Summary of the geology of the northern part of the Sierra Cuchillo, Socorro and Sierra counties, southwestern New Mexico

Florian Maldonado, 2012, pp. 211-218

in:

This is one of many related papers that were included in the 2012 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual Fall Field Conference that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. Non-members will have access to guidebook papers two years after publication. Members have access to all papers. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only research papers are available for download. Road logs, mini-papers, maps, stratigraphic charts, and other selected content are available only in the printed guidebooks.

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.
This page is intentionally left blank to maintain order of facing pages.
SUMMARY OF THE GEOLOGY OF THE NORTHERN PART OF THE SIERRA CUCHILLO, SOCORRO AND SIERRA COUNTIES, SOUTHWESTERN NEW MEXICO

FLORIAN MALDONADO

U.S Geological Survey, MS 980, Denver Federal Center, CO 80225, fmaldona@usgs.gov

Abstract—The northern part of the Sierra Cuchillo is located within the northeastern part of the Mogollon-Datil volcanic field west of the Rio Grande rift in the Basin and Range Province, approximately 50 km northwest of Truth or Consequences in south-central New Mexico. The Sierra Cuchillo is a north-south, elongated horst block composed of Tertiary volcanic and intrusive rocks, sparse outcrops of Lower Permian and Upper Cretaceous rocks, and sediments of the Tertiary-Quaternary Santa Fe Group. The horst is composed mainly of a basal volcanic rock sequence of andesite-latite lava flows and mud-flow breccias with a 40Ar/39Ar isotopic age of about 38 Ma. The sequence is locally intruded by numerous dikes and plugs that range in composition from basaltic andesite through rhyolite and granite. The andesite-latite sequence is overlain by ash-flow tuffs and a complex of rhyolitic lava flows and domes. Some of these units are locally derived and some are outflow sheets derived from calderas in the San Mateo Mountains, northeast of the study area. These locally derived units and outflow sheets range in age from 28 to 24 Ma.

Introduction

The Sierra Cuchillo is an elongated fault-block located west of the Rio Grande rift in the Basin and Range Province, approximately 50 km northwest of Truth or Consequences in south-central New Mexico (Fig. 1). This summary is based on work conducted as part of a Masters thesis at the University of New Mexico (Maldonado, 1974). Other investigations before and since that study include work by Willard (1957), Hillard (1967; 1969), Maldonado (1980), and Lynch (2003). Jahns (1943; 1944; 1955; Jahns and Glass, 1944) mapped the Sierra Cuchillo south of the study area, McGraw (2003) mapped the surficial deposits of the study area, and McLemore (2010) studied and remapped the study area. The study area is located on the northeastern part of the northern Sierra Cuchillo and is composed of sparse outcrops of Lower Permian and Upper Cretaceous rocks, Tertiary volcanic and intrusive rocks, and sediments of the Tertiary-Quaternary Santa Fe Group. The Sierra Cuchillos are located within the northeastern part of the Mogollon-Datil volcanic field and bordered on the west by the Winston graben and the Black Range and on the east by the Monticello graben and the San Mateo Mountains (Fig. 1). The San Mateo Mountains are composed of Precambrian rocks and rhyolitic ash-flow tuffs; eruptions of the San Mateo Mountains resulted in formation of three calderas, the Mt. Withington caldera (Deal, 1973) and Bear Trap caldera (Chapin, et al., 2004) in the northern end of the range and the Nogal Canyon caldera in the southern end of the range (Deal and Rhodes, 1976). The Black Range consists of sedimentary rocks overlain by Tertiary volcanic rocks composed mainly of andesitic and latitic lava flows and interbedded tuffs and breccias that are overlain by rhyolitic flows and tuffs erupted from the Emory caldera (Kuellmer, 1954; Fodor, 1976; Chapin, et al., 2004).

