

Geologic Map of the San Felipe Pueblo NE Quadrangle, Sandoval County, New Mexico

By

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**New Mexico Bureau of Geology and Mineral Resources
*Open-file Digital Geologic Map OF-GM 037***

Scale 1:24,000

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**GEOLOGIC MAP OF THE
SAN FELIPE PUEBLO NE 7.5-MINUTE QUADRANGLE,
SANDOVAL COUNTY, NEW MEXICO**

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INTRODUCTION

The San Felipe Pueblo NE 7.5-minute quadrangle comprises an area of about 158 km² (61 mi²) just east the Rio Grande Valley in Sandoval County, New Mexico. The study area encompasses portions the Pueblos of San Felipe and Santo Domingo, as well as private and public (state and federal) lands. The study area includes nearly all of Espinazo Ridge, a prominent north- to northwest-trending ridge underlain by Oligocene volcanoclastic rocks. The San Francisco fault, a major Neogene basin-margin to intrabasinal fault, cuts northward through the quadrangle. The Budaghers fault (new name) is a prominent east-northeast-striking zone that juxtaposes slightly to moderately tilted older Santa Fe Group deposits, to the south against subhorizontal to slightly tilted younger Santa Fe Group deposits to the north. The Budaghers fault appears to act as a transfer fault between the San Francisco and La Bajada faults. A nearly complete stratigraphic section, ranging in age from Triassic to Quaternary, is exposed on the quadrangle.

Early work in the study area includes regional reconnaissance by Stearns (1953) and Kelley (1977). Detailed mapping of Cretaceous strata was published by Black (1979) and is incorporated in this report.

Note to 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on this geologic quadrangle map are based on reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist. Cross sections were constructed based upon the interpretations of the authors made from geologic mapping, and available 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. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. The topographic base for the geologic map is the San Felipe Pueblo NE 7.5 minute topographic quadrangle, published by the United States Geological Survey at a scale of 1:24,000 (one inch equals 2000 feet). Topographic and cultural changes associated with recent development may not be shown.

Mapping of this quadrangle was funded by a matching-funds grant from the 1999–2000 STATEMAP program of the U.S. Geological Survey, National Cooperative Geologic Mapping Program, to the New Mexico Bureau of Mines and Mineral Resources (Drs. Charles E. Chapin and Peter A. Scholle, Directors; Dr. Paul W. Bauer, P.I. and Geologic Mapping Program Manager). The quadrangle map has been placed on open file in order to make it available to the public as soon as possible. The map has not been reviewed according to New Mexico Bureau of Mines and Mineral Resources standards. Revision of the map is likely because of the on-going nature of work in the region. ***The report and map should not be considered final and complete until it is published by the New Mexico Bureau of Mines and Mineral Resources.***

DESCRIPTION OF MAP UNITS
CENOZOIC ERATHEM
Neogene and Quaternary System

Colluvial, eolian, and anthropogenic deposits

Thin surficial deposits derived from wind and mass-movement processes, or extensive areas disturbed by aggregate mining or construction operations.

af Artificial fill (Historic) — Dumped fill and areas affected by human disturbances. Locally mapped where areally extensive or geologic contacts are obscured.

Qae Eolian sand and stream alluvium, undivided (Holocene to upper Pleistocene) — Unconsolidated to very poorly consolidated, moderately to well sorted, light reddish-brown to light-brown (7.5-10YR), fine- to medium-grained sand and silty sand with scattered pebbles that commonly forms a relatively thin, discontinuous mantle over broad upland areas. Soil development is generally weak (Bw and Bwk horizons) with maximum Stage I and II carbonate morphologic development. Surface is commonly stabilized by vegetation where not disturbed by human activity. May locally contain hydrocollapsible soils. Mapped only where areally extensive or thick. Variable thickness, ranging from 0-16 ft (0-5 m), but commonly less than 5 ft (1.5 m) thick.

