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1965, pp. 167-174. https://doi.org/10.56577/FFC-16.167

*in:*

*Southwestern New Mexico II*, Fitzsimmons, J. P.; Balk, C. L.; [eds.], New Mexico Geological Society 16 th Annual Fall Field Conference Guidebook, 244 p. https://doi.org/10.56577/FFC-16

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# VOLCANIC ROCKS OF THE MIMBRES AND UPPER GILA DRAINAGES, NEW MEXICO[1]

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## INTRODUCTION

The Sixteenth Field Conference carries the New Mexico Geological Society through parts of one of the world's greatest volcanic provinces. There is rarely a moment when volcanic rocks, mainly of Tertiary age, are not visible. Andesite, latite, and rhyolite predominate; basalt is relatively scarce.

The dominant influence of volcanics on the geology of southwestern New Mexico was apparent as early as 1905 when the great Waldemar Lindgren devoted a lengthy section of his classic report (*in* Lindgren, Graton, and Gordon, 1910) to their distribution, stratigraphy, and petrography. In the succeeding 60 years many local details have been worked out, mainly by geologists of the U.S. Geological Survey and the New Mexico Bureau of Mines and Mineral Resources, but many fundamental question remain unanswered. How and where was the magma generated and differentiated, $10^4$ to $10^5$ cubic kilometers of which was ejected in southwestern New Mexico alone? What was the mechanism of eruption? Where were the eruptive centers, and what structures controlled them? What were the tectonic effects of the withdrawal of this vast volume of magma from its reservoirs? What relationship, if any, do the oldest eruptive centers have to the metal-bearing porphyry bodies? Finally, what was the source of energy for volcanism on so immense a scale? Our principle of uniformitarianism is put to a severe test. Nowhere have eruptions of this magnitude been recorded in historic time. This becomes especially apparent when we consider the volumes of individual rhyolite ash-flow cooling units such as the Kneeling Nun Rhyolite (see article by D. L. Giles, this guidebook).

Impressive as it is, the volcanic province of southwestern New Mexico is only a small block of the circum-Pacific belt. More locally, the relatively continuous volcanic rocks of the Mogollon Plateau north of Silver City continue to the south and southwest, where their former continuity has been broken by Basin and Range faults. Similarities in volcanic sections of adjacent ranges indicate that they were once parts of a nearly continuous blanket thousands of feet thick, consisting of many local lenticular units. Farther south yet, in the Sierra Madre Occidental of Mexico, the volcanics once again form a continuous plateau, one of the largest, but least known, magmatic provinces of our planet.

The tectonic setting of the volcanic province is worth noting. Part of it coincides with parts of the Mexican geosyncline but it spreads far beyond the limits of any geosyncline, across the Basin and Range Province and into the Colorado Plateau. Many geologists have assumed that geosynclinal belts and volcanism of the andesite-rhyolite family are inextricably linked. From this, astronomers and geophysicists have concluded that bodies like the Moon or Mars that lack geosynclines must also lack large scale non-basaltic volcanism. Detailed study of the Cordilleran orogenic belt suggests that this notion is a gross oversimplification.

The material in this article that refers to rocks of the Upper Gila drainage basin has not been published previously. Except where specifically credited to other sources, it was gathered during 1964-65, in the course of a project that is still far from finished. It must be regarded as tentative. Figure 1 shows localities mentioned in the text.

## VOLCANIC SUCCESSION

Superficially seen, the stratigraphic succession seems simple: in many places andesite is overlain by rhyolite, which in turn, is overlain by basalt. This simplicity is deceptive. As field work progresses, it is becoming apparent that rocks which look alike are not necessarily of the same age. Conversely, unlike rocks from different eruptive centers are found to interfinger (fig. 2). Specifically, the andesite-rhyolite association (which includes rock like latite, intermediate between andesite and rhyolite) recurs many times. The dark basaltic-looking rocks do indeed occur late in the history of the region, but detailed studies show them to include many petrographic types, from rocks on the rhyolite-latite boundary to, rarely, true olivine-bearing basalts.

