

United States Department of the Interior
Geological Survey

X-ray Mineralogy of Cores from two Guatemalan Caldera Lakes

By Lawrence J. Poppe, Charles K. Paul
and Christopher G. Newhall

Open-File Report 81- 1333

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

1981

The U.S. Geological Survey (USGS), under the sponsorship of The Agency for International Development, in cooperation with Dartmouth College, collected 13 cores to study the sedimentation in two Guatemalan cauldера lakes, Atitlan and Ayarza. These cores were taken during January-February 1980 aboard the R/V XAMAN EK. The piston cores were collected with an Alpine Geophysical 304 corer fitted with as much as 9.75 m of barrels having internal diameters of 38 mm (Table 1). A few 1.5 m long, 76 mm internal diameter gravity cores were also taken to sample undisturbed sediment for Pb-210 dating. Some cores were partially extruded by expansion caused by high concentrations of biogenic gas. Because of this expansion, alphabetical suffixes have been added to five of the sections listed in Table 2.

Two gravity cores and seven piston cores were collected in Lake Atitlan, which is in the volcanic highlands of western Guatemala (Fig. 1). Four piston cores were also taken in Lake Ayarza, a figure-8-shaped lake occupying two cauldераs in southeastern Guatemala (Fig. 2).

A split from each sample was mounted and X-rayed as a randomly oriented powder (Table 2). The clay fraction from each sample was separated by centrifuge and mounted as an oriented aggregate on a silver filter. Four treatments were performed on the oriented silver filter mounts to determine which clay minerals were present: air drying, glycolation with ethylene glycol, heating to 400°C, and heating to 550°C. After each treatment, the samples were X-rayed between the angles of 2° and 40° two theta on a Philips X-ray diffractometer fitted with a graphite curved-crystal monochromator. This study used CuK α radiation, a scanning rate of 2° per minute, and a chart scale of 1000 counts per second full scale.

Semiquantitative estimates of minerals present were made by comparison of peak intensities with intensities of a collection of standards. Relative

percentages of the clay minerals were estimated by a method described by Biscaye (1965). These semiquantitative estimates are generally considered to be accurate to within 10% of their actual values; however, the smaller values can vary considerably more than this.

A split was taken from each sample and mounted in Caedex (N=1.56) as a smear slide. These slides were used to check the semiquantitative diffraction techniques, to detect minerals lacking X-ray diffraction effects, and to examine the biological debris.

Values reported in Table 2 as T indicate that a trace of that mineral was detected. Blanks indicate that the mineral was not detected. Values generated by X-ray diffraction are in relative percentages of the crystalline material. Values for volcanic glass shards (ASH) and siliceous microfossils (SMF) represent relative percentages of the whole sample.

The cores, X-ray diffraction patterns, and smear slides may be examined at the U.S. Geological Survey offices in Woods Hole, MA 02543.

Reference Cited

Biscaye, P. E., 1965, Mineralogy and sedimentation of recent deep-sea clay in the Atlantic Ocean and adjacent seas and oceans, Geological Society of America Bulletin, v. 76, no. 7, p. 803-832.

