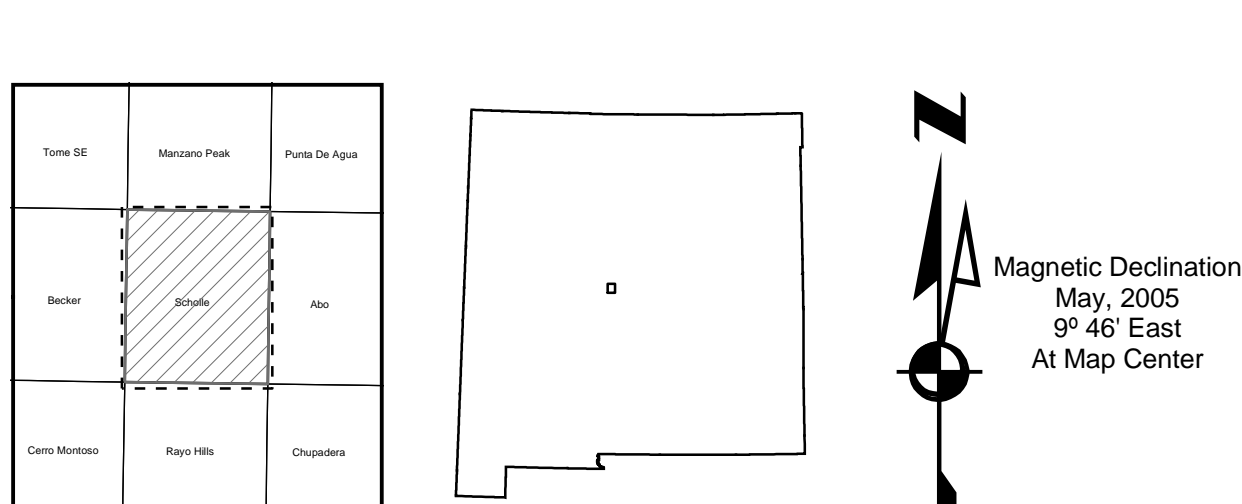


Preliminary Geologic Map of the Scholle 7.5 - minute Quadrangle



A geologic map displays information for users, 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quadrangle map may be based on any of the following reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation.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 geologists. 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.

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by  
Lea Anne Scott, Maya Elrick, Sean Connell, and Karl Karlstrom

May 2005

1:24,000

0 0.25 0.5 1 1.5 2 Miles

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CONTOUR INTERVAL: 30 FEET  
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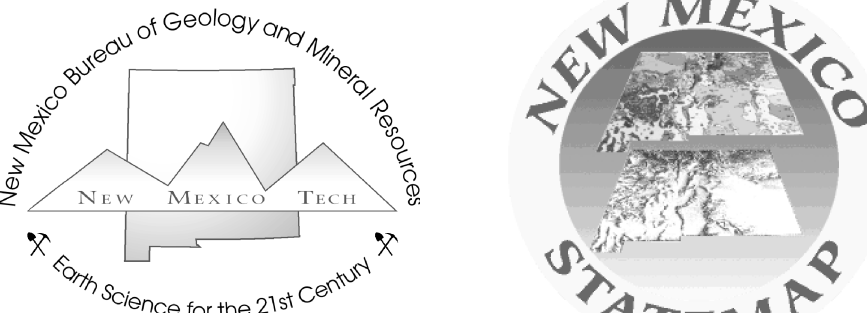
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**DRAFT**  
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This draft geologic map was produced from scans of hand-drafted originals from the author(s). It is being distributed in this form because of the demand for current geologic mapping in this important area. The final release of this map will be made following peer review and redrafting in color using NMBGMR cartographic standards. The final product will be made available on the internet as a PDF file and in a GIS format.

## SCHOLLE QUADRANGLE DESCRIPTION OF MAP UNITS

### CENOZOIC ERATHIEM

#### *Tributary stream-valley alluvium*

Tributary stream-valley alluvium grad to modern and former levels of Abo Arroyo, but is derived from mountain-front drainages of the Los Pinos and southern Manzano Mountains. Stream-terrace deposits typically have an elongate planform shape and are associated with major tributaries to the Rio Grande. Gravels reflect upland drainage composition and are dominated by reddish-brown sandstone.

