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Preliminary report on mid-Tertiary rhyolite vents and associated mineralization south of Georgetown, Colorado

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1. Preliminary report on mid-Tertiary rhyolite vents and associated mineralization south of Georgetown, Colorado, by Richard B. Taylor and Robert U. King. 15 p., 9 figs. (8 are photos).

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Preliminary report on mid-Tertiary rhyolite vents and associated mineralization south of Georgetown, Colorado

By Richard B. Taylor and Robert U. King

The porphyritic intrusive rocks in the Colorado Mineral Belt in the central part of the Front Range have been regarded as "Laramide" in age — Late Cretaceous to Eocene — in most recent publications. Mid-Tertiary igneous activity, long recognized to the north in the volcanic fields of the Rabbit Ears Range, has been dated by Corbett (1966) at 27 to 28 m.y. for the Mt. Richtofen-Iron Mountain region. Taylor, Theobald, and Izett (1967), using K-Ar ages, documented a significant extension of this volcanic activity to the south. Tuffs from centers in the Rabbit Ears Range were found to extend into the Kremmling intermontane basin, and were dated at 33 m.y. Tuff breccias of 29 m.y. age were recognized in the southeastern part of the Fraser intermontane basin on the western flank of the Front Range, and a 27-m.y. vent was identified at Red Mountain (2 miles southwest of Berthoud Pass) on the western margin of the Mineral Belt. Two intrusive masses 5 miles south of Georgetown have recently been examined, and are correlated with the Oligocene volcanic activity at Red Mountain on the basis of features indicating shallow porphyry emplacement, and the nearly identical mineralogy, composition, texture and alteration patterns of the igneous rocks. These bodies, which were probably vents, extend the area of known Oligocene igneous activity southeastward across the Mineral Belt.

Intrusive flow-banded porphyritic rhyolite and flow-banded porphyritic rhyolite breccia make up a plug 1 1/2 miles south-southeast of Paines Mountain (fig. 1). Pervasively altered rhyolite porphyry

