THE PETROLOGY AND GEOCHEMISTRY OF TUFFS AND TUFF BRECCIAS OF THE THIRTYONE MILE MOUNTAIN AREA, THIRTYNINE MILE VOLCANIC FIELD, CENTRAL COLORADO

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INTRODUCTION

Thirtyone Mile Mountain is located in the southeast portion of the Thirtynine Mile volcanic field, approximately 5 km southwest of the village of Guffey, Colorado. It is located in the northeast quarter of the Black Mountain 15' quadrangle map (Epis, Wobus, and Scott, 1980). Epis and Chapin (1968) proposed Thirtyone Mile Mountain to be a separate, earlier center than the Guffey center. The petrology and geochemistry of the Guffey center was studied by the Keck Consortium in the summer of 1987. The results of this study were published in the Abstracts Volume of the First Keck Research Symposium in Geology and in Geology (1990).

FIELD DESCRIPTION

Biotite and hornblende andesite flows and lahars are the most widely distributed rocks of the area. These units are intruded by basalt and rhyolite dikes. The andesite and basalt units are described by Booth and Tittler in this volume. Tuffs and tuff breccias, the focus of this study, are interlayered throughout the sequence. In the field, three units of tuffs and tuff breccias were recognized on the basis of mafic content. The first lay on top of Precambrian rock and contained fragments of Precambrian quartz monzonite, rhyolite, pumice and perlite. The second lay on top of several andesite flows and contained one or more of: rhyolite, pumice and andesite(?). The third unit lay above more andesite flows and contained hornblende andesite, rhyolite and pumice.

PETROGRAPHY

Thin section study shows that the first (oldest) stratigraphic unit varies from hypohyaline to hypocrystalline and is a vitrophyric breccia. It is composed of an estimated 60 - 90% cryptocrystalline rhyolite and Precambrian quartz monzonite fragments which range in size from 0.16 mm to 26 cm (field observation). The fragment texture is intersertal and trachytic. A thin section from a rhyolite dike showed 1% anhedral quartz, 1% subhedral, altered biotite, <1% subhedral sanidine and <1% anhedral skeletal hornblende, partially oxidized to hematite. The matrix is red glass and contains perlite fractures. The breccia is 1 - 2% quartz phenocrysts, 1% altered biotite (chlorite), 5% perlite, <1% glass shards and 4% subangular feldspar. Of the feldspar, 3% is oligoclase, <1% is microcline, and <1% is sanidine or sanidine altering to microcline. The plagioclase is commonly continuously and discontinuously zoned. Two samples were collected from Baldy Peak (5 km northwest of 31 Mile Mountain) for thin section analysis. These were found to be 75% crystalline and to contain 40% angular to subangular rock fragments. The fragments were dacite in composition and ranged in size from 0.23mm to 2cm. 1% of the rock is anhedral quartz phenocrysts and <1% is anhedral oligoclase.

The second stratigraphic unit is hypohyaline to holocrystalline and vitrophyric. Inequigranular, subangular to subrounded rock fragments comprise an estimated 50 - 70% of the breccia and range from 0.2 - 2 cm. The rock fragments are microcrystalline, intersertal and dacite to rhyodacite in composition. Two out of five thin sections contained Precambrian granite. Two outcrops of this unit contained a green silicified material termed "celadonite" by Duhamel (1966). X-ray diffraction shows that this material is sanidine - rich and either celadonite or paragonite. Anhedral oligoclase phenocrysts comprise 2% of the rock. It is commonly oscillatory zoned and altered to sericite. Microcline is present in less than 1% of the rock. When present, biotite phenocrysts comprise 1% of the rock. The biotite is skeletal and sometimes altered to wispy chlorite. Skeletal and embayed hornblende phenocrysts are <1% of the rock. Their texture is euhedral to anhedral. Subrounded perlite fragments comprise up to 2% of the rock and are 0.1 mm to 1 cm. Occasional pumice fragments are 1% of the rock and range in size from 0.2cm - 1 cm. Pumice from this unit was analyzed in thin section and found to contain 4% anhedral quartz, 1% sanidine, 1% altered biotite, and <1% oligoclase.