Pre-Tertiary Rocks

The oldest exposed rocks in the Sierra Cuchillo are sparse pre-Tertiary rocks exposed only in the southwestern part of study area (Fig. 2) where they consist of the Lower Permian Yeso Formation and San Andres Limestone (combined as map unit Pys, Fig. 2) with some Upper Cretaceous rocks. The Yeso Formation is composed of non-marine, reddish-brown, thin- to medium-
FIGURE 2. Geologic map and cross sections. A color version of this map and explanation can be found on Plate 5, p. 178-79.
SUMMARY OF THE NORTHERN SIERRA CUCHILLO

MAP UNITS

- Qal: Alluvium (Holocene)
- CQg: Terrace gravel (Pleistocene)
- CQl: Olive pipe (Pleistocene, Pleistocene, and Miocene)
- Qf: Santa Fe Group (Pleistocene, Pleistocene, and Miocene)
- Tuff of Spring Canyon (Oligocene)
- Tuff of Shipman Canyon (Oligocene)
- Rhyolite of Alamino Creek (Oligocene)
- Latite of Gaspereau Canyon (Oligocene)
- Quartz latite porphyry of Whitewater Canyon (Oligocene)
- Rhyolite of Alamino Creek (Oligocene)
- Volcanic Peak Rhyolite (Oligocene)
- Quartz monzodiorite plug (Oligocene)
- Quartz latite dikes (Oligocene)
- Porphyritic andesite dikes (Oligocene)
- Latite dike (Oligocene)
- Basaltic andesite dikes (Oligocene)
- Porphyritic rhyolite dikes (Oligocene)
- Andesite-latite of Montes Butte (Oligocene)
- Basal dikeflow breccia of andesite-latite of Montes Butte (Oligocene)
- Qal: San Andres Limestone and Yose Formation, undivided (Lower Permian)

SYMBOLS

- Contact:
- Fault, cut and fill on downstream side; dotted where concealed
- Strike and dip of bedding and foliation of purrce
- Shaft

FIGURE 2. Cont.
bedded sandstone and siltstone with abundant medium- to dark-gray limestone. The San Andres Limestone is mostly marine, fine-grained, medium- to dark-gray, limestone with subordinate interbedded silty limestone and reddish siltstone and sandstone. Total thickness for these formations in the region is about 640 m (Jahns, 1955). Units are intruded by porphyritic rhyolite dikes (Tpr). The Upper Cretaceous rocks are composed of interbedded shale, conglomerate, and sandstone with a thickness of approximately 10 m.

TERTIARY VOLCANIC ROCKS

The Tertiary volcanic rocks are of Oligocene age and composed of a basal sequence of andesite to latite lava flows, with a basal tuff-breccia, and interbedded tuff-breccia (mudflow breccia) referred to as andesite-latite of Montoya Butte (unit Tmb of this report) by Maldonado (1974, 1980). These Oligocene rocks are the oldest exposed volcanic rocks in the study area and are intruded by a quartz monzonite plug (Tqm) and numerous dikes (Tql, Tpa, Tld, Tba, Tpr) that range in composition from basaltic andesite through rhyolite which will be described in the intrusive rocks section below. The rocks of Montoya Butte are overlain, unconformably, by Vicks Peak Rhyolite (Tvp) and the rhyolite of Alum Spring (Tas) and successively younger extrusive rocks that include the quartz latite porphyry of Whitewater Canyon (Twc), latite of Grapevine Canyon (Tgc), rhyolite of Alamosa Creek (Tac), tuff of Shipman Canyon (Tsc), and tuff of Spring Canyon (Tsc). The geochemistry of these rocks has been described by McLemore (2010).

The andesite-latite of Montoya Butte (Tmb) are mostly lava flows that form the main rock unit exposed in the study area with the best exposure at Montoya Butte located in the east-central part of study area, west of Alamosa Creek (Fig. 2). The lowest exposed part of this unit is composed of a thick tuff-breccia deposit mapped locally as Tmf that is approximately 200 m thick and is interpreted as a mudflow breccia. The best exposure of this unit is found in Monticello Box in the northwestern part of study area (Fig. 2). The mudflow breccia is poorly sorted, greenish to purplish-gray with a latitic matrix that contains andesitic and latitic clasts as large as 2 m long. The mudflow breccia resembles

FIGURE 3. Correlation chart of rock units, northern part of the Sierra Cuchillo and central and southern San Mateo Mountains, southwestern New Mexico.
SUMMARY OF THE NORTHERN SIERRA CUCHILLO deposits described by Jahns and Glass (1944) at Iron Mountain, located southwest of the study area, where these deposits overlie Paleozoic sedimentary rocks. A sequence of andesite-latite lava flows and interbedded tuff-breccias (Tmb) overlie the tuff-breccia deposits that may be as much as 600 m thick; however, Jahns (1955) estimated a thickness of about 900 m south of the study area. The andesite-latite lava flows usually form steep cliffs and the latite lava flows are light gray, flow banded, and porphyritic.

