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OFR: 78-497

RATTÉ 75-497

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geologic Setting and Revised Volcanic Stratigraphy of the Mogollon Mining District, Catron County, New Mexico--Talk Presented at Symposium on Base and Precious Metal Districts of New Mexico and Arizona, Silver City, New Mexico, May 22, 1975

By

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Open-file Report 75-497

1975

This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

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The Mogollon mining district is located about 100 km northwest of Silver City, New Mexico, within the Datil volcanic area. Mineralization was discovered there in 1874 by Sgt. James Cooney of the U.S. Cavalry, who returned to stake the first claims in the fall of 1875. Indian troubles still deterred settlement in the region, and the district was slow in getting into production. However, between 1879, when the first ore was shipped, and 1942, when the mines were closed by order of the War Production Board, an estimated $25 million was produced in gold and silver and minor copper and lead from quartz fissure veins in volcanic rocks of middle Tertiary age.

Production can be divided into three periods (Anderson, 1957, p. 32-34): The first period was from 1879 to 1904, when the richest oxidized ores were reported to average more than $20/ton in silver and gold at then current prices and produced metals valued at $5 million. The second and most productive period was from 1905 to 1925; however, most of the $15 million in metal values was mined before 1917. The district was almost completely closed down by late 1925. It revived, however, and the third period, between 1931 and 1942, produced metals valued at $5 million. The ores of these later periods reportedly averaged $10-15/ton in silver and gold. The silver to gold ratio throughout the district has generally been about 50:1.

Despite exploration by several companies after 1947, no appreciable production has been reported since 1942. The main productive veins have been the Last Chance-Confidence and Little Fanney east-west veins and the Queen north-south vein.

A geologic map of the district was prepared in 1916 and 1919 by Henry Ferguson; his final report, U.S. Geological Survey Bulletin 787, was published in 1927 and is the most comprehensive study of the mineral deposits. Ferguson mapped about 29 km^2 at 1:12,000 scale and a somewhat larger area in reconnaissance at 1:62,500 scale.

More recently, application of modern concepts of volcanic geology by geologists and geophysicists from the universities and both State and Federal Governments has provided a new and still-evolving understanding of the geologic setting of the Mogollon district and other mineralized areas within the Datil volcanic field. The geologic setting of the district is the focus of this report. I wish to acknowledge work in the Mogollon area by Dr. Rhodes and Professor Elston of the University of New Mexico and by Professor Coney of Middlebury College.

The Datil volcanic area is now generally understood as an Oligocene and Miocene volcanic field that is underlain by one or more igneous bodies of batholithic dimensions. Early andesitic volcanoes were followed by the eruption of voluminous silicic ash-flow tuffs, which resulted in cauldron collapse of major volcanic source areas. This, in turn, was followed by the extrusion of extensive basaltic andesites and minor rhyolites, which accompanied crustal extension during the development of Basin-and-Range structures in this region.

The Mogollon district is localized both along the ring fracture zone of the strongly resurgent Bursum caldera in one of the major source areas of the Datil volcanic field and near the junction of two, maybe three, major Basin-and-Range fault trends. Northwest- and northeast-trending fault systems parallel major grabens or rifts adjacent to the Mogollon Mountains: these have been described as bifurcations of the Rio Grande rift and called the Mangas and San Augustin lineaments by Chapin (1971).

This generalized geologic map of the Mogollon Mountains region (fig. 1) shows most of the Bursum caldera and the older, less well-defined Gila Cliff Dwellings caldera, which are the two major volcanic structures of the area. They were first mapped in part by Rhodes (1970). Attention is directed to the distribution of pre-caldera ash-flow tuffs and lavas and to the Bloodgood Canyon tuff of Elston (1968), which is thickest within its presumed source in the Gila Cliff Dwellings caldera but also forms an extensive outflow sheet along the Gila River Canyon and elsewhere for many kilometres around the calderas. In contrast, the tuff of Apache Spring, which is responsible for most of the subsidence of the Bursum caldera, is confined within the caldera.