### CRETACEOUS AND EARLY TERTIARY VOLCANIC ROCKS

Field evidence has indicated late Cretaceous or very early Tertiary age for the oldest, dominantly andesitic, volcanic rocks. Between Silver City and Pinos Altos, for instance, andesite breccias have been intruded by

1. Research supported by NASA grant NGR-32-004-011.

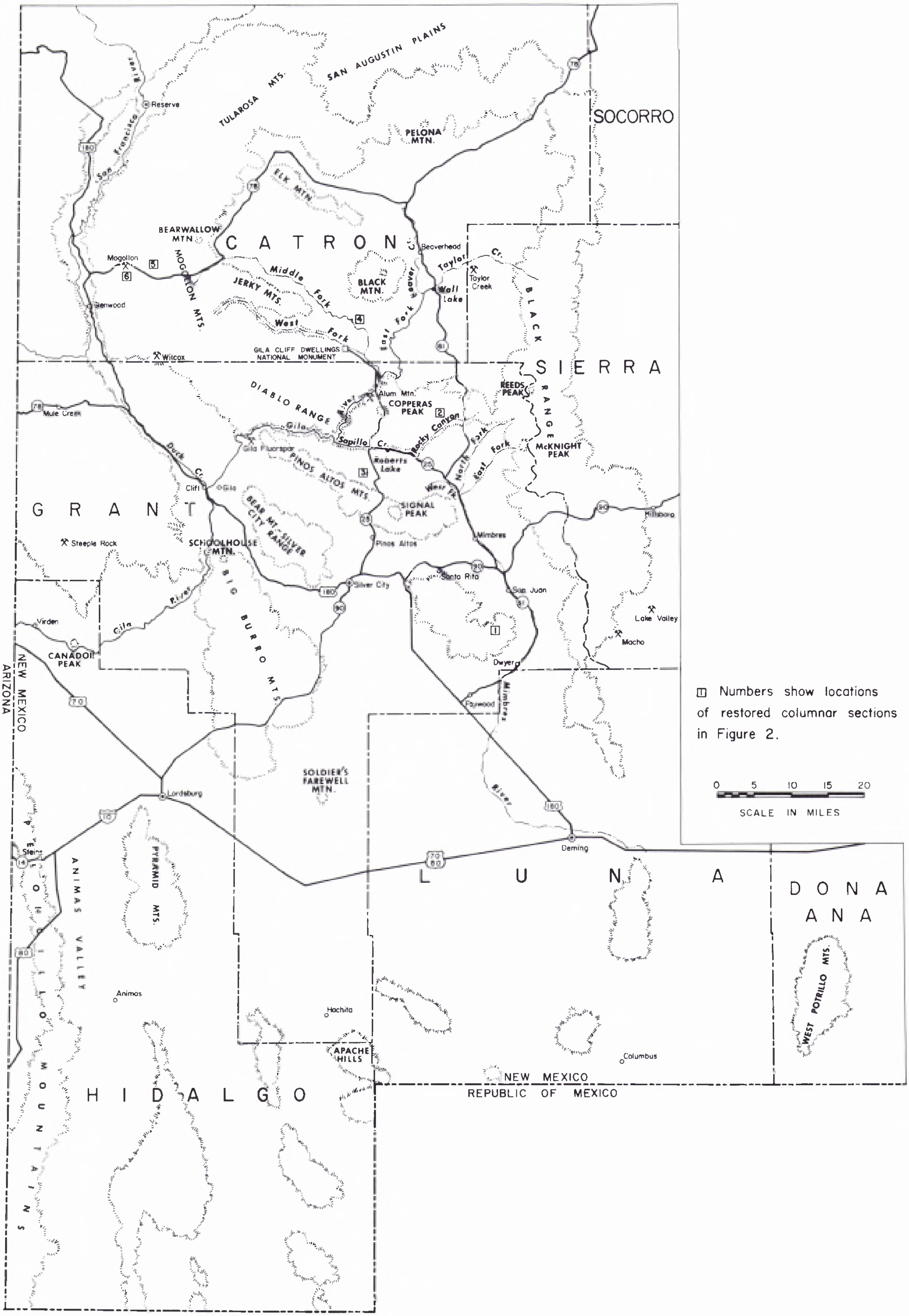


FIGURE 1

Map of Southwestern New Mexico, showing localities mentioned in the text.