The andesite lava flows are propylitized and range in color from purplish, gray, and greenish to light or dark brown, and white where extremely altered. Texture is aphanitic to coarsely porphyritic with scattered xenoliths of coarse- to fine-grained granite and gneissic rocks up to 20 m across (Hillard, 1969). The andesite-latite of Montoya Butte is probably regionally equivalent to Willard’s (1957) Lower volcanic group, Tonking’s (1957) Spears Member of the Datil Formation, and Jahns (1955) and Hillard’s

**EXPLANATION**

- Poorly sorted volcanically derived siltstone, sandstone, and conglomerate with interbedded olivine basalt flow.
- Interbedded crystal-poor rhyolite lava flows, ash-fall and ash-flow tuff, and epiclastic material.
- Flow-banded rhyolite lava flows and domes, locally amethyst-rich.
- Moderately crystal-rich to crystal-rich rhyolite and quartz latite ash-flow tuff.
- Crystal-rich quartz latite lava flows.

- Reddish-brown latite lava flow, porphyritic with sanidine phenocrysts.
- Gray lava flows, coarsely porphyritic with abundant microperthite phenocrysts.
- Crystal-poor rhyolite ash-flow tuff
- Latite to andesite lava flows, ash-flow tuff, and epiclastic material.
- Pre-volcanic deposits.

**FIGURE 3.** Cont.

I, II Northern Sierra Cuchillo—this study
III Southern San Mateo Mtns—Farkas, 1969; Osburn and Chapin, 1983
IV Central San Mateo Mtns—Deal, 1973; Osburn and Chapin, 1983
(1969) Andesite-latite sequence, to Jahns’ et al., (2006) latite-andesite sequence, and to McLemore’s (2010) andesite of Monticello Box and Latite of Montoya Butte. The andesite-latite lava flows probably correlate with the Red Rock Ranch Formation and part of the Rock Spring Formation in the southern San Mateo Mountains (Farkas, 1969) (Fig. 3). The latite of andesite-latite of Montoya Butte has been dated at 37.5 Ma ($^{40}$Ar/$^{39}$Ar, McLemore, 2010) from the study area.

The Vicks Peak Rhyolite (Tdp) was first used by Farkas (1969) in a dissertation for exposures in the southern San Mateo Mountains located northeast of study area. The source of the tuff is the Nogal Canyon caldron (Deal and Rhodes, 1976; Chapin, et al., 2004) located in the southern part of the San Mateo Mountains. The tuff is rhyolitic and contains 1-8% phenocrysts of sanidine and quartz, is approximately 2-370 m thick and exposed in the northeastern and southeastern part of study area, where it probably represents outflow sheets. The tuff is densely welded and varies in color from pink, brownish red, to grayish white and it locally contains walnut-size spherulites. A thin ash-fall tuff (approximately 6 m) locally forms the base of unit. To the south, in the study area, the rhyolite overlies the lavas of Montoya Butte and lies below the latite of Grapevine Canyon (Tgc) or the quartz latite porphyry of Whitewater Canyon (Twe). To the north, it is overlain by the rhyolite of Alamosa Creek (Tac). The tuff has been dated at about 28.4 Ma ($^{40}$Ar/$^{39}$Ar, Lynch, 2003).

The rhyolite of Alum Spring (Tas) is named for lava flows exposed at Alum Spring, located in the northwest part of study area south of Monticello Box (Fig. 2). The unit contains approximately 27% phenocrysts of sanidine, quartz, and trace amounts of apatite. The rhyolite occurs as tabular lava flows about 8-12 m (Hillard, 1969) thick with crude columnar joints. The flows typically overlie the andesite-latite of Montoya Butte, but locally, overlie a Tertiary sedimentary sequence that in turn overlie the lavas of Montoya Butte. Beryllium mineralization is present in the study area near Alum Spring (Fig. 2a) and just south of the entrance to Monticello Box in the northwest corner of the study area (Fig. 2a). This beryllium mineralization has been described by McLemore (2010, this guidebook) and Hillard (1969).

