Geologic Map of the Moriarty North 7.5-Minute Quadrangle, Santa Fe and Torrance Counties, New Mexico

By
Bruce Allen

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

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Open-file Digital Geologic Map OF-GM 258

Scale 1:24,000

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

Description of Map Units to Accompany Geologic Map of the Moriarty North 7.5-Minute Quadrangle

Bruce D. Allen*
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*New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech, Socorro, NM 87801

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General

The Moriarty North 7.5-minute quadrangle (Fig. 1) is located about 50 km east of the Albuquerque metropolitan area in Santa Fe and Torrance counties, New Mexico. The quadrangle is in the ~5000 km^2 Estancia topographic basin; the town of Moriarty and Interstate Highway 40 are located along its southern edge.

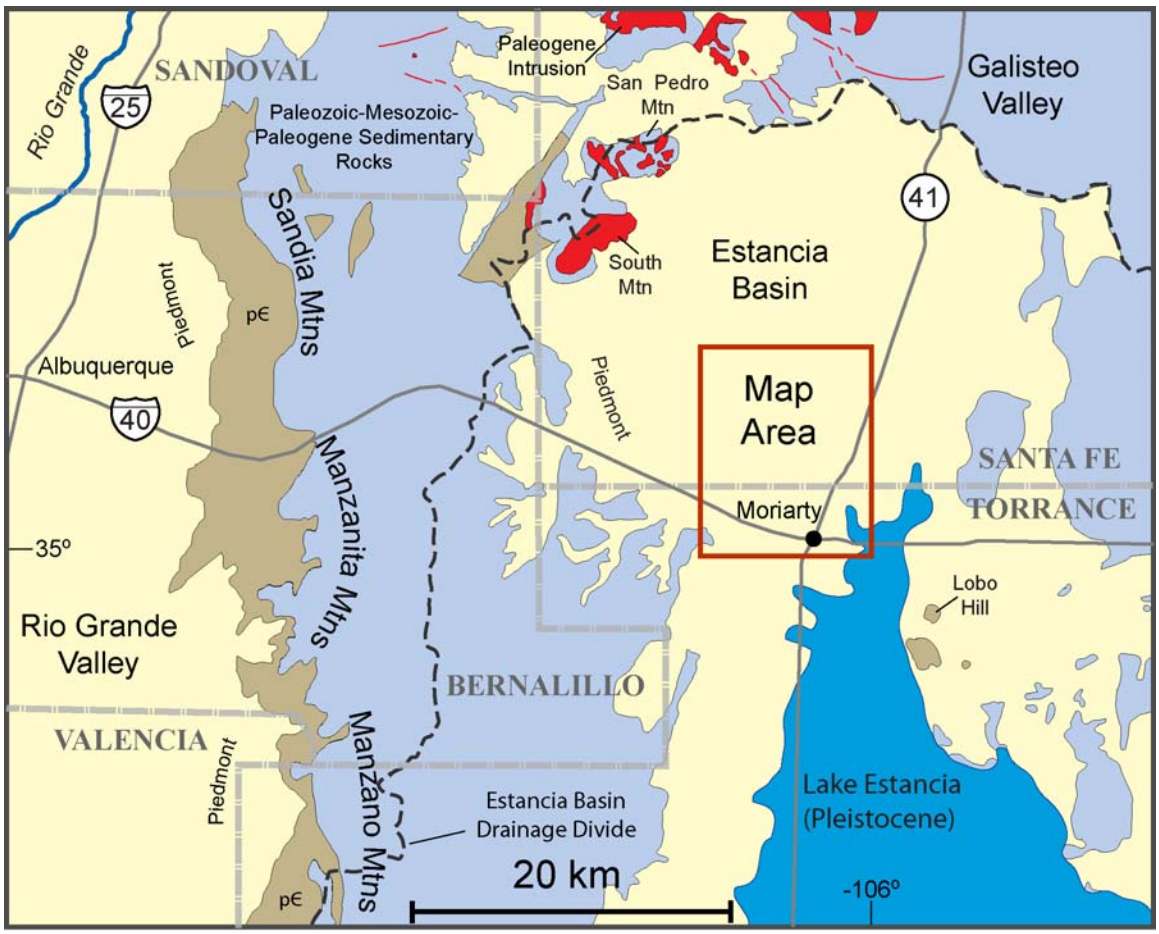

Figure 1. Index map showing location of Moriarty North 7.5' quadrangle, generalized geology, and physiographic features.

