NMBGMR Open-file Geologic Map 72
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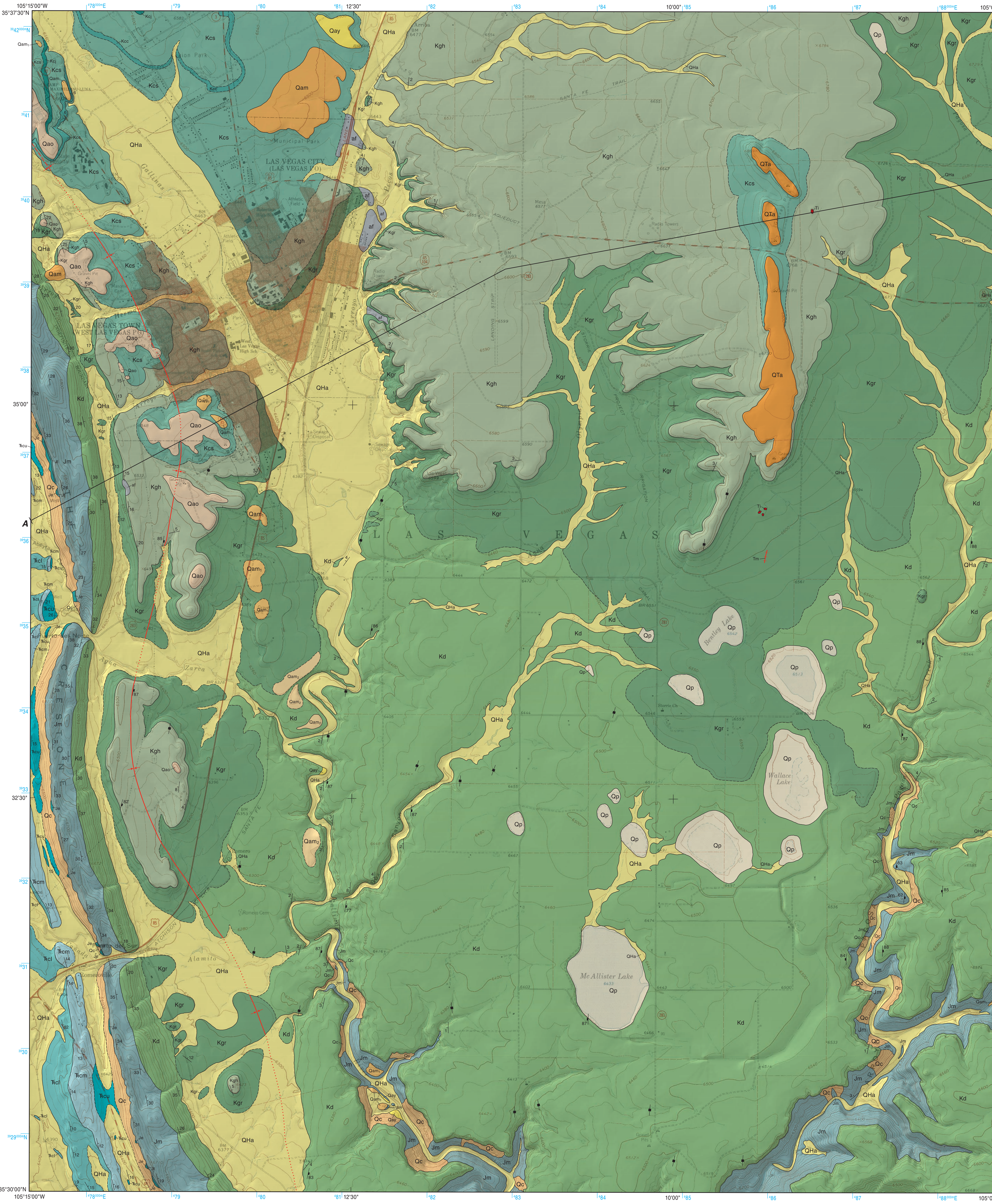


