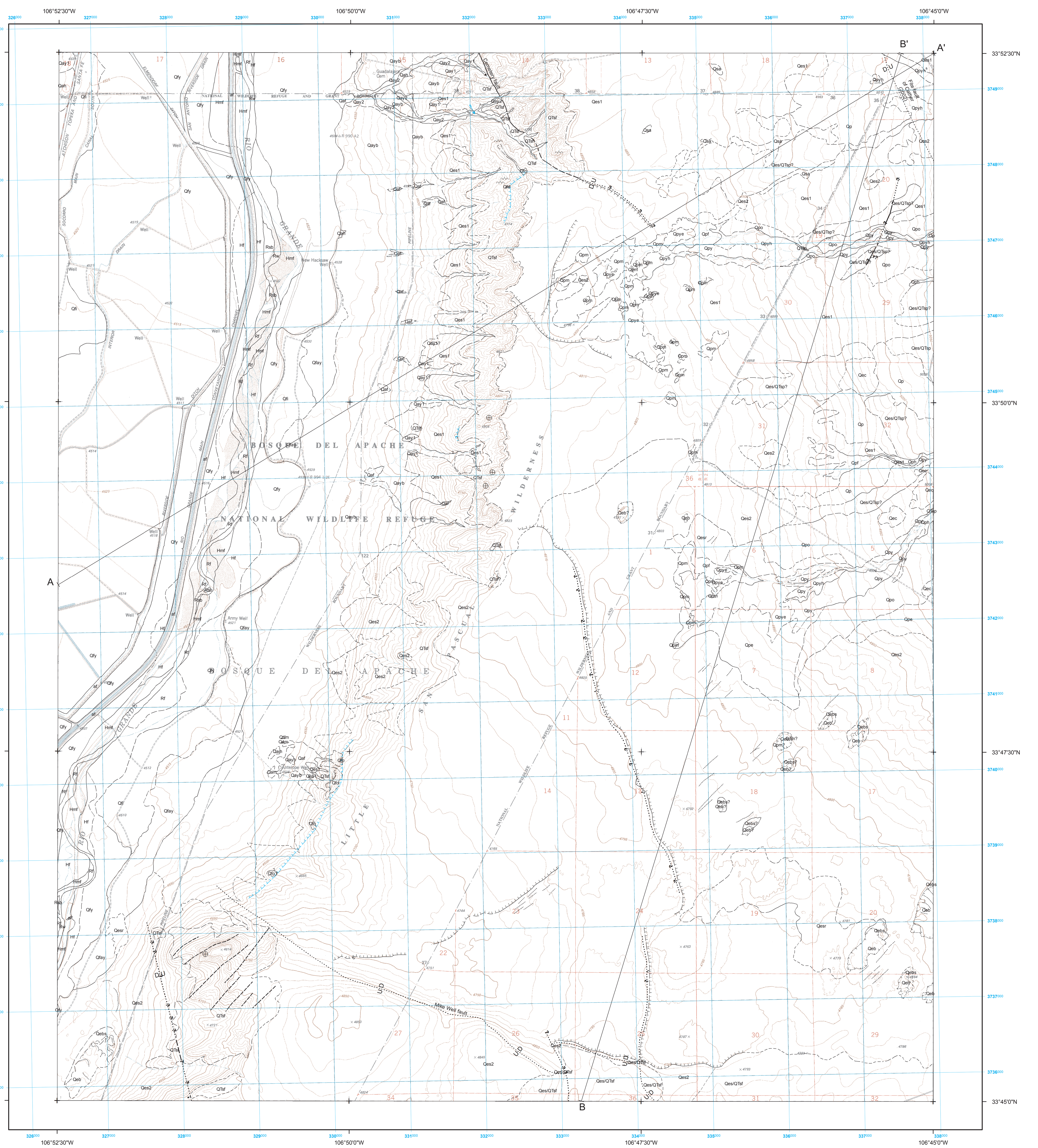


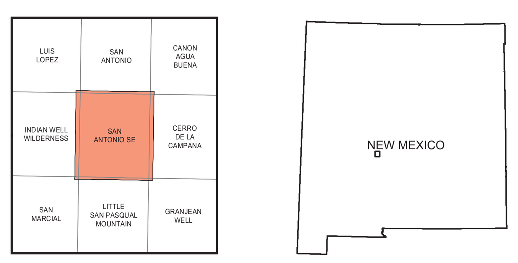
Topography by photogrammetric methods from aerial photographs taken 1972, field checked in 1975. Map edited 1982.
1927 North American datum, New Mexico coordinate system, central zone (Transverse Mercator). Reprojected to UTM projection -- zone 13.
1000-meter Universal Transverse Mercator grid, zone 13, shown in red.