Figure 1.--Near here

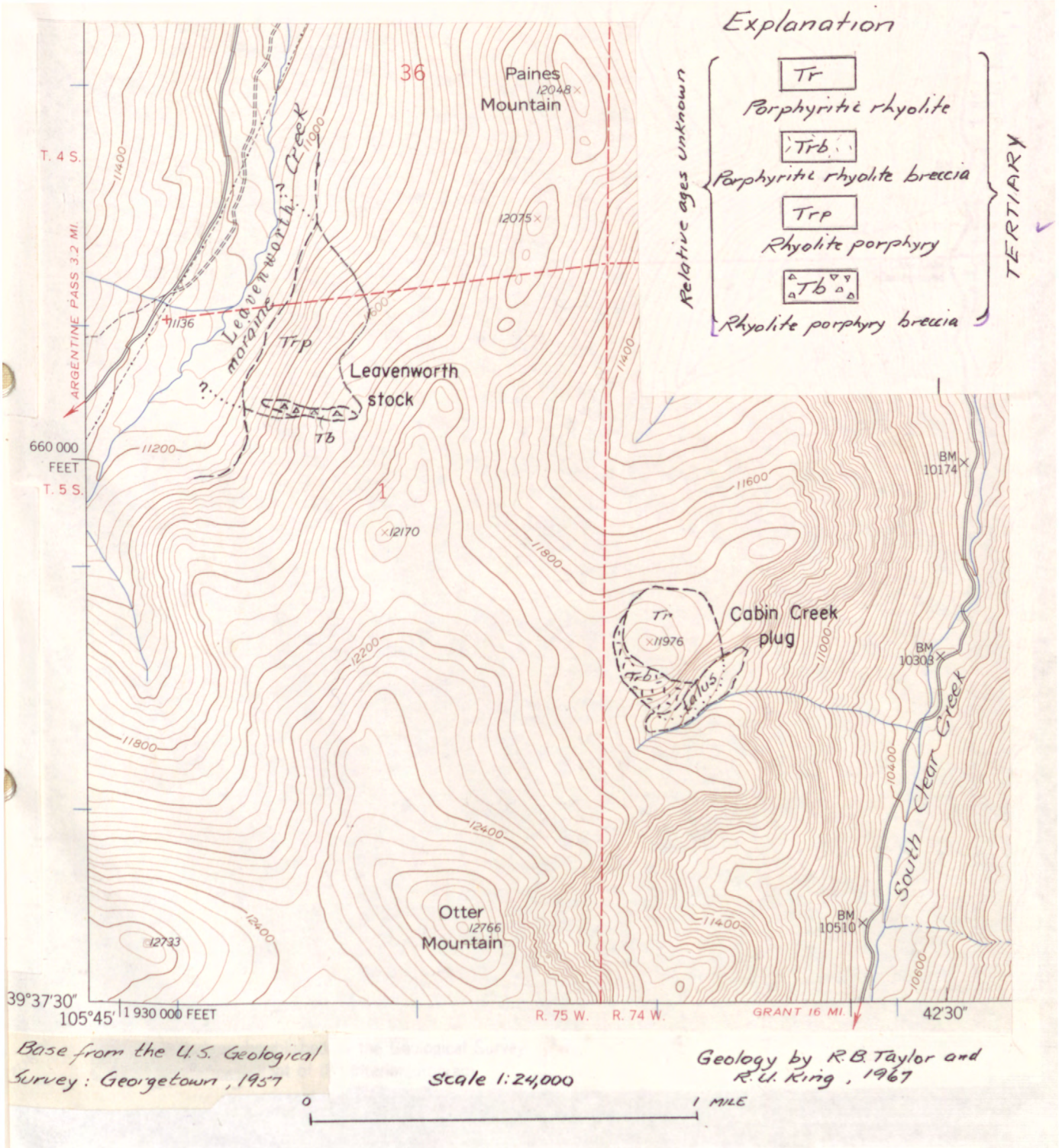

Fig. 1 Geologic sketch map of rhyolite plutons south of Georgetown, Colorado.

with borders of flow-banded rhyolite porphyry or of rhyolitic breccia makes up a stock on the east wall of Leavenworth Creek 1 mile southwest of Paines Mountain. Both of these igneous masses were mapped by Ball (Spurr, Garrey, and Ball, 1908); the eastern mass was called granite porphyry; the western, alaskite porphyry. The detailed petrographic descriptions in this early report led us to examine these igneous bodies, and hence to discover characteristics critical to their correlation with the dated Oligocene porphyry at Red Mountain.

Both of these masses intrude Precambrian rocks, which in this area consist of quartz-feldspar-biotite gneisses intruded by Boulder Creek Granodiorite and Silver Plume Granite.

Cabin Creek Plug

The rhyolite plug southeast of Paines Mountain, called the Cabin Creek plug in this report, has a subcircular plan with a diameter of about 1,100 feet. It lies above timberline, where its surface is covered with frost-riven slabs. Outcrops are limited to the east-facing headwall of a small cirque opening towards South Clear Creek. Two mappable units can be distinguished in this plug; a brown to purplish-brown porphyritic rhyolite breccia with very strong fluidal banding forms the southern part of the plug, and a gray to purplish-gray porphyritic rhyolite with weak to strong fluidal banding makes up the remainder.

Strong fluidal banding in the rocks of the plug has a roughly concentric flow pattern with strong flow lineations directed steeply into the interior of the mass. Measurements at the southern margin showed a foliation of N. 37° W., a dip of 67° NE, and a flow lineation plunging 47° N. 5° E. The foliation swings to a northeasterly trend on the cliff face, and to a nearly vertical N. 25° W. attitude with near-vertical lineation at the eastern margin. The contact of the outer brown porphyritic rhyolite breccia with the main gray porphyritic rhyolite seems essentially conformable with the flow banding. The nature of the contact could not be determined because this zone is covered by talus on the cirque headwall, and is marked only by an abrupt change in float on the alpine surface above.