**Qa** Stream alluvium, undivided (upper Holocene to historic) — Light-brown (7.5YR 6/4), poorly to moderately sorted, pebbles to cobble conglomerate and fine to coarse-grained sand with local accumulations of cobbles and small boulders. Soils are nonexistent to very weakly developed. Deposit underlies narrow to broad streams that are inset against broad valley floors. Deposits are correlative to unit Qyo of Abo Arroyo. Deposit thickness ranges from <1 m to about 4 m.

**Qay** Stream alluvium, undivided (uppermost Pleistocene to Holocene) — Poorly to moderately sorted, poorly consolidated light-brown and light reddish-brown to gray-brown pebble and cobble conglomerate and sand with minor accumulations of boulders. Forms broad valley floors that are inset by stream alluvium of unit **Qa**. Deposits draining limestone and granitic terrain north of Abo Arroyo contain pale-brown to very pale-brown (10YR 6/3-7/3) pebbly sand and gravel. Deposit surface sits about 1-2 m above local base level and contains weakly developed soils with Stage I pedogenic carbonate morphology. Locally overlies moderately to well developed calcic soils (Stage III pedogenic carbonate morphology) formed on older alluvium. Unit on east side of Manzano Mountains consists of light-brown (7.5YR 6/4), poorly consolidated, poorly exposed, poorly sorted pebbly to cobbly sand and gravel. Forms lowest deposit under valley floors. Commonly buries older alluvium upstream, but inset against unit **Qa** towards Abo Arroyo. Contains undifferentiated deposits of unit **Qa** in active stream bottoms. Correlative to unit **Qay** of Abo Arroyo. Two terraces are locally differentiated based on inset relationships and relative height. Thickness ranges from <1 m to 4 m.

**Qayy** Stream alluvium, younger subunit (Holocene) — Unit is inset against older Qyo and sits less than 3 m above local base level.

**Qayy** Stream alluvium, younger subunit (Holocene to uppermost Pleistocene) — Unit is inset by younger alluvium of unit Qyy and sits about 3-4 m above local base level.

**Qpm** Stream-valley alluvium, intermediate deposits (middle to late Pleistocene) — Light-brown to brown (7.5YR 6/4-5/4), poorly sorted, moderately consolidated, pebbly to cobbly sand and gravel. Soils are moderately developed and locally exhibit Stage II- to locally weak Stage III pedogenic carbonate morphology. Deposits are inset by younger stream alluvium of unit Qay downstream, but are commonly buried by younger alluvium upstream. Deposits sit about 6-12 m above local base level. Deposits are locally divided into three units based on inset relationships in the Priest Canyon (and Canon Arado) drainages. Deposit thickness ranges from 0 to 5 m.

**Qpm1** Older subunit (middle Pleistocene) — Inset against older alluvium of unit Qyo and inset by younger subunits of Qpm2 and younger stream alluvium of unit Qay.

**Qpm2** Intermediate subunit (middle Pleistocene) — Inset against unit Qpm1.

**Qpm3** Younger subunit (middle to late(?) Pleistocene) — Inset against unit Qpm2.

**Qpo** Stream-valley alluvium, older deposits (middle Pleistocene) — Pinkish-gray (7.5YR 6/3) pebble to cobble gravel. Inset against oldest alluvium of unit QTP and sits about 6-15 m above local base level. Deposit is about 6-7 m thick.

#### *Alluvium of Abo Arroyo*

Fluvial and alluvial deposits derived from the ancestral and modern Abo Arroyo. Deposits unconformably overlie upper Paleozoic limestone and sandstone and interfinger with local stream alluvium derived from the eastern slopes of the Los Pinos and southern Manzano Mountains.

**Qaa** Abo Arroyo stream terrace, active (upper Holocene to historic) — Brown to reddish-brown (5-7.5YR 5/4) to light-brown (7.5YR 6/4), poorly consolidated, poorly exposed, pebble to cobble gravel. Deposit exhibits no soil-profile development. Underlies active drainage of Abo Arroyo. Thickness of deposit is generally less than 2-3 m.