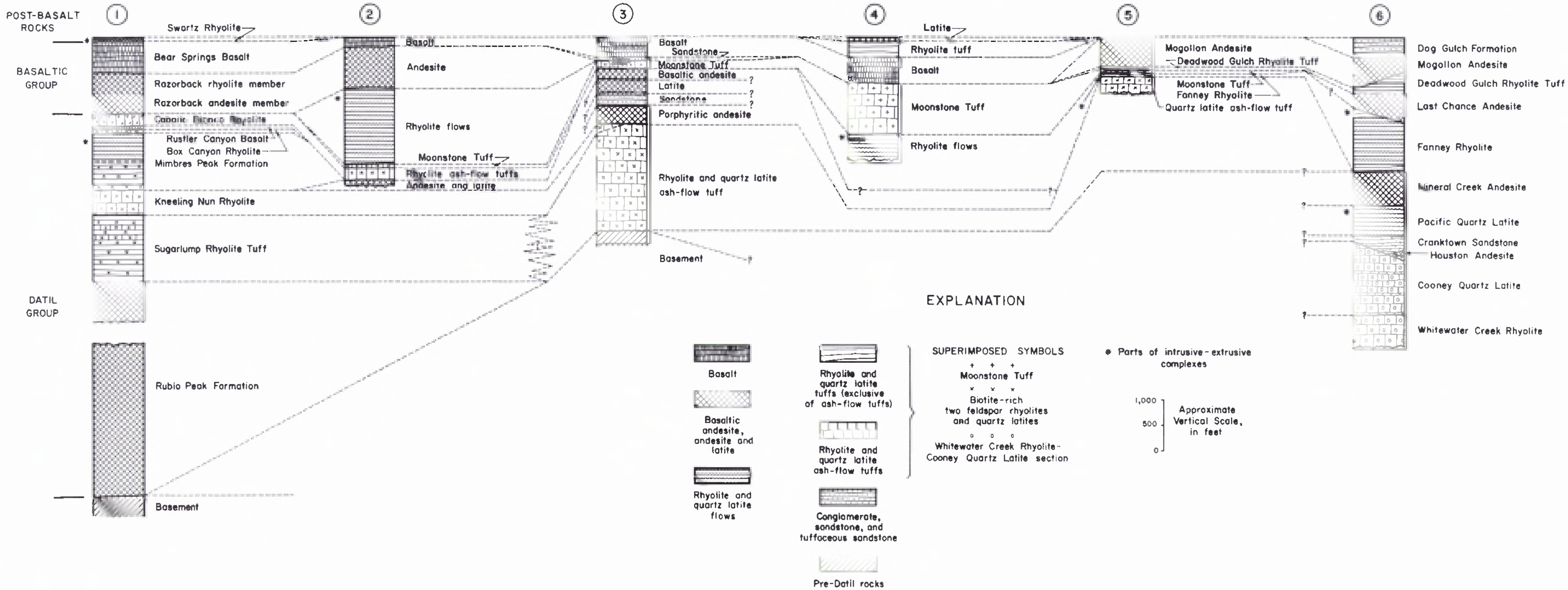


FIGURE 2

Tentative correlation of Tertiary volcanic rocks of parts of the Mimbres and upper Gila drainages. Locations of restored columnar sections and sources of data: 1) Dwyer quadrangle (Elston, 1957); 2) State Highway 61, between Rocky Canyon and Black Canyon (Elston, this article); 3) Pinos Altos Range between Cherry Creek and Pine Flats (Elston, this article); 4) Middle and West Forks of Gila River and Little Creek, near Gila Cliff Dwellings National Monument (Elston, this article); 5) Mogollon Mountains, north wall of Bearwallow Canyon, 3 miles from junction with Mineral Creek (Peter J. Coney, personal communication, August 1965); 6) Mogollon mining district (Ferguson, 1927). See fig. 1 for locations.

Laramide porphyries and dikes, have undergone various types of hydrothermal and deuteric alteration (especially epidotization), and are hosts to Laramide ore deposits. No absolute age determinations have yet been made in southwestern New Mexico, but in Arizona Damon (1965) has demonstrated the existence of a widespread group of volcanic rocks with K-Ar ages in the range of 54 to 76 m.y.

Late Cretaceous to early Tertiary volcanics have not yet been identified in the Mimbres Valley. In the Gila Country, andesite, locally intensely altered, intruded by monzonite and rhyolite porphyries, and mineralized, occurs at the mouth of the Gila Canyon northeast of Gila, New Mexico (the Gila Fluorspar mining district) and at the western foot of the Sacaton-West Baldy part of Mogollon Mountains, near the Grant-Catron County line (the Wilcox tellurium mining district). The geology of neither area is known in detail. Epidotic alteration is conspicuous in the Wilcox district.