Alluvium

Divided into fluvial deposits of the ancestral Rio Grande, tributary stream-valley alluvium, and piedmont alluvium. Fluvial deposits of the ancestral Rio Grande unconformably overlie upper Santa Fe Group deposits and are principally composed of rounded purplish quartzite pebbles and cobbles. Discontinuous deposits of the ancestral Rio Grande are recognized along the margins of the Rio Grande valley along the northern margin of the map area. Stream-valley alluvium typically contain poorly to well sorted, poorly to well stratified, clast- and matrix-supported deposits associated with modern to middle Pleistocene entrenched arroyos across the map area. Gravel composition is predominantly composed of porphyritic intrusive rocks of intermediate composition that were derived from the Ortiz Mountains to the east. Stream-terrace deposits typically have an elongate planform shape and are associated with major drainages. Piedmont alluvium typically contain poorly to moderately sorted, poorly to well-stratified, clast- and matrix-supported deposits associated with middle to early Pleistocene coalescent piedmont fans, alluvial slope deposits, and shallow valley fill deposits that are not graded to entrenched late Pleistocene arroyo systems.

Alluvium of the Rio Grande

Qtal Upper terrace deposit (middle Pleistocene) — Moderately consolidated and weakly cemented sandy pebble to cobble gravel primarily composed of subrounded to rounded quartzite, volcanic rocks, and granite. Discontinuously exposed and recognized along the northern margin of the map area as a lag of rounded quartzite-bearing gravel approximately 240 ft (73 m) above the top of the Rio Grande floodplain. Basal contact forms a low-relief strath cut onto axial fluvial deposits of the upper Santa Group (QTsa). Constructional upper surface and soils are commonly stripped. Smith and Kuhle (1998a, b) report an occurrence of the ca. 660 ka Lava Creek B ash in similar deposits. Commonly less than 16 ft (5 m) thick.

Stream-valley alluvium

- Qal** Youngest stream alluvium (Historic to Holocene) — Unconsolidated deposits of pale-brown (10YR) sand and pebbly to cobbly gravel with minor, thin silty to clayey sand lenses. Inset against young stream alluvium of unit Qvy and underlies modern arroyos that grade westward to the Rio Grande floodplain. Soils are not developed and deposit surface exhibits well developed bouldery and cobbly gravel-bar topography. May locally contain hydrocollapsible soils. Base not exposed, but thickness is estimated to be less than 15-30 ft (4-9 m).
- Qvy** Young stream alluvium (upper Pleistocene) — Poorly consolidated deposits of very pale-brown to light-brown (10YR) sand and gravel that are inset against unit Qpo. Slightly to moderately dissected surface contain weakly developed soils exhibiting Stage I and II carbonate morphology, and rare weakly to moderately developed desert pavement. Locally includes undivided stream alluvium (Qal) in narrow arroyos. Younger stream alluvium, inset about 6 ft (2 m) below Qvy, is recognized but not divided. May locally contain hydrocollapsible soils. Variable thickness, ranging up to 10 ft (3 m).
- Qvo** Older stream alluvium (upper to middle Pleistocene) — Poorly to moderately consolidated, moderately sorted and poorly exposed gravel and sand. Typically recognized as relatively narrow and elongate gravel lags on sandy to muddy pre-Pleistocene deposits. Topographic relationships suggest unit is inset against **Qpo2** along the Arroyo del Tuerto drainage, just west of Espinaso Ridge. Approximately 10 ft (3 m) thick.

