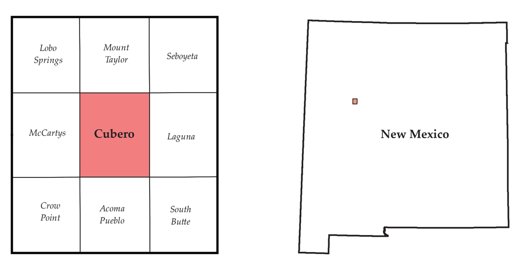
Base map from U.S. Geological Survey 2010.
North American Datum of 1983 (NAD83) World Geodetic System of 1984 (WGS84).
Projection and 1000-meter grid: Universal Transverse Mercator, Zone 13S shown in blue.

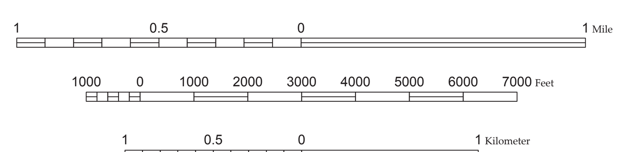
Roads....©2006-2010 Tele Atlas
Names....GNIS, 2008
Hydrography....National Hydrography Dataset, 2005
Contours....National Elevation Dataset, 2000



Quadrangle Location

Magnetic Declination
July, 2015
9° 9' East
At Map Center

1:24,000



Contour Interval 20 Feet
North American Vertical Datum of 1988

New Mexico Bureau of Geology and Mineral Resources
Open-File Geologic Map 256

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act (Fund Number:G15AC00243), administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (Matthew J. Rhoades, Director and State Geologist, Dr. J. Michael Timmons, Assoc. Director for Mapping Programs).

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This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu

Geologic Map of the Cubero 7.5-Minute Quadrangle, Cibola County, New Mexico

June, 2016

by
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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map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation.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 may not be shown due to recent development.

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 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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Digital layout and cartography by the NMBGMR Map Production Group:
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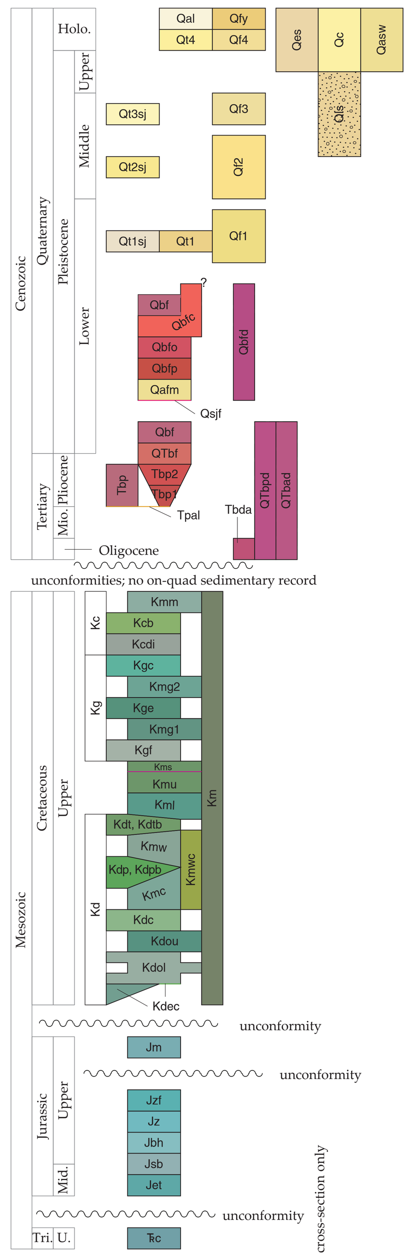
Correlation of Map Units



Explanation of Map Symbols

- Contact—Identity and existence certain, location solid where accurate, dashed where approximate, dotted where concealed and queried where existence is questionable.
- Fault—Identity and existence certain, location accurate where solid and dotted where concealed
- Listric fault at head of landslide block—Identity and existence certain, location accurate
- Normal fault—Identity and existence certain, location accurate where solid, approximate where dashed, dotted where concealed, and queried where existence is questionable.
- Outline of slip surface of landslide—Identity and existence certain, location approximate
- Monocline —Identity and existence certain, location accurate
- Monocline, anticlinal bend —Identity and existence certain, location accurate where solid and approximate where dashed.
- Monocline, synclinal bend —Identity and existence certain, location accurate where solid and approximate where dashed.
- Dike—Identity and existence certain, location accurate
- Topographic ridge interpreted to overlie a dike
- Joint—Identity and existence certain, location accurate
- Fault showing local left-lateral strike-slip offset
- D U — Fault showing relative verticle offset accross a fault (D: down-thrown block, U: up-thrown block).
- Horizontal bedding
- 3 — Inclined bedding
- 3 — Inclined contact, dike, key bed—Showing dip value and direction
- 3 — Inclined fault
- Inclined flow banding, lamination, layering, or foliation in igneous rock
- Lineation on fault surface
- 3 — Minor inclined (dip direction to right) joint, for multiple observations at one locality
- Minor inclined joint
- Contact—Showing location where contact is particularly well exposed in field
- A A′ — Cross section line and label