The regional extent of the late Cretaceous-early Tertiary volcanic rocks is poorly known because they are usually covered by Tertiary rocks not always distinguishable from them. Among possible occurrences seen at a distance during the 16th Field Conference are the Macho mining district southwest of Lake Valley, the Hillsboro area, the Steeple Rock mining district north of Virden, the Pyramid Mountains and Apache Hills, and the Peloncillo Mountains near Steins Pass. In the Steeple Rock area their late Cretaceous age can be confirmed on stratigraphic-paleobotanic grounds (Elston, 1960).

Early Cretaceous and pre-Cretaceous Mesozoic volcanic rocks have been reported from many localities in southwestern New Mexico, southeastern Arizona, and especially, northern Mexico (King, 1939), but their age needs to be confirmed. They are not known from the Mimbres and Gila drainages.

## TERTIARY VOLCANIC ROCKS

The great bulk of volcanic rocks seen during the 16th Field Conference is Tertiary in age. Regionally, a range of ages between 14 and 41 m.y. has been reported from K-Ar determinations. The absence of reported ages between 41 and 54 m.y. is probably due to a hiatus between the Laramide and Cascadian orogenies and not merely to lack of data. Damon (1965) came to the same conclusion. In many places the Tertiary volcanics lie with profound angular unconformity on older rocks, volcanics and others, deformed by the Laramide orogeny. Examples are to be seen around Pinos Altos and at Steins Pass, among other places.

For convenience, the Tertiary volcanic rocks can be divided into three groups, which are, in order of age: (1) the Datil group, mainly in the andesite to rhyolite range, (2) the Basaltic Group, consisting of dark-colored basalt, mafic andesite, and associated felsic rocks, and (3) rhyolites, latites, and basaltic rocks younger than the Basaltic Group.

*Datil Group:*—The great mass of the volcanic mountain of southwestern New Mexico consists of a complex succession of andesites, latites, quartz latites, and rhyolites. To name these rocks, Weber and Willard (1959a and b) and Willard, Weber, and Kuellmer (1961) carried the term "Datil Formation" from the country north of the San Augustin Plains to the Mimbres and Upper Gila drainage areas. In the road log of this guidebook, R. H. Weber has wisely suggested expanding the "Datil Formation" to "Datil Group."

The most conspicuous and widespread members of the Datil Group are the rhyolite and quartz latite ash-flow tuffs. At least three major sequences have been recognized to date. At this stage, it is premature to assign them stratigraphic names. In this article they are informally termed, in order of age, (1) the Whitewater Creek Rhyolite-Cooney Quartz Latite section, (2) biotite-rich two-feldspar rhyolites and quartz latites, and (3) Moonstone Tuff.

Whitewater Creek Rhyolite and Cooney Quartz Latite were first described by Ferguson (1927) in the Mogollon mining district. Between them they are up to 2000 feet thick. Compared with the younger ash-flow units, they are characterized by a scarcity of megascopically visible quartz, and by relatively poorly developed columnar joints. The entire Whitewater Creek Rhyolite is remarkably massive. It makes up the vertical walls of the Whitewater Creek gorge east of Glenwood, accessible to tourists through The Catwalk. Cooney Quartz Latite consists of massive beds of rhyolite and quartz latite ash flows, generally tens of feet thick and locally separated by lenticular beds of purplish-brown andesite tuff. Similar rocks can be seen from Mogollon south along the front of the Mogollon Range for about 35 miles. Since the geology of this country has not yet been mapped in detail it is uncertain whether a single formation is present or several. The Whitewater Creek-Cooney section will not be seen during the 16th Field Conference.

The second sequence of ash-flow tuffs includes the Kneeling Nun Rhyolite of the Santa Rita area and its probable equivalents in the Pinos Altos, Mogollon, and Black Ranges, as well as a complex succession of flows, tuffs, and ash-flow tuffs above and below. Locally, its thickness exceeds 2000 feet. As a whole, the group is characterized by an abundance of megascopically visible phenocrysts of quartz, biotite, glassy sanidine, and variable amounts of plagioclases (usually andesine or oligoclase). Ash-flow tuff members tend to have well developed columnar joints.