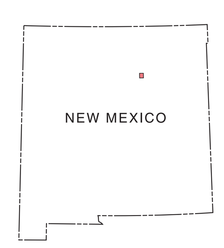
Base map from U.S. Geological Survey 1963, from photographs taken 1961, field checked in 1963.
1927 North American datum, UTM projection – zone 13N

1:24,000

CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

Magnetic Declination
February, 2004
9°42' East
At Map Center



Geologic Map of the Las Vegas Quadrangle, San Miguel County, New Mexico

May 2003

by

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New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map 72

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act, administered by the U.S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources (Dr. Peter A. Scholle, *Director and State Geologist*, Dr. J. Michael Timmons, *Geologic Mapping Program Director*).

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This and other STATEMAP quadrangles are (or soon will be) available for free download in both PDF and ArcGIS formats at:
http://geoinfo.nmt.edu/publications/maps/geologic/ofgm/home.html

Description of Map Units

af **Anthropogenic deposits** (modern)—These deposits have been created by man and are mostly filled with debris and garbage.

QUATERNARY

Qp **Playa/lacustrine deposits** (<10 ka)—These deposits are mostly silt and fine sand that underlay present-day lakes and dry lakes. None of these deposits are dissected, so only the top surfaces are visible in small dry playas.

QHa **Holocene alluvial deposits** (<10 ka)—These deposits are dominated by fine sand and silt, surrounding angular to rounded, poorly sorted clasts of all described rock types. Piedmont alluvium contains more and larger angular clasts. These deposits generally show only minor soil development and, hence, are relatively permeable. Forms flat, incised lowlands along streams and drainages, about 1–2 meters above the active channel.

Qc **Colluvium** (250 to <10 ka)—These deposits mantle steeper slopes and contain angular to sub-rounded, poorly sorted debris derived from the rocks immediately above. Commonly masks underlying rocks.

Qay **Late Pleistocene stream terrace alluvium** (250 to 10 ka)—This conglomerate contains poorly sorted sub-rounded to well-rounded pebbles to cobbles of the same rocks contained in map unit *QTc*. Also contains some large angular blocks of locally-derived Dakota Sandstone. Forms relatively flat terraces 4–5 meters above the active channel.

Qam_2 **Middle Pleistocene stream terrace alluvium, younger member** (750 to 250 ka)—These conglomerates contain sub-rounded to well-rounded, moderately sorted clasts. Clast lithologies are similar to those in map unit *QTc*. Forms flat terraces at levels slightly lower than map unit *Qor*.

Qam_1 **Middle Pleistocene stream terrace alluvium, older member** (750 to 250 ka)

Qam **Middle Pleistocene alluvium** (750 to 250 ka)—Mapped only in one place near the western edge of the map where this deposit contains mostly poorly sorted angular debris shed from the Dakota Sandstone. Appears to overlap map unit *Qor*.

Qao **Early Pleistocene stream terrace alluvium** (750 to 250 ka)—These conglomerates contain sub-rounded to well-rounded, moderately sorted clasts. Clast lithologies are similar to those in map unit *QTc*. Forms flat terraces capping the uppermost hills along the west side of Gallinas Creek.

QUATERNARY OR TERTIARY

QTa **Older stream terrace alluvium**—Poorly sorted conglomerate. These deposits contain sub-rounded to well-rounded pebbles to cobbles of: (1) fine- to medium-grained foliated diorite/granodiorite; (2) medium- to coarse-grained foliated amphibole-bearing intrusive rocks; (3) pink, weakly- to moderately-foliated coarse-grained granite; (4) coarse-grained foliated leucogranite; (5) fossiliferous (crinoidal) limestone; (6) Massive micritic limestone; (7) dark brown sandstone; (8) gray quartzite; (9) white coarse-grained vein quartz; and (10) chert. This unit forms thin deposits a few meters thick locally capped by a 1–2 meter thick cap of laminated caliche (where not stripped away). Deposits rest very high in the landscape and cap hills in the center of the map area.

