THE GEOLOGY OF THE GUFFEY VOLCANIC CENTER NORTH OF GUFFEY, PARK COUNTY, COLORADO

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The field area for this study is a two square mile area in the Thirtynine Mile Volcanic Field just northeast of Guffey, Colorado, approximately centered on section 2, T. 15 S., R. 73 W., in the SE 1/4 of the Thirtynine Mile Mountain 7.5' quadrangle. Within this area, the current geologic map (Epis and others, 1979) identified basalt dikes, rhyolite dikes, pyroxene diorite plugs, hornblende andesite and biotite andesite flows and dikes, and a tuff breccia unit. These andesite flows are surrounded by the Lower Member of the Thirtynine Mile Andesite. The Upper Member occurs in the central part of the field where it caps Thirtynine Mile, Saddle, Castle, McIntyre, Witcher, and Black Mountains surrounding the Guffey volcanic center. One Upper Member specimen has been dated by other workers using K-Ar methods as Early Oligocene (34.1 $\pm$ 1.1 million years).

The Thirtynine Mile Andesite is thought to represent the remnant flanks of a large composite volcano that was centered between the town of Guffey and Chumway Park about three miles to the southwest. The entire area has been interpreted as a collapsed caldera which was named the Guffey caldera. The primary feature of interest in the field area is a horseshoe-shaped diorite intrusion about one mile long by one-half mile wide in the northeast part of the area. Previous work (Buchanan, 1967) stated that the diorite intrusion was the main resurgent dome from which the surrounding hornblende andesite flows originated. This interpretation was based on the fact that the intrusion forms a large circular topographic high and the observed gradational contact between the intrusion and the hornblende andesite flow. However, no definite mineralogic relationship was established between the intrusion and the intruded andesite flows.

Detailed mapping and sampling of the area failed to reveal any of the reported biotite andesite dikes cutting the hornblende andesite flows. The tuff breccia was also not located. A large biotite-hornblende andesite dike was found cutting the biotite andesite and a small basalt dike was extended to three times the length shown on the geologic map. Measurements of the biotite andesite flows produced a strike of N. 19-25° W., and dipping 58-70° SW. The only reliable measurements were taken near two large dikes and therefore may not reflect the original flow direction. The hornblende andesite flows strike N. 45-50° E., and dip 38-50° NW. These measurements were generally limited to outcrops on hilltops and may have had their dips reversed by the intrusion of the diorite beneath the flows.

Mapping of the diorite intrusion also revealed many previously unknown features. The intrusion is larger than was earlier thought with a chilled margin of a dark-colored fine-grained rock identified as pyroxene andesite. In many places the margin zone consisted of a breccia with many xenoliths of hornblende andesite, up to about 10 cm in diameter. Another unique feature was the occurrence of post-diorite granitic veins cutting the breccia and margin rocks, but not the diorite itself. The veins are generally small, ranging in size from 3 mm to 8 cm in width. The reported rhyolite dikes are also found along this margin zone, and are actually areas of heavily silicified breccia or flows. Three "islands" of chilled margin rock were mapped on top of the diorite with very irregular and difficult to trace gradational contacts. These islands are additional evidence that the diorite intruded into the pre-existing flows, and that the top portion of the intrusion is currently exposed.

Thirty of the specimens collected during field work were thin sectioned and examined with a petrographic microscope. Good mafic and plagioclase phenocrysts in a groundmass of plagioclase were seen in most thin sections. The plagioclase phenocrysts are zoned and twinned. The biotite andesites contain hornblende as well as biotite phenocrysts in a matrix of plagioclase and glass. Hornblende andesites are characterized by large, often aligned, hornblende phenocrysts with occasional biotite or clinopyroxene. The biotite-hornblende andesite dike has large hornblendes with some small biotite phenocrysts and glomerocrysts of plagioclase. All of the flow units are quartz normative, but lack modal quartz. The primary phenocryst of the pyroxene andesite and diorite is clinopyroxene. Clinopyroxene often exhibits lamellar twinning and some crystals are zoned. The matrix is all plagioclase, and no orthopyroxene is present. Plagioclase composition of the diorite is andesine ($AN_{37\text{-}47}$) with one diorite plug containing labradorite with a composition near AN_{50}. The pyroxene bearing rocks are all marginal to undersaturated, being nepheline and hypersthene normative. Olivine and clinopyroxene phenocrysts are dominant in the basalt dikes, which are hypersthene normative. The granitic veins are almost entirely quartz and orthoclase with some biotite, magnetite, and zoned plagioclase.