The central part of the quadrangle is underlain by ~100 meters of valley- and basin-fill alluvium. The thickness of these largely unconsolidated deposits thins to the west and to

the east across the quadrangle; along the southern margins of the map area in those directions bedrock is present at relatively shallow depths beneath the land surface.

Average annual precipitation in the area is on the order of 30 cm. Surface runoff drains east and southward in draws toward the lowest part of Estancia basin which, during the last ice age, contained a large perennial lake (Lake Estancia) whose shorelines reached an elevation of about 1890 m. There are no perennial streams in the map area and water for agriculture, stock, and domestic use is obtained from groundwater supplies.

Geology

The general bedrock structure beneath the northernmost Estancia basin has been depicted as a shallow north-plunging syncline (Broadhead, 1997, Fig. 6). The Moriarty North quadrangle lies to the south of this perceived structure and the overall dip of bedrock units beneath the map area is probably only a few degrees to flat lying. Rocks on the western side of the map area pertain to the Pennsylvanian Atrasado Formation. Based on water-well driller's logs and the distribution of sinkholes on the land surface, rocks of Permian age are probably present beneath the unconsolidated fill a short distance to the east of the Atrasado outcrops, and extend beneath the quadrangle in that direction (see cross section A-A'). Mesas to the east of the map area are capped by younger Permian, and farther east by Triassic sedimentary rocks.

The region south of the Galisteo valley, including the map area, was uplifted and eroded during Cenozoic time, as indicated by removal, to varying degrees, of considerable thicknesses of Paleozoic and Mesozoic sedimentary rocks over much of the Estancia basin. Neogene crustal extension resulted in opening of the Rio Grande rift and development of footwall uplifts (e.g., the Sandia Mountains) to the west of the map area, and deposition of the Santa Fe Group in deep (thousands of meters), rift-axis basins. In comparison with the axial basins of the Rio Grande rift, the Estancia basin is a relatively shallow structure, containing only a hundred meters or so of unconsolidated fill. The timing of closure of the topographic basin is not well constrained.

The distribution of faults (and their association with specific tectonic events) beneath the floor of Estancia basin is, for the most part, poorly known. The Pedernal Hills along the eastern side of Estancia basin (southeast of the Fig. 1 map area) are composed of Precambrian crystalline rocks. The hills are often described as the exhumed remnants of the so-called Pedernal land mass, which was a positive element that rose above the Pennsylvanian seas that covered the region during the Penn-Perm Ancestral Rocky Mountains (ARM) orogeny. Precambrian rock exposures to the northeast of the Pedernal Hills are present just to the southeast of the map area in the vicinity of Lobo Hill. Kelly (1972), Barrow and Keller (1994) and Broadhead (1997) have discussed briefly the timing and nature of faulting along the western side of Estancia basin, with speculations regarding faulting ranging from ARM and Laramide (Cretaceous-Paleogene) orogenic episodes, to relatively young crustal extension associated with the Rio Grande rift. The presence of basement rocks on Lobo Hill adjacent to Permian strata in the subsurface a

short distance to the west (as suggested by water-well logs) may indicate buried faults in the vicinity of the map area. With little information from deeper borehole or geophysical surveys available, conjectured structures in the vicinity of the map area, such as figure 6 in Broadhead (1997), remain speculative.

Equally non-conclusive evidence suggests that down-to-the-east faulting may have occurred along the western part of the quadrangle. Rocks pertaining to the Pennsylvanian Atrasado Formation are exposed in small outcrops on the southwestern edge of the map area, where they are relatively flat lying. To the east a few kilometers water-well driller's logs suggest that redbeds of Permian age are present beneath the basin fill, and borehole cuttings collected by the author at the town of Moriarty's municipal water-well field indicates that the Abo-Yeso contact is present approximately 100 meters beneath the land surface at Moriarty. A queried fault is shown on Cross-section A-A' to account for some of the apparent down-to-the-east deflection of strata. Additional ~north-south trending faults may be present farther to the east, but for the purpose of the cross section downward deflection of Paleozoic strata is accommodated by gently dipping bedding, rather than successive down-to-the-east faults.