**Qaay** Abo Arroyo stream terrace, lower deposit (Holocene to upper Pleistocene) — Light-brown (7.5YR 6/4), poorly consolidated, poorly exposed, pebble to cobble gravel. Deposit exhibits little to no soil-profile development with disseminated calcium-carbonate cement. Deposit surface forms broad valley floor of Abo Arroyo and major tributaries. Thickness of deposit ranges from 0 to 10 m.

**Qaam** Abo Arroyo stream terrace, intermediate deposit (upper Pleistocene) — Light-brown (7.5YR 6/4), poorly consolidated, poorly exposed, pebble to cobble gravel. Deposit surface is about 6 m above the valley floor of Abo Arroyo. Deposit about 3 m thick.

**Qaao** Abo Arroyo stream terrace, older deposit (middle Pleistocene) — Light-brown (7.5YR 6/4) pebbly sand and gravel. Dominated by subrounded cobbles (up to 20 cm diameter; mostly < 4 cm) of reddish-brown sandstone with minor limestone schist and quartzite. Lower 3 m is well cemented. Surface contains remnants of well developed calcic soils and thick calcic-carbonate sands or gravel. Soil development is likely at least Stage II pedogenic carbonate morphology. Deposit surface is nearly 25 m above the valley floor of Abo Arroyo. Deposit is about 10 m thick.

#### *Piedmont-slope alluvium*

Alluvium associated with non-incised valleys. Typically recognized as alluvial fans that grade to high-level surfaces and are not integrated with Abo Arroyo. Gravels reflect upland drainage composition.

**Qpy** Piedmont alluvium, younger deposits (upper Pleistocene to Holocene) — Light-brown to brown (7.5YR 5/4-6/4), weakly consolidated, poorly sorted, pebbly to cobbly sand and gravel. Deposits delineated along the western front of the southern Manzano Mountains. Deposits commonly contain matrix-supported gravely sand with local clay-supported gravel lenses. Soils are generally poorly developed and exhibit Stage I pedogenic carbonate morphology. Deposits are at least 2 m thick.

**QTP** Piedmont alluvium, older deposits (upper Pliocene(?) to lower Pleistocene) — Pink (5YR 7/4) pebble gravel with scattered (<4 m diameter) of reddish-brown sandstone (Abo Fm) boulders. Moderately developed soils exhibiting Stage III pedogenic carbonate morphology. Clasts commonly engulfed with 1-8 mm thick carbonate rinds. Clast coatings locally form pisolitic structures, but no laminar carbonate layers. Ridge-crests commonly rounded and forms remnants of formerly widespread conical surface that has been incised by younger valley fill deposits. Inset against older ridge-capping gravels exposed in adjacent Manzano Quadrangle (Karlstrom et al., 2003). Delineated in Priest Canyon on eastern slope of Manzano Mountains. Deposit range from about 4-60 m thick.

#### *Artificial fill and Mass-movement deposits*

Surficial deposits are the name given to a group of generally thin sediments associated with mass movement and erosion processes. This category also includes sand and gravel deposited by mountain-front streams that are not integrated with entrenched tributary drainages to Abo Arroyo.

**af** Artificial fill (historic) — Dumped fill and areas affected by human disturbances. Mapped where deposits are areally extensive.

**Qls** Landslide deposits (upper to middle Pleistocene) — Poorly to well consolidated and very poorly sorted, sand, breccia. Formed by mass-movement, commonly along steep hill slopes. Arrows indicate direction of movement.

**Qca** Colluvium and alluvium, undivided (Holocene to upper Pleistocene) — Brown (7.5YR-10YR 5/3), poorly consolidated and poorly sorted, loose, fine- to coarse-grained silty sand with scattered pebbles and sparse cobbles. Soil development ranges from weakly to moderately developed and locally exhibits Stage II- pedogenic carbonate morphology. Unit is of variable thickness, ranging from less than 30 cm to about 1 m or thick and commonly mantles cuestas underlain by Pennsylvanian and Permian rocks.