The third stratigraphic unit (youngest) is 75 - 90% crystalline, inequigranular and vitrophyric. Subangular to subrounded dacite to rhyodacite fragments compose 70 - 94% of the breccia. These range in size from 0.3mm to 15 cm. The texture is intersertal and trachytic. The breccia is <3% anhedral quartz phenocrysts,<4% sub- to anhedral, wispy biotite (chlorite), <4% euhedral to anhedral hornblende (some oxidized to hematite) which is skeletal and embayed, and 1 - 10% feldspar phenocrysts. Of the feldspar, <10% is anhedral to subhedral oligoclase. The

oligoclase is continuously or discontinuously zoned, and embayed by the glass matrix. Subhedral orthoclase or microcline<1%. Subhedral sanidine is <3%. One outcrop of this unit contains manganese concretions determined by x-ray diffraction to be cryptomelane.

GEOCHEMISTRY

Geochemical analysis was performed on four samples at Franklin and Marshall College. These samples were chosen for homogeneity and likelihood of occurring as clastic material in the breccias. One standard, NBS-278 (rhyolite), was also analyzed for comparative purposes (sample 5). Results were plotted according to the LeBas, et al. (1986) total alkali-silica diagram for chemical classification of volcanic rocks (fig 1). Sample 2 plotted as a trachyte (originally termed rhyolite) while the other three plotted as rhyolites. Sample 1 was collected from Chumway Park, an area to the north of the study area. Sample 4 is a clast from a Guffey center tuff breccia. "Rhyolite Hill Group," "Chumway Park Group," and "Pyroclastic Breccia and Lapilli Tuff" refer to units described by Johnson (1988) and are included for comparison. Figure 2 is a plot of FeO vs. MgO for samples from the study area as well as results from Eide's (1988) study of Castle and McIntyre Mountains and Rothwarf's (1988) study of Castle Mountain. Figure 3 shows plots of cobalt, chrome, and nickel vs. silica for samples from the study area as well as samples from Keating's (1988) study of the Dicks Creek area.

CONCLUSIONS

Based on the angularity of the rock fragments, the eruption which produced the Thirtyone Mile tuffs and tuff breccias was violent and cataclastic. The large size of the fragments indicates proximity to source area. Because of geochemical similarity between the rocks of the study group and and those of Chumway Park and Rhyolite Hill (fig. 1) they are hypothesized to emanate from the same source. Alteration of biotite and hornblende phenocrysts in samples from the Thirtyone Mile Mountain area suggests considerable hydrothermal activity. Thirtyone Mile rocks are lower in FeO than rocks of the Guffey center (Castle, McIntyre, and Cover Mountains, fig. 2). Plots of Cr, Co, and Ni vs. SiO2 (fig. 3) show a definite decrease in mafic elements (and an increase in silica) from Guffey Center rocks to Thirtyone Mile Mountain rocks. Petrographic data show a progression from felsic to mafic rock fragments and the appearance of hornblende in the intermediate unit. Therefore, I conclude that volcanic succession within the Thirtyone Mile Mountain center was from felsic to mafic, and this succession continues with the onset of Guffey center volcanism.

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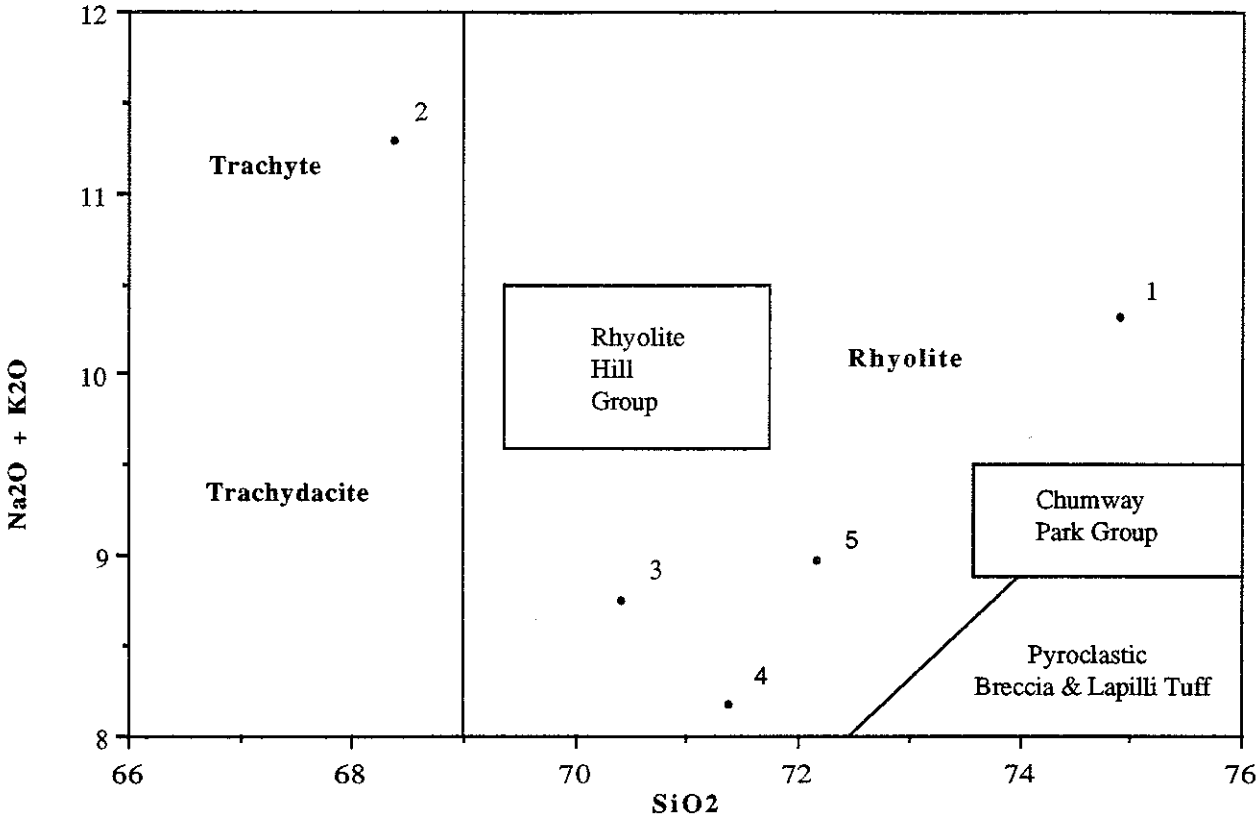

