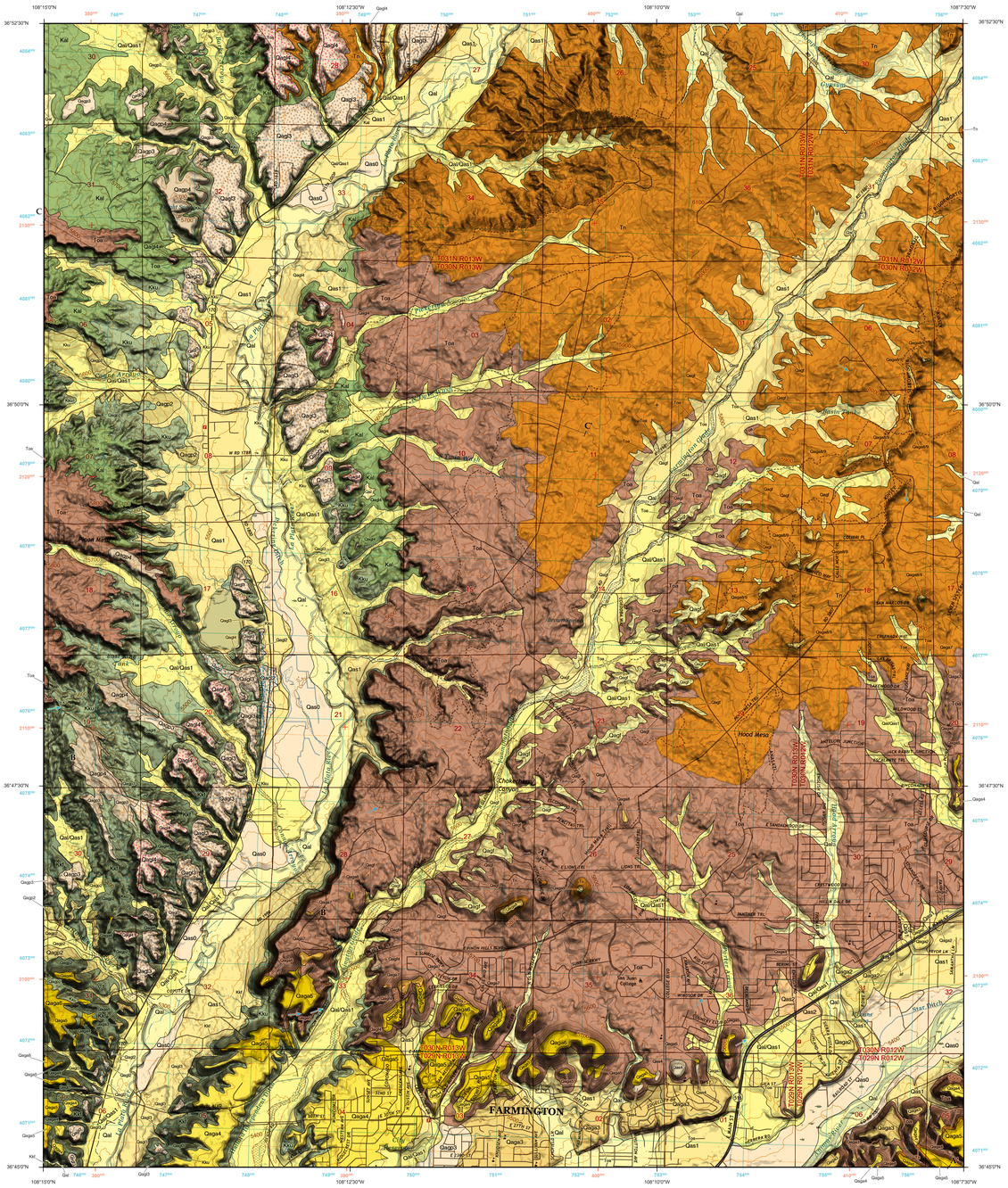
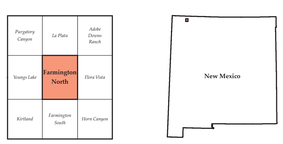


Base map from U.S. Geological Survey 2020.
North American Datum of 1927 (NAD27)
Projection and 1,000-meter grid: Universal Transverse Mercator, Zone 12S, shown in blue.
10,000-foot ticks: New Mexico Coordinate System of 1983 (West Zone), shown in red.