The brown fluidally banded porphyritic rhyolite breccia (fig. 2)

Figure 2 & 3.--Near here

is interpreted as an autoclastic breccia formed during the flow of a highly viscous crystal-rich melt. Ovoid masses of rhyolite drastically flattened in the foliation surface and elongated in the direction of flow lineations, are abundant. The rhyolitic composition of these masses suggests cognate origin due to the pulling apart of viscous materials during flow. Fragments of Precambrian gneisses are locally abundant in the rhyolite, but are not flattened. Rather, the fluidal banding bends around them. Similarly, glassy septae bend around the abundant phenocrysts and the scarce xenocrysts (derived from Precambrian rocks). At one locality near the southern margin, fragments of black vitrophyre are apparently included in the breccia. The largest found, about 8 inches in length, contains feldspar phenocrysts set in an autobrecciated black glass matrix. Striae in the glass are accentuated on the surfaces of weathered fragments, and indicate extension during the viscous flow of emplacement. Although the brown porphyritic rhyolite breccia strikingly resembles a welded tuff in appearance, evidence for a pyroclastic episode prior to viscous emplacement could not be found either in outcrop or in thin section.

Under the petrographic microscope, the rock is seen to be strongly banded with slightly to completely devitrified glass septae curving around individual phenocrysts or glomerophyritic clusters (fig. 3). The phenocrysts are chiefly dark-gray to black smoky quartz bipyramids up to 2 mm in size, glassy sanidine crystals, and tabular plagioclase crystals with slight sericitic alteration. Biotite plates and magnetite crystals are less abundant. Between the glassy septae are spherical aggregates of radially oriented feldspar crystals. As these spherical aggregates are not deformed, they must have formed after emplacement.

Figure 2.--Brown porphyritic rhyolite breccia from the southern margin of the Cabin Creek plug (millimeter scale).

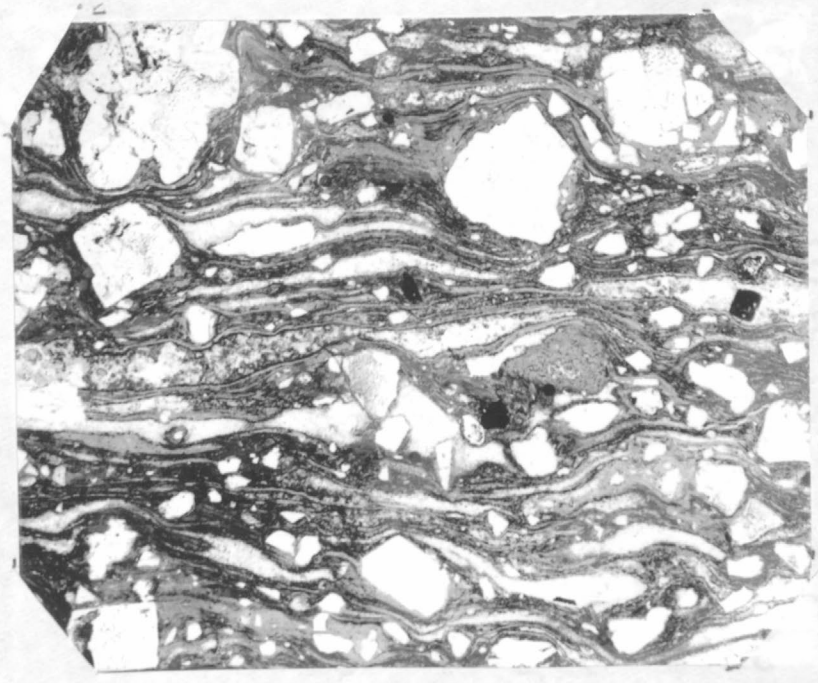

Figure 3.--Photomicrograph of porphyritic rhyolite breccia (same specimen as fig. 2) with strong flow banding (12.5 X magnification).

The gray porphyritic rhyolite is distinguished from the brown porphyritic rhyolite breccia by color and by a much lower proportion of clasts (fig. 4). Near the margin of the plug, fluidal banding

Figure 4.--Near here

and pencil-like linear flow structures are strongly developed in the gray rock. In local layers near the center of the rock unit these structures are weak (fig. 2), but they are present throughout the mass. Cavities with pumiceous walls, in part lined by carbonate minerals, are developed in the center of the mass. Their spacing may be wide, or they may be almost continuous, but they tend to be concentrated in certain flow layers.

