 29, p. 24-25.

RABAUL New Britain-SW Pac 4.27 S 152.20E *VOTW num.*:0502-14=

Morphology: caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 229 m *Edifice relief :* 1200 m
Range of eruptive products: basalt to andesite

SWARM DATE: 82/7/1 ±183 Dur. (days): ± Type: Event type(s):VT Grade :

Max. Magnitude: M 5.1
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1982.

Seismic network in N part of Blanche bay and extended S (total 9 stations). Seismicity essentially consists of shallow short period volcano tectonic earthquakes originating from 6 km to near surface depths. Longer period harmonic events are much less common. Typically swarms last from several (10) minutes to hours. M5.1 measured in period from Jan -Feb. 1982. Figs: seismicity, epicenter density contours.

BVE No. 22, p. 98-101.

SWARM DATE: 83/9/15 ±15 Dur. (days): 630 ±30 Type:3 Event type(s): Grade : B

Max. Magnitude: ML5.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 20199
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from fig. BVE No. 25, p. 58.

From 1971 to mid-1983 seismicity had shown a trend of progressively greater numbers of events in successive swarms. Depth = (0-4 km) , strongest magnitudes ML about 5.0, caldera floor uplift = 10 cm per yr. Since 1971 seismicity and uplift in greater numbers.

Month	#EQs	Max. M	Max. monthly tilt rate	Crises
Sept.	2135	4.2	50 ur	1
Oct.	5199	4.0	60	2
Nov.	5748	3.2	43	2
Dec.	7117	3.8	18	0

Figs: epicenter map.

BVE No. 23, p. 58.
BVE No. 25, p. 58.

SWARM DATE: 84/4/22 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: M 5.1
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration : Y
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1984

Linearly-increasing intensities of successive swarms of volcanic earthquake for past 12 years. Most seismicity occurring in swarms where tens to hundreds of events occurring in minutes to an hour are recorded. Most intense swarms where >=150 events per 24 hours. have been designated 'crises'. Almost all events are high frequency tectonic-like events. Between Jan-Apr. , 1984 average frequency 200-400 events per days peak strength on Mar. 3 with M5.1 quake. Peak freq. on Apr. 22 = 1700 events and included a M4.8 event. The frequency decayed to 100 per day by Sept. 1984. A M4.9 event occurred in crises culminating on Oct. 18 after resurgence of activity in early Oct. 1984. activity decayed after this. In total 19 seismic crises occurred in 1984. Earthquakes in the beginning of 'crises' tend to be concentrated in local area and include >= 1 events M>=3.0 following couple days, earthquakes tend to be all over. Figs: Monthly earthquake counts, epicenter maps.

BVE No. 24, p. 63-64.

RABAUL New Britain-SW Pac 4.27 S 152.20E *VOTW num.*:0502-14=

Morphology: caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 229 m *Edifice relief :* 1200 m
Range of eruptive products: basalt to andesite

SWARM DATE: 85/3/3 ±0.5 Dur. (days):<1 ± Type:3 Event type(s):HF Grade : C

Max. Magnitude: ML3.6
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 649
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Activity increased slightly during Mar. with a seismic crisis on the 3rd

Following the period of intense seismicity and ground deformation which led to a volcano alert at Rabaul Caldera during 1983 and 1984, the activity generally declined throughout 1985 (Fig. 1 in BVE No. 25). The earthquakes continued to occur mainly on the caldera ring-fault as in 1984, with the strongest concentrations on the northern and western portions of the fault (Fig. 2).
In Jan. and Feb., the numbers of earthquakes recorded in the caldera were 1297 and 1672, respectively. All the events were of small magnitude with the largest being ML 3.0.
Activity increased slightly during Mar. with a seismic crisis on the 3rd in the area west and northwest of Matupit Island. 649 earthquakes, including an ML 3.6 event, were recorded on the day of the crisis, and the total of earthquakes for the month was 2052.
BVE No. 25, p.58-59.

SWARM DATE: 85/5/11 ±0.5 Dur. (days): ± Type:3 Event type(s):HF Grade : C

Max. Magnitude: ML3.7
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: On May 11th a large earthquake (Ms 7.1) triggered the last seismic crisis which has occurred to date in the caldera.

On May 11th a large earthquake (Ms 7.1) 180 km to the southwest, was strongly felt (MM V) in Rabaul, and triggered the last seismic crisis which has occurred to date in the caldera. The crisis occurred on the western side of the caldera near Vulcan. The largest event had a magnitude of 3.7. There were no significant ground deformations associated with the seismic crisis.
Throughout the rest of the year, the numbers of earthquakes steadily decreased. By Aug.. the earthquake count (236 per month) had returned to levels similar to those before the volcano alert. In Dec. there were less than 50 events for the month.
BVE No. 25, p. 58-59.

RABAUL New Britain-SW Pac 4.27 S 152.20E *VOTW num.*:0502-14=

Morphology: caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 229 m *Edifice relief :* 1200 m
Range of eruptive products: basalt to andesite

SWARM DATE: 86/4/15 ±15 Dur. (days): 90 ±15 Type:3 Event type(s):HF Grade : B

Max. Magnitude: ML2.7	# EQ total : 6183	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Z	Gravity :	EQ families :
Cum. energy release: 2.3e+8 J	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :		Geothermal :	

Key phrase: A significant increase in seismicity was noted in Apr. this higher level of activity persisted until Jul.

During the first three months of 1986, seismicity was at levels similar to those observed before the 1983-85 crisis period (Mori et al., 1986). Monthly totals of caldera earthquakes were: January 72, Feb. 317, March 223. Only a few events were large enough to be located and these originated from the caldera fault zone. There were no caldera earthquakes of magnitude (ML) 2.0 or greater in this period, and the seismic energy release was less than 5e13 ergs. A significant increase in seismicity was noted in April (Fig. 1, BVE No. 25, p.58) when almost 1800 caldera earthquakes were recorded. This higher level of activity persisted until July. The total number of earthquakes recorded in this 4 month period was 6183. The average monthly totals of events from April-July was 1455 but, unlike previous periods of increased activity, no seismic crises occurred. Most of the events were located on faults bounding the caldera (Fig. 2, BVE No. 25, p.58), as in the period 1971-1985 (Mori and McKee, 1987), but a number occurred within the central part of the caldera block. These events appeared to be of different character to the normal caldera fault zone events in being emergent and of lower frequency and longer duration. The increase in duration was about 50%. The strongest caldera earthquake during this period was a magnitude ML2.7 event on 13 April, and the total seismic energy release was 2.3e5 ergs.

Activity declined in August, and a generally low level of activity persisted to the end of the year. Monthly earthquake counts (Fig. 1) ranged between 173 and 316 (average 261), and the total number of events for this 5 month period was 1306.

BVE No. 26, p 79-81.
Mori, J., and McKee, C. (1987): Outward dipping ring fault structure at Rabaul Caldera as shown from micro-earthquake locations. Science, vol. 235, p. 193-195.
Mori, J., McKee, C., Itikarai, I., Lowenstein, P., de Saint Ours, P., and Talai, B. (1986): Account and interpretation of the seismicity during the Rabaul seismo-deformational crisis September 1983 to July 1985. Geol. Surv. PNG. Rep., 96/26.

SWARM DATE: 86/11/25 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s): Grade : C

Max. Magnitude: ML3.0	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :		Gravity :	EQ families :
Cum. energy release: 5.2e+8 J	Previous swarms : Y	Natural period :		Magnetic :	Rumbling :
		Magnification :		Geothermal :	

Key phrase: A series of earthquakes on 25-26 November (maximum ML3.0).

Although earthquake counts were low, there was proportionally a greater number of stronger events than in the preceding period (Apr.-Jul.), which resulted in greater seismic energy release (5.2 x10e+15 ergs). Nearly all of this energy release was due to a series of earthquakes on 25-26 November (maximum ML3.0). The pattern of earthquake locations in this period resembles that of April-July, in which most events originated from the eastern and western segments of the caldera seismic zone, but a number occurred within the central part of the caldera block.

BVE No. 26, p 79-81.
Mori, J., and McKee, C. (1987): Outward dipping ring fault structure at Rabaul Caldera as shown from micro-earthquake locations. Science, vol. 235, p. 193-195.
Mori, J., McKee, C., Itikarai, I., Lowenstein, P., de Saint Ours, P., and Talai, B. (1986): Account and interpretation of the seismicity during the Rabaul seismo-deformational crisis September 1983 to July 1985. Geol. Surv. PNG. Rep., 96/26.

RABAUL New Britain-SW Pac 4.27 S 152.20E *VOTW num.*:0502-14=

Morphology: caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 229 m *Edifice relief :* 1200 m
Range of eruptive products: basalt to andesite

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s):HF Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1987. Seismicity at a low level in 1987.

Seismicity continued to decline during Jan.; 78 small events were recorded compared to 173 in Dec. In Feb. seismicity remained at a low level but increased to 155 recorded events from 78 in Jan. The earthquakes were concentrated at the NE and NW parts of the caldera seismic zone.
In Mar. seismicity was at a very low level; only 134 small events ware recorded. Seismicity remained at a very low level in April with 103 events recorded. Only 5 events were large enough to be located. All originated from the Greet Harbor area and 4 were immediately N of Tavurvur Volcano (4S14', 152E13') in the E part of the caldera.
Seismicity continued at a very low level, with 84 events recorded in May, compared to 103 in Apr. Of the 7 events that could be located 2 were outside the caldera NE of the city of Rabaul, an unusual location.
A low level of activity continued in Jun. with 128 caldera earthquakes. Most of the 19 located events in Jun. occurred on the NW part of the caldera seismic zone.
A low level of activity continued at Rabaul in July with 107 caldera earthquakes recorded, compared to 128 in Jun. About 20% of these caldera earthquakes for the month were located; normally only 5-10% of the recorded events are locatable. Most of the Jul. events were distributed in a broad NE-treading zone linking the NE and SW parts of the caldera.
In Aug. seismicity declined to its lowest level since the 1983-85 unrest: only 34 caldera earthquakes were recorded, compared to 78-155 per month in the last 7 months. There were periods of several consecutive days with no events and only 3 small events were recorded 13-20 Aug. The 6 located earthquakes were in the Greet Harbor and Karavia Bay areas (NE and E parts of the caldera).
In Sept. seismicity at Rabaul remained at a low level with 69 events. The 4 located events were in the Beehives area and N Blanche Bay (E part of the caldera).
Seismicity has remained at a very low level during Oct. with only 33 events recorded. The 10 events large enough to be located occurred in the Greet Harbor and Vulcan areas (NE and W-central caldera).
Seismicity has remained at a very low level during Nov.; only 34 events were recorded. The 8 events large enough to be located occurred in the Greet Harbor, Vulcan-Matupit Island areas (NE and W-central caldera).
In Dec., seismicity reached its lowest level since Sept. 1979; only 24 caldera earthquakes were recorded. The single event large enough to be located was beneath Tavurvur cone.
Table: Number of recorded small seismic events per month in 1987.

Month	1	2	3	4	5	6	7	8	9	10	11	12
Num.	78	155	134	103	84	128	107	34	69	33	34	24

fig: monthly totals 1972-1987.
BVE No. 27, p. 81-83.

RABAUL New Britain-SW Pac 4.27 S 152.20E *VOTW num.*:0502-14=

Morphology: caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 229 m *Edifice relief :* 1200 m
Range of eruptive products: basalt to andesite

SWARM DATE: 88/8/15 ±15 Dur. (days): <30 ± Type:3 Event type(s): Grade : B

Max. Magnitude: ML2.5	# EQ total : 1392	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: The largest monthly total of 1,392 events recorded in Aug. was due to a series of seismic swarms a total of 170 events were recorded on the 16th alone.

Through most of 1988, seismic activity at Rabaul Caldera was at a normal background level. The general trend of monthly totals of caldera earthquakes showed an increase from Jan. to Aug. and then a decline (BVE No. 28, p. 89, fig. M31). The largest monthly total of 1,392 events recorded in Aug. was due to a series of seismic swarms a total of 170 events were recorded on the 16th alone. This was the highest monthly earthquake total since Jun. 1986 when 1,570 events were recorded. Most of the earthquakes had ML < 2, however some larger events were recorded. Apr. 10 (2.8), Aug. 16 (2.1). Aug. 30 (2.5, 2.1), Oct. 30 (2.6). All of these shocks were felt on Matupit Island near the center of the caldera. The amount of seismic energy released was greatest in Apr. (1.2 x10e+15 ergs) compared to the total of 1.0 x10e+15 ergs for the rest of the year. Most of the locatable earthquakes in 1988 were concentrated around the NE, NW and W parts of the caldera seismic zone (BVE No. 28, p. 89 Fig. M3-2).
fig: monthly counts and epicenter map for 1988.

BVE No. 28, p. 89-90.

SWARM DATE: 89/10/20 ±0.5 Dur. (days): 1.5 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude: 2.7	# EQ total : 67	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: In Oct., a swarm took place; 83 events on Oct. 20-21.

Seismic activity remained at normal background levels through most of 1989, but increased late in the year. Monthly totals of caldera earthquakes were low between Jan. and Sept. with an average of 155 events per month. A progressive increase in activity took place between Oct. and Dec. with a total of 886 caldera earthquakes recorded in Dec. Most of the earthquakes in the period Oct. to Dec. occurred in small swarms. Over the whole year a total of 145 events were large enough to be located. This represents ~5% of the year's total. Depths ranged from near surface to 5 km. earthquake magnitudes were < M2.7. Seismic energy output for the year was 2.73 x10e15 ergs ~ 55% was released in Nov.
In Oct., a total of 2 swarms took place; 83 events on Oct. 20-21 and 67 events on Oct. 24. In Nov. there were 4 swarms, which occurred on Nov. 12 (36 events), 17-18 (138), 20 (39) and 24 (84). A few events from the swarms on Nov. 17-18 and 20 were weakly felt (MM II-III) on Matupit Island in the central part of the caldera. The swarms in Dec. occurred on 12 (52 events), 13 (121), 18 (45) and 24 (76), but none of the earthquakes in theses swarms were felt.
Fig: Num. of earthquakes. monthly totals, Epicenter map.

BVE No. 29, p. 95-96.

RABAUL New Britain-SW Pac 4.27 S 152.20E *VOTW num.*:0502-14=

Morphology: caldera *Tectonic framework:* Convergent (arc)

Elevation above m.s.l. : 229 m *Edifice relief :* 1200 m

Range of eruptive products: basalt to andesite

SWARM DATE: 89/10/24 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: | # EQ total : 67 | Seismograph: permanent | OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at | # Felt total : 0 | Dist. to vent: 1 km | Tremor : | Migration :
Depth (km): ± | b-value : | Type: | Deformation : Y | Focal mech:
Detection threshold: | Repose (yr.): | Component : | Gravity : | EQ families :
Cum. energy release: | Previous swarms : Y | Natural period : | Magnetic : | Rumbling :
Magnification : | Geothermal :

Key phrase: In Oct., a swarm took place; 67 events on Oct. 24.

See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

SWARM DATE: 89/11/12 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: | # EQ total : 36 | Seismograph: permanent | OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at | # Felt total : 0 | Dist. to vent: 1 km | Tremor : | Migration :
Depth (km): ± | b-value : | Type: | Deformation : Y | Focal mech:
Detection threshold: | Repose (yr.): | Component : | Gravity : | EQ families :
Cum. energy release: | Previous swarms : Y | Natural period : | Magnetic : | Rumbling :
Magnification : | Geothermal :

Key phrase: In Nov. there were 4 swarms, which occurred on Nov. 12 (36 events), 17-18 (138), 20 (39) and 24 (84).

See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

SWARM DATE: 89/11/17 ±0.3 Dur. (days): 1.5 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude: | # EQ total : 138 | Seismograph: permanent | OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at 1 km | # Felt total : 3 | Dist. to vent: 1 km | Tremor : | Migration :
Depth (km): ± | b-value : | Type: | Deformation : Y | Focal mech:
Detection threshold: | Repose (yr.): | Component : | Gravity : | EQ families :
Cum. energy release: | Previous swarms : Y | Natural period : | Magnetic : | Rumbling :
Magnification : | Geothermal :

Key phrase: In Nov. there were 4 swarms, which occurred on Nov. 12 (36 events), 17-18 (138), 20 (39) and 24 (84).

A few events were felt. See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

SWARM DATE: 89/11/20 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: | # EQ total : 39 | Seismograph: permanent | OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at 1 km | # Felt total : 3 | Dist. to vent: 1 km | Tremor : | Migration :
Depth (km): ± | b-value : | Type: | Deformation : Y | Focal mech:
Detection threshold: | Repose (yr.): | Component : | Gravity : | EQ families :
Cum. energy release: | Previous swarms : Y | Natural period : | Magnetic : | Rumbling :
Magnification : | Geothermal :

Key phrase: In Nov. there were 4 swarms, which occurred on Nov. 12 (36 events), 17-18 (138), 20 (39) and 24 (84).

A few events were felt.See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

SWARM DATE: 89/11/24 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: | # EQ total : 84 | Seismograph: permanent | OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at | # Felt total : 0 | Dist. to vent: 1 km | Tremor : | Migration :
Depth (km): ± | b-value : | Type: | Deformation : Y | Focal mech:
Detection threshold: | Repose (yr.): | Component : | Gravity : | EQ families :
Cum. energy release: | Previous swarms : Y | Natural period : | Magnetic : | Rumbling :
Magnification : | Geothermal :

Key phrase: In Nov. there were 4 swarms, which occurred on Nov. 12 (36 events), 17-18 (138), 20 (39) and 24 (84).

See Oct. 20, 1989 for additional comments.

BVE No 29. p. 95-96.

RABAUL New Britain-SW Pac 4.27 S 152.20E *VOTW num.*:0502-14=

Morphology: caldera *Tectonic framework:* Convergent (arc)

Elevation above m.s.l. : 229 m *Edifice relief :* 1200 m

Range of eruptive products: basalt to andesite

SWARM DATE: 89/12/12 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: # EQ total : 52 Seismograph: permanent
Max. Intensity: MM at # Felt total : 0 Dist. to vent: 1 km
Depth (km): ± b-value : Type:
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The swarms in Dec. occurred on 12 (52 events), 13 (121), 18 (45) and 24 (76).

None of the earthquakes in theses swarms were felt. See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

SWARM DATE: 89/12/13 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: # EQ total : 121 Seismograph: permanent
Max. Intensity: MM at # Felt total : 0 Dist. to vent: 1 km
Depth (km): ± b-value : Type:
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The swarms in Dec. occurred on 12 (52 events), 13 (121), 18 (45) and 24 (76).

None of the earthquakes in theses swarms were felt. See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

SWARM DATE: 89/12/18 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: # EQ total : 45 Seismograph: permanent
Max. Intensity: MM at # Felt total : 0 Dist. to vent: 1 km
Depth (km): ± b-value : Type:
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The swarms in Dec. occurred on 12 (52 events), 13 (121), 18 (45) and 24 (76).

None of the earthquakes in theses swarms were felt. See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

SWARM DATE: 89/12/24 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: # EQ total : 76 Seismograph: permanent
Max. Intensity: MM at # Felt total : 0 Dist. to vent: 1 km
Depth (km): ± b-value : Type:
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The swarms in Dec. occurred on 12 (52 events), 13 (121), 18 (45) and 24 (76).

None of the earthquakes in theses swarms were felt. See Oct. 20, 1989 for additional comments.

BVE No. 29, p. 95-96.

BAGANA Bougainville-SW Pac 6.14 S 155.19E *VOTW num.*:0505-02=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1702 m *Edifice relief :* 1360 m
Range of eruptive products: andesite

SWARM DATE: 83/9/28 ± Dur. (days): >92 ± Type:1d? Event type(s):B,A Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: After permanent telemetered network was installed on Sept. 28, 83 an avg. of 40-50 A-type and 200 B-type events/day were recorded in Oct., Nov., and Dec. 83.

Portable seismometer 2 km from summit recorded 540 B--type events and a few A-type events in 24 hr of recording. After permanent telemetered network was installed on Sept. 28, 83 an avg. of 40-50 A-type and 200 B-type events/day were recorded in Oct., Nov., and Dec. 83.

BVE No. 23, p. 16-17.

SWARM DATE: 84/10/19 ±0.5 Dur. (days): >27 ± Type:1d? Event type(s):VE,t Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: By Nov 8 frequency of volcanic earthquakes >1000 per day along with periods of large amplitude volcanic tremor occuring for several hours.

Decrease in eruptivity from Apr.-Sept. 1984 accompanied by low levels of seismicity >10 volcanic earthquakes per day of small magnitude. With new eruptivity in Oct. 1984 frequency of volcanic earthquakes form 10 to > 100 per day by Oct. 19, 1984. From Oct. 12 onward, volcanic tremor recorded (sub-continuous occasionally). By Nov. 8 frequency of volcanic earthquakes >1000 per day along with periods of large ampl. volcanic tremor occurring for several hours. Unfelt frequency <10 per day in 1983.

BVE No. 24, p. 20-21

SWARM DATE: 85/11/15 ±5 Dur. (days): 25 ±10 Type:2a? Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 150
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Seismicity increased in the middle of Nov. to about 60 events per day. However, there was a decline to 5-20 per day in late Dec.

A phase of stronger activity began in Oct. 1984 and continued until Feb. 1985. Seismicity was at a relatively low level and daily totals of volcanic events ranged from a few to about 20. Activity was at back to normal from Mar. to Nov. However, begining mid-Aug. until end of Oct. there was a slight increase in seismicity. The daily total of volcanic events ranged from 4 to 15. Seismicity increased in the middle of Nov. to about 60 events per day. However, there was a decline to 5-20 per day in late Dec.

BVE No. 25, p. 20.

SWARM DATE: 86/2/5 ±3 Dur. (days): 9 ±6 Type:1d? Event type(s):VE Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A period of stronger activity was preceded by several days of increased seismicity.

A moderate level of eruptive activity began in Nov. 1985 continued until mid Feb. This period of stronger activity was preceded by several days of increased seismicity including three periods of tremor 30 minutes long on 5-6 February.

BVE No. 26, p. 17-18.

BAGANA Bougainville-SW Pac 6.14 S 155.19E *VOTW num.*:0505-02=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1702 m *Edifice relief :* 1360 m
Range of eruptive products: andesite

SWARM DATE: 86/2/16 ±1 Dur. (days): 159 ±6 Type:1d? Event type(s):VE Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Daily number of volcanic earthquakes increased suddenly from about 60 to 175 by 16 Feb., but progressively declined to 30 by late Jul.

The daily number of volcanic earthquakes increased suddenly from about 60 to 175 by 16 Feb. and was still at a high level (> 100 events per day) by mid-Mar. before gradually decline to about 20 events per day by late-Mar. and then increased slightly again to about 50-70 events per day in Apr. and May. There was a further slight increase in the daily number of volcanic events to about 90-95 during the first half of Jun. but progressively declined to 30 by late Jul.

BVE No. 26, p. 17-18.

SWARM DATE: 86/8/15 ±5 Dur. (days): 35 ±10 Type:1d? Event type(s):VE Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Seismicity progressively increased to 70 events per day by mid-Aug. but declined to about 20 events daily in late-Sep.

Seismicity progressively increased to 70 events per day by mid-Aug. but declined to about 20 events daily in late-Sept. and was at a very low level (5 events per day) between Oct. and Dec.

BVE No. 26, p. 17-18.

SWARM DATE: 87/3/12 ±0.5 Dur. (days): 4 ±1 Type:1a Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Increased seismic activity on 12 and 15 Mar. was followed by a period of stronger activity beginning 27 Mar.

Visual observations and seismicity indicated that viscous lava extrusion was probably continuing at a low level in Jan. In Feb., seismic activity appeared to be unchanged from last month's low level. Eruptive activity continued through Mar. apparently accompanied by increased seismicity. Increased seismic activity on 12 and 15 Mar. was followed by a period of stronger activity beginning 27 Mar. that probably persisted through 1 or 2 Apr.

BVE No. 27, p. 15-16.

SWARM DATE: 87/4/6 ±0.5 Dur. (days):<1 ± Type:1e Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total : 60
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Seismicity increased considerably 16 Apr. when about 60 events were recorded.

Seismicity increased considerably 16 Apr. when about 60 events were recorded.

BVE No. 27, p. 15-16.

BAGANA Bougainville-SW Pac 6.14 S 155.19E *VOTW num.*:0505-02=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1702 m *Edifice relief* : 1360 m
Range of eruptive products: andesite

SWARM DATE: 87/9/1 ±0.5 Dur. (days): 8 ±1 Type:1a Event type(s):HF,t Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Eight days before this activity an increase of high-frequency earthquakes began.

On 8 Sept., between 06:00 and 08:00, a series of pyroclastic flows descended the east flank of Bagana. Eight days before this activity an increase of high-frequency earthquakes began. By about 5 Sept. seismicity had built up to several hundreds of these events per day. At the presumed time of the pyroclastic avalanches, a high-frequency tremor was recorded which lasted about 2 hours.

BVE No. 27, p. 15-16.

SWARM DATE: 88/10/7 ±0.5 Dur. (days): 1 ±0.5 Type:1d Event type(s):B,HF,E Grade : C

Max. Magnitude:	# EQ total : 1500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3.6 K	Geothermal :

Key phrase: Oct. 7 there was a swarm of 1,500 small high-frequency explosion type earthquakes recorded.

From the beginning of the year seismicity was at a low level and consisted of only a small number of B-type earthquakes (up to 15 per day). However. in early Sept. seismicity changed and began to include emergent, high frequency, long-duration events, interpreted to be the product of rock slides. The appearance of these events suggested a higher rate of lava effusion.

An aerial inspection of Bagana on Sept. 5 confirmed the seismic evidence of a higher rate of lava effusion. Seismic activity during Oct. was steady with up to 12 B-type events recorded daily. Rockfall events were occurring at a daily rate of 90-300. Seismicity in Nov. was low in the first few days (< 10 B-type events per day). However, on Oct. 7 there was a swarm of 1500 small-high frequency explosion type earthquakes recorded. Visual observation reports indicated rock slides possibly containing incandescent material, occurring on the E slopes on Oct. 6 and pale brown dust rising from the same area on Oct. 7th. Seismicity declined after Oct. 7th to a few high frequency events and about 15 rockslide events per day, indicating continuing slow steady extrusion of lava. Seismic monitoring of Bagana ceased on Dec. 2 as a result of civil disturbances. No reports of any unusual volcanic activity were received in Dec.

BVE No. 28, p. 20-21.

BAGANA Bougainville-SW Pac

6.14 S 155.19E *VOTW num.*:0505-02=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1702 m *Edifice relief :* 1360 m
Range of eruptive products: andesite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type:1d? Event type(s):LF Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification : 3.6 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1989.

Brief period of seismic monitoring , from Mar. 8 -Apr. 12 was dominated by relatively long-duration, high frequency , spindle-shaped events attributed to rockfalls on the margin of the active lava flow. Daily totals of these events 90-300. Monitoring resumed on Sept. 28. Consistent with visual observations, the seismograms contained a large number of rockfall events ~100-200/day. A few low and high freq. volcanic earthquake were also recorded daily. Activity during Oct.-Dec. 1989 was dominated by rockfall events with daily totals of 2-94 event. Low frequency events were recorded at 0-8 per day Oct., 0-4 per day in Nov. and Dec. Two swarms of discontinuous tremor were also recorded in Dec. (1/2 hour on 8th and 3 hours on 21st).

BVE No. 29, p. 26-27.

SWARM DATE: 89/12/8 ±0.5 Dur. (days): 0.02 ±0.02 Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification : 3.6 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A swarm of discontinuous tremor was recorded in Dec. (1/2 hour on 8th).

See Jul. 1, 1989 record for additional comments.

BVE No. 29, p. 26-27.

SWARM DATE: 89/12/21 ±0.5 Dur. (days): 0.02 ±0.01 Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: Mark L4C
Component : Z
Natural period : 1 s
Magnification : 3.6 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A swarm of discontinuous tremor was recorded in Dec. (3 hours on 21st).

See Jul. 1, 1989 record for additional comments.

BVE No. 29, p. 26-27.

AMBRYM Vanuatu-SW Pacific 16.25S 168.12E *VOTW num.*:0507-04=

Morphology: strato with caldera *Tectonic framework:*
Elevation above m.s.l. : 1334 m *Edifice relief :* 3800 m
Range of eruptive products: basalt

SWARM DATE: 89/4/29 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: none?	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : / Migration :
Depth (km): ±	b-value :	Type:	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : / Rumbling : Y
		Magnification :	Geothermal :

Key phrase: Place holder for Apr. 29, 1989 eruption. Local inhabitants said the eruption was normal for the volcano even though there were more small earthquakes than in 1986 or 1988.

On the night of Apr. 29, local inhabitants said the eruption was normal for the volcano even though there were more loud roaring noises and small earthquakes than in 1986 or 1988.

BVE No. 29, p. 28.
SEAN Vol. 14, no. 4, p. 16-17, 1989.

YASUR Vanuatu-SW Pacific 19.52S 169.43E *VOTW num.*:0507-10=

Morphology: strato or composite *Tectonic framework:*
Elevation above m.s.l. : 350 m *Edifice relief :* 4000 m
Range of eruptive products: andesite

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s):E,t Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1988.

During the Sept. 1988 observations, an average rate of 21.5 explosion earthquakes per hour was recorded. Each explosion results from the discharge of volcanic gas, while the high level of recorded volcanic tremor is correlated with the continuous gas discharge through the lava lake.

BVE No. 28, p. 22-23.

Indonesia

SORIK MARAPI Sumatra

0.69 N 99.54 E *VOTW num.*:0601-12=

Morphology: strato with crater lake *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2145 m *Edifice relief :* 1600 m
Range of eruptive products: andesite

SWARM DATE: 86/7/4 ±0 Dur. (days): 8 ±0.5 Type:1c Event type(s):VT Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 29
Felt total : 0
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 5 km
Type: Hosaka
Component : Z
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Duration from plot of volcanic earthquake amplitude vs. time.

Unfelt shocks 4 per day S-P 0.5 sec. Micro-tremors occurred 1 hour in total, maximum amplitude 5 um or 6 um at 5 km from the vent.
BVE No. 26, p. 19-20.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s):Tect,? Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1987.

In late Aug. 1987, seismic activity began to increase. By early Sept., near-surface earthquakes averaged about 7 per day and deeper, tectonic earthquakes averaged about 40 per day.
BVE No. 27, p. 83.

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s):Tect Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1989.

Normal activity continued in late July, with a weak gas plume reaching 5-10 m above the crater. 29 tectonic earthquakes (but no volcanic shocks) were recorded.
BVE No. 29, p. 96.
SEAN Bull., Vol. 14 no. 7, p. 8, 1989.

MARAPI Sumatra 0.38 S 100.47E *VOTW num.*:0601-14=

Morphology: compound or complex *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2891 m *Edifice relief :* 2000 m
Range of eruptive products: basalt to andesite

SWARM DATE: 87/1/8 ±0.5 Dur. (days): 7 ±1 Type:1b Event type(s):felt Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 7	Dist. to vent: 4 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.): 14	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: One felt shock per day from 7 days before the eruption. Unfelt shocks not recorded

BVE No. 27, p. 17.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type:2a Event type(s):LF Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: Place holder for 1988

The number of volcanic explosions was about 30 per day, compared to 20 per day in 1987. These explosions were accompanied by low frequency volcanic earthquakes occurring 2 - 5 times per day.

BVE No. 28, p. 23-24.

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type:1e? Event type(s):VE,E Grade :

Max. Magnitude:	# EQ total : 17000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: Place holder for 1989.

Earthquake counts are from Fig 13-1 on page 30 of BVE No. 29. About 1500 per month, the volcano was in almost continuous eruption for 1989.

BVE No. 29, p. 30-31.

KRAKATAU Indonesia

6.10 S 105.42E *VOTW num.*:0602-00=

Morphology: caldera
Tectonic framework: Convergent (arc)
Elevation above m.s.l. : 813 m
Edifice relief : 950 m
Range of eruptive products: basalt to andesite

SWARM DATE: 80/3/15 ± Dur. (days): ± Type:2a Event type(s):E Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:2.4
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: temporary
Dist. to vent: 60 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1980. A strong explosion on Sept. 9. The explosion was recorded on a seismograph 60 km away.

Mid Mar. explosions accompanied by detonations heard 60 km E of the volcano. A stronger explosion occurred at 00:39 on Sept. 9. The explosion rattled windows and shook houses in Pasauran, and a 3-4 cm amplitude was recorded on the seismograph there.

BVE No. 20, p. 35-36.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1988

Unfelt shocks recorded, frequency 1-5 per day. Micro-tremors recorded, period ca. 0.75 sec.

BVE No. 28, p. 24-26.

TANGKUBAN PARAHU Java   6.77 S 107.60E   *VOTW num.*:0603-09=

Morphology: strato or composite   *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2084 m   *Edifice relief :* 1300 m
Range of eruptive products: basalt to andesite

SWARM DATE: 83/9/5 ±5   Dur. (days): 70 ±10   Type:1d   Event type(s):A,B,t   Grade : B

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 30 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type:	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: At the beginning of Sept., seismicity increased sharply. Seismicity continued to increase through mid-Oct. Duration from figure.

Tangkuban Parahu has shown increased seismicity, thermal activity, and inflation during the past several months. As many as 7 shallow volcanic tremors per day in early Jun., 19 per day by early Aug. and 25 per day the last week in Aug. At the beginning of Sept., seismicity increased sharply from an average of 14 to between 60 and 74 events per day and by the middle of the month reached a daily average of 106-110. Epicenters were in the in the vicinity of Baru fumarolic field, on the W wall of crater 3. No deep volcanic earthquakes have been detected.
Seismicity continued to increase through mid-Oct. but no surface changes have been noted. Tectonic earthquakes and both A- and B-type micro-tremors were recorded. A-type events occurred irregularly, usually at 1-3 per day, but as many as 5 were detected on several days. B-type earthquakes increased substantially. Fig: Weekly deep and shallow earthquake counts

BVE No. 23, p. 59.

SWARM DATE: 85/4/15 ±15   Dur. (days): 210 ±15   Type:1bq   Event type(s):   Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification : 4 K	Geothermal : Y

Key phrase: Duration from figure in BVE No. 25.

Fig on p 22. Temperature of solfatara increased near the time of the eruption.
BVE No. 25, p 22.

SWARM DATE: 86/7/1 ±183   Dur. (days): ±   Type: Event type(s):VT.t   Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification : 4 K	Geothermal :

Key phrase: Place holder for 1986.

Seismic tremor was recorded at Kawah Batu on 17 Mar., from about 09:00 until 24:00. Tremor was again recorded briefly on 18 and 19 Mar. Fig. Monthly VT counts and temp.
BVE No. 26, p. 80.

GALUNGGUNG Java

7.25 S 108.05E *VOTW num.*:0603-14=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2168 m *Edifice relief :* 1820 m
Range of eruptive products: basalt to andesite

SWARM DATE: 82/4/4 ±0 Dur. (days): 0.26 ±0 Type:1b Event type(s):felt Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: temporary	Tremor : Y	Migration :
Max. Intensity: MM at	# Felt total : 1	Dist. to vent: 4 km	Deformation : Y	Focal mech:
Depth (km): ±	b-value :	Type: electromagnetic	Gravity :	EQ families : Y
Detection threshold: 1.4	Repose (yr.): 64	Component :	Magnetic : Y	Rumbling : Y
Cum. energy release:	Previous swarms :	Natural period : 1 s	Geothermal :	
		Magnification : 4 K		

Key phrase: Apr. 4 (22:00) felt earthquake at foot of volcano. At 24:00 rumbling followed by white fume. Eruption followed (VEI 4).

Apr. 4 (22:00) felt earthquake at foot of volcano. At 24:00 rumbling followed by white fume. Eruption followed (VEI 4).
Apr. 8 (21:08) Large explosions began 23 mininutes after M3.8 (felt).
May 6 (01:00) intermittent large explosions preceded by shallow quakes and tremors.
Sept. 20, 24, 27 Only Strombolian eruption always preceded by increase in amplitude of volcanic tremors.

BVE No. 22, p. 31-34.

SWARM DATE: 82/5/8 ±0 Dur. (days): 0.02 ±0 Type:1b? Event type(s):felt Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 3.8	# EQ total :	Seismograph:	Tremor :	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Large explosions began 23 mininutes after M3.8 (felt).

See Apr. 4, 1982 for additional comments.

BVE No. 22, p. 31-34.

SLAMET Java — 7.24 S 109.21E — *VOTW num.*:0603-18=

Morphology: strato or composite — *Tectonic framework:*
Elevation above m.s.l. : 3432 m — *Edifice relief :* 3400 m
Range of eruptive products: basalt to andesite

SWARM DATE: 88/7/12 ±4 Dur. (days): 4 ±0.5 Type:1c? Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.): 15
Previous swarms :

Seismograph: permanent
Dist. to vent: 6 km
Type: telemetered
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for tremor information in 1988.

On July 12, at 12:10, Slamet began to erupt after 15 years of quiesence. The eruption ceased mid-night July 13. Micro-tremors recorded-duration four days in total.

BVE No. 28, p. 26.

DIENG VOLCANIC COMPL Java 7.20 S 109.91E *VOTW num.*:0603-20=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2565 m *Edifice relief :*
Range of eruptive products: andesite

SWARM DATE: 86/4/15 ±15 Dur. (days): 45 ±15 Type:1aq Event type(s):VT Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 4 K	Geothermal : Y	

Key phrase: Duration taken from histogram of earthquakes (monthly bins).

Unfelt shocks: recorded; frequency: very small; S-P duration 1 sec.; Max. ground amplitude: 12 um at 1 km from the vent from 5 months before the eruption. Micro-tremors: recorded; max. amplitude 5 um at 1 km from the vent. Fig. monthly earthquake count for Mar. to Nov. 1986.

BVE No. 26, p. 21.

MERAPI Java 7.54 S 110.44E *VOTW num.*:0603-25=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2911 m *Edifice relief :* 2800 m
Range of eruptive products: basalt to andesite

SWARM DATE: 82/12/15 ±0.5 Dur. (days): 13 ± Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: eletromagnetic	Deformation : Y Focal mech:
Detection threshold:0.2	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 50 K	Geothermal :

Key phrase: Very weak volcanic tremors recorded from Dec. 15

Dec. 28, 1982 new lava was observed at the edge of the remaining old lava. Its appearance to surface was preceded by very weak volcanic tremors recorded from Dec. 15 by nearest seismometer 1 km away.

BVE No. 22, p. 35.

SWARM DATE: 84/6/7 ±0.5 Dur. (days): 8 ±1 Type:1b Event type(s):VT Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.6 km	Tremor : N Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:0.6	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Y Rumbling :
		Magnification : 50 K	Geothermal :

Key phrase: Unfelt shocks recorded at a frequency of 10 per day (avg.), with S-P durations of 0.5-2.0 sec., from 8 days before the eruption.

An eruption on Jun. 15 was immediately followed by the emergence of a new lava dome. The development of the dome was associated with a large number of shallow volcanic earthquakes and rock falls. mid June 84. Activity ceased at the end of Dec. indicated by remarkable decreases in the number of rockfall and earthquakes.
Unfelt shocks recorded at a frequency of 10 per day (avg.), with S-P durations of 0.5-2.0 sec., from 8 days before the eruption. No tremor recorded. 1 gamma magnetic anomaly.

BVE No. 24, p. 23.

SWARM DATE: 86/10/12 ±0.5 Dur. (days): 44 ±11 Type:1e Event type(s):VE Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.5 km	Tremor : N Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : .8 K	Geothermal : Y

Key phrase: From 12 Oct. 1986, shallow volcanic earthquakes suddenly increased from about 4 per day to 200 per day and continued until the end of Nov.

During the 6 days from 12 Oct. 1986, shallow volcanic earthquakes suddenly increased from about 4 per day to 200 per day. Such frequent occurrence of earthquake continued until the end of Nov.
Unfelt shocks occurred at a frequency of 10 per day from 7 days before the eruption.. S-P duration: none; Max. ground amplitude: +/- 0.7 um at 1.5 km for the vent; Micro-tremors: none.

BVE No. 26, p 22.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s):S Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : .8 K	Geothermal :

Key phrase: Place holder for 1987.

Seismic instruments recorded a significant decrease in the number of rockfall events in late Jan. and early Feb., suggesting that growth of the Oct.-Nov. lobe of the lava dome had ceased. Rock fall seismicity remained weak through early Mar.

BVE No. 27, p. 17-18.

MERAPI Java		7.54 S 110.44E *VOTW num.*:0603-25=
Morphology: strato with lava dome	*Tectonic framework:* Convergent (arc)	
Elevation above m.s.l. : 2911 m	*Edifice relief* : 2800 m	
Range of eruptive products: basalt to andesite		

SWARM DATE: 89/8/15 ±15 Dur. (days): 45 ±15 Type:1d? Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Mark L4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : .8 K	Geothermal :

Key phrase: Seismicity was generally increased in Sept. from Aug.

The seismicity was generally increased in Sept. from Aug. values, see table below: Number of volcanic earthquakes

	Jan.	Feb.	Aug.	Sept.
avalanche	416	208		
collapse		430	609	
volcanic	11	4		
multi-phase volcanic			50	34
B-type	2	0	2	2
A-type	0	0		
tectonic	70	65	64	279

BVE No. 29, p. 31.
SEAN Bull. Vol. 14, No. 11 p. 10 1989.

KELUT **Java** **7.93 S 112.31E** *VOTW num.*:0603-28=

Morphology: strato with crater lake *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1731 m *Edifice relief :* 1650 m
Range of eruptive products: andesite

SWARM DATE: 89/11/15 ±5 Dur. (days): 90 ±5 Type:1aq Event type(s):VT Grade : **A**

Max. Magnitude: Md2.0	# EQ total : 800	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.5 km	Tremor : Y Migration :
Depth (km): ±	b-value : 0.8	Type: Mark L-4C	Deformation : Focal mech:
Detection threshold:	Repose (yr.): 24	Component : Z	Gravity : EQ families : Y
Cum. energy release: 5.6e+8 J	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Duration determined from fig. in Lesage and Surono

Seismic activity and an increase of temperature and acoustic noise in the crater lake appeared three months before the eruption and were the main precursory signs of the eruption. During the pre-eruptive stage, the number of events was 8 per day on average and the cumulative seismic energy released was 5.6x10e+15 ergs. Seismic activity mainly consisted of swarms of very shallow VT earthquakes, many of which were part of seismic multiplets. In the last three weeks before the eruption, seismic activity remained at a very low level. This quiescent period was followed, 24 hours prior the eruption, by an intense swarm of low energy events which progressively became continuous spasmodic tremor.

Ph. Lesage and Surono, (in press): Seismic precursors of the February 10, 1990 eruption of Kelut Volcano, Java, JVGR.

SEMERU Java

8.11 S 112.92E *VOTW num.*:0603-30=

Morphology: strato with lava dome *Tectonic framework:*
Elevation above m.s.l. : 3676 m *Edifice relief :* 3620 m
Range of eruptive products: basalt to andesite

SWARM DATE: 81/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.5
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1981.

Almost constant eruptive activity. Unfelt shocks 66 per day .

BVE No. 21, p. 32-33.

SWARM DATE: 82/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.5
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1982.

For the year the explosion frequency per month ranged from 33 in Feb. to 491 in Mar the average being around 250. No seismic activity was reported.

BVE No. 22, p. 36-37.

SWARM DATE: 86/6/15 ±15 Dur. (days): 45 ±15 Type:1e Event type(s):VE Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7 km
Type: Hosaka
Component : 3
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration taken from monthly frequency of volcanic earthquakes figure.

Fig: frequency of volcanic earthquakes. From graph the numbers of earthquakes decrease from a high level of about 120 per month to 50 per month in Feb. through May. June and July show an increase to about 110 per month and then decrease to 20 per month by Oct.

BVE No. 26, p. 23.

SWARM DATE: 89/7/15 ±15 Dur. (days): 150 ±15 Type:1e Event type(s):A,B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 47
Felt total : 33
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration picked from fig.

Both A- and B-types of volcanic earthquake occurred most frequently in Oct. (fig. 15-2). During Mar. 3263 explosion earthquakes, 83 avalanche events, 33 strong and 5 local tectonic shocks, 5 nuee ardente signals and 2 A-type volcanic events. July 1-20 explosion 793, collapse 1, A-type 9, B-type 8, nuee ardente 11. From figure: A-type 47 B-type 100 between Jul. and Dec. Good figs. on p. 32 of BVE.

BVE No. 29, p. 32-33.
SEAN Bull. Vol. 14, no. 5 p. 15, no. 7 p. 8, 1989.

BROMO Java 7.95 S 112.95E *VOTW num.*:0603-31=

Morphology: cinder cone in caldera *Tectonic framework:*
Elevation above m.s.l. : 2329 m *Edifice relief :* 200 m
Range of eruptive products: basalt to andesite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s):G Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Place holder for 1989

Normal activity continued in July with weak white fumes rising 30-60 m above the summit. A total of 449 gas emission earthquakes were recorded.

BVE No 29, p. 97.
SEAN Bull. Vol. 14, no. 7 p. 8, 1989.

LAMONGAN Java

8.00 S 113.34E *VOTW num.*:0603-32=

Morphology: strato or composite
Tectonic framework:
Elevation above m.s.l. : 1651 m
Edifice relief : 1630 m
Range of eruptive products: basalt

SWARM DATE: 85/10/6 ±1 Dur. (days): 6 ±2 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 27.5 ±17.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Earthquake swarms occurred during Oct. 1985, and the peak of the events took place from Oct. 6 to 12

Earthquake swarms occurred in the westward area of Lamongan volcano during Oct. 1985, and the peak of the events took place from Oct. 6 to 12 (fig. 1, BVE No. 25, p. 59.). Distribution of the foci was between 10 and 45 km in depth. The swarms were associated with formation of fissures which are located mainly around maars, namely Lamongan, Pakis and Lading (Fig. 2, BVE no. 25, p. 59.).
Similar evidences took place in 1924/25 which resulted in formation of fissures of SW-NE direction on the west foot of Lamongan volcano, while the 1979 swarm associated with smaller fissures in north of Lamongan Volcano Observatory (Fig. 2). All of these earthquake swarms were not followed by any volcanic activity, even by change in temperature of solfataras or water surface of maars around the volcano. Fig: epicenter map.

BVE No. 25, p. 59.

SWARM DATE: 88/2/8 ±0 Dur. (days): 20 ± Type:3 Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A brief seismic swarm began on Feb. 8 at 04:45. Additional seismicity was recorded through Feb.

A brief seismic swarm centered immediately W of Lamongan cone began on Feb. 8 at 04:45. Additional seismicity was recorded through Feb. No changes have been noted in the temperature or behavior of the maar lakes within the epicentral region. The earthquakes occurred in virtually the same epicentral area as those from 1978 and 1985 swarms.(Information from : Volcanological Survey of Indonesia, 6th Floor, Hizon Bld., 20 Quezon Ave., Bandong, Indonesia. from SEAN Bulletin, vol. 13, no. 2, p. 14, 1988).

BVE No. 28, p. 90.

RAUNG Java — 8.13 S 114.04E *VOTW num.*:0603-34=

Morphology: strato with caldera — *Tectonic framework:* Uncert. Convergent (arc)

Elevation above m.s.l. : 3332 m — *Edifice relief :*

Range of eruptive products: basalt to andesite

SWARM DATE: 82/7/18 ±0 — Dur. (days): 2 ± — Type: — Event type(s):t — Grade : c

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS		
Max. Intensity: MM at	# Felt total : 1	Dist. to vent:	Tremor : Y	Migration :	
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:	
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :	
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :	
		Magnification :	Geothermal :		

Key phrase: Place holder for 1982 tremor information.

Activity began with weak tremor (July 18) at 3:00. On July 19 at 5:00 an earthquake was felt. Vibrations registered a max. ampl. of 3.9 mm at seismograph post for Ijen volcano (8.05S, 114.24W)

BVE No. 22, p. 37.

IJEN Java 8.06 S 114.24E *VOTW num.*:0603-35=

Morphology: strato with crater lake *Tectonic framework:*
Elevation above m.s.l. : 2386 m *Edifice relief :* 2100 m
Range of eruptive products: basalt to andesite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s):A,B,T Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: Place holder for 1989.

9 volcanic A-type, 4 volcanic B-type, 25 distant tectonic and 4 local tectonic earthquakes were recorded.

BVE No. 29, p. 97.
SEAN Bull vol. 14 no. 7 p. 9, 1989.

BATUR Lesser Sunda Is 8.24 S 115.38E *VOTW num.*:0604-01=

Morphology: strato with caldera *Tectonic framework:*
Elevation above m.s.l. : 1717 m *Edifice relief :* 686 m
Range of eruptive products: basalt to andesite

SWARM DATE: 89/11/15 ±5 Dur. (days): ± Type: Event type(s):VE Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 2
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1989.

Seismic stations recorded 1 local and 26 distant tectonic events, and 1 volcanic earthquake in Nov.

BVE No. 29, p. 97.
SEAN vol. 14, no. 11, p. 11, 1989.

AGUNG Lesser Sunda Is 8.34 S 115.51E *VOTW num.*:0604-02=

Morphology: strato or composite *Tectonic framework:*

Elevation above m.s.l. : 3142 m *Edifice relief :*

Range of eruptive products: andesite

SWARM DATE: 89/6/25 ±5 Dur. (days): 10 ±5 Type: Event type(s):Tect,B Grade : C

Max. Magnitude:
Max. Intensity: MM I at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 3
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: temp?
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: In late Jun., 69 tectonic, 3 volcanic B-type events were recorded.

In late Jun., 69 tectonic, 3 volcanic B-type events were recorded. An earthquake (MM I) was felt on June 9; 59 tectonic and 2 volcanic shocks were recorded in Nov.

BVE No. 29, p. 71-72.

SANGEANG API Lesser Sunda Is 8.18 S 119.06E *VOTW num.*:0604-05=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1949 m *Edifice relief :* 3950 m
Range of eruptive products: andesite

SWARM DATE: 85/4/29 ±0.5 Dur. (days): 90 ±7 Type:1b Event type(s):felt,A Grade : B

Max. Magnitude:
Max. Intensity: MM III at 5 km
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 900
Felt total : 90
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Unfelt shocks: 10 per day from 3 months before the eruption.

The activity was preceded by continuous felt tectonic earthquakes a few hours before the eruption. On 29 July, two felt events occurred. Felt shocks 1 per day, maximum MM intensity II-III at 5 km from the vent. Unfelt shocks occurred 10 per day from 3 months before the eruption. S-P duration 1.25 sec.
BVE No. 25, p. 24-25.

SWARM DATE: 87/3/15 ±15 Dur. (days): ± Type:1e Event type(s):Tect,VE Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place hoder for 1987. Twenty-two earthquakes were recorded during Mar.

Twenty-two earthquakes were recorded during Mar. Of these, 17 were of tectonic origin (deep) and 5 were volcanic (shallow).
Eruptive activity continued during Apr., May and Jun. with about 50 explosions per day. No earthquakes accompanied the explosions. In Jul., Aug., Sept., and Oct. about 45, 25, 25, and 18 explosions occurred per day, respectively. Plumes reached about 600 m above the crater rim. No earthquakes accompanied the explosions. The Oct. rate was the lowest since the eruption started in Jul. 1985.
BVE No. 27, p. 19.

ANAK RANAKAH Flores Island 8.61 S 120.61E *VOTW num.*:0604-071

Morphology: lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products: andesite to dacite

SWARM DATE: 87/12/28 ±0 Dur. (days): 0 ± Type:4 Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: temporary		
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 3 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 55 K	Geothermal :	

Key phrase: Unexpected eruption occurred on 28 Dec., 1987 at 22:00 in an area where there was no historic eruptions.

Unexpected eruption occurred on 28 Dec., 1987 at 22:00 in an area where there was no historic eruptions. Ash column reached a height ~500 m above the surface. No evidence of magmatic material was found in the deposit.
BVE No. 27, p. 20.

SWARM DATE: 87/12/30 ±0.5 Dur. (days): 5 ±1 Type:1b Event type(s):VT Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: temporary		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor : N	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 55 K	Geothermal :	

Key phrase: Unfelt shocks recorded frequency 126 per day, from 5 days before the lava extrusion.

Unfelt shocks recorded, frequency 126 per day, S-P 3 sec. Max. ground amplitude 0.5 um at 3 km from the vent from 5 days before the lava extrusion. Micro tremors were not recorded.
BVE No. 28, p. 29-30.

SWARM DATE: 89/11/15 ±15 Dur. (days): ± Type: Event type(s):Te,A,B,S Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: temporary		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 55 K	Geothermal :	

Key phrase: Place holder for 1989.

In Nov. 1989, a white plume rose to 25 m above the solfatara field between the older Poco Ranakah and the new Anak Ranakah lava dome which was constructed in 1988. A seismograph recorded 121 distant and 15 local tectonic earthquakes, 8 A-type and 2 B-type shocks and 87 collapse events.
BVE No. 29, p. 97-98.

ILI BOLENG Lesser Sunda Is 8.34 S 123.26E *VOTW num.*:0604-22=

Morphology: strato or composite *Tectonic framework:*
Elevation above m.s.l. : 1659 m *Edifice relief :*
Range of eruptive products: basalt to andesite

SWARM DATE: 82/11/15 ±0 Dur. (days): 2 ±0.5 Type:1b Event type(s):felt Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total : 1
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Eruption preceded by a moderately strong felt earthquake on 15 Nov at ~23:00.

An ash eruption began on Nov. 17 at 06:15. Eruption preceded by a moderately strong felt earthquake on 15 Nov. at ~23:00.

BVE No. 22, p. 38.

SWARM DATE: 86/11/14 ±0.5 Dur. (days): 10 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.): .5
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Hosaka
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling : Y
Geothermal :

Key phrase: Nov. 1986, when 10 days of increased seismicity preceded the first explosions in almost 6 months.

Ash eruptions occurred on Nov. 24 at 07:12 LT with rumbling. Dark ash column reached a maximum height of 1 km above the summit.

BVE No. 27, p. 20.
BVE No. 26, p. 24-25.

SWARM DATE: 87/6/20 ±0.5 Dur. (days): 5 ±1 Type:1a Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total : 100
\# Felt total :
b-value :
Repose (yr.): .92
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Hosaka
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The number of shallow volcanic earthquakes increased to about 20 per day 20-25 June, compared to 1 per day previously.

The number of shallow volcanic earthquakes increased to about 20 per day 20-25 June, compared to 1 per day previously. No eruptive activity has been reported since Nov. 1986, when 10 days of increased seismicity preceded the first explosions in almost 6 months. Several shallow volcanic earthquakes were recorded daily during early July. In late July, seismic activity had returned to low background levels.
During the week 9-15 Oct., about 13 tectonic and 11 volcanic events were recorded per day.

BVE No. 27, p. 20.

SWARM DATE: 89/7/15 ± Dur. (days): ± Type: Event type(s):Tect,A,B Grade :

Max. Magnitude:
Max. Intensity: MM II at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type: Hosaka
Component : Z
Natural period : 1 s
Magnification : 4 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: Place holder for 1989.

On July 15, an MM II earthquake was felt. 131 distant, 3 local tectonic, 2 volcanic A-type, and 144 volcanic B-type. The level of activity is slightly higher than normal.

BVE No. 29, p. 98.
SEAN Bull. vol.14, no. 7, p. 9, 1989.

ILIWERUNG Lesser Sunda Is		8.54 S 123.59E	*VOTW num.*:0604-25=
Morphology: strato or composite	*Tectonic framework:*	Uncert. Convergent (arc)	
Elevation above m.s.l. : 1018 m	*Edifice relief :*		
Range of eruptive products: basalt to andesite			

SWARM DATE: 83/8/16 ±0.5 Dur. (days):<1 ± Type:1b? Event type(s):felt Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total : 1	Seismograph: none		
Max. Intensity: MM I at	# Felt total : 1	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Place holder for 1983 eruption. One felt shock one day before the eruption.

One felt shock one day before the eruption.

BVE No. 23, p. 19.

SIRUNG Lesser Sunda Is 8.51 S 124.15E *VOTW num.*:0604-27=

Morphology: strato with caldera *Tectonic framework:*
Elevation above m.s.l. : 862 m *Edifice relief :*
Range of eruptive products: basalt to andesite

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: none	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1987.

A Volcanological Survey of Indonesia observer visited the volcano on 12 Dec. 1987. Fumaroles and the crater lake were normal and showed no evidence of increased activity that might be attributed to the magnitude 5.6 earthquake of 26 Nov. 1987. The only notable change in the crater was a fresh landslide scar that may have resulted from the earthquake. Sirung's last reported eruption was in 1970.

BVE No. 27, p. 83.

BANDA API Banda Sea		4.53 S 129.87E *VOTW num.*:0605-09=
Morphology: caldera with strato	*Tectonic framework:*	
Elevation above m.s.l. : 685 m	*Edifice relief :* 1150 m	
Range of eruptive products: andesite		

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1987.

A magnitude 6.7 tectonic earthquake occurred 150 km SE of the volcano on 17 June 1987. Activity consisting of a white plume, reaching 100 m above the crater was repeatedly observed after the earthquake. However, photographs taken during a climb to the crater 24-26 April showed no plume or gas emission. On 8 September, 8 earthquakes were recorded at the Banda Api Observatory post. No change in the activity of the volcano was noted.

BVE No. 27. p. 83.

SWARM DATE: 88/4/20 ±0.5 Dur. (days): 18 ±1 Type:1b Event type(s):VE,felt Grade : B

Max. Magnitude: 3.7	# EQ total : 2110	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM IV at 2 km	# Felt total : 156	Dist. to vent: 2 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation : / Focal mech:
Detection threshold:	Repose (yr.): 99	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Volcano became (seismically) active on April 20, 1988, and erupted on May 9.

After a 99 years of dormancy, Banda Api Volcano became active on April 20, 1988, and erupted on May 9. The number of volcanic earthquakes has increased since April 25, up to an average of 6 - 8 events per day Normally 1 - 2 events per day. In May felt shock recorded as follows :

On May 4 : 2 events, M2.8
5 : 11 events, M3.7
6 : 11 events, M3.7
7 : since 06:16, in average, Felt. shocks ; every 30 minutes, unfelt shocks ; every 5 minutes.
8 : felt shocks; every 15 minutes, unfelt shocks ; every 1 minute.
9 : Between 01:00 and 04:15 unfelt shocks recorded almost continuously. At 04:15 volcanic tremors recorded followed by explosion earthquake at 06:30. Felt shocks occurred at a frequency of 2-60 per day from 5 days before the eruption. Unfelt recorded 6-8 per day S-P <3 sec. from 18 days before the eruption. Micro-tremors recorded 2 hours total duration with a period of 0.2 seconds.

BVE No. 28, p. 30-32.

BANDA API Banda Sea 4.53 S 129.87E *VOTW num.*:0605-09=

Morphology: caldera with strato *Tectonic framework:*

Elevation above m.s.l. : 685 m *Edifice relief :* 1150 m

Range of eruptive products: andesite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s):A,B,G Grade :

Max. Magnitude:	# EQ total :	Seismograph: temp?	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Place holder for 1989.

After the eruption of May 9-15, 1988 the activity of the volcano approached background level by Jul. 1989. White weak fumes were observed during the last week of July. Three volcanic A-type, 49 B-type, 1 degassing, and 165 tectonic earthquakes were recorded.

BVE No. 29, p. 98.
SEAN Bull. Vol. 14, no. 7 p. 9-10, 1989.

COLO [UNA UNA] Sulawesi-Indonesia 0.17 S 121.61E *VOTW num.*:0606-01=

Morphology: strato with crater lake *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 508 m *Edifice relief :* 2000 m
Range of eruptive products: andesite

SWARM DATE: 83/7/4 ±0.5 Dur. (days): 24 ±1 Type:1c Event type(s):felt Grade : B

Max. Magnitude: M 4.6
Max. Intensity: MM V at 6 km
Depth (km): 16 ±16
Detection threshold:
Cum. energy release:

EQ total : 400
Felt total : 1
b-value :
Repose (yr.): 85
Previous swarms :

Seismograph: temporary
Dist. to vent: 6 km
Type: Teledyne telemetered
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Activity commenced with felt earthquake on Jul 4.