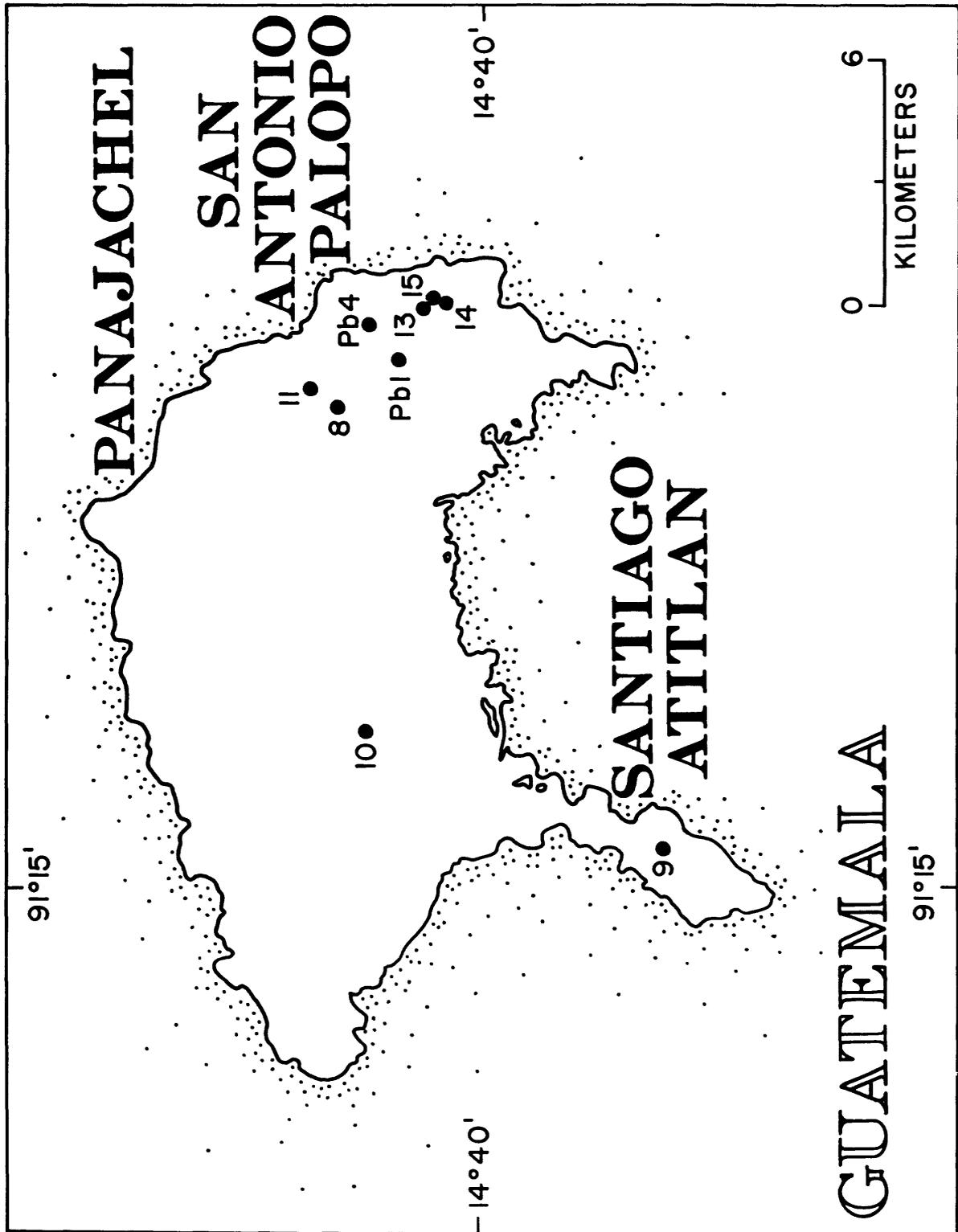


Figure 1. Location map showing numbered core sites in Lake Atitlan.