In thin section the gray porphyritic rhyolite (fig. 5) has

Figure 5.--Near here

phenocrysts similar to those of the brown porphyritic rhyolite breccia. Striking dark-smoky-gray to black quartz bipyramids are ubiquitous. Plagioclase and sanidine crystals are abundant, and biotite and magnetite crystals are present in minor amounts. Spheroidal feldspar aggregates and glass in various stages of devitrification form the aphanitic matrix of the flow-banded rocks, and an aphanitic quartz-feldspar intergrowth furnishes the matrix for the less-banded varieties.

Most of the porphyritic rhyolite is surprisingly fresh. Several strongly altered areas in the gray porphyritic rhyolite stand out on the cirque headwall as light-yellowish to almost white zones. These in part follow the flow foliation and in part cut across it. Alteration minerals include clays, sericite, and pyrite.

Leavenworth Stock

The rhyolite porphyry stock 1 mile southwest of Paines Mountain, called the Leavenworth stock in this report, occupies the steep eastern wall of the glaciated valley of Leavenworth Creek. It extends about 2,500 feet along the creek, from an elevation of 11,900 feet near timberline down to 11,100 feet where it is covered by moraine. Several

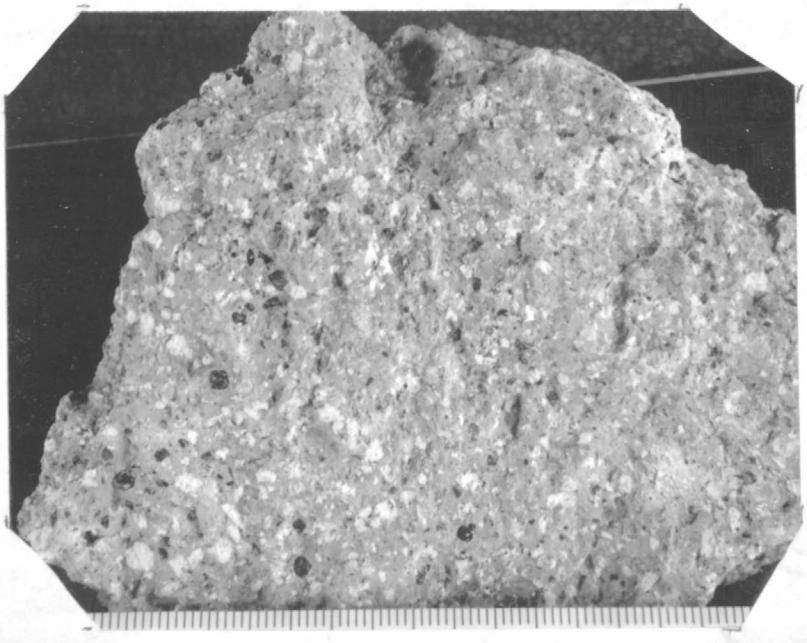

Figure 4.--Gray porphyritic rhyolite from the central part of the Cabin Creek plug with weak flow banding (millimeter scale).