Activity commenced with felt earthquake on Jul. 4, frequency increased from 10 per day to 40 on Jul. 14. On Jul. 19 frequency = 110 per day and measured 4.6 on Richter. The numbers declined form July 21 to 22 but again increased from Jul. 25 to 28. Epicenters located ~ 6 km S of Una Una and depth of hypocenter < 33 km. Telemetered seismograph installed on island and recorder installed at Ampana, 70 km S of vent. Island jolted by continuous earthquakes from Jul. 4. The major eruption occurred on Jul. 23.
Micro-tremors: recorded. No eruption in 85 years.
BVE No. 23, p. 20-21.

SOPUTAN Sulawesi-Indonesia 1.11 N124.72E *VOTW num.*:0606-03=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1784 m *Edifice relief* :
Range of eruptive products: basalt to andesite

SWARM DATE: 84/8/6 ±0.5 Dur. (days): 19 ±1 Type:1aq Event type(s):A,B Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.): 11
Previous swarms :

Seismograph: temporary
Dist. to vent: 9 km
Type:
Component :
Natural period :
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increase in seismicity on Aug. 6 1984 , all seismicity ceased from Aug. 25, until time of eruption on Aug. 26.

Eruption preceded by increase in seismicity on Aug. 6 1984 starting Aug. 14 a sequence of tremor recorded. Irregular numbers of A and B-type events averaging 1-2 per day. Curiously all seismicity ceased from Aug. 25, until time of eruption on Aug. 26. Micro tremors from 17 days prior.

BVE No. 24, p. 25.

SWARM DATE: 85/3/15 ±15 Dur. (days): 65 ±15 Type:1bq Event type(s):V,felt Grade : B

Max. Magnitude: M 5.6
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 300
Felt total : 3
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A notable increase in volcanic earthquakes were observed in April 1985.

A notable increase in volcanic earthquakes were observed in April 1985. On May 18, following the occurrence of felt shocks in April - early May, Soputan began to emit dense smoke up to 250m high from the main crater. Earthquake counts estimated from figure. Magnitude from fig. in Newhall and Dzurisin (1988).

BVE No. 25, p. 26.
Newhall and Dzurisin, (1988): Historical Unrest at Large Calderas of the World, USGS Bull. 1855.

SWARM DATE: 89/4/22 ±0.5 Dur. (days): 0.29 ±0 Type:1c Event type(s):t Grade : b

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 5 km
Type: Radio Telseismograph
Component : Z
Natural period : 1 s
Magnification : 64 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1989 tremor information.

April 22 at 10:20 (LT = GMT+8) tremor was recorded 17 minutes later, the eruption occurred. Duration of tremor 7 hours in total, ~3 sec period.

BVE No. 29, p. 34.

LOKON-EMPUNG Sulawesi-Indonesia 1.36 N124.79E *VOTW num.*:0606-10=

Morphology: strato or composite *Tectonic framework:*
Elevation above m.s.l. : 1579 m *Edifice relief :*
Range of eruptive products: basalt to andesite

SWARM DATE: 86/4/14 ± Dur. (days): 90 ± Type:1b? Event type(s):Tect Grade : C

Max. Magnitude:	# EQ total : 270	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at 5 km	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Unfelt shocks recorded from 3 months before the eruption.

On July 10, 1986, a strong earthquake was felt M6.5 on the Richter scale (PDE July 9 23:10 1.95N, 126.59E depth 53 Mb 6.2). Four days later eruption occurred on July 14, at 12:23. Tremor duration 6 hours total, ca. 0.4 sec. period. A strong earthquake was felt on Aug. 15 03:39, the epicenter was the same as the July 10 earthquake.

BVE No. 26, p. 25-27.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type:1e Event type(s):Tect Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 1	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Place holder for 1987.

Some seismicity was recorded but was reported as tectonic.
During the first half of Apr., an average of 15 tectonic earthquakes were detected daily, but no seismic activity was reported for the second half of the month.

BVE No. 27, p. 21.

SWARM DATE: 88/4/14 ±1 Dur. (days): 7 ±2 Type:1b Event type(s):VE Grade : C

Max. Magnitude:	# EQ total : 2	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 1	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Place holder for 1988.

Two volcanic earthquakes were recorded one week before the April activity.

BVE No. 28, p. 32.

MAHAWU Sulawesi-Indonesia 1.36 N124.86E *VOTW num.*:0606-11=

Morphology: strato or composite *Tectonic framework:*
Elevation above m.s.l. : 1331 m *Edifice relief :* 630 m
Range of eruptive products: basalt to andesite

SWARM DATE: 87/4/23 ±1 Dur. (days): 68 ±2 Type:3 Event type(s):Tect,VE Grade : B

Max. Magnitude:	# EQ total : 952	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal : Y

Key phrase: During the last week of Apr., tectonic earthquakes occurred at a rate of about 9 per day and shallow volcanic events at about 5 per day.

Beginning on 17 Apr. 1987, a white plume was observed about 100 m above the Mahawu summit crater. The plume persisted into early May. Between 1 and 22 Apr., tectonic earthquakes occurred at a rate of 1 per day, with no shallow volcanic earthquakes. During the last week of Apr., tectonic earthquakes occurred at a rate of about 9 per day and shallow volcanic events at about 5 per day.

The whitish plume was continuously present above the summit in May and Jun. Both tectonic and volcanic earthquakes had increased at the end of Apr. and continued to be recorded in May, Jun. and Jul. By 30 Jun., the crater lake volume had increased to 45,000 m3 and water temperature had increased to 48C.

BVE No. 27, p. 83.

API SIAU Sangihe Is-Indonesia 2.78 N125.48E *VOTW num.*:0607-02=

Morphology: strato or composite *Tectonic framework:*
Elevation above m.s.l. : 1784 m *Edifice relief :* 2700 m
Range of eruptive products: andesite

SWARM DATE: 84/1/23 ±0.5 Dur. (days):>30 ± Type:1e Event type(s):felt Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM II at 5 km	# Felt total :	Dist. to vent: 5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Felt shocks: 1 per month before the eruption.

Unfelt shocks: 10 per day S-P 1.25. Max. intensity II a 5 km.

BVE No. 25, p. 27.

SWARM DATE: 86/9/28 ±0.5 Dur. (days): ± Type: Event type(s):felt Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at 5 km	# Felt total : 73	Dist. to vent: 4.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Katsujima	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Place holder for 1986. A few minutes before the eruption a weak earthquake (MMII) was felt.

Unfelt shocks recorded: 3 per day; Micro-tremors recorded; from Jan.-Dec. 1986 , 73 felt earthquakes in total between MM II-III.

BVE No. 26, p. 27-28.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type:4? Event type(s):t Grade :

Max. Magnitude:	# EQ total : 0	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 4.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Katsujima	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Place holder for 1987.

Felt shocks: none, Unfelt shocks: none, Micro-tremors: recorded duration 5 days in total.

BVE No. 27, p. 22.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s):A Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM II at 4.5 km	# Felt total :	Dist. to vent: 4.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Katsujima	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Place holder for 1988.

Felt shocks occurred. Unfelt shocks recorded at 2 per day, S-P 2.5 seconds.

BVE No. 28, p. 33.

GAMALAMA Halmahera-Indonesia		0.80 N 127.33E	*VOTW num.*:0608-06=
Morphology: strato or composite	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 1715 m	*Edifice relief* : 2700 m		
Range of eruptive products: basalt to andesite			

SWARM DATE: 88/1/5 ±1 Dur. (days): 28 ±1 Type:1bq Event type(s):felt,V,E Grade : B

Max. Magnitude:	# EQ total : 480	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at 3 km	# Felt total : 48	Dist. to vent: 3 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: Hoska	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : 2	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Felt shocks 2 per day from 28 days before the eruption.

Activity increased after a series of felt shocks in the middle of Jan. 1988. On Feb. 12 and eruption took place. Felt shocks 2 per day from 28 days before the eruption. Unfelt shocks 20 per day, S-P duration 6 seconds. Fig. monthly counts of volcanic and tectonic earthquakes Jan. 87 to Mar. 88.

BVE No. 28, p. 34.

SWARM DATE: 89/7/28 ±0 Dur. (days): 2 ±0.5 Type:3 Event type(s):VE, VT,t Grade : B

Max. Magnitude:	# EQ total :	Seismograph: temp?	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type:	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : / Rumbling :
		Magnification :	Geothermal : Y

Key phrase: July 28 and 29, 16 volcanic and 10 local tectonic earthquakes were recorded.

Volcanic tremor episodes with amplitudes of 0.5 mm were recorded for 11 and 16 minutes on July 28 and 29. 16 volcanic, 420 distant, 10 local tectonic earthquakes were recorded.

BVE No. 29, p 98.

SEAN Bull vol 14 no 7 p 9, 1989.

MAKIAN Halmahera-Indonesia 0.32 N127.40E *VOTW num.*:0608-07=

Morphology: strato or composite *Tectonic framework:*
Elevation above m.s.l. : 1357 m *Edifice relief :* 2350 m
Range of eruptive products: andesite

SWARM DATE: 88/7/20 ±0.5 Dur. (days): 9 ±1 Type:1b Event type(s):VE,t Grade : B

Max. Magnitude:	# EQ total : 3000	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.): 98	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal : ?

Key phrase: Unfelt shocks recorded 3-500 per day from 9 days before the eruption.

After 98 years of dormancy, on July 17, 1988 Kie Besi (syn. for Makian) became active. On July 20, the first volcanic earthquakes were recorded. Then, until July 28, the seismicity continuously increased accompanied by volcanic tremor. Unfelt shocks recorded 3-500 per day form 9 days before the eruption. Micro-tremors recorded: 7days in total at a period of ca. 0.5 seconds.

BVE No. 28, p. 35-36.

Philippines

CANLAON Philippines-C

10.41 N 123.13E *VOTW num.*:0702-02=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 2465 m *Edifice relief :* 2405 m
Range of eruptive products: basalt to andesite

SWARM DATE: 80/5/6 ±0.5 Dur. (days): 41 ±1 Type:3 Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 2652
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarm began on May 6, May 19 the seismicity declined.

Swarm began on May 6, numbers of earthquakes = 108 per day at peak level of May 19, then seismicity declined. late June volcanic shocks = 40 per day.
As of Jun. 27 2652 events recorded.
Canlaon last erupted in 1978 (BVE No 18) no surface eruption recorded with seismicity in 1980.
BVE No. 20, p. 95.

SWARM DATE: 85/3/13 ±0 Dur. (days): 0.19 ±0 Type:1bq Event type(s):VT,LF Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 139
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Sustained seismic activity started suddenly on 13 Mar. at 13:12, 4.5 hours before the onset of eruption.

Totaled 139 recorded events, 60 high-frequency and 79 low frequency types. At the beginning of the seismic crisis, only High-freq. tremors were recorded, then low freq. types predominated between 14:00 and 16:00. The number declined before the eruption began. During the eruptions first 24 hours (until 14 Mar. at 17:59) 51 VT and 9 LF tremors were recorded.
BVE No. 25, p. 28.

SWARM DATE: 85/10/5 ±0.5 Dur. (days): 3 ±2 Type:2a? Event type(s):felt,LF Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Earthquakes were felt during the eruption.

Activity had declined to voluminous emission of white vapor on Oct. 8 and weakened further the next day, but seismographs continued to record low-frequency events.
BVE No. 25, p. 28.
SEAN Bull. vol. 10, no. 2, p. 8; no 9, p. 8, 1985

SWARM DATE: 86/6/3 ±0 Dur. (days): 0.18 ±0 Type:2b Event type(s):E Grade : B

Max. Magnitude:
Max. Intensity: MM I at 5.5 km
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling : Y
Geothermal :

Key phrase: Without any preceding seismic activity ash was weakly ejected. The ejection was accompanied by explosion earthquakes.

The ejection was accompanied by audible rumbling and an explosion earthquake felt at intensity I, 5.5 km SE of the crater. The event lasted 15 minutes, 45 sec. Another explosion earthquake, with 18 mm amplitude, occurred at 04:35; and lasted 55 sec.
BVE No. 26, p. 28.
SEAN Bull. vol. 11; no. 5 p. 16 and no. 6 p. 8,1986.

CANLAON Philippines-C

10.41N 123.13E *VOTW num.*:0702-02=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 2465 m *Edifice relief* : 2405 m
Range of eruptive products: basalt to andesite

SWARM DATE: 86/6/14 ±0.5 Dur. (days): 8 ±1 Type:1b Event type(s):LF Grade : B

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at 6 km	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: On June 14 , 8 days prior to the eruption, seismicity increased.

Canlaon erupted on 21 Jun., at 19:07 and a ash-steam cloud rose to 4 km above the summit. The event was initiated by an explosion-type earthquake felt with intensities III and II at seismic stations 6 and 8.7 km from the summit. Booming and hissing sounds accompanied the ash ejection. The number of LF events remained at a high level after 3 June and decreased slightly 9-13 June. Seismicity increased again on 14 Jun., 8 days prior to the eruption. As of 1 Jul., seismicity has decreased slightly.

BVE No. 26, p. 28.
SEAN Bull. vol. 11; no. 5 p. 16 and no. 6 p. 8, 1986.

SWARM DATE: 87/3/1 ±1 Dur. (days): 64 ±1 Type:1b Event type(s):LF,E Grade : B

Max. Magnitude:	# EQ total : 2000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 6 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 1	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 4 K	Geothermal : Y

Key phrase: Unfelt shocks recorded from 64 days before the eruption.

Strong emissions of white to dirty white steam plumes with a minimal amount of ash were observed on 4, 5, 6, and 7 May 1987. These were accompanied by small-amplitude explosion type earthquakes and increasing number of low frequency volcanic earthquakes with daily counts varying from 30-50.
Between eruptive periods, moderate amounts of white steam plume occupied about 40%-50% of the crater, and seismic levels as well as thermal readings fluctuated with a general downward trend. By 8 May, steam emission at the active crater, seismic activity, thermal values gathered at Mambucal area and other monitored parameters slowly went back to pre-eruptive levels.
Unfelt shocks recorded from 64 days before the eruption. The maximum ground amplitude was 65 mm at 0.7 km (temp. station?) from the vent.
BVE No. 27, p. 23.

CANLAON Philippines-C

10.41N 123.13E *VOTW num.*:0702-02=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 2465 m *Edifice relief :* 2405 m
Range of eruptive products: basalt to andesite

SWARM DATE: 88/5/6 ±0.5 Dur. (days): 45 ±1 Type:1b Event type(s):HF,E,t Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 6 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: Ranger PS-1A	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): 1.25	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling : Y
		Magnification :	Geothermal : Y

Key phrase: Unfelt shock frequency, increasing trend from 1.5 months before the eruption. Jun. 21, the initial outburst was observed. This event not recorded by seismic stations on the lower slopes.

On June 21, the initial outburst was observed from 17:25 to 17:48 (LT. GMT + 8 hours). Light grayish ash and steam column rose to a maximum height of 300 m above the crater. Traces of ash were noted at the village of Mananawin on the volcano's SE slope, at elevation 980 m above sea level. This event was not recorded by the seismic stations on the lower slopes. On the next day (Jun. 22) at 13:30 and 14:18, ash ejections ensued. This time, the maximum height of the eruption column attained 600 m above the crater, and harmonic tremor of small amplitude (0.5 mm) were recorded on seismograms.
On June 24, two mild ejections occurred at 11:55 and 14:55, accompanied by faint rumbling sounds. Ashes from the 500 m eruption column were dispersed on the SF upper slopes. No eruption signal was recorded by the PHIVOLCS seismic stations.Four more ash ejections were observed during Jun. 25 and 27. These were accompanied by explosion earthquakes as recorded by the seismographs. Ash-laden steam columns reached a maximum height of 500 m and were drifted to the SW slopes. On June 28, harmonic tremors were recorded by the Masolog station seismograph from 11:18 to 15:00. These events were followed by ash ejections which were all reflected in the seismograms as explosion type earthquakes. The ash-laden steam columns reached a maximum height of 1,000 m. The final activity occurred at 07:14 - 07:19 on July 2. An explosion type earthquakes was recorded coincident with the event; steam and ash column rose to a height of 500 m above the crater.
Felt shocks none. Unfelt shock frequency 2-10 per day increasing trend, S-P 1.0 - 3.0 sec. max. ground amplitude of 20.0 um at 6 km from the vent from 1.5 months before the eruption. Micro-tremors: none.

BVE No. 28, p. 36-37.

SWARM DATE: 89/10/25 ±0.5 Dur. (days): 11 ±0.5 Type:2a Event type(s):LF Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 6 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Ranger PS-1A	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): 1.33	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal : Y

Key phrase: Oct. 25, 1989 an eruption began without clear precursors

Oct. 25, 1989 an eruption began without clear precursors after 15 months of repose from its last eruption on Jul. 2, 1988 No seismic signals preceded the eruption as activity varied from 0-low levels. The ash ejections were recorded by the seismographs as small magnitude explosion type earthquakes. On Dec. 5 seismic activity decreased significantly as the daily count of recorded volcanic earthquakes varied 0-5. During the entire eruptive period (Oct. 25-Dec. 5) High levels of local seismicity (15-20 volcanic earthquake per day) were recorded. These included ash ejections that were recorded as low frequency earthquakes by a seismograph installed at the base of the volcano. Good Fig. on p 36 of BVE.

BVE No. 29, p. 35-37.

BULUSAN Luzon-Philippines 12.77N 124.05E *VOTW num.*:0703-01=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 1559 m *Edifice relief* : 1265 m
Range of eruptive products: andesite

SWARM DATE: 80/4/29 ±0 Dur. (days):>3 ± Type:1c Event type(s):B Grade : B

Max. Magnitude:	# EQ total : 170	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM I at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: At 19:50, 29 Apr. eruptions preceded by 3 days of increased seismicity.

The eruption began on 27 Dec., 1979 continued with a second explosion on 12 Jan., 1980 After an increase in the number of earthquakes, a third explosion occurred on 7 Feb.
Mar. 27 a magnitude of 1 on the modified Rossi-Forel scale was felt at Lake Bulusan 4.5 km SE of the crater.
Through Apr. seismic activity accompanied by eruptive activity (volcanic earthquakes and/or B-type events).
At 19:50, 29 Apr. eruptions preceded by 3 days of increased seismicity.
19, 30 July strongest eruptions preceded by I-IV earthquakes.
28 Sept. volcanic activity followed by earthquakes decreasing in freq.

BVE No. 20, p. 43-44.

SWARM DATE: 80/7/6 ±0.5 Dur. (days): 5 ±1 Type:1a Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM IV at	# Felt total : 6	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling : Y
		Magnification :	Geothermal :	

Key phrase: An earthquake swarm began on 6 July. The swarm gradually delcined after the 10th.

An earthquake swarm began on 6 July, when 108 volcanic events were recorded in a 24-hr period. Six events were felt at MRF intensity I-IV. Seismicity peaked on 10 July with 189 events, 10 felt at I-IV. The swarm gradually declined after the 10th.
SEAN, (1989), Gobal Volcanism 1975-1985 p. 234-235.

SWARM DATE: 80/7/22 ±0.5 Dur. (days):>7 ± Type:1e Event type(s):VE Grade : C

Max. Magnitude:	# EQ total : 558	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM IV at	# Felt total : 22	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Seismicity increased again on 22 Jul., The swarm was continuing as of 29 Jul.

Seismicity increased again on 22 Jul., with 235 volcanic earthquakes recorded in 24 hours. Ten were felt at intensities up to IV on the MRF scale on 27 Jul., 323 events were recorded and 11 felt, again at intensities of as much as IV. The swarm was continuing as of 29 Jul.
SEAN, (1989), Gobal Volcanism 1975-1985 p. 235.

BULUSAN Luzon-Philippines 12.77N 124.05E *VOTW num.*:0703-01=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 1559 m *Edifice relief :* 1265 m
Range of eruptive products: andesite

SWARM DATE: 81/4/20 ±0.5 Dur. (days): 8 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM V at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1812
Felt total : 64
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS

Tremor :	Migration :
Deformation :	Focal mech:
Gravity :	EQ families :
Magnetic :	Rumbling : Y
Geothermal :	

Key phrase: Swarm began on 20 Apr. Seismicity declined since the renewed eruptive activity on 27 Apr.

Swarm began on 20 Apr., during the next week 1812 events were recorded, 64 felt at intensities I-V on the MM scale and were accompanied by rumbling. Seismicity declined since the renewed eruptive activity on 27 Apr.

BVE No. 21, p. 36.

SWARM DATE: 81/6/30 ±0.5 Dur. (days): 5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM II at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 700
Felt total : 11
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS

Tremor :	Migration :
Deformation :	Focal mech:
Gravity :	EQ families :
Magnetic :	Rumbling : Y
Geothermal :	

Key phrase: Local earthquake swarm from Jun. 30 - Jul. 4, 700 recorded events. No eruption took place.

Local earthquake swarm from Jun. 30 - Jul. 4, 700 recorded events, 11 felt at intensity I-II on Mod. Rossi-Forel scale and 7 others accompanied by rumbling. No eruption took place.

BVE No. 21, p. 36.

SWARM DATE: 83/6/25 ±0.5 Dur. (days): 0 ± Type:4 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS

Tremor :	Migration :
Deformation :	Focal mech:
Gravity :	EQ families :
Magnetic :	Rumbling :
Geothermal : Y	

Key phrase: The eruption of Bulusan, in June 1983, was not preceded by an increase in seismicity.

The eruption of Bulusan, in June 1983, was not preceded by an increase in seismicity, but hot spring temperatures had increased several degrees.

BVE No. 26, p. 80-81.
SEAN Bull., vol. 11, no. 4 p. 20-21, 1986.

BULUSAN Luzon-Philippines 12.77N 124.05E *VOTW num.*:0703-01=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 1559 m *Edifice relief* : 1265 m
Range of eruptive products: andesite

SWARM DATE: 86/4/19 ±0 Dur. (days): 0.41 ±0.02 Type:3 Event type(s):VT,LF Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:3.0
Cum. energy release:

EQ total : 229
Felt total : 3
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A seismic swarm began on 19 April at 20:22 LT and lasted for about 10 hours.

A seismic swarm began on 19 April at 20:22 LT(= GMT + 8 hours) and lasted for about 10 hours. A total of 229 volcanic earthquakes were recorded by most of the 5 seismic monitoring stations. The initial phase was characterized by high-frequency volcanic earthquakes, gradually replaced by low-frequency volcanic earthquakes during the peak and latter part of the activity. Three of the events were felt, with epicenters initially located about 7.4 km SE (azimuth 134) of the summit crater, within the caldera.
The last eruption of Bulusan, in June 1983, was not preceded by an increase in seismicity, but hot spring temperatures had increased several degrees. The April 1981 eruption, however, was preceded by an 8-day earthquake swarm. A seismic swarm following that eruption did not culminate in additional eruptive activity. (Information from: Office of the Director, PhilippineInstitute of Volcanology and Seismology, 6th Floor, Hizon Building, 29 Quezon Avenue, Quezon City, Philippines. From: SEAN Bulletin, vol. 11, no. 4, p.20-21, 1986)

BVE No. 26, p. 81-82.

SWARM DATE: 87/3/3 ±0.5 Dur. (days): 18 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarm occurred on 3-21 Mar.

See May 5, 1987 record for additional comments.

BVE No. 27, p. 84.
SEAN Bulletin, vol. 12, no. 5, p. 19; no. 12. p. 7, 1987

SWARM DATE: 87/5/5 ±0.5 Dur. (days):<1 ± Type:3 Event type(s):LF,HF Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 411
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Seismicity rose again to a high level on 5 May 1987.

Seismicity rose again to a high level on 5 May 1987 with 2 high-frequency and 18 low-frequency volcanic earthquakes recorded in the area of the volcano. The beginning of the swarm was accompanied by a slight increase in the steam emission at an upper fissure. Five tectonic earthquakes with large maximum double amplitudes were recorded the same day. A total of 103 high- frequency and 308 low-frequency volcanic events were recorded by the 3 station seismic network during the entire crisis.
This swarm occurred 55 days after the previous swarm on 3-21 Mar. A two month recurrence had been recognized for seismic swarms prior to the May episode.

BVE No. 27, p. 84.
SEAN Bulletin, vol. 12, no. 5, p. 19; no. 12. p. 7, 1987

BULUSAN Luzon-Philippines

12.77N 124.05E *VOTW num.*:0703-01=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 1559 m *Edifice relief* : 1265 m
Range of eruptive products: andesite

SWARM DATE: 87/10/22 ±0.5 Dur. (days): 43 ±1 Type: Event type(s):HF Grade : C

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM II at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Strong volcanic earthquakes were detected by the single instrument in operation at Bulusan from 22 Oct. to 3 Dec.

Strong volcanic earthquakes were detected by the single instrument in operation at Bulusan from 22 Oct. to 3 Dec. (typhoons damaged the remainder of the seismic telemetry network). High-frequency earthquakes with S-P intervals ranging from 2.0 to 2.6 seconds were recorded on 22, 23, and 31 October, and 3 Dec., The 22 Oct. earthquake was felt at intensity II.
Several seismic swarms have been recorded at Bulusan during the past 2 years. It's last eruption, in June 1983, was not preceded by an increase in seismicity, but the Apr. 1981 eruption followed an 8-day earthquake swarm.
(Information from: Philippine Institute of Volcanology and Seismology)

BVE No. 27, p. 84.
SEAN Bulletin, vol. I2, no. 5, p. I9; no. I2. p. 7, 1987

SWARM DATE: 88/1/20 ±1 Dur. (days): 30 ±1 Type:1b Event type(s):E,HF Grade : B

Max. Magnitude:	# EQ total : 90	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 5.1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: Hosaka	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): 5	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 20 K	Geothermal : Y

Key phrase: Unfelt shocks occurred from 30 days before the eruption.

On Feb. 20, 1988, after five years of repose, Bulusan volcano began to erupt without clear precursor phenomena. Six more ejections ensued and were all recorded as explosion earthquakes. On Mar. 7, at 11:07, an ash-laden steam column of 1430 m high was observed from Salvacion, SE of the volcano. In the night, the activity continued and five more explosions were recorded. During outburst, Bulusan volcano remained restive as high to alarming levels of local seismicity continued to be recorded daily. Unfelt shocks: occurred from 30 days before the eruption, 3 per day, S-P duration 1.7~4.0 sec., max. ground ampl.: 22 um at 5.1 km from the vent.

BVE No. 28, p. 38-39.

MAYON Luzon-Philippines

13.26N 123.69E *VOTW num.*:0703-03=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 2990 m *Edifice relief* : 2422 m
Range of eruptive products: andesite

SWARM DATE: 80/8/16 ±0.5 Dur. (days): 106 ± Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total : 214	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1980 tremor information.

Short duration harmonic tremor recorded on Aug. 16, occasional tremor through Nov. Similar seismic activity preceded 1978 eruption and accompanied crater glow. Steam accompanied by short duration tremor at Mayon Resthouse observatory, faint glow noted same day.

BVE No. 20, p. 45.

SWARM DATE: 84/9/13 ± Dur. (days): ± Type: Event type(s):t,E Grade : c

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM II at	# Felt total : 1	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for Sept. 1984 tremor and explosion earthquake infromation.

Continuous tremor with increasing ampl. accompanied by explosion earthquakes recorded Sept. 13. Mild eruptivity Sept. 22 accompanied by felt quake intensity II (Modified Rossi Forel) at Mayon Resthouse Observatory on NW flank. By Oct. 1984 volcanic. tremor and discrete earthquakes remained.

BVE No. 24, p. 27-28.

SWARM DATE: 88/8/5 ±5 Dur. (days): 100 ±10 Type:3 Event type(s):HF,LF,t Grade : B

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling : Y
		Magnification :	Geothermal :

Key phrase: High level of local seismicity was detected starting early Aug. 1988. Duration of HF earthquake swarm determined from figure.

On Aug. 18, 1988, PHIVOLCS declared the condition of Mayon as abnormal, citing the observation of crater glow for the past three days, rumbling sounds during earthquakes, and the occurrence of some inflationary tilting of the volcano since Mar. 1988. High level of local seismicity was detected by the Mayon Resthouse Observatory starting early Aug. 1988. This seismicity included high and low frequency volcanic earthquakes and volcanic tremors. The level attained by the volcano's seismicity exceeded that of the pre-eruption period of early 1984 (Fig. M7-2, BVE No. 28, p. 91). By Nov. 1988, all of the observed parameters gradually disappeared and the daily activities went back to background levels. For the rest of the year, there was no abnormal volcanic activity being manifested by Mayon volcano. All monitoring and observational data gathered were within background levels. Fig: event counts Jan. 81. to Dec. 88.

BVE No. 28, p. 91.

MALINAO **Luzon-Philippines**		**13.42N 123.60E** *VOTW num.*:0703-04=
Morphology: strato or composite	*Tectonic framework:*	Uncert. Convergent (arc)
Elevation above m.s.l. : 1657 m	*Edifice relief :*	
Range of eruptive products: basalt to andesite		

SWARM DATE: 80/7/6 ± Dur. (days): 23 ± Type:**1b** Event type(s):**mseism** Grade : **c**

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:	Tremor :	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families : Y
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms :	Natural period :	Geothermal : Y	
		Magnification :		

Key phrase: Jul. 6 strange micro-seisms were recorded. Jul. 29 a small phreatic explosion took place.

As early as Jul. 6 strange micro-seisms were recorded. Geyersing of muddy water observed 2 hrs. prior.
BVE No. 20, p. 46.

TAAL Luzon-Philippines 14.00N 120.99E *VOTW num.*:0703-07=

Morphology: strato with crater lake *Tectonic framework:* Uncert. Convergent (arc)
Elevation above m.s.l. : 300 m *Edifice relief* : 295 m
Range of eruptive products: basalt

SWARM DATE: 87/10/30 ±0.5 Dur. (days): 15 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total : 19	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at 10.7 km	# Felt total : 5	Dist. to vent:	Tremor : Migration :
Depth (km): 6.4 ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling : Y
		Magnification :	Geothermal :

Key phrase: Recorded earthquakes began increasing 30 Oct., 1987. Seismic activity has abated and few local events have been recorded since 14 Nov.

Recorded earthquakes began increasing 30 Oct., 1987. A maximum of 19 events per day was recorded on 31 Oct.; five of the events were felt by residents of Agoncillo, 10.7 km SW of the crater on the W shore of Taal Lake. The events were recorded but not felt on the volcano island, the site of historic eruptions in the Taal Caldera. Some residents of Agoncillo also reported rumbling sounds accompanying the earthquakes. Isolated reports of sulfurous stench were unconfirmed. Many residents of Agoncillo and nearby villages described the quakes as having prominent vertical movements, similar to those prior to the 1965 eruption.
Events on 6 Nov. had epicenters [near] Manalao Point on the W shore of Taal lake and across the lake from the 1965-1977 eruption site. The earthquakes had depths of 6.4 km and suggested ground fracturing beneath the caldera.
Seismic activity has abated and few local events have been recorded since 14 Nov.

BVE No. 27, p. 84.

SWARM DATE: 88/8/10 ±5 Dur. (days): 14 ±1 Type:3 Event type(s):HF Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal : Y

Key phrase: During a two week period in mid-Aug., 1988, several small, high frequency events were detected.

During a two week period in mid-August, 1988, several small, high frequency events with average maximum double amplitudes of 2 mm were detected at the Pira-Piraso seismograph station (~2.5 km from the main crater). From Aug. 16-22, 11 high frequency events were recorded.

BVE No. 28, p. 92.

SWARM DATE: 89/6/19 ±0.5 Dur. (days): 161 ±1 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 500	Seismograph: permanent?	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at	# Felt total :	Dist. to vent: 2 km	Tremor : Migration : Y
Depth (km): 5.9 ±2.8	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling : Y
		Magnification :	Geothermal : Y

Key phrase: On Jun. 19 seismicity began to increase from 0 to moderate levels. On Nov. 18 seismic activity returned to background.

On Jun. 19 seismicity began to increase from 0 to moderate levels (varying form 11- 20 earthquakes per day). The daily count of volcanic earthquakes slowly increased. The highest number of events recorded during the earthquake swarm was 33 on Aug. 23. On Aug. 24 the frequency of recorded events began to decrease. But perceptible and large volcanic events were still recorded. Majority were accompanied by rumbling sounds. The most distinct ones occurred on Sept. 19 and Oct. 7, being felt at MM II and III, respectively. On Nov. 1 there was a noticeable decrease in the daily counts of recorder volcanic earthquakes (3-5 per day). On Nov. 18 seismic activity returned to background levels (0-2 volcanic earthquakes per day). The epicenters of the located earthquakes were confined at the NE portion of the volcanic island which includes the main crater lake and Pinagulbuan crater. From Aug. 18 to Nov. 9 the hypocenters migrated from the surface toward a depth of 8.6 to 3.1 km.
FIG: Daily event counts, epicenter map. Total number of earthquakes est. from figure.

BVE No. 29, p. 98-99.

PINATUBO, MT. Luzon-Philippines		**15.14N 120.35E** *VOTW num.*:0703-083
Morphology: strato or composite	*Tectonic framework:*	Convergent (arc)
Elevation above m.s.l. : 1600 m	*Edifice relief* :	
Range of eruptive products:		

SWARM DATE: < 91/4/5 ± Dur. (days): > 67 ±20 Type: **1bq** Event type(s): VT,t,LP Grade : **A**

Max. Magnitude: 4.3	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 5 ±5	b-value :	Type: Mark L4-C	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): 670	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : N	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: When seismographs were installed on April 5, seismic activity was already at an elevated level. Reports of felt earthquakes in the vicinity beginning on March 15, 1991.

When the first portable seismographs were installed on April 5, seismic activity was already at an elevated level. Sabit and others (USGS Pinatubo volume, in press) note reports of felt earthquakes in the vicinity of Mt. Pinatubo beginning on March 15, 1991.

Almost all the recorded seismic activity to May 31, consisted of VT earthquakes with magnitudes ranging from less than 1 to 3. The majority of the VT earthquakes occurred as separate events or in small flurries of events with overlapping codas lasting from 1 to a few minutes. The longest flurry occurred on May 29, and lasted ~20 minutes. The earthquakes were located 5 km northwest of the summit at depths of 1 to 10 km, with the majority located at depths of 3 to 7 km. Sporadic episodes of shallow low-level tremor with frequencies between 1-8 Hz were also recorded before May 29.

Distinct changes in seismic activity began in early June that included an increases in the number of locatable VT earthquakes beneath the active fumaroles, small explosions, intensity and durations of tremor episodes. Seismic activity between June 1-7 evolved into an intense swarm of shallow VT earthquakes that marked the beginning of the dome growth on the northwest flank of the volcano.

At ~07:00 on June 6, VT activity beneath the active fumaroles began to increase rapidly. This swarm continued to intensify until 16:30 on June 7, when it evolved into an hour-long episode of sustained activity. This swarm continued until 23:00 on June 7, when activity abruptly declined.

From June 8, to 08:51 June 12, swarms of VT earthquakes gradually increased, the intensity and incidence of tremor also increased and a few shallow LP reappeared. This period begins with a 33-hours of relative seismic quiescence and ends with the first major explosive eruption on June 12.

About 400 deep long-period earthquakes and 25 hours of deep long period tremor occurred beneath Mt. Pinatubo, in two pluses, during May 26-28 and May 31-June 8.

Harlow, D., et al. (USGS Pinatubo volume, in press)
White, R. (USGS Pinatubo volume, in press)
Power, J. (per. comm., 1995)

Japan, Taiwan, and Marianas

SUWANOSE-JIMA Ryukyu Is		29.53N 129.72E	*VOTW num.*:0802-03=
Morphology: strato or composite	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 799 m	*Edifice relief :* 800 m		
Range of eruptive products: andesite			

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
		Component :	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Natural period :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms :	Magnification :	Geothermal :	

Key phrase: Place holder for 1989.

Air shocks felt

BVE No. 29, p. 38.
JMA (1992): The Volcanological Bull of JMA, Vol. 29, Nos. 1-4.

SAKURA-JIMA Kyushu-Japan 31.58N 130.67E *VOTW num.*:0802-08=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1118 m *Edifice relief :* 1100 m
Range of eruptive products: andesite

SWARM DATE: 14/1/10 ±0.5 Dur. (days): 3 ± Type:1b Event type(s):VT Grade : A

Max. Magnitude: Ms 5.2
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 44
Felt total :
b-value :
Repose (yr.): 15
Previous swarms :

Seismograph:
Dist. to vent: 150 km
Type: Omori tromometer
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from fig. 2 Abe (1979)

From the night of Jan. 10, 1914 earthquakes were felt with increasing frequency in the Sakurajima island. The maximum frequency of earthquakes was attained between the night of the 11th and the next morning. On the morning of the 12th, at about 8 am a column of white smoke was seen rising from the west side of the volcano, ant about 10 am explosive eruptions began. the eruptions cloud attained at a height of over 6 km with lightning flashes through dense cloud. At 6:28 pm a strong earthquake (Ms 7.0) took place and caused severe damage to the city of Kagoshima and the Sakurajima island. Around 1 am of the 13th the eruption was particularly violent, but in the afternoon the violence was greatly diminished.
At Nagasaki, 150 km north of Sakurajima, Omori horizontal tromometers were operated, and 44 shocks were registered during the period from Jan. 9 to 20. The maximum frequency of shocks was attained on Jan. 11, but the earthquake activity fell off rapidly after the eruption had started.

Abe, K. (1979) Magnitudes of Major Volcanic Earthquakes of Japan 1901 to 1925, J. Fac. Sci., Hokkaido Univ., Ser. VII (Geophysics), Vol VI, No. 1, 1979.

SWARM DATE: 55/4/20 ±10 Dur. (days): 175 ±10 Type:1aq Event type(s):VE Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from fig. 26 of Shimozuru 1971.

The number of volcanic earthquakes increased markedly from May onwards, and reached a culmination in the middle of Sept., followed by a sharp decrease. The eruption occurred almost four weeks after the culmination of seismic activity.

Shimozuru, D., in "The surveillance and prediction of volcanic activity" Unesco Paris 1971

SWARM DATE: 79/7/1 ±183 Dur. (days): ± Type:1e Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 1.6
Cum. energy release:

EQ total :
Felt total : 261
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: electromagnentic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Place holder for 1979.

Frequency of volcanic earthquakes = 5000 per month, lower frequency in Oct. and Nov. Swarms of small volcanic. earthquakes sometimes took place prior to extrusion of lava on the crater floor. Large amplitude tremor (max. 15um) for 20 min. (Jun. 6, 1979).

BVE No. 19, p. 43-44.

SAKURA-JIMA Kyushu-Japan

31.58N 130.67E *VOTW num.*:0802-08=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1118 m *Edifice relief :* 1100 m
Range of eruptive products: andesite

SWARM DATE: 80/3/15 ±15 Dur. (days): 75 ±15 Type:1e Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: B-type accompanied by lava extrusions on crater bottom swarmed in Mar-May 1980.

3219 explosions since 1955. 277 in 1980. B-type accompanied by lava extrusions on crater bottom swarmed in Mar-May 1980. Tremor, large amplitude with block ejection continued from Feb. 15-16. Frequency of earthquakes counted automatically with seismograph > 1um in amplitude.
Figs: Monthly earthquake totals, explosions and ash clouds
BVE No. 20, p. 50-52.

SWARM DATE: 81/7/1 ±183 Dur. (days): ± Type:1e Event type(s):B Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total : 22192
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.4 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Place holder for 1981.

22,192 volcanic earthquakes recorded in 1981 by seismograph 2.4 km NW. Earthquakes and tremors increased from Aug. 81 as well as frequency of explosions. B-type swarms accompanied extrusions on crater floor in Jan, Feb., Apr., Jul., and Sept. 1981. Figs: Monthly numbers of explosions, B-type earthquake, accumulated duration time of volcanic tremors. Fig. station map
BVE No. 21, p. 38-41.

SWARM DATE: 82/2/15 ±15 Dur. (days): 45 ±15 Type:1e Event type(s):V Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total : 22038
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.4 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: The frequency of volcanic earthquakes increased in Feb. and Mar. 1982.

Much activity throughout year, more than 22,038 volcanic earthquakes were recorded. The frequency of volcanic earthquakes increased in Feb. and Mar. 1982.
BVE No. 22, p. 42-44.

SWARM DATE: 83/1/15 ±15 Dur. (days): 45 ±15 Type:1e Event type(s):V,t,E Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increase in shallow volcanic earthquake and or volcanic tremor preceded explosive eruptions in early Jan, late May mid-late Aug. mid-late Oct., and mid Dec.

May 18 explosion earthquake measures 56 um on seismogram (4.5 km WNW of crater, x200). Frequency of volcanic tremors at high levels in Jun. and Jul. 1983 corresponding with increase in ash ejections. Increase in shallow volcanic earthquake and or volcanic tremor preceded explosive eruptions in early Jan, late May, mid-late Aug., mid-late Oct., and mid Dec. Figs: Monthly tremor time summations, earthquake counts and explosions.
BVE No. 23, p. 24-25.

SAKURA-JIMA Kyushu-Japan 31.58N 130.67E *VOTW num.*:0802-08=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1118 m *Edifice relief* : 1100 m
Range of eruptive products: andesite

SWARM DATE: 84/7/1 ±183 Dur. (days): ± Type:1e Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.6
Cum. energy release:

EQ total : 35665
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.4 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Volcanic earthquakes frequency swarmed in every month this year.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Expl.	22	26	36	25	43	4?	21	12	13	14	19	5?
Ht. (km)	1.8	2.3	>=2.0	2.3	3.1	>=4?	>=4.0	1.7	2.0	2.4	>=2.6	2.8
EQ	2672	3295	>=2665	>=1140	5216	>=480?	>=6030	2663	2523	>=2771	>=4447	4286

Earthquakes recorded at station 2.4 km NW of crater.

BVE No. 24, p. 29-30.

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type:1e Event type(s):V, E, t Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 56834
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.3 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Volcanic earthquakes swarms in every month this year.

The occurrence of volcanic tremor shows a high level.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Expl.	20	35	54	37	10	33	66	20	49	47	34	75
Ht. (km)	2.4	>=4.0	2.8	3.8	1.5	3.5	>=4.0	>=4.0	4.0	3.0	3.0	2.6
EQ*	>=3350	3456	>=3815	>=6292	>=2745	>=4884	>=4682	>=3885	>=4573	>=5580	5065	8507

*Recorded by seismograph (x2000) 2.3 km NW of the crater.

BVE No. 25, p 29-32.
JMA (1985-1986): The Volcanological Bulletin, vol. 25, nos. 1-4.

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s):V,E,t Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 35168
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.3 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarms of volcanic earthquakes frequently throughout 1986, except for the relatively low occurrences in Feb. May and June.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Expl.*	35	8	13	55	8	12*	4	22	20	21	12	6
Ht. (km)	2.4	3.0	1.5	3.2	1.0	3.2	3.0	1.8	1.8	2.0	2.7	2.5
EQ**	4588	1667	2352	3707	>=1787	3092	2099	3970	4715	2486	2348	2357

* Small ash emissions are not included
** Recorded at B station (x2000), 2.3 km NW of the crater.
Volcanic tremor was frequently recorded, except in Jan., Mar., and Sept.-Nov.
BVE No. 26, p 29-31. JMA (1987): The Volcanological Bulletin of JMA, vol. 26, nos. 1-4.

SAKURA-JIMA Kyushu-Japan 31.58N 130.67E *VOTW num.*:0802-08=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1118 m *Edifice relief :* 1100 m
Range of eruptive products: andesite

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type:1e Event type(s):V,t,E Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.3 km
Type:
Component :
Natural period :
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1987.

Number of volcanic earthquakes in 1987 was relatively infrequent until Sept. while there were swarms in Jan., May, Jun., Jul., Sept., Oct., Nov., and Dec. The volcanic earthquakes were located just under the summit crater. Volcanic tremors were also frequently recorded in this year, though lower than the previous record in total but having high level during Aug.-Nov.
The number of explosions, the maximum height of explosion cloud above the crater, and number of volcanic earthquakes in each month in 1987 were observed as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Expl.*	13	0	1	0	1	3	4	3	18	16	16	31
Ht.(km)	2.8	1.0**	1.3	1.5**	1.3**	1.5	0.9	1.7**	2.5	3.0	>=4.0	3.5
EQ	1828	359	>488	182	1105	305	>1800	1646	3172	1668	3944	5599

* Ash-emissions are not included. ** Ash cloud. Recorded by a seismograph (x 2,000), installed at B Station, 2.3 km NW or the crater. figs: hypo maps and explosion counts.

BVE No. 27, p. 24-27.
The Japan Meteorological Agency (1988-1989): Volcanological Bulletin of JMA, vol. 27, nos. 1-4.
Sakurajima Volcanological Observatory. Disaster Prevention Research Institute, Kyoto Univ. (1989): The Activities of Volcanic Eruptions and Earthquakes at Sakurajima Volcano (IV). Rep. Coordinating Committee for Prediction of Volcanic Eruptions. no. 42, p. 56-60.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type:1e Event type(s):V Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 26436
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.3 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity : Y
Magnetic : Y
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1988.

Activity of volcanic earthquakes in 1988 was still at a higher level until Apr. with frequent occurrence of earthquake swarms. The number of earthquakes and earthquake swarms decreased after May, and no volcanic earthquakes or swarms were recorded in Dec.
Monthly data for explosions and volcanic earthquakes of Sakurajima Volcano in 1988.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Expl.*	29	35	21	19	12	6	11	6	3	8	5	0
Ht. (km)	3.0	2.5	>=4.0	2.0	2.7	2.6	3.3	1.8	2.8	2.0	1.0	0.8**
EQ***	2872	4667	3556	4591	1273	>=1733	>=1092	1409	1548	1528	1716	451

* Weak ash-emissions not included
**Ash cloud
***Recorded by a seismograph (x 2000) at B station, 2.3 km NW of the crater.

BVE No. 28, p. 41-43.
Japan Meteorological Agency (1990): The Volcanological Bulletin of JMA, Vol. 28, Nos. 1 - 4.

SAKURA-JIMA Kyushu-Japan		31.58N 130.67E	*VOTW num.*:0802-08=
Morphology: caldera with strato	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 1118 m	*Edifice relief* : 1100 m		
Range of eruptive products: andesite			

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type:1e Event type(s):A Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Swarm of shallow volcanic earthquakes took place several times in Mar., Oct., Nov., and Dec.

Activity of volcanic earthquakes in 1989 was relatively at a lower level except in Dec. but swarms of shallow volcanic earthquakes took place several times in Mar., Oct., Nov., and Dec. Many volcanic tremors were recorded all the year round. The number of A-type volcanic earthquakes increased since Feb. and the frequency of explosions increased after Sept.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Expl.	2	2	1	3	0	0	0	1	2	10	10	13
Ht.(km)	2.0	1.3	1.5	1.6	1.8	.9	1.5	1.5	2.5	2.2	2.5	3.0
EQ*	390	1279	1185	1201	1952	1017	1162	2289	1413	1324	1192	3293

* At B station 2.3 km. fig: hypocenter map on p. 39 BVE no. 29.

BVE No. 29, p. 39-40.
JMA(1992): Volcanological Bull. of JMA, Vol. 29, Nos.,1-4.
Sakurajima Volcanological Research Institute, Kyoto Unversity (1990): The Activities of volcanic eruptions and earthquakes at Sakura-Jima (V), Rept. Coordinating Committee of Prediction of Volcanic Eruption. No. 47, p. 84-89.

KIRISHIMA Kyushu-Japan 31.93N 130.87E *VOTW num.*:0802-09=
Morphology: strato on a shield *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1700 m *Edifice relief* : 1300 m
Range of eruptive products: andesite

SWARM DATE: 82/8/17 ±0 Dur. (days): 0.06 ±0 Type:3 Event type(s): Grade : B

Max. Magnitude: Md3.4
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 83
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 1.7 km
Type:
Component :
Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Small scale earthquake swarm occcurred from 23:56-01:21 Aug. 17-18.

According to the observations by the Kirishima Volcano Observatory, Tokyo Univ. (1983), a small-scale earthquake swarm took pace during the period from 23:56 on Aug. 17 to 01:21 on Aug. 18. The frequency of the seismic events during this period was 83 and the largest event was magnitude 3.4 (Mf-p).

BVE No. 22, p. 102.

SWARM DATE: 83/1/16 ±0.5 Dur. (days): 2 ±1 Type:3 Event type(s):V Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 1.2
Cum. energy release:

EQ total : 108
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 1.7 km
Type:
Component :
Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Frequency of volcanic earthquakes increased Jan. 16-17, 1983.

Frequency of volcanic earthquakes increased Jan. 16-17, 1983, 108 total events in Jan. 1983. (1.7 km SW is JMA seismograph). Epicentral area is around Shinmoe-dake.

BVE No. 23, p. 60.

SWARM DATE: 83/12/28 ±0.5 Dur. (days): 2 ±1 Type:3 Event type(s):V Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 1.2
Cum. energy release:

EQ total : 100
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 1.7 km
Type:
Component :
Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Volcanic earthquakes swarmed on 28-29 Dec.

Volcanic earthquakes swarmed on 28-29 Dec., and about 100 earthquakes were recorded. The epicentral area was located around Shinmoe-dake.

BVE No 22, p 60.

SWARM DATE: 85/6/12 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 6
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 1.7 km
Type:
Component :
Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increases of seismicity around this volcano: 6 events (max. M2.3) on 12 Jun.

According to the observation by Kirishima Volcano Observatory, Earthquake Research Institute of University of Tokyo, there were increases of seismicity around this volcano: 6 events (max. M2.3) on 12 Jun. in the N of Ohnami Crater.
fig: epicenter map.

BVE No. 25, p. 60.

Japan Meteorological Agency (1985): The Volcanological Bulletin, vol. 25, no. 3. Kirishima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Recent seismicity in Kirishima Volcano. Report of the Coordinating Committee for Prediction of Volcanic Eruptions, no. 35, p. 69-70.

KIRISHIMA Kyushu-Japan 31.93N 130.87E *VOTW num.*:0802-09=

Morphology: strato on a shield *Tectonic framework*: Convergent (arc)
Elevation above m.s.l. : 1700 m *Edifice relief* : 1300 m
Range of eruptive products: andesite

SWARM DATE: 85/8/15 ±0.5 Dur. (days): 2.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.9	# EQ total : 8	Seismograph: Dist. to vent: 1.7 km	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Type:	Tremor : Migration :
Depth (km): ±	b-value :	Component :	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Natural period :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Magnification : 5 K	Magnetic : Rumbling : Geothermal :

Key phrase: Increases of seismicity around this volcano: 8 events (max. M3.9) in 15 - 17 Aug.

An earthquake of M2.7 occurred at the W foot of this volcano at 21:56 JST on 16 Aug. According to the observation by Kirishima Volcano Observatory, Earthquake Research Institute of University of Tokyo, there were increases of seismicity around this volcano: 8 events (max. M3.9) in 15 - 17 Aug. fig: epicenter map.

BVE No. 25, p. 60.

Japan Meteorological Agency (1985): The Volcanological Bulletin, vol. 25, no. 3. Kirishima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Recent seismicity in Kirishima Volcano. Report of the Coordinating Committee for Prediction of Volcanic Eruptions, no. 35, p. 69-70.

SWARM DATE: 85/8/22 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total : 6	Seismograph: Dist. to vent: 1.7 km	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Type:	Tremor : Migration :
Depth (km): ±	b-value :	Component :	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Natural period :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Magnification : 5 K	Magnetic : Rumbling : Geothermal :

Key phrase: Increases of seismicity around this volcano: 6 events in 22 - 23 Aug.

According to the observation by Kirishima Volcano Observatory, Earthquake Research Institute of University of Tokyo, there were increases of seismicity around this volcano: 6 events in 22 - 23 Aug. near Kurikoma-dake. fig: epicenter map.

BVE No. 25, p. 60.

Japan Meteorological Agency (1985): The Volcanological Bulletin, vol. 25, no. 3. Kirishima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Recent seismicity in Kirishima Volcano. Report of the Coordinating Committee for Prediction of Volcanic Eruptions, no. 35, p. 69-70.

SWARM DATE: 85/8/28 ±0.5 Dur. (days): 2.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 2.2	# EQ total : 90	Seismograph: Dist. to vent: 1.7 km	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Type:	Tremor : Migration :
Depth (km): ±	b-value :	Component :	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Natural period :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Magnification : 5 K	Magnetic : Rumbling : Geothermal :

Key phrase: Increases of seismicity around this volcano: 90 events (max. M2.2) in 28 - 30 Aug.

According to the observation by Kirishima Volcano Observatory, Earthquake Research Institute of University of Tokyo, there were increases of seismicity around this volcano: 90 events (max. M2.2) in 28 - 30 Aug. near Shinmoe-dake Crater. Many micro-earthquakes occurred around Shinmoe-dake Crater from 28 to 30 Aug. A total of 108 events was recorded in this term by the JMA's seismograph (x 5000) at A point, about 1.7 km SW of the crater. Another event (M 3.4) took place at 20:16 JST on 1 Sept. at the SW foot. The latter shock was intensity 2 in JMA scale at the neighboring spa. fig: epicenter map.

BVE No. 25, p. 60.

Japan Meteorological Agency (1985): The Volcanological Bulletin, vol. 25, no. 3. Kirishima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Recent seismicity in Kirishima Volcano. Report of the Coordinating Committee for Prediction of Volcanic Eruptions, no. 35, p.69-70.

KIRISHIMA Kyushu-Japan

31.93N 130.87E *VOTW num.*:0802-09=

Morphology: strato on a shield *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1700 m *Edifice relief* : 1300 m
Range of eruptive products: andesite

SWARM DATE: 86/4/28 ±0 Dur. (days): 2.5 ±0.5 Type:3 Event type(s):V Grade : C

Max. Magnitude: M 4.9	# EQ total : 13	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 3	Dist. to vent: 1.7 km	Tremor : / Migration :
Depth (km): 6 ±2	b-value :	Type:	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : / Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Recorded a local seismic activity at 16:01-20:15 JST on 28 Apr., and on 30 Apr.

The seismological observation of Earthquake Research Institute, University of Tokyo, recorded a local seismic activity including the largest event of M4.9 at the site about 15 km SW of this volcano at 16:01-20:15 JST on 28 Apr., and on 30 Apr. Out of 13, 8 events were located at depths of 4-8 km in the Nakatsu River area. Three events were felt at Makizono area, and ground cracks and small land slides along the Nakatsu River were reported. No change of fumarolic activity inside the Shinmoe-dake Crater was observed. Monthly number of volcanic earthquakes recorded by the JMA's seismological observation at A station (x 5,000), 1.7 km SW of Shinmoe-dake Crater did not show a high level in 1986, though the number slightly increased in September and November.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Earthquake	9	13	12	18	5	4	5	4	25	10	19	9

(Communication from: Y. Sawada, Seismological. and Volcanological. Dept., Japan Meteorological Agency, 1-3-4 Ote-machi Chiyoda-ku, Tokyo 100, Japan)

BVE No. 26, p. 82.
Earthquake Research Institute, University of Tokyo (1986): Observation and Survey of Hypocenters of the Nakatsu River Earthquakes in April 1986, Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 37, p. 43-47. Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

SWARM DATE: 88/10/8 ±0.5 Dur. (days): 2 ±0.5 Type:3 Event type(s):V Grade : B

Max. Magnitude:	# EQ total : 267	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.7 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type:	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : / Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Volcanic earthquake-swarm took place in early-Oct. 1988.

Volcanic earthquake-swarm took place in early-Oct. 1988, counting 160 and 107 events on Oct. 8 and 9, respectively. The hypocenters were considered to be at shallow depths under Shimnoe-dake cone.
The total number of volcanic earthquakes Oct. reached 330, showing a high level compared to the usual 10-30 events per month. During the seismic activity, a small volcanic tremor lasting 2 minutes was registered on Oct. 8 by the seismograph about 1.7 km SW of Shinmoe-dake. The last record of tremor was on Dec. 29, 1983.(Communication from: Y. Sawada, Shizuoka Meteorological Observatory, JMA, 2-1-5 Magarikane, Shizuoka 422, Japan)

BVE No. 28, p. 92.
Japan Meteorological Agency (1990): Volcanological Bulletin of JMA. vol. 28, no 4.

UNZEN Kyushu-Japan 32.75N 130.30E *VOTW num.*:0802-10=

Morphology: lava dome *Tectonic framework:* Convergent (arc)

Elevation above m.s.l. : 1360 m *Edifice relief* : 1300 m

Range of eruptive products: andesite

SWARM DATE: 80/8/7 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):felt Grade : B

Max. Magnitude:
Max. Intensity: MM VI at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 1
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: An earthquake swarm occurred on Aug 7.

An earthquake swarm (including felt shock max. intensity = 4 on JMA scale) occurred on Aug. 7 1980. Many swarms (including felt shock) around this volcano, but a felt shock of intensity 4 has not occurred since Mar. 1972.

BVE No. 20, p. 95.

SWARM DATE: 80/11/7 ±0.5 Dur. (days): 1.5 ±0.5 Type:3 Event type(s):felt Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 1
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Earthquake swarm with felt shocks took place on Nov 7-8.

Many swarms (including felt shock) around this volcano, but a felt shock of intensity 4 has not occurred since Mar. 1972.

BVE No. 20, p. 95.

UNZEN Kyushu-Japan

32.75N 130.30E *VOTW num.*:0802-10=

Morphology: lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1360 m *Edifice relief :* 1300 m
Range of eruptive products: andesite

SWARM DATE: 82/6/6 ±0.5 Dur. (days): 4 ±1 Type:3 Event type(s):felt Grade : B

Max. Magnitude:
Max. Intensity: MM V at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 180
Felt total : 9
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarm recorded from June 6-10.

Jun. 6 1982 20:24 1 felt shock JMA intensity = I. By Jun. 9, 180 earthquakes 9 felt shocks (I~III). There was not any other anomalous changes.
BVE No. 22, p. 103.

SWARM DATE: 84/5/15 ±15 Dur. (days): 270 ±15 Type:3 Event type(s): Grade : B

Max. Magnitude: JMA5.7
Max. Intensity: MM VII at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 10544
Felt total : 519
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Since May, local earthquakes around this volcano increased. Duration from figure.

Since May, local earthquakes around this volcano increased, and then earthquake swarms intermittently occurred in this year. On Jun. 13 more than 100 events were recorded, and the seismic activity further increased from Jul. including felt shocks. On Aug. 8, at 17:30 JST, and earthquake JMA M5.7 and intensity 4 occurred, and the same day at 17:38 a JMA M5.0 intensity 5 was located at the west at the WNW side of this volcano and caused injuries and landslides. In Aug. a total of 6370 local earthquake including 409 felt shock were recorded. Occurrence of the local seismicity remained at a high level by early Nov., and on 19 Oct. a swarm including 7 felt shocks JMA intensity 4 occurred. The earthquakes as strong as JMA intensity 5 was the first since 1924. No anomalous fumarolic activity was observed.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	58	56	55	41	410	341	676	6370	871	929	546	
>=191												
felt	1	1	0	1	9	5	12	409	33	31	11	6

BVE No. 24, p. 65.

UNZEN Kyushu-Japan 32.75N 130.30E *VOTW num.*:0802-10=

Morphology: lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1360 m *Edifice relief :* 1300 m
Range of eruptive products: andesite

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type:3 Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1211
Felt total : 29
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1985.

The seismicity in and around this volcano increased in Jan., May, Jun. and Dec. 1985 and small earthquake swarms occurred in these months. The monthly numbers of local earthquakes was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
number	149	67	84	59	235	234	>=58	59	>=78	34	44	110
felt	0	1	2	0	5	17	0	1	3	0	0	0

BVE No. 25, p. 61.
Japan Meterological Agency (1985 -1986): The Volcanological Bulletin, vol. 25, nos. 1-4.