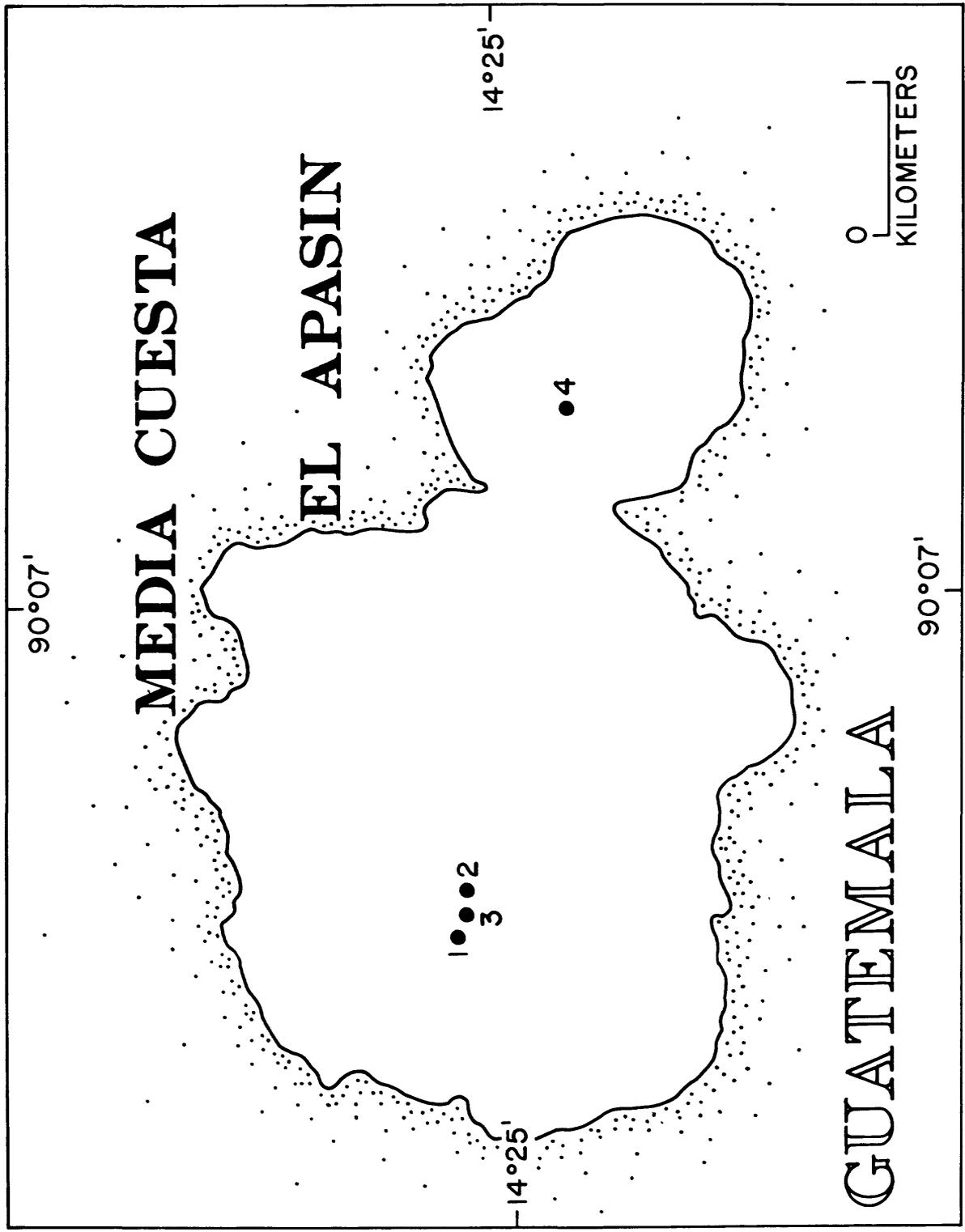


Figure 2. Location map showing numbered core sites in Lake Ayarza.

LAKE	CORE	TSEC	LENGTH (M)	WDEPTH (M)	DATE	CT
AT	PB1	1	.72	308	1/29/80	GC
AT	PB4	1	1.00	314	1/31/80	GC
AT	8	6	9.39	306	1/29/80	PC
AT	9	4	3.14	58	1/29/80	PC
AT	10	5	6.79	320	1/29/80	PC
AT	11	3	3.75	314	1/30/80	PC
AT	13	4	6.66	249	1/30/80	PC
AT	14	6	7.12	315	1/31/80	PC
AT	15	7	7.04	315	1/31/80	PC
AY	1	9	9.77	239	2/16/80	PC
AY	2	7	9.30	238	2/16/80	PC
AY	3	4	6.10	238	2/16/80	PC
AY	4	5	2.66	85	2/16/80	PC

Table 1. Description of cores collected from Lake Atitlan and Lake Ayarza, Guatemala. LAKE: AT =

Atitlan, AY = Ayarza; CORE: core identification number; TSEC: total number of sections;

LENGTH (M): length of core in meters; WDEPTH (M): water depth at site in meters; DATE:

date core was collected; CT: core type, GC = gravity core, PC = piston core.

Table 2. Estimated mineral modes, in relative percent, determined from X-ray diffraction and smear slide observation for sediments cored in Lake Atitlan and Lake Ayarza, Guatemala. LAKE: AT = Atitlan, AY = Ayarza; CORE: core identification number; SEC: section number in core; CM: depth of sample in section in centimeters; DS: depth of sample below sediment/water interface in centimeters; SMC: smectites; CHL: chlorite; M/L: mixed-layer clay minerals; I/M: illite/mica; KAO: kaolinite; QTZ: quartz; FELD: K, Na, and Ca feldspars; CALC: calcite; PYR: pyrite; AMPH: amphiboles; SID: siderite; ZEO: zeolites; DC: disordered cristobalite; ASH: volcanic glass shards; SMF: siliceous microfossils.