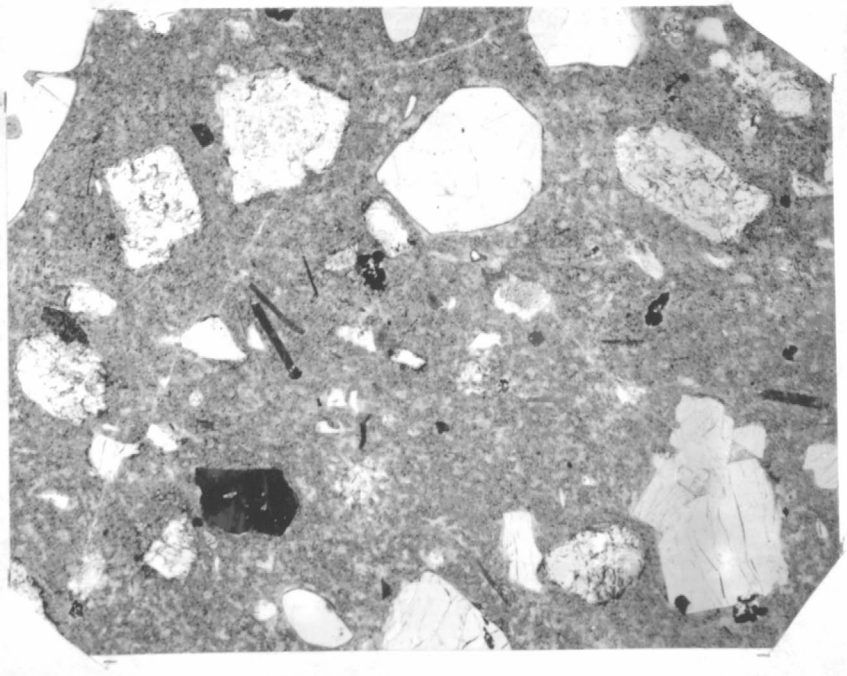

Figure 5.--Photomicrograph of gray porphyritic rhyolite (same specimen as fig. 4) cut in the foliation direction (12.5 X magnification).

outcrops were found near its northern margin, but all the rest of its area is covered by talus and scree. The stock probably extends for a considerable distance to the west under the swamp on the valley floor and possibly under moraine on the west wall of the valley of Leavenworth Creek, inasmuch as fluidal-textured rhyolite characteristic of its marginal material was not found in the talus at the western side where it is bordered by moraine.

The structure of this stock is almost certainly more complicated than indicated on the map (fig. 1), but natural exposures to prove this do not exist. Rock with fluidal banding (fig. 6) was found

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Figure 6.-- Near here

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essentially in place near the northern margin of the mass. The flow foliation seems to parallel the contact, and the flow lineations are essentially vertical. Talus fragments with fluidal banding seem to be concentrated near the contacts with the enclosing Precambrian gneisses. Near the southern margin a breccia unit was mapped on the basis of abundant fragments of several types of altered breccia that form the talus slopes. The remainder of the mass is far from homogeneous, even though by far the largest proportion of the talus is composed of altered rhyolite porphyry. Fragments of altered rhyolite porphyry with different textures and phenocryst percentages suggest that the main porphyry is cut by rhyolitic dikes of varying appearance, including both pebble and breccia dikes (fig. 7).

Figure 7.--Near here

No rock was found that can be described as fresh. Quartz bipyramids are the most prominent phenocrysts throughout, and attain a maxium size of about 3 mm. In most of the rock, the quartz phenocrysts are light gray to white, but in the freshest, they are black and smoky. Abundant altered tabular feldspars can be identified

Figure 6.--Rhyolite porphyry from northern margin of Leavenworth stock with flow banding accentuated by differential weathering (millimeter scale).