Roads	U.S. Census Bureau, 2015–2016
Names	GNIS, 2016
Hydrography	National Hydrography Dataset, 2014
Contours	IFSAR 4.5 m Digital Terrain Model, 2008
Wetlands	FWS National Wetlands Inventory 1977–2014
Public Land Survey System	BLM, 2019



Quadrangle Location

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

87801-4796
[575] 835-5490

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

http://geoinfo.nmt.edu

Digital layout and cartography by the NMBGMR Map Production Group:
Phil L. Miller, Amy L. Dunn, Ann D. Knight, Tyler Askin, and Hannah N. Hunt

1:24,000

1 0.5 0 1 Mile

1000 0 1000 2000 3000 4000 5000 6000 7000 Feet

1 0.5 0 1 Kilometer

Contour Interval 20 Feet

National Geodetic Vertical Datum of 1929

New Mexico Bureau of Geology and Mineral Resources
Open-File Geologic Map 82
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. Nelia W. Dunbar, , Dr. *Director and State Geologist* J. Michael Timmons,) *Assoc. Director for Mapping Programs*

Geologic map of the Farmington North 7.5-minute Quadrangle, San Juan County, New Mexico

May 2004

by
Joel L. Pederson and Carol M. Dehler

Utah State University Department of Geology, 4505 Old Main Hill, Logan, Utah 84322

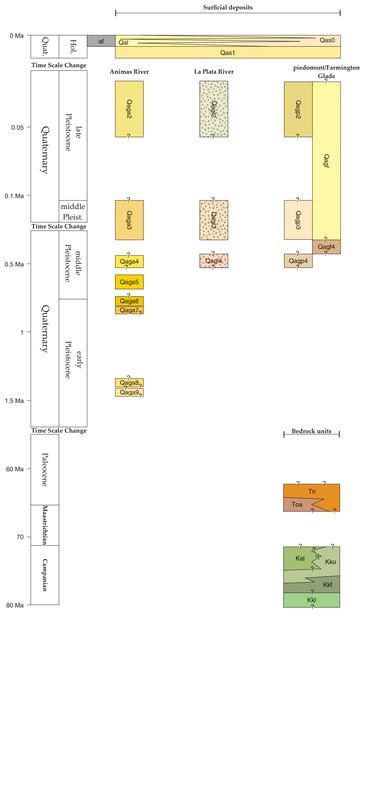
Comments to Map Users

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, a 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 (drill hole) 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 human-made structures.

The New Mexico Bureau of Geology and Mineral Resources created the Open-File Geologic Map Series to expedite the dissemination of these geologic maps and map data to the public as rapidly as possible while allowing for map revision as geologists continued to work in map areas. Each map sheet carries the original date of publication below the map and the latest revision date in the upper right corner. In most cases, the original publication date coincides with the date of delivery of the map product to the National Cooperative Geologic Mapping Program (NCGMP) as part of New Mexico's STATEMAP agreement. While maps are produced, maintained, and updated in an ArcGIS geodatabase, at the time of the STATEMAP deliverable, each map goes through cartographic production and internal review before uploading to the Internet. Even if additional updates are carried out on the ArcGIS map data files, citations to these maps should reflect this original publication date and the original authors listed. The views and conclusions contained in these map documents are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico or the U.S. Government.

Correlation of Map Units



Explanation of Map Symbols

The identity and existence are certain or questionable where queried. Location is accurate where solid and approximate where dashed.

Gradational contact—The identity and existence are certain and the location is accurate.

Inclined bedding—Showing strike and dip.

Fluvial transport direction.

