Preliminary Geologic Map of the Gran Quivera Quadrangle, Torrance and Socorro County, New Mexico (Year 1 of 1-Year)

By

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Open-file Digital Geologic Map OF-GM XXX

Scale 1:24,000

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GEOLOGY OF THE GRAN QUIVIRA 7.5-MINUTE QUADRANGLE, TORRANCE COUNTY, NEW MEXICO

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ABSTRACT

The Gran Quivira quadrangle, in central New Mexico, is dominated by low rolling hills and broad depressions. The hills are underlain by limestone and gypsum of the Permian San Andres Formation that have been deformed by dikes of Tertiary igneous rocks; the depressions are formed between the dike-cored hills, and in places are enhanced by subsurface dissolution of the limestone and gypsum. Total relief is low; the highest altitudes (about 6800 ft – 2070 m) are on Chupadera Mesa along the western edge of the quadrangle, and the lowest altitudes (about 6300 ft – 1900 m) are on the bottoms of closed depressions. All surface drainage in the Gran Quivira quadrangle terminates within the map area, or in closed depressions just outside the quadrangle. There is no surface-water connection to a master stream. Bedrock exposures are poor throughout the quadrangle, but roadcuts provide glimpses of the underlying bedrock units. Coarse-grained gravel, composed of well-rounded pebbles, cobbles, and boulders of rock types exotic to the quadrangle (such as quartzite, quartz, chert, red sandstone, and fine-grained volcanic rocks), is poorly exposed in one small area in the northwest corner of the quadrangle, and pebbles of these rock types are mixed with Quaternary deposits in low-lying areas in the northern 1/3 of the quadrangle. Sandy alluvium and eolian sand and silt, of Quaternary age, fills depressions and valleys between hills of bedrock. The Chupadera fault cuts Permian rocks and strikes north-south along the western margin of the quadrangle. The fault plane is not exposed, and the sense of motion (normal or reversed) cannot be determined on the Gran Quivira quadrangle.

INTRODUCTION

The Gran Quivira quadrangle is dominated by gently rolling hills and broad depressions. The hills are underlain by limestone and gypsum of the Permian San Andres Formation and dikes of Tertiary igneous rocks. There are no towns on the quadrangle. The Gran Quivira unit of Salinas Pueblo Missions National Monument is close to the southern margin of the quadrangle, and a few isolated homes and ranch houses are located near Highway 55, the only paved road in the quadrangle.

All ephemeral streams on the Gran Quivira quadrangle flow either into closed depressions within the map area, or into closed depressions just outside the quadrangle. A few streams enter the quadrangle from the east and west, and these streams terminate in closed depressions. There is no evidence that any of the closed depressions held surface water in lakes during wetter periods, and it is likely that all ephemeral surface water seeps into the surficial deposits and bedrock in the closed depressions. Altitudes range from as high as about 6800 ft (2070 m) along the western edge of the quadrangle, to as low as about 6300 ft (1900 m) in the Atkinson Flats closed depression in the southeast corner of the quadrangle and on the valley bottom southwest of Gran Quivira pueblo and mission.

Bedrock at the surface in the Gran Quivira quadrangle is Early Permian (Wolfcampian to Leonardian) in age, and consists of the San Andres Formation. Gray limestones dominate the rocks at the surface, and small outcrops of limestone and gypsum are present in the hilly areas. Blocks of Tertiary mafic intrusive rocks (probably basaltic andesite; Chamberlin et al., 2009) are present in the colluvium in some places, but the intrusive rocks are not well exposed. The

bedrock structure is simple; the Permian rocks are essentially horizontal, except where they are deformed by the Tertiary intrusions, and by collapse related to subsurface dissolution of the limestone and gypsum.

The geology of the surrounding quadrangles has not been mapped. Bates et al. (1947) mapped the Gran Quivira 30' quadrangle at a relatively small map scale (approximately 1:100,000). They showed the geology of the Gran Quivira 7.5-minute quadrangle as being dominated by the San Andres Formation, and plotted roadcut and fence-line exposures of Tertiary intrusive rocks. A few scattered strike-and-dip symbols for Permian rocks on their map show the jumbled nature of the dips in this area. Cather (2009) discussed the Chupadera fault and the deformation of the Permian sedimentary rocks by the Tertiary intrusions.

Some additional references to previous geologic studies in the vicinity of the Gran Quivira quadrangle include: Lee (1909), Darton (1928), Needham and Bates (1943), Perhac (1970), Machette (1978), and Lueth et al. (2009).

STRATIGRAPHY AND DESCRIPTION OF MAP UNITS

At the surface of the Gran Quivira quadrangle, the bedrock sedimentary units are Early Permian in age, and consist of limestone and gypsum of the Lower Permian San Andres Formation. Tertiary igneous rocks intrude the Permian rocks. Older stratigraphic units (Paleozoic and Precambrian) are shown on the cross section but are not exposed on the Gran Quivira quadrangle.

