# Geologic Map of the Seven Springs Quadrangle, Sandoval and Rio Arriba Counties, New Mexico

By

# Shari Kelley, G. Robert Osburn, Charles Ferguson, Kirt Kempter, and Magdalena Osburn

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### New Mexico Bureau of Geology and Mineral Resources Open-file Digital Geologic Map OF-GM 88

#### Scale 1:24,000

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New Mexico Bureau of Geology and Mineral Resources 801 Leroy Place, Socorro, New Mexico, 87801-4796

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# Geology of the Seven Springs 7.5 Minute Quadrangle, Sandoval and Rio Arriba Counties, New Mexico



Shari Kelley<sup>1</sup>, G. Robert Osburn<sup>2</sup>, Charles Ferguson<sup>3</sup>, Kirt Kempter<sup>4</sup>, Magdalena Osburn<sup>2</sup>

- (1) Dept. of Earth and Environmental Science, New Mexico Tech, Socorro, NM 87801
- (2) Earth and Planetary Science Dept., Washington University, St. Louis, MO 63130
- (3) Arizona Geological Survey, Tucson, AZ 85701

(4) 2623 Via Caballero del Norte, Santa Fe, NM 87505

#### INTRODUCTION

The Seven Springs quadrangle lies on the west side of the Valles Caldera in the Jemez Mountains, and includes western margin of the caldera. The area is transitional between the late Neogene Jemez volcanic field to the east and the Laramide-age Sierra Nacimiento to the west. The landscape in the central part of the area, which is underlain by 1.6 to 1.2 Ma outflow sheets of Bandelier Tuff, is characterized by dissected mesa tops bound by steep cliffs and intervening broad, grass-covered valley bottoms (e.g., Rio Cebolla). The western topographic rim of the Valles Caldera and post-collapse, intracaldera lavas, debris flows, and lake deposits occupy the southeastern portion of the area. Mildly deformed Pennsylvanian Madera Limestone and Permian Abo Formation are present in the northwest corner. The elevation across the Seven Springs quadrangle ranges ~2300 m (7600 feet) in the southwestern corner near Fenton Lake to ~2800 m (9200 feet) on the slopes of San Antonio Mountain in the northeast corner.

Smith et al. (1970) previously mapped the area and Timmer (1976) examined the copper resources of the Abo Formation in the northeast corner of the map. Furthermore, considerable research was conducted in the southeastern part of the area as a consequence of Los Alamos National Lab's Hot Dry Rock effort on Fenton Hill in the 1970s and early 1980s (Purtymun, 1973; Purtymun et al., 1974; Pettitt, 1975a,b,c, 1978; Brookins et al., 1977; Laughlin et al., 1983; Shevenell et al., 1988; Purtymun, 1995). The Hot Dry Rock project, as well as geothermal exploration on Thompson Ridge, led to the drilling of a dozen wells. This report briefly discusses some of the modifications that we have made to the classic Smith et al. (1970) map. In addition, a few of the key outcrops in the area that were helpful in unraveling the history recorded by the pre-Bandelier Pliocene to Miocene volcanic and sedimentary rocks exposed on the western topographic rim of the caldera are illustrated and described.

#### **PROJECT HIGHLIGHTS**

Several observations not previously discussed in the voluminous literature about the Jemez Mountains and the Valles caldera are noted below.

(1) For the first time, individual flows and interbedded sedimentary units within the intracaldera Redondo Creek Rhyolite have been recognized and mapped. This work allows a better understanding of the stratigraphic and structural relationships within the caldera and has implications for developing water resources for the growing community on Thompson Ridge.

(2) Good exposures on the south and east facing slopes in the central portion of the Seven Springs quadrangle allowed us to map with fair precision the paleotopography that developed on top of the Otowi member of the Bandelier Tuff prior to the eruption Tshirege member. Documentation of the paleodrainage network on the Otowi has both tectonic and hydrologic uses.

(3) Using a combination of surface mapping and well data, we have identified a fault with 45-60 m of down-to-the east offset roughly paralleling San Antonio Creek. The fault juxtaposes the upper Abiquiu against the lower Abiquiu in the northern part of the San Antonio Creek drainage, but it apparently does not offset Paliza Canyon andesite. This

fault, which can be tied to a fault on the Jemez Springs quadrangle to the south, may be an early rift-related structure.

(4) The highly welded nature of the thick Otowi member of the Bandelier Tuff in the central portion of the map area has a profound control on the hydrology and the geomorphology of many of the canyons in the area, particularly Calaveras Canyon. The contact between the welded and non welded part of the Otowi member controls the location of the major spring in Calaveras Canyon and the welded section forms a pronounced topographic bench along this canyon.

(5) Outcrops along State Highway 126 between Fenton Hill and Fenton Lake provide an important window into the Tertiary history of this area. Key relationships between the upper member of the Abiquiu Formation (or possibly the Chama-El Rito member of the Santa Fe Group), the Ojo Caliente member of the Santa Fe Group, Paliza Canyon andesite, Tschicoma dacite, as well as at least three generations of post-Santa Fe volcaniclastic sedimentary packages, are exposed here.