A A' Cross section line and label

Description of Map Units

af **human disturbance (Present)**

SURFICIAL DEPOSITS

Qal **Alluvium (Late Holocene)**—Grayish tan to reddish tan, moderately well sorted, silt to coarse- grained sand to cobbly gravel of active channels and floodplains. Composition and texture varies with drainage.

Qas0 Qas1 **Alluvial sand of Animas River, La Plata River, Farmington Glade, and piedmont (Holocene)**—Grayish tan to reddish tan, bioturbated, thin to medium scale interbeds of laminated and dessication-cracked very fine sandy and clayey silt, and ripple-cross-stratified moderately well sorted silty fine sand. Lenticular beds of pebbles and cobbles are rare in small piedmont drainages to common in the Animas River deposits. 1–4+ m thick with base generally not exposed. **Qas1** is associated with a broad fill terrace, whereas **Qas0** is a lower, inset cut-fill that may be flooded at high stages and may be a continuous deposit with **Qal**. **Qas1** locally includes hillslope deposits transported by slopewash or mass movements at the toes of bedrock escarpments. Ward (1990) reports radiocarbon ages ranging from 1400–2500 years B.P. for **Qas1** to 245 years B.P. for **Qas0** from samples within a couple miles of the mapping area up Thompson Arroyo (tributary to the La Plata River), Farmington Glade, and near Flora Vista. Units of **Qas2**-**Qas4** are seen on the map, but have not been described and their relationship is not certain.

Qaga2 Qaga3 Qaga4 Qaga5 Qaga6 Qaga7 Qaga8 Qaga9 **Gravels of the Animas River (Pleistocene to Early Holocene)**—Up to 4 m of clast-supported, subrounded, pebble-to-mostly cobble gravel with few boulders and poorly sorted sand matrix, with relatively minor interbeds of moderately-poorly sorted, weakly carbonate cemented, sand lenses with small to medium scale, low-angle crossbedding. Deposits are associated with well- developed strath terraces to thin fill terraces. Imbrication consistent with flow direction of modern Animas River, and lower 1–1.5 m commonly carbonate cemented. Representative clast composition (**Qaga4**) is 46% porphyry, 32% quartzite, 18% granite or metamorphic rock, and 4% sedimentary rocks; and mean clast size is 7 cm.

Qagp2 Qagp3 Qagp4 **Gravels of the La Plata River (Pleistocene to Early Holocene)**—Up to 5 m of clast-supported, subangular to subrounded, pebble- and some cobble gravel with moderately poorly sorted sand matrix, with few interbeds of moderately poorly sorted, weakly carbonate cemented, sand lenses with small–medium scale, low-angle crossbedding. Deposits are associated with well-developed strath terraces to thin fill terraces. Imbrication consistent with flow direction of modern La Plata River, and lower 0.5 m may have weak carbonate or iron-oxide cement. Representative clast composition (**Qagl4**) is 52% porphyry, 30% sedimentary rocks, 16% quartzite, and 2% granite or metamorphic rock; and mean clast size is 3 cm.

Qagf Qagf4 **Gravels of the Farmington Glade (Pleistocene to Early Holocene)**—<4 m thick or erosional lag of subangular-to-subrounded, pebbles and cobbles from reworked Animas terrace gravels of Hood Mesa and pebbles weathered out of conglomeratic Ojo Alamo bedrock. Deposits are not readily distinguished or correlated in terms of landscape position, except for near the mouth of the drainage and are both deposits of Farmington Glade itself and of small piedmont (tributary drainage and hillslope) systems. Deposits are associated with preserved terraces in a few cases, and field relations indicate all Farmington Glade gravels are younger than Animas gravel **Qaga4**.

Qagp2 Qagp3 Qagp4 **Piedmont gravels (Pleistocene to Early Holocene)**—<4 m thick, immature pebbly sand to clast-supported pebble gravel with poorly sorted sand matrix of small tributary drainage and hillslope systems. Composition varies with bedrock exposed in drainages, with subrounded pebbles from reworked conglomeratic Ojo Alamo bedrock or older terrace gravels and subangular clasts of weak sandstone bedrock. These are typically stream deposits that can be associated with strath terraces to thin fill terraces, notably to the west of the La Plata valley, and grade to stream gravels of major drainages. But deposits locally include sediment transported by hillslope processes and, in any case, often are not be readily distinguished or correlated in terms of landscape position.

