Geologic Map of the Mound Springs Quadrangle, Lincoln, Otero, Sierra, Socorro Counties, New Mexico

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Open-file Digital Geologic Map OF-GM 163

Scale 1:24,000

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(BDA_MSMUdraft of 12/12/06)

DESCRIPTION OF MAP UNITS, MOUND SPRINGS QUADRANGLE

CENOZOIC EARATHEM

NEOGENE

Valley -floor deposits

af **Artificial fill (Historic)** — Dumped fill and areas affected by human disturbances; mapped where deposits or extractions are areally extensive. Commonly includes earth dams in alluvial drainages, borrow pits for road construction and raised roads, and large sand and gravel quarries where original deposits can no longer be interpreted.

Qa **Valley-floor alluvium, undivided young deposits (Holocene to uppermost Pleistocene)** — Very pale brown to light reddish-brown (10 YR 8/3 to 5YR 6/4), inter-channel dominantly fine-grained (fine sand, silt, and clay) alluvium and anastomosing small channels of poorly to moderately sorted, unconsolidated pebbly sand with local gravel bars. Relief between channels and alluvial valley floors is typically less than 1 m. Locally buries older gravel bars, former terrace deposits (Qpil), and accumulations of gypsum. Soil horizons are not evident. In bedrock areas, deposit is less than about 3 m thick. In bajada areas, deposit is more than 10 m thick and probably caps similar bolson fill.

Qag **Thin alluvium in drainages crossing thick gypsum deposits (Holocene to upper Pleistocene?)** — Unconsolidated pale brown to light reddish brown (10 YR 8/3 to 5YR 6/4) fine-grained sand to clayey silt alluvium and loess with angular clasts of gypsum crust. Rarely contains pebbles derived from the Oscura Mountains. Locally fills dissolution-related small valleys developed in gypsum megamounds. Commonly less than 1 m thick, but ranges to more than 4 m thick.

Qc **Colluvium (Holocene to uppermost Pleistocene)** — Unconsolidated to very poorly consolidated, angular blocks of sandstone and minor limestone resting on slopes below bedrock ledges. Colors similar to underlying units and blocks. Matrix includes mudstone and rare pedogenic gypsum crust. Deposits range from less than 1 m to about 3 m thick.

Qe **Eolian sand (Holocene to uppermost Pleistocene)** — Unconsolidated to very poorly consolidated, moderately to well sorted, very pale brown (10 YR 7/3) sand. Forms extensive sheets and low dunes along the northeast sides of drainages. Common as coppice dunes beneath mesquite (*Prosopis glandulosa*) thickets. Deposits range from less than 1 m to about 3 m thick.

Spring-related deposits

Qgs **Gypsum spring deposits as spring mounds (Holocene to upper Pleistocene?)** — Well to semi-consolidated, conical to domal, white (N9), gray (10 YR 8/2), to light tan (10 YR 8/3) gypsum deposits surrounding central spring-orifice craters. Eolian siliceous-sediment accumulations and finely disseminated organic matter form a minor component of some mounds, although the surfaces of a few mounds contain significant amounts of eolian silt and sand. Gypsum precipitates generally consist of scattered, sand-sized lenticular grains set in a cryptocrystalline matrix, and may contain up to several weight percent carbonate minerals. Spring mounds range from less than 1 to more than 6 m high and from 12 to more than 100 m in diameter. Inactive craters are nearly filled with pale brown fine sand, silt, and clay deposited as loess and extensively burrowed by small mammals. Crater rims and upper slopes of mounds commonly are unburrowed consolidated gypsum crusts underlain by rock gypsum. Lower slopes commonly have discontinuous eolian and alluvial cover. Subsurface deposits of active spring mounds are moist beneath gypsophilous vegetation and powdery evaporite efflorescence. Gypsum precipitates on the substrate of active pools are largely silt- and fine-sand-sized lenticular and hemi-bipyramidal crystals. Consolidated gypsum commonly is broken into sub-meter columnar polygons with vertical and anastomosing fractures filled with banded gypsum and minor calcium carbonate. Iron and manganese staining of consolidated gypsum is locally apparent. Deposits overlie valley floor alluvium and/or older gypsum deposits.