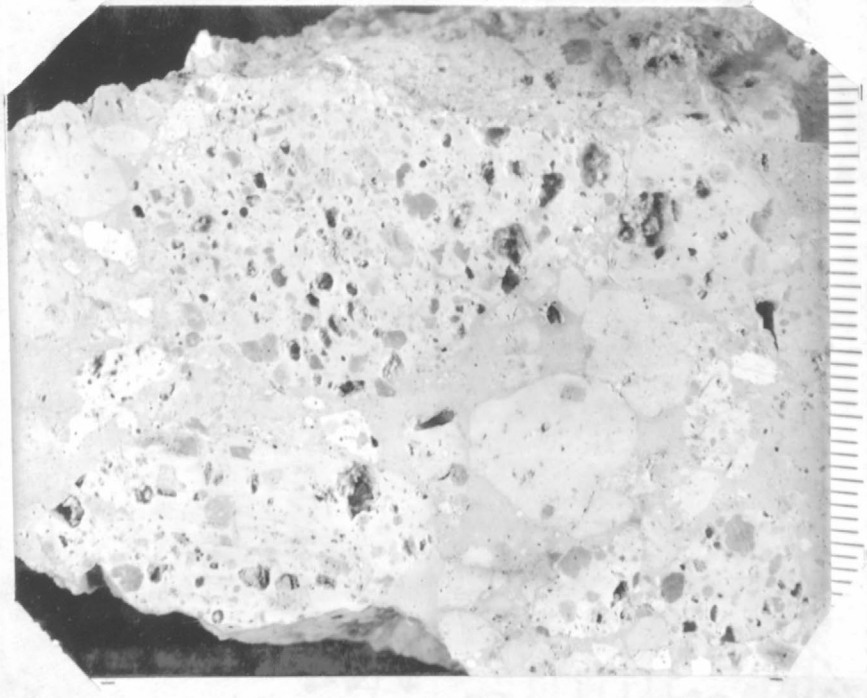

Figure 7.--Rhyolite breccia from pebble dike in central part of Leavenworth stock (millimeter scale).

by their shape, and from microscopic remnants both plagioclase and K-feldspar can be identified. Biotite phenocrysts are least abundant, and in most samples have been completely replaced by sericite. The ground mass is aphanitic to very fine grained, and is much altered. The porphyritic texture and massive aspect of the porphyry near the center of the stock give way to a rock with fluidal banding near the margin, in which the quartz and feldspar phenocrysts are smaller and less prominent.

Breccia dikes throughout the mass are inferred from the distribution of their fragments in the talus. They are made up of abundant fragments of porphyry typical of the main stock, as well as rhyolite fragments with smaller phenocrysts, and typically have a matrix of very fine grained to aphanitic rhyolite. The abundant inclusion of fragments of the principal porphyry type indicates that they are younger than the main stock.

The mass mapped as porphyritic rhyolite breccia (fig. 1) is composed of altered fragmental rocks of varying aspects. The most abundant is a breccia with altered aphanitic fragments set in a fine-grained matrix resembling a pyroclastic rock (fig. 8). Its original

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Figures 8 and 9.--Near here

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composition cannot be ascertained because all of this rock is too completely altered, but probably it was originally made up of several varieties of rhyolite. Near the top of the mass the breccia is less regular in appearance and it contains abundant fragments of granite and gneiss derived from the Precambrian metamorphic complex. This breccia type is also pervasively altered.