Piedmont alluvium

- Qpo** Older piedmont alluvium, undivided (middle to lower Pleistocene) — Poorly to moderately consolidated, sorted and stratified, yellowish-brown (10YR) pebbly to bouldery gravel and sand with minor silty-clay mixtures. Clasts are derived from local upland sources. Soils are commonly stripped or strongly modified. Clasts exposed on broad, nearly flat summit surfaces commonly exhibit thick calcium-carbonate rinds. Inset against the Tuerto gravel and upper Santa Fe Group piedmont deposits (**QTsp**). Locally divided into two subunits on the basis of inset relationships. The stratigraphic position of these deposits relative to unit Qtal has not been established. Variable thickness, about 10-20 ft (3-6 m) thick.
- Qpo2** Older eastern-margin piedmont alluvium, lower subunit — Poorly to moderately sorted and moderately consolidated deposits of pale-brown to reddish-brown (7.5-10YR) gravel and sand. Soils are commonly stripped, but contain thick carbonate rinds on clasts, suggesting the presence of at least Stage II+ to III carbonate morphologic development. Gravel clasts are predominantly subangular to subrounded pebbles, cobbles and minor boulders of porphyritic intrusive rocks of intermediate composition (Ortiz porphyry), with subordinate to minor amounts of rounded to subrounded light green to black hornfels, quartzite, and rare petrified wood. Ortiz porphyry clasts are generally split and slightly gussified. Topographic relationships indicate unit is inset about 160-180 ft (49-55 m) below the base of the Tuerto gravel.

Qpol Older eastern-margin piedmont alluvium, upper subunit — Moderately consolidated deposits of pale-brown to reddish-brown (7.5-10YR) subangular to subrounded pebble to boulder gravel and sand. Unit is poorly exposed and forms a discontinuous gravelly veneer inset against the Tuerto gravel west of Espinaso Ridge, along Arroyo del Tuerto. Soils are commonly stripped, but contain thick carbonate rinds on clasts, suggesting the presence of at least Stage III carbonate morphologic development. Gravel clasts are predominantly subangular to subrounded pebbles, cobbles and minor boulders of porphyritic intrusive rocks of intermediate composition (Ortiz porphyry), with subordinate to minor amounts of rounded to subrounded light green to black hornfels, quartzite, and rare petrified wood. Ortiz porphyry clasts are generally split and slightly grussified. Topographic relationships indicate unit is about 60 ft (18 m) inset below the base of the Tuerto gravel.

Basin-Fill Deposits

Santa Fe Group (upper Oligocene-lower Pleistocene)

The Santa Fe Group comprises the syntectonic sedimentary fill and associated volcanic rocks of basins within the Rio Grande rift of central Colorado, New Mexico and northern Chihuahua (Bryan, 1938; Chapin and Cather, 1994). The Santa Fe Group consists of axial-fluvial and piedmont-slope related to deposition within the Santo Domingo sub-basin prior to widespread valley incision. The Santa Fe Group is divided into lower and upper and lower groups in the map area by an intraformational angular unconformity exposed beneath the Tuerto Gravels (upper Santa Fe Group) in the southeastern part of the quadrangle. The Santa Fe Group consists of axial and piedmont deposits related to deposition within the Santo Domingo Basin and the Hagan embayment prior to valley incision. For the purposes of mapping, these units were divided on the basis of textural criteria and dominantly volcaniclastic versus dominantly nonvolcaniclastic nature using the method of Cather (1997).

The San Felipe Pueblo NE quadrangle contains deposits representative of three ancient depositional systems. The axial *fluvial* system (QTsacs, QTsas) consists of weakly indurated quartzite-dominated sand, gravel and minor mud of the ancestral Rio Grande. These units constitute the most important aquifer in the study area. Axial fluvial deposits are generally restricted to the hanging wall of the San Francisco fault although a thin tongue (-2m) of axial sand (QTsas) is present immediately to the east of this fault in sec. 5 T14N R6E. Paleoflow was generally southward. Axial deposits and associated piedmont deposits in areas to the south are termed the Sierra Ladrones Formation (Machette, 1978).

The piedmont system consists mostly of volcaniclastic-dominated (>50%) conglomerate and sandstone (QTspcs_(v), QTsp_(v), QTtpc_(v), Tspc_(v), Tspcs_(v), Tsp_(v)) that were derived from volcanic and igneous rocks exposed in the Ortiz Mountains and Cerrillos areas to the northeast, east, and southeast. A fine-grained muscovite-bearing, largely non-volcanic unit (Tspsm) crops out along the east-central edge of the quadrangle and appears to record the unroofing of Mesozoic strata in the footwall of the La Bajada fault nearby to the east. Paleoflow in piedmont units was generally westward.