SWARM DATE: 89/11/21 ±0.5 Dur. (days): 3 ±1 Type:1a? Event type(s): Grade : B

Max. Magnitude: M 3.7
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 569
Felt total : 5
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarm of earthquakes occurred on Nov. 21-24.

Swarm of earthquakes occurred on Nov. 21-24. The largest event (M3.7) occurred on Nov. 21. Temporary increase of the number of earthquakes was observed on Nov. 30. One shock was felt in mid Dec. but the level of seismicity became normal thereafter. No extraordinary phenomena were detected in fumaroles and hot water springs. The Nov. earthquakes were mostly located in Chijima Bay to W of the volcano. A small group of earthquakes was detected at the W-NW foot of Unzen from Dec. 1989 through Jan. 1990. This is the first time that the seismic activity was located near the summit of the volcano since seismological observation was started by Kyushu Univ. in 1984. Number of events is a total for the month of Nov.
Fig: Monthly seismicity 1965-1989; Epicenter maps.
BVE No. 29, p. 99-100.
JMA (1992): Volcanological Bull Vol. 29. No. 4. Shimabara Earthquake and Volcano Observatory, Faculty of Science, Kyushu Univ. (1990): Seismic activity in and around Unzen Volcano, Rept. Coord. Comm. for the Prediction of Volcanic Eruption, No. 46, pp 69-72.

ASO Kyushu-Japan 32.88N 131.10E *VOTW num.*:0802-11=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1592 m *Edifice relief* : 1100 m
Range of eruptive products: andesite

SWARM DATE: 79/6/13 ±0.5 Dur. (days): 0.83 ±0.02 Type:1aq Event type(s):V,t Grade : b

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:1.4	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling : Y
		Magnification : 3 K	Geothermal :

Key phrase: Prior to the eruption the amplitude of the tremor decreased. Duration ca. 20 hours before Jun. 13 eruption.

One felt shock took place before the June eruption, but the details of the activity of the volcanic earthquakes were uncertain owing to large amplitude continuous tremor.
Early June intensification of ejecta accompanied by large amplitude tremor. Prior to the eruption the amplitude of the tremor decreased.

BVE No. 19, p. 46-48.

SWARM DATE: 79/8/26 ±0.5 Dur. (days): 10 ±0.5 Type:1aq Event type(s):t Grade : b

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:1.4	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling : Y
		Magnification : 3 K	Geothermal :

Key phrase: Prior to the eruption the amplitude of the tremor decreased. Duration ca.10 days before Sept. 6 eruption.

Volcanic activity decreased its strength since Aug. 10 and volcanic tremor almost faded away after Aug. 27.

BVE No. 19, p. 46-48.

SWARM DATE: 79/11/2 ±0.5 Dur. (days): 0.3 ±0.1 Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:1.4	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Prior to the eruption the amplitude of the tremor decreased. Duration ca. sevral hours before Nov. 2 eruption.

Several hours of volcanic tremor recorded.

BVE No. 19, p. 46-48.

SWARM DATE: 80/1/27 ±0.5 Dur. (days): 1 ±0.5 Type:2b? Event type(s):V,E Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: eletromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 3 K	Geothermal : Y

Key phrase: Volcanic earthquakes swarmed on Jan 27.

An explosion earthquake (ampl. 28.0 um) was recorded 0.8 km W of the crater on Jan 26. Volcanic earthquakes swarmed on Jan 27.

BVE No. 20, p. 53-54.

Seismology and Volcanology Research Div., Meteorological Research Inst. (1980): Temperature measurements in and around craters of On-take and Aso volcano by means of remote sensing from the air, Rept. of the Coord. Comm. for Prediction of Volcanic Eruptions, 19, 12-20.

ASO Kyushu-Japan 32.88N 131.10E *VOTW num.*:0802-11=
Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1592 m *Edifice relief :* 1100 m
Range of eruptive products: andesite

SWARM DATE: 81/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1981.

Activity of volcanic earthquakes was rather low level this year.

BVE No. 20, p. 42.

SWARM DATE: 83/6/9 ±0.5 Dur. (days): 11 ±1 Type:3 Event type(s): Grade : C

Max. Magnitude: 3.0
Max. Intensity: MM III at
Depth (km): ±
Detection threshold: 1.4
Cum. energy release:

EQ total : 212
Felt total : 1
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: There was 212 earthquakes in Jun., most of which swarmed in 9-20 Jun.

Seismic activity was rather active in the year, with an earthquake felt around the summit crater on 21 Mar., and a felt shock of intensity I JMA occurred on 29 Mar.
There was 212 earthquakes in Jun., most of which swarmed in 9-20 Jun. The swarm was located at the N somma area and the magnitudes were less than 3. It was interpreted that the swarm was probably not related to the present volcanic activity.
Amplitude of the continuous volcanic tremors observed by JMA (at station 0.8 km w of crater, x3000) was 0.3 um in average in early and mid Mar. Mean amplitude of the tremors was 0.2 um through 27 Sept., but it sharply increased to 3.3 um on 28 Sept. corresponding with mud and sand spattering. On the next day amplitudes suddenly decreased to 0.1-0.2 um. Fig: epicenter map.

BVE No. 23, p. 60.

SWARM DATE: 84/7/1 ±183 Dur. (days): ± Type:1e Event type(s):V,t Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 1.4
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type:
Component : 3
Natural period : 1 s
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Place holder for 1984. Frequency of volcanic earthquakes was at a relatively higher level in Feb., Mar. and Jun.

Frequency of volcanic earthquakes was at a relatively higher level in Feb., Mar. and Jun., but in the rest of the months it remained at a normal level. Continuous volcanic tremor, mean amplitude 0.1-0.2 um until mid Apr. 84. After ampl. = 0.3-0.4 um, reached a maximum at 0.9 um Apr. 21-22. decreased to 0.2-0.3 um Sept. 84. Dec. 84 found mean ampl. ≈ 0.4-0.5 um. Max. tremor corresponding with water spouting Apr. 16 - mid May 84.
Figs: Volcanic activity 1965-1984; Monthly number of tremors and volcanic earthquakes, monthly averaged amplitude of volcanic tremor, eruption phenomena, water level.

BVE No. 24, p. 30-31.

ASO Kyushu-Japan 32.88N 131.10E *VOTW num.*:0802-11=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1592 m *Edifice relief :* 1100 m
Range of eruptive products: andesite

SWARM DATE: 85/5/15 ±15 Dur. (days):<30 ± Type:1d Event type(s):V,t Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 80
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: The number of volcanic earthquakes shows a higher level in 1985, especially in May.

The number of isolated volcanic tremors showed a relatively high level by 1985. The epicenters of earthquakes in Aug. and September were located at the N side of the Aso caldera rim and around Nakadake. Fig: Hypo maps.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Earthquake	30	37	18	54	80	37	12	111	>=113	17	17	11
Isolated Tremor	>=1790	1638	3418	>=1670	>=2269	1470	>=208	989	>=1846	>=145	218	397
Cont. Tremor*	.3	0.2-0.3	0.4-0.5	0.3	0.4	0.3	0.1	0.2	0.2	0.2	0.2	0.2

*Average ampl. in um by the seismograph (x3000) at station A, 0.8 km W of crater.

BVE No. 25, p. 33-34.
JMA (1985-1986): Volcanological Bulletin, no. 25, no 1-4.
Aso Volcano Observatory, Kyoto Univ. (1986): Activities of volcanic earthquakes and energy variation of volcanic mircotremor at Nakadake, Aso Volcano, during the period from Jan. to Dec., 1985. Report of volcanic Eruptions No.36, p. 40-42.

SWARM DATE: 85/8/15 ±15 Dur. (days):<60 ± Type:3 Event type(s):V Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 224
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: The number of volcanic earthquakes shows a higher level in 1985, especially in Aug. and Sept.

see May 5, 1985 comments

BVE No. 25, p 35-36.

ASO Kyushu-Japan 32.88N 131.10E *VOTW num.*:0802-11=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1592 m *Edifice relief* : 1100 m
Range of eruptive products: andesite

SWARM DATE: 86/1/15 ±5 Dur. (days):<15 ±5 Type:3 Event type(s):V Grade : C

Max. Magnitude:	# EQ total : 233	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Number of minor volcanic earthquakes increased in mid-Jan.

BVE No. 26, p. 82-83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

SWARM DATE: 86/3/5 ±5 Dur. (days):<10 ±5 Type:3 Event type(s):V Grade : C

Max. Magnitude:	# EQ total : 242	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Number of minor volcanic earthquakes increased in early Mar.

See Jan. 15, 1986 for additional comments.
BVE No. 26, p. 82-83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

SWARM DATE: 86/3/15 ±5 Dur. (days):<15 ±5 Type:3 Event type(s):V Grade : C

Max. Magnitude:	# EQ total : 242	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 1	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Number of minor volcanic earthquakes increased in mid-Mar. One felt shock on Mar. 23.

See Jan. 15, 1986 for additional comments.
BVE No. 26, p. 82-83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

SWARM DATE: 86/5/15 ±15 Dur. (days):<30 ± Type:3 Event type(s):V Grade : C

Max. Magnitude:	# EQ total : 109	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Seismicity increased in May.

See Jan. 15, 1986 for additional comments.
BVE No. 26, p. 82-83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

SWARM DATE: 86/6/15 ±15 Dur. (days):<30 ± Type:3 Event type(s):V Grade : C

Max. Magnitude:	# EQ total : 67	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Seismicity increased in June.

See Jan. 15, 1986 for additional comments.
BVE No. 26, p. 82-83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

ASO Kyushu-Japan		32.88N 131.10E *VOTW num.*:0802-11=
Morphology: caldera with strato	*Tectonic framework:* Convergent (arc)	
Elevation above m.s.l. : 1592 m	*Edifice relief* : 1100 m	
Range of eruptive products: andesite		

SWARM DATE: 88/5/15 ±5 Dur. (days): <30 ± Type:3 Event type(s):t Grade : C

Max. Magnitude:	# EQ total : 5900	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM IV at	# Felt total :	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: A sharp increase in the number of discrete type volcanic micro-tremors occurred in May.

Seismic activity remained low early this year, but the frequency of discrete type tremors began to increase since mid-March. A sharp increase in the number of discrete type volcanic micro-tremors occurred in May. The daily frequency exceeded 200 events since 9th until the end of the month, and the events totaled 5900 in May, While the usual monthly number had been 100 - 300. The activity slightly declined after May 30 to a level of about 100 events per day until June 6, but the higher level counting 500 - 1000 events a month remained. Continuous volcanic micro-tremors also showed larger amplitude in May, almost twice as large as usual. One earthquake was felt with an intensity of 2 JMA's scale at 21:23 JST on May 4, and it was located under the N caldera rim. fig: recorded earthquakes for 1965 to 1989, energy released from Jan. 1988 to Jan. 1989, hypocenter maps.

BVE No. 28, p. 92-93.
Aso Volcanological Laboratory, Faculty of Science, Kyoto University (1989): Observations of the volcanic microtremors and volcanic earthquakes at Aso Volcano (Jan. 1988 - Jan. 1989). Rept. Coord. Comm. for Prediction of Volcanic Eruption, No. 43, p. 66-71.

ASO **Kyushu-Japan** **32.88N 131.10E** *VOTW num.*:0802-11=

Morphology: caldera with strato *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1592 m *Edifice relief :* 1100 m
Range of eruptive products: andesite

SWARM DATE: 89/5/15 ±15 Dur. (days): 90 ±15 Type:2b? Event type(s):V,t Grade : C

Max. Magnitude: 3.2
Max. Intensity: MM V at
Depth (km): .5 ±1.5
Detection threshold:
Cum. energy release:

EQ total : 111
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling : Y

Key phrase: Duration from monthly earthquake counts.

The number of discrete volcanic tremors sharply increased since Mar. through the end of the year. Continuous volcanic tremors commonly showed a large amplitude before and during the eruptive activity, though there was a 28-minute-long period of low amplitude event on May 31. Number of discrete tremors and amplitude of continuous tremor remained high, accompanied with high frequency tremors during the active period. Oct.-Nov., long period wave forms generated by large amplitude tremors were recorded in the Kyushu district. Dec., with decrease of eruptive activity, the number of discrete tremors and amplitude of continuous tremors declined.
On May 8, a felt shock of intensity 3 JMA and M3.2 was followed by about 10 aftershocks.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ's	26	11	15	15	33	30	48	16	6	2	16	23
Disc. tremor	1325	1460	2934	5821	3846	7419	7756	7104	16286	13587	12016	14830
Mean Amp (um)	.3	.3	.3	.4	.3	.4	.5	.6	1.4	2.7	2.1	.8
Max. Ampl (um)	1.6	1.6	1.5	1.6	1.5	1.9	1.6	2.5	8	12.8	13	7.4

figs: LP example, hypocenter maps, variations of amplitudes of continuous tremor.

BVE No. 29, p. 41-46.
Aso Volcanological Laboratory, Kyoto University (1989): Observation of the volcanic earthquake (1988,1989 Jan to May 7 and May 8 to 9) and volcanic micro-tremors (July 1988 to May 16, 1989), Rept. Coordinating Committee for Prediction of Volcanic Eruption, No. 44, p. 127-132.
Faculty of Science, Kyoto Unversity (1990): The observation of volcanic earthquakes, volcanic micro-tremor, Fluctuation of ground temp, tectonic movement and terrestrial magnetism at Aso Volcano, Rept. Coordinating Comm. for the prediction of volc. eruptions.
Hashida, T. (1990): Long period micro-tremors observed in the Kyushu District, as excited by 1989 volcanic activity of the Aso Naka-dake, Bull. Volc. Soc. Japan, Vol. 35 No. 3, p. 323-326.
JMA (1989): Activity at Aso Volcano, Rept. Coordin. Comm. for Prediction of Volc. Eruptions.
JMA (1992): Volcanic activity at Aso Volcano, Rept. Comm. for Pred. of Volc. Erupt.
JMA (1992): Volcanological Bull. of JMA, Vol. 229, Nos. 1-4.

ASO Kyushu-Japan		32.88N 131.10E *VOTW num.*:0802-11=
Morphology: caldera with strato	*Tectonic framework:* Convergent (arc)	
Elevation above m.s.l.: 1592 m	*Edifice relief :* 1100 m	
Range of eruptive products: andesite		

SWARM DATE: 89/7/1 ±15 Dur. (days): 158 ±30 Type:1d Event type(s):t,LP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM III at	# Felt total : 2	Dist. to vent: 0.8 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling : Y
		Magnification : 3 K	Geothermal :	

Key phrase: Long period isolated tremor (LP events) Duration from BVE No. 29 fig.

Number of discrete tremors and amplitude of continuous tremor remained high, accompanied with high frequency tremors during the active period. Oct.-Nov., long period wave forms generated by large amplitude tremors were recorded in the Kyushu district. Dec., with decrease of eruptive activity , the number of discrete tremors and amplitude of continuous tremors declined.

Felt earthquakes of intensity 1 occurred on Nov. 19 and 26.

BVE No. 29, p. 41-46.

IZU-TOBU Honshu-Japan

34.98N 139.16E *VOTW num.*:0803-01=

Morphology: submarine *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products: andesite to rhyolite

SWARM DATE: 89/5/21 ±0 Dur. (days): 23 ±0.5 Type:3 Event type(s): Grade : A

Max. Magnitude: M 2.6	# EQ total : 1217	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Y Migration :
Depth (km): ±	b-value : 1.2	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling : Y
		Magnification : 2 K	Geothermal : Y

Key phrase: Small scale swarm May 21 (06:00) - Jun 12, 23 days

Small scale swarm May 21 (06:00) - Jun. 12, 23 days, 1217 events. Good figs: earthquake counts, hypo maps, tremor amplitude, geodetic info.

BVE No. 29, p. 47-54.

Hamuro, K. et al., (1980): The Higashi-Izu oki submarine volcanoes, Part 1, Bull. Earthquake Res. Inst. vol 55., p. 259-297.

Oshima, S. et al. (1991): "Birth of a submarine volcano Teishi Knoll". Jour. Phys. Earth, vol. 39, p.1-19.

Yamasato, J., et al. (1990): "Volcanic tremors associated with the July ,1989 volcanic activity off eastern Izu Peninsula -- Analysis of data by JMA network". Meteorology and Geophysics, vol. 41, p. 83-95.

Matsumura, S., et al. (1991): "Seismic Swarm Activity in and around the Izu Peninsula Preceding the Volcanic Eruption of July 13, 1989." J. Phys. Earth, 39, 93-106. (b-value ref.)

SWARM DATE: 89/6/30 ±0 Dur. (days): 11 ±1 Type:1aq Event type(s): Grade : A

Max. Magnitude: M 5.5	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM VIII at 2 km	# Felt total :	Dist. to vent: 2 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling : Y
		Magnification : 2 K	Geothermal : Y

Key phrase: Excellent fig. in BVE No. 29 used for duration.

Small scale swarm May 21 (06:00) - Jun. 12, 23 days, 1217 events. good figs. in BVE :earthquake counts, hypo-maps, tremor ampl., geodetic info.

BVE No. 29, p. 47-54.

Hamuro, K. et al., (1980): The Higashi-Izu oki submarine volcanoes, Part 1, Bull. Earthquake Res. Inst. vol 55., pp 259-297.

Oshima, S. et al. (1991): "Birth of a submarine volcano Teishi Knoll". Jour. Phys. Earth, vol 39, pp.1-19.

Yamasato, J., et al. (1990): "Volcanic tremors associated with the July ,1989 volcanic activity off eastern Izu Peninsula -- Analysis of data by JMA network". Meteorology and Geophysics, vol 41, pp. 83-95.

FUJI Honshu-Japan 35.35N 138.73E *VOTW num.*:0803-03=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 3776 m *Edifice relief :* 3700 m
Range of eruptive products: basalt

SWARM DATE: 87/8/15 ±20 Dur. (days): 6 ±1 Type:3 Event type(s):felt,LF Grade : B

Max. Magnitude: M 2.2
Max. Intensity: MM V at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 4
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 8 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: August 20-27, 4 felt shocks were felt.

In August, there were 4 shocks, that were felt only at Fuji Weather Station of JMA, situated on the rim of the summit crater, but not felt on the foot of the volcano. These were the first felt events in 50 years of weather observation at the summit.

Felt earthquakes						
Date	1987	VIII 20	23	24	27
Intensity (JMA scale)		3	1	2	1

The amplitude of the recorded waves of these events was not large. New seismological stations were established on the summit and the middle slope in late Sept. and there was a relatively high level of seismicity generated at the summit area as of the end of 1989, numbering 55 events, none were felt. No extraordinary surface phenomena was observed in and around the summit crater.

Active seismic activity of low frequency type earthquakes beneath this volcano has been observed. since 1979. The largest. of these low frequency type earthquakes occurred at 03:40 JST, May 16, 1987, with M2.2, and was located just beneath the volcano.

BVE No. 27, p. 84-85.
Japan Meteorological Agency (1988, 1989): Volcanological Bulletin. vol. 27. nos. 3-4.
National Research Center for Disaster Prevention (1988): Seismic Activity in and around Mt. Fuji. Rep. Coordinating Committee for Prediction of Volcanic Eruption, vol. 40, p. 101-105.

ON-TAKE Honshu-Japan

35.90N 137.48E *VOTW num.*:0803-04=

Morphology: strato or composite — *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 3063 m — *Edifice relief* : 1000 m
Range of eruptive products: basaltic andesite to andesite

SWARM DATE: 76/8/15 ±15 Dur. (days): 1020±180 Type:1d Event type(s): Grade : C

Max. Magnitude: Ms 5.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 3.5
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): 23000
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3.5 km
Type: electromagnetic
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic : Y
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Since Aug 1976 very shallow swarms at the SE foot of the volcano most activity in late 1978

Previous swarms: Aug. 1976, hypocenters shallow, 10-15 km SE of crater. Swarm most active in late 1978. No change in level of activity pre or post eruption. Large activity-free area between hypocentral and eruption areas. It is difficult to find any clear and direct relationships between the eruptions and the earthquake swarms. Occurrance of the volcanic earthquakes located just beneath the summit area was confrimed with a temporary seismological network.
Seismic activity decreased sharply after 1979 eruption. In 1980 the earthquake swarm at SE foot of volcano still continued, in the same epicentral area.
Fig: epicenter map

BVE No. 19, p. 49-50.
BVE No. 20, p. 55-56.

SWARM DATE: 84/9/14 ±0 Dur. (days): 90 ±15 Type:3 Event type(s):Tect? Grade : C

Max. Magnitude: JMA6.8
Max. Intensity: MM at
Depth (km): 7 ±5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value : 2.6
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: electromagnetic
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Tectonic mainshock aftershock sequence?

Sept. 14 shallow quake (JMA M6.8) occurred hypocenter located at 35N49.3', 137E 33.6' depth 2 km(about 11 km from the vent). Next day Sept. 15 JMA M6.2 occurred on W side of above epicenter, aftershocks continued and decreased through Dec. 1984. The first big earthquake triggered collapse of the southern slope at two places, generating large debris flows. No anomalous phenomena at the volcano have been observed during or after these events.
Fig: Good daily earthquake counts, b-value plot, hypo map. b-value est. from fig.
BVE No. 24, p. 65-66.

SWARM DATE: 88/10/4 ±0.5 Dur. (days): 6 ±0.5 Type:3 Event type(s):LF Grade : B

Max. Magnitude: M 0.8
Max. Intensity: MM at
Depth (km): 4 ±
Detection threshold:
Cum. energy release:

EQ total : 24
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: electromagnetic
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families : Y
Rumbling :

Key phrase: 24 small seismic events were registered during the period from 19:00 JST on Oct. 4 to 13:00 JST on Oct. 10.

There have been three kinds of seismic activities in and around On-take; the events located under the volcanic edifice, the aftershocks of the 1984 Western Nagano Pref. earthquake (M6.8) occurring on E-SE foot and the earthquake swarms in and around this volcano. According to the seismological observation of Nagoya University, 24 small seismic events were registered at the Takayama seismic station during the period from 19:00 JST on Oct. 4 to 13:00 JST on Oct. 10. The hypocenters were located at depths of about 4 km under the summit, and the biggest event was about M0.8. Those earthquakes showed the almost identical and peculiar wave forms having low frequency signals.
BVE No. 28, p. 94.
Takayama Seismological Observatory, School of Science, Nagoya University (1989): The peculiar earthquakes of Mt. On-take. Rept. Coord. Committee for Prediction of Volcanic Eruption, No. 42, p. 51-53.

ON-TAKE Honshu-Japan 35.90N 137.48E *VOTW num.*:0803-04=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 3063 m *Edifice relief :* 1000 m
Range of eruptive products: basaltic andesite to andesite

SWARM DATE: 89/1/2 ±0.5 Dur. (days):<1 ± Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: electromagnetic
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Small discrete volcanic tremors were recorded on Jan. 2.

Small discrete volcanic tremors were recorded on Jan. 2 and Aug. 19. Frequency of local earthquakes around On-take has been rather high but most of them are considered to be the aftershocks of the 1984 W Nagano Prefecture Earthquake (M6.8), located at the E-SW foot of the volcano. There was no extraordinary variation in plume emission.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Earthquake	256	206	256	202	212	=>183	=>145	130	=>162	=>139	=>110	=>124

BVE No. 29, p. 100.
Japan Meterological Agency (1992): Volcanological Bull. of JMA, vol. 29, Nos. 1 and 3.

SWARM DATE: 89/8/19 ±0.5 Dur. (days):<1 ± Type:3t Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3 km
Type: electromagnetic
Component : Z
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Small discrete volcanic tremors were recorded on Jan. 2 and Aug. 19.

See Jan. 2, 1989 for additional comments.

BVE No. 29, p. 100.
Japan Meterological Agency (1992): Volcanological Bull. of JMA, vol. 29, Nos. 1 and 3.

NORIKURA **Honshu-Japan** **36.12N 137.55E** *VOTW num.*:0803-06=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 3026 m *Edifice relief :* 1000 m
Range of eruptive products: andesite

SWARM DATE: 86/3/7 ±0.5 Dur. (days): ± Type:3 Event type(s): Grade :

Max. Magnitude: M 5.1	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Immediately after the M5.1 event on Mar. 7, 1986, the frequency of earthquakes in this area increased.

Low levels of seismicity had been known in the area near Norikura Volcano, but an area of frequent earthquake swarms was found 5-10 km SSW of the volcano, since a permanent seismic network was established by Nagoya Univ. in 1980. Immediately after the M5.1 event on Mar. 7, 1986, the frequency of earthquakes in this area increased. No extraordinary volcanic phenomenon has been reported. Fig: epicenter map.

BVE No. 29 p. 100-101.
Faculty of Science, Nagoya Univ. (1990): Earthquake swarm at the southern foot of Norikura-dake, Rep. Coord. Committee for the Prediction of Volc. Eruption, No. 46, p. 25-28.

ASAMA Honshu-Japan		36.40N 138.53E	*VOTW num.*:0803-11=
Morphology: strato on a shield	*Tectonic framework:* Convergent (arc)		
Elevation above m.s.l. : 2542 m	*Edifice relief* : 1300 m		
Range of eruptive products: andesite to dacite			

SWARM DATE: 80/9/19 ±0 Dur. (days): 0.4 ±0.2 Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 5 K	Geothermal :	

Key phrase: An earthquake swarm broke out around 10:00 (JST) on Sept. 19 and lasted for several hours.

Daily frequency of volcanic earthquakes has been at high level since Jul. 1980, and an earthquake swarm broke out around 10:00 (JST) on Sept. 19 and lasted for several hours. In Oct., frequency of volcanic earthquakes increased, and the quantity of volcanic cloud rose above the mean level.

BVE No. 20, p. 95.

SWARM DATE: 81/1/12 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 5 K	Geothermal :	

Key phrase: Volcanic earthquakes recorded increased in frequency on Jan. 12.

Volcanic earthquakes recorded increased in frequency at following 6 peaks: Jan. 12, Mar 7-13, May 5, early Jun., mid-Jul., and Aug. 10-11. Volcanic tremors were also recorded in mid-Jul. However, any indication of eruption was not observed, but fuming from the summit crater was slightly increased and white cloud emitting from the crater reached 2 km high above the crater rim.

BVE No. 21, p. 88.

SWARM DATE: 81/3/7 ±0.5 Dur. (days): 6 ±1 Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 5 K	Geothermal :	

Key phrase: Volcanic earthquakes recorded increased in frequency Mar 7-13.

See Jan. 12, 1981 for additional comments.

BVE No. 21, p. 88.

SWARM DATE: 81/5/5 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 5 K	Geothermal :	

Key phrase: Volcanic earthquakes recorded increased in frequency on May 5.

See Jan. 12, 1981 for additional comments.

BVE No. 21, p. 88.

ASAMA Honshu-Japan

36.40N 138.53E *VOTW num.*:0803-11=

Morphology: strato on a shield — *Tectonic framework:* Convergent (arc)

Elevation above m.s.l.: 2542 m — *Edifice relief:* 1300 m

Range of eruptive products: andesite to dacite

SWARM DATE: 81/6/5 ±5 Dur. (days): 10 ±5 Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : — Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : — Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Volcanic earthquakes recorded increased in frequency early Jun.

See Jan. 12, 1981 for additional comments.

BVE No. 21, p. 88.

SWARM DATE: 81/7/15 ±0.5 Dur. (days): 10 ±5 Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Y — Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : — Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Volcanic earthquakes recorded increased in frequency in mid-Jul.

See Jan. 12, 1981 for additional comments.

BVE No. 21, p. 88.

ASAMA Honshu-Japan   36.40N 138.53E   *VOTW num.*:0803-11=

Morphology: strato on a shield   *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2542 m   *Edifice relief* : 1300 m
Range of eruptive products: andesite to dacite

SWARM DATE: 81/8/10 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Volcanic earthquakes recorded increased in frequency on Aug. 10-11.

See Jan. 12, 1981 for additional comments.

BVE No. 21, p. 88.

SWARM DATE: 82/1/15 ±5 Dur. (days): 7.5 ±2.5 Type:1aq Event type(s):VE,t Grade : B

Max. Magnitude:	# EQ total : 1199	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y / Focal mech:
Detection threshold:1.2	Repose (yr.): 9	Component : 3	Gravity : Y / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y / Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: The frequency of volcanic earthquakes in Jan., was at a high level, and especially increased in mid-Jan. The seismic activity became normal level since Jan. 20. No significant percursor (micro swarms) immediately before.

Frequency of volcanic earthquakes has some times increased since Jul. 1981. The maximum frequency of recorded by the seismograph at B point of the Karuizawa W.S., JMA (2.0 km S of the crater, x5000) was 1338 in Aug. 1981. The monthly frequency in 1982 was the following:

Month:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ.	1199	563	383	308	287	>263	459	>393	785	662	686	392

The frequency of volcanic earthquakes in Jan. 1982, was at a high level, and especially increased in mid-Jan. and volcanic tremors also occurred. However the seismic activity became normal level since Jan. 20.
Steam cloud from the summit increased in late-Jan. In Mar., frequency of volcanic tremor increased and emission of steam clouds also increased.
Apr. 26 eruption showed no significant precursor (micro swarms) immediately before. At 02:25 the first eruption started. No detonation was heard. The amplitude of the explosion earthquake was measured at 35 um by seismograph at Karuizawa W.S., JMA (7.7 km SSE of crater x300).

BVE No. 22, p. 44-46.

ASAMA Honshu-Japan		36.40N 138.53E *VOTW num.*:0803-11=
Morphology: strato on a shield	*Tectonic framework:*	Convergent (arc)
Elevation above m.s.l. : 2542 m	*Edifice relief :* 1300 m	
Range of eruptive products: andesite to dacite		

SWARM DATE: 82/9/15 ±5 Dur. (days): 15 ±5 Type:1aq Event type(s):VE,t Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold: 1.2	Repose (yr.): .44	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: There were increases of volcanic earthquakes in Mid- and late-Sept.

There were increases of volcanic earthquakes in Mid- and late-Sept. Seismic activity including volcanic tremors slightly increased in mid-Oct. Oct. 2 a minor eruption occurred at 09:58. The amplitude of the explosion earthquake was 2 um by the seismograph at B point (2.0 km of the x 5000).

BVE No. 22, p. 44-46.

SWARM DATE: 83/3/17 ±0.5 Dur. (days): 7 ±1 Type:1aq Event type(s):VE,t Grade : B

Max. Magnitude:	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Y Migration :
Depth (km): 1 ±1	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold: 1.2	Repose (yr.): .5	Component : 3	Gravity : Y EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: In early 1983, it gradually increased from Jan. through Mar., and showed a temporal increase during 17-24 Mar.

Explosion earthquake Apr. 8 was 125 um (on JMA seismograph 7.7 km SSE of crater, x300). Its air vibration was 1.4 mb 7.7 km SSE of the crater and a moderate detonation was audible at 50 km E and 175 km NE from the volcano. Based on seismic records, the duration of the eruption was estimated to be about 25 minutes.

Frequency of volcanic earthquakes had been at a high level since the previous eruption in Oct. 1982. In early 1983, it gradually increased from Jan. through Mar., and showed a temporary increase during 17-24 Mar. However, there was not extraordinary increase before the eruption. After the Apr. 8 eruptions, earthquakes decreased notably. The monthly frequency of volcanic earthquakes at B station (2.0 km S of the crater, x5000) :

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	881	1215	1621	231	29	88	75	54	76	>127	96	69

Volcanic tremor decreased markedly after eruption. Peak rate on Mar 19.

Fig: daily earthquake frequency and hypocenters.

BVE No. 23, p. 26-28.

Asama Volcano Observatory, Earthquake Res. Inst., Univ. of Tokyo (1983): Seismic activity associated with the April 8, 1983 eruption of Asama Volcano. Rept. of Coord. Committee for Prediction of Volcanic Eruptions, no. 28, p. 19-22.

KUSATSU-SHIRANE Honshu-Japan 36.62N 138.55E *VOTW num.*:0803-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2176 m *Edifice relief* : 500 m
Range of eruptive products: andesite

SWARM DATE: 82/10/22 ±0.5 Dur. (days): 1.5 ±1 Type:1aq Event type(s):VE,t Grade : B

Max. Magnitude:	# EQ total : 23	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.): 6	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling : Y
		Magnification : 5 K	Geothermal : Y

Key phrase: Prior to eruptions, frequency of volcanic earthquakes increased on Oct. 22 (23 events).

The exact time of occurrence of these phreatic explosions was not well known. However, at 08:55 (JST) continuous volcanic tremors (amplitude = 0.2 um), possibly due to eruptive activity, commenced and was recorded at 1.1 km NE of Yugama crater and the amplitude became 5 um through about 11:00. Then, the amplitude of continuous volcanic tremors decreased; 1 um after 12:30, 0.3 um after 00:00 on Oct. 27. 0.1 um after 16:15 and stopped at 01:24 on Oct. 30.
Prior to eruptions, the frequency of volcanic earthquakes increased on Oct. 22 (23 events) and one volcanic tremor was recorded. Volcanic earthquakes swarmed from 21:45 (Oct. 26) to 07:38 (Oct. 27) but frequency suddenly decreased after that.
Figs: seismic activity before and after phreatic explosion of Oct. 26.
BVE No. 22, p. 47-50.

SWARM DATE: 82/10/26 ± Dur. (days): 0.41 ± Type:1d? Event type(s):VE,t Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:1.2	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Volcanic earthquakes swarmed from 21:45 (Oct. 26) to 07:38 (Oct. 27) but the frequency suddenly decreased after that.

Volcanic earthquakes swarmed from 21:45 (Oct. 26) to 07:38 (Oct. 27) but the frequency suddenly decreased after that. 08:55 (Oct. 24) continuous volcanic tremor (ampl. = 0.2 um) possibly due to eruptive activity recorded by seismograph ~1.1 km NE of Yugama crater and ampl. became 5 um through 11:00. Then amplitude decreased to 1 um after 12:30, 0.3 um after 00:00 on Oct. 27, 0.1 um after 16:15, and stopped at 01:24 on Oct. 30.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	6	17	>1	>6	12	11	>14	>10	>45	>412	>12	>12

Figs: seismic activity before and after phreatic explosion of Oct. 26.
BVE No. 22, p. 47-50.

SWARM DATE: 82/12/30 ±0.5 Dur. (days): 0.83 ± Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Place holder for tremor information. Volcanic tremors recorded at 04:52 and 07:52 then stopped at 15:38.

Dec. 29 eruption: volcanic tremors recorded at 04:52, ampl. = 0.2 um and 07:52 with 2.1 um ampl. then stopped at 15:38. Small tremors (0.1 um) were recorded since 19:00 through 15:00 on Dec. 30.
See Oct. 26, 1982 record for additional comments.
BVE No. 22, p. 47-50.

KUSATSU-SHIRANE Honshu-Japan 36.62N 138.55E *VOTW num.*:0803-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2176 m *Edifice relief :* 500 m
Range of eruptive products: andesite

SWARM DATE: 83/7/19 ±0.5 Dur. (days): 5 ±1 Type:1aq Event type(s):VE,t Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.2
Cum. energy release:

\# EQ total : 131
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling : Y
Geothermal :

Key phrase: Jul. 19-24 volcanic earthquakes, 131 events were recorded.

Jul. 19-24 volcanic earthquakes, 131 events were recorded (max. 5.1 um). Volcanic tremor at 10:31 Jul. 26 and faded away by 17:20.
In addition to the explosive activity, seismic activity remained at a high level in 1983. Frequency of volcanic earthquakes increased in early-Jan., early-Mar. and mid- and late-Jun. The monthly frequency of volcanic earthquakes and tremors recorded by a seismograph (x5000) near Yugama crater (Jan. -13 Nov.: 1.1 km NE of the crater, 14 Nov. - : 0.7 km S of the crater) were as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	126	42	74	36	89	209	226	83	53	38	199	191
Tremor	44	2	1	2	0	0	2	0	0	0	3	2

Fig: daily EQ counts and tremor.
BVE No. 23, p. 28-29.

SWARM DATE: 83/11/1 ±1 Dur. (days): 7 ±1 Type:1d Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM V at 0.7 km
Depth (km): ±
Detection threshold:1.2
Cum. energy release:

\# EQ total : 200
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Duration determined from figure.

Nov. 13, explosion earthquake felt for 10 sec (JMA scale III) 0.7 km S of Yugama crater.
Nov. 2, 02:51, 5 um volcanic earthquake recorded and during 07:00-20:00 on Nov 10 volcanic tremors 0.1-0.3 um occurred intermittently. Volcanic tremor of max. amplitude = 1.2 um on 17:22 Nov. 12. Max. amplitude of tremor on Nov. 13 at 02:17 = 5 um but disappeared at 04:00.
Fig: Daily earthquake and tremor counts.
BVE No. 23, p. 28-29.

SWARM DATE: 83/12/18 ±0.5 Dur. (days): 2 ±0.5 Type:1c Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total : 191
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.7 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Duration determined from figure.

See July 1983 for additional comments.
BVE No. 23, p. 28-29.

KUSATSU-SHIRANE	Honshu-Japan	36.62N 138.55E	*VOTW num.*:0803-12=
Morphology: strato or composite	*Tectonic framework:* Convergent (arc)		
Elevation above m.s.l. : 2176 m	*Edifice relief* : 500 m		
Range of eruptive products: andesite			

SWARM DATE: 84/5/29 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 83	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.7 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Minor volcanic earthquakes swarmed on May 29 (38 times), and 30 (45).

The seismicity remained at a background level, but minor volcanic earthquakes swarmed on May 29 (38 times), 30 (45), Jun. 23 (54), and 24 (19).

BVE No. 24, p. 66.

SWARM DATE: 84/6/23 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 73	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.7 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Minor volcanic earthquakes swarmed on Jun. 23 (54), and 24 (19).

The seismicity remained at a background level, but minor volcanic earthquakes swarmed on May 29 (38 times), 30 (45), Jun. 23 (54), and 24 (19).

BVE No. 24, p. 66.

SWARM DATE: 86/6/25 ±5 Dur. (days): 10 ±5 Type:3 Event type(s):VE? Grade : B

Max. Magnitude:	# EQ total : 96	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Many earthquakes occurred in late-June.

Seismicity at this volcano has been increasing since last year, and many earthquakes occurred in late-June, totaling 96 events. This was six times as much the mean of the former year. According to the JMA's seismological observation at A station (x 5,000), 1.1 km NE of Yugama Crater Lake, the number was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	28	23	38	31	44	96	46	35	14	22	12	19

BVE No. 26, p. 83.

Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

SWARM DATE: 87/10/14 ±0.5 Dur. (days): 6 ±1 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 74	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Seismic activity increased in mid-Oct. 1987.

Seismic activity increased in mid-Oct. 1987, counting 25 events on 15 Oct. and 74 on 14-19 Oct. by a seismograph at A station, 1 km NE of Yugama Crater. After 20 Oct. minor volcanic earthquakes took place at a lower rate of 2-4 per day, totaling 114 events in Oct.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	12	8	17	9	28	34	>=31	18	10	114	38	15

BVE No. 27, p. 85.

KUSATSU-SHIRANE Honshu-Japan 36.62N 138.55E *VOTW num.*:0803-12=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2176 m *Edifice relief* : 500 m
Range of eruptive products: andesite

SWARM DATE: 89/10/19 ±0.5 Dur. (days): 57 ±15 Type:3 Event type(s):V,t Grade : C

Max. Magnitude:	# EQ total : 185	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Numbers of volcanic earthquakes increased after Oct. 19. Activity decreased in Dec.

Volcanic tremors were recorded during the period from 03:55 (JST), Jan 6, - 03:36, Jan 7, 1989, the first time since May 1988. Amplitudes were mostly ~0.1 um and the largest was 0.5 um. Frequency of volcanic earthquakes was at normal levels (13 per month), while 4 events occurred on Jan. 7. Numbers of volcanic earthquakes increased after Oct. 19, counting 75 events in the month and a minor volcanic tremor was registered on Oct. 27. The higher level of seismicity continued in Nov., counting 110 events, and 3 minor tremors were recorded on Nov. 3. The seismic activity decreased to a monthly number of 23 in Dec.

Fig: Variation of water level.

BVE No. 29, p. 101-102.
Faculty of Engineering, Tokyo Inst. of Technology (1989): Volcanic activity of Kusatsu-Shirane-san on Jan 6, 1989, Rep Coord. Committee for the Prediction of Volc. Eruptions no. 43, p. 58-63.

NASU Honshu-Japan 37.12N 139.97E *VOTW num.*:0803-15=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1917 m *Edifice relief* : 500 m
Range of eruptive products: basalt to andesite

SWARM DATE: 85/9/9 ±0.5 Dur. (days): 4 ±1 Type:3 Event type(s):VT Grade : B

Max. Magnitude: M 3.4	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.9 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Local earthquakes (max. M3.4) swarmed at about 10 km N of Nasu volcano in 9 -12 Sept.

Local earthquakes (max. M3.4) swarmed at about 10 km N of Nasu volcano in 9 -12 and 27 - 29 Sept. Other earthquake swarms took place in the same area on 16 and 30 Dec., and the largest event (M4.3) occurred at 06:27 JST on 16 Dec. The seismic activity has been well monitored by the net of Tohoku Univ. and the National Research Center for Disaster Prevention. The monthly numbers of earthquakes recorded in 1985 at seismograph station (A point, x3000) at 1.9 km SE of the summit was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Number	19	13	25	35	54	22	25	34	124	50	50	159

BVE No. 25, p. 61.

SWARM DATE: 85/9/27 ±0.5 Dur. (days): 2 ±1 Type:3 Event type(s):VT Grade : B

Max. Magnitude: M 3.4	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.9 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification : 3 K	Geothermal :

Key phrase: Local earthquakes (max. M3.4) swarmed at about 10 km N of Nasu volcano on 27 - 29 Sept.

See Sept. 9, 1985 for additional comments.

BVE No. 25, p. 61.

NASU Honshu-Japan		37.12N 139.97E	*VOTW num.*:0803-15=
Morphology: strato or composite	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 1917 m	*Edifice relief* : 500 m		
Range of eruptive products: basalt to andesite			

SWARM DATE: 85/12/16 ±0.5 Dur. (days): 1 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude: M 4.3	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.9 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification : 3 K	Geothermal :	

Key phrase: Earthquake swarms took place at about 10 km N of Nasu volcano on 16 Dec.

See Sept. 9, 1985 for additional comments.

BVE No. 25, p. 61.

SWARM DATE: 85/12/30 ±0.5 Dur. (days): <30 ± Type:3 Event type(s): Grade : C

Max. Magnitude: M 4.4	# EQ total : 70	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.9 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification : 3 K	Geothermal :	

Key phrase: Earthquake swarms took place at about 10 km N of Nasu volcano on 30 Dec.

Seismicity in the southern part of Fukushima Prefecture, N of this volcano, showed a continuing activity in Jan. following the latter part of 1985. 70 events, containing several shocks that were located beneath this volcano, were recorded in Jan. by the JMA's seismograph (x 3,000) at A station, located 1.9 km ESE of the summit. The largest event was a M4.4 shock on 12 Mar., located at N of this volcano.
No extraordinary activity was observed in the fumaroles. These seismic activities have been also monitored by the seismological nets of Tohoku University and National Research Center for Disaster Prevention. According to the JMA's seismological observation, the monthly number of earthquakes recorded in 1986 at A station was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	70	12	48	35	116	92	155	47	56	92	25	43

BVE No. 25, p. 61.
BVE No. 26, p. 83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.
National Research Center for Disaster Prevention (1986): Seismic Activity near Nasu Volcano Sept., 1985 - May, 1986), Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 37, p. 19-22.
Tohoku University (1986): Seismic Activities in and near the Nasu Volcano, Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 37, p. 23-32.

NASU Honshu-Japan		37.12N 139.97E	*VOTW num.*:0803-15=
Morphology: strato or composite	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 1917 m	*Edifice relief :* 500 m		
Range of eruptive products: basalt to andesite			

SWARM DATE: 86/7/1 ±0.5 Dur. (days): 3 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 4.1	# EQ total : 72	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM III at	# Felt total :	Dist. to vent: 1.9 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification : 3 K	Geothermal :	

Key phrase: Another seismic activity took place at the SW foot, on 1-3 July

Another seismic activity took place at the SW foot, on 1-3 July, with daily numbers of 26, 34 and 12 on 1st, 2nd and 3rd, respectively. The monthly number in July was 155, and the largest event was a M4.1 shock at 22:54 JST on 1 July, that was felt at Nasu and Shirakawa areas as 1 grade by the JMA intensity scale.

BVE No. 26, p. 83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.
National Research Center for Disaster Prevention (1986): Seismic Activity near Nasu Volcano Sept., 1985 - May, 1986), Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 37, p. 19-22.
Tohoku University (1986): Seismic Activities in and near the Nasu Volcano, Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 37, p. 23-32.

BANDAI Honshu-Japan		37.60N 140.08E	*VOTW num.*:0803-16=
Morphology: strato with caldera	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 1819 m	*Edifice relief* : 1100 m		
Range of eruptive products: andesite			

SWARM DATE: 86/4/29 ±0.5 Dur. (days):<1 ± Type:3 Event type(s):VE Grade : C

				OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total : 8	Seismograph:		Tremor :	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	1.8 km	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:		Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :		Magnetic :	Rumbling :
Cum. energy release:	Previous swarms :	Natural period :		Geothermal :	
		Magnification :	5 K		

Key phrase: Seismicity occurring very near to this volcano showed a higher level on 29 Apr.

Seismicity occurring very near to this volcano showed a higher level on 29 Apr, counting 8 events on the seismogram (x 5,000) at A station, 1.8 km SSE of the summit of this volcano, though the monthly number of volcanic earthquakes was not at a higher level. No surface change of the volcano was detected during the field inspection on 4-5 June.
The monthly number of volcanic earthquakes recorded at A station was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	9	2	15	19	37	26	19	10	14	26	18	16

BVE No. 86, p. 83.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.

SWARM DATE: 87/6/16 ±0.5 Dur. (days): 9 ±5 Type:3 Event type(s): Grade : B

				OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 4.5	# EQ total : 380	Seismograph:		Tremor :	Migration :
Max. Intensity: MM V at	# Felt total : 14	Dist. to vent:	1.8 km	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:		Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :		Magnetic :	Rumbling : Y
Cum. energy release:	Previous swarms : Y	Natural period :		Geothermal :	
		Magnification :	5 K		

Key phrase: Many local earthquakes occurred on 16 June 1987. The seismicity returned to the normal level by the end of June.

Many local earthquakes,located near the Aizu Wakamatsu area, about 10 km SW of the summit of this volcano, occurred on 16 June 1987. They included 14 felt shocks and accompanying rumblings. The largest event was M4.5 at 16:49 JST, 16 June, and the maximum intensity was 3 in JMA scale. The seismicity returned to the normal level by the end of June.
Monthly number of earthquakes recorded at seismological station A, 1.8 km SSE of the summit:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	20	14	11	21	19	414	41	>=11	>=18	25	60	32
Felt						14					2	1

BVE No. 27, p. 85.
Japan Meteorological Agency (1988, 1989): Volcanological Bulletin, vol. 27. no. 2.
Observatory Center for Prediction or Earthquakes Volcanic Eruptions. Faculty of Science, Tohoku Univ. (1988): Recent Volcanic Activity at Azuma Volcano and its Surrounding Area. Rep. Coordination Committee for Prediction of Volcanic Eruptions, no. 40, p. 94-100.

BANDAI **Honshu-Japan** **37.60N 140.08E** *VOTW num.*:0803-16=

Morphology: strato with caldera *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1819 m *Edifice relief* : 1100 m
Range of eruptive products: andesite

SWARM DATE: 88/11/23 ±0.5 Dur. (days): 12 ±1 Type:3 Event type(s):V Grade : B

Max. Magnitude: M 1.4
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 54
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 1.8 km
Type:
Component :
Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Volcanic earthquake swarm occurred in the latter part of Nov., numbering 31 events in two days (24th and 25th). Duration from figure.

Volcanic earthquake swarm occurred in the latter part of Nov, numbering 31 events in two days (24th and 25th) and totaling 191 during the month. However, the seismic activity declined in early Dec. Most earthquakes showed wave-forms having the S-P time of 0.5-0.7 seconds. The largest amplitudes on the seismograms at the station at 1.8 km SSE of the summit of the volcano ranged 0.1-1.0 um. The usual monthly number of volcanic earthquakes has been several to 20 events. According to the temporary seismological observation by Tohoku University at a site about 10 km NE of this volcano, the largest events were two M1.4 ones occurred on Nov. 25 and on Dec. 4, being located near the summit of the volcano. Fig: monthly counts 1966-1989; daily counts Nov. - Dec. 1988; and hypo maps, number earthquakes total taken from fig. >= 3 mm.
The monthly number of volcanic earthquakes recorded at JMA's seismic station was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	8	8	4	23	>=18	39	18	21	18	>=28	191	47

BVE No. 28, p. 94-95.
Faculty of Science, Tohoku University (1989-1): Seismic activity in and around Bandai Volcano (Oct. 1987 - Jan. 1989). Rept. Coordinating Committee for Prediction of Volcanic Eruptions, No. 13, 52-55.
Faculty of Science, Tohoku University (1989-2): Temporary seismic observation at Bandai Volcano (Aug.- Nov. 1998). Rept. Coordinating Committee for Prediction of Volcanic Eruption, No. 45, 59-62.
Japan Meteorological Agency (1990): Volcanological Bulletin of JMA, Vol. 29, No. 4.

AKITA-KOMAGA-TAKE Honshu-Japan 39.75N 140.80E *VOTW num.*:0803-23=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1637 m *Edifice relief :* 950 m
Range of eruptive products: basalt to andesite

SWARM DATE: 88/6/19 ±0.5 Dur. (days): 3.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.6
Max. Intensity: MM at
Depth (km): 3 ±2
Detection threshold:
Cum. energy release:

EQ total : 186
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent: 4.2 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Local earthquakes occurred in swarm during Jun. 19-22.

Local earthquakes containing the largest event of M3.6 and felt shocks occurred in a swarm during June 19-22 in Obonai area, about 8 km SW of the volcano, and about 3-km E of Lake Tazawa. According to the temporary seismological observation by Tohoku University since June 22, the hypocenters were located at depths of 1-5 km along the active fault that produced the 1896 Rikuu Earthquake (M7.2) and other active faults in this area. The seismic activity declined in July, and no anomalous volcanic phenomena were observed at Akita-Komaga-Take. (Communication from Y. Sawada, Shizuoka Meteorological Observatory, JMA, 2-1-5 Magarikane, Shizuoka 422, Japan). # earthquakes total taken from fig. >= 2 mm. Fig: Daily frequency Jun.-Oct 1988 and epicenter map.

BVE No. 28, p. 95.
Faculty of Science, Tohoku University (1989): Earthquake swarm at the south western foot of Akita-Komaga-Take Volcano (June to October 1988). Rept. Coordinating Committee for Prediction of Volcanic Eruption No. 42, 35-41.

SWARM DATE: 89/11/17 ±0.5 Dur. (days): 8 ±1 Type:3 Event type(s):Tect? Grade : C

Max. Magnitude: M 3.4
Max. Intensity: MM at
Depth (km): 8 ±4
Detection threshold:
Cum. energy release:

EQ total : 46
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4.3 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from figurein BVE No. 29.

A series of local seismic activity occurred at the SE foot of the volcano in Nov. 1989. The sequence was foreshock-mainshock- aftershock with the main shock 3.4 occurring on Nov. 20. During the period Nov. 18-25, 46 earthquakes at depths of 10-13 km, 10 km SSE of the volcano with the largest event of M2.1 were recorded. During Nov. 20-25, epicenters were located at depths of 4-10 km ~5 km SE of the summit with the largest event of M3.4. FIGS: Earthquake counts (>= 3mm on seismograph), epicenter maps.

BVE No. 29, p. 102.
Faculty of Science, Tohoku Univ. (1990): Seismic activity at the southeastern foot of Akita-Komagatake in Nov. 1989, Rep. Coord. Committe for the Prediction of Volc. Eruption, No. 46, p. 11-13.

IWAKI **Honshu-Japan**		**40.65N 140.30E** *VOTW num.*:0803-27=
Morphology: strato or composite	*Tectonic framework:* Convergent (arc)	
Elevation above m.s.l. : 1625 m	*Edifice relief* : 1400 m	
Range of eruptive products: andesite		

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type:3 Event type(s): Grade :

Max. Magnitude: M 3.6	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 3.8 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1985.

From middle 1985 seismic activity increased in the NE area of this volcano, according to the observation by Hirosaki University. The maximum event was a M3.6 shock which occurred on 14 Oct. The seismicity of this volcano commenced in 1972, but it had been at a low level during 1983 - 1984. fig: epicenter map.

BVE No. 25, p. 61.
Hirosaki University (1985, 1986): Seismic activity of Iwaki Volcano. Report of the Coordinating Committee for Prediction of Volcanic Eruptions, no. 34 (1985), p. 5-8; no. 35 (1984), p. 29-28.

HAKKODA GROUP	**Honshu-Japan**	**40.65N 140.88E**	*VOTW num.*:0803-28=
Morphology: caldera with strato	*Tectonic framework:* Convergent (arc)		
Elevation above m.s.l. : 1585 m	*Edifice relief :* 1000 m		
Range of eruptive products: andesite			

SWARM DATE: 86/8/10 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 4.5	# EQ total :	Seismograph:	Tremor :	Migration :
Max. Intensity: MM V at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): 20 ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms :	Natural period :	Geothermal :	
		Magnification :		

Key phrase: An earthquake swarm occurred at the NW foot of this volcano on 10-11 Aug., at the depth of 20 km.

An earthquake swarm occurred at the NW foot of this volcano on 10-11 Aug., at the depth of 20 km. They were monitored by the seismological net of Hirosaki University. The largest event was a M4.5 shock at 17:50 JST on 10 Aug., and was felt as grade 3 in JMA intensity scale. There were slight damages such as cracks on outer walls of houses in the epicentral area.

(Communication from Y. Sawada, Seismol. and Volcanol. Dept., Japan Meteorological Agency, 1-3-4 Ote-machi, Chiyoda-ku, Tokyo 100, Japan)

BVE No. 26, p. 83.

Faculty of Science, Hirosaki University (1987): Seismic Activity of Hakkodasan, Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 38, p. 26-28.

Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, no. 2.

OSHIMA **Izu Is-Japan** **34.73N 139.38E** *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief* : 500 m
Range of eruptive products: basalt

SWARM DATE: 83/1/16 ±0.5 Dur. (days): 9 ±1 Type:3 Event type(s):V, felt Grade : B

Max. Magnitude:	# EQ total : 822	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 47	Dist. to vent: 4 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification : .5 K	Geothermal :	

Key phrase: On Jan. 16-25 local earthquakes swarmed off E of Izu Peninsula.

During 1983 seismic activity in and around O-Shima Island has been at rather increased level. On Jan. 16-25 local earthquakes swarmed off E of Izu Peninsula and 822 earthquakes including 47 felt shocks were observed by JMA seismograph (4.0 km NNW of the central crater, x5000).

BVE No. 23, p. 60-61.

SWARM DATE: 83/3/5 ±0.5 Dur. (days): 13 ±1 Type:3 Event type(s):felt Grade : C

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 4	Dist. to vent: 4 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification : .5 K	Geothermal :	

Key phrase: 4 felt events were observed - Mar. 5-18.

See Jan. 16, 1983 for additional comments.

BVE No. 23, p. 60-61.

SWARM DATE: 83/5/31 ±0.5 Dur. (days): 2 ±0.5 Type:3 Event type(s):V,f Grade : B

Max. Magnitude: M 2.3	# EQ total : 51	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 5	Dist. to vent: 4 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification : .5 K	Geothermal :	

Key phrase: Between 31 May-1 June, volcanic earthquakes swarmed outside the NW caldera rim.

4 felt shocks in Mar. 83, Max M2.3 in early June.

BVE No. 23, p. 60-61.
Nishi, K. and Tazawa, K. (1984): Earthquake Swarm on May 31, 1983 in Izu-Oshima. Bull. Volcanol. Soc. Japan, II, vol. 29, P. 109-111.

SWARM DATE: 83/7/2 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):V,felt Grade : C

Max. Magnitude:	# EQ total : 51	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 5	Dist. to vent: 4 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification : .5 K	Geothermal :	

Key phrase: On 2 Jul. 51 earthquakes and 5 felt shocks occurred.

On 2 Jul. 51 earthquakes and 5 felt shocks occurred and their epicenters were located inside the island.

BVE No. 23, p. 60-61.

OSHIMA Izu Is-Japan 34.73 N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief :* 500 m
Range of eruptive products: basalt

SWARM DATE: 83/10/22 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 21
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4 km
Type: electromagnetic
Component :
Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Volcanic earthquakes increased on 22 Oct.

See Jan. 16, 1983 for additional comments.

BVE No. 23, p. 60-61.

SWARM DATE: 83/12/22 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):V Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 12
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4 km
Type: electromagnetic
Component :
Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Volcanic earthquakes increased on 22 Dec.

See Jan. 16, 1983 for additional comments.

BVE No. 23, p. 60-61.

SWARM DATE: 83/12/30 ±0.5 Dur. (days): 76 ±15 Type:3 Event type(s):V,f Grade : B

Max. Magnitude: M 3.8
Max. Intensity: MM VI at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 200
Felt total : 34
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4 km
Type: electromagnetic
Component :
Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Between Dec. 30-31 30 felt shocks occurred. Still at a high level in Jan. then decreased in Feb. and Mar.

Between Dec. 30-31 30 felt shocks occurred, whose epicenters were located around the N part of this island. Max. M3.8 Max. intensity JMA IV.

BVE No. 23, p. 60-61
BVE No. 24, p. 67.

SWARM DATE: 84/4/22 ±0.5 Dur. (days): 54 ±5 Type:3 Event type(s):V Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 366
Felt total : 13
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4 km
Type: electromagnetic
Component :
Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: An earthquake swarm occurred on Apr. 22 and continued with a relatively high level through mid-Jun near the volcano.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	167	14	25	101	161	105	68	63	2639	187	81	41
Felt	3	0	1	2	6	5	4	1	102	8	1	1

recorded at station C x500.

BVE No. 24, p. 67.

OSHIMA Izu Is-Japan 34.73N 139.38E *VOTW num.*:0804-01=
Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief :* 500 m
Range of eruptive products: basalt

SWARM DATE: 84/7/7 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):V Grade : C

Max. Magnitude: # EQ total : Seismograph:
Max. Intensity: MM at # Felt total : Dist. to vent: 4 km
Depth (km): ± b-value : Type: electromagnetic
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increase of local earthquakes occurred on July 7

See Apr. 22, 1984 for additional comments.

BVE No. 24, p. 67.

SWARM DATE: 84/7/28 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):V Grade : C

Max. Magnitude: # EQ total : Seismograph:
Max. Intensity: MM at # Felt total : Dist. to vent: 4 km
Depth (km): ± b-value : Type: electromagnetic
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increase of local earthquakes occurred on July 28.

See Apr. 22, 1984 for additional comments.

BVE No. 24, p. 67.

SWARM DATE: 84/8/12 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):V Grade : C

Max. Magnitude: # EQ total : Seismograph:
Max. Intensity: MM at # Felt total : Dist. to vent: 4 km
Depth (km): ± b-value : Type: electromagnetic
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increase of local earthquakes occurred on Aug. 12

See Apr. 22, 1984 for additional comments.

BVE No. 24, p. 67.

SWARM DATE: 84/9/2 ±0.5 Dur. (days): 7 ±1 Type:3 Event type(s):V Grade : C

Max. Magnitude: # EQ total : Seismograph:
Max. Intensity: MM at # Felt total : 73 Dist. to vent: 4 km
Depth (km): ± b-value : Type: electromagnetic
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Between Sept. 2-9, 73 felt shocks occurred.