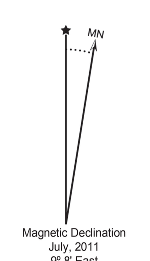
1:24,000

1 MILE; 7000 FEET; 1 KILOMETER

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929





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

New Mexico Bureau of Geology and Mineral Resources
Open-File Geologic Map 228

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, (L. Greer Price, *Director and State Geologist*, Dr. J. Michael Timmons, *Geologic Mapping Program Manager*).

Geologic map of the San Antonio SE quadrangle, Socorro County, New Mexico

June, 2012

by
Colin T. Cikoski

New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Place, Socorro, NM 87801

This draft geologic map is preliminary and will undergo revision. It was produced from either scans of hand-drafted originals or from digitally drafted original maps and figures using a wide variety of software, and is currently in cartographic production. It is being distributed in this draft form as part of the bureau's Open-file map series (OFGM), due to high demand for current geologic map data in these areas where STATEMAP quadrangles are located, and it is the bureau's policy to disseminate geologic data to the public as soon as possible.

After this map has undergone scientific peer review, editing, and final cartographic production adhering to bureau map standards, it will be released in our Geologic Map (GM) series. This final version will receive a new GM number and will supercede this preliminary open-file geologic map.

DRAFT

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 not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document 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.

MAP UNIT DESCRIPTIONS

Post-Santa Fe Group units

Artificial units

af Artificial fill (Historic, 0-100 yrs BP): Compacted gravel, sand, silt, and clay composing artificial channels and dams. Only used for larger channels. 0-3 m thick. Rio Grande fluvial alluvium

Rio Grande alluvium

Rw Water (Active, as per 2009 aerial imagery): Active channel of the Rio Grande. Composed of water, sand, silt, and rare gravels. Includes small sand bars. 0-2 m thick.

Rsb Sand bar (Active, as per 2009 aerial imagery): Active sand bars of the Rio Grande. Composed of sand, silt, and rare gravels. 0-2 m thick.

Rf Recent fluvial deposits (Recent, 2005 to 2009): Recent sand, silt, and rare gravels of the Rio Grande. Water and unvegetated alluvium in 2005 imagery, poorly vegetated in 2009 imagery. 0-2 m thick.

Hmf Modern fluvial deposits (Modern, 2001 to 2005): Sand, silt, and rare gravels of the Rio Grande. Poorly vegetated in 2005 imagery, generally well vegetated in 2009 imagery. Maps by Pearce and Kelson (2003) suggest this was active alluvium in 2001. 0-2 m thick.

Hf Historic fluvial deposits (Historic-modern, 1935-2001): Sand, silt, and rare gravels of the Rio Grande. Generally well vegetated in 2005 and 2009 imagery, with scroll bar textures apparent in vegetation banding. Maps by Pearce and Kelson (2003) suggest this was active alluvium in 1935. 0-2 m thick.

Qfy Young fluvial deposits (Holocene to Historic): Sand, silt, and lesser gravels of the Rio Grande underlying the present floodplain level. Surface generally modified by agricultural or conservational land management, inhibiting further reliable division. Where undisturbed, bears weak scroll bar textures. No significant soil development. 0-2 m thick.

Qfi Intermediate fluvial deposits (upper Pleistocene?): Sand, silt, and lesser gravels underlying a continuous terrace with tread 3 to 6 m above the active channel. Moderately vegetated in 2005 and 2009 imagery, with weak scroll bar textures. 0-6? m thick.

