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PRELIMINARY CATALOG OF EARTHQUAKES IN NORTHERN IMPERIAL VALLEY, CALIFORNIA OCTOBER 1978 - DECEMBER 1978

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IN NORTHERN IMPERIAL VALLEY, CALIFORNIA

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CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

The northern section of the Imperial Valley region in southern California is an area of known geothermal resources and high seismicity. To investigate the relationship between geothermal areas and earthquakes in the Imperial Valley, a 16-station seismic network was established in early 1973 by the U. S. Geological Survey. Six more stations were added to the network in November 1976. This catalog contains a description of the network and a list of preliminary data on earthquakes detected and recorded by the network from October 1978 through December 1978.

AREA COVERED AND INSTRUMENTATION

Earthquakes reported in this catalog are located in the area indicated in Figure 1. Locations of most of the seismographic stations used to locate the earthquakes reported here are listed in Table 1 and many of these are shown in Figure 2.

The telemetered seismographic network in the Imperial Valley employs the same type of instrumentation developed by the U. S. Geological Survey for use in the central California network. (See Wesson and others, 1974, or Hill and others, 1975, for more details.) Seismometers are mostly vertical-

component Mark Products instruments (Model L-4C) [1/] (T_{seis} = 1 sec.). Horizontal component instruments are present only at stations SNR and DHS. Signals from these instruments are filtered in the field ($T_{amplifier}$ = 0.1 sec.), multiplexed, and telemetered to the California Institute of Technology in Pasadena, California. At Caltech, the signals are discriminated and filtered again ($T_{discriminator} \approx 0.3$ sec.). The signals are digitally recorded by the Caltech Earthquake Detection and Recording System (CEDAR) (Johnson, 1978) and are also recorded on 16mm films using Develocorders [1/] (T_{galvo} = 0.06 sec.). When a Geotech [1/] film viewer is used, peak magnification ranges from 10^5 to 10^6 and occurs at $T_{peak} \approx 0.3$ sec. An earthquake detection algorithm is used in CEDAR, and only "detected" earthquakes are saved.

DATA ANALYSIS

During this quarter, all analysis has been based on the digital recordings made by CEDAR. (For a description of the CEDAR data reduction procedure, see Johnson, 1978, or Fuis, Johnson, and Richter, 1978.) To locate each earthquake, P and S wave arrival time data were processed using an abbreviated and modified version of the computer program HYPO71 (Lee and Lahr, 1975). During this step, no station delays were used and a simple velocity structure was imposed (see Discussion).

The geographic areas in which the resulting preliminary epicenters are located determine which velocity structures and associated station delays should be used for subsequent refinement of the locations. These ultimate locations will appear in the final catalog and will be based on the use of new, improved, and regionalized velocity models to be obtained from upcoming

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refraction-calibration explosions in the Imperial Valley.

This catalog lists only the preliminary location parameters for all well-located earthquakes in northern Imperial Valley for this quarter. These preliminary parameters appear in Table 2. The epicenters are plotted in Figure 2.

DISCUSSION

The velocity model used for the earthquake locations in this catalog is taken from Kanamori and Hadley (1975):

VELOCITY (km/sec)	DEPTH TO TOP OF LAYER (km)
5.5	0.0
6.3	5.5
6.7	16.0
7.8	37.0

This model was obtained from refraction studies in the western Mojave Desert, Transverse Ranges, and Peninsular Ranges of southern California. For a discussion of the differences in earthquake location that result from using this model rather than a more appropriate model for Imperial Valley (Biehler and others, 1964), refer to Fuis, Johnson, and Jenkins (1978).

Richter magnitudes have been calculated for all events in this catalog with $M_L \geq 3.0$ and for some earthquakes with smaller magnitudes. Magnitudes appearing in the final catalog will be based on values of M_L, M_{CA} (coda-amplitude magnitudes calculated from the digital CEDAR recordings), and other data where possible. (For a description of M_{CA}, see Johnson, 1979.)

A filter was applied to the events in this catalog to eliminate very bad hypocenter solutions. A location was not listed or plotted unless its solution quality, Q (slightly different from that of Lee and Lahr, 1975), was either A, B, or C (see below). No arrival times have been reread to improve the preliminary locations.

