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MAGMATIC DIFFERENTIATION AT AMBOY CRATER, CALIFORNIA

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Amboy Crater, a recent group of nested cinder cones near Highway 66, approximately 75 miles east of Barstow, San Bernardino County, affords an excellent example of magmatic differentiation of basaltic magma. The general geology of the area will be described elsewhere (Parker, Calif. Div. Mines, to be published). The suite of rocks selected for this discussion are from the cones themselves. The surrounding flows are not suitable for such a study due to the uncertainty of their relative ages. The absolute age of none of these rocks is known, but the relative ages of those from the cones can be judged with a high degree of certainty. All of the samples are from nested cones built around a single, central conduit with the exception of No. 4 which comes from a short intracrater-flow which breached the older cones from which specimens Nos. 1, 2, and 3 were collected.

All of the specimens are olivine basalts. In general they are composed of a groundmass of glass, plagioclase, clinopyroxene, and magnetite with phenocrysts of olivine and plagioclase. Plagioclase phenocrysts are not present in all specimens, hence were not studied for comparative purposes. Pyroxenes could not be determined due to small grain size. Olivine was determined from optic angle measurements and the curve of Tröger (1956, p. 37). Plagioclase microlites were determined by the method of Emmons and Gates (1948, p. 617). Artificial glasses were prepared from powdered samples by the method of Mathews (1951). Chemical factors after the convention of Niggli (1954, pp. 12–14) were calculated from chemical analyses of three of the specimens, Table 1. All of the above data are combined in Fig. 1.

Several features are of interest. The younger the basalt the higher is the

TABLE 1. CHEMICAL ANALYSES

	1		3		6	
	Wt. %	Mol. %	Wt. %	Mol. %	Wt. %	Mol. %
SiO_2	45.91	51.43	48.04	53.00	46.80	56.00
Al_2O_3	16.14	10.65	17.13	11.17	16.82	11.85
FeO	5.89	5.46	5.96	5.46	4.28	4.29
Fe_2O_3	4.88	2.04	4.24	1.77	5.67	2.59
TiO_2	2.32	1.97	2.33	1.97	2.32	2.04
MnO	0.20	0.20	0.19	0.20	0.17	0.20
CaO	9.14	9.07	8.34	9.33	9.73	8.17
MgO	8.68	14.52	7.48	12.35	5.54	9.94
K_2O	1.72	1.25	1.72	1.18	1.53	1.16
Na_2O	2.96	3.15	3.27	3.48	3.18	3.68
H_2O-	0.38	—	0.30	—	0.49	—
H_2O+	0.64	—	0.54	—	1.37	—
CO_2	0.95	—	0.27	—	2.03	—
P_2O_5	0.36	0.20	0.26	0.13	0.15	0.07
	100.17	99.94	100.07	100.04	100.08	99.97
al	22.0		23.9		26.2	
fm	49.9		46.0		45.0	
c	18.9		20.1		18.1	
alk	9.1		10.0		10.6	
si	107.5		114.0		124.0	
k	.28		.25		.24	
mg	.60		.57		.51	
Qz	−28.9		−26.0		−18.4	

Analyst: W. H. Herdsman.

Mole per cent values were recast eliminating water and carbon dioxide plus lime to make calcite with the carbon dioxide present. Values for CaO and *c* are of low reliability as a result of these adjustments, and the fact that the hydrous minerals in these rocks are of unknown nature.

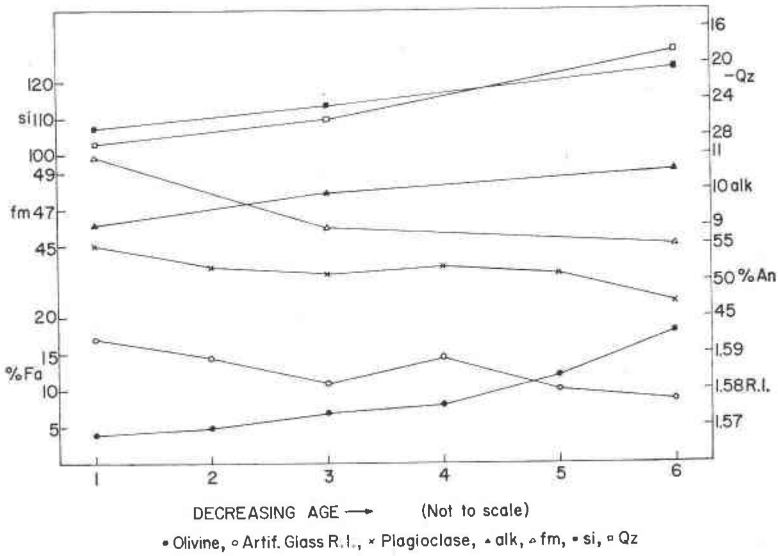

FIG. 1. Comparison of composition and refractive indices with age.

fayalite content of its olivine. While variations in the plagioclase microlites and refractive index of artificial glasses are slight compared to inherent errors in determinative methods, it is significant that the curves have the same form. The mineralogical and chemical changes observed in this sequence are precisely what would be predicted on experimental grounds in the case of a magma being "sampled" at intervals during a differentiation course of crystallization. In brief, the liquids are successively enriched in silica and alkalies, and impoverished in magnesia and alumina. Total iron diminishes slightly with decreasing age. The mechanism of differentiation must remain speculative, but perhaps removal of plagioclase and olivine by crystal settling was the major factor. Similar changes in composition of effusive material from Parícutin were observed in the early history of the volcano's eruptions (Wilcox, 1954, pp. 316–317).

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