TERTIARY

Ti **Dark intrusive rock**—This dark-colored, intermediate-composition intrusive rock contains abundant (40–50%) black, subhedral amphibole in tabular and needle habit, and light gray plagioclase. In general the rock is relatively equigranular, although locally amphibole is slightly porphyritic. Salt-and-pepper appearance. The texture is palotaxitic to slightly diabasic. Forms small resistant plugs.

Tm **Medium-grained intermediate-composition intrusive rock**—Generally equigranular with crystals between 2–8 mm across. Contains abundant (~40–50%) black subhedral amphibole and light gray plagioclase. Pilotaxitic texture. Salt and pepper appearance. Forms a small plug in the eastern portion of the quad.

CRETACEOUS

Kcj **Carlile Shale, Juana Lopez Member** (Upper Cretaceous)—Upper part is gray to dark gray, thin, platy, highly fossiliferous to bioclastic limestone beds and interbedded thin gray shale and thin bentonite beds, forming a unit about 5 m (16 ft) thick. Lower part is gray fissile shale containing a few limestone concretions and thin bioclastic limestone beds. Near top, member contains *Scaphites whitfieldi* and *Prionocyclus wyomingensis*; near base, contains *Prionocyclus macombi* and *Lopha lugubris*. Total thickness of member is 19 m (63 ft). (Description from Baltz and O'Neill.)

Kcc **Carlile Shale, Codell Sandstone Member** (Upper Cretaceous)—Light olive gray, rusty brown-weathering, fine-grained to silty sandstone. Upper part contains gray septarian limestone concretions; middle and lower parts contain boulder-size, yellow, silty-limestone concretions and some septarian concretions. Forms prominent ledge on west side of Gallinas Creek near northwest corner of the map. Contains *Pionocyclus hyatti* and *Spathites puercoensis*. Thickness is about 9 m (30 ft). (Description from Baltz and O'Neill.)

Kcs **Carlile Shale, lower member** (Upper Cretaceous)—Gray to dark gray, fissile clay shale. Upper 9 m (30 ft) contains a few thin, platy siltstone beds and cobble-size limestone concretions. Lower 2 m (7 ft) is marly clay shale containing a 10-cm-thick bentonite bed at the top. The thickness of this member is about 76 m (250 ft) northwest of Sapello. The shale occurs both above and below the Codell Sandstone member. (Description from Baltz and O'Neill.)

Kgh **Greenhorn Limestone** (Upper Cretaceous)—Medium- to thin-bedded, light gray micritic limestone interbedded with thin calcareous shale beds. Contains rare dark gray broken shell fragments up to several centimeters long. Rusty spots are ubiquitous. Most are irregularly shaped, although some are elongate and tube-like (filled burrows?), while others are rectilinear and resemble crystal pseudomorphs. They appear to be hematite (after pyrite?). Some horizons contain cylindrical holes a few mm across and locally over 1 cm long. The rock weathers into rectangular blocks and plates due to pervasive jointing orthogonal to bedding.

Kgr **Graneros Shale** (Upper Cretaceous)—Dark gray, fissile shale containing subordinate amounts of thin, platy sandstone and siltstone beds. Lowermost 1–2 m contains orange and gray fissile sandstone beds a few tens of centimeters thick interbedded with darker shales. The dark tan-colored sandstone beds in the lower part of the formation are fine- to medium-grained and contain very abundant irregularly shaped burrows visible on bedding planes.

Kd **Dakota Sandstone** (Lower? and Upper Cretaceous)—This unit consists of interbedded sandstone and gravelly conglomerate. Sandstone beds are medium- to coarse-grained and contain moderately sorted to well sorted, sub-rounded quartz grains. Ubiquitous planar cross-beds are in sets from several tens of centimeters to 1–2 meters thick. Gravelly conglomerate layers contain sand- to pebble-size fragments of light gray aphanitic rock. At first glance the fragments resemble rhyolite but at least one contains a crinoid mould, indicating these are chert fragments. The smaller fragments are angular, while the larger pebbles are sub-rounded to well-rounded. A small amount of iron-oxide cement gives the light tan outcrops a slight rusty-orange tint. Irregularly shaped iron-oxide spots are locally common. Vertical jointing is very prominent in this unit and strikes between 0°–15° east. The Dakota Sandstone has elsewhere been divided into three members, but the members could not be distinguished in this quadrangle.