Qfay Intermediate fluvial deposits, overlain by tributary bajada sediments (upper Pleistocene to Holocene): Intermediate fluvial deposits overlain by thin tributary alluvium and lesser eolian sands. Generally looks like Qayb at the surface, but with weak meander scroll textures apparent on aerial imagery suggesting a fluvial component to the underlying deposit. See descriptions of Qayb and Qfi for more details.

Qfo Older fluvial deposits (middle Pleistocene): Pale brown silty fine to coarse sands and gravels of isolated terrace remnants with straths 24 to 41 m above the current Rio Grande channel. Poorly preserved and exposed, likely more common than mapped but obscured by sand sheets and similarity to underlying QTsf. 10YR 8/3 color measured, clots of sand cemented by K fabric at surface of higher deposits may be the remains of a Stage III or greater carbonate horizon. 2-10 m thick.

Tributary alluvium

Qa_ Tributary alluvium (upper Pleistocene to Holocene): Sand, silt, and rare gravels of streams that reach the Rio Grande floodplain. Divided into units based on grain size, morphology, and age inferred from landscape position and relative soil development. Most Qa_ derived from a SSW-trending escarpment that spans the quadrangle; in the northwest corner, some alluvium is derived from the Chupadera Mountains to the west, and this alluvium is significantly more gravel-rich than the escarpment-derived alluvium. Surface sediments of all Qa_ units are significantly reworked or partly buried by eolian processes.

Qah Historic tributary alluvium (upper Holocene? to Historic): Pale brown silty, pebbly fine to medium sand with rare pebble channels. Includes alluvium that is inset upon by up to 1 m by active channels. 10YR 7/4 to 6/4 colors measured, no carbonate accumulation. 0-1 m thick.

Qaf Historic tributary gully-mouth fans (upper Holocene? to Historic): Pale brown silty, pebbly fine to medium sands. Map unit applies to small fans at the terminal mouths of current channels. No significant soil development. 0-1 m thick.

Qam Mud-rich tributary alluvium (Holocene to Historic?): Pale brown sandy silts. Found locally at the terminus of some streams. May be the top of an older unit, locally exposed by erosion. No evidence of significant soil development. 0-1? m thick.

Qay2 Younger tributary alluvium (Holocene): Light brown silty pebbly fine to medium sands with rare coarse sand channels. Alluvium composes terraces with treads 1.5 to 2 m above local active channels, inset upon by Qayb, and is overlain by that of Qay1. Sparse outcrop, but soil development appears comparable to Qay2 (up to Stage I Bk, slightly reddened Bw). Color of 10YR 6/4 measured. 0-3 m thick.

Qayb Bajada of young tributary alluvium (upper Pleistocene? to Holocene): Pale brown silty fine sands with sparse pebbles. Alluvium composes a bajada of small fans emanating from the escarpment, with a surface that is inset upon by Qay2 and is overlain by that of Qay1. Sparse outcrop, but soil development appears comparable to Qay2 (up to Stage I Bk, slightly reddened Bw). Color of 10YR 6/4 measured. 0-3 m thick.

Qay1 Older tributary alluvium (upper Pleistocene): Pink muddy fine to medium sands with sparse pebbles. Very poorly exposed, but appears to be thin alluvial deposits that are inset upon by Qayb and Qay2, with surface treads 3 to 7 m above local active channels. Small gullies reveal muddy fine to medium sands with color of 10YR 7/3, up to Stage II carbonate morphology, and up to Stage I gypsic morphology. 0-3? m thick.

Piedmont alluvium

Qp_ Piedmont alluvium (upper Pleistocene to Holocene): Sand, silt, and gravels of streams that do not reach the Rio Grande floodplain. Generally divided into units based on grain size, morphology, and age inferred from landscape position and relative soil development. Alluvium is mainly derived from the Cerro de la Campana-area to the immediate east of the quadrangle. Surface sediments of all Qp_ units are reworked by or variably buried by eolian processes.

Qph Historic piedmont alluvium (upper Holocene? to Historic): Very pale brown sand, silt, and gravels of active stream channels, including low terrace levels with treads up to 1 m above the channel. Generally moderately to strongly bedded with no soil development. Channel sediment is poorly sorted and gravel-rich, dominantly of various andesitic lithologies, with a medium to coarse sand matrix. Extra-channel sediment is silty fine to medium sands with sparse pebbles. Colors of 10YR 7/3 to 8/2. 0-1.5 m thick.