Cenozoic

Qae Stream alluvium and eolian sand (late Holocene to late Pleistocene) – poorly sorted, sandy to gravelly alluvium on valley bottoms, and eolian sand and silt in small dunes and mixed with alluvium and colluvium. Eolian deposits are present throughout the quadrangle, and these deposits, plus alluvium and colluvium, effectively cover the bedrock everywhere. Eolian sand in poorly developed longitudinal dunes appears on aerial photographs and satellite images as long streaks, having a southwest to northeast trend, but the longitudinal dunes are difficult to detect on the ground. Thickness is less than 30 ft (10 m).

Ti Mafic dike rocks (Tertiary) – fine- to medium-grained basaltic andesite in poorly exposed dikes and sills that have intruded limestone and gypsum of the Permian Yeso Group and San Andres Formation. These dikes are Oligocene in age, and are part of the Magdalena radial dike swarm described by Chamberlin et al. (2009). Because the dikes intrude the Permian rocks and are poorly exposed, they are mapped on the Gran Quivira quadrangle with the San Andres Formation using the symbol Psa/Ti. Small exposures of Ti are marked on the geologic map with an **X** symbol. Thickness not determined.

Ts Gravel (Tertiary) – coarse-grained gravel, including well-rounded pebbles, cobbles, and boulders of rocks exotic to the Gran Quivira quadrangle; clast lithology includes: quartzite, chert, quartz, fine-grained volcanic rocks, and red, ripple-laminated sandstone similar to that from the Abo Formation. None of these rock types is presently exposed in the Gran Quivira quadrangle; the closest potential sources for most of the rocks is west of Chupadera Mesa, in the vicinity of Abo Pass and the Manzano and/or Los Pinos

Mountains. Pebbles of these rock types are mixed with Quaternary deposits in low-lying areas in the northern 1/3 of the quadrangle. Thickness not determined.

Paleozoic

Psa San Andres Formation (Lower Permian or Leonardian) – gray marine limestone and interbedded gypsum. Thickness greater than 200 ft (60 m); neither the top nor the base of the formation is exposed in the Gran Quivira quadrangle.

[Paleozoic rocks not exposed at the surface on the Gran Quivira quadrangle, but shown on the cross section; thicknesses from exposures of these rocks west of the Gran Quivira quadrangle (Lucas et al., 2005; Scott et al., 2005; Krainer et al., 2009)]

Pgy Glorieta Sandstone and Yeso Group (Lower Permian or Leonardian) – sandstone, mudstone, gypsum, dolomite, limestone; Yeso Group consists of the Los Vallos and Arroyo de Alamillo Formations (Lucas et al., 2005). Thickness about 1100 ft (330) m.

Pab Abo and Bursum Formations (Lower Permian or Leonardian) – sandstone, mudstone, limestone. Thickness about 1100 ft (330 m).

IPu Pennsylvanian stratigraphic units, undifferentiated (Pennsylvanian) – limestone, mudstone. Thickness about 2100 ft (650 m).

Precambrian

PC Precambrian rock units, undifferentiated (Precambrian) – includes metamorphic rocks, such as quartzite, schist, and gneiss, and igneous rocks, such as granite, in the Manzano and Los Pinos Mountains to the west and northwest (Baer et al., 2003; Scott et al., 2005).

X **X**s indicate small exposures of mafic intrusive rocks (Ti) in roadcuts, and along pipeline roads and fence lines (including approximate locations mapped by Bates et al., 1947).

STRUCTURAL GEOLOGY

Permian rocks in the Gran Quivira quadrangle are generally horizontal, although the dip of isolated bedrock exposures might be oriented in almost any direction. The jumble of dip directions is caused by complex sub-surface igneous intrusion and/or by dissolution and collapse of the limestone and gypsum.

The Chupadera fault (Cather, 2009) crosses the quadrangle and is parallel to the western margin of the quadrangle. The fault is expressed as a topographic escarpment, which marks the eastern edge of Chupadera Mesa, with altitudes dropping from west to east several hundred ft (up to about 100 m) across the escarpment. Highway 55 crosses the escarpment in the northwest corner of the quadrangle. Rocks are poorly exposed along the escarpment, so the sense of displacement, and the dip of the fault plane, thus whether the fault is normal or reversed, cannot be determined here. This situation is typical of the Chupadera fault all along its strike, and led Cather (2009) to conclude that the fault could be either a normal fault, with the east side faulted down along an east-dipping fault plane, or a reverse fault, with the west side faulted up along a