Between Sept. 2-9, 73 felt shocks occurred. See Apr. 22, 1984 for additional comments.

BVE No. 24, p. 67.

SWARM DATE: 84/9/12 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s):V Grade : C

Max. Magnitude: # EQ total : Seismograph:
Max. Intensity: MM at # Felt total : Dist. to vent: 4 km
Depth (km): ± b-value : Type: electromagnetic
Detection threshold: Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Increase of local earthquakes on Sept. 12-13.

See Apr. 22, 1984 for additional comments.

BVE No. 24, p. 67.

OSHIMA Izu Is-Japan 34.73N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief* : 500 m
Range of eruptive products: basalt

SWARM DATE: 85/7/20 ±0.5 Dur. (days):<1 ± Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.2
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 35
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4 km
Type: electromagnetic
Component :
Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A distinct earthquake swarm occurred on 20 Jul.

According to the seismological observation by the Earthquake Research Institute, University of Tokyo, there were 4 distinct earthquake-swarms that occurred on 20 Jul., 16 and 17 - 20 Aug. and 1 Sept. in and around this volcano, as shown in Fig. 3.

BVE No. 25, p. 61-62.

Japan Meteorological Agency (1985 - 1986): The Volcanological Bulletin, vol. 25, nos. 1-4.

Izu-Oshima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Seismic activity at Izu-Oshima Volcano (Apr. - Sept. 1985).

Report of the Coordinating Committee for Prediction of Volcanic Eruptions. no. 35. p.41-47. National research Center for Disaster Prevention (1986: A peculiar earthquake of August 27, 1985 occurring just beneath Izu-Oshima Island.

Report of the Coordinating Committee for Prediction of volcanic eruptions, no. 95, p. 48-52.

SWARM DATE: 85/8/16 ±0.5 Dur. (days):<1 ± Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 4 km
Type: electromagnetic
Component :
Natural period :
Magnification : .5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A distinct earthquake swarm occurred on 16 Aug.

According to the seismological observation by the Earthquake Research Institute, University of Tokyo, there were 4 distinct earthquake-swarms that occurred on 20 Jul., 16 and 17 - 20 Aug. and 1 Sept. in and around this volcano, as shown in Fig. 3.

BVE No. 25, p. 61-62.

Japan Meteorological Agency (1985 - 1986): The Volcanological Bulletin, vol. 25, nos. 1-4.

Izu-Oshima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Seismic activity at Izu-Oshima Volcano (Apr. - Sept. 1985).

Report of the Coordinating Committee for Prediction of Volcanic Eruptions. no. 35. p.41-47. National research Center for Disaster Prevention (1986): A peculiar earthquake of August 27, 1985 occurring just beneath Izu-Oshima Island.

Report of the Coordinating Committee for Prediction of volcanic eruptions, no. 95, p. 48-52.

OSHIMA Izu Is-Japan

34.73N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera — *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l.: 758 m — *Edifice relief:* 500 m
Range of eruptive products: basalt

SWARM DATE: 85/8/17 ±0.5 Dur. (days): 7 ±1 Type:3 Event type(s):tor? Grade : B

Max. Magnitude: M 3.0	# EQ total : 288	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 3	Dist. to vent: 4 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : / Rumbling :
		Magnification : .5 K	Geothermal :

Key phrase: A distinct earthquake swarm occurred on 17 - 20 Aug.

There were earthquake swarms during 16 - 24 Aug. on the NW side of this insular volcano. Showing its peak level on 18 Aug.(Fig. 1,BVE No. 25, p. 62). An earthquake (M2.7) of peculiar type, showing a wave-form of harmonic oscillations with a period of about: 1 sec. occurred at 06:03 JST on 27 August (Fig. 2). It was widely observed on many seismograms in the central region of Honshu.

The Seismicity in Dec. was at a relatively high level. The monthly number of earthquakes in 1985 were as follows. (data by JMA)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Number	48	12	33	>=3	21	26	35	288	13	13	9	169
Felt	0	0	0	1	0	0	0	3	0	2	0	0

According to the seismological observation by the Earthquake Research Institute, University of Tokyo, there were 4 distinct earthquake-swarms that occurred on 20 Jul., 16 and 17 - 20 Aug. and 1 Sept. in and around this volcano, as shown in Fig. 3 in BVE No. 25.

BVE No. 25, p. 61-62.
Japan Meteorological Agency (1985 - 1986): The Volcanological Bulletin, vol. 25, nos. 1-4.
Izu-Oshima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Seismic activity at Izu-Oshima Volcano (Apr. - Sept. 1985).
Report of the Coordinating Committee for Prediction of Volcanic Eruptions. no. 35. p.41-47. National research Center for Disaster Prevention (1986): A peculiar earthquake of August 27, 1985 occurring just beneath Izu-Oshima Island. Report of the Coordinating Committee for Prediction of volcanic eruptions, no. 95, p. 48-52.

SWARM DATE: 85/9/1 ±0.5 Dur. (days):<1 ± Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : / Rumbling :
		Magnification : .5 K	Geothermal :

Key phrase: A distinct earthquake swarm occurred on 1 Sept.

According to the seismological observation by the Earthquake Research Institute, University of Tokyo, there were 4 distinct earthquake-swarms that occurred on 20 Jul., 16 and 17 - 20 Aug. and 1 Sept. in and around this volcano, as shown in Fig. 3.

BVE No. 25, p. 61-62.
Japan Meteorological Agency (1985 - 1986): The Volcanological Bulletin, vol. 25, nos. 1-4.
Izu-Oshima Volcano Observatory, Earthquake Research Institute, University of Tokyo (1986): Seismic activity at Izu-Oshima Volcano (Apr. - Sept. 1985).
Report of the Coordinating Committee for Prediction of Volcanic Eruptions. no. 35. p.41-47. National research Center for Disaster Prevention (1986): A peculiar earthquake of August 27, 1985 occurring just beneath Izu-Oshima Island. Report of the Coordinating Committee for Prediction of volcanic eruptions, no. 95, p. 48-52.

OSHIMA Izu Is-Japan 34.73N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l.: 758 m *Edifice relief :* 500 m
Range of eruptive products: basalt

SWARM DATE: 86/4/1 ±0 Dur. (days): 2.92 ±0.02 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.1
Max. Intensity: MM V at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 650
Felt total : 38
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Swarm started around 0800 JST, 1 April, 1986, >650 unfelt shocks were recorded within the period of 70 hours.

BVE No. 26, p 31-36.
In The 1986 eruption of Izu-Oshima volcano(1988): Special Issue, Bull. Volcanol. Soc. Japan, second series, vol. 33: Sakaguchi, K., Takada, A., Uto, K. and Soya, T.:p.20-31.Yamaoka, K., Watanabe, H. and Sakashita, S.: p.91-101.Yamasato, H., Churei, M., Seino, M. and Ando, K.: p. 120-127.Hashimoto, M. and Tada, T.: p. 136-144. Shimada, S.J. Watanabe) H., Fukui, K. and Fukuyama,E.: p. 161-169.Yamamoto, E., Kumagai, T., Shimada, S. and Fukuyama, E.: p. 170-178. Fujii, T., Aramaki, S., Kaneko, T., Ozawa, K.,Kawanabe, Y. and Fukuoka, T.: p.234-254. In: The 1986 - 1987 eruption of Izu-Oshima volcano; (1988); Earthq. Res. Inst., Univ. Tokyo. Aramaki, S.: p.7-10. Watanabe, H.: p.12-21. Yukutake, T.: p.28-36.
In Rep. Coordinating Committee for Prediction of Volcanic Eruptions (1988): Japan Meteor. Agency: p.1-18; 36-50. Seism. Volcanol. Division, Meteor. Res. Inst.: p.104-109. Earthq. Res. Inst., Univ. Tokyo: p. 140-145; 181-185. Geol. Survey Japan: p.157-165.

SWARM DATE: 86/8/25 ±5 Dur. (days): 5 ± Type:3 Event type(s):felt Grade : C

Max. Magnitude:
Max. Intensity: MM III at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 41
Felt total : 5
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling : Y
Geothermal : Y

Key phrase: Increase of seismic activity took place in late Aug.

Increase of seismic activity took place in late Aug., counting 5 felt shocks (all were 1 in JMA's intensity scale). Two felt shocks on 21 Aug. were accompanied by rumbling sounds.
BVE No. 26, p. 31-36.
See Apr. 1, 1986 for additional refs.

OSHIMA Izu Is-Japan		34.73N 139.38E *VOTW num.*:0804-01=
Morphology: strato with caldera	*Tectonic framework:* Convergent Intraoceanic	
Elevation above m.s.l. : 758 m	*Edifice relief :* 500 m	
Range of eruptive products: basalt		

SWARM DATE: 86/9/11 ±0.5 Dur. (days): 1.5 ±5 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 2 K	Geothermal :	

Key phrase: A swarm occurred on 11-13 Sept.

See Apr. 1, 1986 for additional comments.

BVE No. 26, p. 31-36.
See Apr. 1, 1986 for additional refs.

SWARM DATE: 86/9/26 ±0.5 Dur. (days): 1.5 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.8 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 2 K	Geothermal :	

Key phrase: A swarm occurred on Sept. 26-27

See Apr. 1, 1986 for additional comments.

BVE No. 26, p. 31-36.
See Apr. 1, 1986 for additional refs.

SWARM DATE: 86/11/16 ±0 Dur. (days): 2.13 ±0 Type:2b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 55	Dist. to vent: 0.8 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation :	Focal mech:
Detection threshold:	Repose (yr.): 12.4	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 2 K	Geothermal :	

Key phrase: Many felt events, 16 November, and continued until 07:00 of 19.

Earthquakes remained at a low level even after the eruption of 15 Nov. However, active seismicity including many felt events (55 shocks on 16th) started at 10:00, 16 Nov., and continued till 07:00 of 19. The earthquakes were located at N and W parts of the caldera.

BVE No. 26, p. 31-37.

OSHIMA Izu Is-Japan 34.73N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief :* 500 m
Range of eruptive products: basalt

SWARM DATE: 86/11/21 ±0 Dur. (days): 9 ±1 Type:1c Event type(s): Grade : B

Max. Magnitude: M 6.0
Max. Intensity: MM VIII at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Strong seismicity resumed at 14:17, 21 Nov. about 2 hours before of the B-fissure eruption. By the end of Nov., the frequency went down to one event per day.

Frequent and strong seismicity including many felt shocks suddenly resumed at 14:17, 21 Nov., about 2 hours before the outbreak of the B-fissure eruption. Those earthquakes were located at N part of the caldera. The seismicity, kept a high level during the eruption with the largest event of M6.0 occurring at 09:41 JST 22 Nov., located 15 km S off the Oshima Island (intensity V on JMA scale).
After 23 Nov., number of shocks felt on the island gradually decreased. By the end of Nov., the frequency went down to one event per day. On 24 Nov., small earthquake swarm occurred S off the island. General pattern of epicenters was in the NW-SE direction passing the volcano.

BVE No. 26, p. 31-37.

SWARM DATE: 87/5/22 ±0.5 Dur. (days): 4 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.0
Max. Intensity: MM III at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1795
Felt total : 89
b-value :
Repose (yr.): .92
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.2 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Many small earthquakes located on the SE foot of O-shima volcano were observed during 22-26 May.

Eruptions: 1987 16 Nov. (10:47, 11:02, 14:45 and 15:46) After a series of felt shocks, eruption took place at 10:47, with a strong detonation and strong air shock. Small eruptions took place on 16, 18 and 19 Nov., after 11 month's dormancy, since the last eruption in Dec., 1986. Preceding the eruptions in Nov. 1987, gradual but slight increase in the amplitude of volcanic tremor was recorded. Individual tremor started in May, Aug. and Oct., and number of minor earthquakes located inside the summit caldera also gradually increased. The number of small earthquakes sharply increased before the eruption.
The tremor resumed in Dec. with short duration and very low amplitude. Seismicity had remained low after the eruption in Dec. 1986, until Apr. 1987. The hypocenters were distributed in the direction NNW-SSE, extending southward off the island. However, after the occurrence of the earthquake-swarm off the E Izu Peninsula during the period 6 May through late May, with 89 felt events (at Oshima Weather Station), many small earthquakes located on the SE foot of O-shima volcano were observed during 22-26 May. The largest one was felt with intensity 1 in JMA scale (M3.0) on 23 May.
Volcanic tremor, which stopped on 22 Dec. 1986, resumed on 1 Jan., and became continuous on 25 Jan. The occurrence of tremor became intermittent after 4 Feb., with a time interval of 1-2 hours, but varying its duration and interval widely. Long-duration tremor was observed intermittently in Jun., Jul. and Sept. Tremor was nearly continuous in mid-late Aug., and became really continuous in late-Oct. The amplitude of tremor became very small on 11 Nov. which lasted until the eruption of 16 Nov.

BVE No. 27, p. 28-29.
Japan Meteorological Agency (1988-1989): The Volcanological Bull. of JMA, vol. 27, nos. 1-4.
Watanabe, H., (1988): Seismic Activity, The 1986- l987 Eruption of Izu-Oshima Volcano. Earthq. Res. Inst. Univ. Tokyo, p. 12-21.
Yamaoka, K., et al. (1988): Seismicity during the 1986 Eruption of Izu-Oshima Volcano. Bull. Vol. Soc. Japan, II, vol. 33, Special Number, The 1986 Eruption of Izu-Oshima Volcano, p. 91-101.

OSHIMA Izu Is-Japan 34.73N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l.: 758 m *Edifice relief :* 500 m
Range of eruptive products: basalt

SWARM DATE: 87/9/15 ±5 Dur. (days): 64 ±5 Type:1c Event type(s):V Grade : B

Max. Magnitude:	# EQ total : 795	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2.2 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: Numbers of minor volcanic earthquakes located in the summit caldera increased since the mid-Sept. Seismicity sharply decreased after the eruption of 18 Nov.

Numbers of minor volcanic earthquakes located in the summit caldera increased since the mid-Sept., and remained frequent in Oct. and in early Nov. The monthly number of earthquakes recorded at C station, 2.2 km NW of the crater (JMA, 1989).

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	>=207	>=35	>=32	>=9	1795	>=132	67	84	67	>=108	620	>=47
felt	1				89							

BVE No. 27, p. 28-29.
Japan Meteorological Agency (1988-1989): The Volcanological Bull. of JMA, vol. 27, nos. 1-4.
Watanabe, H., (1988): Seismic Activity, The 1986- l987 Eruption of Izu-Oshima Volcano Earthq. Res. Inst. Univ. Tokyo, p. 12-21.
Yamaoka, K., et al. (1988): Seismicity during the l986 Eruption of Izu-Oshima Volcano. Bull. Vol. Soc. Japan, II, vol. 33, Special Number, The 1986 Eruption of Izu-Oshima Volcano, p. 91-101.

SWARM DATE: 87/11/10 ±0.5 Dur. (days): 6 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 1	Dist. to vent: 2.2 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: A sharp increase in seismicity was detected at the summit caldera area after 10 Nov., especially from AM, 16 Nov. with one felt event.

See Sept. 15, 1987 for additional comments.

BVE No. 27, p. 28-29.

OSHIMA **Izu Is-Japan** **34.73N 139.38E** *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief :* 500 m
Range of eruptive products: basalt

SWARM DATE: 87/11/18 ±0.5 Dur. (days): 3 ±1 Type:1e Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 1	Dist. to vent: 2.2 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: There was an increase in seismicity lasting from 18 to 21 Nov.

There was an increase in seismicity centered on the E side of the volcano lasting from 18 to 21 Nov., with one felt event on 21 Nov. The seismicity, however, sharply decreased after the eruption of 18 Nov.

BVE No. 27, p. 28-29.

SWARM DATE: 88/1/3 ±0.5 Dur. (days): 15 ±1 Type:1b? Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: An increase in amplitude of volcanic tremors which sporadically occurred from Jan. 3 to 13. Then, after Jan. 18, the tremors changed to continuous type though their amplitude decreased.

No clear precursory phenomena prior to these phreatic eruptions were detected in seismic nor ground deformation observations, except increase in amplitude of volcanic tremors which sporadically occurred from Jan. 3 to 13. Then, after Jan. 18, the tremors changed to continuous type though their amplitude decreased.
Volcanic tremors occurred intermittently or continuously at times, showing variation in amplitude throughout the year. Discrete type tremors were replaced by the continuous type episodes from mid-Jan. to late Mar., though sometimes accompanied with discrete type events in this term. Following the occurrence of discrete type tremors in late Mar., continuous type episodes occurred almost every day from Apr. through mid-Oct., showing increase in amplitude in May 3-5, mid and late Aug. and early to mid-Sept. During the high seismic activity in Aug., the amplitude of tremor sharply increased to a level 3-6 times as large as the usual amplitude. In Aug. 18-22, tremors of the larger amplitude occurred at a time interval of about 30 minutes. Increase amplitude at the time interval of about 30 minutes was also recorded during early and mid-Sept. Continuous episodes occurred sporadically until Dec., showing increase in amplitude at the time interval of 10-30 minutes.

BVE No. 28, p. 43-44.
Japan Meteorological Agency (1990): The Volcanological Bull. of JMA, Vol. 28, Nos. 1 - 4.
Rept. Coord. Committee for Prediction of Volcanic Eruptions, No. 47, p. 60.

OSHIMA Izu Is-Japan		34.73N 139.38E *VOTW num.*:0804-01=
Morphology: strato with caldera	*Tectonic framework:* Convergent Intraoceanic	
Elevation above m.s.l. : 758 m	*Edifice relief :* 500 m	
Range of eruptive products: basalt		

SWARM DATE: 88/3/3 ±0.5 Dur. (days): 2 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: The seismicity in the summit caldera area increased from Mar. 3, reaching 20-30 events per hour in the afternoon on Mar. 4, though it sharply decreased thereafter to several events per day.

In 1988, no felt event of volcanic earthquake occurred, but in Feb. and Jul. - Aug., the earthquake swarms that took place off the E Izu Peninsula, about 20-25 km NNW of this volcano, caused felt events at Oshima Weather Station, especially during the latter period. Occurrence of minor volcanic earthquakes located in the summit caldera area remained at higher level throughout 1988. The seismicity in the summit caldera area increased from Mar. 3, reaching 20-30 events per hour in the afternoon on Mar. 4, though it sharply decreased thereafter to several events per day.
Monthly number of earthquakes recorded at C station, 2.2 km. NW of the crater (JMA, 1990)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
EQ	32	115(8)	149	>=76	>=186	>=128	449(19)	804(38)	482	>=62	>=98	44	( ) felt events

BVE No. 28, p. 43-44.
Japan Meteorological Agency (1990): The Volcanological Bull. of JMA, Vol. 28, Nos. 1 - 4.
Rept. Coord. Committee for Prediction of Volcanic Eruptions, No. 47, p. 60.

SWARM DATE: 88/7/25 ±5 Dur. (days): 51 ±10 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total : 804	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 57	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: Seismicity sharply increased from late Jul. through Aug., showing a peak of frequency up to several tens of events a day during Aug. 19-22. The higher level continued until mid-Sept.

Showing sporadic increases during Apr. and mid-Jul. The seismicity sharply increased from late Jul. through Aug., showing a peak of frequency up to several tens of events a day during Aug. 19-22. The higher level continued until mid-Sept., and there after decreased with sporadic increases in late Oct. and early Nov. See Mar. 3 record for earthquake counts.

BVE No. 28, p. 43-44.
Japan Meteorological Agency (1990): The Volcanological Bull. of JMA, Vol. 28, Nos. 1 - 4.
Rept. Coord. Committee for Prediction of Volcanic Eruptions, No. 47, p. 60.

OSHIMA Izu Is-Japan 34.73N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief :* 500 m
Range of eruptive products: basalt

SWARM DATE: 89/5/5 ±5 Dur. (days): ± Type:3 Event type(s):V Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: Frequency increased in early-May

Volcanic earthquakes occurring near the summit crater remained at a low level, while the frequency increased in early-May, and on Nov. 29 and Dec. 23-25. No felt shocks of volcanic origin, though one shock was felt E of the Izu peninsula.

During Jan-April 1989 volcanic tremor episodes were almost continuously recorded showing intermittent increase of amplitude at a time interval of 20-30 min. The amplitude sharply increased on Jan 9-13 and 27 and in late April, while the intermittent increase of tremor ampl. was not clearly observable during early-mid May.

In Jun. volcanic tremor occurred at a regular interval of ~30 min. but in July the occurrence became more irregular with a range of intervals 20-60 min. However in Aug., the tremor became continuous again, showing intermittent increase of ampl. at time interval of ~30 min. The time interval varied from 20-40 min. in Sept. to 30-40 min. in Oct. -Nov. On Nov. 28, duration of periodic large ampl. of the continuous tremor decreased to 2 min. The amplitude of the continuous tremor increased after Dec. 5, with a temporary decrease on Dec. 15 and increase continuing until the end of the month. During Dec. 22-28, the time interval of intermittent increase of tremor's amplitude became very irregular, and the amplitude of the tremor became larger.

FIGS: Temp variations, SO2

BVE No. 29, p. 103.
JMA (1992): Volcanological Bull. of JMA, Vol. 29, Nos. 1-4.
Rept. Coord. Comm. for the Prediction of Volc. Eruptions, No 45, p. 116.

SWARM DATE: 89/11/29 ±0.5 Dur. (days): <1 ± Type:3 Event type(s):V Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.8 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 2 K	Geothermal : Y

Key phrase: Frequency increased on Nov. 29.

See Mar. 1989 additional comments.

BVE No. 29, p. 103.
JMA (1992): Volcanological Bull. of JMA, Vol. 29, Nos. 1-4.
Rept. Coord. Comm. for the Prediction of Volc. Eruptions, No 45, p. 116.

OSHIMA Izu Is-Japan 34.73N 139.38E *VOTW num.*:0804-01=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 758 m *Edifice relief* : 500 m
Range of eruptive products: basalt

SWARM DATE: 89/12/23 ±0.5 Dur. (days): 2.5 ±5 Type:3 Event type(s):V Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.8 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 2 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Frequency increased on Dec. 23-25.

See Mar. 1989 additional comments.

BVE No. 29, p. 103.
JMA (1992): Volcanological Bull. of JMA, Vol. 29, Nos. 1-4.
Rept. Coord. Comm. for the Prediction of Volc. Eruptions, No 45, p. 116.

NII-JIMA Izu Is-Japan 34.37N 139.27E *VOTW num.*:0804-02=

Morphology: lava dome *Tectonic framework:* Convergent (arc)

Elevation above m.s.l. : 429 m *Edifice relief :* 620 m

Range of eruptive products: rhyolite

SWARM DATE: 85/9/22 ±0 Dur. (days): 0.54 ±0 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.8
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.7
Cum. energy release:

EQ total : 120
Felt total : 30
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: There was an earthquake swarm that occurred from 16:18 JST on 21 to 05:28 JST on 22 Sept.

There were earthquake swarms that occurred from 16:18 JST on 21 to 05:28 JST on 22 Sept., and from 04:45 to 06:45 JST on 29 Sept. The epicenters were located at about 10 km NW off this island. The maximum event was a M3.8 shock at 03:18 JST on 22 Sept., and about 30 events of the earthquakes were felt on the island. Count at station NJM. Fig: count data for Aug. to Oct. 1985.

BVE No. 25, p. 62.

Japan Meteorological Agency (1985): The Volcanological Bulletin, vol. 25, no. 3.

National Research Center for Disaster Prevention (1986): An earthquake swarm near Nii-jima Island occurred in Sept. of 1985.

Report of the Coordinating Committee for Prediction of Volcanic Eruptions, no. 35, p. 60-64.

SWARM DATE: 85/9/29 ±0 Dur. (days): 0.08 ±0 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.1
Cum. energy release:

EQ total : 15
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: There was an earthquake swarm that occurred from 04:45 to 06:45 JST on 29 Sept.

There were earthquake swarms that occurred from 16:18 JST on 21 to 05:28 JST on 22 Sept., and from 04:45 to 06:45 JST on 29 Sept. The epicenters were located at about 10 km NW off this island. The maximum event was a M3.8 shock at 03:18 JST on 22 Sept., and about 30 events of the earthquakes were felt on the island. Count at station NJM. Fig: count data for Aug. to Oct. 1985.

BVE No. 25, p. 62.

Japan Meteorological Agency (1985): The Volcanological Bulletin, vol. 25, no. 3.

National Research Center for Disaster Prevention (1986): An earthquake swarm near Nii-jima Island occurred in Sept. of 1985.

Report of the Coordinating Committee for Prediction of Volcanic Eruptions, no. 35, p. 60-64.

KOZU-SHIMA Izu Is-Japan 34.22N 139.15E *VOTW num.*:0804-03=

Morphology: lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 574 m *Edifice relief :* 800 m
Range of eruptive products: rhyolite

SWARM DATE: 86/7/29 ±0.5 Dur. (days): 2.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 2.3	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): 8.5 ±4.5	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: A small earthquake-swarm was detected on 29-31 July.

A small earthquake-swarm was detected by the seismograph of National Research Center for Disaster Prevention on 29-31 July. The swarm was located at depths of 4-11 km very close to this insular volcano. The largest event was a M2.3 shock at 05:25 JST on 29 July. Fig: epicenter map.

BVE No. 26, p. 84.
National Research Center for Disaster Prevention (1987): Seismic Activity of July 1986 in the Vicinity of Kohzu-Shima, Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 38, p. 32.

MIYAKE-JIMA Izu Is-Japan		**34.08N 139.53E** *VOTW num.*:0804-04=
Morphology: strato or composite	*Tectonic framework:*	Convergent Intraoceanic
Elevation above m.s.l. : 815 m	*Edifice relief :* 900 m	
Range of eruptive products: basalt to andesite		

SWARM DATE: 83/10/3 ±0 Dur. (days): 3 ±1 Type:**1d** Event type(s):VT,LP,t Grade : B

Max. Magnitude: Ms6.2	# EQ total : 2411	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM VII at	# Felt total : 101	Dist. to vent: 3.2 km	Tremor : Y Migration :
Depth (km): 3.5 ±2.5	b-value :	Type: electromagnetic	Deformation : Focal mech:
Detection threshold:1.9	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: The first volcanic earthquakes (unfelt) recorded at 13:59 ~1.5 hrs. prior to eruption, earthquakes swarmed thereafter.

Commencement of eruption estimated at 15:23 from the appearance of low frequency volcanic tremor among high frequency seismic events. (3.2 km N of the Oyama summit, x1000) The first volcanic earthquakes (unfelt) recorded at 13:59 ~1.5 hrs. prior to eruption, earthquakes swarmed thereafter. There were 5 felt earthquakes prior to eruption, largest Ms6.2 and intensity V (JMA). Total of 101 felt shocks occurred by 11:09 of Oct. 15, 2281 earthquakes in Oct., 110 in Nov. and 35 in Dec.

Figs: Hourly freq., hypocenter maps.

BVE No. 23, p. 29-32.
Earthquake Research Inst., Fac. of General Education. and Fac. of Science, Univ. of Tokyo, Fac. of Science, Kagoshima Univ., and Geological Survey of Japan (1984): Ejection of the Oct. 3-4 Eruption of Miyakejima. Rept. of Coordinating. Committee for Prediction of Volcanic Eruptions, No. 29, p. 15-22.
Fac. of Science, Tohoku Univ., and Fac. of Science, Hirosaki Univ. (1984): Seismic Activity following the Oct. 1983 Eruption of Miyakejima Volcano, Ibid No. 30, p. 24-27.
JMA (1984): The Volcanic. Bull., vol. 23, no. 4, p. 108-111.

IWO-JIMA Volcano Is-Japan

24.75N 141.33E *VOTW num.*:0804-12=

Morphology: cinder cone *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 165 m *Edifice relief :* 170 m
Range of eruptive products: andesite

SWARM DATE: 82/11/25 ±0.5 Dur. (days): 5 ±1 Type:1aq Event type(s): Grade : B

Max. Magnitude:	# EQ total : 1492	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM IV at	# Felt total :	Dist. to vent: 2 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:0.9	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : .1 s	Magnetic : Y Rumbling : Y
		Magnification : 10 K	Geothermal :

Key phrase: Swarms with rumblings and felt shocks (Max intensity II JMA scale during Nov. 25-30).

Small scale phreatic explosions occurred on Nov. 28, 29 1982. Earthquake swarms with rumblings and felt shocks (Max. intensity II JMA scale during Nov. 25-30). Total 1492 earthquakes recorded by seismograph (x10,000 at 10 Hz). Cracks on road and displacements of faults observed.

BVE No. 22, p. 51-52.

UNNAMED SUBMARINE Mariana Is-C Pac 20.30N 144.90E *VOTW num.*:0804-14*

Morphology: submarine *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products:

SWARM DATE: 89/9/21 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for a possible submarine eruption.

Good examples of T-phase arrivals from a possible submarine eruption.

BVE No. 29, p. 104-105.
SEAN Bull. vol. 14, no. 10, p. 2; no. 12, p. 11, 1989, and communication from: Y. Sawada, Shizuoka Meterological Observatory, JMA, 2-1-5 Magarikane, Shizuoka 422, Japan.

PAGAN, NORTH Mariana Is-C Pac 18.13N 145.80E *VOTW num.*:0804-17=

Morphology: strato with caldera *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 570 m *Edifice relief :* 2500 m
Range of eruptive products: basalt

SWARM DATE: 81/4/1 ±0.5 Dur. (days):>45 ±10 Type:1b Event type(s):HF,f,t Grade : B

Max. Magnitude: 4.0	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 135	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Felt earthquake frequency: 3 per day from 1.5 months prior.

Eruption on May 15 preceded by earthquakes felt in late Mar. or early Apr. Earthquakes (3 per day) shook houses, felt outdoors. Magnitude probably between 3 and 4. At least 13 felt on May 15, began at 7:45. May 22, increase in tremor and number of discrete higher frequency events 1.2 hrs. prior to minor a flow from S summit. Seismic monitoring by the USGS on May 20-28 showed continuous harmonic tremor indicating magma movement a few km beneath surface of the volcano with short bursts of high frequency signals indicating intermittent extrusive events. Ongoing tremor suggests more secondary activity to take place.
At the same time, no significant earthquake activity was detected, indicating no prominent build up of stresses typically associated with activities prior to a major explosive eruption. However, the deformation survey indicated possible swelling of the volcano, which may lead to an increase in future micro-earthquake activity and eventually to an eruptive event more significant than those of 20-28 May.
Felt earthquake frequency: 3 per day from 1.5 months prior and at least 13 felt shocks during 90 min. prior (all felt) M3-4, one >M4.

BVE No. 21, p. 43-48.

KOMAGA-TAKE Hokkaido-Japan 42.07N 140.68E *VOTW num.*:0805-02=

Morphology: strato or composite *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 1140 m *Edifice relief :* 1100 m
Range of eruptive products: andesite

SWARM DATE: 83/6/13 ±0.5 Dur. (days): 2 ±1 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 23	Seismograph:		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	4.1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :		Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :		Magnetic :	Rumbling :
		Magnification :	2 K	Geothermal :	

Key phrase: Volcanic earthquakes swarmed 13-14 Jun., 1983.

Volcanic earthquakes swarmed 13-14 Jun., 1983 and 23 events were recorded on JMA`s seismograph (4.1 km WSW , x 2000). On the same day Hokkaido Univ. network detected 423 volcanic earthquakes, whose epicenters were mostly located around the summit crater. No anomalous evidence was observed at the summit.

BVE No. 23, p. 61.

SWARM DATE: 89/12/30 ±0.5 Dur. (days):<1 ± Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 20	Seismograph:		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:		Tremor :	Migration :
Depth (km): ±	b-value :	Type:		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :		Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :		Magnetic :	Rumbling :
		Magnification :		Geothermal :	

Key phrase: Sharp increase of volcanic earthquakes took place on Dec. 30, 1989

Sharp increase of volcanic earthquakes took place on Dec. 30, 1989, totaling 20 events per day, while the monthly number was 23. Similar seismic activity was observed in Mar 1988. No changes in fumarolic activity was detected. Fig.: Monthly frequency of volcanic earthquakes recorded at A station (1966-1989).

BVE No. 29, p. 106.
JMA (1992): Volcanological Bull. of JMA, Vol. 29, No. 4.

USU **Hokkaido-Japan** **42.53N 140.83E** *VOTW num.*:0805-03=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 725 m *Edifice relief :* 650 m
Range of eruptive products: basalt to dacite

SWARM DATE: 10/7/22 ±0.5 Dur. (days): 4 ±0.5 Type:1bq Event type(s):VT Grade : A

Max. Magnitude: Ms 5.1	# EQ total : 204	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM VIII at	# Felt total :	Dist. to vent: 70 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: long period Omori	Deformation : Focal mech:
Detection threshold:	Repose (yr.): 57	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: The eruption of 1910 was preceded by notable foreshock activity. Duration from fig. 4 in Abe (1979).

The eruption of 1910 was preceded by notable foreshock activity. From July 21, 1910, 4 days before the first eruption, earthquakes were felt near Usu with increasing frequency. As the frequency continued to increase in a marked way, the inhabitants at the immediate base of the mountain began to leave their homes. The maximum frequency of earthquakes was attained on July 24. On the 24th and 25 strong shocks occurred and caused minor damage. On July 25 at about 10pm the initial explosion occurred near Kompira-yama on the northern flank of the volcano. The earthquakes were most numerous during the period from 6pm on the 24th to 9am on the 25th and during the next 13 hours, at the end of which the eruption began, the earthquake activity fell off rapidly.

Abe, K. (1979) Magnitudes of Major Volcanic Earthquakes of Japan 1901 to 1925, J. Fac. Sci., Hokkaido Univ., Ser. VII (Geophysics), Vol VI, No. 1, 1979.

SWARM DATE: 77/8/6 ±0.5 Dur. (days): 1.25 ±0.02 Type:1b Event type(s): Grade : B

Max. Magnitude: 4.3	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM VI at 2.5 km	# Felt total :	Dist. to vent: 0.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): 32	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: Felt and unfelt shocks occurred 30 hours before the eruption.

BVE No. 17, p. 49-53.

USU Hokkaido-Japan	**42.53N 140.83E** *VOTW num.*:0805-03=
Morphology: strato with lava dome	*Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 725 m	*Edifice relief :* 650 m
Range of eruptive products: basalt to dacite	

SWARM DATE: 77/8/6 ±0.5 Dur. (days): **1681±15** Type:**1d** Event type(s): Grade : B

Max. Magnitude: 4.3	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.5 km	Tremor : Migration :
Depth (km): 1 ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 1 K	Geothermal :

Key phrase: In the middle of Mar. 1982, after 4 years and 7 months since the beginning of the activity in Aug. 1977, the seismicity declined to pre-eruption levels.

Felt earthquakes swarmed about 30 hours before the eruption and precursory crustal movements such an fault fissures were found just before the eruption. Notable earthquake swarm and topographical change which were caused by ascending of a viscous dacite magma beneath the atrio continued after the eruption.
Earthquakes including a number of felt shocks frequently took place, the foci of which were located beneath the somma with a depth of ca. 1 km below sea level. The frequency of earthquakes recorded at 2-4 km from the crater are shown in BVE No. 17, p. 52, figure. The mean daily frequency is as follows:

Month	EQ per day	felt per day
Aug.	1018	125
Sept.	504	60
Oct.	411	43
Nov.	401	29
Dec.	377	35

The maximum magnitude was 4.3 and cumulative energy release through Dec. was 3.8 x10e+20 ergs.
Felt and unfelt shocks occurred 30 hours before the eruption.
Unfelt frequency: 100-200 per hour at the max. S-P duration 0.5-0.7 sec.

BVE No. 17, p. 49-53.
BVE No. 23, p. 61.

SWARM DATE: 79/7/1 ±183 Dur. (days): ± Type:1e Event type(s): Grade :

Max. Magnitude: 4.3	# EQ total : 605	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 107	Dist. to vent: 2.4 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : Y EQ families :
Cum. energy release: 8.8e+13 J	Previous swarms :	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 1 K	Geothermal : Y

Key phrase: Place holder for 1979.

Frequent shallow earthquakes accompany ground deformations. Total upheaval in 1979 = 17 m (4.7 cm /day). Ugu-Shinzan and 19 m (5.3 cm/day) at Ogari-yama (both crypto-domes). Cum. energy release from Aug. 1977 to Oct. 1979 is 8.8e+20 ergs. The average rate for Aug. to Sept. 1978 is about 1.7e+18 ergs per day. Figs: Daily energy release.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ*	76	65	64	61	51	54	47	36	35	36	36	44
felt**	13	12	12	10	7	9	8	7	7	7	7	8

* 65 events detected by seismograph at ~2.4 km SSW of craters.
** 107 felt determined by amplitude on seismogram.

BVE No. 19, p. 56-57.
Okada, H., et al., Seismological Significance of the 1977-1978 eruptions and magma intrusion process of Usu volcano, Hokkaido, JVGR, 9, (1981) 311-334.
Yokoyama, I., et al., Geophysical characteristics of dacite volcanism--the 1977-1978 eruptions of Usu volcano, JVGR, 9, (1981) 335-358.

USU Hokkaido-Japan

42.53N 140.83E *VOTW num.*:0805-03=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 725 m *Edifice relief* : 650 m
Range of eruptive products: basalt to dacite

SWARM DATE: 80/7/1 ±183 Dur. (days): ± Type:1e Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.9
Cum. energy release:

EQ total : 7832
Felt total : 1427
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.4 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Place holder for 1980.

All of 1980 at summit crater growth of new cryptodome continued with earthquakes and deformation. Crustal movement and seismicity on decrease for 1980. Fig: Hourly frequency of earthquake swarms.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ*	1176	1004	890	582	673	211	601	486	620	413	604	572
Felt**	234	216	162	92	121	32	112	82	108	69	106	93

*detected on seismograph 2.4 km SSW of craters
**determined by amplitude on seismograms
BVE No. 20, p. 58-60.

SWARM DATE: 81/7/1 ±183 Dur. (days): ± Type:1e Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.9
Cum. energy release:

EQ total : 3694
Felt total : 718
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.4 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Place holder for 1980.

Shallow earthquakes accompany outward deformation of N somma wall and growth of cryptodome. Figs: change in seismicity with time after 1977 eruption.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ*	357	289	235	485	153	151	423	317	244	315	285	44
Felt**	63	49	41	92	35	33	89	64	41	52	54	105

*detected on seismograph 2.4 km SSW of craters
**determined by amplitude on seismograms
BVE No. 21, p. 49-51.

SWARM DATE: 82/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:1.9
Cum. energy release:

EQ total : 808
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.4 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 1 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1982.

Since pumice eruption in 1977, ground deformation in and around somma continued with earthquakes owing continuous shallow intrusion. However rate has decreased after Mar. 1982 deformation has nearly stopped. Earthquake frequency to pre-eruption levels. Figs Hourly frequency earthquake swarms for Aug. 1977 to Mar. 1982.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ*	497	232	79	>9	>9	>9	30	22	49	>8	9	13

*detected on seismograph 2.4 km SSW of craters magnify 1000 x
BVE No. 22, p. 54-56.

USU **Hokkaido-Japan**		**42.53N 140.83E** *VOTW num.*:0805-03=
Morphology: strato with lava dome	*Tectonic framework:*	Convergent (arc)
Elevation above m.s.l. : 725 m	*Edifice relief :* 650 m	
Range of eruptive products: basalt to dacite		

SWARM DATE: 83/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Place holder for 1983.

Seismicity declined to background levels by early 1983. Fig: Monthly number of volcanic earthquakes
BVE No. 23, p. 67.

TARUMAI Hokkaido-Japan 42.68N 141.38E *VOTW num.*:0805-04=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1024 m *Edifice relief :* 400 m
Range of eruptive products: andesite

SWARM DATE: 79/1/15 ±15 Dur. (days): 58 ±20 Type:**1d** Event type(s):VE Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 2 ±
Detection threshold:1.1
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 1.1 km
Type: electromagnetic
Component :
Natural period :
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Frequency of volcanic earthquakes high in early 1979 but tapered since mid Mar.

Most ash ejections accompanied by tremor. The frequency of volcanic earthquakes high in early 1979 but tapered since mid Mar. The hypocenteral area was NW-SW site near summit and at depth = 2 km below sea level. Shallower activity in Sept. -Oct.
BVE No. 19, p. 58.

SWARM DATE: 80/11/15 ±15 Dur. (days): 240 ±30 Type:**1cq** Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 621
Felt total : 22
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: electromagnetic
Component :
Natural period :
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from figure on p. 52 BVE No. 21.

Frequency of volcanic earthquakes increased in Nov. and Dec. 1980.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQs	30	38	18	31	24	20	36	22	20	25	205	152

Volcanic tremor occurred in Dec. 1980.
Frequency of volcanic earthquakes increase since Nov. 1980 and peaked Feb. 1981. Figs: Monthly freq. 1967-81 and 5 month running average.
BVE No. 20, p. 96.
BVE No. 21, p. 51-52.

SWARM DATE: 88/1/25 ±5 Dur. (days): 20 ±10 Type:3 Event type(s):VE,LF Grade : B

Max. Magnitude: 2.0
Max. Intensity: MM IV at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 124
Felt total : 1
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1.1 km
Type: electromagnetic
Component :
Natural period :
Magnification : 3 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Small earthquake swarms occurred from late Jan. through mid-Feb.

Small earthquake swarms occurred from late Jan. through mid-Feb., showing the daily frequency more than 5-10 events and totaling; 124 events in Feb., according to JMA's seismological observations.
According to the seismological observation by Hokkaido University, minor earthquakes continued until early Mar. The swarm contained many low frequency type earthquakes. Besides them, there were five events larger than 2.0 in Jan. - Mar., including one felt shock on Mar. 21 at the upper slope (intensity 2 in JMA-scale). Fig: earthquake counts 1965-1988.
The monthly number of earthquakes recorded at JMA's station A, about 1.1 km NE of the summit dome

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	30	124	10	2	2	>=20	1	10	1	1	1	1

BVE No. 28, p. 96-97.

TOKACHI Hokkaido-Japan 43.42N 142.68E *VOTW num.*:0805-05=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2077 m *Edifice relief :* 1000 m
Range of eruptive products: andesite

SWARM DATE: 83/1/6 ±0.5 Dur. (days):<1 ± Type:3 Event type(s): Grade : C

Max. Magnitude: # EQ total : 22 Seismograph:
Max. Intensity: MM at # Felt total : Dist. to vent: 4.5 km
Depth (km): ± b-value : Type:
Detection threshold:1.3 Repose (yr.): Component :
Cum. energy release: Previous swarms : Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Seismicity temporarily increased on 6 Jan.

Seismicity was generally weak, but temporarily increased on 6 Jan. (22 events), 9-10 Feb.. (77 events) and 9-10 May (79 events). Data of a JMA seismograph (x 5000) at 4.5 km NNW of the active craters.
BVE No. 23, p. 61.

SWARM DATE: 83/2/9 ±0.5 Dur. (days): 1.5 ±0.5 Type:3 Event type(s): Grade : C

Max. Magnitude: # EQ total : 77 Seismograph:
Max. Intensity: MM at # Felt total : Dist. to vent: 4.5 km
Depth (km): ± b-value : Type:
Detection threshold:1.3 Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Seismicity temporarily increased on 9-10 Feb.

Seismicity was generally weak, but temporarily increased on 6 Jan. (22 events), 9-10 Feb. (77 events) and 9-10 May (79 events). Data of a JMA seismograph (x 5000) at 4.5 km NNW of the active craters.
BVE No. 23, pp 61.

SWARM DATE: 83/5/9 ±0.5 Dur. (days): 1.5 ±0.5 Type:3 Event type(s): Grade : C

Max. Magnitude: # EQ total : 79 Seismograph:
Max. Intensity: MM at # Felt total : Dist. to vent: 4.5 km
Depth (km): ± b-value : Type:
Detection threshold:1.3 Repose (yr.): Component :
Cum. energy release: Previous swarms : Y Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Seismicity temporarily increased on 9-10 May.

Seismicity was generally weak, but temporarily increased on 6 Jan. (22 events), 9-10 Feb.. (77 events) and 9-10 May (79 events). Data of a JMA seismograph (x 5000) at 4.5 km NNW of the active craters.
BVE No. 23, pp 61.

SWARM DATE: 85/6/12 ±0.5 Dur. (days): 7 ±1 Type:1bq Event type(s): Grade : B

Max. Magnitude: # EQ total : 442 Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 0.3 km
Depth (km): ± b-value : Type: electromagnetic
Detection threshold: Repose (yr.): Component : Z
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: Duration from fig. in BVE No. 25.

Seismic activity in May showed relatively high level (32 events), but after Jul. the seismicity remained at normal levels. Good figure of daily earthquakes counts (June-Sept. 1985) in BVE No. 25.
BVE No. 25, p. 35-36.
JMA (1986): Volcanological Bulletin, vol. 25, nos. 1-4.
Usu Volcano Observatory, Hokkaido Univ. (1986): Observation report on the volcanic activities in Hokkaido (Apr.-Sept., 1985). Report to the Coord. Committee for Prediction of Volcanic Eruptions, no. 35, p. 13-25.

TOKACHI **Hokkaido-Japan** **43.42N 142.68E** *VOTW num.*:0805-05=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2077 m *Edifice relief :* 1000 m
Range of eruptive products: andesite

SWARM DATE: 86/9/15 ±15 Dur. (days): 15 ±15 Type:3 Event type(s):VE Grade : C

Max. Magnitude:	# EQ total : 18	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Monthly number of volcanic earthquakes was 18 in Sept. showed a higher level than the normal.

Monthly number of volcanic earthquakes was 18 in Sept. at A station (x 5,000), 4.5 km NNW of Tokachi-dake peak, showing a higher level than the normal. There was a felt shock on 31 Aug., but it was not located beneath this volcano. A shock was felt at Shirogane Spa, about 4 km NNE of the craters, on 3 Dec., and this event was located at depth of 1 km near the summit.

Monthly number of volcanic earthquakes recorded by JMA was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	8	6	14	15	10	12	8	8	18	7	14	25

Volcanic tremors were recorded by JMA's A station at 00:20-00:40 JST on 20 Dec., that was the first record since 1 Sept. 1985. The earthquakes were also recorded by the seismographs installed within a distance of 2 km of the crater at 00:19-00:56 JST on 20 Dec. and 05:08-05:22 JST on 21 Dec.

(Communication from: Y. Sawada, Seismol. and Volcanol. Dept., Japan Meteorological Agency, 1-3-4 Ote-machi, Chiyoda-ku, Tokyo 100, Japan)

BVE No. 25, p. 35-36.
JMA (1986): Volcanological Bulletin, vol. 25, nos. 1-4.
Usu Volcano Observatory, Hokkaido Univ. (1986): Observation report on the volcanic activities in Hokkaido (April-Sept., 1985). Report to the Coord. Committee for Prediction of Volcanic Eruptions, no. 35, p. 13-25.

SWARM DATE: 86/11/6 ±0.5 Dur. (days): 1 ±0.5 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Earthquake swarms occurred around the 62-I Crater on 25 Nov.

See Sept. 15, 1986 for additional comments.

BVE No. 26, p. 84.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.
Usu Volcano Observatory, Hokkaido University (1988): Observational Report on the Volcanic Activities in Hokkaido (October 1985 - April 1987), Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 39, p. 203-230.

TOKACHI **Hokkaido-Japan** **43.42N 142.68E** *VOTW num.*:0805-05=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 2077 m *Edifice relief :* 1000 m
Range of eruptive products: andesite

SWARM DATE: 86/12/6 ±0.5 Dur. (days): 1 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type:
Component :
Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Earthquake swarms occurred around the 62-I Crater on 6 Dec.

See Sept. 15, 1986 for additional comments.

BVE No. 26, p. 84.
Japan Meteorological Agency (1987): Volcanological Bulletin, vol. 26, nos. 1-4.
Usu Volcano Observatory, Hokkaido University (1988): Observational Report on the Volcanic Activities in Hokkaido (October 1985 - April 1987), Report of Coordinating Committee for Prediction of Volcanic Eruptions, no. 39, p.203-230.

SWARM DATE: 87/6/29 ±0 Dur. (days): 0.18 ±0 Type:3 Event type(s):HF,MF,LF Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 25
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4.5 km
Type:
Component :
Natural period :
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Earthquake swarms occurred at the NE foot of the volcano at 03:40 JST on 29 Jun. counting 25 events until 08:00 JST

Seismicity was high during Jan.-Nov. 1987, and volcanic tremors were recorded. Number of minor volcanic earthquakes increased on 14 Jan. and in mid- and late-Feb. Minor volcanic tremors were recorded on 11 and 21 Feb., for the first time since Dec. 1986. Tremors were also recorded on 1 and 2 Mar., 15 Jul. and 2 Aug., this year. Seismicity remained at a higher level in April and May. Earthquake swarms occurred at the NE foot of the volcano at 03:40 JST on 29 Jun., counting 25 events until 08:00 JST at A station, 4.5 km NNW of the crater. The seismometer installed near the 62-II crater recorded more frequent occurrence of minor volcanic earthquakes, and the seismicity further increased on 30-31 July.
Monthly number of earthquakes recorded at Station A was as follows:

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	11	13	25	9	11	42	18	8	>=6	3	8	16

According to the seismological observation by Hokkaido Univ., high and medium frequency volcanic earthquakes were located around the Ansei (Kyu-Fun) crater, while low frequency earthquakes were located around Ground crater which nests the 62-11 crater. fig: epicenter map.

BVE No. 27, p. 86.
Japan Meteorological Agency (1986,1989): Volcanological Bulletin, vol. 27, nos. 1-4.
Usu Volcano Observatory, Faculty of Science, Hokkaido Univ., Japan Meteorological Agency and Geological Survey of Hokkaido (1988): Hypocenter Distribution of Volcanic Earthquake at Mt. Tokachi, Hokkaido. Rep. Coordinating Committee for Prediction of Volcanic Eruption, no. 41, p. 78-81.

TOKACHI **Hokkaido-Japan** **43.42N 142.68E** *VOTW num.*:0805-05=

Morphology: strato with lava dome *Tectonic framework:* Convergent (arc)
Elevation above m.s.l.: 2077 m *Edifice relief :* 1000 m
Range of eruptive products: andesite

SWARM DATE: 88/9/16 ±5 Dur. (days): 170 ±10 Type:1dq Event type(s):HF,LF Grade : B

Max. Magnitude: M 4.4
Max. Intensity: MM VII at 4.5 km
Depth (km): 4 ±1
Detection threshold:
Cum. energy release:

EQ total : 487
Felt total : 10
b-value :
Repose (yr.): 26
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: electromagnetic
Component : 1
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity : Y
Magnetic : Y
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Duration from fig BVE No. 28, p. 50.

On Dec. 16, 1988, Tokachi-dake began to erupt after 26 year's dormancy (last eruption in 1962) Long-term but sporadic increase of activity prior to the 1988 eruption had been observed since 1983 in emission of volcanic cloud, thermal state and seismicity. Notable seismic activity with felt shocks, earthquake swarms and tremors began in late Sept. 1988, about 3 months before the present eruption. There were peculiar seismic precursors that were observed immediately before some eruptions; LF earthquakes occurred and increased but rapidly changed to large amplitude volcanic tremor after the beginning of eruptions.
Summary of the long-term precursors since 1983 until the first eruption on Dec. 18 follows: 1983 Feb. & May increase of volcanic earthquakes and a tremor took place.1985 Jun. 13-15 small earthquake-swarms occurred. Dec. 20 a small tremor was recorded. 1988 Three earthquakes were felt. Number of volcanic earthquakes increased from late-Sept., Higher seismic level with felt earthquakes continued since Nov. Number of LF earthquakes gradually increased. Oct. 4 two small volcanic tremors occurred. On Nov. 10, 14 felt earthquakes occurred. On Nov. 15 a swarm with 3 felt events took place, with 29 shocks on Dec. 15. Dec.19-22, 25 the number of small LF earthquakes increased. On Dec. 11-13 volcanic tremors were registered.
Immediately before the beginning of explosive eruptions, seismic precursors were observed; occurrences of small LF earthquakes and of HF earthquake followed by LF earthquake. LF earthquake changed to large amplitude continuous tremor at the same time or immediately after the beginning of explosion, mostly being felt at JMA's observatory. The HF earthquakes that occurred before the beginning of the 1988 eruption were located under two areas around Ground Crater and Kyu-fun Crater. Number of the LF earthquakes increased gradually before the beginning of eruption on Dec. 16, while number of the HF events gradually decreased after beginning of the eruptions. Volcanic earthquakes after eruptions were still located under Ground Crater and Kyu-fun Crater, and the hypocenters of the LF events are estimated to be at depths of 3-5 km under Ground Crater.
High level of seismic activity continued in Jan., but decreased after Feb., while there was a small increase in Jul. Most earthquakes were located at shallow depths under 62-II craters, and LF earthquakes are considered to be located under the Ground crater. Volcanic tremors were frequently recorded since Dec. 1988 through Feb. 1989, but sharply decreased after late Feb., though there were temporary increases in Mar. Volcanic tremors were not recorded after Apr., while many minor tremors were observed in Jun. and Jul. w/ the near station. Small tremors were observed on Dec. 24, 1988, and there was a slight increase of volcanic earthquakes on Dec. 25. Since Jan 14 1989 the frequent seismic activity started 20-30 km E of the volcano. The activity included felt events, the largest was M4.4 at 23:21 on Jan. 15. This activity was at a high level in Jan., then decreased in Feb.and futher decreased thereafter, while there was an increase in late Jul. Near the epicenter, there is a newly confirmed active volcano, Maruyama.
Monthly number of volcanic earthquakes recorded at A stn. (4.5 km NNW of 62-II) for 1988 and 1989 felt in ( )

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ	15	14(2)	12	13	20	17	20	15	23	39(1)	93(3)	105(4)	174	76	17	22	5	17	25	17	14	13	7	8

Seismic events associated with explosions: 1988 Dec. 16, 05:24 Ampl. 12.9, Inten. 3 at Fukiage, Shirogane & Tokachi-dake Spa. LF preceded an earthquake swarm, then changed to cont. tremor. Dec. 18, 08:38 Ampl. 13.6, Inten.1 at Fukiage Spa. HF changed to LF, and then to cont. tremor. Dec. 19, 21:48 Ampl. 16.1, Inten.1at Shirogane & Fukiage Spa. HF changed to LF, then to tremor. Remarkable variations of tremor ampl. were observed after the erupt. Dec. 24, 22:12 Ampl. 5.6 HF changed to LF. Dec. 25, 00:49 Ampl. 22.0, Inten. 2 at Fukiage Spa. LF preceded. Dec. 30, 05:27 Ampl. 6.9, Inten. 1 at Fukiage Spa. HF changed to large LF. An air-shock was recorded by a microphone. Eruption time=(JST). Ampl.=The max. ampl. (um) of explosion earthquake on Z comp. at JMA's A station. Inten. in JMA scale

BVE No. 28, p. 46-52; No. 29, p. 55-61. JMA (1992): Volcanological Bull , Vol. 29, Nos. 1-4. Usu Volc. Obs., Fac. of Science, Hokkaido Univ., JMA & Geol.Survey of Hokkaido (1988): Hypocenter dist. of volcanic earthquake at Mt. Tokachi, Hokkaido. Rept. Coord. Com. for Prediction of Volc. Erupt., No. 41, p. 78-81. Katsui, Y., et al. (1990): The 1988-1989 explosive eruption of Tokachi-dake, central Hokkaido, its sequence and mode. Bull. Volc. Soc. Japan, 2nd ser., vol. 35, No. 2, p. 111-129. Nishimura, Y. (1990): Joint seismological observations by the National Univ. Team during the 1988-1989 eruptive activity of Mt. Tokachi, Hokkaido. Bull. Volc. Okada. H. et al., (1990): Geophysical significance of the 1988-1989 explosive eruptions of Mt. Tokachi, Hokkaido, Japan. Bull. Volcanol. Soc. Japan, 2nd ser. Vol. 35, no. 2, p. 175-203.

MARU-YAMA Hokkaido-Japan 43.42N 143.03E *VOTW num.*:0805-061

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1692 m *Edifice relief :*
Range of eruptive products:

SWARM DATE: 89/1/14 ±0.5 Dur. (days): **60** ±5 Type:3 Event type(s): Grade : **B**

Max. Magnitude: M 4.4
Max. Intensity: MM at
Depth (km): 5 ±5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from fig. on p. 60 BVE no. 29.

During the 1988-1989 eruption of Tokachi-dake, earthquakes swarmed after Jan. 14 (See Tokachi-dake 89), with the largest event of M4.4. Epicenters of the earthquake swarm were located at the NW and SSE side of Maru-Yama. The frequency sharply decreased in Feb. and Mar., but the earthquakes still continued towards the end of the year with a low level. Increases of seismicity were observed in early Jun. and late Jul. in the NW region, and then in Oct. in the SSE region. Figs: Topo. and Hypocenter maps.

BVE No. 29, p. 106-107.
Research Center for Earthquake Prediction, Faculty of Science, Hokkaido Univ. Obihiro Univ. of Agriculture and Veterinary Medicine and Faculty of Science, Hokkaido Univ. (1989) : The latest explosion from Maruyama Volcano, Higashi-Taisetsu Mountains, Rep. Coord. Committee for the Predictions of Volc. Erupt. No. 45, p. 44-58.

SWARM DATE: 89/6/5 ±5 Dur. (days): 2.5 ±1 Type:3 Event type(s): Grade : **B**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from fig. on p. 60 BVE no. 29.

Increases of seismicity were observed in early Jun. in the NW region

BVE No. 29, p. 106-107.
Research Center for Earthquake Prediction, Faculty of Science, Hokkaido Univ. Obihiro Univ. of Agriculture and Veterinary Medicine and Faculty of Science, Hokkaido Univ. (1989) : The latest explosion from Maruyama Volcano, Higashi-Taisetsu Mountains, Rep. Coord. Committee for the Prediction of Volc. Erupt. No. 45, p. 44-58.

SWARM DATE: 89/7/25 ±5 Dur. (days): 7 ±1 Type:3 Event type(s): Grade : **B**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from fig. on p. 60 BVE no. 29.

Increases of seismicity were observed in late Jul. in the NW region

BVE No. 29, p. 106-107.
Research Center for Earthquake Prediction, Faculty of Science, Hokkaido Univ. Obihiro Univ. of Agriculture and Veterinary Medicine and Faculty of Science, Hokkaido Univ. (1989) : The latest explosion from Maruyama Volcano, Higashi-Taisetsu Mountains, Rep. Coord. Committee for the Predictions of Volc. Erupt. No. 45, p. 44-58.

ME-AKAN **Hokkaido-Japan**		**42.38N 144.02E**	*VOTW num.*:0805-07=
Morphology: strato or composite	*Tectonic framework:*	Convergent (arc)	
Elevation above m.s.l. : 1503 m	*Edifice relief :* 700 m		
Range of eruptive products: andesite			

SWARM DATE: 82/3/19 ±0.5 Dur. (days): 17 ±5 Type:3 Event type(s):VE Grade : B

Max. Magnitude:	# EQ total : 411	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Frequency of minor earthquakes increase since Mar. 19,1982 and continued to early Apr. 1982.

Frequency of minor earthquakes increase since Mar. 19, 1982 and continued to early Apr. 1982. Mar. 21 11:23 a big tectonic quake (M JMA 7) off of Urakawa 220 km SW of Me-Akan. Frequency of volcanic earthquakes in Mar. 1982 = 411/day and max. ampl. = 7.4 um by seismograph of Kushiro L.M.O., JMA. Table: daily frequency of volcanic earthquakes in Mar. and annual numbers during 1977-1982.

BVE No. 22, p. 106.

ME-AKAN **Hokkaido-Japan** **42.38N 144.02E** *VOTW num.*:0805-07=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l. : 1503 m *Edifice relief :* 700 m
Range of eruptive products: andesite

SWARM DATE: 87/9/9 ±0 Dur. (days): 105 ±1 Type:1a Event type(s):VE,tor? Grade : B

Max. Magnitude:	# EQ total : 406	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: electromagnetic	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 5 K	Geothermal :

Key phrase: Earthquake swarms were recorded before the eruption from Sept. 9, 1987 to Jan. 2, 1988.