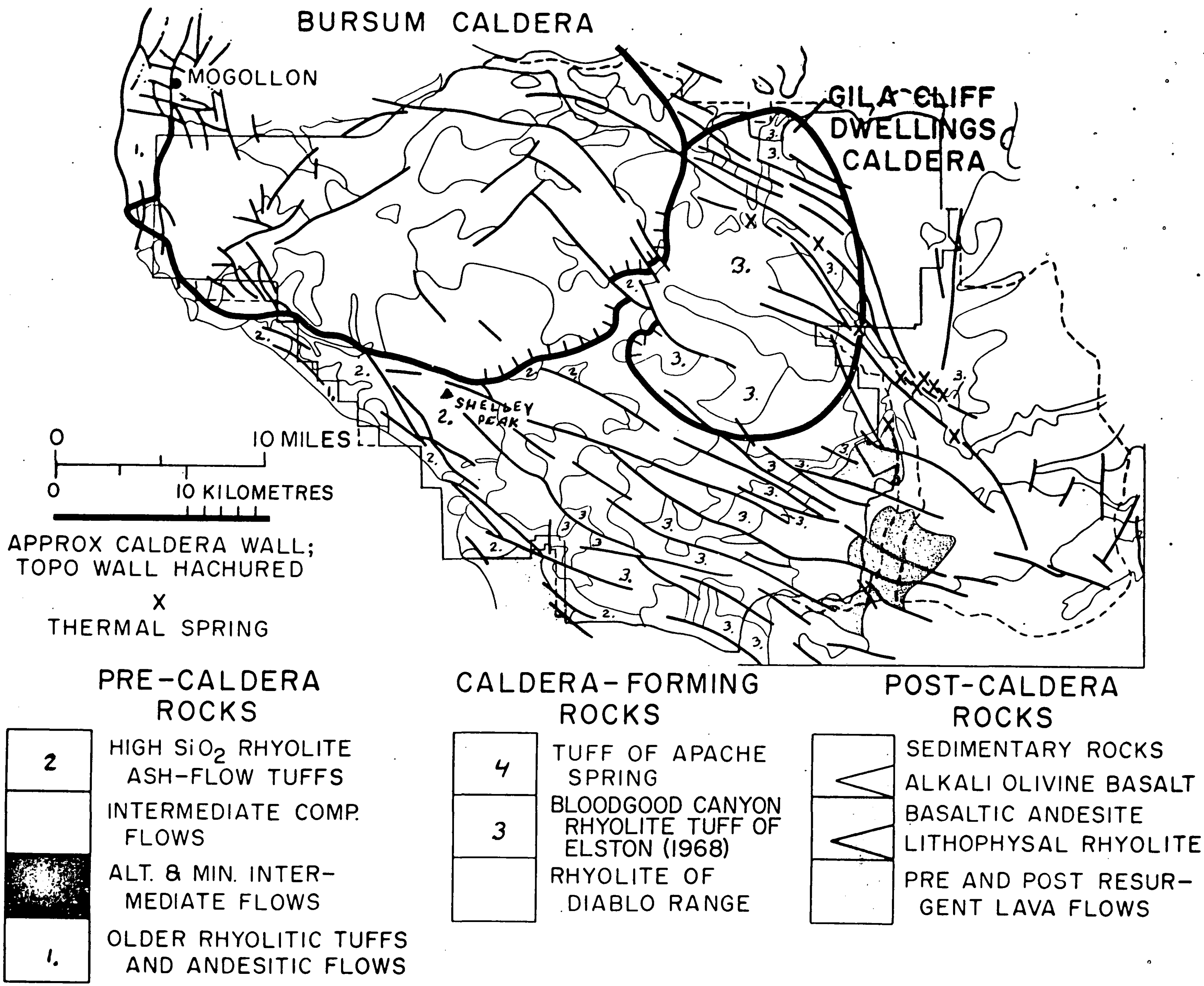

Figure 1.--Generalized geologic map of the Mogollon Mountains. Originally prepared as a color slide, this map is used here mainly to show the location of the Mogollon district relative to the Bursum caldera and the location of the Shelley Peak section in the Bursum caldera wall. Only those rock units specifically noted in the text are identified by numbers on the map.

