

# **GEOLOGY OF THE ABO 7.5-MINUTE QUADRANGLE, TORRANCE COUNTY, NEW MEXICO**

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## **ABSTRACT**

The Abo quadrangle in central New Mexico, is dominated by outcrops of Permian red sandstones in stream cuts and low mesas, and by gently sloping gravel-capped benches. Except for Chupadera Mesa, which rises abruptly to an altitude of about 7200 ft (2200 m) along the eastern and southern margins of the map area, relief is generally low and ranges from approximately 6000 ft (1830 m) to 6500 ft (1980 m). Most of the map area is drained by tributaries of Abo Arroyo, which flows westward to the Rio Grande valley. Bedrock units exposed at the surface consist of the Lower Permian Abo Formation, the Arroyo de Alamillo and Los Vallos Formations of the Yeso Group, the Glorieta Sandstone, and the San Andres Formation. Coarse gravel caps sloping surfaces, and is derived from the Manzano Mountains and Chupadera Mesa. Geologic structure in the Abo quadrangle is simple, with gentle southeasterly dips in the northwestern part, flattening to nearly horizontal in most of the quadrangle. Two small-displacement faults cut Permian rocks in the far northwestern corner of the quadrangle.

## **INTRODUCTION**

The Abo quadrangle is dominated by outcrops of Permian red sandstones in stream cuts and low mesas, and by gently sloping gravel-capped benches. Chupadera Mesa frames the quadrangle on its eastern and southern margins, and low-relief hills, mesas, and valley floors occupy most of the map area. U.S. highway 60 transects the northern half of the quadrangle; all other roads are gravel or dirt. The town of Mountainair lies a few miles northeast of the quadrangle boundary, and the hamlet of Abó consists of scattered dwellings along the highway in the central part of the quadrangle. Numerous isolated homes and ranches are distributed throughout the quadrangle. The ruins of Abó mission and associated pueblo structures, part of Salinas Pueblo Missions National Monument, are located about 1/2 mile (1/3 km) north of highway 60 near the western margin of the quadrangle.

Except for a few low-order streams that drain to the east on the top of Chupadera Mesa, the quadrangle is drained westward to the Rio Grande valley by Abo Arroyo and its many tributaries. Altitudes range from slightly less than 6000 ft (1830 m) where Abo Arroyo exits the quadrangle on the west, to slightly over 7200 ft (2200 m) on Chupadera Mesa. Relief in most of the map area is generally low (less than about 500 ft [150 m] over distances of 1 to 5 mi [2-8 km]).

Exposed bedrock in the quadrangle is Early Permian (Wolfcampian) in age, and consists of the Abo Formation, the Yeso Group, the Glorieta Sandstone, and the San Andres Formation, in order of decreasing age. Red sandstones dominate the Abo and Yeso units. Rocks of the Yeso Group are found throughout the quadrangle except on the top of Chupadera Mesa, and in the far northwestern corner. Coarse fluvial gravel of Pleistocene age covers the Yeso rocks in many areas; as shown by clast composition, south of Abo Arroyo the gravel was derived from Chupadera Mesa and north of Abo Arroyo the gravel source was the Manzano Mountains. Coarse-gravel landslide deposits are found along the steep flanks of Chupadera Mesa, and fine-grained alluvium fills major stream valleys. The bedrock structure is relatively simple, with gently dipping to nearly horizontal bedding broken by two faults in the far northwestern corner

of the quadrangle. Gypsum dissolution in rocks of the Yeso, Glorieta, and San Andres formations has caused locally variable dips in the overlying sandstones and limestones.

The Abo quadrangle is bounded on the west by the Scholle quadrangle, the geology of which has been mapped by Myers (1977) and Scott et al. (2005). The Manzano Peak quadrangle, which touches the Abo quadrangle at its northwestern corner, has been mapped by Baer et al. (2003). No other quadrangles adjacent to the Abo quadrangle have been mapped. Along the western edge of the Abo quadrangle, Quaternary alluvium (Qa) is roughly equivalent to the units Qay and Qaay of Scott et al. (2005), and geologic contacts on the two maps match reasonably well at Abo Arroyo and north of there in the valley of Cañon de Espinoso. South of Abo Arroyo, Qa is mapped in places where alluvium was not recognized by Myers (1977) or Scott et al. (2005).