A volcanic earthquake swarm started at 13:00 JST on 9 Sept., counting 98 events as of 10 Dec., and 406 events were registered in Dec. This was the second highest record of monthly number, following the record of 411 in Mar. 1982. These earthquakes were located around the crater, according to the temporary seismological observations. Earthquake swarms were recorded before the eruption from Sept. 9, 1987 to Jan. 2, 1988. Seismic events did not occur on Jan. 3, but continuous volcanic tremors of low amplitudes (0.1 ~ 0.3 um) took place from 17:15 (JST) on Jan. 4 through 03:00 on Jan. 6 showing wavetrains of high frequency. Discrete tremors occurred until Feb. 27. Volcanic tremor was detected at the JMA's seismic station for the first time from its installation in 1973. Higher amplitudes of volcanic tremors were recorded during the two eruptions in Feb., and the continuous volcanic tremors were intermittently recorded on the seismograms through Feb. 26.
The precursory earthquake swarm since Sept. 1987, involved larger earthquakes with wavetrains of monotonic and low frequency. Their foci were located around Ponmachineshiri Crater. There were low frequency earthquakes showing peak activity in Mar. and another type of earthquakes of large amplitude during Jan. - Apr. 1988. The low frequency earthquakes showing duration time of about one minute, amplitude of 0.2 ~ 0.3 um and wave-period of about one second were frequently recorded since Jan., although their epicenters were not determined. Activity of the events decayed in Apr., and the event was not recorded after May. Figure: seismogram of special volcanic earthquake.
Monthly number of volcanic earthquakes of Me-akan Volcano in 1987 and 1988. Record at JMA's station A, 2.3 km NW of the summit of the volcano.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
EQ(87)	7	38	>=75	26	>=47	>=35	7	>=5	6	>=8	>=7	406
EQ(88)	83	62	298	53	>=14	4	>=90	55	11	831	>=349	28

BVE No. 27, p. 86-87.
BVE No. 28, p. 52-54.
Usu Volcano Observatory, Faculty of Science, Hokkaido University (1988): Observational report on the volcanic activities in Hokkaido (Oct., 1987 - Apr. 1988). Rept. Coordinating Committee for Prediction of Volcanic Eruptions, No. 41, p. 64 -77.
Japan Meteorological Agency (1990): Volcanological Bulletin of JMA, Vol. 28, Nos. 1 - 4.

ME-AKAN Hokkaido-Japan

42.38N 144.02E *VOTW num.*:0805-07=

Morphology: strato or composite *Tectonic framework:* Convergent (arc)
Elevation above m.s.l.: 1503 m *Edifice relief:* 700 m
Range of eruptive products: andesite

SWARM DATE: 88/10/15 ±5 Dur. (days): 15 ±10 Type:3 Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 441
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: An earthquake swarm commenced since mid-Oct., 298 events occurred on Oct. 18 and 143 events on 19, and a total of 831 events were recorded in Oct.

Minor earthquake swarm was detected in Jul. - Aug., and active earthquake swarm involving tremors took place in Oct. - Nov. The earthquake swarm commenced since mid-Oct., 298 events occurred on Oct. 18 and 143 events on 19, and a total of 831 events were recorded in Oct. These records show highest frequency both in daily and monthly number during the JMA's seismological observation since 1973.

BVE No. 28, p. 52-54.

SWARM DATE: 88/11/13 ±0.5 Dur. (days): 1.5 ±0.5 Type:3 Event type(s):VE,t Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 307
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: In Nov., there was a sharp increase of volcanic earthquakes, counting 92 events and 215 events on 13th and 14th, respectively

In Nov., there was a sharp increase of volcanic earthquakes, counting 92 events and 215 events on 13th and 14th, respectively, while 0 - 6 events per day in other days. The monthly number in Nov. was 349 events. A small volcanic tremor with duration time of 4 minutes was recorded on Nov. 14.

BVE No. 28, p. 52-54.

SWARM DATE: 89/4/10 ±0.5 Dur. (days): 1 ±0.5 Type:3 Event type(s):VE Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 34
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Small scale seismic activity with 34 events counted on Apr. 10.

In Apr. 1989, a small scale seismic activity located at the W foot of the volcano was recorded with 34 events counted on Apr.10. No magmatic activity was observed.

BVE No 29, p. 107.
JMA (1992): Volcanological Bull. No. 29, Nos. 2-4.

SWARM DATE: 89/9/13 ±0.5 Dur. (days): 93 ±15 Type:3 Event type(s):VE Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 952
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: electromagnetic
Component : 3
Natural period : 1 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Number of the volcanic earthquakes sharply increased since Sept. 13 frequency decreased in Dec.

Number of the volcanic earthquakes sharply increased since Sept. 13, counting the monthly number of 513 and the high level of seismicity continued in Oct. and Nov., amounting to 313 and 126 events, respectively. Frequency decreased to 69 events in Dec. No magmatic activity was observed.

BVE No 29, p 107.
JMA (1992): Volcanological Bull. No. 29, Nos. 2-4.

Kurile Islands

IVAN GROZNY Kurile Is		45.02N 147.87E *VOTW num.*:0900-07=
Morphology:	*Tectonic framework:*	Convergent Intraoceanic
Elevation above m.s.l. :	*Edifice relief :*	
Range of eruptive products:		

SWARM DATE: 89/5/3 ±1 Dur. (days): 5 ±1 Type:2b Event type(s): Grade : C

				OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:		Tremor : Y	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	30 km	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:		Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :		Magnetic :	Rumbling : Y
Cum. energy release:	Previous swarms :	Natural period :		Geothermal :	
		Magnification :			

Key phrase: Weak earthquakes at various depths and short-period tremor was recrded for 5 days following May 3-4.

On May 3-4 an abrupt increase of white fumarolic emissions accompanied by weak explosions of gas and black ash was observed. A seismograph at Kurilsk (~30 km from the volcano) recorded weak earthquakes at various depths and short-period tremor for the following 5 days.

BVE No. 29, p. 61-62.
SEAN Bull. vol. 14. ; no. 5, p. 13-14, no. 12, p. 7-8, 1989.

SARYCHEV PEAK Kurile Is 48.09N 153.20E *VOTW num.*:0900-24=

Morphology: strato with somma *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 1497 m *Edifice relief :* 4000 m
Range of eruptive products: basaltic andesite to andesite

SWARM DATE: 89/1/5 ±0.5 Dur. (days): 7 ±1 Type:1b Event type(s):felt Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The activity was preceded by a series of felt earthquakes Jan 5-12.

An ash eruption was reported on Jan. 14 at 11:36. Two narrow gray bands on the volcano's snow-covered N and NE slopes suggested ash emission had occurred the previous day. The activity was preceded by a series of felt earthquakes Jan. 5-12. Epicenters of some strong earthquakes (M<6.2) were located in the Simushir Island region by the Inst. of Marine Geology and Geophysics.

BVE No. 29, p. 62.
SEAN Bull. vol. 14, no. 3, p. 15, 1989.

CHIKURACHKI Kurile Is

50.33N 155.46E *VOTW num.*:0900-36=

Morphology: strato or composite
Tectonic framework:
Elevation above m.s.l. : 1817 m
Edifice relief :
Range of eruptive products:

SWARM DATE: 86/11/20 ±   Dur. (days): ±   Type: Event type(s):   Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): 13
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1986 eruption.

Strong earthquakes were registered at 12 km from the volcano. Numerous lightning pierced the eruptive column.

BVE No. 26, p. 41.

EBEKO Kurile Is 50.67N 155.93E *VOTW num.*:0900-38=

Morphology: compound or complex *Tectonic framework:*
Elevation above m.s.l. : 1138 m *Edifice relief :*
Range of eruptive products: basaltic andesite to andesite

SWARM DATE: 87/9/1 ±1 Dur. (days): 45 ±2 Type:**1b** Event type(s):Tect Grade : C

Max. Magnitude:	# EQ total : 7	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7 km	Tremor : N Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: 1.5 months before the eruption seven tectonic earthquakes occurred.

Analysis of the seismotectonic situation indicated that during 1.5 months before the eruption seven tectonic earthquakes occurred. No volcanic tremor, earthquakes, or acoustic waves have been registered during the eruption (the distance between station and volcano is 7 km).

BVE No. 27, p. 32.

ALAID Kurile Is		50.80N 155.50E	*VOTW num.*:0900-39=
Morphology: cinder cone	*Tectonic framework:*	Convergent Intraoceanic	
Elevation above m.s.l. : 2339 m	*Edifice relief :* 3000 m		
Range of eruptive products: basalt			

SWARM DATE: 81/4/26 ±0.5 Dur. (days): 22 ±0.5 Type:1d Event type(s): Grade : B

Max. Magnitude: 3.5	# EQ total : 132	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 5 km	Tremor : N	Migration :
Depth (km): ±	b-value : 1.0	Type: SKM-3 VETIK & SKD	Deformation : Y	Focal mech:
Detection threshold: 1.0	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release: 1.3e+11 J	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 10 K	Geothermal :	

Key phrase: Using earthquake count data, 22 days total duration.

6 day precursory duration using energy values. Total duration using energy curve is 40 days. Using count data 1 day precursory and 22 total. Unfelt shocks frequency = 1-2 per day, S-P durations 5-10 seconds, maximum ground amplitude 4 um at 45 km from 6 days prior. No micro tremors detected. The max. magnitude is a maximum value and the energy rate ranges from 1 x10e+7 to 1 x10e+11 J per day.

Good fig. on p. 88 of BVE

BVE No. 22, p. 86-88.
BVE No. 21, p. 54-55.

Kamchatka

GORELY Kamchatka 52.56N 158.03E *VOTW num.:*1000-07=

Morphology: compound or complex *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 1829 m *Edifice relief :* 1200 m
Range of eruptive products: andesite

SWARM DATE: 84/8/3 ±0.5 Dur. (days): 120 ± Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent: 2.2 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: Place holder for 1984 tremor information. Total duration of microtremors: 120 days

Aug. 3-8, 1984 volcanic tremor recorded with accompanying steam and gas emission.
Dec. 21 volcanic tremor again recorded, for the next 3 days tremor level increased gradually. On Dec. 27 a steam-gas column 1.2 km high observed.
Total duration of microtremors: 120 days Max. ampl. = 1 um 2.2 km from vent.
BVE No. 24, p. 34.

SWARM DATE: 85/8/5 ±5 Dur. (days): 10 ±5 Type:1e Event type(s): Grade : C

Max. Magnitude: M 6.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The eruption was accompanied by weak earthquakes. In the beginning of Aug. local volcanic earthquakes with M<=6 were registered.

Volcanic tremor in the first half of the year was unstable, the power level of the tremor varied form 0.1 to 1 kW. Explosive volcanic earthquakes were registered only in the first half of the year. In the beginning of Aug. local volcanic earthquakes with M<=6 were registered.
BVE No. 25, p. 37.

BEZYMIANNY Kamchatka

55.97N 160.60E *VOTW num.*:1000-25=

Morphology: compound or complex *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2800 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

SWARM DATE: 55/10/11 ±0.5 Dur. (days): 172 ±1 Type:1b Event type(s): Grade : A

Max. Magnitude: M 4.4	# EQ total : 448	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 42 km	Tremor :	Migration :
Depth (km): 2.5 ±2.5	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:2.9	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release: 5.1e+12 J	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Duration and magnitude from phase II-2 and phase III-1 of the pre-eruptive swarm (Tokarev, 1985).

Tokarev, P.I., (1985): The prediction of large exposions of andesitic volcanoes, J. Geodynamics, 3, 219-244.

SWARM DATE: 81/11/15 ±0.5 Dur. (days): >1 ± Type:4? Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Begining only from Nov. 15 the number of earthquakes increased a little.

In spite of the fact that this was a practically uninterrupted eruption lasting for more than 4 months (started on Jun. 12 1981) the seismic activity of the volcano was very small. Beginning only from Nov. 15 the number of earthquakes increased a little.
BVE No. 21, p. 56.

SWARM DATE: 84/1/15 ±5 Dur. (days): 20 ±5 Type:1d Event type(s):VT,t Grade : B

Max. Magnitude: K 6.5	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Solitary earthquakes occurring from mid Jan. 1984 were precursors to Feb. 5 eruption.

Solitary earthquakes occurring from mid Jan. 1984 were precursors to Feb. 5 eruption. Largest (K>= 6.5) on Feb. 10. Since Feb. 13 frequency of earthquakes increased and Feb. 15 saw most intense seismic activity on Feb. 16 seismicity decreased and slight continuous volcanic tremor recorded. Power of explosions = 2.5-5.0 x10e+9 kW
BVE No. 24, p. 34-35.

BEZYMIANNY Kamchatka 55.97N 160.60E *VOTW num.*:1000-25=

Morphology: compound or complex *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2800 m *Edifice relief* : 1500 m
Range of eruptive products: andesite

SWARM DATE: 84/10/12 ±0.5 Dur. (days): 23 ±1 Type:1d Event type(s):VT,t Grade : B

Max. Magnitude: K 6.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The eruption was preceded and followed by seismic activity. Sept. 24 saw earthquakes (K>=6). By the end of 14 Oct. the seismic activity began to wane and by Oct. 16 it had ceased completely.

Fall eruption also preceded and followed by seismic activity. Sept. 24 saw earthquakes (K>=6). On Oct. 5 again continuous tremor, numbers of events increased to 2 or 3 and Oct. 12 to 10-15 each hour. Oct. 13 maximum number recorded from 12:00-14:00 to 22:00-24:00 totaling 1000 earthquakes with amplitude > 1 um. During periods of strongest explosivity, ampl. of spasmodic tremor reached 5 um. By the end of 14 Oct. the seismic activity began to wane and by Oct. 16 it had ceased completely.
On 13 Oct., at 07:00 a dark gray gas-ash plume 2 km high and 40 km long was observed.
BVE No. 24, p. 34-35.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s):VT,S Grade :

Max. Magnitude: Ks 5.0
Max. Intensity: MM at
Depth (km): 1.5 ±1.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 16 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1987.

In 1987 (at a station located 16 km from the NE flank of the volcano) an earthquake was recorded with Ks >5. The source depth was 0-3 km. In the second half-year (Jun.-Jul. and Nov.) rock avalanches were recorded on seismograms.
BVE No. 27, p. 33.

SWARM DATE: 88/1/3 ±0 Dur. (days): 0.04 ±0 Type: Event type(s):t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for tremor information in 1988.

The only manifestation of seismic activity of the volcano in 1988 was a spasmodic volcanic tremor lasting one hour (from 23:30 on January 3 to 00:30 on January 4, GMT). The amplitude of volcanic tremor Amax = 0.9 um, the period Tmax = 0.7 sec.
BVE No. 28, p. 55.

BEZYMIANNY Kamchatka 55.97N 160.60E *VOTW num.:*1000-25=

Morphology: compound or complex *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2800 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

SWARM DATE: 89/8/1 ±0.5 Dur. (days):>2 ± Type:2a? Event type(s):VT,t,S Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 13 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Forerunning: Unfelt shocks & micro-tremors recorded.

The explosive-effusive eruption from the evening of Aug. 1, 1989, was accompanied by earthquakes of type II and III and by spasmodic tremor. During the Aug. 1 and 2 the seismic station ZLN has recorded several surface earthquakes.

BVE No. 29, p. 63-64.

KLIUCHEVSKOI Kamchatka

56.06N 160.64E *VOTW num.*:1000-26=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l.: 4850 m *Edifice relief:* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 81/8/4 ±0.25 Dur. (days): <1 ± Type: Event type(s): t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent: 14 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A strong noise was heard from the volcano side, at the same time all seismic stations recorded volcanic tremor.

On the night of Aug. 4 at the seismic station "Apakhonchich" located 14 km from the crater a strong noise was heard from the volcano side. At the same time all seismic stations recorded volcanic tremor. Since then the volcano was at a state of moderate fumarolic activity.

BVE No. 22, p 90.

SWARM DATE: 83/3/1 ±0.5 Dur. (days): 7 ±1 Type: 1b Event type(s): VT,felt Grade : C

Max. Magnitude:
Max. Intensity: MM III at 10 km
Depth (km): ±
Detection threshold: 1.5
Cum. energy release:

EQ total : 120
Felt total : 7
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 10.5 km
Type: SM-3
Component : 3
Natural period : 1.2 s
Magnification : 5 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Felt shocks: 1 per day, from 1 week prior.

Felt shocks: 1 per day, from 1 week prior, MM intensity 2.5, 10 km away. Unfelt: 15 per day , S-P duration = 4.2 sec., Max. ground ampl. = 8.0 um, from 5.5 days prior. Micro-tremors: 111 days in total, max. ampl. 1.0 um, 10 km away.

BVE No. 23, p. 34-35.

SWARM DATE: 85/8/1 ±0.5 Dur. (days): >137 ± Type: 2b Event type(s): t Grade : c

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The eruption was accompanied by seismic activity.

During stage I (Aug. 16-Sept. 13 steam and gas outbursts) volcanic tremor with ampl. of 0.1-0.25 um, T = 0.4 sec., was registered. During stage II (Sept.. 14 -Nov. 4 -explosive stage) volcanic tremor increased up to 0.85 um, T = 0.5 sec. the max. amplitude of volcanic tremor was 0.85 -1.7 um, T = 0.7 sec. The maximum amplitude of volcanic tremor (2.4 um) was noted on Nov. 2. during stage III (Nov. 5-Dec. 26 -effusive) volcanic tremor was 0.85 1.7 um, T=0.7 sec. The max. value of volcanic tremor (3.6 um) was noted on 12 Nov. and 2 Dec. During stage IV (up to Jan. 1, 1986 -explosive) the value of volcanic tremor decreased to 0.2 um.

BVE No. 25, p. 38.

SWARM DATE: 86/8/15 ±15 Dur. (days): 45 ±15 Type: 1e Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 20 ±10
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: In Aug. and Sept. the number of earthquakes was largest.

Eruptions from the summit crater were accompanied by seismic activity. In Jan. 1986, during the last stage of the eruption the amplitude of volcanic tremor changed within the ranges of 0.1-0.2 um, T=0.7 s. The summer eruptions were preceded by volcanic tremors with an amplitude of 0.1 um, T=0.4-0.6 s. At the end of the eruptions the amplitude of volcanic tremors increased to 0.24 um, T=0.6-0.7 s. In mid-Dec. small volcanic tremor was recorded again (A<0.1 um). Earthquakes of type I with the focal depth of 10-20 and 20-30 km occurred in the region of the central crater in Jul., Aug. and Sept.

BVE No. 26, p. 43.

KLIUCHEVSKOI **Kamchatka** **56.06N 160.64E** *VOTW num.*:1000-26=
Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 4850 m *Edifice relief :* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 87/2/20 ±0.5 Dur. (days): 14 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 2.5 ±2.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarms of surface earthquakes occurred on: 20 Feb. - 6 Mar.

Summit eruptions at Klyuchevskoy were accompanied by swarms of earthquakes shallower than 5 km deep and by volcanic tremor. The largest swarms of surface earthquakes were observed in the near-crater area. They occurred on: 20 Feb. - 6 Mar., 24 Aug. - 1 Sept.; 28 Dec. 1987 - 8 Jan. 1988. The swarm of 20 Feb.- 6 Mar. preceded the formation of the centers of the flank eruption on the SE slope of the volcano. Variations in the regime of volcanic activity were reflected in the low-frequency volcanic tremor records. During the peak of explosive activity from 7 to 22 Feb. the average and maximum amplitude of volcanic tremor varied from 0.3-0.4 um to 3.0-4.0 um and from 3.0-4.0 to 13-14 um, respectively.
(SiO_2 = 53.28 wt %, basalt).

BVE No. 27, p. 33-34.

SWARM DATE: 87/8/24 ±0.5 Dur. (days): 8 ±1 Type:1e Event type(s):VT,t Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 2.5 ±2.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Swarms of surface earthquakes occurred on: 24 Aug. - 1 Sept.;

Summit eruptions at Klyuchevskoy were accompanied by swarms of earthquakes shallower than 5 km deep and by volcanic tremor. The largest swarms of surface earthquakes were observed in the near-crater area. They occurred on: 20 Feb. - 6 Mar., 24 Aug. - 1 Sept.; 28 Dec. 1987 - 8 Jan. 1988.

BVE No. 27, p. 33-34.

KLIUCHEVSKOI Kamchatka		56.06N 160.64E *VOTW num.*:1000-26=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 4850 m	*Edifice relief :* 3000 m	
Range of eruptive products: basalt to basaltic andesite		

SWARM DATE: 87/12/27 ±0.5 Dur. (days): 10 ±1 Type:1d? Event type(s):VT,t Grade : B

Max. Magnitude: Ks 8.9	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): 2.5 ±2.5	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Earthquake swarms of Dec. 27, 1987 - Jan. 6, 1988 accompanied the increase in explosive activity of the summit crater.

In 1988 the seismic activity of Klyuchevskoy was concentrated in the area around the summit crater (central zone) and was represented by volcanic earthquakes of the I-IV types (classification by P.I.Tokarev) and by volcanic tremor. Within the central zone the overwhelming majority of earthquakes were of energy class Ks >= 6.0. At a depth of shallower than 5 km the central seismically active area in 1988 was the largest in size. This is almost an isometric area with a radius of ca. 7 km and with a center shifted to the east with respect to the summit crater. Here, in the upper layers of the earth's crust and in the volcanic edifice, groups and swarms of earthquakes of the II-III types originated. Those were associated with the summit and flank Klyuchevskoy eruptions (Ks max. = 7.3). More active were the lower horizons of the earth's crust at depth of 20-30 km.
Of most interest in the seismic activity of the volcano in 1988 was the origin of earthquake swarms. The duration of swarms varied from 2 to 28 days, and the number of earthquakes in swarms changed from 30 to 480. The energy class of strongest events in swarm varied within a few orders of magnitude (from 6.0 to 8.9). All swarms occurred around the central crater at a depth of less than 5 km.
One of the largest flank eruptions was preceded by an earthquake swarm of 19-31 Jan. 1988. Earthquake swarms of Oct. 25 - Nov. 10, Nov. 13 - Dec. 3, Dec. 25-30, 1988 occurred when the effusive-explosive activity of the summit crater was low. A good spatial coincidence of epicentral zones of these swarms and fissure formation area is observed. A time relationship between the initiation of earthquakes, fissures and eruptions at the surface in 1988 at an accuracy of up to 1 day is not traced. Earthquake swarms of Dec. 27, 1987 - Jan. 6, 1988, Jan. 6 - Apr. 8, 1988 and Oct. 7-13, 1988 accompanied the increase in explosive activity of the summit crater.
On the whole, all seismic activity beneath Klyuchevskoy was concentrated within the depths from 3 km below sea level to 3 km above sea level. In 1988 only three small earthquakes occurred at depths of 15-19 km. Volcanic tremor and earthquakes of type IV, which accompanied the summit and flank eruptions were recorded in 1988 almost continuously. Some explosion earthquakes of type IV and volcanic tremor with an amplitude less than 0.1 m were recorded during an earthquake swarm which took place before the beginning of the flank eruption of Jan. 27, 1988. From the onset of the flank eruption volcanic tremor increased up to Feb. 5, with impulses reaching from 0.1 to 1.8 um; then the tremors showed an even character up to the end of Feb. In early Mar. the activity decreases, and during the second ten-days of Mar. and early May volcanic tremor increased again. Volcanic tremor repeatedly changed in intensity during the year; i.e. May 14-18, May 22 - Jun. 2; Jun. 7-19; Jul. 6-10; and Aug. 20-28. These variations were from 20 min. to 2-3 hours long. Increase in max. amplitudes took place in the third ten-days of Oct.; from Nov. to Dec. the maximum amplitudes of volcanic tremor decreased to 0.2 um. No significant variations in the character of volcanic tremor were observed during the upsurge of volcanic activity from Dec. 12.

BVE No. 28, p. 55-57.

KLIUCHEVSKOI Kamchatka		56.06N 160.64E *VOTW num.*:1000-26=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 4850 m	*Edifice relief :* 3000 m	
Range of eruptive products: basalt to basaltic andesite		

SWARM DATE: 88/1/6 ±0.5 Dur. (days): 92 ±1 Type:1d? Event type(s):VT,t Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent	Tremor : Y	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Earthquake swarm of Jan. 6 - Apr. 8, 1988 accompanied the increase in explosive activity of the summit crater.

See Dec. 27, 1987 record for additional comments.

BVE No. 28, p. 55-57.

SWARM DATE: 88/1/19 ±0.5 Dur. (days): 12 ±1 Type:1b Event type(s):VT,t Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent	Tremor : Y	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: One of the largest flank eruptions was preceded by an earthquake swarm of 19-31 Jan. 1988.

See Dec. 27, 1987 record for additional comments.

BVE No. 28, p. 55-57.

SWARM DATE: 88/10/7 ±0.5 Dur. (days): 6 ±1 Type:1e Event type(s):VT Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent	Tremor :	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Earthquake swarm of Oct. 7-13, 1988 accompanied the increase in explosive activity of the summit crater.

See Dec. 27, 1987 record for additional comments.

BVE No. 28, p. 55-57.

SWARM DATE: 88/10/25 ±0.5 Dur. (days): 16 ±1 Type:1e Event type(s):VT,t Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent	Tremor : Y	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Earthquake swarms of Oct. 25 - Nov. 10 occurred when the effusive-explosive activity of the summit crater was low.

See Dec. 27, 1987 record for additional comments.

BVE No. 28, p. 55-57.

SWARM DATE: 88/11/13 ±0.5 Dur. (days): 20 ±1 Type:1e Event type(s):VT,t Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent	Tremor : Y	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Earthquake swarm of Nov. 13 - Dec. 3, occurred when the effusive-explosive activity of the summit crater was low.

See Dec. 27, 1987 record for additional comments.

BVE No. 28, p. 55-57.

KLIUCHEVSKOI Kamchatka		56.06N 160.64E	*VOTW num.*:1000-26=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin	
Elevation above m.s.l. : 4850 m	*Edifice relief* : 3000 m		
Range of eruptive products: basalt to basaltic andesite			

SWARM DATE: 88/12/25 ±0.5 Dur. (days): 5 ±1 Type:1e Event type(s):VT Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Earthquake swarm of Dec. 25-30, 1988 occurred when the effusive-explosive activity of the summit crater was low.

See Dec. 27, 1987 record for additional comments.

BVE No. 28, p. 55-57.

SWARM DATE: 89/1/1 ±0.5 Dur. (days): 15 ±1 Type:1c Event type(s):VT Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Swarm occurred from Jan. 1-16,

Seismic activity was concentrated in the area around the summit crater in 1989, being represented by volcanic earthquakes of types I-IV after Tokarev's classification and by volcanic tremor. The radius of the central seismically active area almost isometric. Groups of swarms of earthquakes occurred in the shallow depths of the earth's crust and in the volcanic edifice associated with the summit and flank eruptions. The distribution of the number and energy are shown in BVE fig. A swarm that occurred from Jan. 1-16, 1989 took place along with the low level of explosive-effusive activity of the summit crater, probably accompanying the formation of a system of fissures and subsequent short term effusions on the NE flank, as evidenced by the coincidence of the epicenter areas of these swarms and the area of fissure formation.
Good Fig. on p. 67.

BVE No. 29, p. 65-69.

KLIUCHEVSKOI **Kamchatka** **56.06N 160.64E** *VOTW num.:*1000-26=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 4850 m *Edifice relief :* 3000 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 89/7/22 ±0.5 Dur. (days): 8 ±1 Type:1bq Event type(s):VT,t Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Earthquake swarm which preceded the Skuridin flank eruption from July 22-30. The eruption commenced when the number of earthquakes decreased.

The earthquake swarm which preceded the Skuridin flank eruption from July 22-30 was the most noteworthy. The eruption commenced when the number of earthquakes decreased. The energy class of the largest event in the swarm varied within several orders of magnitude, from 6.0-8.9. Volcanic tremor and earthquakes of type IV were observed practically persistently during the summit and flank eruptions. Variations in mode of eruptive activity are reflected in the character of changes of the amplitude of volcanic tremor. The value of the max. amplitude of volcanic tremor was 4 um in the first and 6 um in the second halves of 1989. Seismic activity was concentrated in the area around the summit crater in 1989, being represented by volcanic earthquakes to type I-IV after P.I. Tokarev's classification and by volcanic tremor. The radius of the central seismically active area was ~7 km. The center of this area shifted to the E with the seismically active area almost isometric. Groups and swarms of earthquakes occurred in the shallow depths of the earth's crust and in the volcanic edifice associated with the summit and flank eruptions. Good fig in BVE on p 67.

BVE No. 29, p. 65-69.

SHIVELUCH Kamchatka

56.65N 161.35E *VOTW num.*:1000-27=

Morphology: compound or complex *Tectonic framework:*
Elevation above m.s.l. : 3395 m *Edifice relief :* 2700 m
Range of eruptive products: basalt to andesite

SWARM DATE: 64/11/2 ±0.5 Dur. (days): 10 ±1 Type:1b Event type(s): Grade : A

Max. Magnitude: M 4.9
Max. Intensity: MM at
Depth (km): 2.5 ±2.5
Detection threshold: 2.9
Cum. energy release: 1.2e+12 J

EQ total : 58
Felt total :
b-value :
Repose (yr.): 14
Previous swarms :

Seismograph: permanent
Dist. to vent: 45 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration and magnitude from phase II-2 and phase III-1 of the pre-eruptive swarm (Tokarev, 1985).

Tokarev, P.I., (1985): The prediction of large exposions of andesitic volcanoes, J. Geodynamics, 3, 219-244.

SWARM DATE: 81/1/1 ±0.5 Dur. (days): 10 ±1 Type:1d? Event type(s):VE Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent: 6 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Maximum number of volcanic earthquakes for whole recording period fell in first ten days of Jan. 1981.

Data on active growth of dome agree with character of seismic control system 6 km away. Maximum number of volcanic earthquakes for whole recording period fell in first ten days of Jan. 1981.
BVE No. 22, p. 91.

SWARM DATE: 81/6/16 ±0.5 Dur. (days): 3 ±1 Type:1e Event type(s):VT Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 6 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A swarm of volcano-tectonic earthquakes registered Jun. 16-20.

From mid Mar. 1981- end Jun. 1981 numbers of volcanic earthquakes decreased to 10-15 per day. Volcano-tectonic earthquakes registered Jun. 16-20. In Sept. only individual earthquakes registered.
BVE No. 22, p. 91 (supplement).

SHIVELUCH Kamchatka

56.65N 161.35E *VOTW num.*:1000-27=

Morphology: compound or complex *Tectonic framework:*
Elevation above m.s.l. : 3395 m *Edifice relief* : 2700 m
Range of eruptive products: basalt to andesite

SWARM DATE: 86/8/4 ±0.5 Dur. (days): ± Type:1d Event type(s):E,VT,t Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 2 km
Type: radio-telemetered
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1986. Insuffcent information to distinguish swarms.

An upsurge of explosive activity at the extrusive dome of Sheveluch was observed in 1986. They were accompanied by earthquakes and volcanic tremor (Aug. 4, 10, 13 & 27, and Sept. 1). Seismic signals were recorded by the radio-telemetry station located 2 km south of the extrusive dome in the crater of the volcano. In four cases (Mar. 28, May 11 & 23, and Jun. 12) the intensified activity was accompanied by gas-ash ejections with the formation of ash deposits in the region of the extrusive dome and explosion funnels at the dome. Explosions were recorded on seismograms. In other cases the explosive activity was detected only from data obtained at the telemetry seismic station (Aug. 1, 8, Sept. 17, and Oct.). The explosion of Jul. 1 was of small intensity and was not recorded on seismograms.

BVE No. 26, p. 44.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s):E,t Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent: 3.5 km
Type: radio-telemetered
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1987.

Seismic monitoring of the volcano was carried out with two radio-telemetered stations 8.5 km and 3.5 km from the extrusive dome. In 1987 about 40 blasts were recorded. The number of explosions increased by an order of that in 1984 when the explosive activity started at the dome. Two largest ash ejections occurred on 12 Jan. (the altitude of the ash column H~3.0 km) and on 19 Jul. (H~5 km). Explosive activity was accompanied by volcanic tremor which lasted from 0.5 to 6.5 hours, with amplitude of 0.5-2.0 um.

BVE No. 27, p. 35.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 5 ±5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent: 2 km
Type: radio telemetered
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1988.

Seven of the eruptions occurred with lacking visibility of the volcano. They were deciphered from records of radio-telemetry seismic station located at a distance of 2.0 km from the extrusive dome. Earthquakes recorded in the region of Sheveluch were located not farther than 15-20 km from the active dome, predominantly to the south, at depths of 0-10 km.

BVE No. 28, p. 58.

SHIVELUCH Kamchatka 56.65N 161.35E *VOTW num.:*1000-27=

Morphology: compound or complex *Tectonic framework:*
Elevation above m.s.l. : 3395 m *Edifice relief :* 2700 m
Range of eruptive products: basalt to andesite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): 5 ±5	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1989.

Volcanic earthquakes occurred not farther than 15-20 km from the active dome, predominantly in the south at depths of 0-10 km. Compared to 1988, seismic activity increased in 1989. Explosive activity was accompanied by spasmodic volcanic tremor lasting several hours.

BVE No 29 pp 69-70.

Aleutian Islands and Alaska

GARELOI **Aleutian Is** **51.78N 178.80W** *VOTW num.*:1101-07=

Morphology: strato or composite *Tectonic framework:* Convergent Intraoceanic
Elevation above m.s.l. : 1573 m *Edifice relief :*
Range of eruptive products: basalt to dacite

SWARM DATE: 82/1/15 ±0.5 Dur. (days): 7 ±1 Type:**1b?** Event type(s):**Tect?** Grade : C

Max. Magnitude: mb3.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 120 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: 9 mb 3.2-3.3 earthquakes on Jan. 15 at 05:21(9 hrs. before eruption seen on satellite image).

Seismic network of Adak Is. recorded 9 mb 3.2-3.3 earthquakes on Jan. 15 at 05:21(9 hrs. before eruption seen on satellite image). No hypocenter can be determined for this event however 1 of 2 possible solutions places it under Gareloi. Additional event recorded following week. An infra-sound array at College, Alaska (~2200 km NE) recorded no acoustic wave with the eruption.

BVE No. 22, p. 59.

ADAGDAK Aleutian Is		51.98N 176.60W	*VOTW num.*:1101-112
Morphology: strato or composite	*Tectonic framework:*	Convergent Intraoceanic	
Elevation above m.s.l. : 610 m	*Edifice relief* :		
Range of eruptive products: basalt to andesite			

SWARM DATE: 78/10/23 ±0.5 Dur. (days): 865 ±3 Type:3 Event type(s):VT Grade : C

Max. Magnitude: Md2.3	# EQ total : 82	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): 5 ±2	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Activity began on Oct. 23, 1978 continuing through the first week in Mar. 1981.

A cluster of 82 small, shallow-focus earthquakes was observed near the dormant Adagdak volcano between Sept. 1978 and Mar. 1981. The true burst of activity began, however, on Oct. 23, 1978 continuing through the first week in Mar. 1981.

Pohlman, J. C., A study of a Shallow-Focus Earthquake Cluster Possibly Related to Volcanism, MS thesis Univ, of Colorado, 1982.

OKMOK **Aleutian Is**		**53.41 N 168.13W** *VOTW num.*:1101-29-
Morphology: shield with caldera	*Tectonic framework:*	Convergent Intraoceanic
Elevation above m.s.l. : 1072 m	*Edifice relief :*	
Range of eruptive products: basalt to rhyolite		

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Place holder for 1987.

At 03:12 LT (= GMT - 9 hours) 5 Jan. 1987 a 6.5 Ms earthquake occurred in the Umnak Island region of the Aleutian arc, which had an hypocenter of 52.3N, 169.2W and a depth of 40 to 55 km.

BVE No. 27, p. 44-46.

DUTTON, MT. Alaska Peninsula 55.18N 162.26W *VOTW num.*:1102-011

Morphology: lava dome *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 1474 m *Edifice relief* :
Range of eruptive products: basalt to andesite

SWARM DATE: 88/7/10 ±0.5 Dur. (days): 32 ±2 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.8	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	4 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: S13		Deformation :	Focal mech:
Detection threshold:	Repose (yr.): 38	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	5 K	Geothermal :	

Key phrase: On July 10, 1988, a swarm of small shallow earthquakes began. Duration taken from fig.

On July 10, 1988, a swarm of small shallow earthquakes began SW of Mt. Dutton, a 1506 m-high volcano near the tip of the Alaska Peninsula and 35 km SW of Pavlof. Epicenter gradually migrated NW underneath the mountain's SW flank. The events were similar to a smaller swarm that occurred in 1984. On July 15 and August 8, days of peak activity, earthquakes (M<3.8) were felt in the King Cove and Cold Bay areas, about 13 km S and 28 km W of Mt. Dutton, respectively. No harmonic tremor or B-type events have been recorded, and geologists have been unable to determine whether the seismicity is related to magmatic migration or tectonic movement.
Seismicity near Mt. Dutton has continued at a low level since the last day of high activity on August 8. Earthquakes have been high-frequency in character (i.e. not low-frequency volcanic events) and the best-located hypocenters lay at shallow depths (1-10 km) beneath the volcano's SE: flank. Fig. M 23-1-I shows 3 pulses of high activity followed by a few events/day through September 4. This level of activity is still much higher than the background rate of a few events per year that existed before the swarm started in July. Fig: count data for Jul. 11-Aug.31.

BVE No. 28, p. 97-98.

PAVLOF Alaska Peninsula 55.42N 161.90W *VOTW num.*:1102-03-
Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2519 m *Edifice relief* : 2410 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 79/9/5 ±0.5 Dur. (days): 8 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.9
Cum. energy release:

EQ total : 102
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

SWARM DATE: 79/12/17 ±0.5 Dur. (days): 8 ±1 Type:1c? Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.9
Cum. energy release:

EQ total : 281
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

Possible eruption(?), but no explosions recorded.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

SWARM DATE: 80/11/6 ±0.5 Dur. (days): 80 ±1 Type:1d Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.9
Cum. energy release:

EQ total : 3534
Felt total :
b-value :
Repose (yr.): 3.85
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 8.5 km
Type: radio telemetered
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

Strong harmonic tremor accompanied the Nov. eruptions. Unfelt and felt: recorded. Precursory 5 days

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 20, p. 70.

SWARM DATE: 81/3/11 ±0.5 Dur. (days): 95 ±1 Type:1d Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.9
Cum. energy release:

EQ total : 4501
Felt total :
b-value :
Repose (yr.): .38
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

16 days precursory seismicity.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 21, p. 60-61.

PAVLOF Alaska Peninsula — 55.42N161.90W *VOTW num.*:1102-03-

Morphology: strato or composite — *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2519 m — *Edifice relief* : 2410 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 81/9/25 ±0.5 Dur. (days): 96 ±1 Type:1dq Event type(s):B,t Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 31875
Felt total : 0
b-value :
Repose (yr.): .33
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Duration from McNutt 1989.

About 2 weeks prior to eruption occasional harmonic tremor was recorded plus an increase in the size of B-type events; however, just before the commencement of visible activity there was a decrease in number and size of earthquakes. Strong continuous harmonic tremor ended at 12:20 Sept. 27; however B-type earthquakes. (M 0-1) remained high for several months after.
Unfelt and micro-tremors: from 14 days prior.
Period : ~ 0.6 sec., max. ampl.: 200 um at 7.5 km.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 21, p. 60-61.

SWARM DATE: 82/1/2 ±0.5 Dur. (days): 3 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 450
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Duration from McNutt 1989.

Observations in the summer of 1982 found that Pavlof was steaming with "sporadic minor ash emission." Low seismic levels.
Because of the low seismicity, it is likely that this is not a primary eruptive event, but either minor phreatic eruptivity or simply collapse activity like that found a Etna.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 22, p. 60.

SWARM DATE: 82/1/8 ±0.5 Dur. (days): 7 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 1191
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

PAVLOF Alaska Peninsula

55.42N 161.90W *VOTW num.*:1102-03-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2519 m *Edifice relief :* 2410 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 82/2/6 ±0.5 Dur. (days): 9 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 1657
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

SWARM DATE: 82/2/20 ±0.5 Dur. (days): 4 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 500
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

SWARM DATE: 82/4/2 ±0.5 Dur. (days): 14 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 530
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

SWARM DATE: 82/7/18 ±45 Dur. (days): 199 ±30 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 20308
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

SWARM DATE: 82/11/5 ±0.5 Dur. (days): 11 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 0.9
Cum. energy release:

EQ total : 646
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 7.5 km
Type: HS-10B
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.

PAVLOF **Alaska Peninsula** 55.42N 161.90W *VOTW num.*:1102-03-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2519 m *Edifice relief :* 2410 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 83/7/8 ±0.5 Dur. (days): 12 ±1 Type:1d Event type(s):E,LF Grade : A

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 2.3	# EQ total : 595	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7.5 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: HS-10B	Deformation :	Focal mech:
Detection threshold:0.9	Repose (yr.): 1.79	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase: An increase in seismic activity was recorded in mid-Jul. 1983. Duration from McNutt 1989. (4 days precursory)

An increase in seismic activity was recorded in mid-Jul. 1983. Seismicity remained at background levels until 11 Jul. during the 24-hour period beginning at 15:00 on the 11th, 6 explosions were recorded at a Lamont-Doherty seismic monitoring station near the volcano. The number of recorded events increased to 55 for the same period on 12-13 Jul., and to 150 on 13-14 and 14-15 Jul., then decreased to 120 on the 15-16th, 38 on the 16-17th, and 19 on the 17-18, returning to background after 15:00 on 18 Jul. During the period of increased seismicity, approximately half of the recorded events were explosions and half low-frequency events.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 23, p. 38.

SWARM DATE: 83/11/5 ±0.5 Dur. (days): 29 ±1 Type:1d Event type(s):t,B Grade : A

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 2.3	# EQ total : 20219	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: HS-10B	Deformation :	Focal mech:
Detection threshold:0.9	Repose (yr.): .32	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase: A 30-minute burst of volcanic tremor began at 20:00 on 4 Nov. Intermittent low-amplitude tremor and numerous low-frequency (B-type) events recorded after 12:00 on 18 Nov. were continuing on 21 Nov. Duration from McNutt 1989. (9 days precursory)

Through Oct. and early Nov. background levels of 0-40 (usually 0-30) small low-frequency events per day. A 30-minute burst of volcanic tremor began at 20:00 on 4 Nov., and a 6 minute burst at 17:57 on 9 Nov. Between 14:30 on 11 Nov. and 11:00 on 13 Nov. 15 explosions were recorded. Several bursts of tremor of 1-2 minute duration occurred between 17:00 and 19:00, when continuous tremor started. Its amplitude gradually increased, and tremor began to saturate the seismometer at 11:00 on 14 Nov. tremor was the strongest between midnight and 12:00 on 15 Nov., and continued to saturate the seismograph until 21:00 on 15 Nov. when its amplitude began to decrease. Tremor remained continuous but at low amplitude between 13:00 on 16 Nov. and 12:00 on 18 Nov. Intermittent low-amplitude tremor and numerous low-frequency (B-type) events recorded after 12:00 on 18 Nov. were continuing on 21 Nov.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 23, p. 38.

PAVLOF Alaska Peninsula 55.42N 161.90W *VOTW num.*:1102-03-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2519 m *Edifice relief* : 2410 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 83/12/10 ±0.5 Dur. (days): 13 ±1 Type:1d Event type(s):E,t Grade : A

Max. Magnitude: M 2.3	# EQ total : 7081	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: HS-10B	Deformation : Focal mech:
Detection threshold: 0.9	Repose (yr.): .03	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Duration from McNutt 1989. (1 day precursory)

Airline pilots last reported eruption clouds from Pavlof at 14:00 on 15 Dec. and there have been no reports of eruptive activity since then. Six explosions were recorded between 16:00 and 20:00 on 15 Dec. by a Lamont-Doherty's 5-station seismic net. 4.5-10 km from the volcano. One of these stations, about 7.5 km from Pavlof, detected bursts of harmonic tremor 17 Dec., 11:00-18 Dec., 03:30; 18 Dec., 05:30-06:15 and 10:40-11:10; 20 Dec., 22:00-22:45; and 21 Dec., 20:35-20:48. seismicity then decreased to the background level of several tens of events per day and remained at that level as of 26 Jan.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 23, p. 38.

SWARM DATE: 83/12/26 ±0.5 Dur. (days): 11 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3	# EQ total : 1408	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: HS-10B	Deformation : Focal mech:
Detection threshold: 0.9	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Duration from McNutt 1989.

No witness reports of activity at Pavlof are available since Dec. 15, 1983. After an increase on Dec. 17-21, seismicity decreased at the background level and remained so as of April, 1984.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 24, p. 39.

SWARM DATE: 84/1/12 ±0.5 Dur. (days): 13 ±1 Type:3 Event type(s):B Grade : A

Max. Magnitude: M 2.3	# EQ total : 1228	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: HS-10B	Deformation : Focal mech:
Detection threshold: 0.9	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Duration from McNutt 1989.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485

PAVLOF Alaska Peninsula		55.42N 161.90W *VOTW num.*:1102-03-
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 2519 m	*Edifice relief :* 2410 m	
Range of eruptive products: basalt to basaltic andesite		

SWARM DATE: 86/4/7 ±0.5 Dur. (days): 16 ±1 Type:1d Event type(s):B Grade : A

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 2.3	# EQ total : 5203	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: HS-10B	Deformation :	Focal mech:
Detection threshold:0.9	Repose (yr.): 2.33	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase: Above normal on 6 April, the rate then stayed relatively constant until the main eruption on 18 April. background levels were reached by 26 April. Duration from McNutt 1989. (4 day precursory)

The number of volcanic events increased from a slightly above normal 20 events on 6 April, to 370 events on 11 April and 750 events on 13 April. The rate of seismicity then stayed relatively constant until the main eruption on 18 April. Continuous tremor: began at around 14:40 and intensified around 16:10, when it was visible at stations > 100 km away. The strong tremor continued until 19:00 then gradually subsided, ending around 21:00. The number and duration of volcanic events dropped abruptly after the tremor ended and continued to decrease until background levels were reached by 26 April.

The vigorous seismicity that had preceded and accompanied the mid-April eruption declined to background by 26 April.

McNutt, S. R., (1989), Some Seismic Precursors to Eruptions at Pavlof Volcano, Alaska, October 1973-April 1986, in: IAVCEI Proceedings in Volcanology 1, Latter, J. H., (Ed.), Volcanic Hazards, Springer-Verlag Berlin Heidelberg, p. 463-485.
BVE No. 26, p. 54-57.
SEAN Bull. vol. 11, 1986, no. 4, p. 9.

SWARM DATE: 86/5/23 ±0.5 Dur. (days): 100 ±1 Type:1d Event type(s):B,t,E Grade : A

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 7.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: HS-10B	Deformation :	Focal mech:
Detection threshold:0.9	Repose (yr.): .11	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase: A gradual increase on 23 May, and reached high levels by 28 May, remaining vigorous through 16 June, declined slightly 17 June, but was still strong as of 4 July. Duration from McNutt et al. 1991.

Seismicity which had begun a gradual increase on 23 May and reached high levels by 28 May, remaining vigorous through 16 June, declined slightly 17 June, but was still strong as of 4 July. No harmonic tremor was recorded. Seismicity was stronger on GMT days 28 June and 1 July than other days between 17 June and 4 July, but USGS personnel did not observe significant fluctuations in eruptive activity.

Seismicity increased substantially on 31 July at 18:45 LT (= GMT - 8 hours) and an airline pilot reported explosions an hour later. Pulses of seismicity that varied in amplitude from 5-6 mm to about 40 mm saturated instruments for about 20 hours, and were recorded by stations as far as 60 km from the volcano. Seismic activity declined somewhat on 2 Aug., remaining vigorous but detected only on the instrument 7.5 km from the summit. As of 5 Aug., discrete high-amplitude volcanic events averaging 30-40 seconds long continued to be recorded.

Seismicity in early Nov. reached more than 150 events a day, all apparently explosion shocks. Individual events had similar durations but variable amplitudes. Only a few hours of tremor were recorded

McNutt, S. R., et al. (1991), Geological and seismological evidence of increased explosivity during the 1986 eruptions of Pavlof volcano, Alaska, Bull. Volcanol. vol. 53, p. 86-98.
BVE No. 26, p. 54-57.
SEAN Bull. vol. 11, 1986, no. 5, p. 5.

PAVLOF Alaska Peninsula 55.42N 161.90W *VOTW num.*:1102-03-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2519 m *Edifice relief :* 2410 m
Range of eruptive products: basalt to basaltic andesite

SWARM DATE: 86/11/5 ±0.5 Dur. (days): 34 ±1 Type:1d Event type(s):B,t,E Grade : A

Max. Magnitude: ML2.5	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	7.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: HS-10B		Deformation :	Focal mech:
Detection threshold:0.9	Repose (yr.):	Component :	3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	100 K	Geothermal :	

Key phrase: Duration from McNutt et al. 1991.

John Taber reported that from 1-6 Dec., 140-200 volcanic events per day were recorded; 30-60 were explosions with a distinct air wave arrival. On 8 and 9 Dec. the number of individual events gradually decreased until replaced by low amplitude harmonic tremor. Tremor amplitude gradually increased until the record suddenly became saturated on 9 Dec. at 23:10, remaining saturated until 13 Dec. at about 1400. Tremor continued to decrease until discrete events were again visible by about 01:00 the next morning.

McNutt, S. R., et al. (1991), Geological and seismological evidence of increased explosivity during the 1986 eruptions of Pavlof volcano, Alaska, Bull. Volcanol. vol. 53, p. 86-98.
BVE No. 26, p. 54-57.
SEAN Bull. vol. 11, 1986, no. 5, p. 5.

SWARM DATE: 86/12/10 ±1 Dur. (days): 9 ±2 Type:1d Event type(s):B,t,E Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	7.5 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: HS-10B		Deformation :	Focal mech:
Detection threshold:0.9	Repose (yr.):	Component :	3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	100 K	Geothermal :	

Key phrase: Duration from McNutt et al. 1991.

McNutt, S. R., et al. (1991), Geological and seismological evidence of increased explosivity during the 1986 eruptions of Pavlof volcano, Alaska, Bull. Volcanol. vol. 53, p. 86-98.

VENIAMINOF **Alaska Peninsula**	**56.16N 159.38W** *VOTW num.*:1102-07-
Morphology: strato or composite	*Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m	*Edifice relief :* 1560 m
Range of eruptive products: basalt to dacite	

SWARM DATE: 83/6/8 ±0.5 Dur. (days): 1.5 ±0.5 Type: Event type(s):t,LF Grade : c

Max. Magnitude: M 2.0	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 31 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: radio telemetered	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Between Jun. 8-10 nearly continuous low ampl. tremor with occasional larger bursts reaching M1-2

Between Jun. 8-10 nearly continuous low ampl. tremor with occasional larger bursts reaching M1-2 recorded at Ivanof Bay 30 km from crater. Tremor appeared again Oct. 1-8.
Earthquakes felt at Perryville 10:45 on Dec. 2 and 14:15 on Dec. 27.

BVE No. 23, pp 39.

SWARM DATE: 83/10/1 ±0.5 Dur. (days): 7 ±1 Type: Event type(s):t Grade : c

Max. Magnitude: M 2.0	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 31 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: radio telemetered	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for tremor information. Tremor appeared again Oct. 1-8.

Tremor appeared again Oct. 1-8. Earthquakes felt at Perryville 10:45 on Dec. 2 and 14:15 on Dec. 27. (both regional)
BVE No. 23, p. 39.

ANIAKCHAK Alaska Peninsula		56.88N 158.15W	*VOTW num.*:1102-09-
Morphology: strato with caldera	*Tectonic framework:*	Convergent Continental Margin	
Elevation above m.s.l. : 1341 m	*Edifice relief :* 1285 m		
Range of eruptive products: basalt to rhyodacite			

SWARM DATE: 95/3/16 ±0 Dur. (days): 0.5 ±0.02 Type:3 Event type(s):VT Grade : A

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: Md1.0	# EQ total : 129	Seismograph: permanent		
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: Mark L-4C	Deformation :	Focal mech:
Detection threshold:	Repose (yr.): 44	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: A swarm of small volcano tectonic earthquakes began on Mar. 16, 1995 at 08:00 UT and continued until 20:00.

Power, J., and Paskievtch, J., Alaska Volcano Observatory (1995) written communication.

AUGUSTINE Alaska-SW

59.36N 153.41W *VOTW num.*:1103-01-

Morphology: strato with lava dome *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 1282 m *Edifice relief* :
Range of eruptive products: andesite to dacite

SWARM DATE: 85/7/5 ±0 Dur. (days): 65 ±1 Type:3 Event type(s): Grade : A

Max. Magnitude: 1.5
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.8
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): 10
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.5 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration : Y
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Early Swarm, Jul. 5 to Sept. 9, 1985.

Increased seismicity activity started 264 days before the eruption. Decreases in earthquake depths during this time suggests an upward magma migration over a distance of 0.6 km. The most active period occurred on Jul. 27 when 180 events where counted. Earthquake counts remained elevated through Aug. (average 9/day) and increased to a second, but smaller, max. of 47 events on Sept. 8. Largest event was 1.5

Power, J., MS thesis Univ. of Alaska, Seismicity Associated with the 1986 eruption of Augustine Volcano, Alaska, p. 55, 1988.

SWARM DATE: 85/12/18 ±0.5 Dur. (days): 13 ±1 Type:3 Event type(s): Grade : A

Max. Magnitude: ML1.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.8
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.5 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Dec. Swarm, Dec. 18, 1985 to Jan. 3, 1986.

A small increase in the number of countable events began on Dec. 18. This increase culminated in a short but intense swarm from Dec. 31 to Jan 2, 1986. The peak of activity was on Dec. 31 when 62 countable events occurred. The largest event occurred on Jan 1.

Power, J., MS thesis Univ. of Alaska, Seismicity Associated with the 1986 eruption of Augustine Volcano, Alaska, p. 55, 1988.

SWARM DATE: 86/2/10 ±0.5 Dur. (days): 45 ±1 Type:1b Event type(s): Grade : A

Max. Magnitude: ML2.1
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.3
Cum. energy release: 2.0e+9 J

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.5 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Pre-eruptive Buildup, Feb 10, to Mar 26, 1986.

On Feb. 10 the number of countable events increased a order of magnitude to tens of events/day. While the number of events fluctuated greatly the overall level of seismicity did not drop from this level until after the eruption. Cumulative energy is seismic moment in dyne-cm for the precursory phase.

Power, J., MS thesis Univ. of Alaska, Seismicity Associated with the 1986 eruption of Augustine Volcano, Alaska, p. 55, 1988.

SWARM DATE: 86/8/10 ±0.5 Dur. (days): 31 ±1 Type:2a Event type(s):S Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:0.3
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 0.5 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Second dome building phase: Aug 10 to Sept. 10. 1986. Surface events only

No increase in earthquake counts or tremor was noted during this period.

Power, J., MS thesis Univ. of Alaska, Seismicity Associated with the 1986 eruption of Augustine Volcano, Alaska, p. 55, 1988.

AUGUSTINE Alaska-SW — 59.36N 153.41W *VOTW num.:*1103-01-

Morphology: strato with lava dome — *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 1282 m — *Edifice relief :*
Range of eruptive products: andesite to dacite

SWARM DATE: 88/7/30 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 0.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1988.

At 14:05 on July 30, 1988 a 'steam-blast' like eruption of Augustine volcano was observed. An earthquake was felt in the lower Cook Inlet region in the afternoon of July 30, 1988. Based on the regional NOAA and USGS seismic network, this earthquake event occurred at 14:01:29, had a 4.1 local Richter magnitude, and had a hypocenter location of 60.0N, 153.5W, and 169 km depth (comm. with P. Whitmore, Alaska Tsunami Warning Center), which is about 75 km N of Augustine volcano in the Benioff earthquake zone. The event occurred at about the same time as the above 'steam-blast ' event would have started.
The University of Alaska Geophysical Institute seismic network did detect two Augustine earthquakes at about 16:00 and 16:15 of about one local Richter magnitude (comm. with J. Power, USGS at the Univ. of Alaska Geophysical Inst.), which is above normal Augustine earthquake daily activity. In addition, a University of Alaska Geophysical Institute individual on the Island at the time of the above pilot observations did note above average steam emission from the summit region of the volcano (comm. with J. Power).

BVE No. 28, p. 98.

REDOUBT Alaska-SW		**60.48N 152.75W** *VOTW num.*:1103-03-
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 3109 m	*Edifice relief* : 2150 m	
Range of eruptive products: basalt to dacite		

SWARM DATE: 89/12/13 ±0.02 Dur. (days): **0.95** ±0.02 Type:**1b** Event type(s):LP Grade : **A**

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: ML2.0	# EQ total : 4000	Seismograph: permanent		
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 8 km	Tremor :	Migration :
Depth (km): 1.5 ±2	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families : Y
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal : Y	

Key phrase: More than 4000 earthquakes smaller than ML 2 were recorded in the 23 hours before the eruption on Dec. 14.

Shallow seismicity (hypocenter depths of less than 2 km beneath the crater) increased slightly during the morning of Dec. 13 with a noticeable increase at 11:00 of up to 1-2 low-frequency micro-earthquakes per minute. More than 4000 earthquakes smaller than ML2 were recorded in the 24 hours before the eruption on Dec. 14. A sharp seismic signal ~1 hour long began about 01:40 Dec. 14. At 03:30 satellite data showed an eruption cloud. A second sharp seismic signal, ~1 hour began at 03:48. A powerful explosive episode was marked by a vigorous pulse of seismicity between 10:15 and 11:00. Earthquake activity declined after 11:00 for about 8 hours, but remained above previous background levels. Nearly continuous eruptive activity renewed at ~19:00 with continuous ash emission and high levels of seismicity. Seismicity increased at about 03:00 on Dec. 18 and plumes were reported up to 9 km in altitude. Satellite and seismic data at 06:30 on Dec. 19 indicated the start of another moderately large eruption event. After Dec. 21 a change in the character of local earthquakes and a light increase in the number of small shocks suggested that magma might be approaching the surface and starting to form a new lava dome. A slight increase in small earthquakes and rock avalanches near the summit during the next few days suggested an increased rate of lava extrusion. On Dec. 29 dome growth was confirmed.

Figs: hypo map.

BVE No. 29, p.73-76.