The problem has been to relate the structurally complex and pervasively altered rocks of the Mogollon district to the relatively simple volcanic stratigraphy in the southeast part of the Bursum caldera wall. I shall try to demonstrate that the volcanic sections are the same and that the caldera wall goes through the district, but that the volcanic rocks of the upper part of the section at Mogollon and the mineralized structures are mostly inside the wall above the ring fracture zone and occupy the moat between the topographic wall of the caldera and its resurgent dome.

The volcanic section in the Bursum caldera wall (fig. 2) is most complete and best exposed beneath Shelley Peak and along Mogollon Creek in the southern part of the caldera wall. The section includes five major ash-flow tuff sheets. Isotopic ages bracket the section between about 26 and 32 million years old. The andesitic and latitic lavas that separate ash-flow tuff sheets are related to local centers or were derived mainly from the east; they are not present in the Mogollon section and will not be considered further.

The tuff of Rain Creek at the base of the section is over 300 m thick; it is a biotitic quartz latite that is densely welded and pervasively altered where best exposed along Rain Creek and Mogollon Creek near the range front west of Shelley Peak. The rhyolitic tuff of Fall Canyon has moderately abundant angular quartz, sanidine, and biotite phenocrysts and distinctive spherulites in its upper part. The rhyolitic tuff of Davis Canyon has sparse, tiny moonstone, quartz, and biotite phenocrysts and distinctive coarse blocks of varicolored pumice; the compositionally zoned tuff of Shelley Peak is a red crystal-rich tuff containing distinctive green pyroxene crystals in most places, and the Bloodgood Canyon Rhyolite Tuff of Elston (1968) contains abundant large moonstone and rounded quartz phenocrysts and yellow sphene; it lacks appreciable biotite.

Advances in the interpretation of fragmental volcanic rocks over the past 40 years enable us to show that in Ferguson's Mogollon district section (fig. 3) the Whitewater Creek Rhyolite and Cooney Quartz Latite (Ferguson, 1927) are parts of a compositionally zoned ash-flow tuff sheet that is at least 800 m thick in Whitewater Canyon south of