### PALEOZOIC ERATHIEM

**Pyt** Yesso Formation, Torres Member (Lower Permian or Leonardian) — Base of member mapped at base of gypsum. Poorly exposed gypsum with interbedded limestone lenses. Gypsum is bedded and weathers very light gray. Limestone lenses are up to 5 feet (1.5 m) thick and weather light-olive gray. Lower 100 feet (<30 m) exposed in southeast part of quadrangle; upper beds and contact not present in quadrangle.

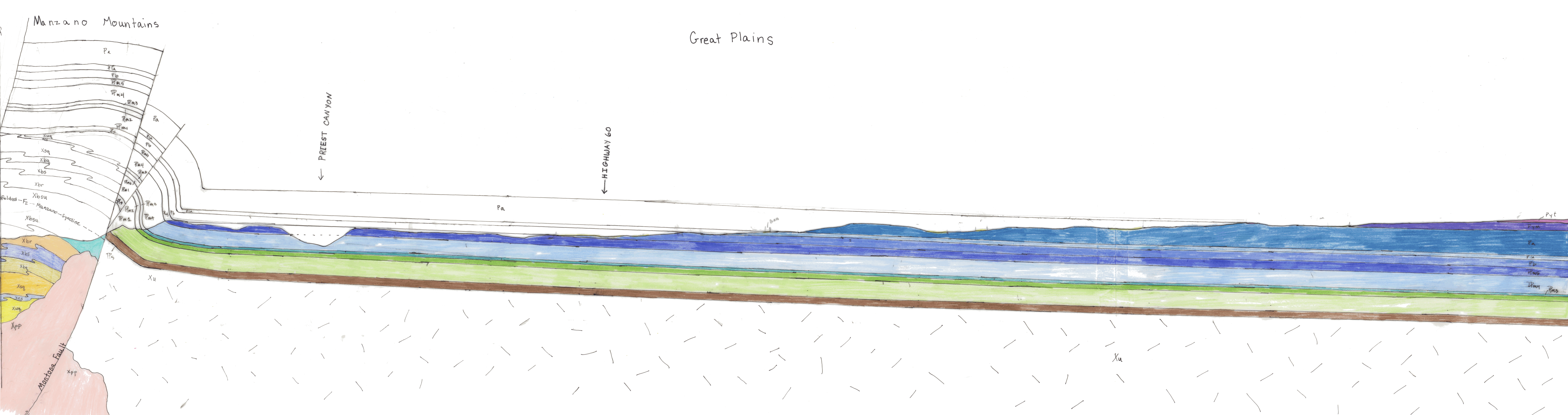
**Pym** Yesso Formation, Mesa Blanca Sandstone Member (Lower Permian or Leonardian) — Gradational basal contact with underlying Abo Formation is mapped at change in topography from cliff forming Abo Formation to gentle slopes and undulating terrain of Yesso Formation. Basal sandstone is massive; overlying beds composed of thin-bedded, fine-grained sandstone (arenite to wacke) and siltstone. Weathers white and light orange-tan. Trace fossils observed on bedding surfaces along with ripple marks and cross bedding. Associated soils to orange to pink. Approximately 250 feet (76 m) thick.

**Pa** Abo Formation (Lower Permian or Leonardian and Wolfcampian) — Base of unit mapped the first bench of fine-grained silticlastics overlying the coarser Lower Abo Formation (Pla). Overall fine-grained than lower part of Abo Formation (Pai), and composed of thin- to thick-bedded micaceous siltstone and fine-grained sandstone. Upper portion contains sandstone and occasional granule conglomerate interbedded with siltstones and mudstones. Weathers light red and pale reddish brown, with local white and green oxidation/reduction spots. Cross laminae, ripple-marks, mudcracks and interbedded paleosols observed. Fossil plant debris and some bioturbation present. Uppermost 20-30 feet (6-9 m) interbedded with light orange-tan sandstones similar to those in the Yesso Formation. Approximately 800 ft (243 m) thick.