S. R . Brantley, Editor (1990): The eruption of Redoubt volcano, Alaska, Dec 14, 1989-Aug 31, 1990. USGS Circular, 1061, p. 33.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

SWARM DATE: 89/12/26 ±0.5 Dur. (days): **7** ±1 Type:**1b** Event type(s):LP Grade : **A**

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 8 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Dec. 26, onset of swarm of long period events which intensified until Jan. 2, 1990.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

REDOUBT Alaska-SW 60.48N 152.75W *VOTW num.*:1103-03-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l.: 3109 m *Edifice relief :* 2150 m
Range of eruptive products: basalt to dacite

SWARM DATE: 90/2/12 ±0.02 Dur. (days): 3.42 ±0.02 Type:1b Event type(s):LP Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 8 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Feb. 15, 1990, 04:03 AST: Tephra eruption, 20 minute duration at station SPU. Eruption preceded by 82 hours of increased long-period seismicity.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

SWARM DATE: 90/3/4 ±0.02 Dur. (days):>0.21 ± Type:1b Event type(s):LP Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Mar. 4, 1990, 20:40 AST: Tephra eruption 8 minute duration at SPU. Event is preceded by swarm of long-period events seen at RSO in its first 5 hours of operation.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

SWARM DATE: 90/3/13 ±0.02 Dur. (days): 1.42 ±0.02 Type:1b Event type(s):LP Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Mar. 14 1990, 09:47 AST: Tephra eruption, 14 minute duration at SPU. Eruption is preceded by 34 hours of increased long-period seismicity.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

SWARM DATE: 90/3/22 ±0.02 Dur. (days): 1.42 ±0.02 Type:1b Event type(s):LP Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Mar. 23 1990, 04:04 AST: Tephra eruption, 8 minute duration at SPU. Eruption is preceded by 34 hours of increased long-period seismicity.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

SWARM DATE: 90/3/28 ±0.02 Dur. (days): 1.17 ±0.02 Type:1b Event type(s):LP Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 4 km
Type:
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Mar. 29, 1990, 10:34 AST: Tephra eruption, 7 minute duration at SPU. Eruption is preceded by 28 hours of increased long-period seismicity.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

REDOUBT Alaska-SW		**60.48N 152.75W** *VOTW num.:*1103-03-
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 3109 m	*Edifice relief :* 2150 m	
Range of eruptive products: basalt to dacite		

SWARM DATE: 90/4/6 ±0.02 Dur. (days): **0.54** ±0.02 Type:1b Event type(s):LP Grade : **A**

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Apr. 6, 1990, 17:24 ADT: Tephra eruption, 7 minute duration at SPU. Eruption is preceded by 13 hours of increased long-period seismicity.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

SWARM DATE: 90/4/15 ±0.02 Dur. (days): **0.13** ±0.02 Type:1b Event type(s):LP Grade : **A**

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 4 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Apr. 15, 1990, 14:52 ADT: Tephra eruption, 8 minute duration at SPU. Eruption is preceded by 3 hours of increased long-period seismicity.

Power, J., et al. (1994): Seismic evolution of the 1989-1990 eruption of Redoubt Volcano, Alaska, JVGR, 62, p. 69-94.

SPURR Alaska-SW		61.30N 152.25W *VOTW num.*:1103-04-
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 3374 m	*Edifice relief* : 3255 m	
Range of eruptive products: andesite to dacite		

SWARM DATE: 91/8/15 ±5 Dur. (days): 180 ±5 Type:1bq Event type(s):VT Grade : A

Max. Magnitude: ML1.7	# EQ total : 1900	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 0.4 km	Tremor : Y Migration :
Depth (km): 2 ±3	b-value :	Type:	Deformation : Focal mech:
Detection threshold:-0.5	Repose (yr.): 39	Component : z	Gravity : EQ families : Y
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Precursory seismicity began in Aug. 1991. It was marked by a conpicuous swarm of shallow VT earthquakes beneanth Crater Peak.

Power, J., et. al. (in press) Seismicity and Forecasting of the 1992 Eruptions of Crater Peak Vent, Spurr Volcano Alaska: An Overview, USGS prof. paper.

Western North America

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.*:1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief :* 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 80/3/20 ±0.5 Dur. (days): 59 ±1 Type:1d Event type(s):A,B,felt Grade : A

Max. Magnitude: 5.0
Max. Intensity: MM IV at
Depth (km): 2.5 ±3.5
Detection threshold:0.5
Cum. energy release: 1.8e+13 J

\# EQ total : 10000
\# Felt total : 200
b-value : 2.8
Repose (yr.): 123
Previous swarms : N

Seismograph: permanent
Dist. to vent: 4 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 45 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Y Focal mech: Y
Gravity : Y EQ families : Y
Magnetic : Y Rumbling :
Geothermal : Y

Key phrase: Felt and unfelt shocks recorded from 59 days before the eruption.

Seismometer installed on west flank 1973. Number of events per 6 hours dropped from 38 (Mar 25) to ~7 early May but energy release rate remained roughly constant. b-value for B-type=2.8, A-type=0.6.

BVE No. 20, p. 71-79.

USGS Professional Paper 1250: pp. 101, 105, 106, 119.

SWARM DATE: 80/5/25 ±0.02 Dur. (days): 0.13 ±0.02 Type:1b? Event type(s):HF,t Grade : a

Max. Magnitude: M 4.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.): .02
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type: short period
Component : Z
Natural period : 1 s
Magnification : 45 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: No change in the earthquake frequency or type occurred immediately before the May 25 eruption; however a change in the tremor amplitude was noted 3 hours before the eruption.

May 25.--This eruption began at about 02:28 PDT nearly a week after the cataclysmic eruption of May 18. Harmonic tremor had been observed continuously during the preceding week at varying intensity levels. Large shallow earthquakes, which occurred prior to the May 18, had virtually ceased. Smaller earthquakes continued to occur but essentially all of these were either deep events below the volcano or earthquakes located to the S or N of the volcano. No change in the earthquake frequency or type occurred immediately before the May 25 eruption; however a change in the tremor amplitude was noted 3 hours before the eruption.

Malone, S., et al., (1981): Seismic monitoring for eruption prediction, in USGS Professional Paper 1250, p. 803-813.

SWARM DATE: 80/6/13 ±0 Dur. (days): 0.03 ±0 Type:1aq Event type(s):t Grade : a

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 45 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: At 19:00 a large increase in tremor amplitude that lasted at least 40 min., followed by a very quite period. At 21:09 a major eruption began.

Jun. 12.--On Jun. 3 there was a repeat of the pattern observed on May 25, that is, an increase in harmonic tremor amplitude followed by a sudden quiet period. There was no eruption.

By Jun. 8 the harmonic tremor had died out completely. In mid afternoon on Jun. 12, harmonic tremor was again observed at low level. By late afternoon its amplitude increased and at about 19:00 there was a large increase in tremor amplitude that lasted at least 40 min., followed by a very quite period. At 21:09 a major eruption began.

Malone, S., et al., (1981): Seismic monitoring for eruption prediction, in USGS Professional Paper 1250, p. 803-813.

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.:*1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief :* 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 80/7/22 ±0.02 Dur. (days): 0.5 ±0.25 Type:1b Event type(s):LF,HF Grade : A

Max. Magnitude: M 2.0	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : N Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.): .11	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Duration detemined from figure in Malone et al. 1981.

Jul. 22.--On the morning of Jul. 22 two LF shallow events located under the N flank were recorded. By mid afternoon the rate of these events was obviously increasing. By 16:00 the rate was greater than 20 events per hour. At 17:13 the eruption began without any precursory harmonic tremor. The eruption was followed by HF events.

Malone, S., et al., (1981): Seismic monitoring for eruption prediction, in USGS Professional Paper 1250, p. 803-813.

SWARM DATE: 80/8/7 ±0 Dur. (days): 0.25 ±0 Type:1b Event type(s):t Grade : a

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.): .04	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: At 12:17 on Aug. 7 harmonic tremor began quite abruptly. The eruption began at 16:26

Aug. 7.--At 12:17 on Aug. 7 harmonic tremor began quite abruptly; it was recorded at moderate amplitude of 4 mm on SHW. Two small LF earthquakes occurred at 15:29 and 15:54, but the harmonic tremor was considered to be the significant activity. The eruption began at 16:26, the last pulse was followed by few deep HF earthquakes.

Malone, S., et al., (1981): Seismic monitoring for eruption prediction, in USGS Professional Paper 1250, p. 803-813.

SWARM DATE: 80/10/4 ±0.5 Dur. (days): 11 ±1 Type:1b Event type(s):LF,t Grade : A

Max. Magnitude: M 2.8	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.): .11	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Possibly the first of the seismic precursors to the Oct. eruption was LF earthquake on Oct. 4. Over the next 11 days, 16 more shallow volcanic earthquakes occurred.

Oct. 16-17.--From Aug. 7 until mid-Oct. there was little unusual seismic activity. Possibly the first of the seismic precursors to the Oct. eruption was a moderate sized LF earthquake on Oct. 4. Over the next 11 days, 16 more shallow volcanic earthquakes occurred. By 19:00 the rate of activity was up to 2 events per hour, and then up to 6 and 20 per hour in the next 2 hours, respectively. At 19:00 the largest event of the sequence took place M2.8. The eruption began at 21:58 with an eruption column to 12 km height.

Malone, S., et al., (1981): Seismic monitoring for eruption prediction, in USGS Professional Paper 1250, p. 803-813.

SWARM DATE: 80/12/24 ±0.5 Dur. (days): 2 ±1 Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): 1.5 ±1.5	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.): .2	Component : Z	Gravity : EQ families :
Cum. energy release: 4.0e+8 J	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Duration determined from figure in Malone et al. 1983.

Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science vol. 221, no. 4618, p.1376-1378.

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.*:1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief :* 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 81/2/2 ±0.5 Dur. (days): 3 ±1 Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM I at 0.5 km	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.): .13	Component : Z	Gravity : EQ families :
Cum. energy release: 4.0e+8 J	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Duration determined from figure in Malone et al. 1983.

Each eruption preceded by ground deformation (accelerated rate). Increasing seismicity 1 to 4 days prior to extrusion enabled refining of prediction windows. Felt: 5 per hour from 1-3 days prior to each eruption MMI at 0.5 km. Unfelt: max. 20 per hour from 2-7 days prior to each eruption. Micro-tremors: duration episode = 1 to 10 minutes randomly from Jul. - Dec. 1981, Max. ampl. = 10 mm peak to peak at 1 km from the vent (typically 1-5 mm). Some episodes may not be related to magma intrusion.

BVE No. 21, p. 62-64.
Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

SWARM DATE: 81/4/5 ±0.5 Dur. (days): 5 ±1 Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.): .18	Component : Z	Gravity : EQ families :
Cum. energy release: 8.0e+8 J	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Duration determined from figure in Malone et al. 1983.

BVE No. 21, p. 62-64.
Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

SWARM DATE: 81/6/13 ±0.5 Dur. (days): 5 ±1 Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.): .19	Component : Z	Gravity : EQ families :
Cum. energy release: 3.5e+8 J	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Duration determined from figure in Malone et al. 1983.

Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

ST. HELENS, MT. US-Washington		46.20N122.18W	*VOTW num.*:1201-05-
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin	
Elevation above m.s.l. : 2500 m	*Edifice relief :* 1450 m		
Range of eruptive products: andesite to dacite			

SWARM DATE: 81/8/30 ±0.5 Dur. (days): 8 ±1 Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation :	Focal mech:
Detection threshold:	Repose (yr.): .22	Component : Z	Gravity :	EQ families :
Cum. energy release: 3.0e+8 J	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: Duration determined from figure in Malone et al. 1983.

Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

SWARM DATE: 81/10/24 ±0.5 Dur. (days): 7 ±1 Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation :	Focal mech:
Detection threshold:	Repose (yr.): .15	Component : Z	Gravity :	EQ families :
Cum. energy release: 1.5e+8 J	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: Duration determined from figure in Malone et al. 1983.

Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

SWARM DATE: 82/2/24 ±0.5 Dur. (days): 22 ±1 Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM I at	# Felt total :	Dist. to vent: 1 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y	Focal mech:
Detection threshold:0.2	Repose (yr.): .38	Component : Z	Gravity : Y	EQ families :
Cum. energy release: 1.7e+9 J	Previous swarms : Y	Natural period : 1 s	Magnetic : Y	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: Duration determined from figure in Malone et al. 1983.

Seismic rates in late Feb. and early Mar. 1982 (precursory to eruptivity on Mar. 19). Unfelt: 5 per day background and up to 20 per hour from 3 days to 1 month prior to each eruption.
Felt: up to 10 per hour from 1-7 days prior to each eruption.

BVE No. 22, p. 61-64.
Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

SWARM DATE: 82/4/4 ±0.5 Dur. (days):<1 ± Type:1b Event type(s):SV,S Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.): .04	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: For the eruption of Apr. 4, 1982 all the precursory seismic events took place in less than a day.

On 4 and 5 Apr., a series of large rockfalls from the north face of the dome was followed by two additional plinian outbursts that sent eruption plumes to a height of 9 km above the eruption floor.

BVE No. 22, p. 61-64.
Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.*:1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief :* 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 82/5/6 ±0.5 Dur. (days): 8 ±1 Type:**1b** Event type(s):SV,S Grade : **A**

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .09	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Duration determined from figure in Malone et al. 1983.

Seismicity and the rates of deformation decreased and remained at a low level for a few weeks. In early May they increased, and a new extension of lava on the dome began on May 14, lasting until about May 20.

BVE No. 22, p. 61-64.
Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

SWARM DATE: 82/7/27 ±0.5 Dur. (days): 21 ±1 Type:**1b** Event type(s):SV,S Grade : **A**

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .26	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: Duration determined from figure in Malone et al. 1983.

Late Jul. deformation and seismicity rates increase again prior to new lava extrusion Aug. 18-23.

BVE No. 22, p. 61-64.
Malone, S., et al., (1983): Seismic precursors to the Mount St. Helens Eruptions in 1981 and 1982, Science, vol. 221, no. 4618, p.1376-1378.

SWARM DATE: 83/1/20 ±10 Dur. (days): 13 ±10 Type:**1b** Event type(s):**felt** Grade : **B**

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM I at 0.5 km	# Felt total :	Dist. to vent: 1 km	Tremor : N Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .45	Component : Z	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 45 K	Geothermal :

Key phrase: From middle to late Jan. 1983 the rates of seismicity and rates of ground displacement and SO2 emission all increased.

Seismicity and rates of ground displacement and SO2 emission had remained at background levels since Aug. 1982, but from middle to late Jan. 1983 each of these parameter began to increase. Feb 2 seismographs detected a series of vigorous explosions.
Felt shocks occurred from 3 weeks before the eruption at a frequency of 1-12 per day (max. MMI at 0.5 km from the vent). Unfelt shocks were recorded, 1-5 per day background levels and 20-50 per day for the precursory level.

BVE No. 23, p. 40-41.

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.*:1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief :* 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 84/2/5 ±5 Dur. (days): 3 ±5 Type:1c Event type(s): Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y	Focal mech:
Detection threshold:0.2	Repose (yr.):	Component : Z	Gravity :	EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: Seismicity increased dramatically in early Feb. Extrusion of a new lobe onto the dome began Feb. 7-10

During Jan. 1984, SO2 emissions and seismicity remained at slightly elevated levels, and continuous activity shifted to the northwest sector of the dome. Several explosions occurred on the dome in late Jan., before seismicity and swelling increased dramatically in early Feb. Extrusion of a new lobe onto the dome began Feb. 7-10 and ended on Feb. 15.

General comment for 1984:

Felt shocks: 1-10 per day, from 5 days prior, max. MMI, 0.5 km away. Unfelt: 1-5 per day background, > 100 per day precursory from 5 days prior. Micro-tremors: 1 day duration, immediately prior to eruption. No incorrect eruption predictions, most predicted a few weeks to several days in advance.

BVE No. 24, p. 40-41.

SWARM DATE: 84/3/22 ±0.5 Dur. (days): 7 ±1 Type:1c? Event type(s): Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: Increased seismicity and swelling on the dome starting on Mar. 22. On Mar. 29, rapid endogenous growth triggered a rock avalanche.

The second episode was preceded by increased seismicity and swelling on the dome starting on Mar. 22. On Mar. 29, rapid endogenous growth trigger a rock avalanche. Extrusion ended on Mar. 31.

BVE No. 23, p. 40-41.

SWARM DATE: 84/6/15 ±0.5 Dur. (days): 20 ±5 Type:1d? Event type(s): Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: Seismicity increased slightly on Jun. 15. Extrusion stopped by Jun. 30, but seismicity and swelling of the domes N flank increasing rapidly in late Jun. before quickly returning to background levels in early Jul.

Activity returned to background levels in Apr. Several explosions occurred on May 14, 26, and 27. Additional explosions occurred on Jun. 6 and 7, before seismicity and swelling increased slightly on Jun. 15. Extrusion stopped by Jun. 30, but seismicity and swelling of the domes N flank increasing rapidly in late Jun. before quickly returning to background levels in early Jul.

BVE No. 23, p. 40-41.

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.*:1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief* : 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 84/8/25 ±5 Dur. (days): 20 ±5 Type:2a Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 45 K	Geothermal :	

Key phrase: In late Aug. seismicity and swelling of the domes N and W flanks again began to increase. Extrusion stopped and activity returned to background levels by Sept. 14.

Activity remained at background levels until late Aug., when seismicity and swelling of the domes N and W flanks again began to increase. Precursory activity that accelerated rapidly during early Sept. culminated with extrusion of another dacite lobe. Extrusion stopped and activity returned to background levels by Sept. 14.

BVE No. 23, p. 40-41.

SWARM DATE: 85/4/24 ±0.5 Dur. (days): 9 ±1 Type:1? Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM I at 0.5 km	# Felt total :	Dist. to vent: 1 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y	Rumbling :
		Magnification : 45 K	Geothermal : Y	

Key phrase: Intense seismicity accompanied the faulting (strain and tilt data suggest that major faulting began on May 24) and intrusion.

After about 9 days of geodetic and seismic precursors typical of previous period of dome growth, the southern crestal area began to sag between May 21 and 23. Telemetered strain and tilt data suggest that major faulting began on May 24, during bad weather that lasted until May 30. Intense seismicity, the strongest since 1980, accompanied the faulting and intrusion.

BVE No. 25, p. 40-41

SWARM DATE: 86/5/3 ±3 Dur. (days): 11 ±3 Type:1b? Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y	Rumbling :
		Magnification : 45 K	Geothermal : Y	

Key phrase: Seismic precursors increased in the first week of May indicative of a forthcoming dome growth event.

Seismic precursors to the May episode began at the end of Jan. and continued through Apr. with 12-15 deep (3-8 km) earthquakes. The deep earthquakes ended on Apr. 15 with the start of phreatic explosions at the center of the crater. Seismic and geodetic precursors increased in the first week of May indicative of a forthcoming dome growth event. Most monitoring equipment was destroyed or damaged by the explosions and poor weather hampered direct observations, but crews did make measurements mid-morning on May 8 that showed accelerated deformation of the north side of the dome. Endogenous growth of the dome was taking place throughout May 8 and seismic and tilt data suggested that extrusion of a new lobe began late that day. At 19:40 PDT May 9 a large seismic event took place, telemetry from a tiltmeter site (base of the dome, north side) was lost, and trip wires at Loowit gauge (head of Loowit Gully, 2 km north of the base of the dome) recorded the passage of a "flood". Poor weather hindered all direct observations of the volcano after May 8 until May 14, by which time seismic activity had decreased substantially.

BVE No. 26, p. 59-60.

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.*:1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief :* 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 86/9/25 ±5 Dur. (days): 10 ±5 Type:1? Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .42
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 45 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: In late Sept. elevated seismic activity heralded the beginning of precursory activity to the October dome-building episode

OCTOBER 1986 EVENT
A small "gas emission" from the lava dome in late September, which was preceded by elevated seismic activity heralded the beginning of precursory activity to the October dome-building episode only 5 months after the last event. After a short lull, two days of increasing seismicity and tilt culminated on Oct. 5 at 20:05 PDT with a two-minute seismic event. This event was caused by a large (tens of meters across) block of dacite that broke loose from a oversteepened portion of the May 1986; lobe and avalanched down the north face of the dome, producing a pyroclastic flow and surge hot enough to singe wood. Seismicity began to increase again following another short lull in mid Oct.

BVE No. 26, p. 59-60.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: Md1.5
Max. Intensity: MM at
Depth (km): 6 ±6
Detection threshold:
Cum. energy release:

EQ total : 85
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 45 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1987.

Since Oct. 1986 there have not been any eruptions at Mount St. Helens. The Univ. of Washington Geophysics Program reported approximately 85 earthquakes located beneath Mount St. Helens during 1987. Most earthquakes had coda magnitudes less than 1.5 and were located at depths ranging from 0 to 12 km.

BVE No. 27, p. 87.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: 2.4
Max. Intensity: MM at
Depth (km): 5 ±5
Detection threshold:
Cum. energy release:

EQ total : 156
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 45 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1988

The University of Washington reported 156 earthquakes located under Mount St. Helens during 1988. All were in the 0-10 km depth range, and most were shallower than 6 km. The max. magnitude was 2.4, but most were less than 1.0.

BVE No. 28, p. 98-99.

ST. HELENS, MT. US-Washington 46.20N 122.18W *VOTW num.*:1201-05-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2500 m *Edifice relief :* 1450 m
Range of eruptive products: andesite to dacite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: M 2.7
Max. Intensity: MM at
Depth (km): 5 ±5
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1989.

Using a mini network of 16 seismic stations located up to 30 km dist. from the crater, UW reported 734 earthquakes located under MSH during 1989. All were in the 0-10 km depth range, most were shallower than 6 km . The max. magnitude was 2.7, but most were <1.0. The greatest number of earthquakes, 24% of the year's total, occurred during Oct.; both the shallow and deeper parts of the system recorded more earthquakes in Oct. than in any other individual month in 1989. In late Aug. and early Dec., there were periods of increased seismicity including sustained episodes up to 5 hours long of closely spaced small earthquakes with some tremor. These signals resembled seismicity associated with ash-emission episodes during and before 1986. Aug. events had smaller amplitude and much shorter durations than did the signals recording the Dec. events. Signal patterns also differed in Dec. when smaller impulsive earthquakes did not dominate the post-event hours as they did following the Aug. episodes. Rather, several cigar-shaped signals resembling either hydrothermal fluid jetting, small debris-flow events, or short-duration tremor occurred; the source of these post-episode events in Dec. is unknown. Other than the signal strength differences and post-episode behavior, the Aug. and Dec. events recorded similar characteristics of multiple, shallow earthquakes superimposed on volcanic tremor. Whatever the source of the vented steam and gas, these episodes were apparently not precursors to renewed magmatic activity. FIGS: hypo maps, depth time

BVE No. 29, p. 76-78.

HOOD, MOUNT US-Oregon 45.36N 121.70W *VOTW num.*:1202-01-

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3426 m *Edifice relief :*
Range of eruptive products: andesite to dacite

<u>SWARM DATE:</u> 80/7/6 ±0.5 Dur. (days): 7 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.5	# EQ total : 84	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : N Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Series of earthquakes began with a M3.3 shock on Jul. 6, 1980. A few shocks per day through Jul. 12 and only 1 Jul. 13.

Series of earthquakes about 100 km SSE of Mt. St. Helens began with a M3.3 shock on Jul. 6, 1980 at 18:17. Only 37 minutes later 4 events of M2.0-3.2 were recorded in an 11 minute period from area 85 km NNW (and 14 km toward Mt. Hood from Mt. St. Helens).
Continuous aftershocks of initial event recorded for several hrs. ranging in magnitude 2-3. A M3 at 02:59 on Jul. 7 followed by 1 aftershocks per hour. An event of M2.7 at 13:15 located 4-6 km directly beneath Mt. Hood.
In the first 24 hrs. 55 events recorded, only 8 events in next 24 hrs. ending Jul. 8. A few shocks per day through Jul. 12 and only 1 Jul. 13. None have been reported since. Strongest events occurred later in the swarm: Jul. 8 at 11:40 and 11:45 (M3.2 & 3.5) and on Jul. 9 at 20:26 (M3.2) The swarm's total energy release exceeded that from all previous earthquakes at Mt. Hood since 1965.

Date (July):	6-7	7-8	8-9	9-10	10-11	11-12	12-13
# of events	55	8	6	1	8	5	1

BVE No. 20, p. 97.

MEDICINE LAKE US-Calif

41.53N 121.53W* *VOTW num.*:1203-02-

Morphology: shield with caldera *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2412 m *Edifice relief :*
Range of eruptive products: basalt to rhyolite

SWARM DATE: 88/9/29 ±0.25 Dur. (days): 2 ±0.5 Type:3 Event type(s):VT,LP Grade : B

Max. Magnitude: M 4.1
Max. Intensity: MM at
Depth (km): 2 ±2
Detection threshold:
Cum. energy release:

EQ total : 200
Felt total :
b-value :
Repose (yr.): 900
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Starting on the morning of Sept. 29, 1988, a swarm of small earthquakes occurred beneath the summit caldera . Activity declined rapidly with 90 earthquakes recorded in the next 24 hours,

Starting on the morning of Sept. 29, 1988, a swarm of small earthquakes occurred beneath the summit caldera of Medicine Lake Volcano. The swarm peaked in the late afternoon with more than 80 earthquakes recorded in one hour, including two M3.5 events and one M4.1 event, the largest of the sequence. Activity declined rapidly with 90 earthquakes recorded in the next 24 hours, several events per day during Oct. 1988, several events per week during the remainder of 1988, and only sporadic flurries of small events (M=<3.1) during 1989.
Most of the 1988-1989 earthquakes occurred within 2 km of the surface (Fig. M26-1 BVE). With one exception, all were short-period, tectonic-type events; a single long-period event of M2.7 occurred about 15 km beneath the W part of the caldera on Dec. 1, 1989. The significance of this long-period event and a similar one that occurred in Oct. 1986 is unknown.
Seismic records starting in 1909 suggest that the summit area of Medicine Lake Volcano was virtually aseismic prior to the 1988-1989 activity, although small events may have gone undetected prior to the 1950's. In repose for 900-3000 years. Fig: epicenter and vertical cross section of earthquake locations.
BVE No. 28, p. 99-100.

LASSEN PEAK US-Calif **40.49N 121.51W** *VOTW num.*:1203-08-

Morphology: strato with lava dome *Tectonic framework:* Convergent Continental Margin

Elevation above m.s.l. : 3187 m *Edifice relief :* 1130 m

Range of eruptive products: basaltic andesite to rhyolite

SWARM DATE: 81/1/15 ±15 Dur. (days): 105 ±15 Type:3 Event type(s): Grade : C

Max. Magnitude: 2.5	# EQ total : 128	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent:	Tremor : / Migration :
Depth (km): ±	b-value :	Type:	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Jan. to Apr. 1984 there were 128 earthquakes (none felt) after this seismic levels returned to normal.

Seismometers located at Manzanita Lake Crescent Cliffs, Reading Peak., and SW entrance station.
During Feb. to Dec. 1981 there were 200 earthquakes (< M2.5) mostly under Tehama caldera.
In Jan. to Apr. 1984 there were 128 earthquakes (none felt), after this seismic levels returned to normal.
BVE No. 22, p. 107.

LONG VALLEY US-Calif   37.70N 118.86W *VOTW num.*:1203-14-

Morphology: caldera   *Tectonic framework:* Uncert. Divergent Rift Continental
Elevation above m.s.l. : 2590 m   *Edifice relief* :
Range of eruptive products: basalt to rhyolite

SWARM DATE: 78/10/4 ±0.5 Dur. (days): 570 ±15 Type:3 Event type(s):HF Grade : B

Max. Magnitude: M 5.7	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	1 km	Tremor : Y	Migration : Y
Depth (km): ±	b-value :	Type: short period		Deformation :	Focal mech:
Detection threshold:	Repose (yr.): 730000	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	50 K	Geothermal :	

Key phrase: Major swarm (M5.7 on Oct. 4 1978) 15 km SE of caldera. Next 19 months earthquake zone migrated NE and concentrated activity at S tip of caldera

Major swarm (M5.7 on Oct. 4 1978) 15 km SE of caldera. Next 19 months earthquake zone migrated NE and concentrated activity at S tip of caldera. Bursts of activity (Dec. 12, 1979-Apr. 1980) had increasingly dense spatial clustering. Monthly earthquake counts peaked in the spring 1980. Intense swarming mid May (10 days prior to largest event). On May 25-27, 1980, six events M 5.7-6.3 where epicentral zone rapidly extended to the S and W. Six weeks after strong shocks earthquakes in one small area of the caldera intensely swarmed lasting typically 1-2 hr. producing 100's of micro earthquakes and appearance of spasmodic tremor as observed in volcanic regions. Up to 1982, 8 such bursts have occurred (all within 4 km just E Mammoth Lakes).
During 1981 seismicity concentrated along S caldera boundary in a N-S zone 7 km into caldera and 15 km S of it. Largest shock in 1981 on Sept. 30 M5.9, 5 km S of caldera.
Routine analysis (daily seismic records) show earthquakes signal recorded at some stations in northwestern Great Basin from events located S of the caldera showed lack of S-wave and heavily filtered P-waves. These anomalous signal show evidence for magma chamber deeper than 7-8 km in S-central portions of the caldera.
Fig: Epicenter map p. 92, BVE.

BVE No. 21, p. 90-93.
Hill, D. (1976): Structure of Long Valley caldera, CA, from a seismic refraction experiment. JGR vol. 81, pp. 753-845.
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Ryall, A. and Ryall, F. (1981): Spatial-temporal variations in seismicity preceding the May 1980, Mammoth Lakes, California, earthquakes. Bull. Seism. Soc. Am., vol. 71, pp. 747-760.
Ryall, A. and Ryall, F. (1983): Spasmodic tremor and possible magma injection in Long Valley caldera eastern California, Science, vol. 219, pp. 1432-1433.
Savage, J.C. and Clark, M.M. (1982): Magmatic resurgence in Long Valley caldera, California: possible causes of the 1980 Mammoth Mountain earthquakes. Science, vol. 217, p. 531-533, 6 August 1982.

LONG VALLEY US-Calif — 37.70N 118.86W *VOTW num.*:1203-14-

Morphology: caldera — *Tectonic framework:* Uncert. Divergent Rift Continental
Elevation above m.s.l. : 2590 m — *Edifice relief :*
Range of eruptive products: basalt to rhyolite

SWARM DATE: 80/6/7 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 8.4 ±1.2
Detection threshold:3.0
Cum. energy release:

EQ total : 6
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : — Migration :
Deformation : — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Duration from Ryall 1982.

Ryall, A., written comm. 1982.

SWARM DATE: 80/7/2 ±0.5 Dur. (days): 5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 8 ±1
Detection threshold:3.0
Cum. energy release:

EQ total : 14
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : — Migration :
Deformation : — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Duration from Ryall 1982.

Ryall, A., written comm. 1982.

SWARM DATE: 80/8/1 ±0.5 Dur. (days): 2.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 8.2 ±1.3
Detection threshold:
Cum. energy release:

EQ total : 7
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : — Migration :
Deformation : — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Duration from Ryall 1982.

Ryall, A., written comm. 1982.

SWARM DATE: 80/11/25 ±0.5 Dur. (days): 1 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 7.8 ±1.3
Detection threshold:3.0
Cum. energy release:

EQ total : 5
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : — Migration :
Deformation : — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Duration from Ryall 1982.

Ryall, A., written comm. 1982.

SWARM DATE: 81/4/21 ±0.5 Dur. (days): 3 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 8.5 ±3
Detection threshold:3.0
Cum. energy release:

EQ total : 6
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : — Migration :
Deformation : — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Duration from Ryall 1982.

Ryall, A., written comm. 1982.

LONG VALLEY US-Calif

37.70N 118.86W *VOTW num.*:1203-14-

Morphology: caldera *Tectonic framework:* Uncert. Divergent Rift Continental
Elevation above m.s.l. : 2590 m *Edifice relief :*
Range of eruptive products: basalt to rhyolite

SWARM DATE: 81/7/9 ±0.5 Dur. (days): 7 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 5.9 ±1.3
Detection threshold:3.0
Cum. energy release:

EQ total : 30
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from Ryall 1982.

Ryall, A., written comm. 1982.

SWARM DATE: 81/8/9 ±0.5 Dur. (days): 1 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 9 ±2.9
Detection threshold:3.0
Cum. energy release:

EQ total : 5
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Duration from Ryall 1982.

Ryall, A., written comm. 1982.

SWARM DATE: 83/1/7 ±0.5 Dur. (days): 67 ±5 Type:3 Event type(s):HF Grade : A

Max. Magnitude: ML5.2
Max. Intensity: MM at
Depth (km): 4 ±4
Detection threshold:
Cum. energy release:

EQ total : 7000
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification : 50 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech: Y
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Major swarm began at 00:23 on Jan. 7, 1983. Activity from 30 M1 per hour on Jan. 7 to 2-3 M1 or greater per day by mid Mar. 1982.

Major swarm that began at 00:23 UT Jan. 7, 1983 includes ML5.3 at 01:38, ML5.6 and 02:25, numerous M4 events and smaller. Activity from 30 M1 per hour on Jan. 7 to 2 to 3 M1 or greater per day by mid Mar. 1982.
Initial swarm 4 km SE of Mammoth. Activity expanded to fill elliptical area 7 km further to ESE along S moat. Hypocenters from < 2-10 km depth. Strike slip mechanisms with right lateral slip along planes sub-parallel to long axis of swarm distance. Cumulative uplift (resurgent dome) since mid 1979 = 50 cm. from late fall 1982-mid Jan. 1983.
Fig: Hypocenter maps p. 108, BVE.

BVE No. 22, p. 107-108 (for duration).
Savage and Cockerham (1984): Earthquake Swarm in Long Valley, JGR, vol. 89 no. B10, p. 8315-8324 (for max. magnitude, depth, and number of earthquakes).

LONG VALLEY US-Calif 37.70N 118.86W *VOTW num.:*1203-14-

Morphology: caldera *Tectonic framework:* Uncert. Divergent Rift Continental

Elevation above m.s.l. : 2590 m *Edifice relief :*

Range of eruptive products: basalt to rhyolite

SWARM DATE: 84/6/15 ±0.5 Dur. (days): 15 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.6	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 50 K	Geothermal :

Key phrase: Swarm began on July 15 and tailed off through July 30.

Two notable earthquake sequences occurred within LVC during 1984; both were located within the south moat. The first was a M4.2 mainshock-aftershock sequence near Laurel Canyon at the southern boundary of the caldera on Apr. 28, and the second was an earthquake swarm that included M3.6 and M3.2 and several hundred smaller events all located just west of the junction between Highways 395 and 203.

BVE No. 24, p. 67-68.

SWARM DATE: 84/11/23 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech: Y
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 50 K	Geothermal :

Key phrase: Place holder for the M5.8 Round Valley earthquake Nov. 23

M5.8 Round Valley earthquake Nov. 23 (18:08) solitary foreshock M2.8 preceded by 4 seconds, and a vigorous aftershock sequence followed including a M5.2 (19:12 UT) and M5.2 on Nov. 26. At least 4 events M>4 during first 5 days and > 1000 events M>1 through Dec.1984. Depths to 10 km. Focal mechanism for mainshock involves left-lat. slip on near vertical plane strike N 30 E.

Figs: epicenter map 1984 swarm.

BVE No. 24, p. 67-68.

LONG VALLEY US-Calif		37.70N118.86W *VOTW num.*:1203-14-
Morphology: caldera	*Tectonic framework:*	Uncert. Divergent Rift Continental
Elevation above m.s.l. : 2590 m	*Edifice relief :*	
Range of eruptive products: basalt to rhyolite		

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: M 2.2	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 50 K	Geothermal :	

Key phrase: Place holder for 1985.

No detectable earthquakes occurred within the caldera between 1 and 23 Jul., and only 4 small ones (M<2.2) were recorded during the last 8 days of Jun. On 24 July, however, the low-level seismicity characteristic of the previous several months resumed and continued through Aug. The largest earthquake in the caldera during Jul.-Aug. was a magnitude 2.1 event on 12 Aug. Preliminary examination of more recent data suggests that this pattern of low-level seismicity continued through Sept. and Oct.

The geodetic evidence that broad-scale deformation across the entire caldera is continuing at a more-or-less uniform rate points to continuing inflation of the deeper section of the magma chamber (depths of 10-12 km). In contrast, the marked decrease in both the seismicity rate within the caldera and the rate of local deformation across the S moat indicate that stress differences in the upper crust associated with the Jan. 1983 earthquake swarm (and possible related intrusive event) have substantially relaxed. However, as long as we see evidence for continuing inflation of the deeper magma chamber, we must regard the resurgence of another episode of unrest somewhere within the caldera as a distinct possibility.

S. McNutt reported that no low-frequency events were recorded in the Long Valley Caldera between Jul. 1984 and Oct. 1985.

BVE No. 25, p. 63-64.

Communication from: D.P.Hill and J.C.Savage, USGS, MS 77, 345 Middlefield Road, Menlo Park, California, 94025 U.S.A.- S.McNutt, California Division of Mines and Geology, 630 Bercut, Sacramento, California 95814 U.S.A. from: SEAN Bulletin, vol. 10, no. 10, p. 6-9.

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: M 3.0	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 50 K	Geothermal :	

Key phrase: Place holder for 1986

Earthquake activity within Long Valley caldera persisted at a low level throughout 1986 with only one event reaching magnitude 3. This earthquake occurred in the south moat of the caldera on Mar. 14. Activity in the Sierra Nevada block to the south persisted at a somewhat higher level; although even here only two events exceeded magnitude 3. The spatial pattern of earthquake epicenters within the caldera and the Sierra Nevada block showed little change from the distribution established by the principal earthquake sequences in the area beginning with the M5.8 Wheeler Crest event of 4 Oct. 1978 and including the four M6 events of 25-27 May 1980, the South Moat swarm of Jan. 1983 and the M5.8 Round Valley event of 24 Nov. 1984.

BVE No. 26, p. 87.

LONG VALLEY US-Calif	37.70N 118.86W *VOTW num.*:1203-14-
Morphology: caldera *Tectonic framework:*	Uncert. Divergent Rift Continental
Elevation above m.s.l. : 2590 m *Edifice relief* :	
Range of eruptive products: basalt to rhyolite	

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: M 2.7	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	50 K	Geothermal :	

Key phrase: Place holder for 1987.

A M3.8 earthquake on Jan. 27 in the Chalfant Valley aftershock zone was the largest event to occur in the region during 1987. Aftershock activity to 21 July 1986, M6.4 Chalfant Valley earthquake showed a gradual slowing trend throughout the year. Only two earthquakes approached M3 within Long Valley caldera during 1987; one on 7 Apr. in the south moat and the other on 6 May on the southern margin of the caldera just 2 km south of Mammoth Lakes. Both were M2.7 events. Earthquake activity in the Sierra Nevada block south of the caldera showed little change from the last several years. fig: epicenter map.

BVE No. 27, p. 87-88.

SWARM DATE: 88/11/20 ±0.02 Dur. (days): 2.5 ±0.02 Type:3 Event type(s): Grade : B

Max. Magnitude: M 2.0	# EQ total : 393	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	1 km	Tremor :	Migration :
Depth (km): 6 ±	b-value :	Type: short period		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	50 K	Geothermal :	

Key phrase: Significant earthquake swarm occurred November 20-22.

One of Long Valley caldera's more significant earthquake swarms of the last several years occurred November 20-22 (BVE Fig. M27-l). Of the 393 recorded events (to M2.0), most were located in the E moat of the caldera (near the E: margin of the resurgent dome) with minor activity in the S moat (BVE Fig. M27-2). The swarm trended N-S at depths of about 6 km. As the number of events per hour decreased, average magnitudes increased. First order leveling surveys were completed across the epicentral area in 1986, about, 2 weeks before the swarm, and the day after it began. The data sugested slight uplift of the area W of the epicentral zone relative to the E side, consistent with normal faulting, measured changes were within error limits.

Fig: epicenter maps and number of earthquakes per hour for Nov. 20-22.

BVE No. 28, p. 100.

LONG VALLEY US-Calif

37.70N 118.86W *VOTW num.*:1203-14-

Morphology: caldera — *Tectonic framework:* Uncert. Divergent Rift Continental

Elevation above m.s.l.: 2590 m — *Edifice relief :*

Range of eruptive products: basalt to rhyolite

SWARM DATE: 89/5/4 ±0.5 Dur. (days): 180 ±1 Type:3 Event type(s):VT,LP Grade : A

Max. Magnitude: M 3.4	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): 7.5 ±1.5	b-value : 1.2	Type: short period	Deformation : Y Focal mech: Y
Detection threshold:0.5	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 50 K	Geothermal : Y

Key phrase: The swarm began on 4 May 1989. First indenitifiable LP event occurred southwest of Mammoth Mountain on July 27, midway through the six month long earthquake swarm.

The initial phase of the current swarm developed much like an aftershock sequence in reverse. Following its onset on 4 May 1989, the activity rate grew with an exponential-like increase peaking on 12 Jun. with some 25 M=>1.2 events. From 12 Jun. through early Aug., the activity fluctuated about an average rate of five M>= 1.2 events per day with occasional bursts exceeding 20 events per day. The activity rate began to slow through Aug. and Sept. and has been characterized by brief flurries of M=<1.2 events separated by days of relative quiescence. The largest events recorded in the swarm to date include only four ~M3 earthquakes that occurred on 26 May, 20 Jun., 12 Jul., and 1 Aug. These events stand out in a plot of cumulative seismic moment for the swarm through the end of Sept., and their widely spaced temporal occurrence emphasize the swarm-like character of this earthquake sequence. The cumulative seismic moment of all located events (M>0.5) in the swarm through the end of Sept. is 2.72 e+22 dyne-cm, which corresponds to the moment of a single ~M4 earthquake.

Rapid-fire (spasmodic) bursts of small earthquakes with overlapping coda have occurred virtually daily since early Jun. in this swarm. Particularly strong sequences with durations of several minutes occurred on 2 Jun., 26 Jun., 6 Jul., 13 Jul., 19 Jul., and 26 Jul.

First indenitifiable LP event occurred southwest of Mammoth Mountain on July 27, 1989, midway through the six month long earthquake swarm.

Hill, D. P., et al., The 1989 Earthquake Swarm Beneath Mammoth Mountain, California: An Initial Look at the 4 May Through 30 September Activity, BSSA, vol. 80, no. 2, p. 325-339.

Pitt, A.M. and Hill, D.P., Long-Period Earthquakes in the Long Valley Caldera Region, Eastern California, GRL, 1994.

SWARM DATE: 91/3/23 ±1 Dur. (days):>3 ± Type:3 Event type(s): Grade : C

Max. Magnitude: M 3.0	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 50 K	Geothermal :

Key phrase: Place holder for 1991.

In the south moat up to 35 events per hour were recorded including 9 M3 events. Activity is continuing at 10 events per hour.

Seismicity Report for the SF Bay area, Northern and Central CA and Long Valley Caldera. Mar. 21-27, 1991.

YELLOWSTONE US-Wyoming		44.58N 110.53W* *VOTW num.*:1205-01-	
Morphology: caldera	*Tectonic framework:*	Continental Hot Spot	
Elevation above m.s.l. : 2400 m	*Edifice relief :*		
Range of eruptive products: basalt to rhyolite			

SWARM DATE: 89/9/5 ±	Dur. (days): ±	Type:	Event type(s):	Grade :
Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling : Y
		Magnification :	Geothermal :	

Key phrase: Place holder for 1989.

The destruction of Porkchop Geyser. Coincided with and was probably triggered by annual widespread thermal disturbance in the Norris Geyser Basin. No seismological info reported.

BVE No. 29, p. 108.
SEAN Bull. vol. 14, no. 9, pp.13-14, 1989.

Hawaiian Islands and Pacific Ocean

LOIHI SEAMOUNT Hawaiian Is 18.91 N 155.25W *VOTW num.*:1302-00-

Morphology: submarine *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products: basalt

SWARM DATE: 84/9/15 ±15 Dur. (days): 90 ±30 Type:3? Event type(s): Grade : C

Max. Magnitude: M 4.2
Max. Intensity: MM at
Depth (km): ±
Detection threshold: 1.5
Cum. energy release:

EQ total : 50
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 35 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A relative increase in the seismicity occurred between Sep.-Dec.

Seismicity peaked in Nov. 84 where 50 earthquakes M>= 1.5 detected, Six of the largest events were M3-4.2. Nearest station 35-40 km away. Fig : Epicenter map 1970-84.
BVE No. 24, p. 68-69.

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 35 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1985.

Loihi Seamount remained in repose during 1985. There were intermittent bursts of earthquakes from the newly developing submarine volcano Loihi.
BVE No. 25, p. 64.

SWARM DATE: 86/9/20 ±0.5 Dur. (days): <1 ± Type:3 Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 35 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: A short but notable swarm of earthquakes on Sept. 20

Loihi Seamount was not in eruption during 1986. A short but notable swarm of earthquakes on Sept. 20 highlighted the year's activity. Regional seismicity of Hawaii consisted of several thousands of earthquakes of magnitude 1.5 to 5.0 in 1986. Most of the earthquakes were located at 5 to 10 km beneath the south flank of Kilauea and southeast flank of Mauna Loa. These earthquakes were generally dispersed throughout the year and were attributed to strain-release induced tectonically by the gradual accumulation of stresses along the flanks of the active volcanoes, in contrast to swarms of shallower earthquakes that occur in eruptive zones immediately before eruptions. See also descriptions for Mauna Loa and Kilauea. (Communication from: R. Koyanagi and J. Nakata, Hawaii Volcano Observatory, U.S. Geol. Survey, Hawaii National Park, Hawaii 96718, USA).
BVE No. 26, p. 87.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.:*1302-01-

Morphology: shield *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l. : 1250 m *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 79/5/29 ±0.5 Dur. (days): **0.33** ±0.02 Type:**3i** Event type(s): Grade : **A**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 5.5 ±3.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration : Y
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Intrusion ERZ

ERZ

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 79/8/12 ±0.5 Dur. (days): **0.2** ±0.02 Type:**3i** Event type(s): Grade : **A**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 2.5 ±1.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration : Y
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Intrusion UERZ

UER

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 79/9/22 ±0.5 Dur. (days): **0.13** ±0.02 Type:**3in** Event type(s): Grade : **A**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration : Y
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Inflation Caldera

Cald.

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 79/11/15 ±0.5 Dur. (days): **0.88** ±0.02 Type:**1aq** Event type(s): Grade : **A**

Max. Magnitude:
Max. Intensity: MM III at 10 km
Depth (km): 1.5 ±2.5
Detection threshold:0.2
Cum. energy release:

EQ total : 600
Felt total : 3
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent:
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Eruption in the UERZ. Duration from Klein et al. 1987.

Frequency of micro-earthquakes and rate of summit inflation high 1 month prior to eruption. Activity culminated with swarm of earthquakes at 21:00 Nov. 15 near Pauahi crater. Onset of ground subsidence recorded shortly following earthquake swarm and tilt preceded eruption by 11 hrs. Harmonic tremor and subsidence accompanied eruption. S-P = 1 sec. from 1 month prior.

BVE No. 19, p. 63-64.

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 1250 m — *Edifice relief :* 6800 m
Range of eruptive products: basalt

SWARM DATE: 80/3/2 ±0.5 Dur. (days): 0.25 ±0.08 Type:3i Event type(s): Grade : A

Max. Magnitude: 3.3	# EQ total : 1500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 6	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 2.5 ±1.5	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion in ERZ; Hiiaka

Subsurface magmatic events instrumentally detected and monitored. Swarms of tremor and rapid deflation of summit area characterized events. (shallow emplacement of magma from summit to upper E rift zone).

Date	location	EQ.>0.1	felt	Max. Mag.	depth(km)
3/2	Hiiaka	1500	6	3.3	<4
3/10-12	Mauna Ulu	3000	20	4.2	<5
8/27-28	Puhimau	2500	12	3.9	<4
10/22	Mauna Ulu	2000	10	2.4	<4
11/2	Kokoolau	1500	15	3.5	<5

Table : est. magma emplacements. Fig: epicenter maps p. 81 BVE.

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)
BVE No. 20, p. 80-81. (earthquake numbers and magnitude)

SWARM DATE: 80/3/10 ±0.5 Dur. (days): 1.25 ±0.16 Type:1c? Event type(s): Grade : A

Max. Magnitude: 4.2	# EQ total : 3000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 20	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 3 ±2	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: ERZ eruption; Mauna Ulu

ERZ

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)
BVE No. 20, p. 80-81. (earthquake numbers and magnitude)

SWARM DATE: 80/7/30 ±0.5 Dur. (days): 0.04 ±0.02 Type:3i Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 2.5 ±1.5	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion in the UERZ

UERZ

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l.: 1250 m — *Edifice relief:* 6800 m
Range of eruptive products: basalt

SWARM DATE: 80/8/27 ±0.5 Dur. (days): 0.5 ±0.04 Type:3i Event type(s): Grade : A

Max. Magnitude: 3.9	# EQ total : 2500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 12	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 2 ±4	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion in the UERZ; Puhimau

UERZ

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)
BVE No. 20, p. 80-81. (earthquake numbers and magnitude)

SWARM DATE: 80/10/21 ±0.5 Dur. (days): 1.13 ±0.02 Type:3i Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 2.5 ±2.5	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion in ERZ

ERZ

Klein et al., (1987): The Seismicity of Kilauea`s Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 80/10/22 ±0.5 Dur. (days): 0.13 ±0.02 Type:3i Event type(s): Grade : A

Max. Magnitude: 2.4	# EQ total : 2000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 10	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): 2.5 ±2.5	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion in UERZ; Mauna Ulu

UERZ

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)
BVE No. 20, p. 80-81. (earthquake numbers and magnitude)

SWARM DATE: 80/11/2 ±0.5 Dur. (days): 0.16 ±0.02 Type:3i Event type(s): Grade : A

Max. Magnitude: 3.5	# EQ total : 1500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 15	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 2.5 ±1.5	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion in UERZ; Kokoolau

UERZ

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)
BVE No. 20, p. 80-81. (earthquake numbers and magnitude)

KILAUEA **Hawaiian Is** **19.43N 155.29W** *VOTW num.*:1302-01-

Morphology: shield *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l. : 1250 m *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 81/1/20 ±0.5 Dur. (days): 1.2 ±0.02 Type:3i Event type(s): Grade : A

Max. Magnitude: 3.2
Max. Intensity: MM at
Depth (km): 3 ±.5
Detection threshold:0.1
Cum. energy release:

EQ total : 1500
Felt total : 1
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Slow intrusion USWR; South caldera

Surface magmatic events monitored throughout 1981. Swarms, tremor and accelerating deflation of summit indicated shallow emplacement from summit to SW rift.

In Aug. 81 4 e+6 m3 magma moved to SW rift, earthquake made zone 18 km long, 1-2 km wide and 0-5 km deep. Migration intrusion propagation of 2 km per hour decreasing to 0.5 km per hour.

Shallow tremor as well as subsidence rate of 10 m3 per hour indicate high volume rate of intrusion up to 4 e+6 m3 per hour.

Date	location	EQ>0.1	felt	Max. Mag.	Depth (km)
1/20	S Caldera	1500	1	3.2	3
1/25-26	SW rift	1000	0	2.8	3
6/25-26	S Caldera	2000	1	3.6	3
8/10-12	SW rift	10000	30	4.5	4

Figs : epicenter map p. 66 BVE.

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)

BVE No. 21, p. 65-66. (earthquake numbers and magnitude)

SWARM DATE: 81/1/24 ±0.5 Dur. (days): 5 ±1 Type:3i Event type(s): Grade : A

Max. Magnitude: 2.8
Max. Intensity: MM at
Depth (km): 3 ±.5
Detection threshold:0.1
Cum. energy release:

EQ total : 1000
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Slow intrusion in the USWR

USWR

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)

BVE No. 21, p. 65-66. (earthquake numbers and magnitude)

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l. : 1250 m — *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 81/2/9 ±0.5 Dur. (days): 8 ±1 Type:3i Event type(s): Grade : **A**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 4.5 ±2.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Slow intrusion in LSWR

Slow intrusion in LSWR

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 81/6/25 ±0.5 Dur. (days): 1.5 ±0.5 Type:3i Event type(s): Grade : **B**

Max. Magnitude: M 3.6
Max. Intensity: MM at
Depth (km): 3 ±
Detection threshold:
Cum. energy release:

EQ total : 2000
Felt total : 1
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Earthquake swarm and magma intrusion in the South Caldera on June 25-26.

This swarm is not listed in Klein et al. 1987.

BVE No. 21, p. 65-66.

SWARM DATE: 81/8/2 ±0.5 Dur. (days): 8 ±1 Type:3i Event type(s): Grade : **A**

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 3 ±.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Slow intrusion USWR

USWR

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 81/8/10 ±0.5 Dur. (days): 3.5 ±1 Type:3i Event type(s): Grade : **A**

Max. Magnitude: 4.5
Max. Intensity: MM at
Depth (km): 3 ±3
Detection threshold:0.1
Cum. energy release:

EQ total : 10000
Felt total : 30
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Y Focal mech:
Gravity : Y EQ families :
Magnetic : Y Rumbling :
Geothermal :

Key phrase: Intrusion in SWRZ

Intrusion in SWRZ

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)
BVE No. 21, p. 65-66. (earthquake numbers and magnitude)

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.:* 1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l. : 1250 m — *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 82/3/23 ±0.5 Dur. (days): 0.04 ±0.02 Type:3i Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : — Migration : Y
Depth (km): 3 ±.5	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:0.2	Repose (yr.):	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion USWR

USWR

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 82/4/30 ±0.5 Dur. (days): 0.16 ±0.02 Type:1c? Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y — Migration : Y
Depth (km): 1.5 ±1.5	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Caldera eruption

Apr. 30 eruption commenced after 3 hrs. of inflation, tremor, and intense seismic swarm.
Fig: Long and short period daily earthquake counts. (1982) BVE

Klein et al., (1987): The Seismicity of Kilauea`s Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.(duration)
BVE No. 22, p. 65-67.

SWARM DATE: 82/6/22 ±0.5 Dur. (days): 5 ±1 Type:3i Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : — Migration : Y
Depth (km): 5 ±5	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion in SWRZ

Jun. 22-24 Summit deflation, an earthquake swarm and tremor accompanied injection of at least 20 e+6 m3 of magma in SW rift.

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350. (duration)
BVE No. 22, p. 65-67.

SWARM DATE: 82/9/25 ±0.5 Dur. (days): 1.6 ±0.02 Type:1aq Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y — Migration : Y
Depth (km): 2 ±2	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Eruptive swarm at USWR UERZ; caldera

Sept. 25-26 eruption preceded by 2 hrs. of summit inflation , tremor and an earthquake swarm. On Migration: following Sept. 82 eruption most earthquake activity shifted from SW rift to E rift.

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350. (duration)
BVE No. 22, p. 65-67.

KILAUEA Hawaiian Is		**19.43N 155.29W** *VOTW num.*:1302-01-
Morphology: shield	*Tectonic framework:*	Oceanic Hot Spot
Elevation above m.s.l. : 1250 m	*Edifice relief :*	6800 m
Range of eruptive products: basalt		

SWARM DATE: 82/12/9 ±0.5 Dur. (days): 2 ±0.5 Type:3i Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration : Y
Depth (km): 2 ±2	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Intrusion at UERZ; Summit deflation, earthquake swarm, and magma intrusion. Duration from Klein et al. 1987.

From 17:30 to 20:00 on Dec. 9 an intense earthquake swarm occurred between Lua Manu and Kokoolau craters on E rift accompanied by 3 urad deflation (1 e+6 m3 magma intrusion)

Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350. (duration)
BVE No. 22, p. 65-67.

SWARM DATE: 83/1/1 ±0.5 Dur. (days): 6 ±0.5 Type:1aq Event type(s): Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration : Y
Depth (km): 5 ±5	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Eruptive swarm at ERZ, duration from Klein et al. 1987.

Beginning of the continuous eruption.
Hawaiian volcanic and seismic activity was significantly high in 1983. The middle east rift eruption of Kilauea was preceded by 24 hours of high seismicity, harmonic tremor and rapid summit deflation as the feeding dike of the eventual eruption was emplaced beneath a 10 km segment of the east rift zone.
Subsequent episode of the eruption occurred from the same dike system with out new seismic swarms, indicating that the continuing eruption was using portions of the same conduit system established during the first episode.
BVE No. 23, p. 42-44.
Klein et al., (1987): The Seismicity of Kilauea's Magma System, in: Volcanism in Hawaii, vol. 2, p.1019-1185. USGS Prof. Paper #1350.

SWARM DATE: 83/7/5 ±1 Dur. (days): 16 ±3 Type:1b Event type(s):SP Grade : A

Max. Magnitude:	# EQ total : 16000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.): .04	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: UERZ swarm. Greater than 1000 earthquakes per day. Duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 1250 m — *Edifice relief* : 6800 m
Range of eruptive products: basalt

SWARM DATE: 83/9/6 ±1 Dur. (days): 2 ±1 Type:2b? Event type(s):LP Grade : A

Max. Magnitude:	# EQ total : 2000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.): .05	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Summit LP swarm. Greater than 1000 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

SWARM DATE: 83/11/6 ±0.5 Dur. (days): 5 ±1 Type:2b Event type(s):LP Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .08	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Summit LP swarm. Greater than 800 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

SWARM DATE: 83/11/24 ±1 Dur. (days): 1 ±0.5 Type:1aq Event type(s):SP Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .06	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Summit SP swarm. Greater than 400 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

SWARM DATE: 83/12/1 ±1 Dur. (days): 2 ±1 Type:2b Event type(s):LP Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .06	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Summit LP swarm. Greater than 700 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

SWARM DATE: 83/12/30 ±1 Dur. (days): 2 ±1 Type:1aq Event type(s):SP Grade : A

Max. Magnitude:	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.): .13	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: UERZ swarm. Greater than 1000 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

KILAUEA Hawaiian Is		19.43N 155.29W	*VOTW num.*:1302-01-
Morphology: shield	*Tectonic framework:*	Oceanic Hot Spot	
Elevation above m.s.l. : 1250 m	*Edifice relief :* 6800 m		
Range of eruptive products: basalt			

SWARM DATE: 84/1/30 ±1 Dur. (days): 1 ±0.5 Type:2a? Event type(s):LP Grade : A

Max. Magnitude:	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:0.1	Repose (yr.): .02	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Summit LP swarm. Greater than 1000 earthquakes per day, duration from Koyanagi et al. fig. 7.12

The times of vigorous eruption were accompanied by intense tremor in the eruptive zone, and rapid deflation and temporary decrease of earthquakes in the summit region. Continued high rate of summit deflation led to tremor an long period events that lasted up to several days beneath the deformation center.
Following an eruptive episode, eruption tremor in the east rift typically decreased by about an order of magnitude, and continued with minor variations in amplitude throughout the interval of repose. the amplitude of tremor generally varied according to the vigor of lava movement within the eruptive vent. Micro-shocks caused by rock-fracturing, rockfalls and degassing persisted near the active vent and new lava flows.
Regional seismicity included 2500 Hawaii earthquakes of M1.5 or greater in 1984. 120 of the largest were M3.0-5.3.

BVE No. 24, p. 44-45.
Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

SWARM DATE: 84/2/5 ±1 Dur. (days): 4 ±1 Type:1a Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .04	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/2/15 ±1 Dur. (days): 1 ±0.5 Type:2b Event type(s):LP Grade : A

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .04	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Summit LP swarm. Greater than 1000 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

KILAUEA Hawaiian Is — 19.43N155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l.: 1250 m — *Edifice relief:* 6800 m
Range of eruptive products: basalt

SWARM DATE: 84/2/24 ±1 Dur. (days): 7 ±1 Type:1a Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/3/5 ±1 Dur. (days): 1 ±0.5 Type:2b Event type(s):LP Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1000
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Summit LP swarm. Greater than 1000 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

SWARM DATE: 84/3/16 ±1 Dur. (days): 8 ±1 Type:1a Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .07
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/3/31 ±0.5 Dur. (days): 1 ±0.5 Type:2a Event type(s):LP Grade : A

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .07
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Summit LP swarm. Greater than 1000 earthquakes per day, duration from Koyanagi et al. fig. 7.12

Koyanagi et al., (1988): The Puu Oo Eruption of Kilauea Volcano, Hawaii, Episodes 1 Through 20, Jan. 3, 1983, Through Jun. 8, 1984, in USGS Prof. Paper # 1463, p.183-235.

SWARM DATE: 84/4/10 ±1 Dur. (days): 10 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l. : 1250 m — *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 84/5/7 ±1 Dur. (days): 8 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km		Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period		Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.): .07	Component :	3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	100 K	Geothermal :	

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/5/22 ±1 Dur. (days): 6 ±1 Type:3 Event type(s):SP Grade : b

Max. Magnitude:	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km		Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period		Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component :	3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	100 K	Geothermal :	

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/6/1 ±1 Dur. (days): 5 ±1 Type:1a Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km		Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period		Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.): .05	Component :	3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	100 K	Geothermal :	

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/6/17 ±1 Dur. (days): 12 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km		Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period		Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.): .03	Component :	3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	100 K	Geothermal :	

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/7/8 ±1 Dur. (days): 2 ±1 Type:2b Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 3000	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km		Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period		Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.): .02	Component :	3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	100 K	Geothermal :	

Key phrase: LP caldera swarm. Duration from HVO fig S-3 and BVE figure.