The hypocentral parameters listed in Table 2 are the following:

1) Y, year of occurrence
2) M, month of occurrence
3) D, day of occurrence
4) H, hour of occurrence
5) M, minute of occurrence
6) SEC, second of occurrence

} Coordinated Universal Time

7) LAT, north latitude of epicenter, in degrees and minutes
8) LONG, west longitude of epicenter, in degrees and minutes
9) DEP, depth of hypocenter, in kilometers
10) MAG, magnitude
11) N, number of P and S arrivals used in locating the earthquake
12) GAP, maximum azimuthal gap, in degrees, between stations contributing P or S arrivals
13) DM, distance from epicenter to nearest station used in locating the earthquake, in kilometers
14) RMS, root mean square of travel time residuals, R_i, in seconds

$$RMS = \sqrt{\sum_{i=1}^{N} R_i^2 \; / \; N}$$

15) ERH, standard error of the epicenter, in kilometers
16) ERZ, standard error of the focal depth, in kilometers
17) Q, solution quality of the hypocenter:

Q	RMS	ERH	ERZ
A	< 0.15	≤ 1.0	≤ 2.0
B	< 0.30	≤ 2.5	≤ 5.0
C	< 0.50	≤ 5.0	
D	others		

ACKNOWLEDGMENTS

Thanks go to Anne Blanchard, Shirley Fisher, Doug Given, Kate Hutton, and Karen Richter who simplified the preparation of Table 2 by timing the P and S wave arrivals and by processing this data to attain the preliminary earthquake parameters.

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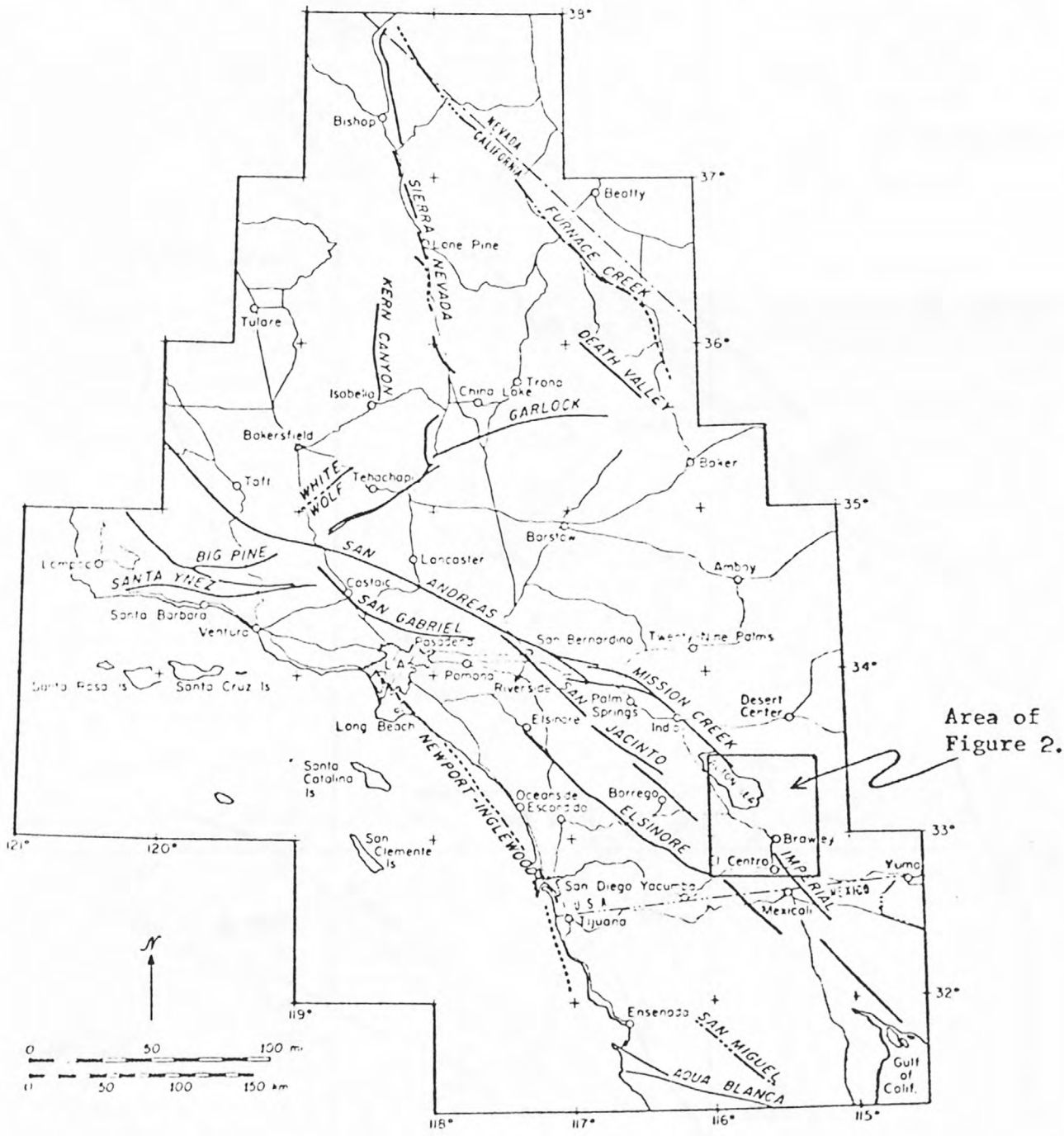