A basin-floor system (Tsbs_(v)) is present low in the Santa Fe Group section above the Espinaso Formation. The basin-floor facies is similar to the sandstone dominated

volcaniclastic piedmont deposits (Tsps,,) that overlie it, except for the defining presence of one or more of the following characteristics: (1) gray-green mudstones, (2) thin limestone beds, (3) anomalous flaggy-bedded sandstone that exhibit coloration (red or light gray) uncharacteristic of piedmont deposits. The basin-floor unit is thought to represent floodplain, pond, and poorly organized sandy fluvial deposits that flowed northward, oblique to the trend of westward paleoflow in associated piedmont deposits. The lower part of the basin-floor system contains a basalt flow dated 25.1 ± 0.6 Ma (Baldrige et al., 1980).

Several marker beds were mapped locally in the Santa Fe Group. These include several travertines (QTtr, Ttr) 0.3–1.5 m thick that represent spring deposits near the San Francisco and Budaghers faults. An extreme distal exposure of the lower Bandelier tuff (Qbo, Otowi Member) only 0.2 m thick is present in the piedmont facies (QTsps_(v)) in the north-central part of the quadrangle and has yielded a $^{40}\text{Ar}/^{39}\text{Ar}$ age of 1.59 ± 0.02 Ma (Peters, 1999). Pumiceous sandstone marker beds (pum ss) occupy a similar stratigraphic position to the tuff outcrops and represent reworking of the Bandelier tuff by piedmont streams. An ash marker bed is present in SE/4 sec. 16 T14N R6E. Dating of this ash is in progress.

In areas where intercalated in a manner in which they cannot be separated at a scale of 1:24,000, interfingering sandstone and mudstone of piedmont and axial systems are mapped as transitional deposits (QTtstm, Cather 1997).

Upper Santa Fe Group (Pliocene(?)-lower Pleistocene)

QTtpc_(v) **Tuerto Gravels of Steams (1953)** (lower Pleistocene to upper Pliocene) — Yellowish- to reddish-brown and yellowish-red (5-10YR), moderately consolidated and slightly cemented, moderately to well stratified pebble to cobble conglomerate and pebbly to cobbly sandstone with scattered boulders and muddy sandstone interbeds. Matrix is fine- to very coarse-grained, very poorly sorted sandstone, and gravel clasts contain abundant subrounded to subangular porphyritic intrusive rocks of the Ortiz porphyry (40-50%) with subequal to subordinate light-green bedded hornfels, yellowish-brown and black massive hornfels (45-50%), and minor (10-15%) rounded quartzite and black and brown chert, subrounded sandstone, subrounded to subangular petrified wood, and rare ironstone. Ortiz porphyry clasts are typically platy in shape and imbricated, indicating northwest paleoflow direction. Unit is typically undeformed and subhorizontally bedded, except where adjacent to fault zones. Overlies lower Santa Fe Group rocks with an angular unconformity that is up to 25-30' along the northeastern flank of Espinaso Ridge in the Arroyo del Tuerto drainage. Exposures become relatively poor and the angular nature of the contact decreases to the northeast. The top of the Tuerto gravels typically is overlain by approximately 3-6 ft (1-2 m) of sand that is similar in composition to unit Qae. The constructional top of the Tuerto gravels forms a broad, north-sloping piedmont-slope associated with the Ortiz Mountains. This constructional surface is the Ortiz surface of Ogilvie (1905) and Kelley (1977), which is inset about 40 ft (12 m) against the crest of Espinaso Ridge, just north of Arroyo del Tuerto. This broad piedmont-slope has since been incised by middle to late Pleistocene-aged streams. Unit is differentiated from the underlying older Santa Fe Group strata by the abundance of black and light-green hornfels and subhorizontal bedding orientation. Spiegel and Baldwin (1963) suggested a correlation between the Ancha Formation and the Tuerto gravels. Both these units rest