The bedrock contacts of Myers (1977) and Scott et al. (2005) could not be projected onto the Abo quadrangle. For the most part, Scott et al. (2005) borrowed bedrock geologic contacts mapped by Myers (1977) in the southern part of the Scholle quadrangle. The stratigraphy of the Yeso Group has been revised considerably since the maps by Myers (1977) and Scott et al. (2005) were published, and I have chosen to employ stratigraphic names that were not available to these mappers. Specifically, the Arroyo de Alamillo (Pya) and Los Vallos (Pyl) Formations of the Yeso Group (Lucas et al., 2005) are mapped on the Abo quadrangle, rather than the Meseta Blanca and Torres Members of the Yeso Formation (Myers, 1977; Scott et al., 2005). Because the definitions of Pya and Pyl are slightly different than those of the Meseta Blanca and Torres Members, and because of other differences in interpretation of the bedrock in this area, the contacts along the western margin of the Abo quadrangle do not match those on the adjacent Scholle quadrangle. Neither Myers (1977) nor Scott et al. (2005) mapped Quaternary gravel derived from Chupadera Mesa (Qgc). An inferred fault at the contact between the Abo Formation and the Arroyo de Alamillo Formation in the northwest corner of the Abo quadrangle, was not recognized by Myers (1977) or Scott et al. (2005).

Some additional references to previous geologic studies in the vicinity of the Abo quadrangle include: Lee (1909), Darton (1928), Needham and Bates (1943), Machette (1978), Hatchell et al. (1982); Myers (1982), Machette and McGimsey (1983), and Lueth et al. (2009)

## **STRATIGRAPHY AND DESCRIPTION OF MAP UNITS**

In the Abo quadrangle, exposed bedrock sedimentary units are Early Permian in age, and consist of sandstone, mudstone, siltstone, limestone and dolomite, and gypsum. Stratigraphic units, in order of decreasing age, are the Abo Formation, Yeso Group, including the Arroyo de Alamillo and Los Vallos Formations, Glorieta Sandstone, and San Andres Formation. Most sandstones in the Abo and Yeso are red to orange, and these colors dominate roadcuts and natural exposures and the younger alluvium derived from these rocks.

Igneous rocks in dikes of Tertiary (Oligocene) age are exposed in several places in the southwest quarter of the quadrangle. Coarse gravel of Pleistocene age caps surfaces that slope toward the axis of Abo Arroyo. Clast composition reflects the source areas of the gravel, either the Manzano Mountains, to the northwest, or Chupadera Mesa, to the east and south. The youngest deposits in the map area are sandy sediments in floodplain and terrace landforms in stream valleys.