Figure 1. Base map of southern California region with major faults.

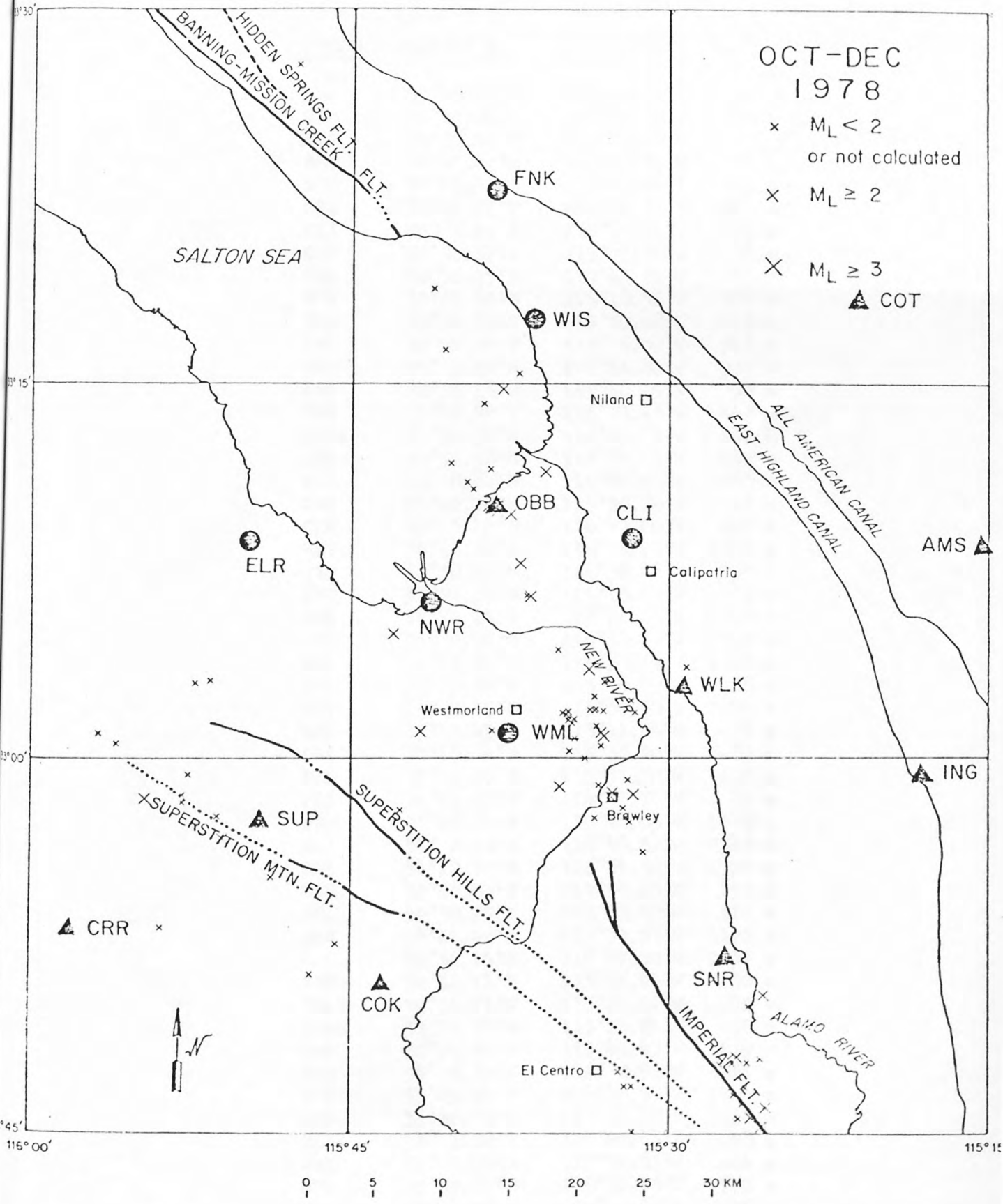

Figure 2. Locations of earthquake epicenters (X's) in the Imperial Valley with respect to major faults for the period October 1,1978 through December 31, 1978. Solid triangles are seismograph stations in the Imperial Valley installed in 1973; solid circles are the seismograph stations installed in November 1976.

Table 1. STATION DATA

STATION	LATITUDE	LONGITUDE	ELEV.
AMS	33° 8.48'N	115°15.25'W	140 m
BAR	32°40.80'N	116°40.30'W	549 m
BC2	33°39.42'N	115°27.67'W	1185 m
BON	32°41.67'N	115°16.11'W	14 m
BSC	32°43.49'N	115° 2.64'W	43 m
CH2	33°17.77'N	115°20.17'W	347 m
CLI	33° 8.45'N	115°31.64'W	-59 m
COA	32°51.81'N	115° 7.36'W	34 m
COK	32°50.95'N	115°43.61'W	-15 m
COY	33°21.63'N	116°18.56'W	232 m
CO2	33°50.83'N	115°20.68'W	276 m
CPE	32°52.80'N	117° 6.00'W	213 m
CPM	34° 9.24'N	116°11.80'W	937 m
CRR	32°53.18'N	115°58.10'W	98 m
DHS	33°55.58'N	116°23.13'W	442 m
DHSE	33°55.58'N	116°23.13'W	442 m
DHSN	33°55.58'N	116°23.13'W	442 m
ELR	33° 8.84'N	115°49.95'W	-63 m