LAKE	CORE	SEC	CM	DS	SMC	CHL	M/L	I/M	KAO	QTZ	FELD	CALC	PYR	AMPH	SID	ZEO	DC	ASH	SMF	
AT	PB1	1	14	14	57	1	1	2	9	6	15	3	1	2		3	4	25	5	
AT	PB1	1	63	63	56	T	1	2	8	6	20	1	1	2		3		40	1	
AT	PB4	1	22	22	64	T	1	3	8	6	14	3	4			3		10	5	
AT	PB4	1	74	74	52	T	T	7	11	6	17	2	2	T		2	10	30	5	
AT	8	1A	5	5	52	T		4	13	6	15		T	T		T	11	60	5	
AT	8	2	106	271	58	T		1	7	5	17		T	T		1	8	25	T	
AT	8	3	121	438	51	T		2	12	6	21	3	3	T		1	10	15	T	
AT	8	4	90	559	56	T		2	11	4	19	9	7	T		1	10	40	15	
AT	8	5	91	726	42	T	1	5	7	1	27	3	3	T		3	50	35	40	
AT	8	5	97	733	67	T	1	3	5	5	14	T	1	1			50	35	35	
AT	8	6	151	787	50	T	1	4	17	6	20	1	1			T	15	1	1	
AT	9	1	4	4							41	5	54				10	80	80	80
AT	9	3	48	159	T	2				1	94	T	1	1			5	5	5	5
AT	9	4	91	273	T	T				1	96	2	1	T			5	5	5	5
AT	10	1A	38	38	57	T		2	7	2	19	2	2	T		9	10	10	10	10
AT	10	1B	79	117	55	T		2	15	1	12	1	3	T		11	10	20	20	20
AT	10	2	147	361	61		4	2	9	3	12	3	6	T			10	65	65	65
AT	10	3	151	517	46	T		3	6	1	25	6	2	T		10	10	25	25	25
AT	10	4	99	617	51	T		1	7	3	24	8	5	T		T	15	25	25	25
AT	11	1	46	46	46	T		1	5	7	26	T	T	T		2	11	20	T	T
AT	11	3	111	182	60	T		2	7	4	24	T	1	T		1	50	T	T	T
AT	13	1	67	126	62	T		3	4	4	10	10	10				1	45	45	45
AT	13	2	111	321	61	T		4	11	3	11	4	5				T	40	40	40
AT	13	4	138	652	53		1	5	11	4	16	5	4	T		1	10	30	30	30
AT	14	1A	33	33	50	T		6	14	4	14	T	1			10	5	35	35	35
AT	14	1C	129	233	48				4	2	25	14	7					5	35	35
AT	14	2	50	306	59	T		3	5	4	14	6	8	T				10	30	30
AT	14	4	84	644	46	T		5	7	3	32	5	1	T				5	30	30
AT	15	1	9	9	46	T	1	6	5	4	15	17	4	T		T	1	T	25	25
AT	15	2	37	62	34	T		4	1	6	42	9	4					5	50	50
AT	15	2	137	163	63			1	1	1	13	15	7			T		5	50	50
AT	15	4	74	275	67		2	2	2	3	17	4	1			1		T	35	35
AT	15	4	88	289	54	T		7	4	3	15	9	6					T	25	25
AT	15	5	96	423	25		1	10	1	5	49	5	2	2				10	5	5
AT	15	6	143	621	48			1	8	4	28	9	2	T				5	35	35
AT	15	7	63	694	38			1	1	8	37	4	8	T		3		10	T	T
AY	1	1	5	5	34		3	17	15	9	15	T	6					T	30	30
AY	1	2	136	160	27		T	31	17	8	8	4	4			T		T	55	55
AY	1	3	16	185	25			17	13	3	22	16	3	T				5	40	40
AY	1	4	108	429	45	T		14	6	8	12	7	8					10	35	35
AY	1	5	141	614	35	T		14	7	12	8	15	8			T		10	25	25
AY	1	8	114	788	31	T		15	14	4	27	7	2					5	15	15
AY	1	9	69	894	22	T		16	7	19	22	9	1	T		3	30	10	10	10
AY	1	9	138	961	22	T	1	30	9	17	10	6	5	T				15	15	15
AY	2	1	5	5	27	T	2	24	12	9	12	9	4	T		T		T	20	20
AY	2	3	69	236	25	T		24	12	10	19	6	3					5	45	45
AY	2	4	49	368	22		1	7	14	9	38	9	3	T				60	T	T
AY	2	4	127	444	22	T	2	19	8	23	20	4	1	T				10	T	T
AY	2	6	126	749	36	T	2	14	5	16	13	10	3	T				15	20	20
AY	2	7	121	896	24	T	T	28	13	13	13	10	9	T				5	30	30
AY	3	1	48	48	30	T	T	22	12	10	10	8	7	T				5	50	50
AY	3	1	71	71	29	12	2	5	8	10	28	3	3			T		80	T	T
AY	3	2	100	252	18	T		9	9	15	33	10	5	T				25	15	15
AY	3	3	130	434	33	T		34	14	6	11	7	1	T				10	T	T
AY	3	4	149	605	40	T	T	15	4	14	9	7	3			1	6	15	15	15
AY	4	3	98	153	28			26	9	12	8	14	2			T		5	5	5