## **Cenozoic**

- Qa** Stream alluvium (late Holocene to late Pleistocene) – poorly sorted, sandy to gravelly alluvium along valley bottoms; includes deposits underlying low stream terraces along some of the major drainages. Most Qa sediments are reddish in color, except in some of the terraces along Cañon Latigo and nearby valleys where some sandy alluvium is pale yellow to white because of a significant component of fine-grained calcium carbonate and/or gypsum. Thickness is less than 30 ft (10 m) in most places.
- Qgm** Gravel derived from Manzano Mountains sources (Pleistocene) – poorly sorted alluvial gravel, including clasts ranging in size from small pebbles to large boulders. Clasts include metamorphic crystalline rocks (Precambrian gneiss, schist, quartzite) exposed in the Manzano Mountains to the northwest, and sedimentary rocks of Pennsylvanian and Early Permian age (limestone eroded from Pennsylvanian formations and from the Permian Bursum Formation; sandstone from the Permian Abo Formation). Thick deposits (up to 30 ft; 10 m) of Qgm cap hills and low mesas north of Abo Arroyo. Broad surfaces capped by Qgm generally slope to the south, overlie rocks of the Los Vallos Formation, and are mapped as Qgm/Pyl. Some surfaces mapped as Qgm/Pyl have a wind-blown silt (loess) cap that may be a meter or more thick. Thickness of Qgm is less than 30 ft (10 m) in most places.
- Qgc** Gravel derived from Chupadera Mesa sources (Pleistocene) – poorly sorted alluvial gravel, including clasts ranging in size from small pebbles to large boulders. Clasts include limestone (San Andres) and sandstone (Glorieta) derived from Chupadera Mesa to the south and east. Qgc caps broad, flat-topped surfaces that slope generally to the northwest. Qgc that covers a large area of the Los Vallos Formation south of Abo Arroyo is mapped Qgc/Pyl, and locally may be capped by wind-blown silt (loess) that may be a meter or more thick. Thickness of Qgc is less than 30 ft (10 m) in most places.
- Qls** Landslide deposits (Pleistocene) – highly fractured bedrock and masses of jumbled, coarse angular gravel and boulders of limestone (San Andres) and sandstone (Glorieta). Landslide masses form cone-shaped hills at the base of the steep slopes of Chupadera Mesa in the eastern part of the quadrangle. Thickness up to 160 ft (50 m) in some places.
- Ti** Diorite in intrusive bodies (Tertiary) – fine- to medium-grained diorite in poorly exposed dikes at the south boundary of the quadrangle, and in a large, poorly exposed intrusive body in the southwestern quarter of the quadrangle, which could be a dike or a sill (or both). The diorite intrudes the Los Vallos Formation, and in places is overlain by Quaternary gravel derived from Chupadera Mesa sources (Qgc). These dikes are Oligocene in age, and are part of the Magdalena radial dike swarm described by Chamberlin et al. (2009). Thickness not determined.

## **Paleozoic**

- Psa** San Andres Formation (Lower Permian or Leonardian) – gray marine limestone and interbedded sandstone and gypsum. Limestone of the San Andres forms the caprock of Chupadera Mesa. Thickness greater than 200 ft (60 m); the top of the formation is not exposed in the Abo quadrangle.

- Pg** Glorieta Sandstone (Lower Permian or Leonardian) – pale yellow to reddish brown medium-grained sandstone, exposed on the steep flanks of Chupadera Mesa. Thickness about 170 ft (50 m).
- Pyl** Los Vallos Formation, Yeso Group (Lower Permian or Leonardian) – reddish sandstone and mudstone, gray dolomite and limestone, and gypsum. The basal contact of Pyl is marked by a widespread 2-m thick gray dolomite or limestone unit, which is locally well exposed in the northwestern quarter of the Abo quadrangle. Members of the Los Vallos Formation, the Torres, Cañas, and Joyita Members (Lucas et al., 2005), are not discriminated on the Abo quadrangle because the contacts are poorly exposed. Thickness about 750 ft (230) m.
- Pya** Arroyo de Alamillo Formation, Yeso Group (Lower Permian or Leonardian) – dominated by orange to reddish sandstone and minor mudstone; includes some yellowish to pinkish white sandstones near the top of the unit. The Arroyo de Alamillo Formation was previously mapped in this area as the Meseta Blanca Formation (Myers, 1977), but has been redefined and renamed by Lucas et al. (2005). A good description of the contrast between sandstones of the Arroyo de Alamillo Formation and those of the Abo Formation is given by Lueth et al. (2009, p. 89): “The differences between the Abo and the [Arroyo de Alamillo] are obvious. The orange color of the [Arroyo de Alamillo] contrasts sharply with the red Abo. The [Arroyo de Alamillo] contains a larger percentage of sandstone than the Abo, and [Arroyo de Alamillo] sandstones are slightly coarser-grained and have a greater lateral uniformity of thickness. Abo sandstones have basal stratigraphic relief and fill scours, whereas [Arroyo de Alamillo] sandstones have constructional, dune-shaped relief on upper bedding surfaces. Planar laminations and small-scale cross laminations are abundant in the [Arroyo de Alamillo]. Many bedding surfaces are rippled, and some bear tracks and trails. Interference ripples are common. A shallow marine to beach environment is suggested for the [Arroyo de Alamillo].” Thickness about 210 ft (60 m).
- Pa** Abo Formation (Lower Permian or Leonardian) – red sandstone and mudstone; the lower part is dominated by mudstones and sandstones that are conglomeratic and trough cross-bedded (referred to as the Scholle Member by Lucas et al., 2005); the upper member (Cañon de Espinosa Member of Lucas et al., 2005) is also mudstone dominated, but contains sheet-like sandstone bodies that are ripple- and climbing-ripple laminated. White reduction spots, 1-3 cm in diameter, which are almost perfectly circular in cross section, are abundant in some of the red sandstone beds of the Abo. The Cañon de Espinosa Member is exposed in the Abo quadrangle. Thickness about 1000 ft (300 m) (Lucas et al., 2005).
- Pb** Bursum Formation (Lower Permian or Leonardian) – not exposed in the Abo quadrangle; shown on the cross section. In the neighboring Scholle quadrangle the Bursum Formation contains limestones and shales (Scott et al., 2005). Thickness about 115 ft (35 m) (Krainer et al., 2009).