Qgmm **Gypsum megamounds and associated, down-gradient gypsum spring deposits (Holocene? to upper Pleistocene)** — Consolidated light brown to gray to white gypsum deposits forming extensive upland areas above alluviated drainages, and associated, generally thick, distal accumulations. Uppermost ~1 m is generally a consolidated gypsum crust broken into sub-meter columnar polygons, further broken into cobbles and sub-horizontal plates 2-5 cm thick at the surface. In some areas the indurated surface crust is underlain by up to several decimeters of relatively loose, powdery gypsum silt and sand. Loess and thin alluvium locally covers the crust. Beneath the surface where exposed in artificial excavations and in sinkholes are crudely bedded semi-consolidated and consolidated gypsum layers. Estimated to be as much as 14 m thick.

Qgmk **Karst features developed in eastern megamound, and adjacent areas (Holocene)** — Consolidated light brown to gray to white gypsum deposits in the immediate vicinity of sinkholes that are up to 7 m deep and 100 m across, oriented along NW and two parallel NE trends and locally in N-S trends. The floors of several of the sinkholes contain vertical to sub-horizontal dissolution fractures and caves of unknown extent. Observations following an intense rainfall event indicate that large quantities of surface runoff flowing into the sinkholes disappears immediately into these subterranean passages. Other sinkholes have become plugged with eolian loess and alluvium and some are nearly filled.

Qss **Alluvium and saline-spring-affected deposits (Holocene to upper Pleistocene)** — Unconsolidated to partially consolidated, light brown to gray and greenish gray, structureless to crudely bedded sand, silt, and clay cemented with gypsum and other evaporites associated with shallow groundwater adjacent to and northwest of Salt Creek.

Piedmont alluvial deposits

Qpy **Piedmont stream channel and floodplain alluvium (Historic and Holocene)** — Unconsolidated light brown, light reddish brown, reddish brown and gray-brown sand, silt, and clay-with local concentrations of pebble to boulder gravel in bars and riffles in proximal to medial alluvial-apron landscape positions. Pebbles are subangular to rounded with more durable siliciclastic types farther from mountain slopes, and locally-derived sandstones, limestones, and igneous rocks closer to mountain fronts. Color and composition of the sandy and finer alluvium depends on sources upslope. For example, sediments derived from the Bursum Formation pediment commonly are maroon pebbly sand and silt. Pedogenic calcium carbonate accumulation reflecting soil development locally reaches Stage I. The unit commonly buries older layers on the distal piedmont slope, but is inset against older piedmont alluvial units in the proximal and medial piedmont. Discontinuous arroyo channels dissect the piedmont alluvium locally. Thickness estimated to be less than 10 m.

Qpyd **Piedmont, distal foot-slope apron, fine-grained alluvial deposits (Holocene)** — Unconsolidated light brown, light reddish brown, reddish brown and gray-brown sand, silt, and clay with local concentrations of pebbles and eolian loess. Decrease in slope and fewer channels from Qpy upslope to Qa downslope.

Qpi **Piedmont alluvial deposits, undivided intermediate levels (Historic to middle Pleistocene)** — Light reddish brown (5YR 6/4 and other colors), poorly to moderately sorted, unconsolidated fine- to coarse-grained sand and gravel. Medial and proximal deposits contain some boulders. The tops of these deposits are extensive, nearly planar surfaces that are abandoned by inset channels and floodplains of Qpy. Sheet-wash and eolian processes may still take place. Range in ages shown by range in soil horizon development from none to stage I pedogenic calcium carbonate. Thicknesses vary from 3-4 m near apexes to less than 1 m (often less than 0.3 m as they commonly grade to floodplain levels) at their distal margins.