FIGURE 1 —Flower Mountain (rounded hill at right) and the Rio San Jose (in valley at center) with Mount Taylor (skyline at left) in the background. Flower Mountain is the eroded remains of a Lower Pleistocene basaltic volcano; gray sediments below the volcanic rocks directly beneath the peak in this photo are Mancos Shales overlain by ancestral Rio San Jose gravels. Continuous pale yellowish brown sandstone ledge in foreground and beneath Flower Mountain is the Cubero Sandstone Tongue of the Dakota Sandstone; locally exposed sandstones beneath the Cubero belong to the Oak Canyon Member. Pale yellowish brown sandstones in the distance beneath Mount Taylor are tongues of the Gallup Sandstone. Both intercalate with poorly-exposed tongues of the Mancos Shale. Mount Taylor is an eroded Plio-Pleistocene stratovolcano to the north of the study area.

Description of Map Units

Anthropogenic Units

Rw09 Water of Acomita Lake—Standing water in 2009 aerial imagery.

af Artificial fill—Compacted gravel, sand, and muds underlying roads, railroads, and dams.

Colluvial and eolian units

Qls Landslide terrain—Poorly sorted gravels, sands, and muds transported as coherent or partially coherent blocks. Blocks usually show evidence of both translational and rotational transport. Includes colluvial and alluvial material accumulating between slide blocks. Thickness 0 to as much as 60 m.

Qes Eolian material—Isolated deposits of very fine- to fine-grained eolian sand. Deposits consist of well sorted, rounded to subrounded grains of quartz with minor lithics. Soils consist of thin A/C horizonation overlying buried Bk horizons with Stage I carbonate morphology and 7.5YR color. Thickness up to 3 m.

Qc Talus and colluvium—Poorly sorted gravels, sands, and muds transported by slopewash and mass wasting processes. Common fine-grained eolian sand at surface. Only mapped where extensive or concealing geologic relations. Thickness 0 to perhaps 10 m.

Alluvial deposits

Qal Alluvium—Deposits of sand, silt, and gravel in valley bottoms. Typically fine-grained silt and sand with pebbly to cobbly gravel lenses and interbedded colluvium in tributary drainages. Rio San Jose alluvium includes coarse-grained sandy gravel intervals. Deposits are capped by weakly developed soils with 10YR-7.5YR color, no to Stage I carbonate horizon development, and lacking Bt horizons. Rio San Jose intercalates with 0.1 to 0.3 Ma Laguna Pueblo flow (Drakos et al., 1991; ages from Laughlin et al., 1993, and Channer et al., 2015) approximately 12 to 15 m below the valley floor (Risser and Lyford, 1983). Thickness typically 5 to 20 m, but as much as 50 m along the Rio San Jose.

Qasw Slopewash alluvium—Unconsolidated muds and sands transported by alluvial, eolian, and colluvial processes. Typically accumulate up-slope of large landslide blocks, forming low-relief benches.

Terrace deposits

Qt4 Alluvium underlying Qt4 terrace surfaces—Sandy pebbles to boulders underlying terrace treads approximately 3 to 5 m above local base level. Soils developed in deposits underlying Qt4 surfaces are weakly developed, with 10YR color, minimal horizon development, none to minimal carbonate accumulation, and lack Bt horizons. Thickness 2 to 6 m or greater.

Qt3sj Alluvium underlying ancestral Rio San Jose Qt3 terrace surface—Sandy pebbles to boulders underlying small eroded remnants of terrace surfaces located approximately 20 m above the Rio San Jose valley floor. Preserved thickness 0 to 4 m.

Qt2sj Alluvium underlying ancestral Rio San Jose Qt2 terrace surface—Sandy pebbles to boulders and interbedded medium- to coarse-grained sands underlying fill terrace surfaces located approximately 50 m above above the Rio San Jose valley floor. Gravels consists of 70-80% volcanics (typically cobbles to boulders of basalt, andesite, dacite, and rhyolite) with lesser sandstone, chert, shale, and minor quartzite and granite. Medium- to coarse-grained sands are well-sorted, rounded-subangular, parallel to low angle cross-bedded quartz lithics sand (~85% quartz, 15% lithics). Surface is stripped and soils are poorly preserved. Thickness approximately 10 m.