- IPu** Pennsylvanian stratigraphic units, undifferentiated (Pennsylvanian) – not exposed in the Abo quadrangle; shown on the cross section. Rocks include limestone, sandstone, siltstone, and mudstone Scott et al. (2005). Total thickness of Pennsylvanian rocks about 2100 ft (650 m).
- PC** Precambrian rock units, undifferentiated (Precambrian) – not exposed in the Abo quadrangle; shown on the cross section. Rocks include metamorphic rocks, such as quartzite, schist, and gneiss, and igneous rocks, such as granite (Baer et al., 2003; Scott et al., 2005).
- ★ stars indicate locations of thin gravel deposits on San Andres Formation on the top of Chupadera Mesa. Gravel is composed of rounded pebbles of quartzite, chert, andesitic to rhyolitic volcanic rocks, and red sandstone probably derived from the Abo Formation.

## **STRUCTURAL GEOLOGY**

Rocks in the Abo quadrangle are flat-lying to gently dipping. In the northwestern quarter of the quadrangle, some dips are as great as 6 to 9°, or over 15° in fault zones, but rocks are nearly horizontal in the rest of the map area. Anomalous dips of some dolomite, limestone, and sandstone outcrops of the Los Vallos, Glorieta, and San Andres are found in areas of local deformation caused by collapse related to subsurface gypsum dissolution. Hints of wavy bedding (with wave lengths on the order of a half a kilometer or more) visible from a distance on the western flank of Chupadera Mesa are probably also related to differential gypsum dissolution in the subsurface. Local variations in dip are not depicted in the cross section. The gentle dips (3-4°) in the Yeso rocks in the western quarter of the cross section flatten eastward to near 0°.

Two faults are mapped in the northwestern corner of the quadrangle; their sense of displacement is inferred from the relative ages of rocks displaced by them. The map symbols indicate normal displacement, but fault planes are not exposed in this quadrangle so it is not possible to determine whether the faults have normal, reverse, or strike-slip displacement. On the Punta de Agua quadrangle directly to the north, kinematic indicators (nearly horizontal slickenlines) associated with the same faults suggest that at least the most recent episode of motion in the fault zones was right-lateral strike-slip. Estimated fault displacement, in a vertical direction, ranges from negligible to greater than 200 ft (60 m).