UPPER JURASSIC

Jm **Morrison Formation, upper part**—Interbedded greenish-gray shale, siltstone, and sandstone. Sandstone is fine- to medium-grained and commonly slightly arkosic. Siltstone beds commonly exhibit light gray wispy laminations. This upper part locally contains one or two tan-colored, discontinuous, medium-grained arkosic sandstone beds up to 2–3 meters thick that superficially resemble sandstone beds in the overlying Dakota Sandstone. Most exposures are covered by debris from the overlying Dakota Sandstone. Middle part is buff to pale red, fine- to medium-grained sandstone and interbedded red, purple,and gray shale. This unit forms prominent ledges and ridges.

Jt **Todilto Limestone**—Gray bituminous, slightly sandy, slightly gypseous limestone; locally contains thin beds of sandstone. Bedding is fissile and slightly contorted. Thickness is 0 to 25 feet. (Description from Baltz, 1972.)

Je **Entrada Sandstone**—Light-colored buff sandstone. Mostly massive, though locally cross-bedded. Mostly covered by map unit *Qc*. Where exposed it forms a prominent light-colored cliff that stands out in contrast to the darker, more thinly bedded sandstones of the overlying Morrison Formation (map unit *Jm*).

UPPER TRIASSIC

TRcu **Chinle Formation, upper member**—Red shale, interbedded thin brown to red sandstone, and a few thin lenses of limestone and limestone pebbles. (Description from Baltz, 1972.)

TRcm **Chinle Formation, middle member**—Ledge-forming, tan, brown, and red sandstone and interbedded thin red shale and limestone-pebble conglomerate. Some trough cross-bedding. Well exposed in road-cut south of Romeroville.

TRcl **Chinle Formation, lower member**—Red shale, interbedded thin sandstone, and a few thin layers of concretionary limestone. (Description from Baltz, 1972.)

TRs **Santa Rosa Sandstone**—*(Shown in cross section only)* Brown, gray, and red ledge-forming sandstones and interbedded red, purple, and green shale. At many places the basal sandstone contains limestone and chert pebbles. Thickness is 200 to 400 feet. Not exposed in map area. (Description from Baltz, 1972.)

PERMIAN

Pb **Bernal Formation**—*(Shown in cross section only)* Orange-red to red sandstone and siltstone and interbedded red to purple shale. Locally upper part may contain a few beds of Triassic age. Thickness is 115 to 140 feet. Not exposed in map area. (Description from Baltz, 1972.)

Pg **Glorieta Sandstone**—*(Shown in cross section only)* Yellow to buff, ledge-forming orthoquartzitic sandstone. Medial part contains thin shale beds. Thickness is 100 to 240 feet. Not exposed in map area. (Description from Baltz, 1972.)

Py **Yeso Formation**—*(Shown in cross section only)* Orange-red to red sandstone, siltstone, and shale. Contains some tan sandstone and thin lenses of gray limestone and gypsum. Thickness is 200 to 450 feet. Not exposed in map area. (Description from Baltz, 1972.)

Psc **Sangre de Cristo Formation**—*(Shown in cross section only)* Red, purple, and greenish-gray shale and interbedded thin to thick, ledge-forming, arkosic, conglomeratic sandstones. Contains thin beds of unfossiliferous nodular limestone. Uppermost bed in many places is quartzite-pebble conglomerate. Basal bed at most places is massive arkosic conglomerate. Maximum thickness is about 1,300 feet. Not exposed in map area. (Description from Baltz, 1972.)