A little-studied facet of the Neogene-Quaternary history of the Estancia basin has to do with events leading up to and culminating in formation of the present-day internally drained basin. Exposures of older alluvium along the northern escarpment of Estancia basin reveal deposits that rest on the beveled bedrock surface underlying the basin fill. These deposits are comparatively coarse grained and contain, in places, red granitic clasts likely derived from the Sangre de Cristo Mountains to the north. Excavation of the present-day Galisteo valley, and incision of the modern Pecos River valley some distance to the northeast, have subsequently left the Estancia basin stranded from northern (Sangre de Cristo) sediment sources. In addition, relative subsidence of the central and southern part of the basin has prevented drainage of surface water out of the basin to the south-southeast. Whether this subsidence is due solely to structural down-warping or faulting, or has been aided by solution subsidence of Permian evaporites in the subsurface, is a matter that is open to speculation.

The land surface over a portion of the map area reveals geomorphic evidence for solution subsidence in the form of sinkholes. The majority of these depressions are subtle when observed on the ground but are readily apparent on aerial photography. Another subtle aspect of the Quaternary geology is the presence of a generally thin but extensive cover of eolian silt and sand. In the northeastern part of the map area these loessal deposits are up to several meters in thickness and are shown on the geologic map as a mappable unit, map unit Qe. A small area in the southeastern corner of the quadrangle is underlain at shallow depth by lake-margin deposits associated with late Pleistocene Lake Estancia, which reached highstand elevations of approximately 1890 m during the last glacial episode.

Unconsolidated surface deposits over much of the map area are predominantly alluvium derived from the uplands to the west and thus derive from source terrains consisting largely of Paleozoic carbonate and siliciclastic sedimentary rocks (Paleogene igneous

rocks are exposed in the vicinity of South Mountain to the northwest of the map area). Alluvium in proximity to the western uplands is assigned to piedmont deposits, map unit Qp, and contains a relatively large proportion of coarse-grained clasts (sand and gravel). These deposits grade into comparatively finer-grained alluvium toward the floor of the basin, where they are classified as valley alluvium, map units Qam-Qat. Progressive incision of the piedmont has left older deposits in interfluvial areas abandoned at various levels above modern drainages. This is especially apparent along the piedmont to the northwest of the map area, where inset levels related to downcutting and deposition can be recognized and mapped. Areas of erosion, transport or re-deposition of older alluvial deposits along the margins of abandoned surfaces or terraces are represented on the map as mixed alluvium and colluvium, map unit Qac. Comparatively old alluvial deposits on the eastern side of the map area, map unit Qao, may reflect transport and deposition of sediment derived from the east and exhibit strong development of pedogenic carbonate. These deposits are present on low hills that rise above the surrounding landscape, and may overlie Permian Yeso-Glorieta-San Andres bedrock at relatively shallow depths.

Description of Map Units

Geomorphic and Anthropogenic Features and Associated Deposits

a Disturbed Area [Historic]. Artificially disturbed areas including major roads, borrow pits and quarries.

Qel Eolian Lunette [Holocene]. Eolian accumulations on the leeward side of sinkholes, forming typical (parabolic) lunettes. The three lunettes indicated on the map rise several meters above the surrounding landscape.

Qs Sinkhole Deposits [Upper Pleistocene to Holocene]. Topographically closed swale likely resulting from subsurface dissolution of Paleozoic sulfate (Yeso Group gypsum) and carbonate. Relatively young deposits filling depressions probably range in age from Late Pleistocene to Present, and may be several meters thick or more. Investigation of the stratigraphy of sinkhole-fill deposits may provide interesting information concerning late Quaternary climatic changes.

Unconsolidated Deposits

Qa Channel and Floodplain Alluvium [Holocene]. Sand, gravel, silt, and clay underlying active drainages and floodplains. Deposits occupy drainage floors and are generally inset into older alluvial deposits (units Qp and Qam), and are present within incised channels (arroyos) or broad floodplains. Unit may be inset or interfinger with other young deposits (e.g., units Qac and Qe) at low levels above active channels. Generally less than a few meters thick.

Qat Low Terrace Alluvium [Upper Pleistocene (?) to Holocene]. Valley-bottom alluvium at relatively low levels above active channels. Sand, gravel, silt, and clay underlying relatively low terraces in larger drainages. Sediments may have been deposited during waning flow following large, relatively recent flood events, or during periods of increased fluvial discharge, enhanced delivery of sediment and episodes of wetter climate in the past. Generally less than 5 meters thick.