Qpif **Piedmont, intermediate level, fine-grained alluvial deposits (Holocene to upper Pleistocene?)** — Unconsolidated pale brown, fine sand, silt, and clay deposited as alluvium and possibly loess forming broad planar

sloping surfaces in western part of quadrangle and local valley fill in northeast part of quadrangle. Overlies low, gravelly terraces in a few places, but does not have soil horizons developed. At least 3 m thick.

Qpifs **Piedmont, intermediate level, erosional scarps in fine-grained alluvial deposits (Holocene)** — Partially eroded scarps in unconsolidated, pale brown, fine sand, silt, and clay forming at eastern and southeastern edges of Qpif. From 0 to 3 m thick.

Qpil **Piedmont and alluvial-fan deposits (Holocene to upper Pleistocene)** — Pale brown to light reddish brown (10 YR 8/3 to 5YR 6/4), poorly exposed, poorly to moderately sorted, unconsolidated pebbly to cobbly sand. Deposit surfaces are more than 1 m above local base level along active piedmont drainages, continue to be more than 3 m above local base level upstream. Soils are weakly developed and exhibit Stage I+ pedogenic carbonate morphology. This unit probably includes two distinct kinds of deposits that occupy the same landscape position. Some of these gravelly deposits are exhumed terrace deposits; others are late Holocene alluvial fan deposits. Estimated to be 3 to 5 m thick.

Qpih **Piedmont and Alluvial-fan deposits (Pleistocene)** — Light reddish brown (5YR 6/4), unconsolidated to moderately consolidated sand and gravel. Gravels consist of subangular to subrounded limestone, granitic and metamorphic, and red sandstone rock types. Stable surface of deposit, where not deeply dissected on rounded and planar divides between 5 and 12 m above adjacent channels, exhibits well developed soils with Stage III+ pedogenic carbonate morphology. Deposits commonly are more than 12 m thick.

QTp **Piedmont and Alluvial-fan deposits of bolson fill (Neogene)** —In subsurface cross section only, south of range-bounding fault. Light reddish brown (5YR 6/4), unconsolidated sand, mud, and gravel to consolidated sandstone, mudstone and conglomerate. Pebbles consist of subangular to subrounded limestone, granitic and metamorphic, and red sandstone rock types. According to modeled gravity profile across southern Oscura Mountains (Peterson and Roy, 2005) piedmont and alluvial fan deposits of northern Tularosa basin may be at least 2.3 km thick.

PALEOGENE

Ti **Diabase dikes (probably upper Oligocene)** — Dark gray to greenish gray mafic dikes exhibiting diabasic texture of plagioclase and augite. Dikes follow east-west vertical faults and fractures developed in Paleozoic sedimentary rocks. Dikes and wall rocks of Bursum Formation have minor copper oxide and copper carbonate

(malachite) mineralization revealed in numerous prospect pits. Dikes range from less than 1 to 7 m wide.

MESOZOIC ERATHEM

Kd **Dakota Formation (Upper Cretaceous [Cenomanian])** —Unit not exposed in quadrangle; in cross section only. Consists of white, pale gray, and yellow cross-bedded coarse-grained sandstone and conglomeratic sandstone deposited in fluvial and marine environments. 55 m thick east of Mound Springs quadrangle (Arkell, 1986).

Trm **Moenkopi Formation (Middle Triassic [Anisian])** —Unit not exposed in quadrangle; in cross section only. Consists of grayish red to maroon, poorly sorted, cross-bedded micaceous litharenites, mudstones, and intraformational conglomerates. The Moenkopi Formation is 91 m thick at Bull Gap east of Mound Springs quadrangle (Lucas, 1991).