Qpf Piedmont gully-mouth fans (Holocene to Historic): Pale brown silty, pebbly fine to coarse sand associated with the terminations of current channels and gullies. Unexposed, but surfaces suggest the deposit is mainly silty sand with up to 30% pebbles of mainly andesitic lithologies. Sand is lithic- and plagioclase-rich. Colors of 10YR 6/4 to 7/3 measured. No soil development. 0-1 m thick.

Qpm Mud-rich piedmont alluvium (Holocene to Historic): Pale gray to light reddish brown sandy clayey silts at the terminations of eastern streams. Finely laminated deposits with up to Stage I carbonate horizon development, with carbonate restricted to rhizoconcretions. Redder (5YR 5/4 to 6/4) in the north, grayer (10YR 7/2) in the south. May be the top of an older unit, locally exposed by erosion. 0-1 m thick.

Qpy Younger piedmont alluvium (Holocene): Pale to light brown silty sands and local pebbly paleochannels. Moderately laminated bedding to massive, with up to Stage I carbonate horizon development. Gravels are almost exclusively andesitic lithologies, and sands are lithic- and plagioclase-rich. Alluvium underlies terrace treads 1 to 3 m above local channels. As mapped, Qpy includes an erosional surface with indistinguishable tread height and comparable underlying sediments that are 0.25-0.5 m thick that cannot be reliably mapped separately due to poor exposure. Colors of 10YR 5/3 to 8/3 measured. 0-2 m thick.

Qpyh Younger and historic piedmont alluvium, undivided (Holocene to Historic): Deposits of Qpy and Qph combined to fit the map scale. See individual descriptions of these units for details.

Qpye Younger piedmont alluvium overlain by thin younger sand sheet (Holocene to Historic): Younger piedmont deposits overlain by variable thicknesses (up to 2 m) of Qes2-like eolian sand. See description of Qpy and Qes2 for more details.

Qpo Older piedmont alluvium (upper Pleistocene?): Light brown silty clayey pebbly fine to medium sands with carbonate and gypsum accumulation. Very poorly exposed, but appears to be massive with 5-15% fine pebbles with common carbonate coats, with a light brown color mottled white and pale yellow by carbonate and gypsum. Up to Stage II carbonate horizon morphology, Stage I gypsum horizon morphology. Alluvium underlies surfaces that are inset upon by Qpi and Qpy and are 3 to 5 m above the local channels. 0-5? m thick.

Qpe Piedmont alluvium, undivided, overlain by thin younger sand sheet (upper Pleistocene to Holocene): Older and intermediate piedmont alluvium overlain by variable thicknesses (up to 2 m) of Qes-like eolian sand. See descriptions of Qp units and Qes2 for details.

Eolian and slopewash units

Qsa Slopewash alluvium (Holocene): Light reddish brown fine sandy silts to silty sands filling broad shallow swales. Very poorly exposed, but sands are lithic- and plagioclase-rich, with rare potassium feldspar and rare to common quartz, and bear rare fine to medium pebbles of andesitic composition. 5YR 6/3 to 7.5YR 6/4 colors measured. 0-1? m thick.

Qebs Eolian blowout sands (upper Holocene): Light yellow clean fine sands at the downwind sides of blowouts. Blowout sands occur as low, commonly poorly vegetated, parabolic. Sands are moderately sorted and subrounded to rounded, with roughly subequal proportions of quartz, potassium feldspar, plagioclase, and lithics. 7.5YR 7/4 to 10YR 7/4 colors common, with a redder 7.5YR 5/4 color in the southwest corner, immediately downwind of a large outcrop of red sandstones (off quad to south). 0-4 m thick.

Qeb Eolian blowouts (upper Holocene): Deflationary hollows, included on map to show upper Holocene prevailing wind direction, in conjunction with downwind blowout sands. Only map-scale blowouts are shown. No thickness, as these are mainly erosional features.