During the first day the 16th Field Conference crosses a great thickness of the ash flows resembling the Kneeling Nun Rhyolite on the west flank of the Black Range (Kuellmer, 1954). Later in the same day, the same rocks are crossed again in the Dwyer-Faywood area of the Mimbres Valley, (Elston, 1957), but here they include a large proportion of stratified water-laid beds, mainly in the Sugarlump Rhyolite Tuff. These suggest that this area was at some distance from the eruptive centers, which probably were in the mountains to the northeast and north. On the second day, about 2000 feet of massive quartz latite ash flows, with only a little intercalated water-laid material, are crossed in Cherry Creek, north of Pinos Altos. On the third day, similar rocks are visible at a distance in many of the fault-block ranges of Hidalgo County.

The third sequence of rhyolite ash flows, the Moonstone Tuff, is characterized by the presence of conspicuous phenocrysts of quartz and moonstone (sanidine cryptoperthite) and by a relative scarcity of biotite and plagioclase. Massive, columnar-jointed ash flows form spectacular 700-foot cliffs in the canyon walls of the West and Middle Forks of the Gila River northwest of Gila Cliff Dwellings National Monument. Their thickness there is at least 1000 feet and may be considerably more. They seem to center on the poorly known Diablo Range. From there they extend southward into the northwestern end of the Pinos Altos Range and northward into the east flank of the Mogollon Range. State Highway 78 crosses them for many miles east of the Silver Divide. They are absent in Mimbres Valley but just to the north, at the point where State Highway 61 crosses Rocky Canyon, a single bed of moonstone-bearing rhyolite tuff lies directly on rhyolite that resembles Caballo Blanco Rhyolite, the highest member of the previous group of biotite-rich two-feldspar ash flows in the Mimbres Valley. Moonstone Tuff forms most of the higher ledges of the magnifiicent 3000-foot canyon of the Gila River downstream from the junction of the three forks of the Gila River. It continues for at least 15 miles southwestward beyond the mouth of the Gila Canyon, into the Bear Mountain-Silver City Range and the Schoolhouse Mountain quadrangle at the northern end of the Big Burro Mountains (Wargo, 1959). A sample of Moonstone Tuff from the Schoolhouse Mountain quadrangle yielded a K-Ar age of 26.5 $\pm 0.9$ m.y., on the Oligocene-Miocene boundary (Damon, 1965). This age is most significant. The Moonstone Tuff is the youngest known member of the Datil Group in the Mimbres-Upper Gila drainage basin. The Datil Group must then be largely older than the Miocene(?) age usually assigned to it. Oligocene K-Ar ages for pre-Moonstone Tuff Datil rocks from the area north of the Gila drainage basin, cited by Weber and Bassett (1963) and Burke and others (1963), are compatible with this conclusion.

The route of the 16th Field Conference crosses outcrops of Moonstone Tuff in two places on the second day of the trip: in the Pine Flats area of the Pinos Altos Range, and again between Gila Hot Springs and Gila Cliff Dwellings National Monument. Around Gila Hot Springs, the moonstone has lost its iridescence through hydrothermal alteration.

All three rhyolite suites are locally underlain by thick sections of andesite and latite. Examples are the purple-brown andesite beneath the Whitewater Creek-Cooney suite at the western foot of the Mogollon Mountains, the Rubio Peak Formation beneath the Sugarlump-Kneeling Nun suite in the Mimbres Valley, and the andesite and latite beneath the Moonstone Tuff in the Copperas Peak-Alum Mountain area. Although not as widespread as the rhyolites, the andesites and latites locally reach thicknesses on the order of 5000 feet. The accummulations must be bevelled at the top because the overlying rhyolites seem to have been deposited on surfaces of relatively low relief. No genetic connection has yet been established between each rhyolite suite and the underlying andesite-latite suite.