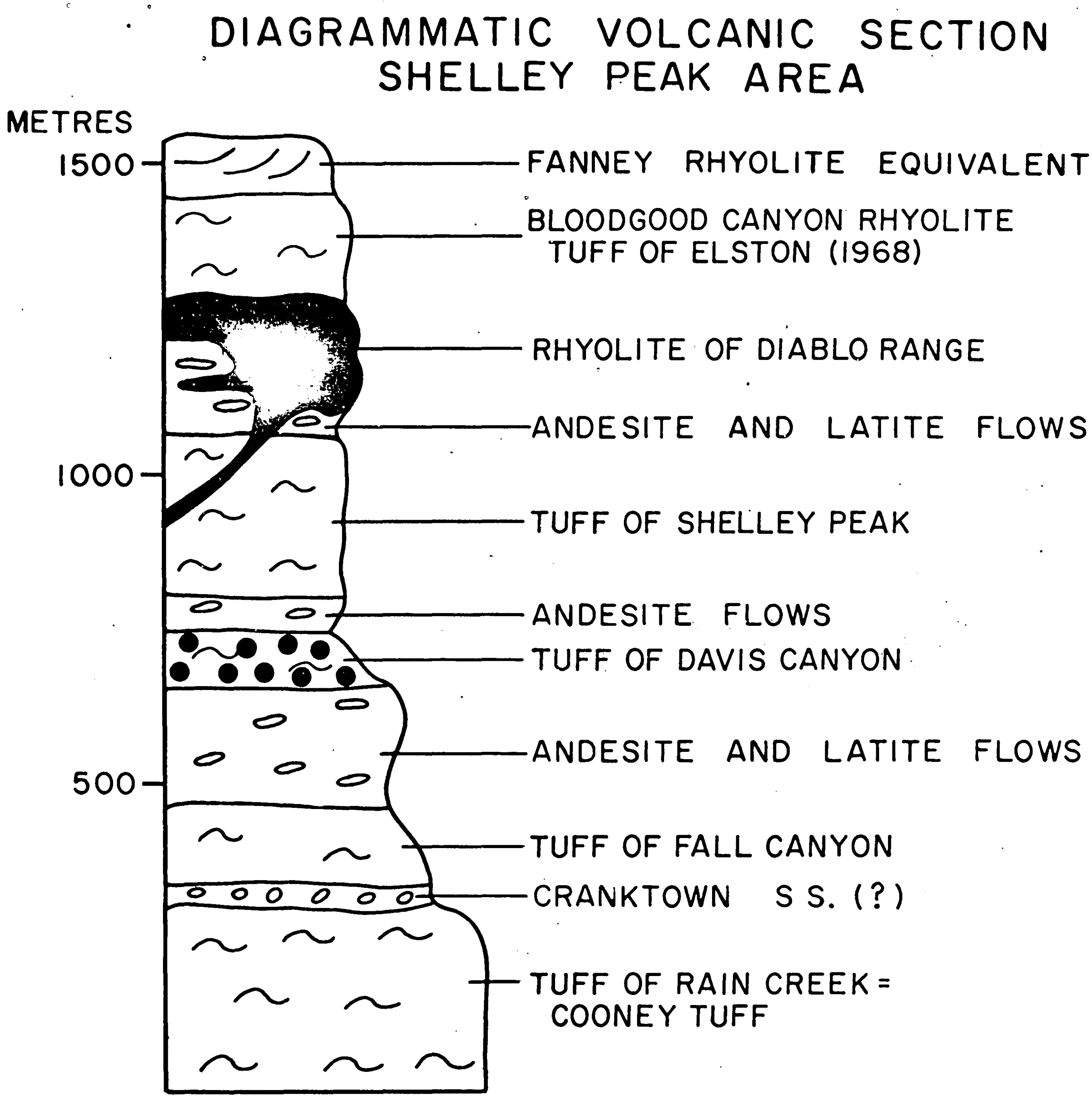

Figure 2.--Composite volcanic section in the Bursum caldera wall in the Shelley Peak area.

the district. The Whitewater Creek Rhyolite is a crystal-poor, simple cooling unit overlain by more-quartz-latitic, crystal-rich tuff consisting of multiple cooling units separated by thin lenticular sandstones. The Cooney Tuff (fig. 3, right column), which correlates with the tuff of Rain Creek of the Shelley Peak section, is overlain locally by as much as 150 m of Cranktown Sandstone, a dark, angular, conglomeratic, locally crossbedded sandstone of mainly andesitic debris with interlayered thin andesitic flows. The sandstone is identical to the thinner sandstone layers between cooling units in the upper Cooney Tuff. Also interlayered locally within the Cranktown Sandstone is a thin, white ash-flow tuff, whose angular quartz phenocrysts and spherulites seem to confirm its correlation with the tuff of Fall Canyon.

The Pacific Quartz Latite is now known to consist of three separate ash-flow tuff sheets: a lower phenocryst-poor rhyolite, correlated with the tuff of Davis Canyon; a red crystal-rich biotitic quartz latite containing altered mafics that may have been pyroxene, which is correlated with the tuff of Shelley Peak; and a highly silicified rhyolite containing abundant rounded quartz and alkali feldspar phenocrysts, which is the same as the Bloodgood Canyon Rhyolite Tuff of Elston (1968). A few kilometres north of the district, these ash-flow tuffs are well-preserved as an unaltered sequence.

To relate the ash-flow tuffs to source calderas, I'd like to propose that the tremendously thick, compositionally zoned Cooney Tuff (including the tuff of Rain Creek), which is known only from a narrow zone along the Mogollon Mountains front, is within a Mogollon cauldron that preceded the Bursum caldera and probably initiated cauldron collapse in the Mogollon source area. The walls of this cauldron probably underlie the alluvial gravels west of Mogollon and the range front (fig. 4), and elsewhere were destroyed by collapse of the younger Bursum caldera. Subsidence of the Mogollon cauldron probably began after eruption of the Whitewater Creek Rhyolite; continued intermittent collapse is recorded by the interlayered sandstones derived from the cauldron wall and deposited between cooling units of the upper Cooney Tuff. The Cranktown Sandstone is merely a thicker accumulation of such alluvial debris, derived from the cauldron walls after final subsidence.