PALEOZOIC ERATHEM

PERMIAN

Pag **Artesia Group: Grayburg, Queen, Seven Rivers, Yates and Tansill formations, undivided (Middle Permian [Guadalupian])** —Unit not exposed in quadrangle; in cross section only. Consists of red to orange to light gray, fine- to very fine-grained sandstone, siltstone, gray limestone, and evaporititic gypsum. The Artesia Group is estimated to be 0 to 100 m thick in the northern Tularosa basin and shown as 100 m thick in cross section.

Psa **San Andres Formation (Lower Permian [Leonardian-Guadalupian])** —Unit not exposed in quadrangle; in cross section only. Consists of gray marine limestone, interbeds of gray marine shale, evaporitic gypsum, and beds of light gray to yellowish fine sandstone. Limestone units are planar over several km and exhibit decimeter scales of cyclic bedding. The San Andres Formation is shown to be 213 m thick in the cross section, but ranges from 140 to 250 m thick in the Chupadera Mesa area (Broadhead and Jones, 2004).

Pg **Glorieta Formation (Lower Permian [Leonardian])** —Unit not exposed in quadrangle; projected in cross section only. Consists of thick-bedded, light gray to yellowish fine sandstone with interbeds of gray marine limestone. It commonly interfingers with the overlying San Andres Formation and resembles sandstone in the underlying Yeso Group. The Glorieta Formation is estimated to be about 30 m thick in the southern Oscura Mountains, but it thins to the south and may range from 0 to 100 m thick according to Broadhead and Jones (2004).

Pyt **Yeso Group: Torres, Canas, and Joyita formations undivided (Lower Permian [Leonardian])** — Base of unit (Bachman's upper Yeso Formation) was mapped in the southern Oscura Mountains at the transition from pale red siliciclastic beds below to dolomitic limestone, yellowish green shale, and gypsum above (see Bachman, 1968). This transition is not exposed on the Mound Springs quadrangle. The unit is present at the surface as a north-south ridge in the northwestern part of the map area, where it contains poorly exposed bedded gray gypsum and yellowish gray siltstone, and resistant, medium-bedded light gray limestone and yellowish brown sandstone interbeds. Estimated by Bachman (1968) to be 435 m thick. To northeast in the subsurface the Torres formation is as much as 1067 m thick and contains salt as well as anhydrite (Broadhead and Jones, 2004). The overlying Canas and Joyita formations are about 100 m thick.

Pya **Yeso Group, Arroyo de Alamillo Formation (Lower Permian [Leonardian]) —** Previously miscorrelated to Mesita Blanca Sandstone but recently described as the Arroyo de Alamillo Formation by Lucas and others (2006). Base of formation mapped at base of meter-scale ledges of ripple-crosslaminated sandstone or local conglomeratic sandstones with colors distinctly different (2.5 YR 4/2; 5/2; 5/6) from underlying Abo Formation. Overlying beds composed of thin-bedded, fine-grained sandstone, pebble conglomerate, and siltstone. Trace fossils common. Top of formation is not exposed in the map area. Weathers weak red (10 R 5/3), with darker weak red (2.5 YR 4/2 to 5/3) mudstone with mudcracks. Estimated to be 50 m thick in the southern Oscura Mountains. Exposed in northwestern and north-central part of quadrangle on east side of Red Hill.

Pa **Abo Formation (Lower Permian [Wolfcampian])** — Base of unit mapped at poorly exposed change from brownish maroon of Bursum Formation to redder (2.5 YR 5/4; 4/3) sandstone and mudstone typical of Abo Formation farther north in central New Mexico. Unit is more mature (less arkosic) than underlying beds in the Bursum Formation, and consists largely of a basal sequence of poorly exposed mudstone, grading up to fine-grained sandstone and mudstone at the top. Sandstone and conglomerate units are commonly lenticular in distinct channels. Unlike Abo Formation farther north, minor thin limestone beds and limestone-clast conglomerates are present throughout. Limestones do not have recognizable macrofossils, and some appear to have been calcareous soils. A distinctive bed of red, ripple-crosslaminated fine-grained sandstone containing pods and stringers of similarly crosslaminated dolomitic calcarenite is present near the top of the Abo Formation in the area. In general, unit weathers red and pale reddish brown with local white and pale green oxidation-reduction spots. Estimated to be about 41 m thick on Red Hill.

