PETROGRAPHY AND GEOCHEMISTRY OF WITCHER MOUNTAIN, THIRTYNINE MILE VOLCANIC FIELD -- CENTRAL COLORADO

Christian Roessler
Geology Department
Washington and Lee University
Lexington, Virginia

Witcher Mountain lies on the eastern edge of the Guffey volcanic center, the largest within the early Oligocene Thirtynine Mile Volcanic Field of central Colorado. Volcanism distributed basalt to rhyolite flows and lahars over an uplifted late Eocene erosional surface (Epis and Chapin, 1975) beginning around 35.8 m.y.a. (Eppley, 1990). Petrogenetic models in this study have been developed through mapping, petrography, and whole rock chemical analysis. Recent modeling for causal mechanisms proposes steepened subduction of the Farallon plate between the San Juan Mountains and the Thirtynine Mile Volcanic Field, or, partial melting of heterogeneous upper mantle initiated by a diapir and aided by initial extensional movement along the Rio Grande Rift (Eide, Rothwarf, Mertzman, Filson, 1988). Indications from this study suggest crystal fractionation of a magma derived from a heterogeneous source to which material possibly derived from a subducted slab had been added at an earlier date.

Field mapping of seven square miles between Four Mile Creek Rd. and Nancy Ann Arroy Rd. revealed seven volcanic units. Those are from youngest to oldest: basalt dikes, rhyolite dome unit (w/ 3.5+ mm plag. phenocrysts), Upper Thirtynine Mile Andesite (hbld-rich flows), Lower Thirtynine Mile Andesite (cpx-rich flows and lahars), lower hornblende andesite, lowlands unit (plag-rich w/ mafic phenocrysts), and biotite dacite flows. An age date of 33.92+/- 0.52 m.y. has been assigned to the rhyolite dome unit by Eppley (1990). The addition of a lower hornblende andesite unit was necessitated by the presence of a sequence of extrusive rocks very similar to Epis and Chapin's Upper Thirtynine Mile Andesite **below** the Lower Andesite. Secondly, the lowlands unit did not follow any pre-existing descriptions, or show a consistent phenocryst assemblage.

Petrographic analysis of twenty samples revealed phenocrysts of cpx, olivine, plagioclase, biotite, Fe-Ti oxide, hornblende, and minor apatite. Modal phenocryst percentages were between 16 and 32 percent. Opx and sanidine were absent as phenocryst phases. Cpx, plagioclase, and Fe-Ti oxide existed in all twenty samples. Groundmass textures were mostly intergranular with trachytic patches; phenocryst textures were commonly cumulophyric. Cpx was the dominant phenocryst phase in basaltic rocks; modally, it composed up to 12 percent of flows and 27 percent of dikes. It occurred in subhedral to euhedral crystals from .25 mm to 3.5 mm in diameter.

Olivine occurred in seven samples--always with cpx--with an average modal abundance of five percent. The phenocrysts were mostly fresh with iddinsite developed along cracks. Biotite existed as primary and secondary phases composing 1 to 3 modal percent in fourteen samples. It was noted as being altered to chlorite in a few thin sections. Hornblende was limited to four of the twenty samples examined. It coexisted with either biotite or clinopyroxene. Fe-Ti oxide occurred as phenocrysts up to 1.5 mm in diameter, as a groundmass constituent, and as poikilitic grains enclosing apatite. Plagioclase existed in each of those circumstances as well, forming phenocrysts as large as 4.0 mm across in a rhyolite. Anorthite content measurements ranged from 45 to 80 percent. Apatite was recognized in 9 samples at less than 1 modal percent, usually as poikilitic grains enclosed in other phenocryst phases and in the groundmass.

Textural relationships suggest that Fe-Ti oxide was an early liquidus phase indicating a relatively high oxygen fugacity. Also, the presence of biotite and hornblende as primary phases indicate hydrous magma conditions.

Major and trace element data were obtained for 15 samples at F&M by x-ray fluorescence and inductively coupled plasma spectrometric techniques. The data suggest that all the rocks studied are genetically related. Silica content ranged from 48 percent in Lower Andesite basalt flows to 69 percent in trachyte flows. Total alkalis were enriched from 5 to 10 percent with increasing SiO_2 while K_20/Na_20 remained near unity. According to the classification of LeBas and others (1986) (Figure 1) the samples range from potassic trachybasalts (region 1) through latites (region 2) to trachytes/trachydacites/rhyolites (region 3). No iron enrichment is discernable from plot of FeO vs. MgO (Figure 2). TiO_2, P_20_5, and CaO contents show similar trends versus MgO; they increase linearly at low MgO contents and level off at higher MgO values. Clinopyroxene fractionation is suggested by CaO vs. MgO (Figure 3) and Al_20_3 vs. CaO plots. That is, CaO and MgO decrease together from a mafic parental composition, while Al_20_3 increases with decreasing CaO. Cpx fractionation would remove CaO and MgO but not Al_20_3. Such differentiation may have served a leading role in producing more silicic magmas.