Qt1 Alluvium underlying Qt1 terrace surfaces—Sandy pebbles to cobbles located 70 to 75 m above the Rio San Jose valley floor. Deposits consist of poorly sorted, subrounded basalt and disc-shaped clasts of sandstone, with quartzite clasts and common reworked Cretaceous shell fragments. Carbonate cement throughout upper 1-2 m of deposit, indicating that the original deposit was capped by a calcic or petrocalcic soil. Thickness approximately 7 m.

Qt1sj Alluvium underlying ancestral Rio San Jose Qt1 terrace surface—Sandy pebbles to cobbles located 70 to 75 m above the Rio San Jose valley floor. Deposists consist of abundant quartzite, chert, and volcanic clasts including basalt and rhyolite, with subordinate granite and limestone cobbles. Carbonate cement throughout upper 1-2 m of deposit, indicating that the original deposit was capped by a calcic or petrocalcic soil. Thickness approximately 7 m.

Fan alluvium

Qf4 Deposits underlying Qf4 fan surfaces—Typically fan-shaped deposits of coarse bouldery gravel and sand, silt, and clay that emanate from tributary drainges along major drainages. Grades into alluvial deposits along main channels.

Qf3 Deposits underlying Qf3 fan surfaces—Sandy pebbles to boulders of mixed volcanic lithologies and subordinate sandstone clasts. Soils are partially eroded, but exhibit Stage II to III carbonate morphology and Bt horizons with 5YR to 7.5YR color. Throughout the area, Qf3 deposits are overlain by less than 1 m of young (Qfy or Qf4) alluvium. Where Qf3 deposits are overlain by thin alluvial deposits they are mapped as Qf3. Qf3 is part of a fan complex at the mouth of Water, Timber, Seco, and San Jose Canyons. Thickness poorly constrained, but greater than 3 m thick.

Qf2 Deposits underlying Qf2 fan surfaces—Rounded to subangular sandy pebbles to boulders underlying surfaces 13 to 15 m above local base level. Soils are stripped; however, clasts eroding from deposit exhibit continuous carbonate coatings. Qf2 is part of a fan complex at the mouth of Timber, Castillo, and San Jose Canyons, including a large fan surface at the mouth of San Jose Canyon. Thickness 6 to 10 m or greater.

Qf1 Deposits underlying Qf1 fan surfaces—Rounded to subangular sandy pebbles to boulders underlying surfaces 30 to 35 m above local base level between the Seco and Castillo canyon drainages. Gravel consist dominantly of basalt with lesser andesite, dacite, and ~5% sandstone. Soils are stripped; however clasts eroding from deposit exhibit continuous carbonate coatings on one or multiple sides. Deposit is partially eroded; remnants are 4 to 6 m thick.

Qfy Young alluvial fans—Typically fan-shaped deposits of coarse bouldery gravel and sand, silt, and clay that emanate from tributary drainges along major drainages. Grades into alluvial deposits along main channels.

Flower Mountain Volcano

Volcanics underlying Flower Mountain

Qbf Basalt of Flower Mountain—Basalt porphyry flow capping Cubero Mesa. Medium to dark gray, weathering black and brownish gray, with 10-15% phenocrysts <1-1 mm across of anhedral, generally degraded pyroxene, plagioclase, and olivine. Very sparse outsized phenocrysts up to 1.5 cm across of pyroxene. Matrix is aphanitic and weakly to moderately flow-foliated. Also contains sparse granitic xenolths up to 4 cm across. Thickness 0 to 12 m.

Qbfc Cinder of Flower Mountain—Variably scoriaceous basaltic lapilli and bombs with lesser ash. Clasts are dark reddish brown to black, mainly aphanitic but with sparse anhedral vitreous pale green phenocrysts <1 mm across of pyroxene or possibly olivine. Sparse gneissic xenoliths up to 30 cm across also present throughout, and sparse xenoliths of altered and brecciated sandstone as well as pebbles of sandstone, granite, chert, and limestone are present near the base. Vesicles and interclast porosity is variably filled with calcite. Preserved thickness is 0 to about 90 m.

Qbfo Older basalt of Flower Mountain—"Spotted" and porphyritic basalt underlying the main Flower Mountain cinder cone. Light to medium gray to light brownish gray, with common to abundant pale gray rounded "spots" up to 2 cm across on weathered surfaces. 5-15% phenocrysts up to 4 mm across that are anhedral and commonly reduced to reddish brown iddingsite(?), with local black cores of remnant pyroxene. Matrix is granular under hand lens, with common vitreous clear plagioclase imparting a specular texture. Sparse gray gneissic xenoliths present throughout. Exposed thickness is up to 40 m.