FNK	33°22.98'N	115°38.26'W	12 m
GLA	33° 3.10'N	114°49.60'W	627 m
HOT	33°18.85'N	116°34.90'W	1963 m
IKP	32°38.93'N	116° 6.48'W	957 m
ING	32°59.30'N	115°18.61'W	2 m
INS	33°56.14'N	116°11.66'W	1700 m
JUL	33° 2.90'N	116°36.77'W	1292 m
KEE	33°38.30'N	116°39.19'W	1366 m
LTC	33°29.34'N	115° 4.20'W	458 m
MOV	34° 9.35'N	116°30.10'W	1239 m
NW2	33° 5.43'N	115°41.54'W	-68 m
OBB	33°10.04'N	115°38.20'W	-69 m
PLM	33°21.20'N	116°51.70'W	1692 m
PLT	32°43.87'N	114°43.76'W	61 m
PNM	33°58.64'N	115°48.05'W	1146 m
RAY	34° 2.18'N	116°48.67'W	2342 m
RMR	34°12.77'N	116°34.52'W	1702 m
RUN	32°58.33'N	114°58.63'W	152 m
SGL	32°38.95'N	115°43.52'W	110 m
SHH	34°11.26'N	115°39.27'W	1122 m
SMO	33°32.15'N	116°27.70'W	2437 m
SNR	32°51.71'N	115°26.21'W	-30 m
SNRE	32°51.71'N	115°26.21'W	-30 m
SNRN	32°51.71'N	115°26.21'W	-30 m
SUP	32°57.31'N	115°49.43'W	219 m
TPC	34° 6.35'N	116° 2.92'W	761 m
VG2	33°49.91'N	116°48.55'W	1484 m
WIS	33°16.56'N	115°35.58'W	-68 m
WLK	33° 3.08'N	115°29.44'W	-48 m
WML	33° 0.91'N	115°37.35'W	-44 m
WWR	33°59.51'N	116°39.36'W	702 m
YMD	32°33.28'N	114°32.68'W	76 m

Table 2.