Qesr Eolian broad sand ridges (upper Holocene): Pale brown clean fine sands composing map-scale topographically high bands. Sands are moderately sorted, subrounded to rounded, with abundant grains of quartz, common lithics and potassium feldspar, and lesser plagioclase. Colors of 10YR 6/4 to 7/4 measured. Appears to be local preferential accumulations of the Qes2 sand sheet. 0-4? m thick.

Qec Eolian coppice dunes (upper Holocene): Very pale brown clean fine sands composing low dunes accumulating around bushes. Sands are moderately sorted, subangular to rounded, with common grains of lithics, plagioclase, potassium feldspar, and quartz. Coppice dunes are 0.5 up to 1.5 m tall relative to barren interdunal areas. No soil development. 0-1.5 m thick.

Qes2 Younger eolian sand sheet (upper Holocene): Very pale brown silty to clean, fine to medium sands. Moderately to poorly sorted, subangular to rounded sand grains of abundant quartz and lithics, and rare to common potassium and plagioclase feldspars. No evidence of soil development. Colors of 10YR 6/4 to 7/4 common, with local colors of 7.5YR 6/4 to 7/3. Common relatively low relief eolian surface textures, including small (4 to 10 m diameter) to map-scale (map unit Qeb) blowouts, linear ridges and scarps that parallel the prevailing wind direction, and small coppice dunes. Locally, browner, Qes1-like sands can be found just below the surface in topographic lows, suggesting Qes2 is burying Qes1. 0-6? m thick.

Qes1 Older eolian sand sheet (upper Pleistocene? to lower Holocene): Light brown to brown to locally light reddish brown silty fine to medium sands. Moderately to poorly sorted, subangular to rounded sand grains of abundant quartz, common lithics, and rare to common potassium and plagioclase feldspars. Up to Stage I+ carbonate horizon development with a reddened (5YR 5/4 to 5/6) Bw horizon. Colors of 7.5YR 5/4 to 7.5YR 6/6 measured at the surface. Generally only minor eolian surface textures, including some coppice development and vague prevailing wind-parallel lineations on aerial imagery. 0-1 m thick.

Qes/_ Sand sheet, undivided, over older sediments: Used to delineate areas where an older unit is suspected to be found <0.5 m below a surface cover of eolian sands. Evidence used to support this include common thick carbonate coats on gravels at the surface or in animal burrows, common fragments of white carbonate horizon at the surface or in burrows, exposure of the older sediments nearby, and relative landscape position of the sand sheet-buried surface. The burying sand sheet can fit the description of either the older or younger sand sheet.

Upper Santa Fe Group units

Equivalent to the Sierra Ladrones Fm to the north and Palomas Fm to the south

QTsf Upper Santa Fe Group, fluvial facies (Pliocene to lower Pleistocene): Light gray pebbly sandstones, pale brown siltstones, and light greenish gray mudstones of the ancestral Rio Grande. Sands are moderately to poorly sorted, silty to clean, subrounded to rounded, with abundant quartz, common lithics, rare potassium feldspar, and sparse plagioclase. Rare fine pebbles are mainly chert, with lesser granite, intermediate to felsic volcanics, and quartzite. Thickness unknown, but at least 60 m of seds are exposed; a water well by Socorro penetrated 340 m of QTsf (Chamberlin, pers. comm.).

QTsp Upper Santa Fe Group, piedmont facies (Pliocene to lower Pleistocene): Pale brown to white conglomerates. Poorly exposed, but typically a cobble conglomerate along the east edge grading to a pebble conglomerate to the west. Gravels are poorly sorted, angular to subrounded, and mainly of andesitic porphyry compositions, with sparse red siltstones and limestones. The top is marked by a Stage IV or V carbonate horizon that is exposed along the east edge of the quadrangle. Thickness unknown, but likely comparable to QTsf.

Pre-Santa Fe Group units

Cross-section only

Mesozoic strata projected from Cather (2002, 2007); Presence of Permian Yeso Group at depth suggested by Weir (1965) and Roybal (1991).

Kgc Cretaceous Gallup Sandstone and Crevasse Canyon Formation (lower Coniacian to Santonian?)