Fig. 1 Total Alkali-Silica Diagram (LeBas, 1986) for 31 Mile Mountain rocks and rocks described by Johnson (1988).

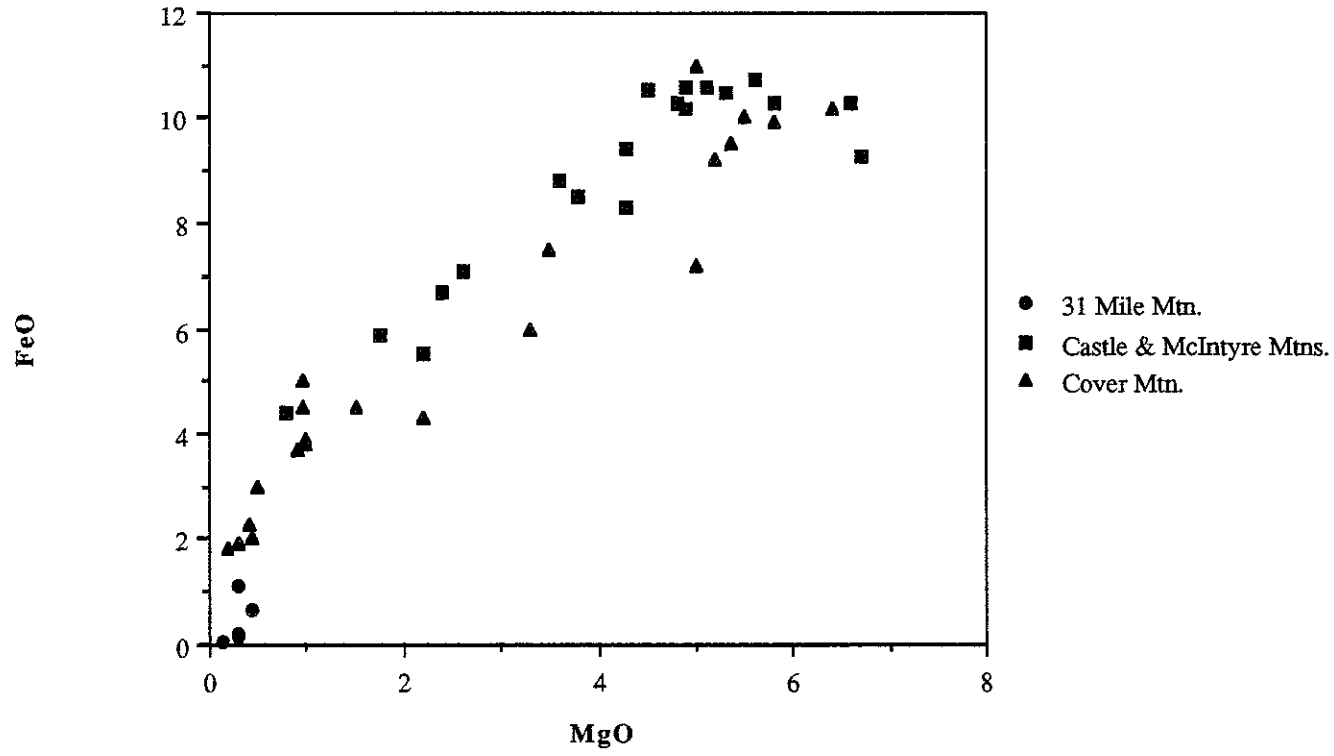

Fig. 2 Plot of FeO vs. MgO for 31 Mile Mountain rocks and rocks described by Eide (1988) and Rothwarf (1988).