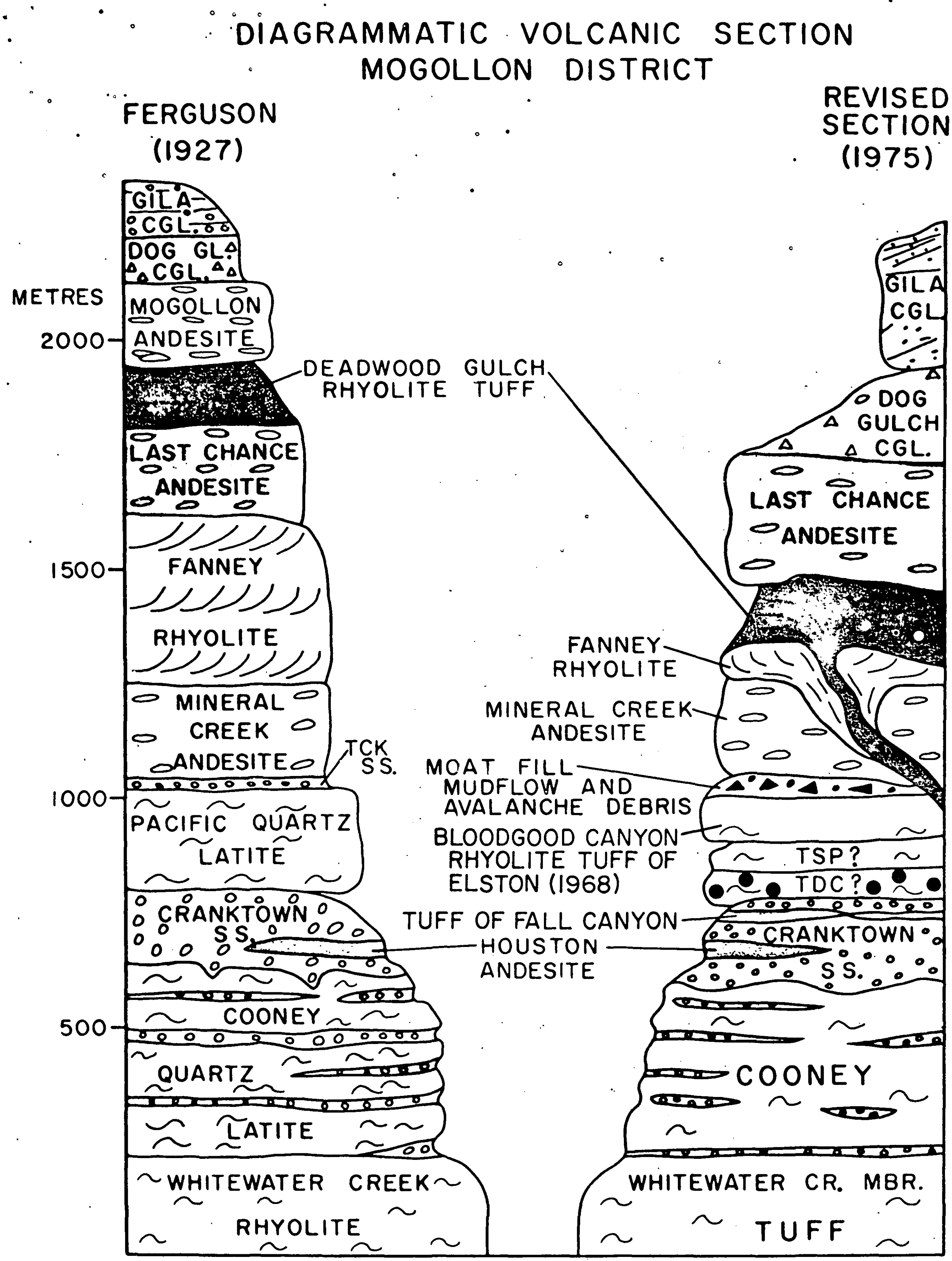

Figure 3.--Diagrammatic volcanic sections of the Mogollon district. In revised section, TSP? and TDC? stand for tuff of Shelley Peak and tuff of Davis Canyon, respectively.