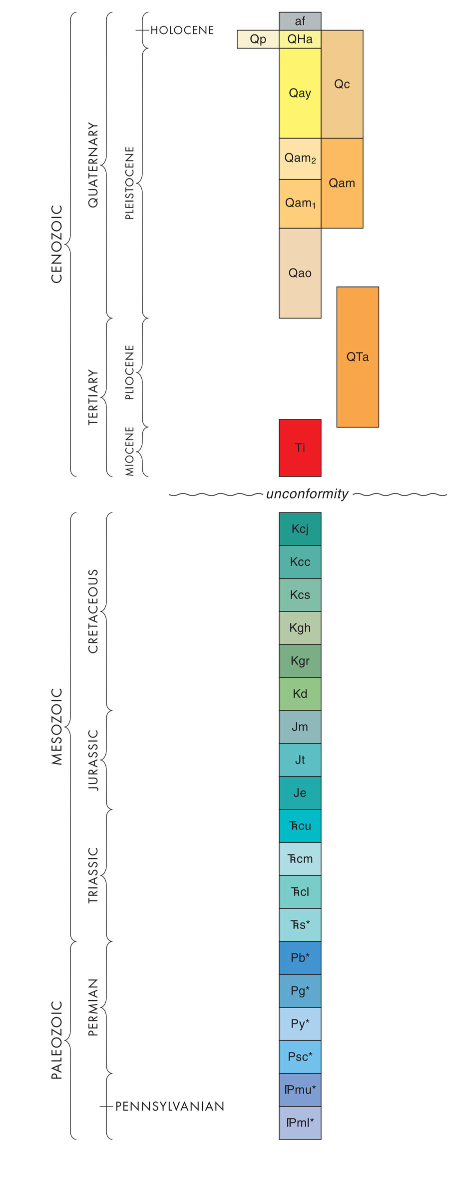
PENNSYLVANIAN

IPmu **Madera Formation, upper member**—*(Shown in cross section only)* Red-gray and greenish-gray shale and calcareous shale. Contains fossiliferous marine thin to thick gray limestones, shaley limestones, sandy arkosic limestones, nodular limestones, and thin to thick marine and non-marine arkosic conglomeratic sandstones. Feldspar fragments are mostly unweathered pink angular orthoclase. Red marly shale and arkose are at or near the base of the member at most places. Fusulinids are late Desmoinesian through late Virgilian in age. Thickness is 140 to 800 feet. Not exposed in map area. (Description from Baltz, 1972.)

IPml **Madera Formation, lower member**—*(Shown in cross section only)* Gray, thin to massive, fossiliferous marine limestone, interbedded thin to thick dark gray shale, and a few thin to thick gray sandstones. Several sandstone beds in upper part are arkosic and contain yellowish weathered rounded orthoclase fragments. Fusulinids are Dakotan and Desmoinesian in age. Thickness is 680 to 1,200 feet. Not exposed in map area. (Description from Baltz, 1972.)

Correlation of Map Units

Asterisk (*) denotes units shown on cross section only



Map Symbols

Contact—Dashed where approximately located

Syncline—Showing direction of plunge; dashed where approximately located; dotted where concealed

Strike and dip of inclined bedding

Strike and dip of inclined joint

Strike and dip of vertical joint

Marker bed exposure

Geologic cross section

Looking northwest from the southeast corner of the map, showing a cliff of Dakota Sandstone overlying slopes of Morrison Formation that are mostly concealed beneath a thin layer of colluvium.

A clean bedding exposure of Greenhorn Limestone (*Kgh*) exposed about 1 mile NE of Romeroville. Note the very consistent jointing pattern that trends about N15°E. Note hammer for scale.

Close-up of intrusive *Ti* showing the coarse, tabular nature of the rocks.

Outcrop view of Dakota Sandstone showing cross-bedding and a pebbly layer containing clasts of chert, quartzite, and quartz.

Close-up of an old gravestone hewn into a slab of Dakota Sandstone, from a small cemetery along Pagosa Creek, eastern side of map.