Kmd Cretaceous D-Cross Tongue of the Mancos Shale (upper middle Turonian to lower Coniacian)

Kth Cretaceous Tres Hermanos Formation (middle Turonian)

Kml Cretaceous lower part of the Mancos Shale (middle Cenomanian to lower Turonian)

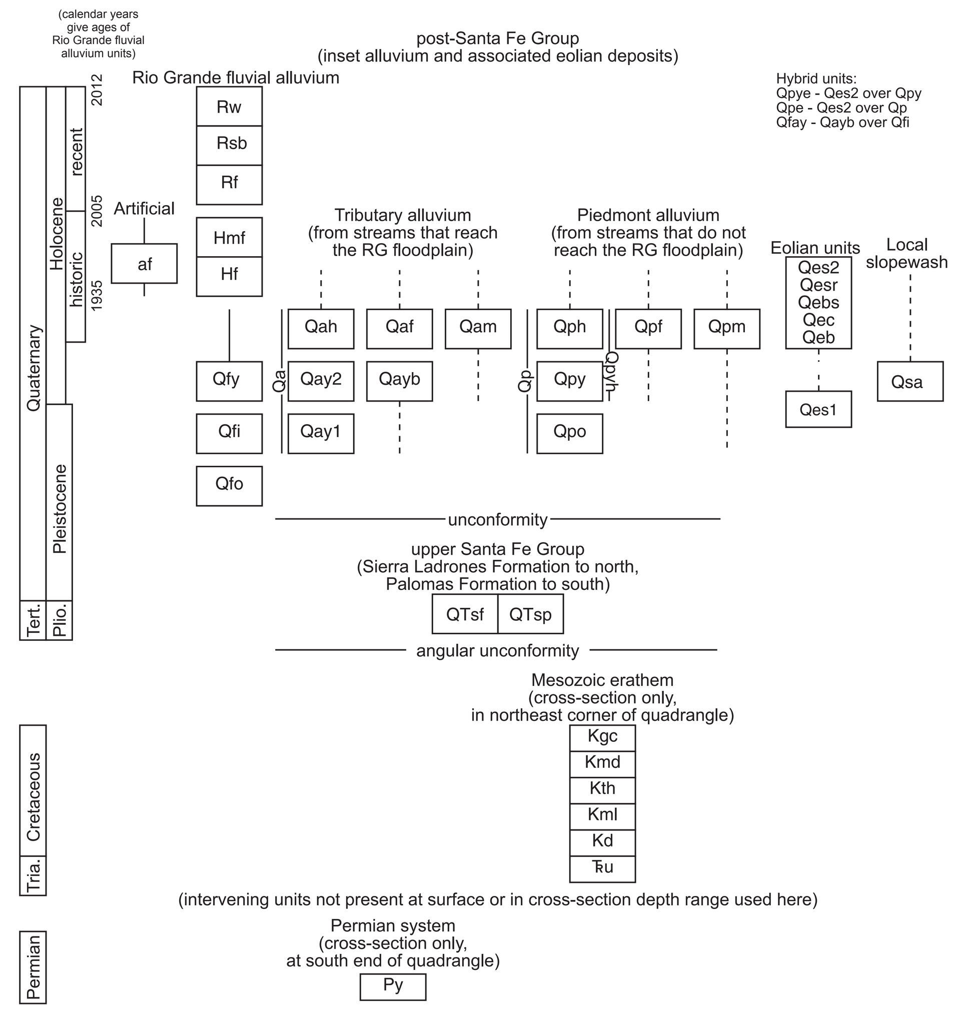
Kd Cretaceous Dakota Sandstone (middle Cenomanian)

Ŧu Triassic rocks, undivided

Gap in rocks presented in cross-sections; gap is not necessarily present in deep subsurface across the quadrangle.

Py Permian Yeso Group (Leonardian)

CORRELATION DIAGRAM



Notes:
- Solid lines indicate known age extent of units
- Dashed lines indicate inferred age extent of units
- Age relations between piedmont alluvium and tributary/Rio Grande alluvium are uncertain
- Only pre-Pliocene units known to be present at depths of given cross-sections are shown; work of Cather (2002, 2007) to north and reconnaissance work to east suggest several more units are present at depth across the San Antonio SE quadrangle

MAP EXPLANATION

Contact, well located, approximately located, inferred location, concealed. Queried where existence is uncertain.