*Basaltic Group:*—The Datil Group tends to be light colored because of the abundance of rhyolite. It is overlain and locally interlayered with predominantly dark colored rocks which can be superficially taken for basalt. Actually, true basalt is scarce. The characteristic rock type of the group is fine-grained to glassy, deep black, vesicular andesite containing little or no olivine or its alteration products. It contains more alkalies and silica than true basalt. Howel Williams has applied the name "basaltic andesite" to this type of rock, which has the blocky, ropy, or amygdaloidal primary structures popularly associated with basalt. Rocks of this type are common on the west flank of the Black Range in the McKnight Peak-Reeds Peak area, in Beaver Creek Canyon near Beaverhead, in the Pinos Altos Range around Signal Peak, and in the higher parts of the Mogollon Mountains. Volcanic bombs at the top of Bearwallow Mountain, about 9 miles northeast of Mogollon, are evidence of a former volcanic vent.

Basaltic andesite is commonly accompanied by fine-grained, dark gray or black siliceous rocks, on the latite-rhyolite boundary. The two rock types make up, respectively, the andesite and rhyolite members of the Razorback Formation in the Mimbres Valley, seen on the first day of the Field Conference. The rhyolite member abounds in spherulitic and perlitic zones. Intricate flow folds are common. Fracturing parallel to the plane of movement has caused the rock to develop shale-like fissility. Rocks of this type are known from the Black Range as well as from the Mimbres Valley.

More basaltic members of the Basaltic Group contain abundant olivine or its alteration products (especially brown flakes of "iddingsite," now taken to be a form of goethite), even though the norm may show a trace of quartz. The groundmass tends to be more stony than in basaltic andesite. It is composed of a finely holocrystalline aggregate of labradorite, pyroxene, and magnetite. For some reason, basalt seems to be scarce or absent on the higher mountains but common at lower elevations. Bear Springs Basalt overlies the Razorback Formation in the Mimbres Valley. Similar rocks occur in the Gila Valley. They are prominent around Gila Cliff Dwellings National Monument and further downstream, in the highest parts of the walls of the Gila Canyon.

Characteristically, the rock types of the Basaltic Group lack simple stratigraphic boundaries. Within the group, the various rock types appear in different stratigraphic order in different places. Locally, representatives of the Basaltic Group occur within the upper part of the Datil Group, even though the bulk of the Basaltic Group lies unconformably on top of the Datil Group. Examples of "stray" intra-Datil basaltic rocks are basaltic andesite underneath Moonstone Tuff in parts of the Pinos Altos and Silver City Ranges and the Rustler Canyon Basalt, found locally underneath Caballo Blanco Rhyolite in the Santa Rita-Mimbres Valley region. Rocks resembling Razorback Rhyolite are known from pre-Moonstone Tuff latites in the Sapillo Creek area south of Copperas Peak. There are also a few local occurrences of Datil-like rocks within the Basaltic Group—further proof that the late stages in development of one group overlapped the early stages of the other. Basalt and basaltic andesite are also common in the next volcanic group.

The age of the Basaltic Group is poorly documented. It is bracketed between the 26.5 ±0.9 m.y. age of the Moonstone Tuff and the 18.5 m.y. age of post-basalt rhyolite from the Mule Creek area (see below). A K-Ar age of 19.8 ± 3.0 m.y. for a basaltic andesite from Tumamoc Hill, Pima County, Arizona (Damon, 1965) falls within the same range. In the Roberts Lake area and around Cliff, New Mexico the latest basalts and basaltic andesites are interlayered with the basal part of the Gila Conglomerate.

*Post-Basaltic Rocks:*—Tertiary volcanic rocks younger than the main basaltic sequences are not voluminous, but they are known from many localities. Rhyolite and latite predominate, but basalt and basaltic andesite are known. Evidently, the renewal of felsic volcanism did not bring the earlier basaltic andesite eruptions to an end; the two types seem to have coexisted.

In the Mimbres Valley, between Dwyer and San Juan, Bear Springs Basalt is intruded by a plug dome of Swartz Rhyolite, a relatively calcium-rich rock (dellenite) containing phenocrysts of sanidine, andesine, quartz, and biotite. Flows and flow breccias of the same rock locally overlie Bear Springs Basalt.

Post-basalt rhyolite has been reported from the Jerky Mountains, 15 miles northeast of Mogollon, by Weber and Willard (1959a). West of the Duck Creek-Gila Valley post-basalt rhyolite, containing much perlite and locally interbedded with Gila Conglomerate, has been mapped in many places by Weber and Willard (1959a) and Elston (1960). Obsidian nodules ("Apache Tears") in perlite collected west of Mule Creek in SE¼ sec. 6, T. 14 S., R. 21 W. have yielded a K-Ar age of 18.6 m.y. (Weber and Bassett, 1963).