BEDROCK UNITS

Tn **Nacimiento Formation (Paleocene)**—White, yellow, tan, maroon, and green tuffaceous shales with gray, green, red, and tan sandstones. Soft sandstones and reworked tuffs present in m-scale intervals within the slope-forming shale intervals, are interbedded with ledgy sandstone beds. Sandstones are fine- to coarse-grained, moderately to poorly sorted, and angular to rounded. Larger clasts are typically composed of petrified wood, chalcedony, many varieties of chert, schist, and granite. Smaller grains are composed of quartz, chert, plagioclase, orthoclase, and biotite. Sandstone are porous and are weakly to moderately cemented with silica, calcite, hematite, and (or) clay. Sandstones exhibit ripple laminations, planar-tabular crossbeds, and trough crossbeds in thin to thick, lenticular to tabular beds. Paleocurrent flow directions from trough crossbeds show flow to south, southwest and southeast (140°, n=9). Poorly consolidated, slope-forming unit that weathers into badlands, and exhibits "popcorn" weathering and extensive piping. Sandstones are less common upsection and laterally to the north along eastern side of the La Plata river. Grades southward into **Toa** in Twin Arroyo area. No upper contact exposed in field area. Thickness in field area ≤130 m.

Toa **Ojo Alamo Formation (Upper Cretaceous(?) to Paleocene)**—Orange, yellow, and tan weathered, and yellow to tan fresh, medium to coarse-grained, locally tuffaceous sandstone with granule- to pebble-sized clasts (20 cm diameter (long axis), 1–2 cm diameter). Coarsest grains found in lowermost 2 meters of unit and along south end of ridge between Farmington Glade and the La Plata drainage and in Jackson Lake area. Grains are poorly sorted, angular to subangular grains, and granules and pebbles commonly show better rounding. Grains are composed of quartz, quartzite, sandstone, red chert, rhyolite, andesite, plagioclase, orthoclase, petrified wood, and bone. Cemented weakly with silica, clay, and hematite. Trough crossbeds are in medium to massive sets that are amalgamated into channels 10's of meters wide and thick. Soft-sediment deformation features are common and plane beds are rare. Paleocurrent flow directions from trough crossbeds show flow dominantly to the southeast (104°, n=32). Iron concretions and secondary gypsum common. Sandstones are interbedded with green to gray to maroon shale and thinly bedded fine-grained sandy intervals 0.25 to several meters thick (**Tn** or shale facies). Weakly to moderately consolidated. Forms rounded cliffs, spires, hoo doos, and caves. This unit undergoes a gradational facies change laterally northward into **Tn** (shale facies) in the Twin Creeks area and the Barker Arroyo areas of the La Plata drainage. Contact with **Tn** is approximated above the last set of substantial (10's of meters thick) sandstone cliffs. Equivalent to the Kimbeto Member (Cather, 2003). Thickness ≈0–140 m.