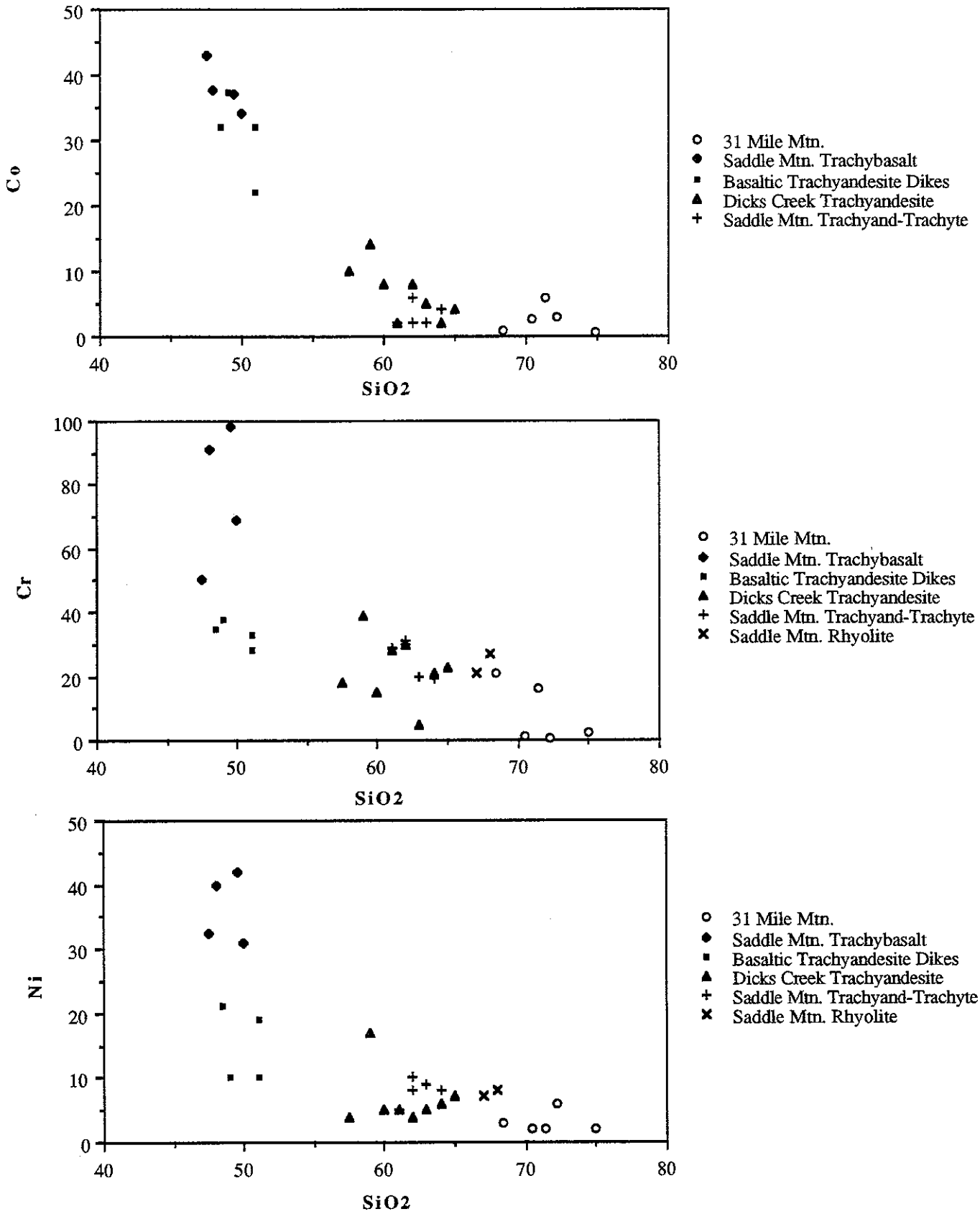

Fig.3 Plots of Co, Cr, and Ni vs. SiO2 for 31 Mile Mountain and rocks described by Keating (1988).