BVE No. 24, p. 44-45. HVO monthly reports 1984.

KILAUEA Hawaiian Is | 19.43N 155.29W *VOTW num.*:1302-01-
Morphology: shield | *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 1250 m | *Edifice relief :* 6800 m
Range of eruptive products: basalt

SWARM DATE: 84/7/17 ±1 Dur. (days): 11 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/7/28 ±1 Dur. (days): 3 ±1 Type:2b Event type(s):LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 3000
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: LP caldera swarm. Duration from BVE figure.

BVE No. 24, p. 44-45. HVO monthly reports 1984.

SWARM DATE: 84/8/7 ±1 Dur. (days): 12 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .06
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/8/21 ±1 Dur. (days): 5 ±1 Type:2b Event type(s):LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 5000
Felt total :
b-value :
Repose (yr.): .06
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: LP swarm in summit caldera. Duration from BVE and HVO figures.

BVE No. 24, p. 44-45. HVO monthly reports 1984.

SWARM DATE: 84/9/1 ±1 Dur. (days): 20 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .08
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l. : 1250 m *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 84/9/19 ±1 Dur. (days): 5 ±1 Type:2b Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 2000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .08	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: LP swarm in summit caldera. Duration from BVE figure.

BVE No. 24, p. 44-45.

SWARM DATE: 84/10/2 ±1 Dur. (days): 29 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .12	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/11/11 ±1 Dur. (days): 9 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .05	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 84/11/20 ±1 Dur. (days): 2 ±1 Type:2b? Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 1500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .05	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: LP swarm in the summit caldera. Duration from BVE and HVO figures.

BVE No. 24, p. 44-45. HVO monthly reports 1984.

SWARM DATE: 84/11/23 ±1 Dur. (days): 9 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .04	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.*:1302-01-
Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l.: 1250 m *Edifice relief:* 6800 m
Range of eruptive products: basalt

SWARM DATE: 84/12/24 ±1 Dur. (days): 11 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .08
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 24 fig.

BVE No. 24. p. 44-45.

SWARM DATE: 85/1/4 ±1 Dur. (days): 2 ±1 Type:2b Event type(s):LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1000
Felt total :
b-value :
Repose (yr.): .08
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE and HVO figures.

The times of vigorous eruption were accompanied by intense tremor in the eruptive zone, and rapid deflation and temporary decrease of earthquakes ant the summit region. Continued high rates of summit deflation led to tremor and long-period events that lasted several to many days beneath the deformation center. Following an eruptive episode, eruption tremor in the ERZ typically decreased with minor variations in amplitude throughout the interval of repose. The amplitude of the tremor usually varied according to the vigor of lava movement within the eruptive vent. Micro-shocks caused by rock-fracturing, rockfalls, and degassing persisted near the active vent and new lava flows. The successive episodes of eruption were preceded by gradual inflation and increasing numbers of short-period earthquakes at the summit. 11 shallow short period swarms in 1985.

BVE No. 25, p. 41-44. HVO monthly reports 1985.

SWARM DATE: 85/1/16 ±1 Dur. (days): 20 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .08
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 1250 m *Edifice relief :* 6800 m
Range of eruptive products: basalt

SWARM DATE: 85/2/6 ±1 Dur. (days): 1 ±0.5 Type:2b Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 700	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera long period. Duration from BVE and HVO figures.

BVE No. 25, p. 41-44. HVO monthly reports 1985.

SWARM DATE: 85/2/28 ±1 Dur. (days): 14 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .1	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

SWARM DATE: 85/3/14 ±1 Dur. (days): 2 ±1 Type:1b Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 25 figure.

BVE No. 25, p. 41-44. HVO monthly reports 1985.

SWARM DATE: 85/3/27 ±1 Dur. (days): 27 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .1	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

SWARM DATE: 85/5/10 ±1 Dur. (days): 35 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .14	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

SWARM DATE: 85/6/21 ±1 Dur. (days): 19 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.): .06	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.*:1302-01-
Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l.: 1250 m *Edifice relief:* 6800 m
Range of eruptive products: basalt

SWARM DATE: 85/7/4 ±1 Dur. (days): 13 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

SWARM DATE: 85/7/6 ±1 Dur. (days): 1 ±0.5 Type:2b Event type(s):LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1200
Felt total :
b-value :
Repose (yr.): .06
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 25 figure.

BVE No. 25, p. 41-44.

SWARM DATE: 85/7/27 ±1 Dur. (days): 1 ±0.5 Type:2b Event type(s):LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 2800
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 25 figure.

BVE No. 25, p. 41-44.

SWARM DATE: 85/8/14 ±1 Dur. (days): 18 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .06
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

SWARM DATE: 85/9/2 ±1 Dur. (days): 2 ±1 Type:2b Event type(s):LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1500
Felt total :
b-value :
Repose (yr.): .06
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 25 figure.

BVE No. 25, p. 41-44.

SWARM DATE: 85/9/10 ±1 Dur. (days): 15 ±1 Type:1b Event type(s):SP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .05
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l. : 1250 m — *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 85/10/5 ±1 — Dur. (days): 16 ±1 — Type:1b — Event type(s):SP — Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y — Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.): .07	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

SWARM DATE: 85/10/21 ±1 — Dur. (days): 2 ±1 — Type:2b — Event type(s):LP — Grade : B

Max. Magnitude:	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y — Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.): .07	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 25 figure.

BVE No. 25, p. 41-44.

SWARM DATE: 85/10/30 ±1 — Dur. (days): 14 ±1 — Type:1b — Event type(s):SP — Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y — Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.): .06	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

SWARM DATE: 85/11/13 ±1 — Dur. (days): 1 ±0.5 — Type:2b — Event type(s):LP — Grade : B

Max. Magnitude:	# EQ total : 500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y — Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.): .06	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 25 figure.

BVE No. 25, p. 41-44.

SWARM DATE: 85/11/26 ±1 — Dur. (days): 32 ±1 — Type:1a — Event type(s):SP — Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y — Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y — Focal mech:
Detection threshold:	Repose (yr.): .13	Component : 3	Gravity : — EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : — Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Greater than 100 earthquakes per day, duration from BVE No. 25 fig.

BVE No. 25, p. 41-44.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.*:1302-01-
Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 1250 m *Edifice relief :* 6800 m
Range of eruptive products: basalt

SWARM DATE: 86/1/2 ±1 Dur. (days): 5 ±1 Type:2b Event type(s):LP Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 5000
Felt total :
b-value :
Repose (yr.): .13
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Caldera - LP swarm. Duration from BVE No. 26 figure.

The episodic pattern of eruption during the first half year was accompanied by changes in tremor amplitude near the eruptive vent in the east rift zone and the number of small earthquakes near the inflation center at the summit. The episodes of high lava output with fountains reaching several hundreds of meters in height were instrumentally characterized by high amplitude tremor near the eruptive vent, and shallow long-period micro-shocks and low amplitude tremor at the summit. The vigorous output of lava from the east-rift vent was accompanied by rapid deflation of the summit. The longer repose periods between episodes were marked by weak tremor near the eruptive vent, and gradually increasing number of shallow micro-earthquakes and inflation at the summit. 8 short period swarms in1986. Seismometers near the eruptive area also detected a variety of seismic signals associated with explosive degassing and rock falls at the vent, micro-fracturing of cooling and contracting lava flows, and explosive combustion of organic gases at forested boundaries of active lava flows. The changed mode of eruption from July 20 that continued through the end of the year was marked by relatively steady output of lava, low-level tremor from the eruptive vent in the east rift zone and small erratic changes in the number of shallow micro-earthquakes and amount of ground tilting at the summit.
Regional seismicity of Hawaii consisted of several thousands of earthquakes of magnitude 1.5 to 5.0 in 1986. Most of the earthquakes were located at 5 to 10 km beneath the south flank of Kilauea and Southeast flank of Mauna Loa. These earthquakes were generally dispersed throughout the year and were attributed to strain-release induced tectonically by the gradual accumulation of stresses along the flanks of the active volcanoes, in contrast to swarms of shallower earthquakes that occur in eruptive zones immediately before eruptions. Intermittent bursts of long-period earthquakes and volcanic tremor occurred at intermediate depths of about 5 to 15 km beneath the summit of Kilauea and in the upper mantle at about 40 to 60 km beneath south Hawaii. Intermediate depth sequences beneath Kilauea generally lasted several days and individual bursts of deeper tremor beneath south Hawaii were limited to a few hours in duration.
Figs: epicenter, time depth maps and short period shallow, long period shallow and deep counts.
BVE No. 26, p. 61-63.

KILAUEA Hawaiian Is — 19.43N 155.29W *VOTW num.*:1302-01-

Morphology: shield — *Tectonic framework:* Oceanic Hot Spot

Elevation above m.s.l.: 1250 m — *Edifice relief :* 6800 m

Range of eruptive products: basalt

SWARM DATE: 86/1/19 ±1 — Dur. (days): 10 ±1 — Type:1b — Event type(s):SP — Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .07
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y — Migration :
Deformation : Y — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/2/8 ±1 — Dur. (days): 16 ±1 — Type:1b — Event type(s):SP — Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .07
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y — Migration :
Deformation : Y — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/2/22 ±1 — Dur. (days): 2 ±1 — Type:2b — Event type(s):LP — Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 3000
Felt total :
b-value :
Repose (yr.): .07
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y — Migration :
Deformation : Y — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/3/7 ±1 — Dur. (days): 9 ±1 — Type:1a — Event type(s):SP — Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .1
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y — Migration :
Deformation : Y — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/3/22 ±1 — Dur. (days): 1 ±0.5 — Type:2b — Event type(s):LP — Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 1500
Felt total :
b-value :
Repose (yr.): .1
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y — Migration :
Deformation : Y — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/4/6 ±3 — Dur. (days): 8 ±3 — Type:1b — Event type(s):SP — Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): .06
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : 3
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y — Migration :
Deformation : Y — Focal mech:
Gravity : — EQ families :
Magnetic : — Rumbling :
Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.*:1302-01-
Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 1250 m *Edifice relief* : 6800 m
Range of eruptive products: basalt

SWARM DATE: 86/4/27 ±1 Dur. (days): 11 ±1 Type:1b Event type(s):SP Grade : B
Max. Magnitude: # EQ total : Seismograph: permanent OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km Tremor : Y Migration :
Depth (km): ± b-value : Type: short period Deformation : Y Focal mech:
Detection threshold: Repose (yr.): .06 Component : 3 Gravity : EQ families :
Cum. energy release: Previous swarms : Y Natural period : 1 s Magnetic : Rumbling :
Magnification : Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/5/7 ±1 Dur. (days): 3 ±1 Type:2b Event type(s):LP Grade : B
Max. Magnitude: # EQ total : 3000 Seismograph: permanent OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km Tremor : Y Migration :
Depth (km): ± b-value : Type: short period Deformation : Y Focal mech:
Detection threshold: Repose (yr.): .06 Component : 3 Gravity : EQ families :
Cum. energy release: Previous swarms : Y Natural period : 1 s Magnetic : Rumbling :
Magnification : Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/5/21 ±1 Dur. (days): 12 ±1 Type:1b Event type(s):SP Grade : B
Max. Magnitude: # EQ total : Seismograph: permanent OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km Tremor : Y Migration :
Depth (km): ± b-value : Type: short period Deformation : Y Focal mech:
Detection threshold: Repose (yr.): .07 Component : 3 Gravity : EQ families :
Cum. energy release: Previous swarms : Y Natural period : 1 s Magnetic : Rumbling :
Magnification : Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/6/18 ±3 Dur. (days): 8 ±3 Type:1b Event type(s):SP Grade : B
Max. Magnitude: # EQ total : Seismograph: permanent OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km Tremor : Y Migration :
Depth (km): ± b-value : Type: short period Deformation : Y Focal mech:
Detection threshold: Repose (yr.): .07 Component : 3 Gravity : EQ families :
Cum. energy release: Previous swarms : Y Natural period : 1 s Magnetic : Rumbling :
Magnification : Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/7/9 ±1 Dur. (days): 10 ±1 Type:1b Event type(s):SP Grade : B
Max. Magnitude: # EQ total : Seismograph: permanent OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km Tremor : Y Migration :
Depth (km): ± b-value : Type: short period Deformation : Y Focal mech:
Detection threshold: Repose (yr.): .06 Component : 3 Gravity : EQ families :
Cum. energy release: Previous swarms : Y Natural period : 1 s Magnetic : Rumbling :
Magnification : Geothermal :

Key phrase: Caldera - SP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 86/7/18 ±1 Dur. (days): 3 ±1 Type:2b Event type(s):LP Grade : B
Max. Magnitude: # EQ total : 6000 Seismograph: permanent OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km Tremor : Y Migration :
Depth (km): ± b-value : Type: short period Deformation : Y Focal mech:
Detection threshold: Repose (yr.): .06 Component : 3 Gravity : EQ families :
Cum. energy release: Previous swarms : Y Natural period : 1 s Magnetic : Rumbling :
Magnification : Geothermal :

Key phrase: Caldera - LP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

KILAUEA Hawaiian Is		19.43N 155.29W	*VOTW num.*:1302-01-
Morphology: shield	*Tectonic framework:* Oceanic Hot Spot		
Elevation above m.s.l. : 1250 m	*Edifice relief* : 6800 m		
Range of eruptive products: basalt			

SWARM DATE: 86/7/20 ±1 Dur. (days): 3 ±0.5 Type:2b? Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 3000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Caldera - LP swarm. Duration from BVE No. 26 figure.

BVE No. 26, p. 61-63.

SWARM DATE: 87/2/12 ±1 Dur. (days): 1 ±0.5 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 300	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Caldera long period swarm. Duration from BVE No. 27 figure. General comments: no distinct shallow short period swarms, LP swarms in Feb., Mar, & Dec.

Low-level tremor accompanied the relatively constant output of lava. Seismic stations within a few km. from the active ERZ vents Pu'u 'O'o and Kupaianaha persistently recorded 2-5 Hz tremor with amplitude several times above background. Minor variation in tremor intensity generally correlated with the vigor of lava movements and degassing in the vents. Bursts of micro-shocks occurred episodically near Kupaianaha, apparently due to crustal adjustments adjacent to the active vents. Also, occasional rockfall signals were detected from the unstable Pu'u O'o cone.
Summit activity was characterized by generally low number of shallow short period micro earthquakes and minor variation in ground tilt, relative to the quasi-steady state of the east rift eruption sustained throughout the year. There were only small bursts of short period events during minor inflation. Tremor related long period events occurred beneath the summit at depths ranging from a few to 15 km. Shallow (< 5 km.) long period events consisted of swarms of very small events that peaked in Feb., Mar., and especially, Dec. In contrast, intermediate depth long period events with usually larger amplitudes occurred regularly at low rates throughout the year.
A relatively sustained swarm of shallow (< 5 km) long period events during the first half of Dec., was followed a week later by increasing carbon/sulfur ratio at the summit crater Halemaumau. There was no apparent increase in carbon/sulfur for shorter bursts of long period events earlier during the year.
Regional seismicity included several thousands of earthquakes in the magnitude range from 1.5-4.7 in 1987. The largest M4.7 earthquake, as well as a M4.0 event, occurred about 50 km offshore to the NW of the island of Hawaii. Most of the higher magnitude earthquakes were centered beneath the south flank of Kilauea and the SE flank of Mauna Loa at depths of 1-10 km. These earthquakes outline the tectonic regions that respond to stresses induced by magma pressures from the active volcanoes. Deep earthquakes and tremor at about 40-60 km. in depth occurred in bursts at irregular intervals beneath south Hawaii, and isolated deep earthquakes were distributed widely beneath the island.
BVE No. 27, p. 59-61.

KILAUEA Hawaiian Is 19.43N 155.29W *VOTW num.*:1302-01-
Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 1250 m *Edifice relief :* 6800 m
Range of eruptive products: basalt

SWARM DATE: 87/3/16 ±1 Dur. (days): 1 ±0.5 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera long period swarm. Duration from BVE No. 27 figure.

BVE No. 27, p. 59-61.

SWARM DATE: 87/12/3 ±1 Dur. (days): 9 ±1 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 10000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera long period swarm. Duration from BVE No. 27 figure.

BVE No. 27, p. 59-61.

KILAUEA Hawaiian Is		19.43N 155.29W *VOTW num.*:1302-01-
Morphology: shield	*Tectonic framework:* Oceanic Hot Spot	
Elevation above m.s.l. : 1250 m	*Edifice relief :* 6800 m	
Range of eruptive products: basalt		

SWARM DATE: 88/4/9 ±1 Dur. (days): 1 ±0.5 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera long period swarm. Duration from BVE No. 28 figure.

Volcanic tremor levels registered beneath Puu Oo and Kupaianaha decreased with this decrease in lava activity. All surface ceased activity by Apr. 27. After Apr. 28, tremor levels gradually increased with a more noticeable increase observed on Apr. 30 and return to pre-pause levels by May 1. Prior to the decrease in tremor and eruption pause, a burst of intermediate depth long period earthquakes beneath Kilauea caldera was registered. While tremor activity at the vents remained low during the pause, large numbers of short period earthquakes beneath the summit caldera and a steady inflation of Kilauea summit were recorded.
Hawaii regional seismic activity included 27 earthquakes with magnitude greater than 4.0. The largest event was a M5.5 event on Mar. 27 which occurred as part of a spatial clustering of activity off-shore, west of the island of Hawaii. Much of the remaining activity occurred beneath the active flank of Kilauea and between Mauna Loa and Kilauea summits through the Kaoiki fault zone. Occasional swarms of intermediate depth long period swarms occur without such associated activity.
figs: counts and epicenter maps.

BVE No. 28, p. 68-70.

SWARM DATE: 88/4/25 ±1 Dur. (days): 18 ±2 Type:1e Event type(s):SP Grade : B

Max. Magnitude:	# EQ total : 11000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera SP swarm. Duration from BVE No. 28 figure.

BVE No. 28, p. 68-70.

KILAUEA Hawaiian Is | **19.43N 155.29W** *VOTW num.*:1302-01-

Morphology: shield | *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l.: 1250 m | *Edifice relief :* 6800 m
Range of eruptive products: basalt

SWARM DATE: 88/9/6 ±1 Dur. (days): 2 ±1 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : / Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera LP swarm. Duration from BVE No. 28 figure.

BVE No. 28, p. 68-70.

SWARM DATE: 89/9/22 ±2 Dur. (days): 2 ±1 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 750	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera LP swarm. Duration from BVE No. 29 figure.

Eleven earthquakes of magnitude >4.0 occurred beneath Hawaii in 1989. the 2 largest were a M6.1 event on Jun. 25 (HST) and a M5.1 event of Dec. 27. Both of these events were located beneath the south flank of Kilauea at depths of 9 km. Structural damage was sustained in the epicentral region of the Jun. 25 event, and felt reports for this event were received from Oahu. Neither of these events had any obvious effect on the eruption. Seismic activity beneath Kilauea summit associated with magmatic processes registered at steady levels punctuated by occasional bursts in activity. The largest fluctuation in long period earthquake activity at intermediate depths beneath Kilauea summit magma chamber occurred during the fourth quarter of 1989. Three long period swarms occurred, two in late Sept. (~1-2 days long) and one in late Nov. (~2 days in duration) Figs: Earthquake counts short, long period, shallow, intermediate and east rift. Hypo maps.

BVE No. 29, p. 78-80.

SWARM DATE: 89/9/29 ±2 Dur. (days): 1 ±0.5 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y / Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y / Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera LP swarm. Duration from BVE No. 29 figure.

BVE No. 29, p. 78-80.

KILAUEA **Hawaiian Is**		**19.43N 155.29W**	*VOTW num.*:1302-01-
Morphology: shield	*Tectonic framework:*	Oceanic Hot Spot	
Elevation above m.s.l. : 1250 m	*Edifice relief :* 6800 m		
Range of eruptive products: basalt			

SWARM DATE: 89/11/25 ±2 Dur. (days): 2 ±1 Type:1e Event type(s):LP Grade : B

Max. Magnitude:	# EQ total : 1000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: short period	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Caldera LP swarm. Duration from BVE No. 29 figure.

BVE No. 29, p. 78-80.

MAUNA LOA Hawaiian Is		19.48N 155.61W	*VOTW num.*:1302-02=
Morphology: shield	*Tectonic framework:*	Oceanic Hot Spot	
Elevation above m.s.l. : 4169 m	*Edifice relief :* 9800 m		
Range of eruptive products: basalt			

SWARM DATE: 82/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 21	Dist. to vent: 1 km	Tremor :	Migration :
Depth (km): 12 ±2	b-value :	Type: Mark L-4C	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase: Place holder for 1982. Shallow earthquakes beneath summit continue (10-14 km).

Shallow earthquakes beneath summit continue (10-14 km) through 1982 (increasing since 1980). 21 earthquakes >= M4.0 occurred beneath of near Hawaii in 1982 incl. M5.6 and a M5.4 at 10-14 km depths beneath S flank of Mauna Loa and the distribution of aftershocks indicate failure on a nearly horizontal rift of Mauna Loa seaward.

BVE No. 22, p. 109.

MAUNA LOA Hawaiian Is 19.48N 155.61W *VOTW num.*:1302-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 4169 m *Edifice relief :* 9800 m
Range of eruptive products: basalt

SWARM DATE: 84/3/24 ±0 Dur. (days): 120 ±15 Type:1d Event type(s):SP Grade : B

Max. Magnitude: M 4.0
Max. Intensity: MM at
Depth (km): 2.5 ±2.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.): 8.6
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: Mark L-4C
Component : 3
Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Weeks before the eruption climaxed, a seismic swarm at the summit started at 22:55 HST Mar. 24, 1984. Rates reached background levels after 4 months.

Pre-eruption activity started from about 1980 with persistent increase in earthquake rate and inflation of the summit region. Seismic activity extended into the flanks of the volcano, with a significant swarm of earthquakes beneath the northwest flank in mid-Sept. 1980, followed by a damaging quake of M6.6 with significant an aftershock sequence beneath the east flank in Nov. 1983. The varying increase in summit earthquakes and relatively steady inflation weeks before the eruption climaxed into a seismic swarm and accelerated ground deformation at the summit starting 22:55 HST Mar. 24, 1984. Seismicity during the months before during and after the eruption included earthquakes beneath the summit and northeast rift zone at shallow depths (<5 km) and range M0.1-4.0. They numbered several tens/day during months prior to eruptivity. About 2.5 hrs. prior to eruption, summit seismicity accelerated to 2-3 earthquakes/min. with continuous background of tremor. The subsequent summit rift migration of eruptive activity was accompanied by a decreased rate of shallow earthquakes and sustained harmonic tremor. Tremor prevailed through eruption with varying amplitude, according to varying eruptivity with locally high amplitudes up to a few microns (1 km away from fountianing vents). Post eruptivity saw low amplitude tremor, many hundreds of earthquakes/day and deflation. Later tremor became sporadic and shallow with micro-shocks. Rate of micro-earthquakes reached background levels after 4 months. Figs: epicenter map p. 43. Mauna Loa's latest eruption, which occurred in Mar.-Apr. 1984 on the NE rift zone, was associated with a large collapse and seismicity that peaked during and following the eruption (fig 2, BVE No. 27, p. 88.).
Following the increase and peak in seismicity of the last eruption in Mar.-Apr. 1984, the number of shallow micro-earthquakes had slowly decreased . Most of the post eruption events were attributed to the gradual structural adjustments from the major deflation at the summit (resulting from the voluminous magma withdrawal) and the principal eruptive vents near Puu Ulaula on the northeast rift zone. The post-eruption pattern of decreasing seismicity is indicated by the daily number of summit micro-earthquakes, and northeast rift events.
fig: Daily counts 1984-1988 short, long period and NE rift events.

BVE No. 24, p. 42-43.
BVE No. 27, p. 88.

MAUNA LOA Hawaiian Is 19.48N 155.61W *VOTW num.*:1302-02=

Morphology: shield *Tectonic framework:* Oceanic Hot Spot
Elevation above m.s.l. : 4169 m *Edifice relief* : 9800 m
Range of eruptive products: basalt

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km
Depth (km): ± b-value : Type: Mark L-4C
Detection threshold: Repose (yr.): Component : 3
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1985.

Mauna Loa remained in repose during 1985. The number of shallow micro-earthquakes at the summit and Northeast rift zone of Mauna Loa decreased gradually subsequent to the 1984 eruption in March-April. Regional seismicity included more than 2000 Hawaii earthquakes of magnitude 1.5 or greater in 1985. One-hundred and two of the largest measured 3.0 to 4.8 in magnitude. Most of the earthquakes were centered along sub-horizontal zones at 5 to 10 km beneath the south flank of Kilauea and southeast flank of Mauna Loa. These events persisted at a relatively constant rate, in contrast to the episodic pattern of shallow volcanic activity.

BVE No. 25, p. 64.

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km
Depth (km): ± b-value : Type: Mark L-4C
Detection threshold: Repose (yr.): Component : 3
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1986

The number of shallow microearthquakes at the summit and northeast rift zone was low.

BVE No. 26, p. 87.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: M 0.5 # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km
Depth (km): ± b-value : Type: Mark L-4C
Detection threshold: Repose (yr.): Component : 3
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1987.

There has beenno significant seismic activity beneath the summit and rift zones of Mauna Loa since the 1984 eruption, and the present level of shallow seismicity is relatively low. There has been some increase in the intermediate-depth events beneath the volcano noticed over the past year. Most of the events are very small, recorded only on a few summit and rift stations, and essentially less than 0.5 in magnitude.

BVE No. 27, p. 88.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: # EQ total : Seismograph: permanent
Max. Intensity: MM at # Felt total : Dist. to vent: 1 km
Depth (km): ± b-value : Type: Mark L-4C
Detection threshold: Repose (yr.): Component : 3
Cum. energy release: Previous swarms : Y Natural period : 1 s
Magnification : 100 K

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1988.

Mauna Loa was not in eruption during 1988. The inflationary rate has been slow but steady since the 1984 eruption. Shallow micro-earthquakes at the summit, and NE rift zone were low in number throughout the year.

BVE No. 28, p. 100.

TEAHITIA Pacific-C 17.56S 148.85W *VOTW num.*:1303-03-

Morphology: submarine *Tectonic framework:* Divergent MOR
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products:

SWARM DATE: 82/3/14 ±0.5 Dur. (days): 39 ±1 Type:1c Event type(s): Grade : B

Max. Magnitude: M 4.0	# EQ total : 10000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 2	Dist. to vent: 40 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: LDG ZM 400	Deformation :	Focal mech:
Detection threshold:0.9	Repose (yr.):	Component : 3 & Z	Gravity :	EQ families : Y
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 125 K	Geothermal :	

Key phrase: Earthquake swarm Mar. 14-Apr. 23.

Mar. 14 Polynesian seismic network recorded earthquakes in vicinity of seamount with summit 2 km below sea level. Increasing activity consisted of low magnitude earthquakes until Mar. 25 when 5 Tahiti-Moorea seismic stations detected tremor of 5-10 Hz frequency. Tremor declined after Apr. and none has been recorded since Apr. 18. As of Apr. 23 weak earthquakes and episodic 1.5-2.0 Hz seismic noise has continued. More than 10,000 individual earthquakes (M >0.9) were recorded in swarm, strongest = M3.5-4 and were felt in Tahiti.

BVE No. 22, p. 85.

SWARM DATE: 83/7/11 ±0.5 Dur. (days): 9 ±1 Type:2? Event type(s): Grade : C

Max. Magnitude:	# EQ total : 3500	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 40 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: LDG ZM 400	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : 3 & Z	Gravity :	EQ families : Y
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 125 K	Geothermal :	

Key phrase: Between July 11-20 recorded 3-4000 shallow earthquakes.

Between July 11-20 Reseau Sismique Polynesian (RSP) recorded 3-4000 shallow earthquakes accompanied by high frequency volcanic. tremor.

BVE No. 23, p. 51.

SWARM DATE: 84/3/3 ±0.5 Dur. (days): 130 ±5 Type:2? Event type(s): Grade : B

Max. Magnitude: M 3.7	# EQ total : 7084	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM IV at 70 km	# Felt total : 4	Dist. to vent: 40 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: LDG ZM 400	Deformation :	Focal mech:
Detection threshold:0.7	Repose (yr.):	Component : 3 & Z	Gravity :	EQ families :
Cum. energy release: 5.6e+9 J	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification : 125 K	Geothermal :	

Key phrase: Swarm started very abruptly on Mar. 3. After 10 days of intense activity, the intensity decayed regularly and died off on July 14.

Swarm started very abruptly on Mar. 3. After 10 days of intense activity, the intensity decayed regularly and died off on July 14. max. M3.7 on Mar. 6. From Mar. 4 - 23, intense high frequency tremor present from Mar. 3-Apr. 17, 7084 earthquakes and 2050 min. of high frequency tremor was recorded. The date of submarine eruption unknown. Felt 4 shocks, MM IV 70 km away. Unfelt: 7000 shocks, 1500 per day. Micro-tremors: 34 hrs. duration. Characteristic sizes: period ~15 sec. max. amplitude 50 um 70 km away. Figs: Earthquake frequency and tremor duration and energy release Mar.-Apr. 1984.

BVE No. 24, p. 54.

TEAHITIA **Pacific-C** **17.56S 148.85W** *VOTW num.:*1303-03-

Morphology: submarine *Tectonic framework:* Divergent MOR
Elevation above m.s.l. : *Edifice relief :*
Range of eruptive products:

SWARM DATE: 85/1/10 ±0.5 Dur. (days): 15 ±1 Type:? Event type(s): Grade : **B**

Max. Magnitude: 4.4	# EQ total : 9600	Seismograph: permanent		OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM V at 70 km	# Felt total : 12	Dist. to vent:	40 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: LDG ZM 400		Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	3 & Z	Gravity :	EQ families :
Cum. energy release: 1.2e+11 J	Previous swarms : Y	Natural period :	1 s	Magnetic :	Rumbling :
		Magnification :	125 K	Geothermal :	

Key phrase: A swarm started very abruptly on Jan. 10. and it died off on Jan. 25.

The 1985 swarm started very abruptly on Jan. 10. After 8 very active days the intensity of the swarm decayed regularly, and it died off on Jan. 25. The maximum magnitude reached was 4.4 on Jan. 15 and 4.3 on Jan. 19. From Jan. 10 to 22, very intense high-frequency tremors were recorded.

From Jan. 10 to 25, 9600 earthquakes were recorded and 4000 minutes of tremors (frequency 6-7 Hz max. ampl. 50um at 70 km from the vent). The total energy released in the swarm was 1.2e+9 ergs^1/2 (from figure).

BVE No. 25, p. 54.

MEHETIA **Pacific-C**		**17.91S 148.03W** *VOTW num.:*1303-06-
Morphology: shield	*Tectonic framework:*	
Elevation above m.s.l. : 435 m	*Edifice relief :*	
Range of eruptive products:		

SWARM DATE: 81/3/6 ±0.5 Dur. (days): **273** ±15 Type:**1d?** Event type(s): Grade : **B**

Max. Magnitude: M 4.3	# EQ total : 50000	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 30	Dist. to vent: 140 km	Tremor : N	Migration : Y
Depth (km): 13 ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold: 1.1	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Swarm began on Mar. 6, continued through late Oct. Seismic activity ceased in Dec. 1981.

A swarm of earthquakes centered beneath Mehetia began suddenly on 6 Mar. and was continuing in late Oct. After the first 2 days of the swarm, characterized by numerous weak events, seismographs began to record occasional larger shocks. The previous total energy released during the first week of the swarm greatly exceeded the previous total energy release detected since 1962-3. Both the number of earthquakes and energy varied considerably, with period of increased activity separated by brief lulls. Epicenters were about 10 km SE of the crater. There were several groups of foci, which may indicate vertical migration, but it was impossible to compute depths for most of the events. A temporary station (25-30 Mar.) recorded local earthquakes at about 13 km depth.
By late Oct. 1981, 3000 events (ML> 0.9) recorded up to this time. 30 events > M3.0 including M4.0-4.3 shocks. Detection limits (~M1.1) determined ability to record harmonic tremor. Mehetia area 140 km from closest Tahitian network. Tremor data not obtained. Estimation of 50,000 events >M0.1 have occurred in total for swarm (Talandier). Talandier notes similarity of Hawaiian seismicity to Mehetia (p. 95, BVE No. 22). Seismic activity ceased in Dec. 1981. Only a few low energy events per month have been recorded since.

BVE No. 22, p. 94-95.

MACDONALD Pacific-C 28.98S 140.25W *VOTW num.*:1303-07-

Morphology: submarine
Tectonic framework:
Elevation above m.s.l. :
Edifice relief :
Range of eruptive products:

SWARM DATE: 81/2/15 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 800 km
Type: hydrophone
Component :
Natural period :
Magnification : 125 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for Feb. 15, 1981. Two explosions (06:11 and 06:20) which were followed by 12 hr. of eruptive noise.

Since 1967 French Polynesian seismic stations have detected intermittent submarine eruptions with hydro-phones. Feb. 15, 1981 2 explosions (06:11 and 06:20) were followed by 12 hr. of eruptive noise. Acoustic waves (T-phase) from total of 6 eruptions. Acoustic record shows each eruption preceded by intense explosive signals, followed by a few hours. to a few days of amplitude modulated noise frequently punctuated by explosive activity and less commonly by strong increases in noise amplitude.

BVE No. 21, p. 83-84.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 800 km
Type: hydrophone
Component :
Natural period :
Magnification : 125 K

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1987.

Five submarine eruptions were recorded in 1987. The activity of the MacDonald volcano is detected only by the waves generated at the lava/seawater interface during submarine effusion of lava at shallow ocean depths. Nine of twenty stations of Polynesia Seismic Network (Reseau Sismique Polynesien) have detected the crisis of MacDonald. These stations, 800 to 1,500 km from the volcano, are equipped with magnetic and graphic recorders are 1) 7,800 at 1 Hz, 2) 125,000 at 1 Hz, 3) 2 x 10 at 3 Hz.

BVE No. 27, p. 70.

MACDONALD Pacific-C		28.98S 140.25W	*VOTW num.*:1303-07-
Morphology: submarine	*Tectonic framework:*		
Elevation above m.s.l. :	*Edifice relief :*		
Range of eruptive products:			

SWARM DATE: 88/9/2 ±0 Dur. (days): 5 ±1 Type:2a? Event type(s):E Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 800 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type: hydrophone	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification : 125 K	Geothermal :

Key phrase: Numerous shallow submarine explosions of moderate intensity occurred from 21:55 Sept. 2 until Sept. 5, recorded as acoustic waves (T-phase)

Frequent seismic swarms from Macdonald Seamount have been detected since August 19, 1987, by the Polynesian Seismic Network. The recorded acoustic waves (T-phases) are generated during eruptions at the interface between lava and sea water. No explosions accompanied the onsets of active periods during Aug. 1987 - Jun. 1988, suggesting to seismologists that the eruption may have been continuous, during that time. Numerous shallow submarine explosions of moderate intensity occurred at Macdonald Seamount from 21:55 (LT. = GMT - 10 hours) on Sept. 2 until Sept. 5, recorded as acoustic waves (T-phase) by the Polynesian Seismic network. Sporadic weak activity persisted from Sept. 6 until the eruption's end at about 07:00 on Sept. 18. (From: SEAN Bulletin vol. 13, no. 1, p.8; no. 9, p.5, 1988)

Seismicity produced by activity at Macdonald Seamount was substantially more vigorous in 1987 and particularly in 1988 than in previous years since 1977. Acoustic T-waves generated from a submarine eruption on Nov. 11-17, 1988, were the most intense since the Polynesian Seismic Research station began to collect. data. more than 25 years ago. Since the end of the Sept. 3-18 eruption nearly continuous weak seismicity from Macdonald was detected Sept. 26 - Oct. 5, Oct. 12 - 24, and Dec. 12 - 14, and weaker, more sporadic, explosions Dec. 25 - 29. (From: SEAN Bulletin vol. 13, no. 12, p. 13, 1988)

BVE No. 28, p. 87.

Central America

COLIMA VOLCANIC COMP Mexico 19.51N 103.62W *VOTW num.*:1401-04=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 3960 m *Edifice relief* : 800 m
Range of eruptive products: andesite

SWARM DATE: 81/12/9 ±0.5 Dur. (days): 0 ±0 Type:4 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent:	Tremor : / Migration :
Depth (km): ±	b-value :	Type: array	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms :	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Little apparent seismicity associated with the eruption on Dec. 9, 1981.

Little apparent seismicity associated with the eruption on Dec. 9, 1981. No felt shocks have been reported or detected in the seismic network around the volcano.

BVE No. 21, p. 67.

SWARM DATE: 82/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : / Migration :
Depth (km): ±	b-value :	Type:	Deformation : / Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : / EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : / Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1982.

Only micro tremors detected on seismic network (10 days of observation)

BVE No. 22, p. 67-68.

COLIMA VOLCANIC COMP Mexico 19.51N 103.62W *VOTW num.*:1401-04=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 3960 m *Edifice relief* : 800 m
Range of eruptive products: andesite

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s):felt Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :	
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:	
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :	
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :	
		Magnification :	Geothermal :		

Key phrase: Place holder for 1985.

Hundreds of tremors were felt during a bivouac near the fumarole field on the night of 26 Nov.

BVE No. 25, p. 65.
SEAN Bull. vol. 8, no. 4, 1985.

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y	Migration :	
Depth (km): ±	b-value :	Type:	Deformation : Y	Focal mech:	
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :	
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :	
		Magnification :	Geothermal : Y		

Key phrase: Place holder for 1986.

Neither earthquakes nor harmonic tremor were detected through the level instrument (normally a fairly sensitive indicator of seismic activity) during Feb. 1-15, although occasional earthquakes were felt at night 27 km NE of the summit).
From the above evidence it seems that the magnitude 8 earthquake in Sept. opened new fractures and accentuated previous ones on the volcano. This may have provoked some depressurization of the near-surface magma, increasing surface temperatures and fumarolic activity, and culminating in the minor ash eruptions of early Jan. The leveling and dry tilt data suggest no build up of magmatic pressure, and the decline in seismic activity since Nov. also indicates that for the moment, there are no portents of a larger eruption such as those which followed the earthquakes of 1611 and 1806.(Information from: C. Robin and J. B. Murray. From, SEAN Bulletin, vol. 11, no. 3, p. 11-12, 1986)

BVE No. 26, p. 63-64.
SEAN Bulletin, vol. 11, no.3, p.11-2, 1986

PARICUTIN Mexico

19.48N 102.25W *VOTW num.*:1401-06=

Morphology: cinder cone
Tectonic framework: Uncert. Convergent Continental Margin
Elevation above m.s.l. : 3170 m
Edifice relief : 410 m
Range of eruptive products: andesite

SWARM DATE: 43/1/7 ±0.5 Dur. (days):>45 ± Type:1b Event type(s):VT Grade : A

Max. Magnitude: M 4.5
Max. Intensity: MM IV at
Depth (km): 10 ±10
Detection threshold:3.0
Cum. energy release: 2.0e+12 J

EQ total : 22
Felt total : 5
b-value :
Repose (yr.):
Previous swarms :

Seismograph: Wiechert
Dist. to vent: 320 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration : N
Focal mech:
EQ families :
Rumbling : Y

Key phrase: Precursory seismic activity lasted for more than 45 days.

The first precursory earthquake occurred on Jan. 7 1943, with a M4.4. Subsequently, 21 earthquakes ranging from M3.2 to M4.5 occurred before the outbreak of the eruption on Feb. 20. The S-P durations of the precursory earthquakes do not show any systematic changes within the observational errors. The hypocenters were shallow and did not migrate.
The precursory earthquakes had a characteristic tectonic signature, which was retained through the whole period of activity. Except for the first shock, the max. earthquake magnitudes show an increasing tendency with time towards the outbreak. the total seismic energy released by the precursory earthquakes amounted to 2x10e+19 ergs. VEI=3, Lava volume=10e+9 m^3, Tephra volume=10e+8m^3.

Yokoyama, I. and S. de la cruz-Reyna, Precusory earthquakes of the 1943 eruption of Paricutin volcano, Michoacan, Mexico, JVGR, 44 (1990) 265 -281.

POPOCATEPETL **Mexico**		19.02N98.62 W	*VOTW num.*:1401-09=
Morphology: strato or composite	*Tectonic framework:*	Uncert. Convergent Continental Margin	
Elevation above m.s.l. : 5452 m	*Edifice relief :* 1600 m		
Range of eruptive products: andesite			

SWARM DATE: 94/10/15 ±15 Dur. (days): 60 ±15 Type:1b Event type(s): Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: 2.9	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Place holder for 1994 activity.

McNutt per. comm. 1995

CHICHON, EL Mexico

17.36N93.23 W *VOTW num.:*1401-12=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 1350 m *Edifice relief :* 850 m
Range of eruptive products: andesite

SWARM DATE: 82/3/1 ±0.5 Dur. (days): **28** ±1 Type:**1bq** Event type(s):B,LP,A Grade : **A**

Max. Magnitude: Md4.0
Max. Intensity: MM IV at 30 km
Depth (km): 15 ±5
Detection threshold:2.0
Cum. energy release:

EQ total : 489
Felt total :
b-value : 0.8
Repose (yr.): 650
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 5 km
Type: telemetric
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Focal mech: Y
Gravity : Y EQ families : Y
Magnetic : Rumbling :
Geothermal :

Key phrase: A dramatic increase in the number of events of type 1 (B-type) occurred on Mar. 1. The seismic activity suddenly declined at 03:27 on Mar. 29 and was followed by the first eruption at 05:15.

A dramatic increase in the number of events of type 1 (B-type) occurred on Mar. 1. The activity subsided some what on Mar. 6 when the largest type 1 events (M~4, coda=380 sec.) occurred. The activity reached a minimum on Mar. 11 and then increased again becoming a maximum on Mar. 26. On Mar. 27 at about 10:15, type 2 (high frequency P waves followed by large surface waves) started for the first time and the number of type 1 events declined rapidly. At 06:00 on Mar 28 type 3 (LP?) events began. For the next 14 hours type 2 and 3 can be easily identified on the seismograms. After 20:00 hours it is difficult to separate these two types of events due to intense activity.
The seismic activity suddenly declined at 03:27 on Mar. 29 and was followed by the first eruption at 05:15.
The table below is from Medina et al.

Date	b	delta_b	Events	max. Md
Mar. 2-25	1.10	0.18	400	4.1
Mar. 16-28	1.39	0.21	567	3.9
Mar. 31-Apr. 3	1.71	0.25	483	3.3
Apr. 7-15	1.21	0.11	1091	3.8
Apr. 16-30	0.93	0.16	322	4.0

b-value entered above (1.25) is an average of the Mar. 2-25 and Mar. 16-28.

BVE No. 21, p. 69.
BVE No. 22, p. 69 -71.
Havskov, J., et al., (1982), Seismic Activity Related to the March-April, 1982 Eruptions of El Chichon Volcano, Chiapas, Mexico, GRL, vol. 10, no. 4, p. 283-296.
Medina, F., et al. (1992), Analysis of the Seismic Activity Related to the 1982 Eruption of the El Chichon Volcano, Mexico, in: IAVCEI Proceedings in Volcanology, vol. 3, Gasparini, Scarpa, and Aki (Eds.), Springer-Verlag Berlin Heidelberg, p. 97-108.
Yokoyama, et al., (1992), Energy partition in th 1982 eruption of El Chichon volcano, Chiapas, Mexico, JVGR 51:1-21.
Repose value from: Rose, W., et al., JVGR 23:147-167.

TACANA Mexico

15.13N92.11 W *VOTW num.*:1401-13=

Morphology: strato with caldera *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 4092 m *Edifice relief :* 2300 m
Range of eruptive products: andesite

SWARM DATE: 85/12/15 ±1 Dur. (days): 72 ±2 Type:1a? Event type(s):Tect, VT Grade : B

Max. Magnitude: 5.0	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling : Y
		Magnification :	Geothermal :

Key phrase: A series of shallow earthquakes began 15-16 Dec., 1985, The rate of seismic energy release increased substantially 18-25 Feb., declined significantly after 25 Feb.

A series of shallow earthquakes centered within 20 km of Tacana began 15-16 Dec., 1985, and was continuing in early Feb. On 19 Dec., a magnitude 5 earthquake centered near Ixchiguan (ca. 15 km ENE of volcano) caused minor damage to 60 adobe houses and a school built of reinforced concrete. This event was followed by a series of aftershocks that had ended by 30 Jan. Geologists from the Universidad Nacional Autonoma de Mexico visited the volcano in late Jan., finding no evidence of increased volcanic activity. A portable seismometer placed on the volcano's summit for 2 hours and at its base for 4 hours on 26 Jan. recorded small earthquakes but no harmonic tremor. On 3 Feb., another magnitude 5 earthquake was recorded in the same area as the 19 Dec. event. Moderate damage occurred to 500 adobe houses (18 km ENE of the summit of Tacana). Shocks of magnitudes 4.2, 3.0, and less than 3.0 followed. Some of the earthquakes had a NW-SE alignment in the Toaca-Ixchiguan area. Volcanic earthquakes were felt in Sibinal and rumbling was heard at the base of the volcano. A joint INSIVUMEH/Universidad Nacional Autonoma de Mexico team recorded only volcanic earthquakes 3-7 February. However, harmonic tremor began to appear on 8 February. Harmonic tremor strengthened the next day and seismicity was migrating around the volcano. (SEAN Bulletin, vol. 11, no. 1, p. 11, 1986)
The majority of felt events were subduction zone earthquakes centered under the coast of northernmost Guatemala. Other events originated in a fault system NE of the volcano, in Guatemala. A third type consisted of events under the volcano, characterized by sharp P arrivals and very long S wave trains, that were strong enough to be felt and heard within 10 km of the volcano. Apparent volcanic tremor episodes with amplitudes just above noise levels were recorded 2-3 times a day. The rate of seismic energy release increased substantially 18-25 Feb., declined significantly after 25 Feb., then started to increase again on Mar. (SEAN Bulletin, vol. 11., no. 2, p. 5, 1986) There have been no certain historic eruptions of Tacana. Although several episodes of plume emissions and/or explosions have been reported since the mid-19th century, none is well-documented.

BVE No. 25, p. 65.
BVE No. 26, p. 64-65.
Mulleried, F.K.G. (1951): La reciente actividad del volcan de Tacana, Estado de Chiapas, a fines de 1949 y principios de 1950. Depto. de Prensa y Turismo, Tuxtla-Gutierrez, Mexico, 28 p.
De la Cruz Martinez, V. and Hernandez Zuniga, R. (1986): Geologia del Volcan Tacana. Geotermia, Revista Mexicana de Geoenergia, vol.2, no. 1, p.5-21. Rose, W.I. and Mercado, R. (1986): Report on UNDRO/ FDA mission to Tacana Volcano Guatemala/Mexico. INSIVUMEH, Guatemala, 30 p. + 3 maps

TACANA **Mexico**		**15.13N92.11 W** *VOTW num.*:1401-13=
Morphology: strato with caldera	*Tectonic framework:*	Uncert. Convergent Continental Margin
Elevation above m.s.l. : 4092 m	*Edifice relief :* 2300 m	
Range of eruptive products: andesite		

SWARM DATE: 86/5/7 ±0 Dur. (days): 2.5 ±0.5 Type:1b Event type(s):A Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total : 4000	Seismograph: temporary		
Max. Intensity: MM IV at 9 km	# Felt total : 1000	Dist. to vent: 9 km	Tremor :	Migration :
Depth (km): ±	b-value :	Type: MEQ-800	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling : Y
		Magnification : 72 K	Geothermal : Y	

Key phrase: A volcanic earthquake swarm started on 7 May at 15:00. The seismic activity continued unchanged through 9 May, then started decreasing on 10 May.

A moderate phreatic explosion on 8 May was preceded by strong regional and local seismicity. In this area, an already high seismic background originated by the interaction of the Cocos, Caribbean and North America plates, increased earthquakes, some of them with magnitudes greater than 4, located in a region about 20 km ENE of the summit of Tacana. On 19 Dec. 1985 and on 3 Feb. 1986 these earthquakes produced some minor damage in the town of Ixchiguan in Guatemala. This activity continued through 20 Apr. 1986, when the earthquakes foci migrated under the Tacana structure. The seismicity, consisting of sharp high-frequency A-type events slowly increased until 6 May. On 7 May an intense seismic swarm of the same type of events raised panic in the population. On 8 May, at the peak of the earthquake swarm, a phreatic explosion occurred and several hours afterwards the seismicity started to slowly decline until reaching the Mar.-Apr. levels. Presently the fumarole from the craterlet continues although significantly decreased, and the seismicity as well. The following is from Servando de la Cruz-Reyna. "A volcanic earthquake swarm started in Tacana volcano on 7 May at 15:00. Earthquakes occurred at an average rate of one per minute, accompanied by thunder-like noises that continued for 23 hours. On 8 May near noon, a moderate phreatic explosion opened a 10-meter diameter vent that ejected a small amount of fine ash, partially destroying vegetation. The seismic activity continued unchanged through 9 May, then started decreasing on 10 May. A white plume some 300 m high continued to be emitted as of 11 May. As of late May, about 2-3 fairly large and a dozen small tectonic events were recorded daily. About 90% of the shocks were very shallow and most epicenters were within 3 km of the vent. Seismicity had declined somewhat by mid-June, while deformation and temperatures of nearby hot springs remained stable.

The phenomenon has been interpreted as some ground water thermal interaction with a deep magmatic body through fracturing of the thick granitic basement produced by regional stresses (which originated the Ixchiguan activity as well). All observed earthquakes have been of the same type, with well defined S and P phases and a very high frequency content, reaching the audio level (most of them could be heard and were referred to as retumbos), and no volcanic tremors nor deformations were detected.

BVE No. 26, p. 64-65.
BVE No. 27, p. 79-80.
SEAN Bulletin, vol.11, nos.4-5, p. 14, p. 3, 1986.

TACANA Mexico

15.13N 92.11 W *VOTW num.*:1401-13=

Morphology: strato with caldera *Tectonic framework:* Uncert. Convergent Continental Margin
Elevation above m.s.l. : 4092 m *Edifice relief :* 2300 m
Range of eruptive products: andesite

SWARM DATE: 87/1/25 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s): Grade : B

Max. Magnitude: M 3.0
Max. Intensity: MM at
Depth (km): 7.5 ±2.5
Detection threshold:
Cum. energy release:

EQ total : 750
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 6 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A swarm that began 25 Jan. about 35 micro-earthquakes occurred per hour, with 750 events (M<1) recorded 25-26 Jan.

Three seismic swarms in the vicinity of Tacana were recorded 20-28 Jan. Two began with magnitude 3 events. During a swarm that began 25 Jan. about 35 micro-earthquakes occurred per hour, with 750 events (M<1) recorded 25-26 Jan. Events from the 25-26 Jan. swarm appeared to be at 5-10 km depth. No change in activity at the volcano has been reported. On 11 Apr. a team of Italian scientists inspected the craters and fumaroles produced by the explosion. A steam column more than 100 m high, was being emitted, but total steam output appeared to have decreased. The largest fumarole had a temperature of 89.3C.
Seismic activity continued in May and Jun. at about the same level as in previous months. Seismic station SBG. 6 km E of the summit recorded 40 micro-earthquakes in May and 30 in Jun. with S-P<=2.0 seconds.

BVE No. 27, p. 89.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 6 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1988

Residents of Tacana and Sibinal, the nearest villages in Guatemala, reported infrequent to occasional seismicity.

BVE No. 28, p. 101.

SANTA MARIA Guatemala	14.76N91.55 W *VOTW num.:*1402-03=
Morphology: strato with lava dome	*Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3772 m	*Edifice relief :* 1500 m
Range of eruptive products: andesite	

SWARM DATE: 79/8/23 ±0.5 Dur. (days):<1 ± Type:1b Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling : Y
		Magnification :	Geothermal :

Key phrase: Seismic activity began before dawn on Aug. 23 followed by fallout of fine ash.

Rumblings and seismic activity began before dawn on Aug. 23 followed by fallout of fine ash.

BVE No. 19, pp 66-67.

SWARM DATE: 85/1/24 ±1 Dur. (days): 16 ±2 Type:2a Event type(s):B Grade : C

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Very shallow B-type earthquakes accompanied the eruptions. The number of events recorded each day ranged from none 27-28 January to 77 on 2 Feb.

A portable seismograph was installed N of the volcano (near the "Hotel Magermann") on 25 Jan. Very shallow B-type earthquakes accompanied the eruptions. The number of events recorded each day ranged from none 27-28 Jan. to 77 on 2 Feb. Continuous seismicity was recorded for more than 11 hours on 25 Jan. and for periods of several hours each 1-4 February.

BVE No. 25, p. 44.

SWARM DATE: 86/12/1 ±0.5 Dur. (days): 1 ±0.5 Type:1d? Event type(s):felt? Grade : C

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Newspapers reported that explosions, increased seismicity, occurred day of the eruption.

Newspapers reported that explosions, increased seismicity, and continuing lava flow from the crater were seen the day of the eruption (Dec. 1, 1986)

BVE No. 26, p 67.

SEAN Bull. vol. 11, no. 11, p. 17, 1986.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2.6 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1988

Observations were made on Jan. 27-28 from about 2 km W of Santiaguito on January 30. Steam and ash were ejected at 09:30 and 10:00. A local observer reported some roaring, whistling noises and very minor seismicity.
The number of explosions, as determined from field observations and seismic records from stations 5 km NNW and 2.6 km S of Santiaguito, has been tabulated since June (BVE Fig. 43-3). Daily explosion totals during June ranged from 5 to 22.

BVE No. 28, p. 71-74.

SANTA MARIA Guatemala 14.76N91.55 W *VOTW num.*:1402-03=

Morphology: strato with lava dome *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3772 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

SWARM DATE: 89/7/1 ±183 Dur. (days): ± Type: Event type(s):E,S Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1989.

Figure of the number of daily explosions and avalanche events p. 82 BVE

BVE No. 29, p. 81-83.
SEAN Bull. vol. 14, no. 6, p. 24, 1989.

FUEGO Guatemala 14.47N 90.88 W *VOTW num.*:1402-09=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 3736 m *Edifice relief :* 2400 m
Range of eruptive products: basaltic andesite

SWARM DATE: 87/6/8 ±0.02 Dur. (days): 0.08 ±0 Type:3 Event type(s):VT Grade : B

Max. Magnitude:	# EQ total : 78	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: On 8 June about 78 micro-earthquakes were recorded at FG3 between 13:00 and 15:00 this day.

A seismic station, Fuego station (FG3), 5 km SE of the summit at 1,500 m altitude, registered 30 micro-earthquakes with S-P~2.0 seconds during May and 40 in June. On 8 June, residents of Guatemala City observed a white column of vapor extending hundreds of meters above the summit. About 78 micro-earthquakes were recorded at FG3 between 13:00 and 15:00 this day. Residents of the area reported that they did not feel any earthquakes. An electronic tiltmeter at the seismic station measured 8 microradians of deformation. On 10 June, a white vapor column was observed emerging from the crater.

During the following days, INSIVUMEH personnel installed portable seismic stations 10 km E and W of the summit (at Alotenango and San Pedro Yepocapa). These did not register any seismicity. INSIVUMEH geologists suggested that heavy rains on 8 June may have been responsible for the observed activity.

Gas emission from the crater and nearby micro-earthquakes continued through July. Seismic station FG3 registered 50 micro-earthquakes with S-P<=2.0 seconds. The tiltmeter, at the same site, did not show abnormal variation.

BVE No. 27, p. 63.

PACAYA Guatemala 14.38N 90.60 W *VOTW num.*:1402-11=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2552 m *Edifice relief* : 1000 m
Range of eruptive products: basalt

SWARM DATE: 87/1/20 ±0.02 Dur. (days): 1 ±0.5 Type:1b Event type(s):t Grade : b

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The explosion was preceded by about 24 hours of low-level tremor.

The explosion that ejected lapilli and blocks onto the N flank on 21 Jan. was preceded by about 24 hours of low-level tremor, which strengthened about 15 minutes before the explosion.

BVE No. 27, p. 63-65.

SWARM DATE: 87/1/24 ±0.5 Dur. (days): 1 ±0.5 Type:1b Event type(s):t Grade : b

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The explosion on 25 Jan. was preceded by about a day of tremor.

A second explosion on 25 Jan. was also preceded by about a day of tremor, initially banded, then increasingly vigorous for about 12 hours. During the 2.5 hours before the explosion, peak to peak amplitude reached 8 mm. The explosion at 17:30 ejected a column to 8 km altitude (tephra volume < 5 x10e+6 m3).

BVE No. 27, p. 64-65.

SWARM DATE: 87/6/14 ±0 Dur. (days): 0.66 ±0 Type:1b Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Stations PGC (1 km N of the crater) and TER (6 km SSW) registered an increase 15 hours before14 Jun, 19:30 eruption.

Seismic activity associated with the eruption recorded by several stations of the National Seismic Network. Stations PGC (1 km N of the crater) and TER (6 km SSW) registered an increase 15 hours before eruption, and the increase was evident 5 hours before the eruption at REC station (6 km NE). AT GCG (24 km N), the maximum seismic amplitude lasted 45 minutes, longer than for 21 and 25 Jan. explosions. After the 14 June eruptions activity declined rapidly. Lava emission stopped and the number of explosions registered on station PGC dropped to 20-30 per day, continuing at that rate through the end of Jun.

During the first 20 days of July, activity was weak, limited to sporadic explosions from MacKenney Crater. No lava flows had been observed since the strong 14 June explosive eruption. Activity increased on 23 July, to 5-10 explosions per 15 minutes from MacKenney Crater as recorded by seismic instruments.

BVE No. 27, p. 63-65.

PACAYA Guatemala 14.38N 90.60 W *VOTW num.*:1402-11=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2552 m *Edifice relief* : 1000 m
Range of eruptive products: basalt

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling : Y
Geothermal :

Key phrase: Place holder for 1988.

Counts of explosions derived from seismic records indicate that explosions increased from a few hundred per day in early Jun. to about 2,000/day in mid-Jun. Ash fell 2.5 km from the volcano on Jun. 11. Explosions dropped to a few hundred per day in Jul. and lava effusion stopped from all but one vent. When the seismograph resumed operation in mid-Sept., daily explosion counts ranged from about 1,500 to 2,300. On Sept. 20 a new lava flow began on the S flank at about 2,100 m altitude. Activity increased late Sept. to early Oct., when some seismic events were felt on Cerro Chino (on the NW somma rim) and rumblings were heard in the S part of Guatemala City. fig: est. explosions per day Jun.-Oct 1988.

BVE No. 28. p. 74-75.

SWARM DATE: 89/2/25 ±1 Dur. (days): 10 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 1 km
Type: short period
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal : Y

Key phrase: Increase in seismicity was observed Feb. 25-27, Feb. 28- Mar. 6. a logarithmic increase began Mar. 7 continuing until the onset of the main eruption at ~13:00.

About 1600 seismic events per day were recorded through most Feb. A slight increase in seismicity was observed Feb. 25-27, and the number of events varied from 1700-2300 events per day, Feb. 28- Mar. 6. A logarithmic increase began Mar. 7 at about 06:00, continuing until the onset of the main eruption at ~13:00.

BVE No. 29, p, 83-85.

TECAPA El Salvador 13.50N 88.50 W *VOTW num.*:1403-08=

Morphology: strato with crater lake *Tectonic framework:* Convergent Continental Margin

Elevation above m.s.l. : 1592 m *Edifice relief :* 600 m

Range of eruptive products: basalt

SWARM DATE: 85/4/21 ±0.5 Dur. (days): 44 ±1 Type:3 Event type(s):felt Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: mb4.7	# EQ total : 2464	Seismograph: permanent	Tremor :	Migration :
Max. Intensity: MM at	# Felt total : 170	Dist. to vent: 55 km	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms :	Natural period :	Geothermal :	
		Magnification :		

Key phrase: An earthquake swarm occurred by surface faulting on 21 Apr.