unconformably on older, tilted Santa Fe Group deposits and interfinger with the Pliocene basalts of the Cerros del Rio (Spiegel and Baldwin, 1963; Stearns, 1979), which have been dated at about 2.8 Ma by Bachman and Mehnert (1978). The age of the upper Ancha Formation is constrained by the presence of ca. 1.6 Ma lower Bandelier pumice (J. Winick, 1999, unpublished NM Geochronologic Laboratory Internal Report, IR-78), near the mouth of Arroyo Hondo on the Seton Village quadrangle (Read et al., 1999). If the Ancha Formation and Tuerto gravels are coeval, then the upper Tuerto gravels and Ortiz constructional surface are also early Pleistocene in age. If the Ancha Formation-Tuerto gravels correlation is valid, then the upper part of units QTsp and QTsa are temporally correlative. This unit is approximately 43 ft (13 m) thick in Arroyo del Tuerto, however, aerial photographic analyses to the south suggest that the Tuerto gravels may approach about 100 ft (30 m) in thickness near the ghost town of Puertecito in the adjacent Hagan quadrangle.

- QTsacs** Axial fluvial deposits consisting of subequal proportions of gravel (pebbles, cobbles) and sand. Weakly indurated; medium to light gray in color. Gravels are quartzite-dominated and well rounded; sands are quartzose and commonly crossbedded. Weakly indurated gravel-clast lithologies include quartzite, chert, granite, sandstone, intermediate volcanics and pumice. Mudstone is minor and is reddish brown to grayish green in color. Bedding thickness is 0.5 to 4 m.
- QTsas** Light gray sandstone-dominated axial fluvial deposits. Mapped separately only in local area east of San Francisco fault. Sandstones are weakly indurated and trough crossbedded.
- QTstsm** Transitional piedmont-axial deposits consisting of subequal sandstone and mudstone. Unmappably intercalated reddish brown to buff piedmont deposits and gray axial fluvial deposits. Conglomerate (both axial and piedmont) is commonly present but volumetrically subordinate. Bedding thickness is typically 0.1–1 m.
- QTspcs_(v)** Piedmont facies, buff to medium gray in color, consisting of subequal conglomerate and sandstone with minor reddish brown mudstone. Clasts are mostly porphyritic to aphanitic volcanic and hypabyssal rocks; non-volcanic clasts (quartzite, chert, sandstone, limestone, granite and petrified wood) are <50%. Sandstones are volcanoclastic, and form beds that are tabular to lenticular and 0.3–2 m thick. Moderately to weakly indurated.
- QTsps_(v)** Sandstone-dominated piedmont facies. Conglomerate and mudstone are commonly present in subordinate amounts. Sandstones are volcanoclastic, buff to light reddish brown, and medium to fine grained. Beds are tabular and 0.1–1.0 m thick. Moderately to weakly indurated.
- QTspsm** Piedmont deposits consisting of subequal sandstone and mudstone. Sandstones are similar to QTsp_(v). Mudstones are weakly indurated and medium reddish brown. Bedding is 2 cm to 1.5 m thick. Weakly developed calcareous paleosols are common.

Lower Santa Fe Group deposits (upper Oligocene–upper Miocene(?))

- Tspc_(v)** Piedmont facies consisting dominantly of buff to medium gray conglomerate with subordinate sandstone. Clasts are composed predominantly of volcanic and hypabyssal rocks. Sandstones are volcanoclastic, buff in color, and form lenticular beds 0.2 to 1.5 m thick. Unit is moderately to well indurated.
- Tspcs_(v)** Piedmont facies consisting of volcanoclastic sandstone and conglomerate. Conglomerate is similar to that in Tspc and forms beds 0.5–2.0 m thick. Sandstone is fine to very coarse grained, is buff to pale reddish brown, and forms beds of tabular to lenticular shape 0.2–1.5 m thick..
- Tsps_(v)** Sandstone-dominated deposits of piedmont facies. Buff to light reddish brown fine to coarse volcanoclastic sandstone with subordinate conglomerate and mudstone. Bedding is typically 0.1–1.0 m thick and tabular in shape.
- Tsbs_(v)** Sandstone-dominated basin-floor facies. Similar to Tsps_(v) except for presence of green mudstone, thin beds of freshwater limestone, and flaggy sandstone beds of light gray or red color. Paleoflow was northward as shown by sparse crossbedding and pebble-imbrication data, and by the northward increase in mudstone and limestone content.
- Tb** Basalt flow intercalated with lower Santa Fe Group at or near basal contact of Tsbs_(v). Flow crops out discontinuously over a strike distance of about 3.5 km. Flow is 1–2 m thick, vesicular at top and bottom, and Santa Fe deposits beneath the flow are locally baked and oxidized red. Vesicle fillings are abundant and consist of green celadonite and white calcite(?). K-Ar date is 25.1 ± 0.6 Ma (Baldrige et al., 1980).