Introduction

The City of Las Vegas sits at the old juncture between the north–south Spanish Empire and the east–west American Empire (Las Vegas Chamber of Commerce, 2002). Poised at the confluence of two major streams, Gallinas Creek and Arroyo Pecos, the area has been a locus of trade since at least the early 16th century. The chance meeting between a band of Missouri traders led by William Becknell and a battalion of Mexican soldiers under the command of Captain Pedro Ignacio Gallego near Puerto del Norte (the "Northern Door") in 1821 led to the opening of the Santa Fe Trail. Although weathered, ruts from wagons heading west on the Trail can still be seen today near the northern boundary of the quadrangle. In 1879 the Atchison, Topeka, and Santa Fe Railroad reached Las Vegas and drastically reduced the travel time from the east. Old wagon roads were widened and improved in the beginning of the 20th Century to accommodate the growing demand for roads suitable for automobile travel, eventually leading to the building of Interstate Highway I–25.

The Las Vegas 7.5' quadrangle was mapped concurrently with mapping immediately to the north in the Las Vegas NW 7.5' quadrangle (Lisenbee, 2003). Fieldwork was carried out during October of 2002.

The Dakota Sandstone

The type section for the Dakota Group is in northeastern Nebraska, named by Meek and Hayden (1861) for rocks in Dakota County. Mateer (1987) gives a detailed summation of previous studies in the Dakota Group and points out that because of facies changes the sedimentology of the Dakota is quite variable on a regional scale. He also points out that the term "Dakota Sandstone" is more a colloquial term than it is a formal designation.

One of the best exposures of the Dakota in the Las Vegas area is in the I–25 highway road-cut immediately east of Romeroville, in the southwest part of the quadrangle (see photo in figure 10 of Mateer, 1987). Here the Dakota can be subdivided into three different units: (1) a lower, thick-bedded sandstone unit, (2) a middle, thin, 1–2 meter-thick, dark, thin-bedded shale interval (the Pajarito Shale: Gilbert and Asquith, 1976; Mateer, 1987), and (3) an upper medium- to thin-bedded sandstone unit. These three units were not mapped separately in the field. The middle shale horizon is not visible everywhere the Dakota was mapped in the field area. The upper sandstone unit, however, is commonly slightly darker orange and finer-grained than the lower thick-bedded sandstone unit. The upper sandstone commonly caps mesas and sheds dark detritus.

Gilbert and Asquith (1976) indicate that the transition from the upper sandstone unit into the overlying Graneros Shale is gradational, but S. Lucas (written communication, to Mateer, 1987) states that the contact is sharp. The contact was observed more thoroughly in this study. Dark shale rests in sharp contact on dark orange sandstone of the Dakota. However, at least two and locally three thin, dark orange quartz–sandstone beds, each up to 10 cm thick are interbedded with dark shale in the lowermost 1–2 meters of the Graneros Shale.

The Greenhorn Limestone

The Greenhorn Limestone is composed of interbedded dark shale and light gray limestone in beds several centimeters to several tens of centimeters thick. Hattin (1987) described the shale–limestone couplets as rhythmites which are apparently time-parallel over a large area of the Midwest. The Greenhorn Limestone was deposited in the Late Cretaceous Interior Seaway in relatively deep water possessing poor circulation. The limestones are predominantly micrite and contain some darker gray fossils of *Inoceramus* and *Gryphaea*. In thin-section much of the limestone is composed of foraminifera tests, calcispheres, fecal pellets, and some organic matter (Hattin, 1987). Hattin (1987) described abundant bioturbation.

The Greenhorn caps the slightly west-dipping plateau east of the city of Las Vegas. Here, the best exposures are along the bluffs on the east side of Gallinas Creek. A few other good exposures are marked on the map. One such exposure is in a cut about one mile north of the city, apparently to divert the creek through the hill to create space for development. This exposure is also shown in Figure 4b of Hattin (1987, p. 238). Rock units were very difficult to map within the city of Las Vegas itself. Most exposures have been either modified or covered over. However, locally light gray rectangular blocks of the Greenhorn Limestone are exposed in driveways or can be seen weathering out of front yards.