The rhyolitic tuffs of Fall Canyon and Davis Canyon and the quartz latitic tuff of Shelley Peak may be parts of another compositionally zoned ash-flow tuff sequence, whose distribution also suggests an origin within the Mogollon source area, perhaps related to another caldera destroyed by the Bursum caldera; another possibility is that the Gila Cliff Dwellings caldera collapsed in response to the eruption of one or more of these tuffs.

The Bloodgood Canyon Tuff apparently initiated another cycle of cauldron collapse. Starting either within the Gila Cliff Dwellings or the Bursum caldera, this cycle culminated in the eruption of the tuff of Apache Spring and collapse of the 40-km Bursum caldera.

At this point, another important modification of the Mogollon volcanic section is necessary. Ferguson mapped three andesite formations (Ferguson, 1927, pl. 1), which are largely indistinguishable except as separated by the Fanney Rhyolite and the Deadwood Gulch Rhyolite Tuff. However, the Deadwood Gulch Tuff is a contemporaneous pyroclastic facies of Fanney Rhyolite, which itself is largely intrusive! This is best shown under Cooney Peak (Ferguson, 1927, pl. 3), where the two rhyolites are separated on Ferguson's 1:62,500-scale reconnaissance map by Last Chance Andesite. But, as beautifully displayed on the north side of Mineral Creek, southwest of Cooney Peak, steeply flow-banded Fanney Rhyolite intrudes Mineral Creek Andesite with a steep contact on the west; it levels off to a flat contact with several metres of chilled black vitrophyre, and then the rhyolite breaks through the old andesite surface in a breccia-filled vent and fans out into a layered pyroclastic deposit 150-200 m thick above the vent. This explains why most of the Fanney Rhyolite contacts on the old maps are shown as faults or steeply crosscut topography; some of the intrusive contacts <u>are</u> faulted, but the main masses of the Fanney within the district are the intrusive roots of rhyolite flows or domes. Thus, most of the Last Chance Andesite on the old maps is really Mineral Creek Andesite, including that dated by Simpson as having a K-Ar age of 24.8 ± 0.5 m.y. (Simpson and Strangway, 1970).

Segments of the Bursum caldera wall are well exposed between the mouths of all the major canyons of the Mogollon district. The topographic wall of the caldera on Silver Peak (fig. 4) has a slope of about 30° and is a glide plane, mantled by old landslide debris. This debris is covered by Mineral Creek Andesite; the andesite actually fills a valley between the caldera wall and a hill of landslide breccia within the caldera, east of Silver Peak. The old landslide breccia commonly consists of large blocks of Bloodgood Canyon Tuff with a matrix of red Cranktown Sandstone. Mudflow conglomerates and fluviatile beds overlie ash-flow tuffs in the caldera floor and are overlain by moat andesites and rhyolites, which lap onto the resurgent dome to the east.

The Great Western fault probably marks the outer edge of the ring fracture zone, and the Fanney vent on Mineral Creek (fig. 4) may be the inner edge. But the major zone of Fanney Rhyolite intrusions is along the Queen fault (Ferguson, 1927, pls. 1, 2). Although these faults are believed to belong to the ring fracture system, they also show post-caldera movement.

The productive parts of the veins of the Mogollon district are all essentially within the zone of Fanney Rhyolite ring fracture intrusions. Although the age of mineralization is not precisely dated, it is at least post-Fanney Rhyolite. If the association between ring fracture intrusions and mineralization is a valid guide to ore within the district, as I believe it is, then further exploration for fissure vein deposits should be concentrated along the ring intrusion zone, which is known to extend along the Mogollon range front at least to the vicinity of Mogollon Creek near Shelley Peak, and is accompanied all the way be evidence of gold, silver, tellurium, copper, lead, zinc, and fluorspar mineralization (Ratté and others, 1972). Insofar as metal anomalies extend southeastward beyond the ring intrusion zone and are largely absent around the eastern margin of the Bursum caldera, the persistence of fracturing along the northwest fracture trend, since at least Laramide time, also may be an important factor in the localization of mineralized rocks.