The quartz latite porphyry of Whitewater Canyon (Twe) is exposed in Whitewater Canyon located in the southeastern part of study area (Fig. 2). The unit contains crystal rich lava flows, about 30% phenocrysts of sanidine (microperthite), quartz, pyroxene, and traces of plagioclase, biotite, olivine, apatite, and chlorite. The rocks are flow-banded, gray, approximately 470 m thick and contain flow folds with amplitudes up to 2 m. An aphanitic matrix consists mainly of spherulites and scattered patches of granophyric quartz-feldspar intergrowths and euhedral microperthite phenocrysts up to 1 cm long.

![FIGURE 4. Photo showing northwest entrance to Monticello Box with high-angle fault and spring. Wolfgang Elston (retired University of New Mexico professor) on left part of photograph and Ed Deal (Montana State Geologist) on right. QTsf, Santa Fe Group; Ttsc, tuff of Spring Canyon; Tmb, andesite-latite of Montoya Butte.](image)

The latite of Grapevine Canyon (Tgc) is a reddish-brown porphyritic rock exposed in Grapevine Canyon in the southeastern part of study area (Fig. 2) and may correlate with the Springtime Canyon Quartz Latite of Farkas (1969) exposed in the San Mateo Mountains. The unit is massive to flow banded lavas and contains 2-4% phenocrysts of sanidine, quartz, and pyroxene and is 6 m to about 200 m. Locally, an ash-fall tuff about 60 cm thick is at the contact between the latite of Grapevine Canyon and quartz latite porphyry of Whitewater Canyon.

The rhyolite of Alamosa Creek (Tac) is exposed in the Alamosa Creek area (Fig. 2) in the southeastern part of study area and is about as much as 200 m thick. The rhyolite forms lava flows and local domes and varies from an amethyst-rich to an amethyst-poor non-vesicular phase and contains 9-12% phenocrysts of sanidine (microperthite), quartz, and traces of biotite and hornblende. In Shipman Canyon (Fig. 2), the rhyolite forms a dome and typically contains numerous vesicles filled with abundant amethyst crystals and lesser amounts of magnetite, anorthoclase, and pseudobrookite. The amethyst crystals range up to 2 mm in length and make up to about 7% by volume in some samples. The rhyolite overlies the latite of Grapevine Canyon in the southeastern part of study area where it fills in paleotopographic low areas in the latite. In the northeastern part of study area where the latite of Grapevine Canyon is missing the rhyolite overlies Vicks Peak Rhyolite. The Taylor Creek Rhyolite, dated at about 27.9 Ma ($^{40}$Ar/$^{39}$Ar, Dalrymple and Duffield, 1988; Duffield and Dalrymple, 1990), is similar to the rhyolite of Alamosa Creek as described by Fries (1940), Fries et al., (1942), and Lufkin (1974) in the Black Range west of study area (Fig. 1). The rhyolite has been dated at 28.4 Ma ($^{40}$Ar/$^{39}$Ar, Lynch, 2003; McLemore, 2010). A trace element analysis of the amethyst-rich and amethyst-poor non-vesicular phase was conducted with the results shown in Table 1. Analysis indicates anomalous amounts of tin, titanium, and beryllium. McLemore (2010) indicated that the rhyolite of Alamosa Creek has similar chemical composition.

### TABLE 1. Trace-element analyses for rhyolite lava of Alamosa Creek, Shipman Canyon area, in ppm.

<table>
<thead>
<tr>
<th>Element</th>
<th>Sn</th>
<th>W</th>
<th>Ti</th>
<th>B</th>
<th>Be</th>
<th>Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amethyst-rich vesicular phase</td>
<td>&lt;20</td>
<td>1.1</td>
<td>1200</td>
<td>0.7</td>
<td>0.5</td>
<td>&lt;8</td>
</tr>
<tr>
<td>Amethyst-poor vesicular phase</td>
<td>&lt;20</td>
<td>2.2</td>
<td>1300</td>
<td>2.3</td>
<td>1.4</td>
<td>&lt;8</td>
</tr>
<tr>
<td>Lower limit of sensitivity</td>
<td>20</td>
<td>0.5</td>
<td>50</td>
<td>0.25</td>
<td>0.25</td>
<td>8</td>
</tr>
</tbody>
</table>
SUMMARY OF THE NORTHERN SIERRA CUCHILLO

