THE PETROLOGY AND GEOCHEMISTRY OF MID TERTIARY EXTRUSIVES OF THE THIRTYONE MILE MOUNTAIN AREA, THIRTYNINE MILE VOLCANIC FIELD, COLORADO.

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The Thirtynine Mile Volcanic Field (TMVF) is the second largest Tertiary volcanic field in Colorado.The majority of the volcanics are Oligocene, overlying a late Eocene erosional surface and the Wall Mountain Tuff (36 Ma from Epis and Chapin, 1974). A great deal of the research in the TMVF has concentrated on the largest eruptive center near the town of Guffey. Recent radiometric data indicate that there was volcanic activity in the Guffey vicinity as early as 58.5 Ma and as late as 29.7 Ma, with the majority of eruptive activity occurring between 35.8 and 34.0 Ma (Eppley, 1990). Geochemical studies of volcanics from the TMVF show a wide range of SiO_2 (values from 47 to 72%), enrichment in K_2O and rare earth elements, relatively high concentrations of Ba and Rb, and depletion of Cr and Ni (Wobus and others, 1990).

The subject of this study is the previously named Thirtyone Mile volcanic center, which comprises Thirtyone Mile Mountain and its flanking ridges and slopes. It covers about 10 square kilometers and is centered 4 kilometers southwest of the town of Guffey. From field relations alone, previous workers identified the Thirtyone Mile volcanic center as separate from, and predating the Guffey center. DuHamel (1968) suggested that either caldera formation or regional block faulting could explain the structural features seen in the area. Thirtyone Mile Mountain was previously mapped as a large exogenous dome, and all flows in the area were believed to have been erupted from the Thirtyone Mile center. The dome and all flows were grouped and described as a single unit, the Thirtyone Mile Andesite. The purpose of this study is to provide a more detailed description and interpretation of the Thirtyone Mile Andesite and its relation to the rocks of the Guffey volcanic center.