Fifteen specimen rock powders were analyzed for major elements by x-ray fluorescence. On the basis of the petrographic evidence and major element data the specimens were reclassified according to the IUGS total alkali-silica (TAS) diagram for the chemical classification of volcanic rocks (fig. 1). For the classification, the oxides were normalized to 100 percent on a volatile-free basis. The basalt is classified as a potassic trachybasalt. The chilled margin rock, as well as the diorite, is a potassium-rich basaltic trachyandesite called a pyroxene shoshonite. The andesitic flow units are also very potassium rich and classify as hornblende latites, hornblende trachytes, and biotite trachydacites, with the dike rock being a biotite-hornblende trachyte. On a chemical basis, the granitic veins classify as rhyolite. Being coarse-grained rocks, the diorite and granitic veins will retain those names according to the QAPF diagram based on petrographic observations.

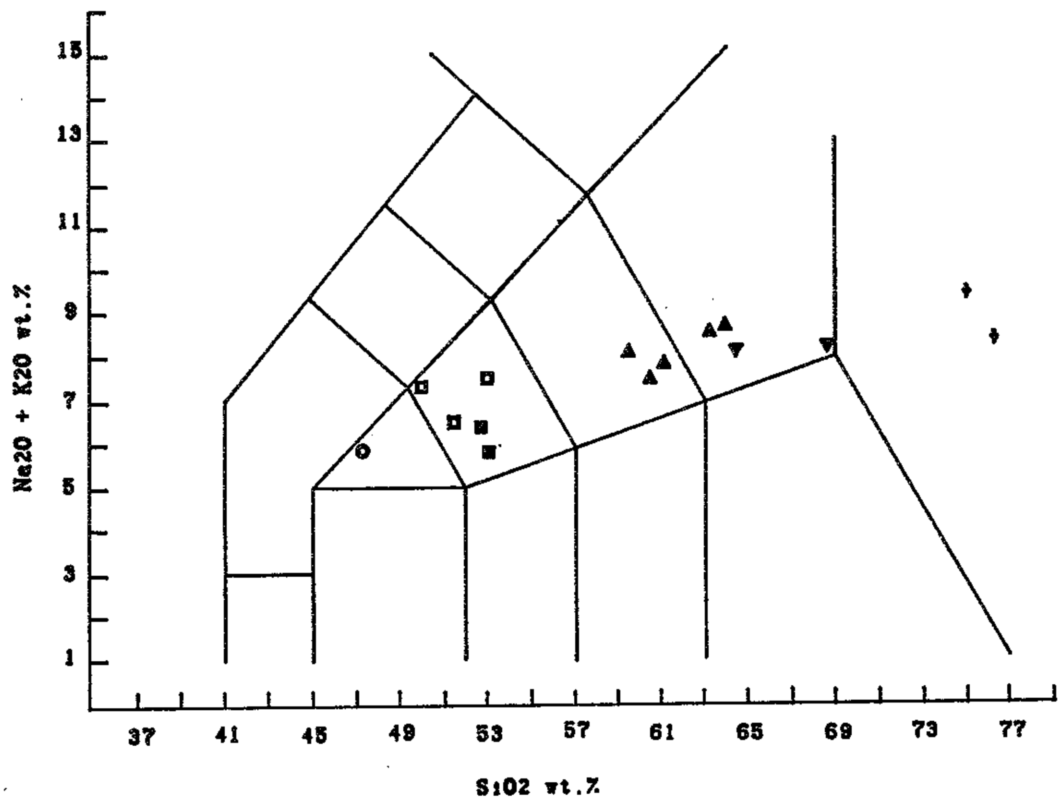

Figure 1. Chemical classification of specimens collected from the Guffey Volcanic Center using the IUGS total alkali-silica (TAS) diagram. The circle is a potassic trachybasalt, open squares are pyroxene diorites (from QAPF), solid squares are pyroxene shoshonites, triangles are hornblende latites and trachytes, one inverted triangle is a biotite-hornblende trachyte dike rock while the other is a biotite trachydacite, crosses are granitic veins (from QAPF).