lPb **Madera Group, Bursum Formation (Pennsylvanian-Permian [Virgilian and Wolfcampian (?)])** — Base of unit mapped at change from fossiliferous gray and yellowish gray limestone and greenish gray shale of top of Atrasado Formation to reddish brown and maroon shale, siltstone, sandstone, and conglomerate. Coarse-grained units are arkosic. Siliciclastic clasts in conglomerate range to 20 cm in

diameter and consist of reddish gray, salmon, and weak red (10 R 4/2, 10R 6/1, 10R 5/6) Precambrian metarhyolite porphyries, quartzites, granite gneisses, and cherts in an arkosic dark reddish gray sandstone matrix (10 R 4/1-4/2). Siltstone and shale commonly are maroon, but may also be glauconitic green. Several gray to yellowish gray to maroon ledges of limestone and/or limestone conglomerate form parallel bands along the outcrop belt, but do not contain macrofossils. The Bursum Formation is estimated to be on the order of 254 m thick or more in the southern Oscura Mountains and the Mound Springs quadrangle.

lPma **Madera Group, Atrasado Formation (Upper Pennsylvanian [Missourian and Virgilian])** — Base of unit not exposed in quadrangle. Kues (2001) summarized regional correlations of Pennsylvanian strata in New Mexico, and concluded that the formation-rank names Gray Mesa and Atrasado, respectively, should be used rather than the informal "lower member" (~Desmoinesian) and "upper member" (~Missourian-Virgilian) division of the Madera used by Bachman (1968) in the Oscura Mountains. Consists of gray and greenish gray shale, reddish brown and brown silty micaceous shale (10 YR 5/3), glauconitic sandstone, crossbedded, quartzose to arkosic sandstone and pebbly sandstone, and gray, fossiliferous (marine) limestone and calcareous shale. Limestone units are planar over several km and exhibit several scales of cyclic bedding. The Atrasado Formation is estimated to be 480 m thick in the southern Oscura Mountains.

lPmg **Madera Group, Gray Mesa Formation (Middle Pennsylvanian [Atokan-Desmoinesian])** —Unit not exposed in quadrangle; in cross section only. Consists of gray marine limestone and interbeds of gray marine shale. Limestone units are planar over several km and exhibit several scales of cyclic bedding. The Gray Mesa Formation is estimated to be 124-140 m thick in the southern Oscura Mountains.

lPs **Sandia Formation (Lower Pennsylvanian [Atokan])** —Unit not exposed in quadrangle; in cross section only. Consists of gray, brown, and pink conglomeratic coarse sandstone, gray micaceous shale, and gray and brown fossiliferous marine limestone. It is estimated to be 76-128 m thick in the southern Oscura Mountains.

CO **Cambrian and Ordovician formations, undivided (Upper Cambrian to middle Ordovician)** —Units not exposed in quadrangle; in cross section only. Consists of dark brown to gray calcareous sandstone of Bliss Formation; olive to gray sandy dolomite of El Paso Dolomite; and gray crystalline dolomite and interbeds of gray marine shale of Upham Dolomite member of the Montoya Dolomite (see Bachman, 1968). Composite thickness in cross section is about 100 m thick in the southern Oscura Mountains.

pCg **Metamorphic and Intrusive rocks (Upper Proterozoic)** —Unit not exposed in quadrangle; in cross section only. Consists of gray and pink granite, granite gneiss, and dark greenish gray diorite. Exposed in major uplifts of Oscura, Mockingbird, and northern San Andres Mountains. Found as cobble-to-boulder-sized inclusions

in Paleogene diabase dikes in quadrangle, as clasts in Bursum Formation, and as clasts in Quaternary piedmont deposits.

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