Preliminary hypocenter solutions for earthquakes
October 1, 1978 through December 31, 1978.
Note that "N" and "DM" have not been
calculated for this preliminary report.

Y M D	H M	SEC	LAT	LONG	DEP	MAG	N	GAP	DM	RMS	ERH	ERZ	Q
781C 3	0 13	11.69	33- 2.98	115-52.28	9.25	C.0		136		0.19	2.5	4.1	C
7810 3	0 13	14.97	33- 3.07	115-51.57	5.03	0.C		72		0.16	2.4	5.1	C
7810 4	21 55	9.89	32-58.88	115-33.28	6.00	C.C		126		0.06	2.1	99.0	C
7810 5	20 39	5.05	33- 4.30	115-35.21	7.43	0.C		78		0.11	1.0	2.7	B
7810 6	1 50	27.68	33-11.81	115-40.32	6.37	C.C		181		0.10	2.2	1.9	B
7810 8	17 48	7.12	32-57.98	115-32.12	13.02	C.0		103		0.10	1.0	2.3	B
781011	10 49	38.49	33- 6.48	115-36.69	13.55	0.C		84		0.09	1.2	1.7	A
781015	1 21	49.22	32-46.78	115-26.97	4.92	C.0		122		0.34	2.1	14.5	C
781018	12 52	5.74	33-27.82	115-47.54	5.79	0.0		63		0.06	0.3	99.0	C
781018	15 23	52.43	32-58.60	115-32.63	13.28	2.60		63		0.14	0.7	1.4	A
781018	15 26	7.11	32-58.41	115-32.67	13.13	2.90		64		0.16	0.6	0.9	B
781021	8 55	12.88	32-50.46	115-25.49	3.61	2.40		95		0.25	1.2	0.7	B
781023	0 33	7.13	32-57.89	115-42.65	8.16	C.C		103		0.15	1.5	3.9	B
781023	5 16	10.13	32-46.86	115-32.00	4.34	0.0		120		0.21	1.7	1.9	C
781023	20 20	11.32	33- 1.73	115-34.81	6.05	0.C		85		0.10	1.0	1.6	A
781023	21 28	31.32	33- 1.80	115-34.98	6.95	0.0		92		0.16	1.2	2.1	B
781023	23 31	18.18	33- 1.86	115-34.71	5.50	0.0		146		0.09	1.4	C.9	A
781024	3 44	13.63	33- 1.38	115-34.54	6.67	0.C		135		0.19	1.4	2.2	B
781024	5 11	28.93	33- 1.55	115-34.45	5.44	0.0		86		0.18	1.3	0.9	B
781024	5 53	21.00	33- 1.63	115-34.70	6.70	0.C		85		0.16	1.2	1.7	B
781024	6 54	34.19	33- 1.51	115-34.71	5.62	0.C		85		0.09	0.8	1.2	A
781024	7 20	32.59	33- 1.56	115-34.46	5.76	0.0		86		0.16	1.6	2.2	B
781025	6 52	59.95	33- 6.44	115-36.50	9.45	2.30		43		0.26	0.9	1.7	B