Qac Hillslope Alluvium and Colluvium [Upper Pleistocene (?) to Holocene]. Undifferentiated alluvial, colluvial, and eolian deposits. Sand, silt, clay and gravel mantling side slopes of drainages and stripped older deposits on interfluvial summits. Deposited in association with erosion and downslope transport of older deposits, with contributions of wind-blown silt and fine sand. Includes areas of unmapped alluvial deposits (e.g., units Qao, Qp, Qam) and may be incised by active drainages or interfinger with young valley-floor alluvium (Qa). Estimated thickness is 5 meters or less.

Qe Eolian Silt and Sand [Upper Pleistocene (?) to Holocene]. Mixed eolian/alluvial deposits, northeastern part of map area. Wind-deposited silt and sand, augmented and modified by alluvial processes. Deposits are typically a distinctive reddish brown color and soils are weakly developed. In some areas these deposits underlie a hummocky land surface that may represent past eolian dune activity (presently stabilized with grasses). Generally less than 5 m thick.

Ql Lake Deposits [Upper Pleistocene]. Nearshore lacustrine deposits associated with pluvial Lake Estancia. Sand, silt, gravel and clay deposited and re-worked by lake-margin processes during highstands and alluvial/fluvial processes during lowstands of the latest Pleistocene lake. Gravel pit exposures in similar settings to the south of the Moriarty North quadrangle commonly exhibit centimeter- to meter-scale bedding defined by grain-size variations (clay to gravel). Some sand and gravel beds exhibit planar, shoreward-dipping cross beds, and, in the vicinity of larger drainages, meter-scale, planar cross beds (probably deltaic foreset beds) that are commonly ripple laminated in thin, finer-grained layers. Aquatic fossils including mollusks and ostracodes are common in some (typically finer-grained) interbeds. Unit is not well-exposed where it is mapped in the southeastern corner of the map, and is probably covered by a veneer of younger loessal and alluvial sediment. The deposits in the map area likely received fluvial sediment from the large drainages that converge on the southeastern corner of the

quadrangle. In similar highstand depositional settings (i.e., close to 1890 m in elevation) elsewhere in the lake basin, the deposits of the littoral zone of the lake are commonly several meters thick, but thickness varies.

Qam Valley Alluvium (Intermediate Levels) [Middle (?) Pleistocene to Holocene]. Undivided valley alluvium at low to intermediate levels above modern drainages. Sand, silt, gravel, and clay deposited over broad, low-gradient areas above an elevation of ~1890 m (6200 ft). The floor of the Estancia basin (to the south of the map area) is covered by lacustrine deposits and a complex of younger, superimposed playas and eolian lunettes that occupy the landscape below an elevation of 1890 m. Thickness of Qam is estimated to range from a few meters to a few tens of meters.

Qp Piedmont Alluvium [Middle (?) Pleistocene to Holocene]. Piedmont-slope alluvium and colluvium. Predominantly sand and silt, with significant amounts of gravel along paleo-drainages and bedrock uplands (eastern side of the Manzanita Mountains) to the west. Undivided unit is depicted in southwestern part of map area where it forms a relatively thin cover over Paleozoic sedimentary rocks. Subdivided map units include surficial deposits underlying interfluvial summits (unit Qp1), and inset deposits (Qp2) at intermediate levels above modern drainages (some areas mapped as Qp2 may be straths, with little accumulation of associated fill). Up to a few tens of meters thick.

Qao Older Alluvium, Eastern Part of Map Area [Early to Middle (?) Pleistocene]. Alluvium (sand, silt, clay and gravel) and residuum on weathered bedrock exhibiting substantial pedogenic carbonate development. Unit at crests of small hills and ridges has been stripped, exposing pedogenic calcrete near the land surface, and is covered by a thin veneer of alluvial and loessal deposits downslope and in swales. The position of Qao deposits on the landscape suggests a source from the east rather than from the north, although study of the provenance of gravel clasts in the deposit may indicate otherwise. Bedrock (Permian Yeso-Glorieta-San Andres rock-stratigraphic units) may be present beneath the unit at a depth of only a few meters in some areas, as suggested by large (boulder-size) fragments of limestone, sandstone, and gypsiferous red mudstone observed in the vicinity of some excavations. Depth to bedrock suggested by the few water-well driller's logs that were available varies from a few meters to several 10s of meters, but precise locality information and definitive lithologic descriptions are lacking in these reports. At least two previous smaller-scale geologic maps depict bedrock outcrops variously assigned to the Glorieta or San Andres formations in the area mapped here as Qao, and these bedrock units may indeed be present at shallow depth beneath the land surface in some areas.