Figure 1. This photograph was taken looking north, so that west is toward the left. The contact between the fluvial member of the Abiquiu Formation (or potentially the Chama-El Rito member of the Santa Fe Group) and the Ojo Caliente member of the Santa Fe Group is well exposed on the north side of Highway 126 at UTM 348237 3972236 (NAD27). A well-cemented, very fine-grained, 0.2 m thick tan sandstone in the fluvial deposit is overlain by 0.2 m of poorly cemented tan sandstone and 0.1 m of brick-red siltstone. The Ojo Caliente sits on the fluvial deposit on a contact that dips gently to the east. The white to light pink Ojo Caliente sandstone (Tsoc) is poorly cemented, fine to medium-grained, and consists of sub-round to angular grains of quartz, feldspar, mafic minerals and rare lithic fragments. High angle cross-beds are preserved high on the east side of the outcrop. A rubbly deposit of Paliza Canyon andesite (Tpa) cuts down at a high angle along the west side of the outcrop; the contact dips steeply to the west. The Otowi member of the Bandelier Tuff rests on Tpa and Tsoc. The contact dips gently east. The Otowi is truncated on the east by a debris flow deposit that contains Qbo and Tpa boulders. The entire sequence is capped by 1.5 to 2 m of Tsankawi pumice and the Tshirege member of the Bandelier Tuff.



Figure 2. This photograph was taken just east of Figure 1 (UTM coordinates 348371 3972304). Again, the photo is taken looking north so that west is on the left side of the photo. Here, the Ojo Caliente member of the Santa Fe Group is overlain by three generations of post-Santa Fe sedimentary packages that contain pre-Bandelier volcanic rocks. The oldest is a red siltstone with subrounded Paliza Canyon andesite (Tpa) boulders at the base (1). This package is overlain by a matrix-supported debris flow that contains Tschicoma dacite (Ttd), subrounded clasts of Abo sandstone (~10% of clasts), pieces of angular Abiquiu sandstone, and Paliza Canyon andesite and basalt (2). The final deposit is a fluvial channel with Ttd and Tpa clasts (3).



Figure 3. This outcrop, located at 348657 3972435 (NAD 27), clearly shows that the Tchicoma dacite is younger than the Paliza Canyon andesite. The geochonology sample for the andesite  $(8.20 \pm 0.09 \text{ Ma})$  was collected here. The Tschicoma debris flow here has the same clast content as unit 2 in the previous figure (Figure 2). Here, the Tschicoma debris flow is overlain by a deposit dominated by Abiquiu sandstone, some of which is highly silicified, and occasional clasts of Pedernal Chert. To the west (left) of this photograph, the basal Tschicoma debris flow is overlain by a glassy flow of dacite.

(6) The outcrops along State Highway 126 between San Antonio Creek and the top of Fenton Hill reveal complex stratigraphic relations among the late Miocene upper member of the Abiquiu Formation, the Polvadera (dacite) and Keres Group volcanic (basalt and andesite) and sedimentary rocks, and post-dacite sedimentary rocks. The complexly incised and interbedded Cenozoic units rest on relatively flat lying to gently dipping Permian Abo Formation. Starting near the top of the hill, below the Bandelier Tuff, the basal breccia of the dacitic rocks of the Tschicoma Formation abuts against the Paliza Canyon andesite, which in turn overlies a matrix-supported Keres Group volcaniclastic sediments.



Figure 4. Matrix-supported debris flow of volcaniclastic sediments beneath the Paliza Canyon andesite is shown here. The largest clast in this photograph is ~0.3 m across. The andesite is filling a valley cut into the upper member of the Abiquiu Formation.



Figure 5. A second valley cut into the Abiquiu Formation located about 50 m to the northwest of the outcrop shown above is filled with Paliza Canyon basalt overlain by Tschicoma andesite.



Figure 6. This is the most noticeable outcrop along Highway 126 and it is the most puzzling. The Abiquiu Formation appears to be in place on the left side of the outcrop, but the unit is slumped and deformed in the middle of the exposure. A unit that appears to be the Ojo Caliente member of the Santa Fe group makes up the lower third of the right side of the outcrop, but the contact between the Abiquiu Formation and this unit is obscured. The contact seems steep and trends northwest (perhaps another fill of a narrow valley). Paliza Canyon basalt rests on this sandstone and exhibits contact metamorphism at its base. A fluvial unit that contains pebbles of Paliza Canyon and Tschicoma volcanics overlies the sandstone. The outcrop is capped with a relatively young debris flow.



Figure 7. This photograph is a close-up of the outcrop shown in Figure 6 and shows the fine-to medium grained sandstone with lenses of volcanic pebbles. The pebbles are dominantly Paliza Formation andesite, but Tschicoma dacite becomes more abundant up section. If the Tschicoma is locally derived, the upper part of the unit is younger than ~4 Ma.



Figure 8. A Paliza Canyon basalt flow appears to be resting on the lower portion of the outcrop, which does not contain the fluvial volcaniclastic lenses, suggesting that parts of this sedimentary deposit are older than 9 Ma.

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Geochronology results for volcanic rocks in Seven Springs quadrangle. Samples run at the New Mexico Geochronology Laboratory at New Mexico Tech.

Sample	UTM coordinates (NAD 27)	Lithology	40 Ar/39 Ar age (Ma)
FJ-0434	13S 349992 3971680	basalt lava clast in Paliza Canyon volcaniclastic sediment	$8.93 \pm 0.11$
FJ-0403	13S 349256 3972491	Paliza Canyon basalt	$8.88\pm0.05$
FJ-0430	13S 350160 3971580	basalt clast in Paliza Canyon volcaniclastic sediment	$9.26\pm0.14$
SS-05	138 348657 3972435	Paliza Canyon andesite	$8.20\pm0.09$