Trace element data demonstrates depletion of mantle-compatible elements like Ni and Cr, a high LREE/HREE, and enrichment in incompatible elements Rb and Ba. Cr and Ni contents ranged from 5 to 100 ppm, while Ba contents ranged from 1550 to 2640 ppm. A crystal fractionation model involving phenocryst phases adequately accounts for the depletion of Cr, Ni, and to some extent Co as well as many major element trends, but enrichment in LREE and certain incompatible elements is more problematic.

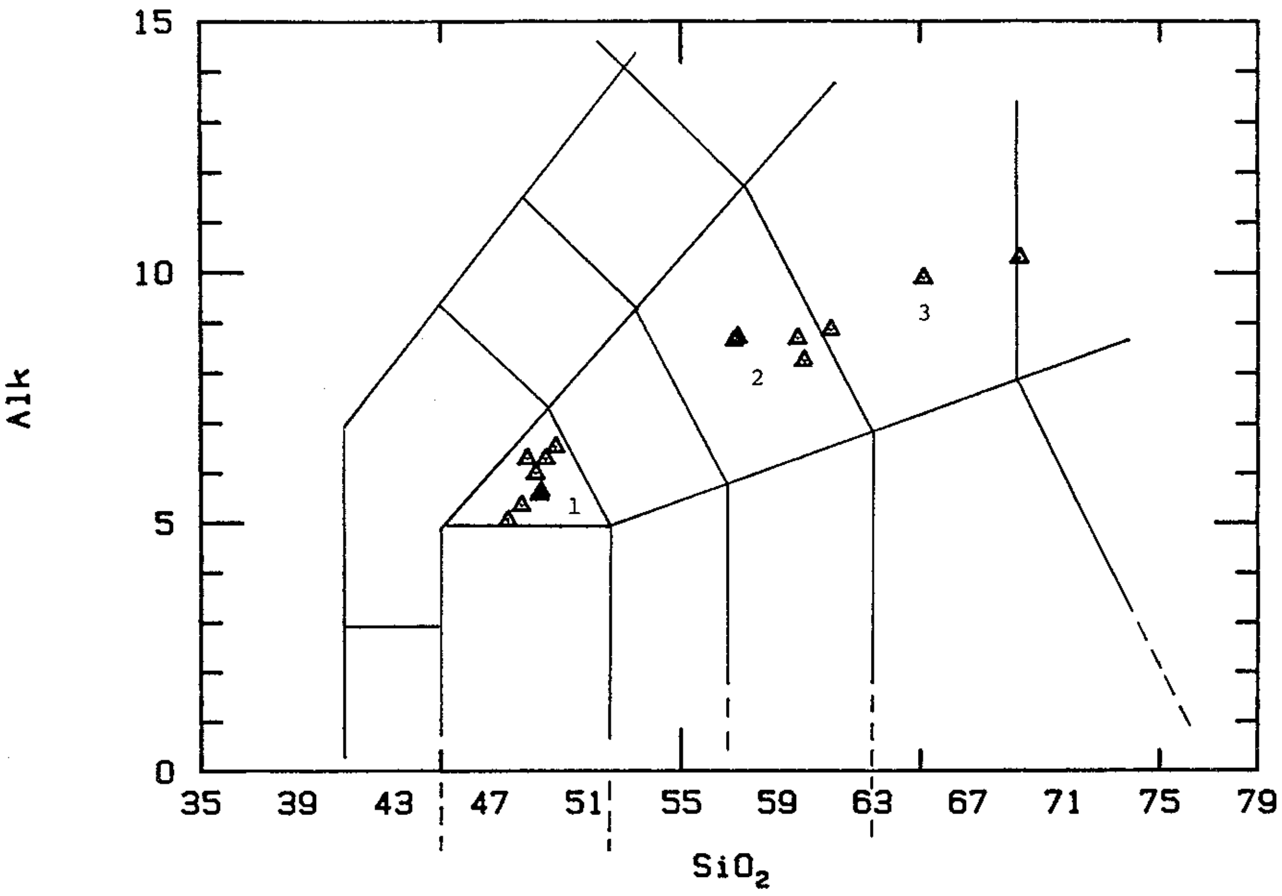

Figure 1. TAS (total alkali-silica) diagram with classifications by LeBas and others (1986). Region 1 consists of potassic trachybasalts, Region 2 consists of latites, and Region 3 has trachytes, trachydacites, and rhyolites.