Structure

Syncline

Uplift of the Sangre de Cristo Mountains during west-directed compression during the Laramide orogeny has folded all of the exposed Mesozoic formations into a narrow syncline. The hinge-line of the syncline trends approximately north–south very close to the eastern side of Crestone Ridge. The syncline is asymmetric. Its eastern limb dives at most 8° westward under the city of Las Vegas. Its western limb is much steeper with dips as steep as 38° to the east. Crestone Ridge itself is held up by the resistant Dakota and Morrison Formations. The center of the syncline contains the Graneros Shale and remnants of the Greenhorn Limestone. Gallinas Creek and Arroyo Pecos preferentially followed the center of the syncline and have subsequently eroded down into these less resistant formations.

Jointing

Jointing is very pervasive in the Mesozoic sedimentary rocks. It is more obvious in the more competent rocks such as the Dakota sandstone and the Greenhorn Limestone. Jointing is nearly perpendicular to bedding, is near-vertical (except where the rocks have been folded), and is spaced commonly 10 to tens of centimeters apart. Joints are preferentially aligned N10°E. Alvis Lisenbee (pers. comm.) suggested that the pervasive jointing may be the result of regional up-warping during the Laramide.

Landscape Develpment

An older level of stream gravels caps hills in the northeastern part of the map area. These older gravels (map unit *QTc*) sit at about 6800 feet and are composed of sub-rounded to well-rounded pebbles and cobbles derived mostly from Proterozoic intrusive rocksexposed in the Sangre de Cristo mountains to the northwest. Only a few meters thick these gravel deposits form flat terraces that are slightly inclined to the northwest. The projection of this ancient surface to the northwest rises up over the current top of Crestone Ridge. Hence, this terrace level formed when the paleo-Gallinas Creek flowed at or above 6800 feet and erosion had not yet removed any material below this level. The remnants of this older terrace level are capped by dense, laminar caliche (Stage IV) up to 2 meters thick where exposed in workings. This caliche has been mined for use in cement and most of the original caliche cap on these remnants has been stripped away. Good exposures of this caliche cap are at UTM $^{39}37^{400m}$N, $^{4}85^{800m}$E. The high level of these remnants and the extensive caliche development implies very old age. Without more precise data the deposits are here designated as probably late Tertiary or early Pleistocene deposits.

Subsequent entrenchment of Gallinas Creek and Arroyo Pecos has removed about 400 feet of older material and created a series of incised terraces. These terraces have been mapped as early Pleistocene (map unit *Qor*), middle Pleistocene (map unit *Qmr*) and late Pleistocene (map unit *Qlr*) terraces based on their relative position in the landscape (i.e., their height above the modern stream channel). Curiously, the older terrace deposits all appear to be consistently coarser-grained than the youngest Holocene terrace deposits (map unit *Qy*). Exposures along the modern entrenched arroyos indicated that the Holocene deposits also locally contain abundant sub-rounded to rounded pebbles, but overall these younger deposits contain fewer larger clasts and more abundant silt and fine sand. The reason for this difference is unclear but it may be tied to fluctuations in climate and subsequent erosion rates in the Pleistocene and Holocene (Peizhen et al., 2001).

Thick soil development, particularly on the Graneros Shale and shale-rich members of the Carlisle Shale, has obscured outcrops and made mapping in these areas difficult. An effort was made to determine what rock type lay beneath these soils because exposures in stream-cuts indicated that soils were no thicker than about 2 meters at least locally. The amount of clay development on slopes indicates that these soils are at least Late Pleistocene in age and probably older.

Much of the Greenhorn Limeston and Graneros Shale are not exposed, but are instead covered by short grasses that form the prairie landscape of the Great Plains. View is from the northeast part of the map looking northwest.

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Comments to Map Users

A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical and subsurface (drillhole) data. Cross sections should be used as an aid to understanding the general geologic framework of the map area, and should not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

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