west-dipping fault plane. If the fault is normal, it probably formed during the middle Cenozoic episode of crustal extension that affected this region, and if it is reversed, it probably formed during the late Mesozoic to early Cenozoic episode of crustal contraction (Cather, 2009). On the accompanying cross section the Chupadera fault plane is show as vertical in the subsurface because the dip has not been determined. Cather (2009) suggests a likely stratigraphic separation across the fault of 360 ft (110 m), or less. A direct quote from Cather (2009, p. 129) is appropriate here: "Throughout much of its length, the trace of Chupadera fault is marked by an east-dipping monocline as much as 0.8 km [0.5 mi] in width [. . .]. This monocline may be a fault-propagation fold related to west-up components of slip on the Chupadera fault. Because the fault is typically poorly exposed beneath alluvium at the toe of the monocline, the attitude of the fault has not been determined. Broad monoclines, however, are not typically associated with normal faults, thus the Chupadera fault may be a west-dipping fault with a reverse component of slip."

The mafic dikes in the Gran Quivira quadrangle are the primary cause of the topographic relief in most of the map area. Previous workers (Bates et al., 1947; Cather, 2009) have hypothesized that the dikes intruded the sedimentary rocks (mudstone, sandstone, gypsum) of the Yeso Group, and caused overlying rocks (rocks of the Yeso Group, Glorieta Sandstone, San Andres Formation) to be bowed upward into anticlinal forms (Figure 1; Cather, 2009). The hill on which Gran Quivira pueblo and mission were built is one of these anticlines, and roadcut exposures along Highway 55 show the San Andres limestone beds dipping approximately parallel to the hill slopes. The mafic rock in the dikes deflects the needle of a Brunton compass, so it is likely that the rock would be detectable in aeromagnetic surveys. Aeromagnetic maps having sufficient resolution may reveal the presence of mafic rocks in the subsurface.

The mafic dikes may provide a clue to the relative age of the Chupadera fault, if, in addition to cutting Permian rocks (Cather, 2009), the fault also cuts Tertiary dike rocks. Tertiary dike rocks are found on both sides of the fault, but it is unknown whether they are actually cut by the fault. If the fault cuts the Oligocene igneous rocks, displacement on the fault is younger, and therefore the fault is most likely normal. If the fault pre-dates the intrusions, it is most likely a reverse fault. Further investigations are required to determine these relationships.

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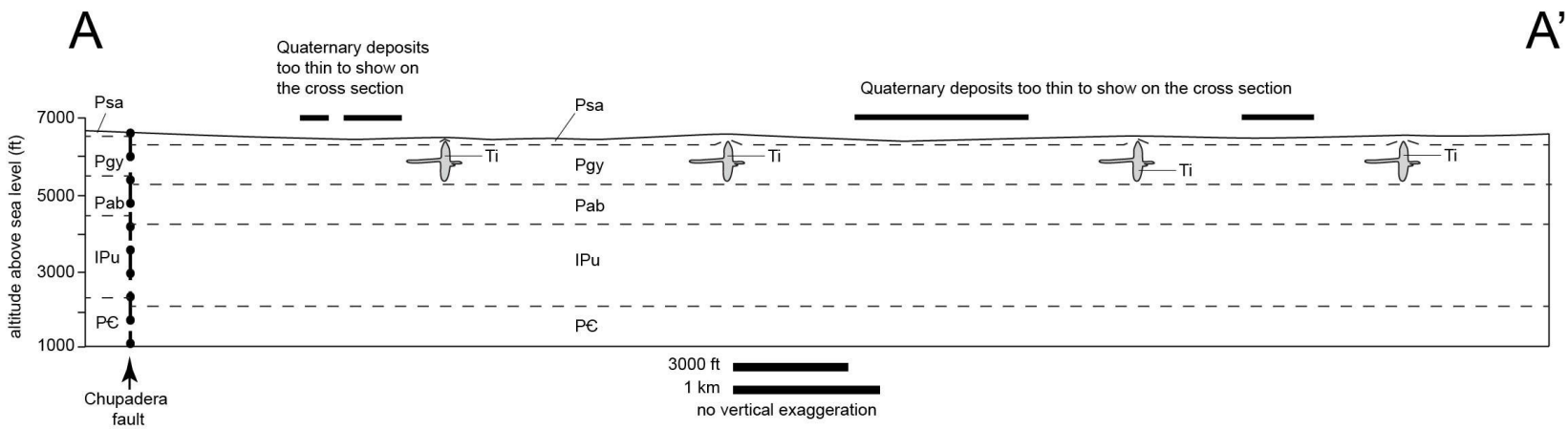
CORRELATION OF UNITS

	SEDIMENTARY	IGNEOUS	IGNEOUS/METAMORPHIC
Quaternary – Holocene	Qae		
Quaternary – Pleistocene	Qae ?		
	UNCONFORMITY		
Tertiary – Oligocene		Ti	
	UNCONFORMITY		
Paleozoic – Permian	Psa, Pgy, Pab		
Paleozoic – Penn.	IPu		
	UNCONFORMITY		
Precambrian			P€



diagramatic shape and relative placement of Ti dikes after Cather (2009, Figure 7)