781028	10 4	37.63	32-47.94	115-25.63	3.98	0.C		111		0.24	1.4	1.5	B
781028	14 46	29.23	32-47.79	115-26.24	4.99	0.0		143		0.13	2.4	11.7	C
781030	5 20	11.86	33- 4.94	115-43.01	10.23	2.00		51		0.24	0.8	1.3	B
781030	5 54	44.33	32-58.52	115-31.66	13.92	2.10		61		0.28	0.8	1.1	B
7811 1	5 21	19.96	32-45.01	115-31.63	4.43	C.C		135		0.16	0.9	C.9	B
7811 2	2 11	28.86	32-57.62	115-51.26	7.51	0.0		95		0.10	1.4	1.4	A
7811 2	18 22	3.12	32-48.01	115-26.73	10.11	2.60		113		0.20	1.0	1.4	B
7811 7	8 36	57.59	32-57.57	115-33.47	14.26	0.0		100		0.15	1.6	2.8	B
7811 7	11 11	19.40	33-11.44	115-35.86	5.39	2.C0		105		0.19	1.5	1.1	B
7811 7	14 31	17.52	33-16.37	115-40.62	5.14	0.0		58		0.07	0.6	1.1	A
7811 8	21 59	48.43	33-14.19	115-38.77	5.07	1.90		58		0.13	1.1	1.1	B
7811 9	8 54	45.07	32-51.31	115-46.87	4.85	0.0		114		0.15	3.4	4.3	C
7811 9	19 33	40.13	32-52.53	115-45.68	12.06	C.C		102		0.08	1.0	1.5	A
781110	19 16	50.37	32-51.12	115-27.84	5.00	0.0		141		0.08	4.3	34.6	C
781112	12 2	53.10	33- 0.96	115-56.75	5.27	0.0		131		0.03	0.6	0.6	A
781116	10 4	33.76	33-18.81	115-41.17	5.52	0.0		112		0.05	0.8	5.6	C
781116	14 13	35.27	33- 7.79	115-37.02	9.33	2.30		45		0.21	1.0	1.6	B
781118	7 43	27.75	33- 0.54	115-55.93	4.66	0.0		61		0.32	2.7	3.1	C
781118	14 21	5.10	33- 1.10	115-38.32	14.35	C.C		170		0.10	3.2	2.6	C
781120	11 4	36.61	33-10.75	115-39.25	5.00	0.0		196		0.11	3.6	1.9	C
781120	11 10	46.51	33-11.03	115-39.54	5.53	0.0		197		0.11	1.1	1.0	B
781120	12 13	21.40	33- 9.88	115-38.13	5.22	2.40		39		0.22	0.8	0.7	B
781120	12 15	34.25	33-10.07	115-38.54	5.00	2.00		88		0.21	0.5	0.5	B
781120	13 45	37.29	33- 9.75	115-37.48	11.76	2.00		83		0.18	1.2	2.0	B
781120	13 46	29.42	33-10.27	115-37.91	5.18	1.90		79		0.23	1.5	0.9	B
781120	13 53	29.80	33-11.56	115-38.44	6.18	1.90		131		0.16	1.6	1.7	B
781122	6 52	24.85	32-57.43	115-31.85	13.38	0.C		103		0.19	1.1	2.2	B