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# CORRELATION OF UNITS

SEDIMENTARY      IGNEOUS

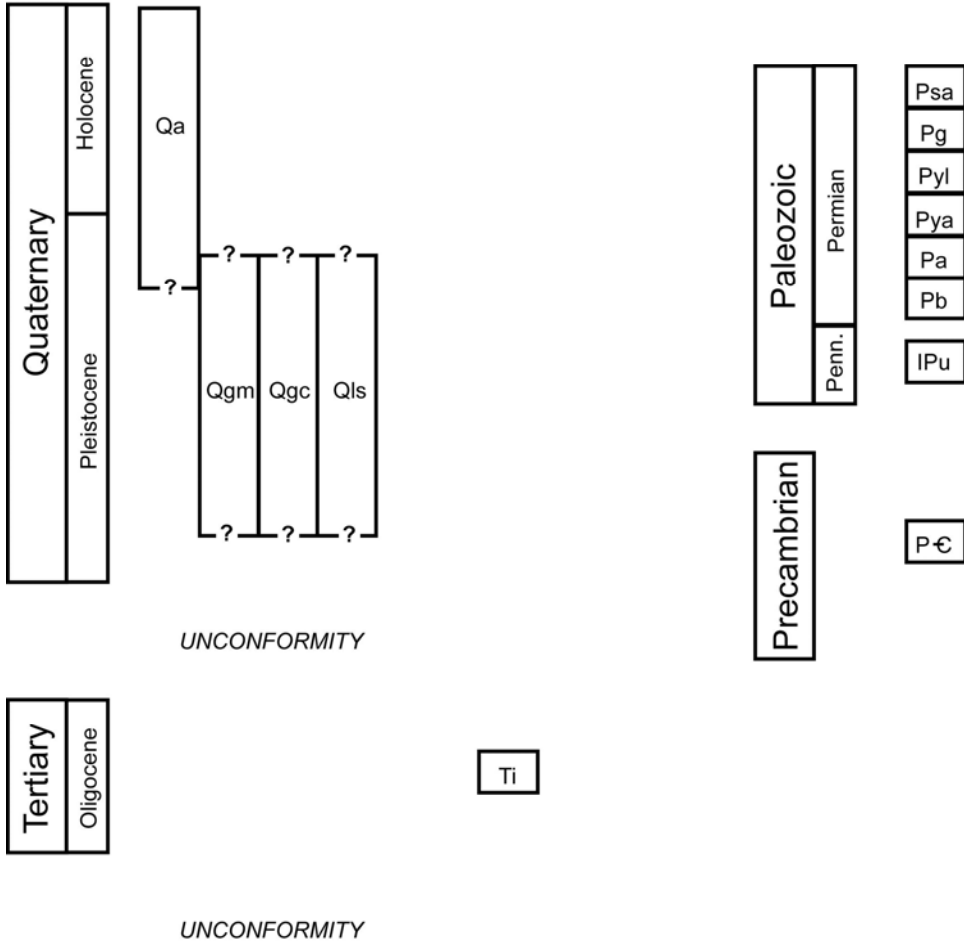


Table of locations for dip measurements on the Abo quadrangle.

UTM E (NAD27)	UTM N (NAD27)	dip angle	dip direction	map unit
376120	3817608	6	105	Pyl
376259	3817936	9	150	Pyl
375727	3817119	6	190	Pyl
375502	3817008	7	0	Pyl
375256	3817663	14	290	Pyl
374152	3817332	9	140	Pa
375826	3816137	16	135	Pya
375639	3816400	2	40	Pyl
376039	3818217	5	160	Pya
375480	3818115	10	290	Pya
374889	3816346	5	150	Pya
376813	3812751	8	180	Pyl
375434	3812040	4	140	Pya
373786	3806607	5	120	Pyl
373816	3812416	3	100	Pya
378356	3804434	10	140	Pg
379026	3805045	5	200	Psa
383255	3814072	6	150	Pyl
383480	3807410	18	145	Pg
374689	3817787	15	330	Pya
374836	3817490	6	180	Pyl
374511	3817672	15	80	Pa
375628	3817266	10	200	Pya
382264	3809527	20	210	Pg
374302	3817167	27	50	Pya
373794	3816404	7	145	Pa



Table of locations of rounded quartzite gravel, Chupadera Mesa, Abo quadrangle.

UTM E (NAD27)	UTM N (NAD27)	material
384741	3805598	gravel
384632	3805009	gravel
382895	3804291	gravel
382281	3804775	gravel
381963	3804866	gravel

