Precambrian metavolcanic rocks of the Tusas Mountains, New Mexico: major elements and oxygen isotopes

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in:

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The Precambrian volcanic rocks of the Tusas Mountains, north-central New Mexico, have been studied in rather spasmodic fashion since the 1930's. Just (1937) reported the results of a brief but commendable reconnaissance. He recognized two types of metagraywacke rocks; those of basaltic and andesitic composition he named the Picuris Basalts, and those of rhyolitic type he named Vallecrucis Rhyolites. He suggested that both types originated as flows, and indicated that they were closely interlayered with quartzite, conglomerate, and other sedimentary rocks of Proterozoic age. In particular, Just (1937) noted that the metarhyolite typically is flow banded, contains phenocrysts of quartz and alkali feldspar, has an aphanitic groundmass, and is conformably interlayered with the enclosing sedimentary rocks.

In his inclusive report on the pegmatites of the Petaca district, Jahns (1946) briefly mentioned amphibole schist and metarhyolite. He noted field relations of these rocks similar to those found by Just (1937).

The geology of the 15-minute Las Tablas quadrangle was studied by Barker (1958), by what now would be called semireconnaissance methods. The mafic-flow rocks were renamed the Moppin Metavolcanic Series, and the metarhyolite, the Burned Mountain Metarhyolite. A number of layers of each of these units were delineated on Barker’s geologic map. Just’s conclusion that the mafic layers and most of metarhyolite are extrusive was substantiated, although Barker did find several bodies of metarhyolite that apparently transected the bedding of the enclosing quartzite. He concluded that the rhyolite was emplaced largely as flows, and partly as sills and dikes. Much of the metarhyolite probably originated as ash flows, for crushed pumice fragments are prominent in sample BLT 1, which was collected just northwest of Burned Mountain (Table 1). In any case, a detailed restudy of the Burned Mountain Metarhyolite should be made. Similar metavolcanic
rocks also have been mapped in the Cebolla 15-minute quadrangle by Doney (1968) and in the Brazos Peak 15-minute quadrangle by Muehlberger (1968).

Four analyses of metabasalt and metabasaltic andesite and one of metarhyolite were given by Barker (1958). This paper presents fifteen new analyses of these rocks, along with oxygen isotopic ratios of fourteen of these samples.

**MAJOR ELEMENTS**

Major-element contents and CIPW rock norms of 20 samples of the Moppin Metavolcanic Series and the Burned Mountain Metarhyolite are given in Table 1. Nine of the Moppin samples are quartz-normative tholeiitic in type. The tenth, BMV2, contains 2.11 percent of K₂O and 54.57 percent of SiO₂. This rock would be classed as an alkalic basaltic andesite, using Lipman and Mehnert's classification (in press). The analyses of the Burned Mountain show two notable features: (1) The ratios of Fe₂O₃/FeO are high; this is because much of the iron present is in hematite, which formed during metamorphism. (2) Abundances of K₂O and Na₂O show what is very nearly a sympathetic relationship (Fig. 1). Alkali exchange probably took place before or during devitrification.

Normative quartz, albite, and orthoclase are plotted in Figure 2. The metatholeiites and metabasaltic andesite contain normative quartz and spread across a relatively Ab-poor part of the diagram. The metarhyolites cluster near the experimentally determined minima of James and Hamilton (1969) for melts containing 3 and 5 percent of An component at 1 kb water pressure. Normative An contents of the metarhyolite range from 0.2 to 5.8 percent; thus, these two minima are compositionally suitable, and we may conclude that these rhyolites are of near-minimum compositions. We have no indication as to whether the rhyolitic liquids were water saturated or not, or as to the magnitude of P_H₂O of these liquids. The two points that plot at more quartzose positions than either of the two minima contain 0.2 and 3.6 percent normative An; positions of the other points on the diagram appear to be randomly related to their normative An contents. A minimum water pressure of these liquids cannot be inferred from the disposition of points relative to any experimentally determined minima.

An Alk-F-M plot of the data (Fig. 3) indicates that the metabasalts are typically tholeiitic.

**OXYGEN ISOTOPES**

The average δ O₁₈ value of the mafic rocks is +6.64 per mil, and that of the metarhyolites is +8.98 per mil (Table 1). These values are typical of fresh tholeiite and of glassy, continental rhyolite, respectively (Taylor, 1968), and we conclude that most of these samples suffered little or no exchange with the enclosing sedimentary rocks during metamorphism.

**AGE**

A preliminary age of the Burned Mountain Metarhyolite of 1,750-1,800 m.y. has been determined by Prof. L. T. Silver (oral commun., 1974) by the U-Pb isotopic method on zircon. He also reports that the Maquinita Granodiorite (Barker, 1958), which cuts the Moppin Metavolcanic Series, is between 1,700 and 1,750 m.y. in age. The quartz-eye trondhjemite of
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APPENDIX

Locations of samples

BMV 1: SW 1/4 NE 1/4 sec. 26, T. 28 N., R. 7 E.
BMV 2: NE 1/4 NE 1/4 sec. 23, T. 28 N., R. 7 E.
BMV 3: SW 1/4 SE 1/4 sec. 9, T. 27 N., R. 7 E.
BMV 4: SE 1/4 SE 1/4 sec. 14, T. 27 N., R. 8 E.
I3MR: NE 1/4 SE 1/4 sec. 14, T. 27 N., R. 7 E.
BLT 1: NW 1/4 SW 1/4 sec. 8, T. 28 N., R. 7 E.
BLT 4: SE 1/4 SE 1/4 sec. 14, T. 27 N., R. 7 E.
BLT 25: SE 1/4 NE 1/4 sec. 36, T. 27 N., R. 7 E.
BLT 26: SW 1/4 NE 1/4 sec. 5, T. 26 N., R. 8 E.
BLT 27: NW 1/4 SE 1/4 sec. 4, T. 27 N., R. 7 E.
BLT 28: NW 1/4 SE 1/4 sec. 4, T. 27 N., R. 7 E.
BLT 29: SE 1/4 NE 1/4 sec. 4, T. 27 N., R. 7 E.
BLT 30: SE 1/4 NE 1/4 sec. 4, T. 27 N., R. 7 E.
BLT 31: NW 1/4 NW 1/4 sec. 10, T. 27 N., R. 7 E.
BLT 32: SW 1/4 SW 1/4 sec. 21, T. 27 N., R. 8 E.
BLT 33: SE 1/4 NE 1/4 sec. 4, T. 26 N., R. 8 E.
BLT 34: NW 1/4 NE 1/4 sec. 17, T. 27 N., R. 8 E.
BLT 35: SW 1/4 NW 1/4 sec. 16, T. 27 N., R. 8 E.
BLT 36: NW 1/4 NW 1/4 sec. 16, T. 27 N., R. 8 E.
BLT 37: SW 1/4 SW 1/4 sec. 9, T. 27 N., R. 8 E.

Figure 3. Ank-F-M plot of metavolcanic rocks of the Tusas Mountains, New Mexico.