Bedrock Map Units

Pa Atrasado Formation [Middle (?) to Upper Pennsylvanian]. Interbedded marine and marginal-marine sandstone, siliciclastic mud, and limestone. Sandstones are typically red to yellow, fine to coarse-grained (with some pebbly beds), and range from quartzose to arkosic. Some fine-grained sandstone to siltstone beds are greenish and micaceous. Siliciclastic mud is present as meter-scale shale and calcareous shale beds and as thin interbeds within carbonate-dominated intervals. Limestone beds are commonly fossiliferous (normal marine) mudstones and wackestones to packstones; coarser-grained accumulations of skeletal fragments comprise some beds. Echinoderm fragments, bryozoans, and brachiopods are commonly present, and fusulinids are abundant in some beds. The Atrasado is underlain by the Gray Mesa Formation, and is overlain by the Bursum Formation. The Atrasado Formation is approximately 200 meters thick to the east of the map area at Cedro Peak on the Sedillo quadrangle. The small exposures in the southwestern part of the map area are approximately midway up from the base of the formation.

Stratigraphic Units Depicted on Cross Section

QT Estancia Valley/Basin Fill, Undifferentiated [Pliocene (?) to Recent]. Includes the unconsolidated surface units described above as well as older, buried deposits (some of which may locally be cemented by carbonate). Up to ~120m thick along the north-south axis of the Estancia basin, thinning toward the margins.

Psg Glorieta Sandstone and San Andres Formation, Undifferentiated [Lower Permian (Leonardian)]. The Glorieta Sandstone is crossbedded, laminated and structureless quartzose sandstone, generally thought to represent an eolianite, although in some areas of New Mexico an argument is made for a coastal-marine (shoreline) depositional environment. The overlying marine to restricted marine San Andres Formation is mostly limestone, but contains significant amounts of sandstone and gypsum in some parts of New Mexico.

Py Yeso Group [Lower Permian (Leonardian)]. Red-bed sandstone, siltstone, and mudstone, carbonate (dolomite-limestone), and sulfate (gypsum-anhydrite). A wide variety of depositional environments for Yeso Group stratigraphic units are inferred, including fluvial, coastal plain and restricted marine. 150m thick on cross section.

Pa Abo Formation. [Lower Permian (Wolfcampian-Leonardian (?)]. Siliciclastic red beds, predominantly mudstone and siltstone, with many thin sandstone beds and sandstone and conglomerate filling channels. Terrestrial (overbank mud and sand, and coarser-grained channel fill). 190m thick on cross section.

ℙ Pennsylvanian Subsystem, Undifferentiated. Pennsylvanian-age rocks underlying Estancia basin consist of four formation, as follows (descending order). 1) Bursum Formation. Upper Pennsylvanian to Permian (Virgilian-Wolfcampian). Interbedded red-bed siliciclastics (mudstone, sandstone and conglomerate) and marine limestone and shale. Age-diagnostic fossils in the northern Manzano-Sandia uplifts to the west suggest a Pennsylvanian (Virgilian) age assignment in this area. 2) Atrasado Formation. (see map unit description above). 3) Gray Mesa Formation. Middle Pennsylvanian (Atokan (?)-Desmoinesian). Thick intervals of cherty limestone, with beds of non-cherty limestone, shale, and lesser amounts of sandstone and conglomerate. Mostly normal marine. 4) Sandia Formation. Middle Pennsylvanian (Atokan). Siliciclastic mud, sand, and conglomerate, with beds of calcareous shale and limestone. Marine to marginal marine. Pennsylvanian rocks are 410 meters thick on the cross section.

XY Crystalline Basement, Undifferentiated [Paleo- to Meso-Proterozoic]. Metamorphic and plutonic rocks are exposed in the uplifts to the west. Felsic schists and amphibolite schists are exposed ~5 kilometers southeast of the map area in a rock quarry on Lobo Hill.

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