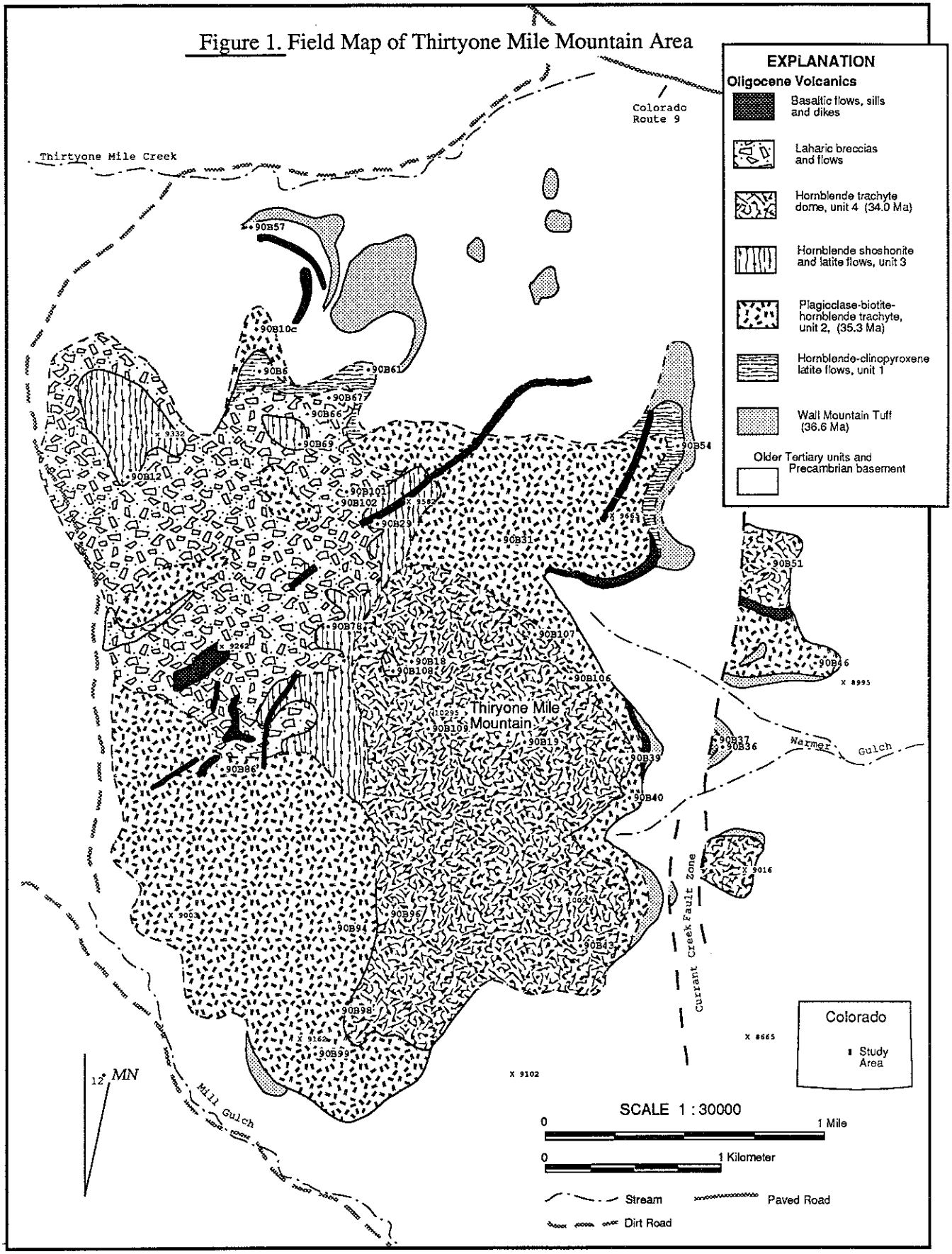
Detailed mapping of the area revealed that there are a number of distinct, mappable units contained within the area previously mapped as Thirtyone Mile Andesite (fig. 1). Four units were defined and numbered by relative ages interpreted in the field. In the northwest quarter of the study area, abundant laharic breccias and flow deposits closely resemble the lower member of the Thirtynine Mile Andesite from the Guffey center. The stratigraphic position of these breccias could not be precisely resolved; however they clearly underlie unit 3. A large conspicuous bluff of similar breccias and flows on the northwest flank of Thirtyone Mile Mountain may overly unit 4. Unit 4 the uppermost, dome forming unit, appears to have lifted unit 2 into a flatiron on the west side of Thirtyone Mile Mountain while it clearly overlies unit 2 on the east side.

Unit 1 consists of hornblende-clinopyroxene latite flows. There are at least two flows forming a unit thickness of 10m. In outcrop the flows have blue-grey phenocryst-rich bases and vesicular or amygdular tops without phenocrysts, weathering to light blue or pink. These flows contain about 20 modal percent phenocrysts; plagioclase and hornblende are equally abundant, together accounting for 90% of phenocrysts with clinopyroxene, magnetite and apatite accounting for the rest. The groundmass has a trachytic texture of 90% plagioclase laths and 10% magnetite.

Unit 2 consists of a single thick, 15-30m, plagioclase-biotite-hornblende trachyte flow. In outcrop the rock is light blue to grey, weathering to tan. The presence of plagioclase as a major phenocryst phase easily distinguishes this unit from other Thirtyone Mile units. Sheet type fracturing is often present with up to three planes of fracture present in the same outcrop. Phenocrysts are 12 modal percent with plagioclase accounting for 95% and hornblende and biotite the rest. Plagioclase phenocrysts generally show two size populations, the larger often being glomeroporphyritic and occasionally intergrowing with biotite. Plagioclase composition is about AN 45. The groundmass is of trachytic or pilotaxitic texture consisting of 90% feldspar laths and magnetite and biotite. The K-Ar age of this unit is 35.3 Ma (Eppley, 1990).

Unit 3 contains a number of hornblende shoshonite and latite flows with a total thickness of about 15m. In outcrop the flows have brown to purple-grey bases with with highly weathered grey vesicular tops. Samples from this unit represent a variety of different flows. Phenocryst content ranges from 1 to 5 modal percent made up of a wide range of relative abundances of hornblende, plagioclase, clinopyroxene and opaque. Olivine and apatite are also present in small amounts as phenocryst phases. The groundmass is of flow aligned plagioclase laths (60-80%) forming a trachytic texture, with lesser magnetite and clinopyroxene.