Thirty-six specimen rock powders, including all those with thin sections, were analyzed by neutron activation for trace and rare-earth elements. In addition, twenty duplicate analyses were done in a separate batch. The rare-earth element (REE) analyses showed relatively high total REE with a high degree of light / heavy REE fractionation, and lacking in Eu anomalies (fig. 2). The biotite trachydacites have 140-290 ppm and the hornblende latites 180-265 ppm total REE with similar REE profiles. The pyroxene shoshonites, at 230-360 ppm, and the diorites, ranging from 215-430 ppm total REE, have similar patterns but at higher REE values. The trachybasalts and granitic veins also follow the same general pattern with the exceptions of negative Tb, negative Lu, and positive Dy anomalies not seen in most other profiles.

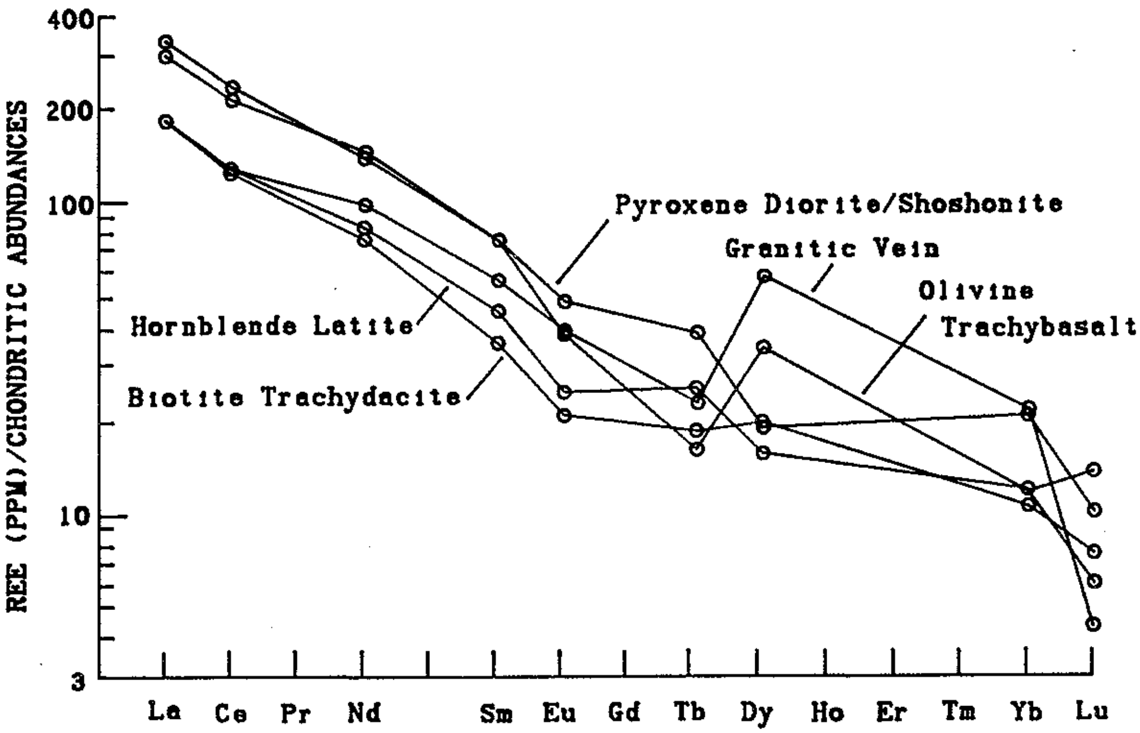

Figure 2. Chondrite normalized REE diagram with REE profiles for five typical specimens representing the major rock units found in the study area: biotite trachydacite, hornblende latite, pyroxene diorite / shoshonite, olivine trachybasalt, and a granitic vein.

The stratigraphic sequence determined by field relationships corresponds to the chemical relationships discussed. The trend is towards decreasing silica with increasing iron and magnesium. The entire series is very potassium rich in character, and late stage intrusives show a distinctive REE profile. The local volcanic sequence begins with the biotite trachydacite, followed by intrusion of the biotite-hornblende dike, hornblende latite and trachyte flows, and intrusion of pyroxene diorite with development of the chilled margin pyroxene shoshonite and breccia. The diorite is followed by the late stage intrusion of residual granitic veins into the margin zone of the diorite, as well as the intrusion of basaltic dikes. The diorite intrusion may be related to the flows, but was not the source. The flows themselves are similar to the Thirtynine Mile Andesite, and should be included as portions of the Lower Member. The data is consistent with a model of partial melting at depth of crustal material related to a subduction zone. Phenocryst variations can be explained as the result of fractional crystallization and crystal settling over a long period of time in a high potassium andesitic magma chamber.

Notes