North of Gila Cliff Dwellings National Monument, on the lowest 5 miles of the Middle Fork of the Gila River, the Basaltic Group is overlain by up to 300 feet of poorly consolidated pumiceous rhyolite tuff, containing boulders of Moonstone Tuff. It is interbedded with beds of sandstone and conglomerate resembling Gila Conglomerate and capped by a single flow, several tens of feet thick, of dark gray latite containing phenocrysts of plagioclase and a green prismatic ferromagnesium mineral (hypersthene?). Similar latite occurs about 12 miles to the northeast in the Wall Lake-Beaverhead area. The dam at Wall Lake is anchored on it. The latite there rests on sandy rhyolite tuff, only about 30 feet thick, which lies in turn on black basaltic andesite. This sequence is best exposed in Beaver Creek Canyon east of Beaver Points.

By present indications, admittedly based on incomplete reconnaissance work, Black Mountain, west of Beaver Points, is a composite volcano younger than the main Basaltic Group. It retains relics of volcanic morphology. In Jordan Canyon, which dissects the southern slope of Black Mountain, the following section is exposed: at the base, basaltic andesite, overlain by about 200 feet of sandstone and pumiceous rhyolite tuff containing boulders of Moonstone Tuff and capped by dark basalt containing minute crystals of "iddingsite." To the south, on the lower slopes of Black Mountain, this section is faulted against Moonstone Tuff, as is the post-basalt section exposed north of the Gila Cliff Dwellings. Correlation between the two sections has therefore not yet been possible. To the north, the Jordan Canyon section is in contact (fault?) with flow-folded chocolate-brown vesicular andesite flows and flow breccias that make up the core of the Black Mountains. A circular drainage pattern suggests that this rock occupies what was formerly a rimmed topographic basin about 3 miles across, perhaps a caldera. The highest part of Black Mountain is on the northern rim of this basin.

Rhyolitic rocks of approximately the same K-Ar age as the dated sample from Mule Creek, New Mexico are common in southeastern Arizona. For example, in the Chiricahua Mountains an age of 16.2 ±0.7 m.y. was obtained by Damon (1965) from Unit 6 of Enlows' (1955) Rhyolite Canyon Formation. Contemporaneous rocks are probably present in nearby ranges in New Mexico, such as the Weatherby Canyon Ignimbrite in the Peloncillo Mountains (Gillerman, 1958). Since the Basaltic Group is generally absent in Hidalgo County south of the Gila River, it is difficult to distinguish Datil and post-Datil rhyolites in the field.

### Quaternary Volcanic Rocks

The lower Mimbres Valley, between Deming and El Paso, is bordered on the east by the West Potrillo Mountains, the largest area of Quaternary volcanic rocks in southwestern New Mexico. On the United States side of the Mexican border alone, flat-lying olivine basalt flows cover Quaternary valley fill over an area of 300 square miles. Erosion has only slightly modified the shapes of dozens of small volcanic cones. Kilbourne Hole is the most famous feature of this volcanic field (see De Hon, p. 204, 238, this guidebook). Smaller patches of olivine basalt are widely scattered over the Rio Grande valley and the Deming-Columbus-Hachita area. On the second day of the Field Conference a late Tertiary or early Quaternary basalt flow, interlayered with the upper part of the Gila Conglomerate, can be seen on high bluffs east of the Mimbres River, 5 miles north of Mimbres.

It is uncertain whether there are any non-basaltic Quaternary volcanic rocks in southwestern New Mexico. Relatively undissected cone-like masses of rhyolite, dacite, and andesite in and around Soldier's Farewell Mountain, in T. 22 S., Rs. 14 and 15 W., lie unconformably on Gila Conglomerate and pre-Gila volcanic rocks; Ballmann (1960) considered them to be Quaternary. Similar rocks occur elsewhere, as in the Vanar Hills on the Arizona side of Steins Pass (Gillerman, 1958) and at Canador Peak on the Gila River near Virden.

The association of certain rhyolites with active thermal springs is circumstantial evidence for a relatively young age for the rhyolites. At Faywood Hot Springs (seen on the first day of the Field Conference) an active thermal spring is associated with an intrusive rhyolite dome, and rhyolite was also encountered in a water well on the east side of the Animas Valley southwest of Lordsburg. The well yielded boiling water with a temperature of 210°F (Kintzinger, 1956). Absolute ages are not yet available on any of the non-basaltic rock suspected of being Quaternary.