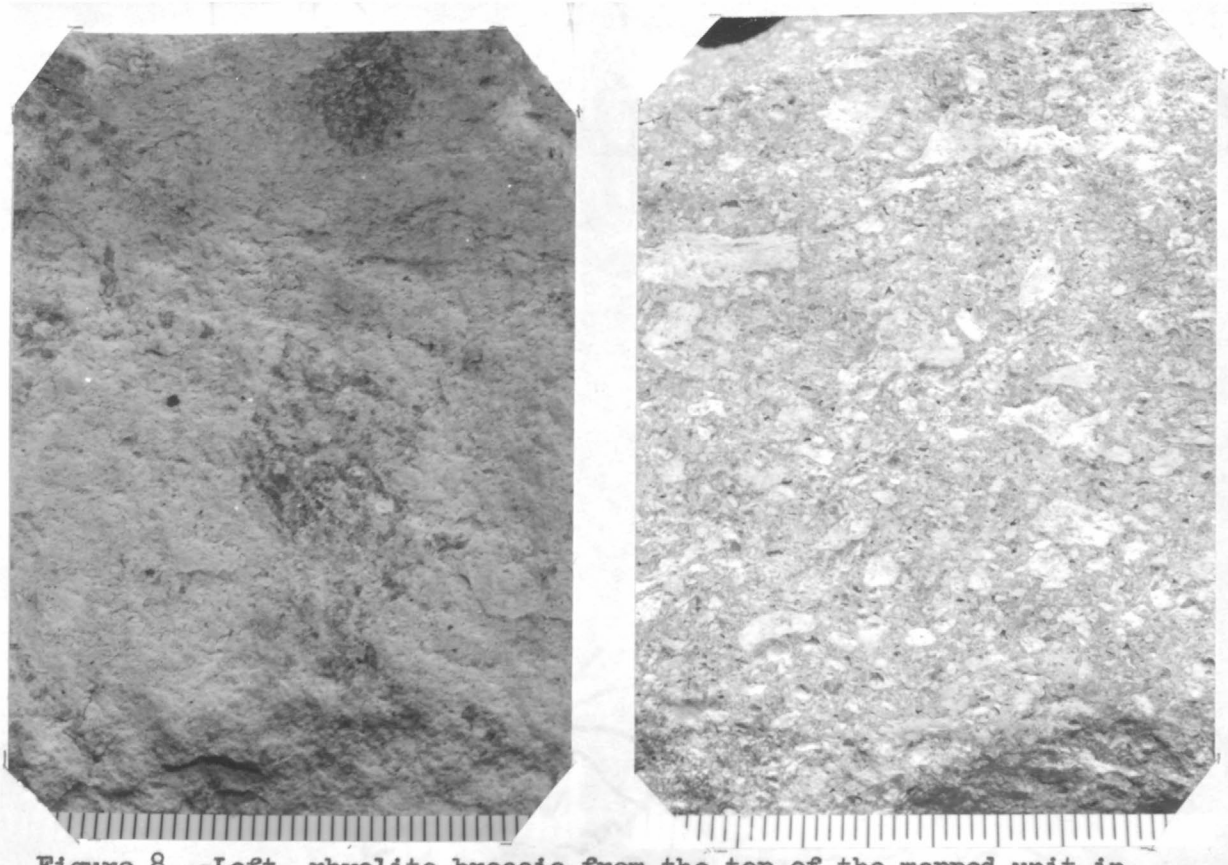

Figure 8.--Left, rhyolite breccia from the top of the mapped unit in the Leavenworth stock (millimeter scale).

Right, rhyolite breccia resembling a pyroclastic rock from the central part of the mapped unit in the Leavenworth stock (millimeter scale).

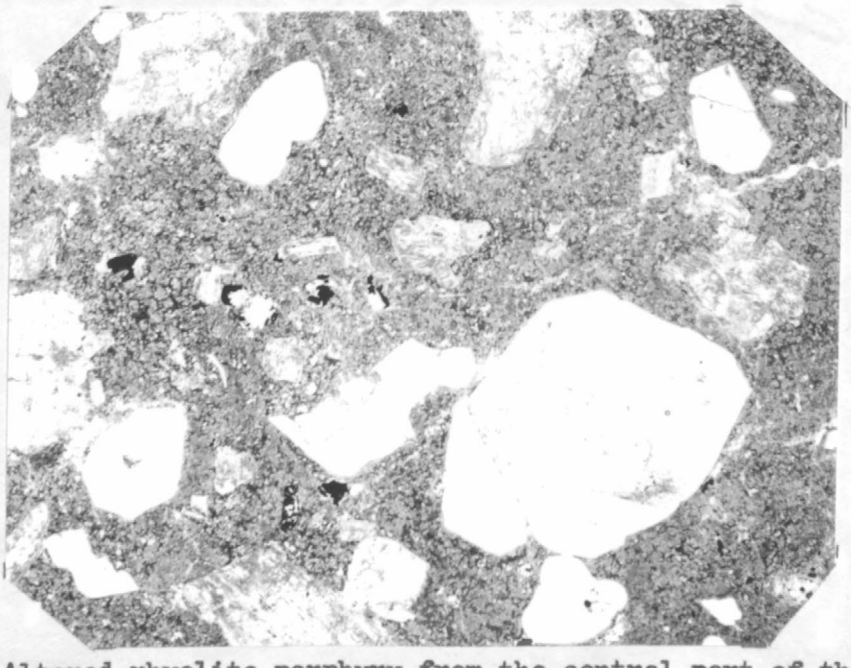

Figure 9.--Altered rhyolite porphyry from the central part of the Leavenworth stock (12.5 X magnification).

Parts of the Leavenworth stock have been ravaged by hydrothermal or pneumatolytic alteration. White powdery minerals give freshly split pieces a chalky-white to light-gray color, which sets off the sparse and tiny pyrite grains and glassy-white or light-gray quartz phenocrysts. The feldspar phenocrysts are corroded, and most have open cavities at their cores. Little feldspar actually remains; the crystal outlines are incompletely filled by sericite and clay minerals. The biotite phenocrysts have been pseudomorphed by coarsely crystalline muscovite clouded by minute inclusions.