Qbfd Feeder dikes of Flower Mountain—Basaltic, porphyritic dikes grading upwards into extrusive facies. Light to dark gray, weathering to brownish gray, with 10-15% phenocrysts <1 mm across of anhedral pyroxene and subhedral plagioclase. Very sparse outsized anhedral pyroxene phenocrysts up to 0.5 cm across. Aphanitic matrix is finely granular under a hand lens, and contains rare to locally abundant pale gray "spots" on weathered surfaces. Dikes are 5 to 30 m wide, and trend east-northeast to north-northeast.

Qbfp Pyroclastics of Flower Mountain—Basaltic lapilli, tuff, and sparse bombs. Thickest on the south flank of Flower Mountain, where it is massive to weakly bedded lapilli tuff of rounded scoriaceous basaltic clasts that vary from medium to dark gray (unweathered) to light yellowish brown (weathered). Also contains sparse xenoliths of gneiss, sandstone, granite, chert, limestone, and chalky white siliceous material. Matrix ash is mainly pale brown to light reddish brown (2.5Y 7/3 measured) and very fine-grained. Here, the exposed pyroclastics are up to about 90 m thick, and inset into underlying alluvium and Cretaceous strata. Where cropping out beneath unit Qbf, pyroclastics grade upsection from massive pale brown ash to well-bedded and cross-bedded lapilli, and is up to about 3 m thick.

Alluvium underlying Flower Mountain

Qafm Tributary alluvium—Locally-derived muddy fine to medium sands with scattered gravel. Sands are pink to pale brown to light yellowish brown (7.5YR7/3, 6/4, 8/3; 10YR 7/2, 6/6; and 2.5Y 7/2 measured) and consist of poorly sorted muddy fine to medium grains of principally rounded to subangular quartz with common basaltic lithics. Local lenses of medium to coarse sand grains and scattered pebbles of chert, quartzite, basalt, intermediate volcanics, and sandstone. Contains locally common clayey mudballs. Maximum exposed thickness of about 3 m.

Qsjf Ancestral Rio San Jose alluvium—Gravels and sands with compositions reflecting source terrains to the west. Gravel are poorly sorted clast-supported pebbles and cobbles of dominantly rounded cherts and quartz sandstones; lesser but common granites; rare basalt, quartzite, and limestone; and sparse dark brownish gray pyroclastic material. Sands are dominantly pale brown to light reddish brown (7.5YR 5/4, 6/6 and 10YR 7/3 measured) very poorly sorted fU to vfU grains of dominantly quartz in the fine-to-medium size fraction and principally chert and quartzite with lesser granite in the coarser size fractions. Deposit grades upsection from massive to channelized and cross-bedded. Intercalates with unit Qafm. Thickness about 1.5 m.

Mount Taylor volcanic field

Qbp Plagioclase porphyry basalt—Medium to dark gray, weathering light to dark brownish gray, with 1-2% phenocrysts of subhedral to euhedral plagioclase lathes up to 10 mm long. Matrix is granular under a hand lens, with very fine vitreous pale gray and black grains that maybe plagioclase and pyroxene. Massive to weakly flow-foliated. Thickness 0 to 7 m.

QTbf Fine-grained basalt—Dark gray, weathering dark brownish gray, fine-grained basalt. Sparse (<1%) phenocrysts are vitreous black to dark greenish gray, variably degraded, subhedral pyroxene <1 mm across, with lesser plagioclase crystals up to 2 mm long. Matrix is granular under a hand lens, but individual grains are not identifiable. Vesicles and white, chalky amygdules present throughout. Thickness 2 to 17 m.

Tbp Porphyritic basalts in paleocanyons—Medium gray, weathering to black, with 10-15% phenocrysts up to 5 mm across of pyroxene and plagioclase. Pyroxene is anhedral, variably degraded, vitreous, and black to reddish brown to dark green. Plagioclase is subhedral, vitreous, and white to clear. Modal abundances vary between 2:1 and 1:1 pyroxene:plagioclase. Thickness 0 to 6 m. Locally divisible into upper and lower flows based on a flow break.

Tbp2 Upper porphyritic basalt—Basalt above the flow break. Typically coarser phenocrysts (up to 5 mm across) and more abundant pyroxene (2:1 pyroxene:plagioclase). Includes a poorly exposed light brown, punky-weathering lithic-rich tuff. Thickness 0 to 6 m.

Tbp1 Lower porphyritic basalt—Basalt below the flow break. Typically finer phenocrysts (<1 mm across) and less abundant pyroxene (1:1 pyroxene:plagioclase). Thickness 0 to 6 m.

Tpal Alluvium underlying high-level mesas—Matrix-rich basalt boulder congomerate. Gravel are rounded, poorly sorted pebbles to boulders (max of 60 cm across) of dominantly coarse plagioclase±pyroxene porphyry basalts, lesser fine pyroxene porphyry basalts, and sparse quartz sandstones and mudrocks. Matrix is pink to reddish yellow (5YR 6/6 measured) poorly sorted vfL to fU sands of mainly quartz with common plagioclase, lesser basalt lithics, and rare potassium feldspar. Grades upsection to weakly planar bedded sands similar to the matrix material. Exposed thickness of 0 to 2 m.

