20. VOLCANIC ASH FROM DSDP SITE 178, GULF OF ALASKA

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A large number of well-defined ash layers occur in the Middle Miocene to Holocene sediments cored at Site 178. Fifty-three samples of silt and sand were selected for a special study of the stratigraphic distribution of volcanic ash and its composition. A smear slide mounted in Cadex was made of all samples and extra ash was retained for measurement of refractive indices with oils (Table 1). In addition, several samples were sized by seiving and were run through a Frantz magnetic separator. Of the fifty-three samples examined for ash, fifteen had over 90 per cent ash (visual estimate) and twenty-six had more than 50 per cent ash. Two varieties of ash were found: a light variety that forms well-sorted, distinct layers and a dark brown variety that is usually found in trace amounts throughout the sediment column.

The light ashes consist almost totally of clear, isotropic glass shards although several of the samples contain numerous crystals of feldspar and quartz. The vertical distribution of the ash in the sediment column and the average refractive indices are presented in Table 1. In general, the light ash is fairly well divided into the medium to coarse silt range. Individual shards are usually angular and about one-third of the samples contained shards that show lineations, small bubbles, or other evidence of flowage. Some shards, which are particularly large and thin, are nearly triangular in shape and are probably remnants of bubble walls. The light ash from Core 1 through Core 39 has an index of refraction of 1.502 to 1.512. Chemical analyses of selected light ash samples in Cores 1, 21, 28, 34, and 39 verify that all light ashes observed at Site 178 form a chemically uniform population (see Table 2). Using calculated CIPW normative mineralogy in place of modal mineralogy in the classification scheme of Johannsen (1931), one finds that all of the light ashes listed in Table 2 are rhyodacites.

The only large recorded volcanic eruption to distribute ash over Site 178 was the 1912 eruption of Mount Katmai (Nayudu, 1964). Although ash from this eruption was looked for in the uppermost sediment at Site 178, it was not found. A sample of Katmai ash from Kodiak Island was studied as part of this investigation (see Table 2). The average index of refraction of our Katmai ash sample (1.484) agrees well with the value of 1.485±.002 reported by Nayudu (1964). Interestingly, our data suggest that Katmai ash has a distinctly lower index of refraction (1.484) and probably a higher silica content than any of the ash samples from Site 178. Just why the only known historic eruption to deposit ash in the area is different remains a problem. It hardly seems reasonable to accept the one historic event as a major change in 15 million years of ash chronology, but on the other hand, the Aleutian system may just now be reaching a state of maturity that supports the production of highly siliceous magma.

The dark ash ranges from olive brown to green and generally has an index of refraction of around 1.56 or greater. It characteristically occurs as a rare component with light ash or detrital silt. Generally, dark ash shows mottled extinction, lacks flow striations or bubbles, and is usually more rounded than those of light ash. Six samples, including one with 85 per cent ash, fell within the 1.55 to 1.56 refractive index range. The first dark ash found in the stratigraphic section at Site 178 composes 2 to 3 per cent of the sample and may correspond to the dark ash or "middle" ash described by Nayudu (1964). Site 178 is located within the northeast Pacific brown ash province described by Hays and Ninkovich (1970). The fact that dark ash is less abundant than light ash at Site 178 is probably a consequence of the greater explosiveness associated with eruptions of highly siliceous magmas.

The geological significance of the ash deposits found at Site 178 is that light ash of rhyodacitic composition and Middle Miocene age is found as deep as Core 39 at about 400 meters. This may not be a maximum depth because there was no recovery from the next three cores and recovery was very poor for the rest of the hole. Our studies indicate that island arc volcanism of the Alaska Peninsula has been contributing highly siliceous ash for a much longer period of time than has been suggested by Hays and Ninkovich (1970). In addition, the abundance of ash layers in Pliocene and younger sediments may be a consequence of the uplift and volcanism associated with the development of the present Alaska Peninsula in upper Pliocene time (Burk, 1965).