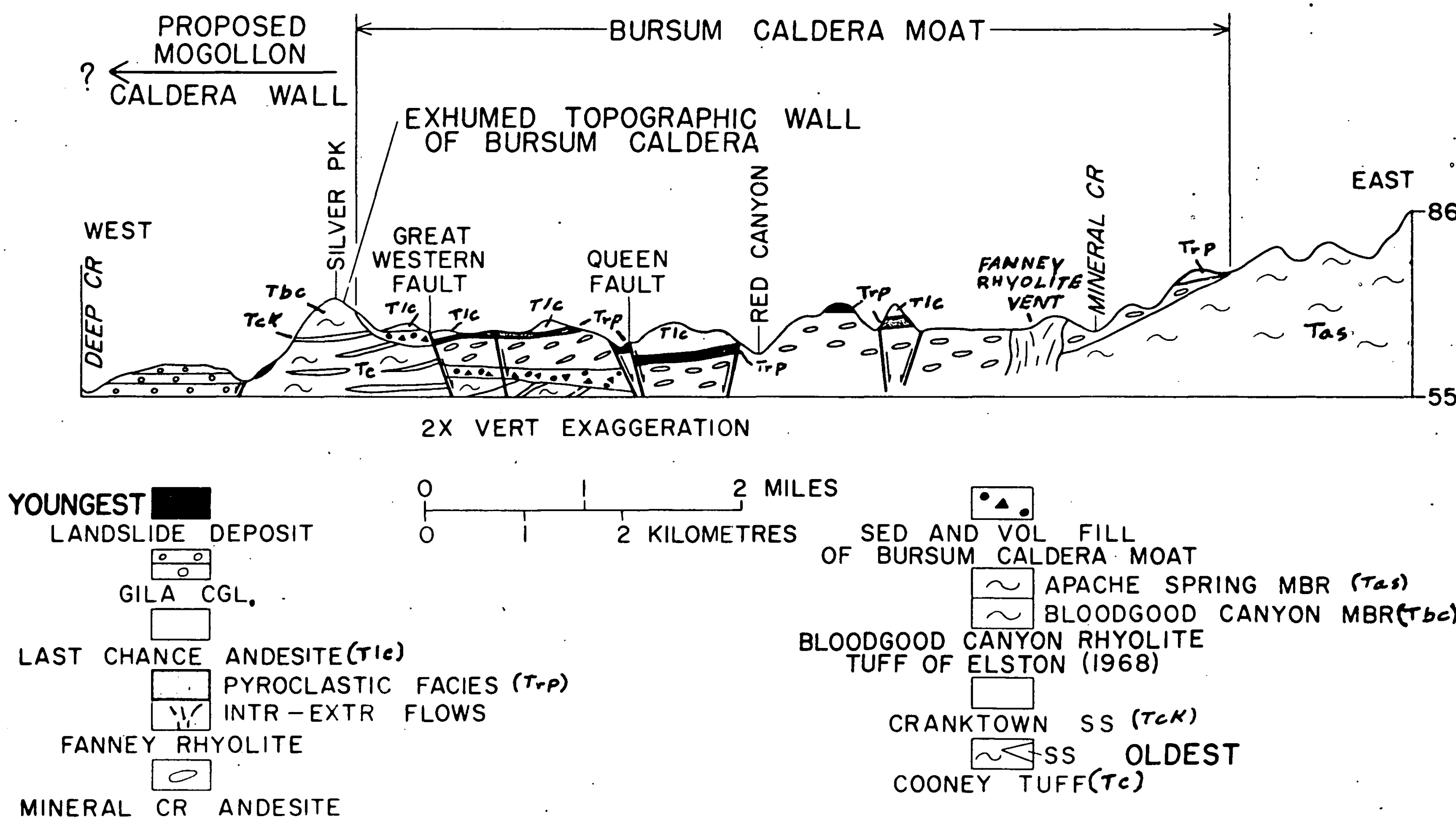

Figure 4.--Geologic cross section from Silver Peak, on the topographic wall of the Bursum caldera, across the caldera moat and ring fracture zone onto the resurgent dome east of the Mogollon district. Section is mostly along the north side of Mineral Creek at the north end of the district. Stratigraphic terminology that disignates the tuff of Apache Spring and the Bloodgood Canyon Rhyolite Tuff of Elston (1968) as members of a single tuff formation is a tentative and informal usage at this time.

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