Intrusive igneous dikes

QTbad Aphanitic dikes—Dark gray to brownish gray, weathering to brown to black. Matrices are granular-textured under a hand lens, with a mix of light and dark grains with local prismatic shapes suggesting plagioclase and pyroxene crystals. Dark grains locally weathered to dark reddish brown material. Sparse xenoliths of wall rock along dike margins. Dominantly north-south in orientation, suggesting either emplacement during Middle Miocene to Holocene east-west extension (cf., Aldrich et al., 1986), or emplacement radial to Plio-Pleistocene Mount Taylor volcanic field. Dikes up to 1.5 m wide.

QTbpd Porphyritic dikes—Medium gray, weathering to brownish gray, with up to 15% phenocrysts <1-1 mm across of mainly plagioclase with a few percent pyroxene. Plagioclase phenocrysts are subhedral to euhedral, white, and milky to chalky. Pyroxene phenocrysts are anhedral with black glassy cores and reddish brown rims. Dominantly northwest-southeast in orientation, suggesting emplacement during Late Oligocene to Early Miocene northeast-southwest extension (cf., Aldrich et al., 1986). Dikes up to 1.5 m wide.

Tbda Acomita dike of Laughlin et al. (1983)—Dark gray, weathering to dark grayish brown, with 0-2% phenocrysts <1 mm across of mainly plagioclase with sparse pyroxene. Plagioclase is subhedral, white, and vitreous. Pyroxene is subhedral to anhedral, black, and vitreous. Very sparse outsized phenocrysts (xenocrysts?) of anhedral, rounded plagioclase up to 1 cm across are also present. Matrix is finely granular under a hand lens, but matrix grains cannot be identified. Common densely-spaced subvertical foliation parallels the dike margins. Sparse sandstone xenoliths up to 0.5 cm across occur along the dike margins. Commonly 0 to 4 m wide, but can be up to 10 m wide.

Cretaceous System

Km Mancos Shale—Dark-gray to grayish-brown gypsiferous shales with lesser siltstones and sandy shales. Poorly exposed. Generally subdivided based on stratigraphic relationships.

Kmm Mancos Shale, Mulatto Shale Tongue—Dark gray to tan, thinly laminated, very poorly exposed shales. Truncated at the top by an angular unconformity. Preserved thickness of 0 to 28 m.

Kmg2 Mancos Shale, Upper Gallup-intercalated tongue—Dark gray to grayish brown (10YR 4/1 and 2.5Y 5/2 measured), gypsiferous, thinly laminated, very poorly exposed shales and local pale brown (2.5Y 8/3 measured) sandy shales and muddy sandstones. Sands and sandstones are very fine to fine grained, dominantly of quartz, with sparse feldpars and black lithics. Thickness about 15 to 20 m.

Kmg1 Mancos Shale, Lower Gallup-intercalated tongue—Dark gray to grayish brown (10YR 4/1 and 2.5Y 5/2 measured), gypsiferous, thinly laminated, very poorly exposed shales and local sandy shales. Sands are very fine grained, and dominantly of quartz. Thickness about 12 to 16 m.

Kmu Mancos Shale, Upper "main body"—Gray to brownish gray (2.5Y 5/1, 5/3, 6/3 measured), gypsiferous, very thinly laminated shales, local sandy shales, and sparse tan sandstones. Sands are very fine grained. Locally abundant shell fragments and imprints. Includes the Semilla Sandstone Member. Thickness approximately 125 m.

Kms Mancos Shale, Top of the Semilla Sandstone Member—Only the uppermost sandstone bed of the Semilla Sandstone Member is mapped; underlying beds are poorly exposed and unmappable, and included with unit Kmu. Uppermost bed consists of pale brown (2.5Y 7/3-7/4 measured), weathering light orangish brown, muddy fine sandstones. Sandstones consist of moderately to poorly sorted muddy vfL to fL sands in wavy laminae to thin beds (0.5-2 cm thick beds). Uppermost bed is 2 m thick.

Kml Mancos Shale, Lower "main body"—Dark to medium gray (10YR 4/1 measured), weathering to a distinctive pale yellowish brown (2.5Y 8/2-8/3 measured), shales, limy shales, and fine-grained carbonate grainstones. Limy shales typically weather to form pale yellowish brown shale plate-covered slopes. Carbonate beds form ledges up to 20 cm thick consisting of grains up to fL sand-sized in massive to internally laminated beds with local carbonate nodules. Map unit includes the Bridge Creek Limestone Member and underlying shales. Thickness about 21-22 m.