An earthquake swarm occurred by surface faulting on 21 Apr. in the Chlnameca Complex, near Tecapa, a volcano with no known historic eruption. A magnitude-4.7 (mb) earthquake, the largest so far, occurred on 23 Apr. at 09:16. Four days later, Apr. 27, during the peak activity (in terms of numbers of recorded and felt events per day), an 8-km-long graben formed on the NW flank of the volcano. The N40W-striking graben is 800 m-1 km wide, with a vertical offset of 30 cm. Through 6 June, 170 earthquakes were felt in the area.

A very preliminary analysis of the earthquake-location data implies that activity began on a tectonic fault some 15 km NW of the volcanic summit, and moved nearer to the volcano at the time the graben formed. Since 3 June, 5-20 earthquakes per day were recorded by a high gain seismograph station 50 km from the volcano, down from 300 events per day on 26, 27, and 28 April and 21 and 23 May.

BVE No. 25, p. 65.

Information from: J.Gonzalez, Centro des Investigaciones Geotecnicas, Departamento de Sismologia, Apartado Postal 109, San Salvador, El Salvador;

D. Harlow, US Geological Survey, Mail Stop 77, 345 Middlefield, Road, Menlo Park, CA 94025 U.S.A. From: SEAN Bulletin, vol. 10, 1985, no. 5, p.5

SAN MIGUEL El Salvador

13.43N 88.27 W *VOTW num.*:1403-10=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 2130 m *Edifice relief :* 1600 m
Range of eruptive products: basalt

SWARM DATE: 85/11/15 ±15 Dur. (days): >80 ±20 Type:2a Event type(s): Grade : C

Max. Magnitude:	# EQ total : 16000	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Frequent small earthquakes began in Nov. and were continuing in early Feb., 1986.

Weak steam and ash emission accompanied by frequent small earthquakes began in Nov. and were continuing in early Feb., 1986. The eruption deposited a thin layer of ash near the summit. Geologists installed a telemetering seismometer about 1 km from the summit, recording about 200 discrete microseismic events per day from Nov. through much of Jan., 1986.

BVE No. 25, p. 45.
SEAN Bulletin, vol. 10, no. 1, p. 12

SWARM DATE: 86/5/15 ±1 Dur. (days): 126 ±2 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: The middle of May to the middle of Sept., the activity increased notably.

Due to the lack of other instruments of control, only micro-seismicity records are taken by the seismological center. In the figure (BVE No. 26, p. 88), it can be observed clearly that from Jan. to the middle of May the seismic activity remained without a considerable increment, whereas from the middle of May to the middle of Sept., the activity increased notably reaching as much as 347 micro-seisms in one day despite of no report of sensitivity. Some of the micro-seisms have an amplitude of 10 mm.

BVE No. 26, p. 88.

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM III at 10 km	# Felt total : 47	Dist. to vent:	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1987.

Seismicity of San Miguel Volcano and the surrounding area is given in Fig. 1(BVE No. 27, p. 89). Because of no availability of data (due to technical problem) during more than 40% of the year, it is difficult to make a thorough comment of the micro-seismicity at San Miguel Volcano. However, the most notable of this period is the occurrence of forty seven shocks which were felt with an approximate intensity of MM II-III.

BVE No. 27, p. 89.

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1988.

Fumarolic activity and micro-seismicity continued throughout 1988 at San Miguel Volcano. Fig: Average micro-seismicity during Sept. and Nov. 1988

BVE No. 28, p. 101-102.

SAN CRISTOBAL Nicaragua 12.70 N 87.00 W *VOTW num.*:1404-02=

Morphology: strato with lava dome *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 1745 m *Edifice relief :* 1700 m
Range of eruptive products: basalt

SWARM DATE: 81/1/15 ±15 Dur. (days): 335 ±15 Type:3 Event type(s): Grade : C

Max. Magnitude: M 2.0	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Shallow seismic activity at levels above background Jan. Late Dec. 1981 diminished seismic activity.

Shallow seismic activity at levels above background with gas emission (Jan-Feb. 1981).
During Feb.-Mar 1981, seismic activity was high level along with continued gas emissions small ash eruptions and slumping. Almost continuous harmonic tremor and at least 1 earthquake M>2 were recorded (this occurred one week prior to elevated SO2 emission were detected). In late Dec. 1981 lowest level of gas emission since 1971 and seismic activity diminished to normal levels but incandescence was still detectable at night.
BVE No. 21, p. 94.

TELICA Nicaragua		12.60N 86.84 W *VOTW num.:*1404-04=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 1010 m	*Edifice relief :* 1000 m	
Range of eruptive products: basalt		

SWARM DATE: 82/1/15 ±5 Dur. (days): 27 ±5 Type:1cq Event type(s): Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 3.0	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.): 6	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: In Jan. and early Feb. there were several M2-3 earthquakes/day. Feb. 12 between 11:00-12:00 eruptions began at 1.5 days of relative seismic quiet.

Feb. 12 between 11:00-12:00 eruptions began at 1.5 days of relative seismic quiet. Feb. 24 irregular pulses of tremor with gas emissions. In Jan. and early Feb. there were several M2-3 earthquakes per day. As of Aug. 1982 no seismicity was being recorded. Last eruption 6 years ago.

BVE No.22, p. 74-75.

SWARM DATE: 85/6/9 ±0.5 Dur. (days): 0.2 ±0.02 Type:3 Event type(s):LF Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total : 24	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: A seismograph registered 24 low-frequency micro-earthquakes in a 5-hour period on 9 July.

Although normal activity continued, Telica continued to show stronger seismic activity than other Nicaraguan volcanoes. A seismograph registered 24 low-frequency micro-earthquakes in a 5-hour period on 9 July.

BVE No. 25, p. 66.

Information from; D.Fajardo B., Departamento de Geologia, Instituto Nicaraguense de Estudios Territoriales, Apartado 1761, Managua, Nicaragua;

C.A. Wood and M.Helfert, Code SN-6, NASA, Johnson Space Center, Houston, Texas 77058 USA From: SEAN Bulletin vol. 10, 1985, no. 11, p.9

MOMOTOMBO Nicaragua		12.42N 86.54 W	*VOTW num.*:1404-09=
Morphology: strato with caldera	*Tectonic framework:*		
Elevation above m.s.l. : 1191 m	*Edifice relief :* 1200 m		
Range of eruptive products: basalt			

SWARM DATE: 85/5/30 ±0.5 Dur. (days): ± Type: Event type(s): Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph: temporary		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): 1.3 ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Place holder for 1985.

On 30 May, Momotombo was monitored with three sensitive portable seismographs. Three micro-earthquakes were recorded, one of which was detected by all three instruments, and was located at 12.45N, 86.54W at 1.27 km depth.
BVE No. 25, p. 66.

MASAYA Nicaragua 11.98N86.16 W *VOTW num.*:1404-10=

Morphology: caldera *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 635 m *Edifice relief :* 430 m
Range of eruptive products: basalt

SWARM DATE: 82/10/7 ±0.5 Dur. (days): 1.48 ±0.5 Type:1d Event type(s): Grade : B

Max. Magnitude: M 2.3
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: temporary
Dist. to vent: 1 km
Type: L22
Component :
Natural period : .5 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling : Y

Key phrase: Oct. 7, 1982 eruption preceded by a change in pattern of seismicity

Oct. 7, 1982 eruption preceded by a change in pattern of seismicity and a earthquake of M2.3 lasting 3.7 sec. After the eruption small earthquakes occurred about every 6 min. until 11:00 of Oct. 8, 1982.

BVE No. 22, p. 76-77.

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1986.

Intensive rock landslides began at midday on 12 Nov. on the S and W sides of Santiago Crater. Part of the SW wall collapsed, extending Santiago into a section of Nindiri crater (Figure in BVE). A floor collapse accompanied the slides. Two seismographs near the crater have recorded only seismicity produced by rock falls down the 350 m crater wall.

BVE No. 26, p. 88-89.

CONCEPCION Nicaragua		11.54N 85.62 W *VOTW num.*:1404-12=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 1610 m	*Edifice relief* : 1600 m	
Range of eruptive products: basalt		

SWARM DATE: 83/3/18 ± Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: 2.9
Max. Intensity: MM at
Depth (km): 4.8 ±4.5
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: temporary
Dist. to vent: 6.5 km
Type: Sprengnether MEQ-800
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS

Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :

Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1983.

Small network (3 portables) installed from Mar. 18-25, 58 earthquakes and harmonic tremors recorded. Hypocenters distributed 0.3 km (in the skirt of the volcano) to 9.3 km down. Fig: epicenter map with stations.

BVE No. 23, p. 46.

RINCON DE LA VIEJA Costa Rica		10.83N 85.32 W	*VOTW num.:* 1405-02=
Morphology: compound or complex	*Tectonic framework:*	Convergent Continental Margin	
Elevation above m.s.l. : 1806 m	*Edifice relief :* 1100 m		
Range of eruptive products: andesite			

SWARM DATE: 85/9/15 ±15 Dur. (days): 60 ±15 Type: **1d?** Event type(s): **A,B,t** Grade : C

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Between Sept. and Nov. when there was increased seismicity.

Sometime between Aug. and 25 Nov. 1985 a phreatic eruption took place at Rincon De La Vieja, most likely between Sept. and Nov. when there was increased seismicity (A- and B-type events) and harmonic tremor.

BVE No. 26, p. 77.
SEAN Bulletin vol. 11, no. 4, p. 14-15.

South America

RUIZ Colombia		4.89 N75.32 W *VOTW num.*:1501-02=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 5400 m	*Edifice relief* : 1300 m	
Range of eruptive products: andesite to dacite		

SWARM DATE: 84/11/13 ±5 Dur. (days): **360** ±10 Type:1a Event type(s):HF,t Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 4.0	# EQ total :	Seismograph: permanent	Tremor : Y	Migration :
Max. Intensity: MM V at 136 km	# Felt total : 1	Dist. to vent: 2.5 km	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type: radio-telemetered	Gravity :	EQ families :
Detection threshold:	Repose (yr.): 152	Component : Z	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Geothermal :	
		Magnification :		

Key phrase: Anomalous phenomena such as occurence of local earthquakes have been observed since one year before the main eruption on 13 Nov. 1985

Since Nov. 1984 local earthquakes felt on upper flanks. Dec. 22 (17:31) Mmax. =3-4 occurred. Unfelt shocks recorded: 30 per day S-P 0-3 sec. Micro-tremors recorded. Felt shocks occurred from 11 months before the eruption.

According to the reports of INGEOMINAS, anomalous phenomena such as occurrence of local earthquakes and increase in fumarolic activity at Arenas Crater have been observed since one year before the main eruption on 13 Nov. 1985. On 22 Dec. 1984, at 1731 (22:31 UT), a strong earthquake (Mmax 3-4) occurred. Then, on 11 Sept. 1985, a phreatic explosion occurred from Arenas Crater and a small mudflow was produced. This explosion was preceded by volcanic tremors lasting for 1 hour 30 min. Minor phreatic explosions also took place between 23 and 29 Sept., but since then the activity declined.

BVE No. 24, p. 70.
BVE No. 25, p. 48-51.
BVE No. 26, p. 48-52.

RUIZ Colombia		4.89 N75.32 W *VOTW num.*:1501-02=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 5400 m	*Edifice relief :* 1300 m	
Range of eruptive products: andesite to dacite		

SWARM DATE: 85/12/15 ±15 Dur. (days): 21 ±15 Type:1c? Event type(s):M,HFLF,S Grade : C

Max. Magnitude: 3.5	# EQ total : 1300	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2.5 km	Tremor : Y	Migration :
Depth (km): 4 ±2	b-value :	Type: radio-telemetered	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Report of seismic activity after main eruption in Nov. of 1985. About 1300 earthquakes were counted in Dec. In Jan., activity was considerably lower.

Seismicity and deformation continued through early Feb., but there had been no eruptive episodes since the minor explosive activity on 4 Jan. Weak ash emission occurred on some days, falling near the crater. After the 4 Jan. ash emission, about 4 mixed frequency seismic events were recorded per day, declining to fewer than 1 per day since 1 Feb. Between mid-Jan. and mid-Feb., there were normally about 10 high-frequency events per day. The low-frequency seismicity also registered about 10 events daily without significant variations. Depths were between 2 and 6 km below the crater, closer than in Dec. In early Feb., events were concentrated in the NE part of the volcano. After the 13 Nov. 1985 eruption, a 6-station telemetry network was installed around the volcano. All stations use vertical 1 Hz seismometers and radio-telemeter to Manizales. Seismic activity was moderate in Nov. and Dec., consisting chiefly of high-frequency earthquakes with magnitudes to 3.5. There were about half as many low-frequency as high-frequency earthquakes during those months, about 1300 earthquakes were counted in Dec. In Jan., activity was considerably lower because of a major decrease in the rate of occurrence of high frequency events. Only a few surface-type events (gas emission signals or avalanches) were recorded by telemetry stations in any month. The most important tremor recorded since the stations were installed occurred 3-5 Jan., preceding and during a minor eruption 4-5 Jan. This tremor was unusual because of its wide range of frequency content; frequencies of 7 Hz or more were recorded within a few hours of its onset, and frequencies as low as 0.7 Hz occurred later in the episode. Very few low-frequency earthquakes have been locatable, and those with epicenters that could be computed usually occurred near Crater Arenas.

More than 150 high-frequency earthquakes have been located, and 81 of better solutions are plotted (figure). Focal depths of the high-frequency events are usually between 2 and 5 km (beneath a datum at 4.7 km above sea level), but depend on the crustal model used. Most of the high-frequency earthquakes occurred in one of two linear zones that intersect under the center of Ruiz. The E-W-striking zone is about 6 km long and was responsible for most of the seismicity. High-frequency activity was comparatively low in the weeks following the 4-5 Jan. eruption. First motions have been mostly compressional for nearly all events under Ruiz, suggesting a normal faulting environment. The data for the high-frequency sequences suggest the intrusion of dike-like bodies of magma along pre-existing fault zones (after Jim Zollweg).

BVE No. 26, p. 69-72.

RUIZ Colombia 4.89 N75.32 W *VOTW num.*:1501-02=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 5400 m *Edifice relief :* 1300 m
Range of eruptive products: andesite to dacite

SWARM DATE: 86/4/20 ±0.5 Dur. (days): 25 ±5.5 Type:1c? Event type(s):HF,LF Grade : C

Max. Magnitude: 2.0
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 31
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.5 km
Type: radio-telemetered
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: A substantial increase in seismic activity began in late Apr. and was continuing in mid-May.

A substantial increase in seismic activity began in late Apr.and was continuing in mid-May. On 20 Apr., there was a swarm of ~7 high-frequency events, with max. magnitudes of 2.0. On 24 Apr. a swarm of 24 low-frequency events was apparently accompanied by an increase in the SO_2 content of the vapor column that emerges from Arenas Crater. Seismic records suggested that a minor ash emission occurred on 4 May, and ashfalls were reported within 3 km of the summit.

Harmonic tremor began on 4 May at 13:00. A seismic signal with a maximum amplitude of 8 mm started at 14:45 and lasted about 4 minutes, apparently marking a brief ash emission that was not directly observed. Periods of tremor of variable duration were recorded on 5, 7, 8, 9, 10 and 11 May, the longest approximately 26 hours, separated by brief quiet intervals. Fig: epicenter map 28 Nov. to Jan. 86.

BVE No. 26, p. 69-72.

SWARM DATE: 86/5/29 ±0.5 Dur. (days): 0.37 ±0.25 Type: Event type(s):LF Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.5 km
Type: radio-telemetered
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: On 29 May, there was a several-hour swarm of low-frequency events.

During a period of weak tremor on 29 May, there was a several-hour swarm of low-frequency events. About 1 day before this swarm, electronic tiltmeters began to show fluctuations, with daily changes of 1.5 micro-radians and periods of several hours to a few days. The pattern of all deformation measurements (EDM, dry tilt, electronic tilt, and leveling) was inflationary as of mid-June, although small and irregular (0.4 urad. per day).

After 6 weeks, harmonic tremor fell to the noise level on 14 June and the number of low-frequency events increased again. Ash emissions were evident on many days, sometimes depositing thin layers on fresh snow.

BVE No. 26, p. 69-72.

SWARM DATE: 86/7/5 ±0.5 Dur. (days): 5 ±0.5 Type:1a? Event type(s):LF Grade : B

Max. Magnitude: 2.2
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 300
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.5 km
Type: radio-telemetered
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: On 5 Jul. the frequency of events increased sharply, totaling 300 by 10 Jul., the highest number for a 5-day period since the 13 Nov. eruption.

Harmonic tremor, which started on 4 May, still dominated the pattern of seismic activity at Ruiz as of 10 Jul. Several times, swarm-like single event sequences of mostly low-frequency earthquakes changed the pattern for hours or even days. On 5 July the tremor declined almost to background level. At the same time the frequency of events increased sharply, totaling 300 by 10 July at Olleta station, the highest number for a 5-day period since the 13 Nov. eruption. The maximum magnitude was 2.2 and most events were of the low-frequency type.

BVE No. 26, p. 69-72.

RUIZ Colombia 4.89 N75.32 W *VOTW num.*:1501-02=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 5400 m *Edifice relief* : 1300 m
Range of eruptive products: andesite to dacite

SWARM DATE: 86/7/20 ±0.5 Dur. (days): 0.29 ±0.02 Type:1b Event type(s):B Grade : B

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type: radio-telemetered	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Swarms of small B-type events started 7-8 hours before the ash emissions.

Swarms of small B-type events, most visible at Refugio station 3.6 km W of Arenas Crater, started 7-8 hours before the ash emissions. Both emissions were also preceded by shallow seismic events occurring 20-120 minutes in advance.

BVE No. 26, p. 69-72.

SWARM DATE: 86/10/28 ±0.5 Dur. (days): 0.31 ±0.02 Type:3? Event type(s):VT Grade : B

Max. Magnitude:	# EQ total : 180	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2.5 km	Tremor : Y Migration :
Depth (km): 5 ±	b-value :	Type: radio-telemetered	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: The swarm lasted 7.5 hours.

A swarm of tectonic earthquakes on 28 Oct. was the major recorded seismic activity for the report period. The swarm lasted 7.5 hours, and included more than 180 events with durations of 5 seconds or more. The events were centered about 3 km W of Arenas Crater and 1 km NE of Olleta Crater, at about 5 km below summit level. Harmonic tremor was the lowest of any period since 4 May. The highest SO2 emission rate, 5400 tons per day (tpd), was measured on 31 Oct. during a tremorless period. The average emission rate was about 300 tpd. (SEAN Bulletin, vol. 11, no. 10, p.1-8, 1986)

BVE No. 26, p. 69-72.

SWARM DATE: 87/5/21 ±0.5 Dur. (days): 1.5 ±5 Type:1a Event type(s):HF,LF,t Grade : B

Max. Magnitude: M 2.0	# EQ total : 125	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2.5 km	Tremor : Y Migration :
Depth (km): 6 ±	b-value :	Type: radio-telemetered	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Swarms of high-frequency earthquakes occurred on 21 and 22 May.

Activity level during Jan. fluctuated but remained similar to the previous 30 days. Shallow, low-frequency seismic events were the dominate activity but a few long-period events occurred during late Jan.-early Feb. Seismicity began to decline slightly on 20 Mar., but continued at moderately high level in Apr.; 920 low-frequency and 172 high-frequency events were registered. The tremor signals have remained weak compared to 1986.
Swarms of high-frequency earthquakes occurred on 21 and 22 May, located 3-6 km SW of the active crater (Arenas), at an average depth of 6 km. 125 events were registered with a maximum magnitude of 2.0. Low-frequency events remained stable. Harmonic tremor was generally absent or just above background, but increased suddenly on 9 Jun. at 20:07 to levels close to saturation, similar to the tremor activity recorded for months after the 4 May 1986 ash emission. Ashfall was first reported more than an hour later at 21:15 (at Cerro Guali), but the onsets of ash emission from Arenas Crater and tremor may have been simultaneous.

BVE No. 27, p.67-68.

RUIZ Colombia 4.89 N75.32 W *VOTW num.*:1501-02=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 5400 m *Edifice relief* : 1300 m
Range of eruptive products: andesite to dacite

SWARM DATE: 87/7/31 ±0.5 Dur. (days): 1.5 ±5 Type:1a Event type(s):HF,LF,E Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 952
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 2.5 km
Type: radio-telemetered
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration : Y
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: The energy release from the high-frequency earthquake swarms of 31 Jul. - 1 Aug. was the fourth largest since the seismic crisis of Nov.-Dec. 1985.

The energy release from the high-frequency earthquake swarms of 31 Jul. - 1 Aug. was the fourth largest since the seismic crisis of Nov.-Dec. 1985. The number of high- and low-frequency events increased respectively in Aug. to 299 and 585 from 162 and 445 in July, but shallow explosion events declined from 68 in July to 50 in Aug. Highest tremor amplitudes were recorded on 17 Aug., associated with an apparent minor ash emission.
Seismic focus had begun to migrate toward the crater in mid Oct., and the activity was accompanied by a sudden increase in harmonic tremor that lasted for about 15 minutes. During Nov., high- and low-frequency earthquake activity increased. Shallow (explosion) seismicity declined. No ash was emitted and deformation measurements showed low to moderate changes.

BVE No. 27, p.67-68.

SWARM DATE: 88/3/21 ±0.5 Dur. (days): 1 ±0.5 Type:1b Event type(s):LP Grade : C

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: permanent
Dist. to vent: 3.9 km
Type: radio-telemetered
Component : 2
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y Migration :
Deformation : Y Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Ash emission began at 09:35 on Mar. 22, 1988, the day after a long period earthquake swarm.

Ash emission began at 09:35 on Mar. 22, 1988, the day after a long period earthquake swarm. Activity briefly became more vigorous Mar. 25, before declining that night. Eruption column heights did not exceed 2-3 km and were usually less than 1 km. No fresh magmatic materials were found in the ash.

BVE No. 28, p. 77-78.

TOLIMA **Colombia** **4.67 N 75.33 W** *VOTW num.*:1501-03=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 5525 m *Edifice relief :* 2000 m
Range of eruptive products: andesite to dacite

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 2 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Place holder for 1988

Seismicity at Tolima was recorded in Dec. 1987 and Sept.- Oct. 1989 (no data between these periods) by a telemetric station 2 km SE of the summit (Fig. M43-1,in BVE) . During Oct., as many as 7 high-frequency events per day were recorded and minor fumarolic activity was observed. A 50 m thick ice cap with an area of about 2 km covers the summit. BVE fig. counts per day Dec. 1987- Oct. 1988.

BVE No. 28, p. 104.

GUAGUA PICHINCHA Ecuador 0.17 S 78.60 W *VOTW num.*:1502-02=

Morphology: strato with caldera *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 4787 m *Edifice relief :* 2000 m
Range of eruptive products: andesite

SWARM DATE: 81/8/15 ±5 Dur. (days): 15 ±1 Type:1b Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM IV at 10 km
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 5
Felt total : 3
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : N
Gravity :
Magnetic :
Geothermal : Y
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Unfelt shock recorded, frequency 2 shocks per day, S-P durations = 1-5 seconds, from 0-15 days prior.

Lack of temporarature change and composition of gases, lack of micro-seismicity, and lack of deformation suggested no eruption. Felt: 3 shocks 0-15 days before eruption mid Aug. 1981. MM intensity = 3-4 at 10 km. Unfelt shocks recorded, frequency 2 shocks per day, S-P durations = 1-5 seconds, from 0-15 days prior. micro-tremors: Avg. 4-14 events per week in Oct.-Dec. 1981, period 0.05-1 sec.

BVE No. 21, p. 74-75.

SWARM DATE: 82/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1982.

Micro-tremors avg. 4 events per week per year. period 0.05-1.0 sec. Unfelt 4-7 per week., S-P durations: 1-5 sec.

BVE No. 22, p. 79-80.

SWARM DATE: 88/4/15 ±5 Dur. (days): 270 ±10 Type:3 Event type(s):A Grade : C

Max. Magnitude: 3.5
Max. Intensity: MM at
Depth (km): 6.5 ±2.5
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 4
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration : Y
Focal mech:
EQ families :
Rumbling :

Key phrase: Local seismicity has increased substantially since mid-Apr. 1988

Local seismicity has increased substantially since mid-Apr. 1988, accompanied by minor changes in the summit crater's fumarole field. Seismicity gradually built from background levels of 5-10 per month to more than 200 per month by Aug., and was continuing in early Oct. Aug. and Sept. events were centered at 4-9 km depth (most 7-9 km) near and N of the S caldera wall. In late Sept. and early Oct. seismicity migrated N toward the modern vent and upward, with some foci as shallow as 1.5 km . All were A-type shocks. Magnitudes of the largest events reached 3-3.5 and a few were felt in Quito at the volcano's E foot.

BVE No. 28, p. 104-105.

NEGRA, SIERRA Galapagos		0.83 S 91.17 W	*VOTW num.*:1503-05=
Morphology: shield with caldera	*Tectonic framework:*	Oceanic Hot Spot	
Elevation above m.s.l. : 1490 m	*Edifice relief :* 1500 m		
Range of eruptive products: basalt			

SWARM DATE: 79/11/13 ±0.5 Dur. (days): 2 ±0.5 Type:1c? Event type(s):tect? Grade : C

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: M 4.8	# EQ total : 14	Seismograph: permanent		
Max. Intensity: MM at	# Felt total :	Dist. to vent: 90 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type: UGGS WNSS	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: 8 events recorded on Nov. 14 and 6 events Nov. 15.

At 7:30 on Nov. 13 an earthquake registered 90 km E of Sierra Negra on Santa Cruz (Darwin Res. station). A second larger earthquake followed in 20 min. and at 8:45 first explosion occurred. Eight events recorded on Nov. 14 and 6 events Nov. 15. Many tremors felt although at peak intensity eruptive intensity decreased. Two earthquakes on at 7:51 on Nov. 13, M4.4 hypocenter 0.89 deg. S, 91.23 deg. W, 18 km SW 8:51 earthquake similar but somewhat smaller. A M4.8 quake recorded Nov. 15 (18:58) hypocenter = 0.96S, 91.25W and 24 km SSW.

BVE No. 19, p. 72-73.

LASCAR Chile-N 23.37S 67.73 W *VOTW num.*:1505-10=

Morphology: strato or composite *Tectonic framework:* Convergent Continental Margin
Elevation above m.s.l. : 5641 m *Edifice relief :* 1500 m
Range of eruptive products: andesite

<u>SWARM DATE:</u> 89/7/1 ±183 Dur. (days): ± Type: Event type(s):t Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

\# EQ total :
\# Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: temporary
Dist. to vent:
Type:
Component : 2
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1989.

Portable 2-component seismographs were installed at 3 sites on the cone on Oct. 16-19. Only a few volcanic earthquakes accompanied significant regional related earthquake activity, but significant tremor was recorded.
BVE No. 29, p. 87-89.

TUPUNGATITO Chile-C

33.40S 69.80 W *VOTW num.*:1507-01=

Morphology: strato or composite
Tectonic framework: Convergent Continental Margin
Elevation above m.s.l.: 5640 m
Edifice relief:
Range of eruptive products: andesite

SWARM DATE: 80/1/14 ±0 Dur. (days): 4 ±0.5 Type:2a Event type(s):reg.? Grade : C

Max. Magnitude:
Max. Intensity: MM III at 150 km
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 30
Felt total :
b-value :
Repose (yr.): 16
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Principle quake (at 18:51, Jan. 14), As of Jan. 18, both seismic and eruptive activity diminished.

Principle quake (at 18:51, Jan. 14) was shallow with calculated epicenter (at 33.2S, 69W) 78 km NE of the volcano. In the next 2 hrs. 17 similar events were recorded, 3 with same calculated epicenter. Between 21:00 (Jan 14) and 01:00 (Jan. 16), 13 more local events were recorded (one large event). As of Jan. 18, both seismic and eruptive activity diminished.

BVE No. 20, p. 88.

SWARM DATE: 85/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1985.

After the M7.8 earthquake that affected the Santiago region on 3 Mar. 1985, vertical aerial photographic coverage was carried out at a scale of 1:20,00 on 25 Mar. 1985. No increased activity was observed within the caldera, which has a diameter of ~5 km and is covered with ice and snow.

BVE No. 27, p. 90.

LONQUIMAY Chile-C		38.37S 71.58 W	*VOTW num.*:1507-10=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin	
Elevation above m.s.l. : 2822 m	*Edifice relief* : 1000 m		
Range of eruptive products:			

SWARM DATE: 88/12/7 ±0.5 Dur. (days): 18 ±1 Type:1b Event type(s):A,felt Grade : B

Max. Magnitude: M 4.6	# EQ total :	Seismograph: temporary	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM VI at 110 km	# Felt total : 200	Dist. to vent: 4 km	Tremor :	Migration :
Depth (km): 5 ±5	b-value : 1.7	Type: MEQ-800	Deformation :	Focal mech:
Detection threshold:	Repose (yr.): 99	Component :	Gravity :	EQ families :
Cum. energy release: 3.0e+12 J	Previous swarms :	Natural period : 1 s	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Felt earthquakes and subterranean noises began December 7. On Dec. 25, 1988, after more than 2 weeks of increasing seismicity, an eruption began.

On Dec. 25, 1988, after more than 2 weeks of increasing seismicity, an eruption began at the NE foot of Lonquimay Volcano.

Felt earthquakes and subterranean noises began Dec. 7. Several of the shocks reached intensities between IV and V, with magnitudes of 4.2 - 4.6. Some were registered at Santiago, 800 km away. About 200 earthquakes were felt during the 3 days prior to the start of the eruption, some of intensity VI. One was felt at Temuco, 110 km from the volcano, on Dec. 24.

Three seismographs from the Department of Geology and Geophysics, University of Chile, Santiago, were installed about 27 hours after the onset of the eruption (between 21:00 on Dec. 26 and 04:00 on the 27th): LON1, on the flank of Cerro Cautin 4 km from the eruptive center; LON2, in Pinitos Malalcahuello, 11 km away; and LON3 in Quebrada Guamachuco, 12 km from the vent (BVE Fig. 51-1). When seismic recording began, activity was very intense, with about 50 events every 3 hours (BVE Fig. 51-2). However, seismic activity declined rapidly between 40 and 120 hours after the start of the eruption. Initial analysis of the seismograms showed that the epicenters were concentrated in the immediate eruption area. Geologists therefore believed that eruptive activity was unlikely to propagate SE toward the main crater of Lonquimay or to another point on the eruptive fissure. Fig: number of events Dec. 25-31.

BVE No. 28, p. 83.

Barrientos, S. E. and Acevedo-Aranguiz, P. S., (1992): Seismological Aspects of the 1988-1989 Lonquimay volcanic eruption, JVGR, vol. 53, p. 73-87.

VILLARRICA Chile-C		39.42S 71.95 W *VOTW num.*:1507-12=
Morphology: strato or composite	*Tectonic framework:*	Convergent Continental Margin
Elevation above m.s.l. : 2840 m	*Edifice relief :* 1600 m	
Range of eruptive products: basalt to andesite		

SWARM DATE: 85/6/15 ±15 Dur. (days):>150 ±15 Type:3? Event type(s):B,t Grade : B

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude:	# EQ total :	Seismograph:		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Since Jun. 1985 volcano-seismic activity has increased significantly.

When the last eruptive cycle of Villarrica Volcano (30 Oct. 1984 to 26 Feb. 1985) began to decay in Jan., 1985, seismic activity also decreased. Between Jan. and Jun. 1985, the seismograph located on the N flank of the volcano recorded a monthly average of 15 volcanic earthquakes (Minakami's B-type). In Feb., only 5 seismic events were recorded with very little harmonic tremor. However, since Jun. 1985 volcano-seismic activity has increased significantly. At the same time, notable harmonic tremor was observed. Figure shows monthly seismic activity between Jan. and Nov., 1985. This situation was continuing as of 25 Nov., with a small gap in mid-late Nov. On 19 Nov. 3t 07:00, harmonic tremor stopped abruptly, and only apparently very shallow seismic activity was recorded. On 21 Nov. at 10:00, harmonic tremor activity resumed. fig: monthly counts Jan.- Nov. 1985.

BVE No. 25, p. 52.

West Indies

LIAMUIGA, MT. W Indies 17.37N 62.80 W *VOTW num.*:1600-03=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Intraoceanic
Elevation above m.s.l. : 1157 m *Edifice relief :* 1707 m
Range of eruptive products: basalt to andesite

SWARM DATE: 88/10/24 ±0.5 Dur. (days): 12 ±1 Type:3 Event type(s):A,Tect Grade : B

Max. Magnitude: mb4.5
Max. Intensity: MM VI at 10 km
Depth (km): 7.5 ±2.5
Detection threshold:
Cum. energy release:

EQ total : 500
Felt total : 5
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 8 km
Type: short period
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : N
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: An earthquake swarm in the vicinity of Mt. Liamuiga began on Oct. 24, 1988, and had declined by early Nov.

An earthquake swarm in the vicinity of Mt. Liamuiga began on Oct. 24, 1988, and had declined by early Nov. The following is from a report by the Seismic Research Unit, University of the West Indies.

These earthquakes show impulsive arrivals and clear P and S phases. They may possibly be small tectonic earthquakes but it is more likely that they are A-type volcanic earthquakes associated with Mt. Liamuiga. Normally, 1 or 2 are recorded per month.

On Oct. 24, a swarm of these events began and built up rapidly, peaking on Oct. 26 when 186 earthquakes were recorded (Fig. M47-2). Many of the earthquakes were felt on St. Kitts and they caused great alarm. At least 5 earthquakes were felt by all on St. Kitts. The most severe earthquakes up to the morning of Oct. 27 were at 12:01 and 18:24 (GMT) on Oct. 26, with estimated magnitudes (mb) of 4.3 and 4.5. Both were felt throughout St. Kitts at up to MM VI and caused minor damage. fig: epicenter map and number of events.

Although it is possible that the earthquake swarm is of tectonic origin, the characteristics of the swarm are similar to those of previous volcanic earthquake swarms in other islands of the Lesser Antilles. Many of these swarms have occurred, particularly in the island of Nevis, Montserrat, Dominica, Guadeloupe and St. Vincent. Only a small proportion of these swarms have culminated in volcanic eruptions, but on the other hand, almost all eruptions have been preceded by earthquake swarms. This is the first known swarm in St. Kitts.

Seismicity remained above background levels in early Dec., with about 3-4 shallow events recorded weekly by the temporary seismic net installed after the swarm began. Hypocenters were at about 5-10 km depth, almost directly below or slightly to the W of Mt. Liamuiga, and magnitudes were generally in the 1.5-2 range. The shocks continued to have impulsive P and S wave arrivals typical of both A-type volcanic events and tectonic earthquakes. No tremor has been recorded.

BVE No. 28, p. 106-107.

SOUFRIERE GUADELOUPE W Indies 16.05N 61.67 W *VOTW num.*:1600-06=

Morphology: strato with lava dome *Tectonic framework:* Uncert. Convergent Intraoceanic
Elevation above m.s.l. : 1467 m *Edifice relief* : 2560 m
Range of eruptive products: basalt to andesite

SWARM DATE: 87/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release: 4.0e+6 J	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal : Y	

Key phrase: Place holder for 1987

Through the year of 1987, the seismic activity of the volcano was weak. The seismic network detected 55 seisms which were attributed to volcanic origin. The seismic energy liberated was 4 x10e+6 J in total. As of 1987, there have been no signs of violent activity on the surface in the past decade.

BVE No. 27, p. 91.

PATATES, MORNE W Indies 15.22N 61.37 W *VOTW num.*:1600-11=

Morphology: lava dome *Tectonic framework:* Uncert. Convergent Intraoceanic
Elevation above m.s.l. : 525 m *Edifice relief :* 1615 m
Range of eruptive products: andesite

SWARM DATE: 86/3/9 ±0.5 Dur. (days): 7 ±1 Type:3 Event type(s):A Grade : B

Max. Magnitude: Md3.5	# EQ total : 15	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 7	Dist. to vent:	Tremor : Migration :
Depth (km): 3 ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Earthquake Swarms at Morne Patates on 9-15 Mar.

Four swarms of felt earthquakes centered near Morne Patates, on the southern tip of Dominica, have occurred since Mar. (table). Activity typically consisted of 10-30 recorded A-type volcanic shocks in a roughly two-hour period, about half of them felt by residents of flank villages. The most recent swarm occurred on 29 Oct. (after 10 days of quiet) when 26 earthquakes were felt between 00:00 and 02:00 LT (=GMT - 4 hours). As of 12 Nov., no new swarms had been recorded.

1986 Earthquake Swarms at Morne Patates

Date	Number of recorded events
9-15 Mar.	15
15-16 Sept..	15
19 Oct.	9
29 Oct.	26

Three telemetered seismometers on Dominica and 15 others within 100 km recorded the events. The events were shall, perhaps at about 3 km depth, and the largest had duration magnitudes on 3-3.5. Fumaroles in the crater and on the N flank appeared unchanged and no other surface changes were evident.

BVE No. 26, p. 89.

Information from: J. Shepherd, Seismic Research Unit, University of the West Indies, St. Augustine, Tridnidad; C. Antenor-Habezac, Observatoire Volcanologique de la Soufriere, I.P.G., 97120 Le Pasnasse Saint Claude, Guadeloupe; SEAN Bulletin. vol. II, no. 10, p. 6-7, 1986

SWARM DATE: 86/9/15 ±0.5 Dur. (days): 1.5 ±1 Type:3 Event type(s):A Grade : B

Max. Magnitude: Md3.5	# EQ total : 15	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 7	Dist. to vent:	Tremor : Migration :
Depth (km): 3 ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal :

Key phrase: Earthquake Swarm at Morne Patates on 15-16 Sept.

Three telemetered seismometers on Dominica and 15 others within 100 km recorded the events. The events were shall, perhaps at about 3 km depth, and the largest had duration magnitudes on 3-3.5. Fumaroles in the crater and on the N flank appeared unchanged and no other surface changes were evident.

For additional comments see Mar. 9, 1986.

BVE No. 26, p. 89.

PATATES, MORNE W Indies 15.22N 61.37 W *VOTW num.*:1600-11=

Morphology: lava dome *Tectonic framework:* Uncert. Convergent Intraoceanic
Elevation above m.s.l. : 525 m *Edifice relief :* 1615 m
Range of eruptive products: andesite

SWARM DATE: 86/10/19 ±0.5 Dur. (days): 0.08 ± Type:3 Event type(s):A Grade : C

Max. Magnitude: Md3.5
Max. Intensity: MM at
Depth (km): 3 ±
Detection threshold:
Cum. energy release:

EQ total : 9
Felt total : 4
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Earthquake Swarm at Morne Patates on 19 Oct.

Three telemetered seismometers on Dominica and 15 others within 100 km recorded the events. The events were shall, perhaps at about 3 km depth, and the largest had duration magnitudes on 3-3.5. Fumaroles in the crater and on the N flank appeared unchanged and no other surface changes were evident.
For additional comments see Mar. 9, 1986.

BVE No. 26, p. 89.

SWARM DATE: 86/10/29 ±0.5 Dur. (days): 0.08 ± Type:3 Event type(s):A Grade : B

Max. Magnitude: Md3.5
Max. Intensity: MM at
Depth (km): 3 ±
Detection threshold:
Cum. energy release:

EQ total : 26
Felt total : 26
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph:
Dist. to vent:
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Earthquake Swarm at Morne Patates on Oct 29.

Three telemetered seismometers on Dominica and 15 others within 100 km recorded the events. The events were shall, perhaps at about 3 km depth, and the largest had duration magnitudes on 3-3.5. Fumaroles in the crater and on the N flank appeared unchanged and no other surface changes were evident.
The most recent swarm occurred on 29 Oct. (after 10 days of quiet) when 26 earthquakes were felt between 00:00 and 02:00 LT (=GMT - 4 hours). For additional comments see Mar. 9, 1986.

BVE No. 26, p. 89.

PELEE, MONTAGNE W Indies 14.82N 61.17 W *VOTW num.*:1600-12=

Morphology: strato with lava dome *Tectonic framework:* Uncert. Convergent Intraoceanic
Elevation above m.s.l. : 1397 m *Edifice relief* : 2743 m
Range of eruptive products: andesite to dacite

SWARM DATE: 86/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude: 2.0
Max. Intensity: MM at
Depth (km): 1.5 ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total :
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 5 km
Type:
Component :
Natural period :
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Migration :
Deformation : Focal mech:
Gravity : EQ families :
Magnetic : Rumbling :
Geothermal :

Key phrase: Place holder for 1985 and 1986

Seismicity began on 11 Dec. 1985, the first recorded since a well-implemented volcano monitoring network was installed in 1978. A constant low level of seismicity has been observed since Dec., totaling 30 events as of 4 June. Two 3-component stations were established for a month, helping to locate the shocks, at a constant depth of 1-1.5 km below the 1929 crater. Magnitudes were weak, all less than 2, and only a few were recorded at the Morne des Cadets observatory, 9 km SW of the epicentral area.
The seismic network is composed of 5 seismometers within 5 km of the summit. Seismic signals noted before the recent activity were attributed to surface phenomena such as rock falls or local landslides.

BVE No. 26, p. 89.

Information from: N. Girardin and A. Hirn, Observatories Volcanologique, Institut de Physique du Globe de Paris, 4 Palace Jussieu, 75252 Paris Cedex 05, France; G. Boudon and J. P. Viode, Observatoire Volcanologique de la Montagne Pelee, Fonds Saint Denis, 97250 Saint Pierre, Martinique. From: SEAN Bulletin, vol. 11, no. 5, p.6-7, 1986

SOUFRIERE ST. VINCENT W Indies 13.33N 61.18 W *VOTW num.*:1600-15=

Morphology: strato or composite *Tectonic framework:* Uncert. Convergent Intraoceanic
Elevation above m.s.l.: 1178 m *Edifice relief:* 2438 m
Range of eruptive products: basalt to andesite

SWARM DATE: 78/8/12 ±1 Dur. (days): 240 ±7 Type:1b? Event type(s): Grade : B

Max. Magnitude:	# EQ total : 720	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 3 km	Tremor : Y Migration :
Depth (km): .5 ±.5	b-value :	Type: Willmore MKII	Deformation : Y Focal mech:
Detection threshold:0.2	Repose (yr.): 8	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period : .8 s	Magnetic : Y Rumbling : Y
		Magnification : 50 K	Geothermal : Y

Key phrase: Unfelt shocks recorded from 8 months before the eruption.

Pre-eruption events <1 km beneath crater. Temperature increased of 25 x10e+6 m3 lake from 25 to 31 deg. C between Feb. and Aug. 1979. Inflation of volcano by 5-10 urad (by dry tilt stations 3-6 km from vent). Continuous tremor by seismographs 3 km and 9 km away from 8:00 Apr. 12. Tremor increased in amplitude through Apr. 12 and was accompanied by increasing frequency of shallow earthquakes from 2-3 per day to 1 per hour. At 3:30 Apr. 13 amplitude of tremor showed full scale deflection.
Micro tremor for 12 hour in total period =0.3 sec. max. amplitude = 100 um/s at 3 km.
Characteristic size: Max. ground amplitude = 45 um/s at 3 km.
Unfelt shocks recorded from 8 months before the eruption.

BVE No. 19, p. 77-79.
Sheperd et al., Nature, 282, 5734, p. 24-26, 1979.

KICK-'EM-JENNY W Indies		12.30N 61.63 W	*VOTW num.*:1600-16=
Morphology: submarine	*Tectonic framework*:	Uncert. Convergent Intraoceanic	
Elevation above m.s.l. :	*Edifice relief* :		
Range of eruptive products:			

SWARM DATE: 88/12/29 ±0.5 Dur. (days): 2 ±1 Type:2a? Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at 250 km	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling : Y
		Magnification :	Geothermal :	

Key phrase: Place holder for submarine eruption

Seismographs throughout the eastern Caribbean recorded strong underwater acoustic signals on Dec. 29-30, 1988. The first signals began at approximately 15:50 on Dec. 29. Onset of the signals was extremely emergent, so their point of origin could not be determined precisely, but their pattern of arrivals and amplitudes suggested an origin in the southern Lesser Antilles. The most likely source was thought to be Kick-'em-Jenny submarine volcano, about 8 km off the N coast of Grenada. When last surveyed in 1982, the summit of this volcano was 160 m below sea level. The initial signals persisted for approximately 56 minutes.

A shorter but more intense signal was recorded on Dec. 29 between 17:22 and 17:50. At this time, residents of Sauteurs on the N coast of Grenada felt strong ground vibrations and heard a deep rumbling sound. Although observers in full view of the location of the volcano had been alerted by this time, no disturbance of the sea surface was noted. Vibrations were felt and heard as far away as Martinique, 250 km to the N.

BVE No. 28. p. 85-86.

Iceland and Jan Mayen

HEKLA Iceland-S | 63.98N 19.70 W | *VOTW num.*:1702-07=

Morphology: lava field (flows) | *Tectonic framework:* Divergent MOR

Elevation above m.s.l. : | *Edifice relief :*

Range of eruptive products: basalt to rhyolite

SWARM DATE: 80/8/17 ±	Dur. (days): 0 ±	Type:4	Event type(s):	Grade : B
Max. Magnitude:	# EQ total : 0	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration :
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:0.4	Repose (yr.): 10	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Eruption commenced without warning.

Eruption commenced without warning. Possibly time predictable eruptive activity (using repose period). The last eruption took place in 1970 and this is the shortest repose period in the last 1100 years.

BVE No. 20, p. 90.

GRIMSVOTN Iceland-S		64.41 N 17.33 W	*VOTW num.*:1703-01=
Morphology: caldera	*Tectonic framework:*	Divergent MOR	
Elevation above m.s.l. : 1719 m	*Edifice relief :*		
Range of eruptive products: basalt			

SWARM DATE: 83/5/28 ±0 Dur. (days): 0.39 ±0 Type:1aq Event type(s): Grade : B

Max. Magnitude: M 4.0	# EQ total :	Seismograph: permanent		OTHER REPORTED OBSERVATIONS		
Max. Intensity: MM at	# Felt total :	Dist. to vent:	65 km	Tremor :	Y	Migration :
Depth (km): ±	b-value :	Type:		Deformation :		Focal mech:
Detection threshold:1.1	Repose (yr.):	Component :	Z	Gravity :		EQ families :
Cum. energy release:	Previous swarms :	Natural period :	.3 s	Magnetic :		Rumbling :
		Magnification :	100 K	Geothermal :		

Key phrase: Dense earthquake swarm began 02:30 on May 28. the last earthquake of this swarm occurred at 11:47.

Dense earthquake swarm began 02:30 on May 28
Largest M4 and 18 events M3.
12:00 continuous tremor visible on paper after last earthquake at 11:47 May 28. Final burst of tremor on Jun. 2.
Seismicity did increase since March. Small jokulhlaup occurred in December 1983.
BVE No. 23, p. 48-49.

KRAFLA Iceland-N		65.73N 16.78 W	*VOTW num.*:1703-08=
Morphology:	*Tectonic framework:*	Divergent MOR	
Elevation above m.s.l. : 620 m	*Edifice relief :* 5 m		
Range of eruptive products:			

SWARM DATE: 79/5/14 ±0.25 Dur. (days): 4 ±1 Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period : .3 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase: In the early hours of 14 May a new deflation event began. This was accompanied by volcanic tremor. Inflation of the volcano resumed on 18 May.

After the deflation and rifting event of 10-15 Nov. 1978 inflation of Krafla volcano showed magma refilling reservoirs located at about 3 km below the surface. In Mar. 1979 previous levels were reached and after that the number of recorded earthquakes increased. In the early hours of 14 May 1979 a new deflation event began. This was accompanied by volcanic tremor observed on seismographs

The deflation was accompanied by rifting (fault movements) and earthquake activity in the fault swarm 10-20 km N of the magma chambers.

Inflation of the volcano resumed on 18 May and continued for the rest of the year except on 3-10 Dec. when a minor deflation took place. The deflation was slow and no volcanic tremor was observed.

BVE No. 19, p. 80.

SWARM DATE: 80/7/10 ±0.5 Dur. (days): ± Type:1b? Event type(s):t Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1.5 km	Tremor : Y	Migration : Y
Depth (km): ±	b-value :	Type:	Deformation : Y	Focal mech:
Detection threshold:-0.1	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : .3 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase:The eruption of Jul. 10-18 was preceded by deflation and earthquake epicenters moved north along the fault swarm.

The pattern observed during all the eruptions is in many respects similar. Continuously recording tiltmeters show rapid deflation and seismographs show volcanic tremor 1-4 hours before eruptions. A fissure then opens up and the rate of eruption increases rapidly and is at a maximum in one or two hours.

The eruption of Jul. 10-18 was preceded by deflation and earthquake epicenters moved north along the fault swarm.

BVE No. 20, p. 91-92.

SWARM DATE: 81/1/30 ± Dur. (days): 0.29 ± Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1.5 km	Tremor : Y	Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y	Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period : .3 s	Magnetic :	Rumbling :
		Magnification : 100 K	Geothermal :	

Key phrase: Eruption of Jan. 30-Feb. 4 preceded by tremor (began 07:30) the eruption started at 14:30.

Basaltic fissure eruptions in 1981 preceded by inflation of chambers as they recovered from previous eruptions, and by very significant earthquake activity and deflation of the magma chambers.

Eruption of Jan. 30-Feb. 4 preceded by deflation (began at 7:00) and tremor (began 07:30) the eruption started at 14:30.

BVE No. 21, p. 78-79.

KRAFLA Iceland-N 65.73N 16.78 W *VOTW num.*:1703-08=

Morphology: *Tectonic framework:* Divergent MOR

Elevation above m.s.l. : 620 m *Edifice relief :* 5 m

Range of eruptive products:

SWARM DATE: 81/11/23 ±0 Dur. (days): 0.05 ±0 Type:1b Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : 1 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Eruption of Nov. 18-23, 1981 preceded by deflation and tremor (began simultaneously at 00:36) the eruption started at 01:52.

See Jan. 30, 1981 for addition comments.

BVE No. 21, p. 78-79.

SWARM DATE: 84/9/4 ±0 Dur. (days): 0.13 ±0 Type: Event type(s):t Grade : c

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total : 0	Dist. to vent: 1.5 km	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Y Focal mech:
Detection threshold:-0.1	Repose (yr.):	Component : Z	Gravity : Y EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : .3 s	Magnetic : Y Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: About 20:40 seismometers began to show volcanic tremor. The first glow was observed at 23:49.

After the last eruption of Krafla in Nov. 1981 magma reservoirs showed rapid inflation. After the inflation Jan. 1982 inflation ceased except for six short periods of gradual inflation and earthquake activity.

The first sign of the imminent eruption was a rapidly increasing deflation that began at 20:25 on Sept. 4. About 15 minutes later seismometers began to show volcanic tremor. The first glow was observed at 23:49.

BVE No. 24, p. 51-52.

SWARM DATE: 87/2/25 ±5 Dur. (days): 25 ±10 Type:3 Event type(s): Grade : C

Max. Magnitude:	# EQ total :	Seismograph: permanent	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent: 1.5 km	Tremor : Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component : Z	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period : .3 s	Magnetic : Rumbling :
		Magnification : 100 K	Geothermal :

Key phrase: Seismic activity increased slightly and reached its highest value in late Feb. and Mar. 1987.

Gradual inflation began in Nov. 1986 until the end of Mar. 1987, when inflation ceased. Seismic activity in the Krafla region increased slightly during this inflation period and reached its highest value in late Feb. and Mar. 1987.

BVE No. 27, p. 91.

BEERENBERG Atl-N-Jan Mayen		71.08N 8.16 W	*VOTW num.*:1706-01=
Morphology: strato with caldera	*Tectonic framework:*		
Elevation above m.s.l. :	*Edifice relief :*		
Range of eruptive products:			

SWARM DATE: 85/1/4 ±0.5 Dur. (days): 2 ±0.5 Type:1b Event type(s): Grade : B

Max. Magnitude:	# EQ total :	Seismograph:	OTHER REPORTED OBSERVATIONS	
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor :	Migration : ?
Depth (km): ±	b-value :	Type:	Deformation :	Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity :	EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic :	Rumbling :
		Magnification :	Geothermal :	

Key phrase: Preceded by an earthquake swarm which began 4 Jan., a fissure opened on 6 Jan.

Preceded by an earthquake swarm which began 4 Jan., a fissure opened on the NE flank of Jan Mayen, extending 1 km down into the sea, on 6 Jan. Most of the activity ended by the afternoon of 7 Jan., lasting 35-40 hours. However, it appears that minor lava effusion lasted until 9 Jan.

BVE No. 26, p 78.
SEAN Bulletin (1984): vol.9, no.l2, p.2-3.
Imsland, P. (1986): The volcanic eruption on Jan Mayen, January 1985: interaction between a volcanic island and a fracture zone. Jour. Volc. Geoth. Res., vol. 28, p. 45-53.

Atlantic Ocean

DON JOAO DE CASTRO BANK Azores 38.23 N 26.63 W *VOTW num.*:1802-07=

Morphology: submarine | *Tectonic framework:*
Elevation above m.s.l. : -14 m | *Edifice relief* : 1500 m
Range of eruptive products:

SWARM DATE: 88/10/16 ±0.5 Dur. (days): 30 ±5 Type:3 Event type(s): Grade : B

Max. Magnitude:	# EQ total : 850	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM V at 80 km	# Felt total :	Dist. to vent:	Tremor : Y Migration :
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.): 268	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms :	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal : Y

Key phrase: A seismic swarm began on Oct. 16, 1988. In mid-Nov., the swarm was ending

A seismic swarm began on Oct. 16, 1988, about 30 km S of Sao Miguel Island. Most of the epicenters were located along a branch of the Azores-Gibraltar fracture zone. In mid-Nov., the swarm was ending after 850 events had been recorded by the Azores University seismic array.
Since early November, tremor has been registered at the Sao Miguel and Terceira Islands stations of the University seismic network. This tremor appeared to originate from Don Joao de Castro Bank (38°14' N, 26°38' W), a shallow (14 m deep) submarine volcano that erupted in December 1720. No surface evidence of submarine volcanism has been reported. Several earthquakes centered near the volcano reached MM V at Terceira, 80 km away.

BVE No. 28, p. 107-108.

SWARM DATE: 88/11/21 ±0 Dur. (days): 1 ±0.5 Type:3 Event type(s): Grade : C

Max. Magnitude: 5.8	# EQ total : 550	Seismograph:	OTHER REPORTED OBSERVATIONS
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Tremor : Y Migration : Y
Depth (km): ±	b-value :	Type:	Deformation : Focal mech:
Detection threshold:	Repose (yr.):	Component :	Gravity : EQ families :
Cum. energy release:	Previous swarms : Y	Natural period :	Magnetic : Rumbling :
		Magnification :	Geothermal : Y

Key phrase: On Nov. 21 a swarm started. By the next day, the number of seismic events per hour had decreased from 24 to 4.

On Nov. 21 at 15:56 (LT. = GMT - 1 hour), a. second swarm started with a magnitude 5.8 shock centered 25 km NW of Sao Miguel along the Sete Cidades Fault, a branch of the same fracture zone. The hypocenter was 53 km SE of Don Joao de Castro Bank. By the next day, the number of seismic events per hour had decreased from 24 to 4; several of the shocks were migrating along the main portion of the Sao Miguel Fault.
As of Dec. 27, a total of 1,300 events had been registered since the activity began. Several patterns of epicentral migration had been noticed along the Azores-Gibraltar Fracture Zone and the Congro regional fault. Volcanic tremor remained frequent. Fumarole temperatures were about 10 C higher than normal at Fernas a Miguel Island Caldera. on Sao Miguel Island

BVE No. 28, p. 107-108.

Antarctica

EREBUS, MOUNT Antarctica 77.53S 167.17E *VOTW num.*:1900-02=

Morphology: strato on a shield *Tectonic framework:*
Elevation above m.s.l. : 3443 m *Edifice relief :* 4500 m
Range of eruptive products: basalt

SWARM DATE: 82/10/8 ±0.5 Dur. (days): 2 ±0.5 Type:3 Event type(s): Grade : B

Max. Magnitude:
Max. Intensity: MM at
Depth (km): 10 ±10
Detection threshold:
Cum. energy release:

EQ total : 700
Felt total : 0
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 1 km
Type: borehole
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Over 700 events were recorded within 48 hours on Oct. 8 and 9, 1982.

Unfelt earthquakes and micro-tremors recorded. The source region appeared to be beneath Abbott Peak.

BVE No. 22, p. 83-84.
Rowe, C., (1988): Seismic velocity structure and seismicity of Mount Erebus Volcano, Ross Island, Antarctica, MS Thesis Univ. of Alaska.

SWARM DATE: 83/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

Max. Magnitude:
Max. Intensity: MM at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total :
Felt total : 0
b-value :
Repose (yr.):
Previous swarms :

Seismograph: permanent
Dist. to vent: 1 km
Type: borehole
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor :
Deformation :
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: Place holder for 1983.

Unfelt earthquakes and micro-tremors recorded.

BVE No. 23, p. 50.

SWARM DATE: 84/9/13 ±0.5 Dur. (days): 5 ±1 Type:1c? Event type(s): Grade : C

Max. Magnitude:
Max. Intensity: MM II at
Depth (km): ±
Detection threshold:
Cum. energy release:

EQ total : 386
Felt total :
b-value :
Repose (yr.):
Previous swarms : Y

Seismograph: peramnent
Dist. to vent: 1 km
Type: borehole
Component : Z
Natural period : 1 s
Magnification :

OTHER REPORTED OBSERVATIONS
Tremor : Y
Deformation : Y
Gravity :
Magnetic :
Geothermal :
Migration :
Focal mech:
EQ families :
Rumbling :

Key phrase: On 13 Sept., 1984, there was a sudden and dramatic increase in seismicity and large Strombolian eruptions commenced. Duration from fig.

On 13 Sept., 1984, there was a sudden and dramatic increase in seismicity and large Strombolian eruptions commenced. After an initial high level of seismicity, with over 386 earthquakes as of 17 Sept., the seismicity declined and fluctuated between 50 and 100 earthquakes during Oct., Nov., and up to Dec.
Felt shocks occurred, 5 per day from 13 day in to the eruption. Fig: Daily earthquake and eruption frequency Sept.-Dec. 1984.

BVE No. 24, p. 52-53.

DECEPTION ISLAND Antarctica		62.96S 60.65 W	*VOTW num.*:1900-03=
Morphology: strato with caldera	*Tectonic framework:*		
Elevation above m.s.l. : 602 m	*Edifice relief :* 1000 m		
Range of eruptive products: basalt to andesite			

SWARM DATE: 88/7/1 ±183 Dur. (days): ± Type: Event type(s): Grade :

			OTHER REPORTED OBSERVATIONS	
Max. Magnitude: mb0.5	# EQ total :	Seismograph:	Tremor :	Migration :
Max. Intensity: MM at	# Felt total :	Dist. to vent:	Deformation :	Focal mech:
Depth (km): ±	b-value :	Type:	Gravity :	EQ families :
Detection threshold:	Repose (yr.):	Component :	Magnetic :	Rumbling :
Cum. energy release:	Previous swarms :	Natural period :	Geothermal :	
		Magnification :		

Key phrase: Place holder for 1988.

Frequent small (mb 0.5) earthquakes were centered about 8 km from the expedition's base camp. These earthquakes were particularly numerous along the 5-km 1969 eruption fissure. Episodes of volcanic tremor with well-defined frequencies and durations of 5-40 minutes were also recorded. Strong regional earthquakes centered 40-80 km from Deception Island and possibly related to the extensive Mar de la Flota (Bransfield Strait) structure seemed to trigger local seismic activity. No significant differences between the 1987 and 1988 seismic data were observed.

BVE No. 28, p. 108.