TERTIARY INTRUSIVE ROCKS

Numerous dikes (Tql, Tpa, Tld, Tba, Tpr) which range in composition from basaltic andesite through rhyolite, and a quartz monzonite plug (Tqm) are found in the northern part of the study area where they intrude the andesite-latite of Montoya Butte but no younger units. The dikes appear to have no particular sequence of intrusion but they may be controlled by fractures and faults and may be feeders for the rocks of Montoya Butte.

The quartz latite dikes (Tql) are up to 20 m in width and contain plagioclase phenocrysts up to 20 mm long in a fine-grained groundmass. The latite dikes (Tld) are 3 m to 130 m in width and contain plagioclase phenocrysts up to 6 mm long in a fine-grained light-brown groundmass. The porphyritic andesite dikes (Tpa) range in width from 0.3 m to about 6 m and consist of plagioclase phenocrysts 8 mm long in a dark-gray fine-grained groundmass. These dikes are the most common dikes in the area and, locally, intrude the latite dikes (Tld). The basaltic andesite dikes (Tba) are usually thin but in the southern half of the study area they are about 60 m wide. The dikes are fine-grained and vary in color from greenish to dark gray and black. The porphyritic rhyolite dikes (Tpr) are restricted to the southwestern part of study area where they intrude Permian rocks and andesite-latite of Montoya Butte. The dikes are reddish brown and fine grained with phenocrysts of plagioclase, sanidine, and quartz. A quartz monzonite plug (Tqm) is found in the northern part of the study area. The plug is fine grained with plagioclase, sanidine, and quartz phenocrysts, and may be related to the porphyritic rhyolite dikes (Tpr).

SANTA FE GROUP

The Santa Fe Group (Miocene to Pleistocene) (Qtsf) consists of poorly sorted siltstone and conglomerate with clasts derived mainly from local volcanic rocks, and this unit correlates with the Winston beds of Jahns (1955). The unit is about 360 m thick in the study area with the lower contact exposed in the southern Alamosa Creek area where it overlies the rhyolite of Alamosa Creek (Tac) and in the northern study area where it overlies the tuff of Spring Canyon (Ttsc). Locally, in the southeastern part of study area, olivine basaltic lava flows (Qtb) are interbedded with the sediments of the Santa Fe Group and locally characterized by pillow-like structures (Fig. 5). McLemore (2010) suggests that these flows may be 2-6 m.y. old based on similarities of dated flows in the general area.

SUMMARY

The Sierra Cuchillo is an elongated, north-south horst block composed of Tertiary volcanic and intrusive rocks, sparse outcrops of Lower Permian and Upper Cretaceous rocks, and sediments of the Tertiary-Quaternary Santa Fe Group. In most of the study area, the volcanic rocks are underlain by Permian and Upper Cretaceous rocks at depth. Most of the volcanic rocks erupted from calderas in the San Mateo Mountains to the northeast of study area and some erupted locally. Beryllium mineralization is associated with some of these local eruptions. Ages for these rocks range from about 38 Ma to 24 Ma. Uplift of the Sierra Cuchillo was post 24 Ma and pre 6 Ma based on ages of rocks in the study area.
ACKNOWLEDGMENTS

The author would like to thank Virginia T. McLemore (New Mexico Bureau of Geology and Mineral Resources) and Rick Page (U.S. Geological Survey) for their review comments. The author would also like to thank Wolfgang Elston (University of New Mexico) for his guidance and friendship while the author was working on his thesis in 1974 and to the U.S. Geological Survey for supporting the fieldwork.

REFERENCES


LuKin, J.L., 1974, Oxide mineral in miarolitic rhyolite, Black Range, New Mexico: Geological Society of America, Abstracts with Program, v. 6, no. 5, p. 455.


Maldonado, Florian, 1974, Geologic map of the northern part of Sierra Cuchillo, Socorro and Sierra Counties, New Mexico: M.S. thesis, University of New Mexico, Albuquerque, 59 p., scale 1:24,000.