Kmw Mancos Shale, Whitewater Arroyo Shale Tongue—Dark gray, well-laminated, very poorly exposed shales and lesser siltstones. Thickness only locally constrained, where it is approximately 28 m.

Kmc Mancos Shale, Clay Mesa Shale Tongue—Dark gray, well-laminated, very poorly exposed shales. Thickness only locally constrained, where it is approximately 21 m.

Kmwc Mancos Shale, Whitewater Arroyo and Clay Mesa Shale Tongues, undifferentiated—Where the Paguate Sandstone Tongue of the Dakota Sandstone is absent, the two shale tongues cannot be differentiated and are mapped together. Combined unit thickness is about 70-71 m.

Kcb Crevasse Canyon Formation, Borrego Pass Lentil—White to pale gray (10YR 8/3 measured), conspicously cross-bedded fine to medium sandstones and rare pebbly sandstones. Sandstones consist of moderately to poorly sorted vfU to mL sands of dominantly quartz with up to 10% feldspars, up to 5% chalky white chert(?) lithics, and sparse black lithics, in thin to medium beds (10-20 cm thick) with common cross-stratification. Rare channel-fill pebbly sandstones consist of poorly sorted fU to cU sands with sparse chalky white rounded siliceous pebbles up to 3 cm across. Preserved thicknes 0 to 20 m. Correlative to the "stray sandstone" of previous reports.

Kcdi Crevasse Canyon Formation, Dilco Member—Interbedded siltstones, shales, sandstones, and local coal seams. Siltstones and shales are gray to light brown with local reddish hues (2.5YR 7/3 and 5YR 5/2 measured) or dark gray to black where carbonaceous, thinly planar laminated, and poorly exposed. Pale brown to pale gray (10YR 8/3 and 2.5Y 8.5/1 measured) sandstone intervals form ledges 1 to 1.5 m thick of moderately to poorly sorted vfL to fL sands in thin to medium (2 to 20 cm thick) planar or wedge-shaped beds that are internally massive or cross-laminated. Sands are mainly quartz with a few percent feldspars, milky light brown chert(?) lithics, and black ferromag lithics. Thickness is about 45 to 50 m.

Kgc Gallup Sandstone, "C" tongue—Pale yellow to pale brown (5Y 8/3, 2.5Y 8.5/2 and 8/4 measured) coarsening upwards sandstones. Sandstones grade from moderately poorly sorted silty vfL to fL sands in wedge-shaped, cross-stratified beds up to 20 cm thick upsection to moderately sorted fL to fU sands in planar tabular, commonly massive beds up to 60 cm thick. Sands are dominantly quartz with sparse tabular feldspars, black lithics, and chalky white chert(?) lithics. Gradational basal contact. Thickness 25 to 28 m. Correlates to the "main body of the Gallup" of previous maps.

Kge Gallup Sandstone, "E" tongue—Pale gray to pale brown (2.5Y 8/1-8/2 and 10YR 8/1 measured) coarsening upwards sandstones. Sandstones grade from moderately sorted vfL to vfU sands in thin to thick (30 cm to 2 m thick) massive or weakly structured beds with local cross-stratification upsection to moderately sorted fL to fU grains in well-structured tabular to wedge-shaped beds up to 20 cm thick with common cross-stratification. Sands are dominantly quartz with rare tabular feldpars and black lithics and sparse milky light brown chert(?) lithics. Gradational basal contact. Thickness 7 to 14 m. Correlates to the "upper tongue of the Gallup" of previous maps.

Kgf Gallup Sandstone "F" tongue—Very pale brown to brownish yellow (10YR 8/1-8/4 and 6/6 measured) sandstones in two coarsening upwards sequences, separated by a thin shale interval. Both sequences are gradational with underlying shales. Lowermost sandstone beds consist of moderately sorted vfL to fL sands in thin (<10 cm thick) planar tabular beds, which grade upsection into moderately sorted fL to mL sands in medium (20-30 cm thick) wedge-shaped cross-stratified beds. Grains are dominantly quartz with rare tabular feldspars and sparse milky brown chert(?) and black lithics. The intervening shale interval consists of up to 3 m of finely laminated gypsiferous gray to light brownish gray (2.5Y 5/1 and 10YR 6/2 measured) locally sandy shales. Total interval thickness is about 20 to 25 m.

Kdt Dakota Sandstone, Twowells Sandstone Tongue—Pale yellowish or brownish gray (2.5Y 7/3-7/4 and 10YR 7/4, 8/3-8/4 measured) coarsening upwards sandstone sequence. Sandstones grade from poorly sorted muddy vfL to vfU sands upsection to moderately sorted vfU to fU sands and locally well-sorted fU to mL sands. Grains are dominantly quartz with up to 10% chalky pale brown chert(?) lithics and sparse tabular feldspars and black lithics. Beds are dominantly thin to medium (20 to 50 cm thick), planar to wedge-shaped, and massive to indistinctly cross-stratified. Top most 2 m are generally thin (up to 20 cm thick), wedge-shaped, and prominently cross-stratified. Gradational lower contact. Thickness is only locally well constrained, where it is about 12 m, but exposure trends suggest the sandstone thins laterally where poorly exposed.