Paleogene System

- Te** Espinazo Formation (Oligocene) — Unit comprises the remnants of widespread, coarse-grained, volcanoclastic aprons that accumulated adjacent to volcanic vent complexes of the Ortiz Mountains. Consists primarily of tuffaceous sandstone, conglomerate, and debris-flow deposits. Originally defined by Stearns (1953). Deposits are dominated by well-bedded sandstone and conglomerate that represent a braid plain that drained the Ortiz Mountains eruptive center to the east (Erskine and Smith, 1993). Also contains ignimbrite, ash-and pumice-fall deposits and a lava flow. Erskine and Smith (1993) report that the lower part of the unit is calc-alkaline (hornblende and pyroxene) and the upper part of the unit is alkaline (biotite and pyroxene). Deposition of the Espinazo Formation occurred between 36–25 Ma (Maynard et al., 1990, cited in Erskine and Smith, 1993). Unconformably overlain by lower Santa Fe Group deposits and rests conformably on nonvolcanic Galisteo Formation. Unit is approximately 400 m thick. Paleoflow direction, based on clast imbrication orientations, in the basal part of the unit was generally west.
- Tg** Galisteo Formation (Eocene) — Yellow, white and red arkosic sandstone, mudstone, and conglomerate deposited within fluvial channels and broad floodplains in an early Tertiary basin between Albuquerque and Santa Fe, New Mexico. Basal conglomerates are coarser grained (generally > 2 cm) and

more compositionally diverse (contains quartzite, chert, limestone, granite, and sandstone) than the underlying Diamond Tail Formation. Conformably overlain by Espinazo Formation. Basal contact with the Diamond Tail Formation is a regional angular unconformity but appears disconformable in individual outcrops. A pronounced basal angular unconformity is recognized in outcrop between the Diamond Tail and San Francisco faults (NW1/4 section 31, T14N, R6E, and NE1/4, section 36, T14N, R5E). Mammal fossils described by Lucas (1982) are late Eocene in age in Arroyo del Tuerto. Variable thickness, up to 979 m (Lucas, 1982; Lucas et al., 1997). Paleoflow was generally south or southwest.

- Tdt Diamond Tail Formation (upper(?) Paleocene to lower Eocene) — Yellow, orange, and gray, medium- to coarse-grained arkose and subarkose that is commonly trough-cross bedded and variegated gray to maroon mudstone. Unit is locally conglomeratic and contains petrified wood; ironstone concretions are locally common. Conglomeratic beds contain fine (<0.5 cm diameter), well sorted pebbles of white and gray quartzite and chert that are distinguishable with coarser-grained and more lithologically diverse clast assemblages in the overlying basal Galisteo Formation (Tg). Disconformably overlies the Menefee Formation of the Mesaverde Group. Divided out of the Galisteo Formation of Stearns (1943) and Lucas (1982) by Lucas et al. (1997). Interpreted to have been deposited within fluvial channels and broad floodplains in an early Tertiary basin between Albuquerque and Santa Fe, New Mexico. Thickness is up to 442 m at the type section near Hagan and thins northwest to approximately 20 m just west of the northern tip of Espinazo Ridge (Lucas et al., 1997). Paleoflow was generally east or northeast.