X-ray diffraction studies, made with the help of William N. Sharp, of the groundmass of several intensely altered samples show that several alteration assemblages may be present. Near the top of the breccia unit where the alteration is most intense, a quartz-kaolinite-alunite assemblage was observed. Almond-sized aggregates of pinkish alunite crystals which have a maximum size near 2 mm are set in a groundmass of quartz, kaolinite, and alunite. A sample from the center of the breccia showed abundant well-crystallized secondary muscovite and prismatic quartz crystals replacing feldspar phenocrysts. Other less-altered samples from the main porphyry contain secondary muscovite and pyrite. The most obvious effect of the weathering of these altered rocks is the destruction of pyrite to form limonite that stains the rock yellowish red to dark reddish brown along fractures and forms liesegang rings within the larger blocks.

Weakly silicified fragments of a medium- to light-gray color and containing a few fine-grained quartz veinlets are found in fragments in the talus. These seem most abundant along the northern side of the mass, particularly high on the northern side. Limonitic staining is especially evident in the same part of the mass, though perhaps it is most intense lower on the valley wall. Little alteration is evident in the adjacent metamorphic rocks, except for limonite stains along fractures.

Semiquantitative spectrographic analyses (by G. W. Sears) of 21 samples of altered porphyry showed the following values: copper ranged from less than 1 to 50 ppm; molybdenum, from less than 3 to 30 ppm; lead, from less than 10 to 100 ppm. These metallic elements are most abundant in samples of highly altered rock and represent significant geochemical anomalies related to rock alteration.

The pervasive alteration of the upper part of the breccia unit, especially as contrasted with the little-altered rock of the plug to the east, indicates that solutions or vapors channeled through this part of the Leavenworth stock. It should be emphasized that in terms of bulk composition the major introduced materials were potassium, water, and sulfur (as sulfate), and that because of the alteration mineralogy the area of intensely modified rock is far less obvious than the typical sulfide-rich alteration zones associated with most porphyry masses in the Front Range.

Comparison of rhyolitic rocks

The least-altered samples of porphyry from the Leavenworth stock are very similar to the gray porphyritic rhyolite in the Cabin Creek plug, except for minor differences in groundmass textures. Of particular importance in the correlation of the two bodies seems the identical phenocryst mineralogy — distinctive black smoky quartz bipyramids, with sanidine, plagioclase, biotite and magnetite. The rocks are similar in bulk composition. The fluidal banding of the Cabin Creek stock closely corresponds to the flow banding of the margin of the Leavenworth stock.

Detailed comparison of the main porphyry type of the Leavenworth stock (fig. 9) with the central porphyry in the Red Mountain stock 10 miles to the northwest shows complete correspondence in texture, phenocryst mineralogy, and even the nature of the alteration. The rock in the Red Mountain stock contains similar quantities of smoky-gray bipyramidal quartz, and tabular feldspar phenocrysts; it is also pervasively altered, with a zone of silicification bordered by

a zone containing clay minerals and sericite, and formation of chlorite, sphene and secondary biotite in the margins of the alteration halo. Many of the altered feldspar crystals in the porphyry have central cavities, and the colloquial name for this porphyry — the "bug hole porphyry" — fits the rock in the Leavenworth stock just as well. The breccia dikes cutting the Leavenworth Creek stock have their analogs at Red Mountain. Locally, fluidal textures are present in both masses. Because of these major similarities, we believe that these stocks must be correlated as to rock type, depth of emplacement, and most important, age.

Summary

The Leavenworth stock and the Cabin Creek plug are correlated, on the basis of geologic criteria, with the porphyry at Red Mountain (Urad Mine), which has been dated by K-Ar methods as 27 ± 3 m.y. in age. These mid-Tertiary rocks are an important feature in the Mineral Belt, and their distinction from the Laramide porphyries is a necessary step in understanding the history of intrusion and mineralization.

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