Shishaldin Volcano, Aleutians: 1975 Eruption and FeTi Basalts

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In late 1975, Shishaldin and Pavlof volcanoes were erupting in the Aleutians. A SEAN (Scienc. Event Alert Net.) observer at Cold Bay, P Sventek, reported vigorous activity by Shishaldin (small summit bursts) on Sept. 13 and 23. On Sept. 17, the NOAA vessel Miller Freeman was 90 km NE of Unimak Island and collected falling ash, although the source was not certain (the flash azimuth led them to suggest Bogoslof). A well-sorted ash sample (95% 0.3-0.7 mm) was received and examined by electron microprobe by Simkin at the Smithsonian Institution in January 1976. The enrichment in FeO (15 wt%) and TiO2 (3 wt%) and depletion in Al2O3 (12-14 wt%) in the basaltic glass was noted as anomalous for a convergent arc volcano. In 1984, Fournelle and Marsh began a study of Shishaldin Volcano and collected a series of lavas and tephra from the volcano's northwest quadrant. The enrichment in Fe, Ti, Mn, P, Zr, Y and REE and Al depletion was immediately noted in the bulk analyses. Fresh tephra that was collected in 1984 has now been examined by electron microprobe, and glass compositions match closely (in all elements but K) the NOAA sample. Based on the distinctive geochemistry of the ash plus reports from the Cold Bay observer, we suggest that Shishaldin was erupting on Sept 17, i.e. the most likely source of the ash collected by the Miller Freeman was Shishaldin.

Phenocrysts present in Shishaldin FeTi basaltic tephra and lava are dominantly plagioclase followed by olivine and Ti-mt. Evaluation of tephra glass and mineral compositions, (i.e., An55-65, Fo63-65) in conjunction with modeled closed system fractionation (MELTS phase equilibria: Ghiorso and Sack, 1995) constrain conditions. Estimated temperature at 10-20% crystallization was 1100-1120°C, and the inferred F02 was QFM - 1; at least one anomalous lava experienced higher F02 (QFM+1, 1100° C by FeTi oxides). Water content was low (≤ 0.5 wt%) at low P (max 0.5 kbar). Some plagioclase (An70-88) and olivine (Fo74) compositions could not have been in equilibrium with the FeTi basalt at these conditions. Some may have been inherited from a parental magma (matching those in Shishaldin high-Al basalt), and some may have been xenocrysts from other sources. Relevant to possible parental magmas are the experiments of Baker and Eggler (1987), who found that 5 kbar (dry) crystallization of Atka high-Al basalt yielded basaltic glasses of high Fe and Ti and low Al. MELTS modeling yields the same conclusion. Other features include skeletal microphenocrysts, groundmass pigeonite, and (in one lava) small regions of dacitic glass with extreme amounts of P2O5 (1.8 wt%) and TiO2 (2 wt%).

Trace element discrimination diagrams (e.g., Pearce and Norry, 1979) have been used to infer tectonic affinity of old rocks. On the Zr/Y-Y diagram, Shishaldin FeTi basalts plot in the "within plate" field. We suggest that the diagram fails here because of unique conditions. This region has some particular features: chains of alkali basalt seamounts are being subducted south of Unimak (e.g. DSDP 183 site)--an anomalous subducted source component may be involved. Also, the ancient Beringian margin is inferred to pass through Unimak, and extensional basins are present south of Unimak (Horowitz et al., 1989) [Kay et al,
1982, inferred Aleutian tholeiitic magmas may be related to crustal extension. These factors, however, cannot be the whole answer. The maturity of the magmatic plumbing system may be critical. The model of Myers et al. (1985) suggests that very large volcanoes--like Shishaldin, ~300 cu. km., located near the maximum rate of Aleutian subduction--represent large fluxes of magma through the mantle and crust with less cooling and contamination. It may be no coincidence that the three Aleutian volcanic centers with FeTi basalts--Shishaldin, Westdahl (Kay, 1977), and Okmok (Nye and Reid, 1986)--are each several hundred cubic km. in size. The existence of these FeTi basalts implies the magma delivery system at these Aleutian volcanoes may be optimal for (1) closed system fractionation of a parent (hiAl basalt?) at ~8 kbar, and (2) small amounts of crystallization at the near surface at moderately high temperature and relatively low fO2, prior to eruption.