MESOZOIC ERATHEM

Upper Cretaceous

- Kme Menefee Formation — Contains three informal members: a lower member
Kmeu (Kmel, 324 ft or 99 m thick), the Harmon sandstone (Kmeh, 140 ft or 43 m
Kmeu thick), and an upper member (Kmeu, 740 ft or 225 m thick). Unit is undivided (Kme) in cross section. Upper and lower members are similar and contain, in order of abundance: gray, tan to orange-tan, cross-bedded, and laminated to thick-bedded siltstone and sandstone; dark-gray to olive-gray and black shale; dull, dark-brown to shiny black lignitic coal; and maroon to dark-brown iron concretions. The upper member has a greater abundance of shale, carbonaceous material, ironstone, thicker coal seams, and lenticular beds of calcareous sandstone. The light-gray to buff or gray-tan Harmon Sandstone is a fluviatile, medium grained, well-sorted, quartz sand with cross-bedding and limonite staining. Thickness of the Harmon Sandstone is variable and thins to at least 73 ft (22 m) in the Hagan embayment east of Placitas. The lower contact between the Menefee Formation and the Point Lookout Sandstone (Kpl) is interfingering and gradational. Total unit thickness varies regionally from 200 ft to 1200 ft (60 m to 365 m) due in part to post-depositional northward truncation beneath the Diamond Tail Formation.
- Kpl Point Lookout Sandstone — Gray-tan to light-tan and drab-yellow, upward coarsening, very fine- to medium-grained, quartz sandstone with limonitic sandstone lenses and interbedded thin gray shale. The unit is moderately

cemented and a prominent ridge- and ledge-former. Both upper and lower contacts are interfingering and gradational. Unit thickness ranges from about 240 ft (73 m) near Placitas, to 315 ft (96 m) in the Hagan embayment.

- Kms** Upper Mancos Shale, Satan tongue — Medium- to dark-gray to olive-gray shale, and silty shale, with less abundant very fine to fine-grained, locally gypsiferous sandstone. This unit forms valleys and covered slopes between the more resistant Point Lookout Sandstone (Kpl) and Hosta-Dalton Sandstone (Khd). The unit produces poor quality, high sulfate ground water. Upper and lower contacts are gradational. Thickness is variable and difficult to measure due to cover but ranges from about 240 ft (73 m) west of Placitas, to 360 ft (110 m) in the Hagan area.
- Khd** Hosta-Dalton Sandstone — Drab, yellow-gray to yellow-tan, very fine- to medium-grained, upward coarsening, moderately cemented sandstone with olive-brown sandstone lenses. The unit is a moderate ridge- and ledge-former. Upper and lower contacts are gradational. Unit thickness ranges from 210 ft (64 m) near Placitas to 370 ft (112 m) near Hagan the unit tapers northward to an exposed pinch-out in SE/4 sec. 30, T14N R6E.
- Kmn** Lower Mancos Shale, Niobrara member — Interbedded tan to light-gray, marly siltstone and fissile, locally gypsiferous brown to black shale. About 600 ft (180 m) thick near Hagan.
- Kmd** Lower Mancos Shale, D-Cross equivalent — Dark gray to black gypsiferous clay shale with subordinate siltstone, sandstone, and calcareous concretions. About 500 ft (150 m) thick.
- Kj** Lower Mancos Shale, Juana Lopez Member — Interbedded calcarenite and calcareous silty shale 1–3 ft (0.3–1.0 m) thick. Gray to pale yellowish brown.
- Kml** Lower Mancos Shale, lower unnamed member — Subequal proportions of olive-brown to gray to black shale and laminated to interbedded, olive-brown to gray, very fine grained sandstone, siltstone, and shale. Selenite and white to yellow gypsum are interbedded throughout the unit. Unit is incompletely exposed and is at least 1300 ft (400 m) thick in the study area.
- Kd** Dakota Formation, undivided — Medium-bedded, pervasively silica-cemented, medium-grained, yellowish-gray to orange-yellow quartz arenite interbedded with dark-gray lower Mancos Shale. Sandstones are well cemented and weather to angular and blocky ridges. Unit thickness ranges from 75 ft (23 m) west of Placitas, to less than 25 ft (8 m) locally in the Hagan embayment. Although unmapped here, the Dakota Formation consists of the Encinal Canyon, Oak Canyon, and Cubero members in areas nearby to the south.