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TABLE 1
Distribution and Refractive Index of Ash from Site 178

Core	Section	Interval (cm from top)	Depth (m)	Bed Thickness (cm)	Petrographic Description	Refractive Index[a]
1	1	111-112	1	1	2-3% olive brown ash	<1.560
1	3	89-90	4	4	100% light ash	1.508
1	4	11-12	4	2	99% light ash	1.508
3	3	19-20	18	2	95% light ash (crystals present)	1.500 - 1.510
3	3	143-144	19	1	50% light ash (large angular shards, quartz crystals abundant)	1.512
3	4	123-134	20	19	85% light ash	1.508 - 1.510
5	3	143-144	38		Rare ash	1.610 - 1.620
5	4	48-50	39	2	70% light ash (well-sorted, crystals abundant)	1.500
6	3	144-150	46		Rare light ash	
6	4	82-84	47	2	100% light ash (fine-grained)	1.512
8	1	64-65	60		95% light ash	1.510
9	4	15-18	73	3	5% dark ash	
10	2	105-109	80	4	100% light ash (crystals present)	1.512
12	3	45-46	99	1	50% light ash (crystals present)	1.500
12	3	66-69	99	3	1-2% brown green ash	
17	4	98-96	146	7	2% light ash	1.512
18	2	95-96	152	45	100% light brown ash	1.522
18	2	116-117	152	45	85% brown ash	1.545 - 1.552
18	3	44-45	153	1	80% light ash (trace dark ash is present)	1.510 - 1.515
21	2	95-98	179	4	90% light brown ash (crystals present, shards striated)	1.538
24	2	33-34	205		100% light ash (some shards are striated)	1.502
26	3	79-82	223	3	50% light ash, 30% dark ash	
28	2	136-137	240	5	94% light ash (clear, well-sorted, large shards)	1.512
28	3	6-7	242	1	70% light ash	1.515
28	5	122-123	245	2	90% light ash (well-sorted and uniform)	1.512
29	5	97-98	255	1	90% light brown ash (shards striated and flow structures are present)	1.530
32	2	13-24	307	11	Trace brown ash	1.560
33	1	94-95	316	1	50% light ash	1.512
33	1	125-128	316	3	Trace light ash	
34	6	105-110	333	5	100% light ash (graded)	1.510
36	2	111-112		1	Ash-bearing diatomite	
37	3	60-65	356	5	50% light ash (graded)	1.502
39	5	114-115	396	19	20% light ash (graded; crystals present)	1.510
39	5	119-120	396	19	50% light ash (graded)	1.502
44	4	70-80	461	10	Light ash (graded; crystals numerous)	1.505
47	2	110-115	507	5	2% dark brown ash (shards angular)	<1.560
51	1	124-125	658	1	10% brown ash (shards are angular, show mottled extinction and may be detrital)	<1.560

[a]Single refractive index values are averages of several measurements.

TABLE 2
Chemical Analyses of Volcanic Ash Layers From Site 178

	Katmai Ash	Interval 1-3 (89-90)	Interval 21-2 (95-99)	Interval 28-2 (136-137)	Interval 34-6 (105-110)	Interval 39-5 (119-120)
SiO	75.91	71.47	65.13	67.50	70.53	71.14
TiO	0.18	0.20	0.59	0.19	0.20	0.28
Al_2O_3	12.64	13.93	15.45	14.90	13.32	13.65
FeO (total Fe)	1.09	1.91	4.75	2.18	1.72	1.68
MgO	0.12	0.23	0.97	0.45	0.27	0.32
CaO	0.96	1.74	3.11	0.92	1.17	1.49
Na_2O	4.32	4.38	4.57	4.12	3.91	4.05
K_2O	2.80	3.52	2.21	3.14	4.20	3.22
Average Refractive Index	1.484	1.508	1.538	1.512	1.510	1.502