Kdtb Dakota Sandstone, Twowells Sandstone Tongue bench—Through the center of the quadrangle, the Twowells Sandstone is unexposed, but a generally continuous topographic bench occurs at comparable elevation to nearby Twowells outcrops. This bench is interpreted to be underlain by a thinned Twowells Sandstone. Thickness is not constrained, but may be only a few meters.

Kdp Dakota Sandstone, Paguate Sandstone Tongue—Pale brown to yellow (2.5Y 7/4 and 8/6 measured) coarsening upwards sandstones and siltstones. The tongue grades from planar laminated siltstones upsection to moderately well sorted fU to mL sandstones in thin to medium (10-50 cm thick) massive and planar to wedge-shaped and cross-stratified beds. Sands are dominanly quartz with rare tabular feldspars and milky pale brown to light gray chert(?) lithics and sparse black lithics. Lower contact is gradational. Unit is only present along the eastern and western margins of the quadrangle, apparently pinching out through the center of the quad. Thickness is about 0 to 10 m thick.

Kdpb Dakota Sandstone, Paguate Sandstone Tongue bench—Along the eastern margin of the quadrangle, an unexposed topograhic bench occurs at comparable elevation to nearby Paguate Sandstone outcrops. This bench is interpreted to be underlain by a thinned Paguate Sandstone. Thickness is not constrained, but is likely 0 to a few meters.

Kdc Dakota Sandstone, Cubero Sandstone Tongue—Pale gray to very pale brown (2.5Y 8/2-9/2 and 7.5YR 4/6 measured) sandstones in two coarsening upwards sequences. The lower sequences is gradational with underlying shales, and grades from moderately poorly sorted vfL to fL sands in thin to medium (5 to 50 cm thick) upsection to well sorted fL to fU sands in beds up to 1 m thick. Grains are principally quartz with rare tabular feldpars and chalky white chert(?) lithics and sparse black lithics. Bedding near the base is commonly tabular and locally wedge-shaped, with common massive or planar internal laminae and only local cross-stratification; bedding near the top is principally wedge-shaped with common internal cross-stratification. Upper coarsening upwards coarsens upsection from laminated siltstones to moderately sorted vfL to fL sandstones in thin (10-20 cm thick) wedge-shaped beds with internal cross-stratification. Lower sequence is about 7-8 m thick, and upper sequence is 2-3 m thick.

Kdou Dakota Sandstone, Upper Oak Canyon Member—Gray (10YR 6/1-5/1 measured), thinly laminated, poorly exposed shales. Thickness is approximately 10 to 12 m.

Kdol Dakota Sandstone, Lower Oak Canyon Member—Consists of two sandstone intervals separated by a medial shale interval. Lower sandstone interval is pale gray (2.5Y 8/1 measured) and composed of well sorted fL to mL sands of dominantly quartz with rare tabular feldspars and sparse black lithics in planar tabular to wedge-shaped and locally lenticular beds that thicken upsection from 10-15 cm thick to 60 cm thick. Upper sandstone is pale brown (10YR 8/3 measured) and composed of moderately well sorted vfL to fU grains of similar lithologic composition, in thin (2-20 cm thick) planar beds. Cross-stratification is common to both. The medial shale interval consists of gray to locally pale yellowish brown (2.5Y 5/1-7/1 and 8/4 measured) shales and siltstones. Lower sandstone is 9 to 12 m thick, medial shale is 6 to 8 m thick, and the upper sandstone is 2.5 to 3 m thick.

Kdec Dakota Sandstone, Encinal Canyon Member—Pale gray (5YR 7/1 and 10YR 8/1-9/1 measured) sandstones, pebbly sandstones, and pebble conglomerates. Sandstones dominate, and consist of poorly sorted vfU to mU grains of mainly quartz with sparse tabular feldpsars and dark gray lithics. Pebbly sandstones and pebble conglomerates are roughly 25% of beds, with poorly sorted pebbles up to 2 cm diameter of rounded dark gray cherts and quartzites, lesser angular to rounded chalky white cherts, and sparse rounded granites, supported by a poorly sorted vfU to vfU sand matrix of dominantly quartz and chalky white chert lithics. Beds are thin to medium (0-50 cm thick) and lenticular with common cross-stratification. Thickness is 2 to 10 m.