Y M D	H	M	SEC	LAT	LONG	DEP	MAG	N	GAP	DM	RMS	ERH	ERZ	Q
781122	6	52	58.54	32-[illegible]7.61	115-32.01	14.52	0.0		68		0.19	0.9	1.5	B
781122	23	34	59.27	33- 1.89	115-33.08	10.15	C.C		86		0.15	1.0	1.6	A
781123	14	6	32.84	32-58.32	115-54.60	14.39	2.60		53		0.31	1.0	1.1	C
781124	19	1	23.69	33- 3.05	115-33.05	11.04	C.C		196		0.05	3.8	2.2	C
781126	17	32	19.18	32-59.29	115-52.58	7.70	0.0		82		0.12	1.0	1.5	B
781127	0	14	51.32	32-45.99	115-25.36	17.27	2.20		126		0.18	1.4	2.1	B
781127	14	46	44.91	32-50.01	115-26.20	4.05	C.C		208		0.04	1.0	C.3	A
781130	4	48	55.55	32-59.99	115-33.95	5.07	1.80		91		0.16	1.3	C.9	B
781130	4	51	10.17	33- C.79	115-34.44	5.39	0.0		144		0.10	2.5	1.2	C
781130	10	9	59.89	33-15.41	115-37.12	4.10	C.C		123		0.11	0.7	C.5	A
781130	17	43	33.30	33-14.79	115-37.87	5.57	2.00		99		0.08	1.3	8.2	C
7812 2	4	37	50.84	33- 2.46	115-33.50	5.49	0.0		84		0.14	1.7	1.5	B
7812 5	20	26	43.17	32-58.17	115-52.84	7.75	0.C		78		0.09	1.7	2.1	B
7812 6	2	3	19.48	32-45.55	115-26.66	5.66	0.0		132		0.32	2.4	33.2	C
7812 7	2	31	55.26	32-47.44	115-32.31	5.28	0.C		115		0.07	0.8	C.8	C
7812 7	22	13	22.43	32-45.20	115-25.55	17.28	2.90		134		0.21	0.9	1.6	B
7812 8	2	2	1.99	32-47.96	115-27.12	14.46	2.60		160		0.19	4.0	2.1	C
7812 8	8	42	19.01	32-45.57	115-26.05	16.31	2.60		131		0.23	1.9	2.6	B
7812 8	16	19	56.64	32-46.51	115-26.88	4.21	0.0		124		0.23	4.7	8.1	C
7812 8	16	23	17.59	32-46.78	115-26.32	5.00	0.C		121		0.11	2.3	22.5	C
781211	4	9	50.89	32-56.72	115-50.99	13.47	2.20		56		0.36	1.2	1.4	C
781211	4	21	15.02	33- 1.29	115-33.42	5.30	0.0		141		0.13	1.2	C.8	B
781211	4	44	21.63	33- C.87	115-33.07	9.42	2.30		54		0.29	1.5	2.4	B
781211	5	49	44.04	33- 1.02	115-33.18	6.97	2.30		142		0.24	1.4	2.2	B
781212	13	5	36.53	33- C.50	115-33.19	6.62	0.C		145		0.07	1.0	1.6	B
781212	14	34	46.82	33- 1.83	115-31.60	7.65	0.C		210		0.07	3.1	1.9	C
781212	18	21	27.94	33- 2.30	115-31.79	8.04	0.C		131		0.12	2.8	2.3	C
781212	18	22	9.62	33- 3.63	115-29.19	5.13	0.C		160		0.09	2.9	1.6	C
781212	18	27	6.19	33- 1.90	115-33.49	9.44	0.0		114		0.12	1.3	1.5	B
781212	18	51	44.15	33- 1.92	115-33.72	8.99	0.0		137		0.07	0.9	C.9	A
781213	10	14	19.21	33- 1.05	115-41.70	13.32	2.60		116		0.30	3.3	3.9	C
781214	9	31	50.16	33- 1.95	115-33.44	8.80	C.C		181		0.15	1.6	4.0	B
781216	3	19	21.73	32-59.12	115-31.92	5.33	0.0		125		0.06	0.8	9.5	C
781219	2	48	7.74	32-55.20	115-48.70	9.72	0.0		91		0.20	2.2	3.2	B
781219	6	53	36.65	33- 0.26	115-34.67	5.95	0.0		136		0.13	1.1	1.6	B
781220	6	13	31.71	32-58.82	115-35.13	9.47	2.20		67		0.22	1.4	2.9	B
781220	16	19	35.03	32-53.16	115-53.83	4.31	0.0		105		0.33	3.4	3.0	C
781220	20	15	26.47	32-56.24	115-31.19	14.53	0.0		74		0.12	0.9	1.9	A
781221	8	28	58.75	33- 3.53	115-33.77	8.95	2.30		81		0.21	1.1	1.9	B
781228	13	59	16.34	32-58.46	115-52.84	7.48	0.C		62		0.10	1.6	2.3	B
781229	12	4	49.60	32-46.13	115-26.47	5.52	0.0		127		0.24	3.1	98.9	D
781229	12	50	58.92	32-45.59	115-25.88	10.95	C.C		122		0.20	1.9	3.5	C
781229	18	4	51.20	32-47.73	115-27.57	6.07	0.C		115		0.11	1.4	8.4	C
781229	18	42	53.93	32-47.75	115-26.96	5.01	0.0		115		0.22	3.6	36.7	C
781230	10	0	53.33	32-46.86	115-31.68	5.45	0.C		121		0.18	1.4	5.6	C