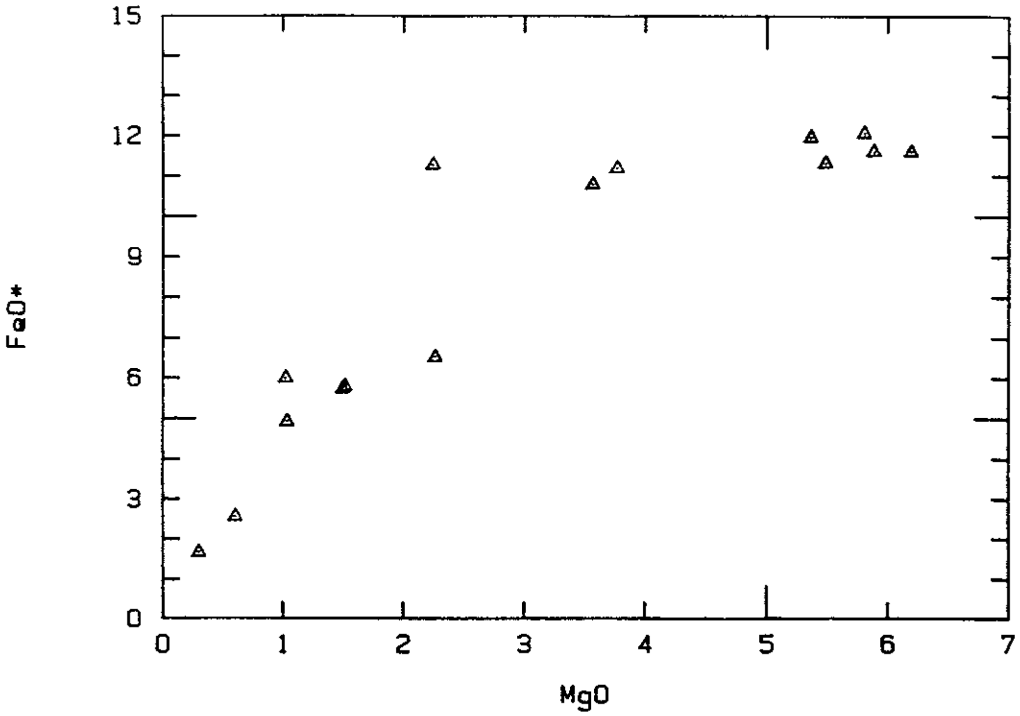

Figure 2. Total iron as FeO* plotted against MgO showing apparent absence of iron enrichment at higher MgO values.

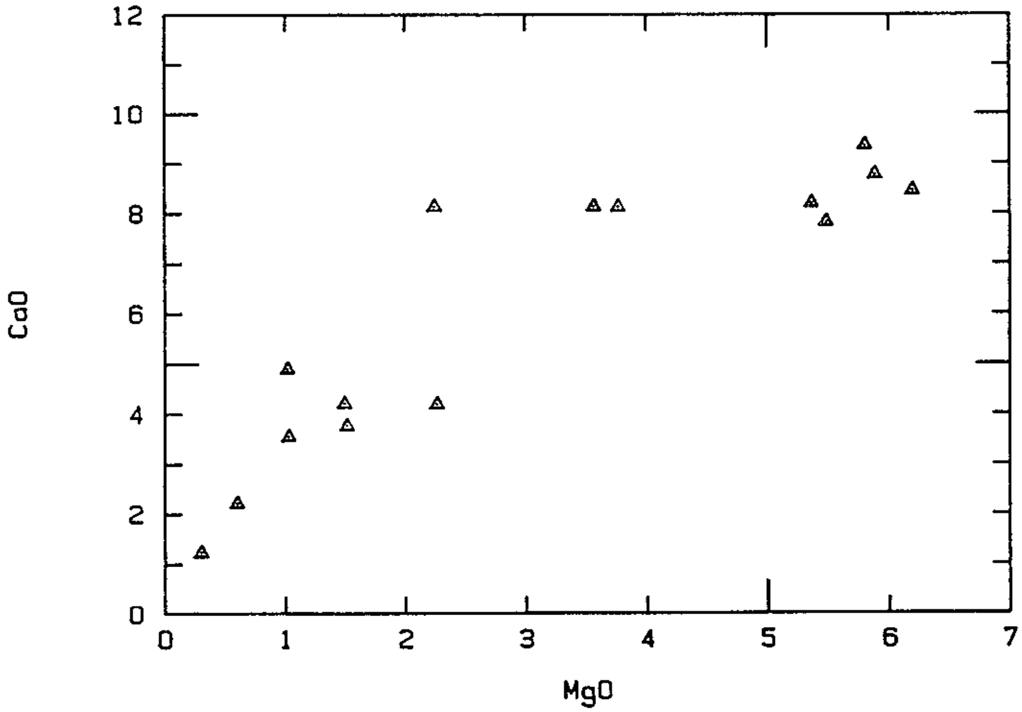

Figure 3. CaO vs. MgO for Witcher samples indicating possible cpx fractionation.

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