Jurassic System

Jm Brushy Basin Member of the Morrison Formation—Principally varicolored mudstones with intercalated pale gray to yellowish (2.5Y 9.5/1 and 5Y 7/3 measured) sandstones and a sparse conglomerates. Mudstones are light reddish brown to pink to greenish gray in color (7.5R 5/2, 2.5YR 5/3, and 5GY 7/1 measured), with common clayey weathering textures and very stiff consistencies. Sandstones are discontinuous and composed of thin to thick (0-1.2 m thick) cross-bedded lenticular beds of poorly to moderately sorted variably muddy vfL to mU sands of quartz with up to 10% tabular feldspars, 10% brown to light gray cherts, and sparse black lithics. Conglomerates consist of pale gray (10YR 9/1 measured) cross-bedded lenticular beds up to 30 cm thick of moderately poorly sorted rounded pebbles of mainly varicolored cherts and quartzites with sparse granites and white chalky cherts. Matrix sands are poorly sorted mL to vcL grains of quartz, up to 30% quartzites and cherts, and rare feldspars. Exposed thickness of 60 to 95 m, thickening to the north.

Jzf Fluvial facies of the Zuni Sandstone—Interbedded fluvial and eolian sandstones, rare clayey mudstones, and sparse lenticular limestones. Sandstones are pale yellow to light greenish gray and locally mottled with reddish brown (5Y 8/3, 5YR 5/3 measured), and commonly consist of moderately well sorted vfU to fU grains of dominantly quartz with sparse feldspars and black lithics in medium to thick (20-60 cm thick) tabular massive beds. Cross-stratification is rare and can be eolian or fluvial in nature. Rare poorer sorted muddy vfL to vfU sandstones that are commonly mottled pink or red (5YR 5/3 measured) and locally pebbly coarse sandstone cross-stratified channel-fills are also present. Sparse pebbles are rounded dark gray to dark brown fine-grained siliceous clasts up to 2 cm diameter. Mudstones are pinkish gray to reddish brown and commonly exhibit clayey weathering textures; beds are typically thin (<10 cm thick) and lenticular. Limestones are thin (<20 cm thick), lenticular, fine-grained, and light gray in color. Uppermost 0 to 1.5 m of unit is light purplish gray (10R 5/2), thinly bedded and internally laminated muddy fine sandstone with white carbonate nodules. Bedding and laminae are undulatory. Unit up to 8 m thick. In cross-section denoted in combination as Jzf+Jz.

Jz Zuni Sandstone—Pale yellow to light greenish yellow distinctly eolian cross-stratified sandstones. Sandstones consist dominantly of rounded and well sorted fU to fL sands of principally quartz with sparse feldspars and dark gray and pink (chert?) lithics in medium to thick (0.5 to 1 m thick) tabular beds commonly with prominent high-angle, large-scale eolian cross-stratification, although massive beds are also present. Base not exposed, but exposures indicate a thickness over 11 m. Maxwell (1976) reports a thickness of 50 to 90 m on the quardrangle to the south. In cross-section denoted in combination as Jzf+Jz.

Jbh Bluff Sandstone / Horse Mesa Member, Wanakah Formation—Massive sandstones. See report for discussion of nomenclature. Not exposed on this quadrangle. Maxwell (1976) reports a thickness of 30 to 45 m on the quadrangle to the south.

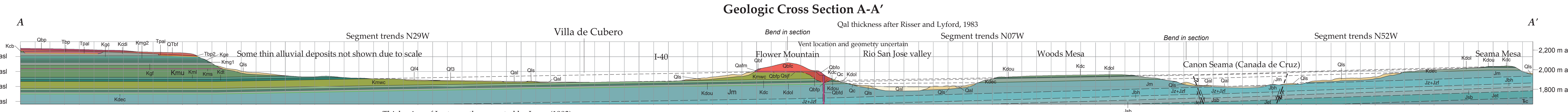
Jsb Summerville Formation / Beclabito Member, Wanakah Formation—Thinly bedded sandstones and mudstones. See report for discussion of nomenclature. Not exposed on this quadrangle. Maxwell (1976) reports a thickness of 35 to 45 m on the quadrangle to the south.

Jet Todilto Limestone and Entrada Sandstone—Variably gypsiferous limestones overlying eolian sandstones. Not exposed on this quadrangle. Maxwell (1976) reports thicknesses of <1 to 7 m for the limestones and 57 to 80 m for the sandstones on the quadrangle to the south.

Triassic

Ɍc Chinle Formation—Variety of continental deposits, dominantly mudstones and sandstones. Not exposed on this quadrangle. Thickness of 535 to 550 m in the Gottlieb #1 core hole on the Grants SE quadrangle (Cikoski, 2013).

Geologic Cross Section A-A′



Thickening of Jm to north suggested by Lupe (1983)
Actual thickness unconstrained here, however