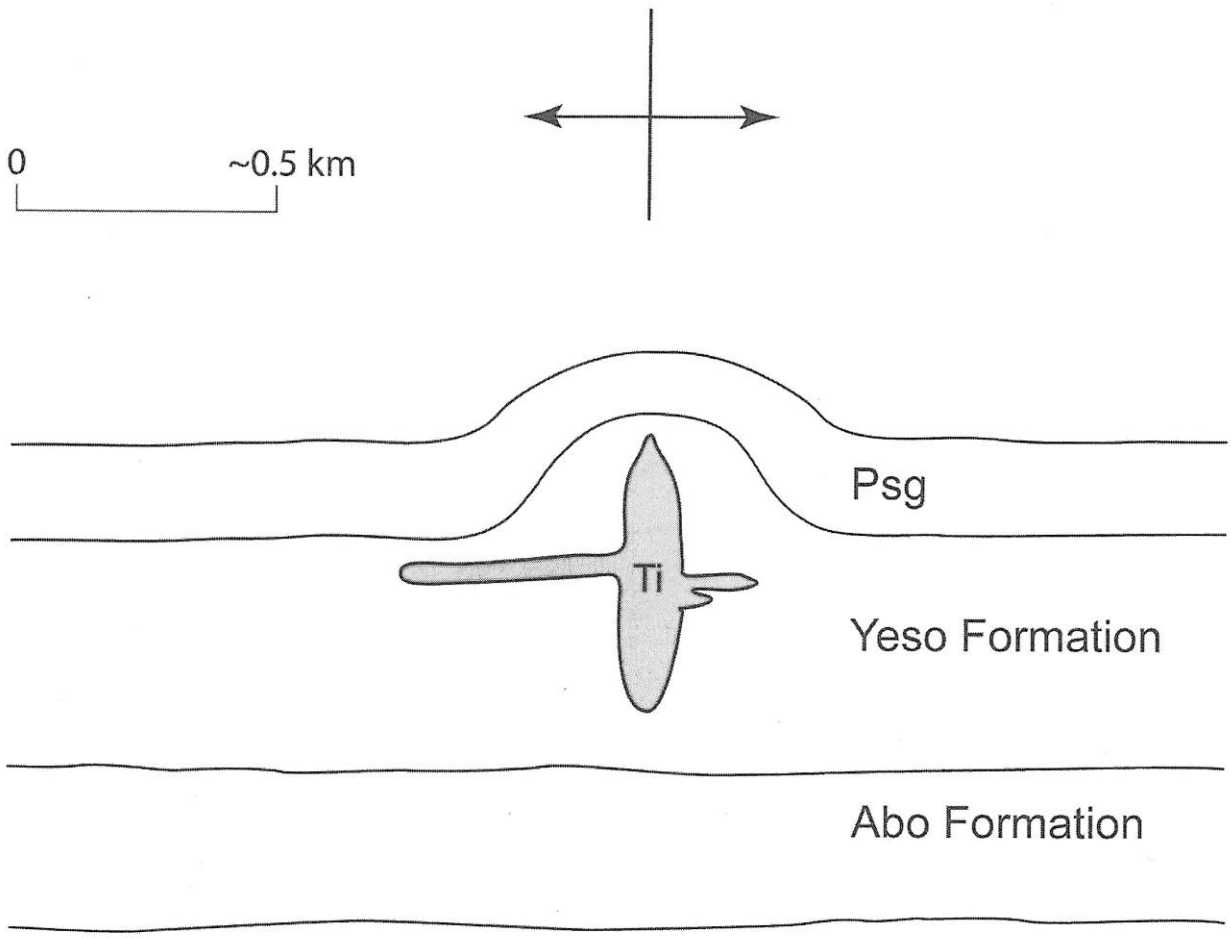


Figure 1. Modified from Cather (2009; Figure 7). Schematic cross section showing the relationship between dikes of the Tertiary intrusive igneous rocks (Ti) and the Permian sedimentary rocks in the Gran Quivira quadrangle. Psg = Permian San Andres and Glorieta Formations. The anticline symbol at the top of the diagram indicates that anticline structures were produced in the overlying sedimentary rocks; these anticline structures create elongate hills in the quadrangle; this includes the hill on which Gran Quivira pueblo and mission are built.

EXPLANATION OF MAP SYMBOLS

Stratigraphic Units

Qae — Quaternary alluvial and eolian sediment

Ts — Tertiary gravel

Psa/Ti — Permian San Andres Formation intruded by Tertiary mafic igneous rock

X — small exposure of Tertiary mafic igneous dike rock

exposed, sub-horizontal, gradational geologic contact

obscured but probable fault; bar and ball on the downthrown side