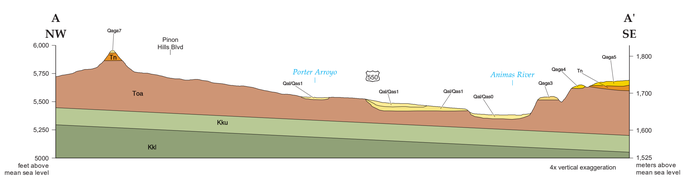
Kai **Lower Animas Formation (Upper Cretaceous(?) to Paleocene(?))**—Gray, green, yellow-tan, and maroon shales and soft sandstones interbedded with subordinate resistant ledges of thin to thick beds of tuffaceous sandstone. Sandstone grains are fine to pebble in size, typically angular to subangular with granules and pebbles (4–5 cm diameter, max) showing better rounding, moderately to very well sorted, and composed of quartz, micas, plagioclase, orthoclase, chert, volcanic lithics, and intraclasts, depending on individual bed. Weakly to moderately cemented with silica, hematite, and clay. Ripple cross-laminated, trough-crossbedded to massive in thin to thick beds. Paleocurrent flow directions from trough crossbeds show flow to the northeast (38°, n=3). Local horizontal burrows in shale. Contact with overlying **Kca** is sharp, scoured, and a slight angular discordance may be present. Yellow sandstones of this unit are very similar to **Toa**. Variegated shales of this unit are very similar to the upper Kirtland Member shales and the Nacimiento Formation shales. Medium bed of pepperite at base of hill X5648 in Section 9 at mouth of South Twin Creek wash. Facies change (?) to **Kku** southward across Piñon Mesa to south. This unit is likely equivalent to the McDermott Member of the Animas Formation or the Naashobito Member of the Ojo Alamo Formation (e.g., Cather, 2003). Thickness 0–≈35m.

Kku **Upper Member of the Kirtland Formation (Upper Cretaceous)**—Tan, yellow, orange, purple, maroon, and green shale with resistant ledges of green, red, and tan-yellow sandstone and slope forming soft sandy intervals. Tuffaceous. Sandstones are fine- to coarse-grained, well to moderately sorted, angular to subangular, and are composed of quartz, orthoclase, plagioclase, chert, chlorite, volcanic lithics, and biotite, depending on individual bed. Weakly cemented with silica, hematite, and (or) clay, and porous. Sandstones are massive to ripple laminated in thin beds. Poorly consolidated slope forming unit that weathers into badlands, and exhibits "popcorn" weathering and extensive piping. Forms badlands around Jackson Lake. Grades laterally and vertically with underlying Farmington Sandstone. This unit is very similar to the shales of the Lower Member of the Animas Formation and the shales of the Nacimiento Formation. Age of upper Kirtland Member is 73.04±0.25 Ma ($^{40}Ar/^{39}Ar$ age, Fassett and Steiner, 1997), although this age is form the southern San Juan Basin. Equivalent to the De-na-zin Member of the Kirtland Formation (Anderson et al., 1997) Thickness of ≈137 m (Baltz et al., 1966; Hunt and Lucas, 1992)

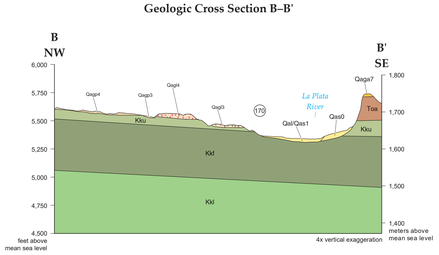
Kkl **Farmington Member (or Middle Member) of the Kirtland Formation (Upper Cretaceous)**—Tan and yellow cliffy sandstone interbedded with slope-forming gray, brown, green, and tan shale and thin interbeds of gray sandstone. Tan and yellow sandstones are medium to coarser-grained with lesser pebbles, moderately sorted, angular to subangular, composed of quartz, chlorite, sandstone, chert, and trough crossbedded in medium to thick tabular sets in tabular to lenticular beds. Local soft sediment deformation. The variegated shales are in decimeter to meter scale intervals punctuated by ledges of thin, tabular to lenticular, fine- to medium-grained sandstone beds. Sandstones are moderately cemented by silica and hematite. Paleocurrent directions from trough crossbeds show flow dominantly to the east (80°, n=7). Moderately indurated and forms rounded to blocky cliffs, and can be ledgy. Yellow sandstones of this unit are very similar to **Toa** sandstone, and shales are similar to other shales in the map area, except are not as colorful. Laterally and vertically gradational with **Kku**. Equivalent to the Farmington Member of the Kirtland Formation (Anderson et al., 1997). Thickness ≈137 m (Baltz et al., 1966, Hunt and Lucas, 1992).

Kkl Undescribed map unit

Geologic Cross Section A–A'



Geologic Cross Section B–B'



Geologic Cross Section C–C'