## INTRUSIVE-EXTRUSIVE RHYOLITE COMPLEXES AS INDICATORS OF GEOLOGIC STRUCTURE

In discussions of rhyolites and quartz latites, the emphasis in this article has so far been on the great sheets of pyroclastic rocks, especially ash-flow tuffs. There is, however, another type of rhyolite that has a significance all its own. Throughout the region, dikes and elongated domal intrusive bodies of flow-banded rhyolite were emplaced at various times along major faults. Some of the intrusions broke through to the surface and formed lava flows and pumiceous tuffs. Because of their high viscosity, none of the flows spread more than a few miles, but around vents they may reach thicknesses of thousands of feet. At Mogollon, for example, the Fanney Rhyolite, thought to be a single lava flow by Ferguson (1927), reaches a maximum thickness of over 1200 feet but pinches out completely within 3 miles.

Since flows are close to vents and vents are controlled by major faults, the flow-banded rhyolites are excellent guides to the regional geologic structure. I first became aware of this relationship while mapping the Dwyer quadrangle in the Mimbres Valley. There, bodies of Mimbres Peak and Swartz Rhyolite, up to one mile long and half a mile wide, are aligned along major faults like beads on a string. The same relationship can be demonstrated to exist on a much larger scale in many other places, including the Mogollon, Diablo, Black and Pinos Altos Ranges.

In detail, the rhyolite bodies are highly complicated and can best be described as intrusive-extrusive complexes. In and around them, hydrothermal alteration is common. Fresh flow and intrusive rocks generally are fine-grained, but they contain variable amounts of phenocrysts of quartz, sanidine, oligoclase, and biotite. Spherulites and lithophysae are common. Alternate flow bands tend to be light gray and pink or dark gray. Characteristically, the bands are intensely contorted. They simulate the ptygmatic folds of gneisses. Autobrecciation is common, especially near contacts.

The bottoms of flows and the margins of intrusive bodies locally consist of perlitic glass, which grades into stony rock via a spherulitic zone. The perlitic base of flows, in turn, commonly rests on bedded pumiceous tuff that contains silicified fragments of the overlying flow rock—a most curious relationship. In some complexes the tuffs spread far beyond the limits of the flows.

The complexes are clearly not all of the same age. In the Diablo Range, for instance, one of them underlies Moonstone Tuff. Twenty miles to the southeast, where State Highway 61 crosses Rocky Canyon, another complex, of slightly different lithology overlies Moonstone Tuff. In the Cherry Creek area north of Pinos Altos, biotite-rich two-feldspar quartz latite contains fragments of flow-banded rhyolite and is in turn intruded by a slightly different (biotite-rich) rhyolite. In the Mimbres Valley, complexes of at least two ages are known: the Mimbres Peak Rhyolite, part of the Datil Group, and the Swartz Rhyolite which is younger than the Basaltic Group. Certain rhyolite domes, such as the Faywood Rhyolite, may be younger yet. At Mogollon two of Ferguson's map units are parts of rhyolite complexes, the Pacific Quartz Latite and the Fanney Rhyolite. Many more examples could be cited.

In an abstract in this guidebook and in another article (Elston, 1965), I have discussed the possibility that the Mogollon Plateau is the surface expression of a structurally controlled ring-dike system 75 miles in diameter. The ring dikes consist of discontinuous arcuate belts of intrusive-extrusive rhyolite complexes. During 1964-65 I traced these belts over more than half of the postulated ring-dike system, from the Mogollon Mountains to the Black Range, through the Diablo Range and the unnamed range east of Copperas Peak. Sparse published data (Stearns, 1962) indicate that the northern semicircle of the ring-dike system can also be traced. Breaching by the Quaternary faults that border the San Augustin Plains introduce a complicating factor.

The Mogollon, Wilcox, Gila Fluorspar, Alum Mountain and Taylor Creek mining districts, are situated on segments of the ring-dike system. No mineralization is known in areas where intrusive-extrusive rhyolite complexes are absent. Mineralizing fluids and rhyolite magmas seem to have ascended along the same system of fractures. A genetic relationship between magmas and mineralizing fluids may exist but has not yet been demonstrated.

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