Upper Jurassic

- Jmj** Morrison Formation, Jackpile Member — Gray to white, kaolinitic, fine- to medium-grained medium to coarse quartzose crossbedded sandstone and gray-green to maroon mudstone. Conformably overlies the Brushy Basin Member. About 200 ft (65 m) thick.

- Jmb Morrison Formation, Brushy Basin Member** — Gray, green, and maroon mudstone and subordinate gray to tan, fine to medium sandstone. Conformably overlies the Salt Wash Member. Thickness is about 455 ft (138 m).
- Jms Morrison Formation, Salt Wash Member** — Gray to yellow-buff medium- to coarse-grained crossbedded arkosic sandstone with minor gray-green to pale brown mudstone. Unconformably overlies the Summerville Formation (Lucaset al., 1995). About 200 ft (60 m) thick.
- Js Summerville Formation** — Pale red fine sandstones and grayish red to greenish gray mudstone with minor thin beds and nodules of limestone. Part of the San Raphael Group of Lucas and Anderson (1997). Unconformably overlies the Todilto Formation. About 160 ft (50 m) thick.

Middle Jurassic

- Jt Todilto Formation, undivided** — Two members are commonly recognized in north-central New Mexico (Lucaset al., 1995), but are not differentiated in the map area. In descending stratigraphic order, the two members are the Tonque Arroyo Member and Luciano Mesa Member. The Luciano Mesa Member is a medium-gray to olive-gray, laminated, fetid, micritic limestone. Dark-brown to black carbonaceous mud is interbedded with limestone laminations near the base and gypsum interlayers are present from the middle to the top of the limestone member. The Tonque Arroyo Member is a thick unit of bedded and nodular-mosaic gypsum. Upper and lower contacts are sharp. Thickness of the Luciano Mesa Member is about 20 ft (6 m). The Tonque Arroyo member is about 215 ft (66 m) thick.
- Je Entrada Sandstone** — Yellowish gray to pale yellow brown, very fine- to medium-grained, weakly cemented, crossbedded to subhorizontally bedded, quartzose sandstone. Large-scale eolian crossbeds are present in the upper part. The contact with the underlying Chinle Group (TRc) is disconformable. Thickness about 66 ft (20 m).

Upper Triassic

- TRc Chinle Group, undivided Petrified Forest Formation and Correo Sandstone** — Predominantly reddish-brown mudstone interbedded with subordinate thin beds of sandstone and limestone-pebble conglomerate. Incompletely exposed in the quadrangle, the Chinle Group is about 1590 ft (485 m) thick nearby to the south (Picha, 1982).

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MAP SYMBOLS

Line of geologic cross section

Geologic contact—Dashed where approximately located; queried where inferred.

Fault— Dashed where approximately located; dotted where concealed; ball-and-bar on downthrown side of normal fault, arrow shows dip direction and amount.

Strike and dip of bedding

Horizontal bedding

Vertical bedding

Brecciated rocks

Approximate location of oil-test well

Approximate location of livestock or water-supply well

Marker bed (Qbo = lower Bandelier tuff; pum ss = pumiceous sandstone; QTtr, Ttr = travertine)

Aeromagnetic anomaly where not associated with topography or known, mapped fault (U.S. Geological Survey and Sander Geophysics, Ltd., 1999)

Paleocurrent direction in piedmont system

Paleocurrent direction in axial system

Paleocurrent direction in basin-floor system

Former course of ancestral Tuerto Arroyo

SAN FELIPE PUEBLO NE 7.5- MINUTE QUADRANGLE UNIT CORRELATION CHART

Steven M. Cather, Sean D. Connell, and Bruce A. Black
Open File Digital Map 37
May, 2000