Fault, well located, approximately located, concealed. Ball on down-thrown side, queried where existence is uncertain.

Rim of a blowout, hashes point into blowout

Crest of ridge of eolian sands

Joints or minor faults inferred from topography

Terrace riser, well located, approximately located. Hashes point down-scarp; queried where existence is uncertain.

Low scarp, well located, approximately located. Here, symbol is simply descriptive, with no assocated interpretation.

Cross-section line

Point symbols

Strike and dip of inclined bedding

Horizontal bedding

Paleocurrent direction from pebble imbrications

Convolute bedding from soft sediment deformation

REFERENCES

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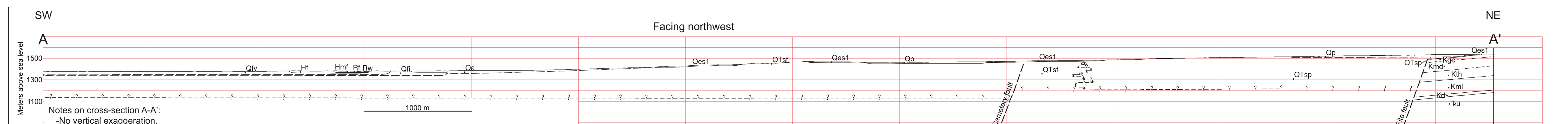
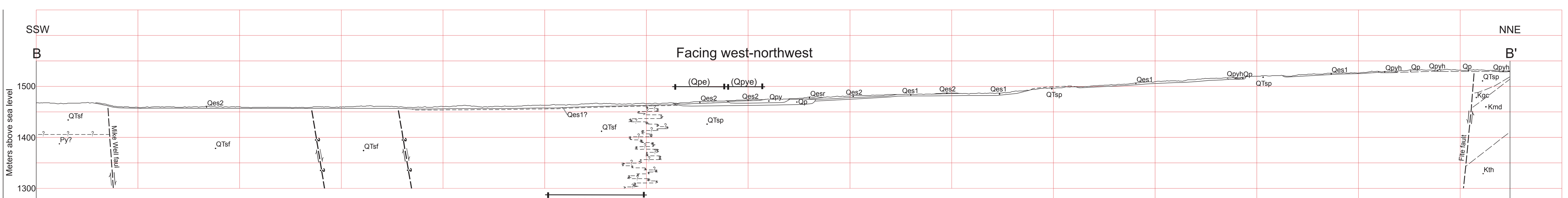
Roybal, F.E. 1991. Ground-water resources of Socorro County, New Mexico: US Geological Survey, Water-resources Investigations Report 89-4083: 103 pp.

Weir, J.E. 1965. Geology and availability of ground water in the northern part of the White Sands Missile Range and vicinity, New Mexico: US Geological Survey, Water-supply Paper 1801: 78 pp.

Mike Well fault scarp with Little San Pascual Mountain in the background. Picture looks southwestward. The scarp may uplift the Permian Yeso Formation to within 90 m of the surface, while another fault lying along the north side of Little San Pascual Mountain uplifts the Yeso as well as underlying Abo Formation and Madera Limestones to the surface (Geddes, 1963).



Notes on cross-section A-A':
- No vertical exaggeration.
- Thicknesses of post-Santa Fe Group units are exaggerated.
- Location of bottom of Santa Fe Group is unconstrained.
- Offset across Cemetery fault is unconstrained.
- Location of contact between QTsf and QTsp is constained by surface observation but not by subsurface data.
- Fite fault and Mesozoic strata are projected from Cather (2002) and Cather (2007). Neither are exposed on San Antonio SE.



Notes for cross-section B-B':
- Vertical scale is 5X horizontal scale.
- Thickness of post-Santa Fe Group units are unconstrained and exaggerated.
- Fite fault and Mesozoic strata at NNE end are projected from Cather (2002, 2007).
- Permian strata may be present at ~90 m depth in footwall of Mike Well fault; Weir (1965) and Roybal (1991) both suggest the Mike well *may* terminate in the Yeso Group.
- post-Santa Fe Group units defined as eolian sand overlying another unit are indicated in parantheses above the cross-section; eolian sands and underlying units are shown separately within the cross-section.