Figure 1. Field Map of Thirtyone Mile Mountain Area



Unit 4 is the dome-forming hornblende trachyte. In outcrop it is characteristically light grey, weathering to buff with sparse hornblende phenocrysts. Sheet fracturing is often present; however, it cannot be used to reconstruct flow structure of the dome as there are three possible planes of fracture any of which might represent flow alignment. Vertical thickness of the unit is about 300m. Modal abundance of total phenocrysts is low, between 3 and 7 percent. Hornblende accounts for the great majority of phenocrysts (99-95%), with two size populations. There are occasional plagioclase phenocrysts. The groundmass is 90% feldspar laths forming a pilotaxitic or trachytic texture with magnetite and small amounts of clinopyroxene as the remaining 10%. The age of this unit is 34.0 Ma (Eppley, 1990).

Chemical analyses of 21 samples were completed at Franklin and Marshall College. X-ray fluorescence and inductively coupled plasma techniques were used to determine major and trace element chemistry. Chemical analysis of 2 samples was completed by H. Eppley. 9 samples were sent to Activation Laboratories Ltd. where instrumental neutron activation provided additional trace element (specifically REE) chemistry. These data reveal a wide range of SiO_2 contents, from 50 to 70 percent. The K_2O content is from 3 to 5 percent with relatively high total alkalies. Using the classification of LesBas and others (1986) the rocks are trachytes, latites, and shoshonites (fig. 2). Plotted with previous analyses, rocks from this study overlap the trend established by rocks from the Guffey volcanic center (fig. 2). This figure also shows that, except for unit 3, the field units exhibit good clustering of compositions. TiO_2, total Fe and P_2O_5 show a positive linear relationship to increasing MgO values. Al_2O_3 does not show variation as a function of MgO.

Trace element values also fall within the ranges of previous Guffey analyses. Rb values are between 80 and 160 ppm, Sr between 600 and 1400 ppm, and Ba concentrations are characteristically high, between 1700 and 2500. Ni and Cr contents are low, <17 and <70 ppm, respectively. Total REE concentrations are high, from 200 to 300 ppm. Light/heavy REE fractionation varies according to SiO_2 content; La/Lu ranges from 11 to 28 when SiO_2 is from 50 to 66 percent. There is no Eu anomaly. A spider diagram of the analyses also shows light/heavy fractionation, with relative enrichment of large ion lithophile elements and depletion of Ti (fig. 3).

From field mapping and chemical data a few conclusions can be drawn concerning the relation of the Thirtyone Mile volcanic center to the Guffey center.

1) Field relations and new K-Ar dates indicate that contrary to previous interpretations, activity at the Thirtyone Mile center did not significantly precede Oligocene activity at the Guffey center; instead the beginning of activity was contemporaneous.

2) Aside from unit 4 of the dome, it is impossible to tell if all the flow units mapped in the area were actually erupted from the Thirtyone Mile center because the compositional trends are so similar to those of the Guffey center.

3) The source of erupted material was very similar to, if not the same as, the source of material for the Guffey center, as indicated by similar major and trace element chemistry.

Works Cited:

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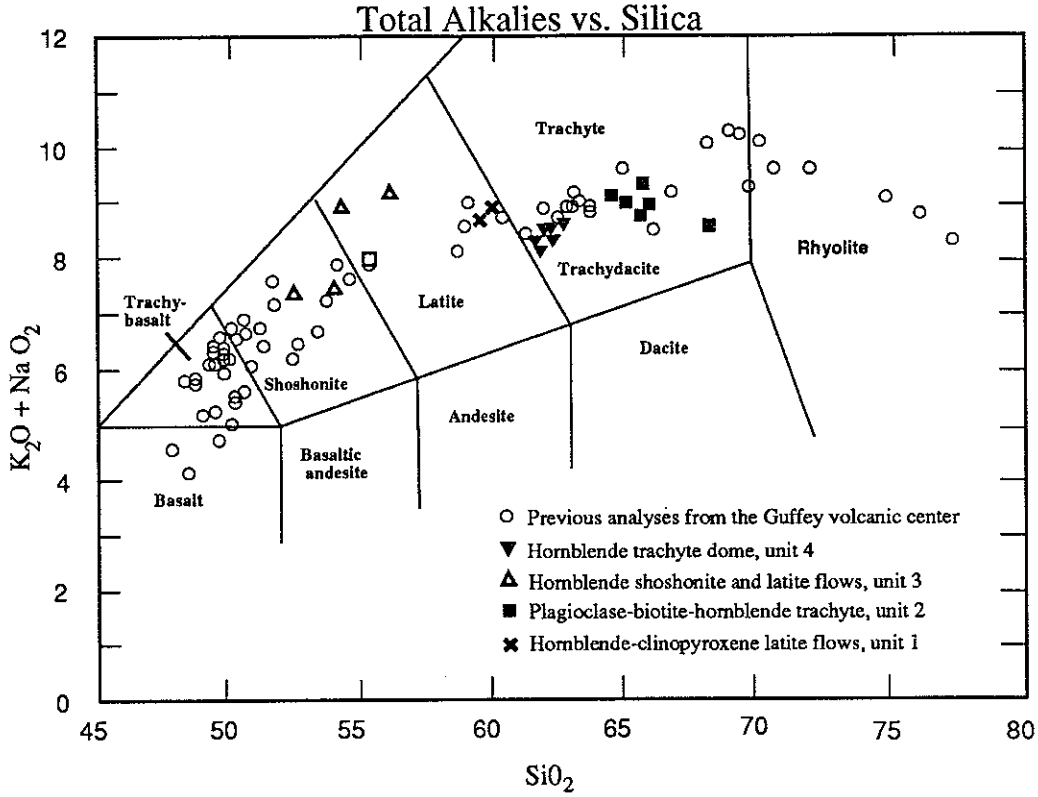

Figure 2. Total alkalies vs. silica diagram showing similarity of Thirtyone Mile rocks to those of the Guffey center

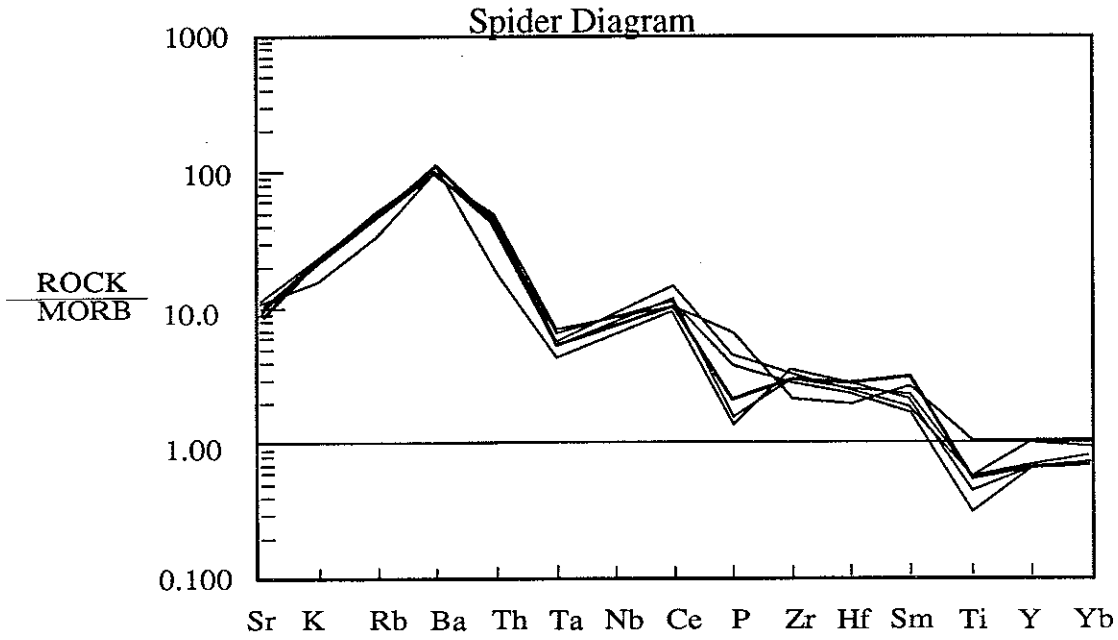

Figure 3. MORB normalized spider diagram showing large ion lithophile enrichment and Ti depletion.