**Pai** Abo Formation, lower units (Lower Permian or Leonardian and Wolfcampian) — Base of unit mapped at top of last laterally extensive marine limestone of underlying Bursum Formation; disconformably overlies underlying Bursum Formation. Unit is coarser grained and darker in color than the upper portion of the Abo Formation (Pa) and weathers dark purple to dark reddish brown and is coated by abundant desert varnish. Contains poorly sorted medium- to coarse-grained, cross-bedded, thick-bedded sandstones (arkose wacke to wacke) to granule conglomerates. May contain calcite cement. Sandstone beds are more laterally continuous than those of underlying Bursum Formation; basal sandstone may contain 10 m limestone clasts. May contain thin (<1 m) clay-supported limestone-sandstone pebble conglomerate bed 5-10 m above basal contact. Thin lenses (average <10 cm; up to 1 m thick) of unfossiliferous, partially dolomitized, laminated limestone beds (non-marine?) at base. Thin interbeds of laminated, micaceous siltstone to fine sandstone present. Copper mineralization and calcite cement present. Unit is present throughout quadrangle, is present, but thinner in the adjoining Becker quadrangle, but is not regionally extensive, as it does not occur in the Lucero uplift region, ~80 km across the Rio Grande Rift (Lucas and Ziegler, 2004). Thickness less than 125 feet (38 m).

**Pb** Madera Group, Bursum Formation (Lower Permian) — Base of unit mapped as last appearance of well-exposed cherty limestone from uppermost PIn-5, which is typically overlain by <5 m of cover followed by 1-2 m thick coarse-grained reddish arkose sandstone with irregular bottom contact. In northern quarter of quadrangle, basal sandstone is replaced by gray-white crinoid packstone. Limestone beds overlying this basal sandstone (skeletal wackestone-lime mudstones) are thin (< 2m) and contain fusulinids *Trinitites crekerensis* Thompson and *Leptotrinitites* sp. (Myers, 1977), finely abraded or large, intact gastropods, ramose bryozoa, crinoids, and bivalves, and rare small chert nodules (<2 cm). Middle portion of unit composed of interbedded fine- to coarse-grained cross-bedded sandstone (lithic to arkose wacke and arkose), which may contain calcite cement, occasional granule-possil conglomerate, red mud-shale, and micaceous siltstone; thickness of sandstone beds varies laterally. Top of unit composed of well- to poorly-exposed < 16 feet (5 m) thick light gray, thin bedded, nodular, fossiliferous limestone bed (skeletal wackestone) that contains small (1 mm thick) stringers of red sandstone, bivalves, crinoids, fenestrae, and fusulinids (*Scavengerina pinosensis* Thompson) sp. (Myers, 1977). Sandstone weathers reddish-brown to purplish-brown; limestone weathers olive-gray; shale and siltstone weather red. May be covered by thin (<1 ft) of Qca. About 250 feet (76 m) thick.

**PIn5-PIn1** Madera Group, informal map units within the Wild Cow Formation and Los Moyos Limestone (Lower Permian, Upper and Middle Pennsylvanian) — Informal map units within the Wild Cow Formation and Los Moyos Limestones as previously mapped by Myers (1977). Units broken out into three intervals that contain cliff-forming limestone (PIn5-5, PIn-3, and PIn-1) interbedded with two slope-forming silticlastic-dominated intervals (PIn-4 and PIn-2). Contains fusulinids of Virgilian, Missourian, and Desmoinesian ages (Myers, 1977).



Geologic Map of the Becker 7.5 minute Quadrangle

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Lea Anne Scott, Maya Elrick, Sean Connell, and Karl Karlstrom

May 2005

1:24,000

0 0.25 0.5 1 1.5 2 Miles

0 0.25 0.5 1 1.5 2 Kilometers

CONTOUR INTERVAL: 30 FEET  
NATIONAL GEODETIC VERTICAL DATUM OF 1985

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**PIn5** Madera Group, middle and upper part of La Casa Member of the Wild Cow Formation (Upper Pennsylvanian – Virgilian) — Base of unit mapped at base of first cliff-forming limestone overlying slope-forming PIn-4. Cliff and slope-forming interval composed of three distinctive, mappable, thick (<3-8 m) limestone cliffs separated by 10-25 m-thick slope-forming intervals. Lower limestone cliff (<4 m) composed of thick-bedded limestone (skeletal wackestone) with laterally continuous dark chert band at base (<10 cm thick) and capped by meter-scale cross-bedded limestone with cross-bedded, laterally discontinuous sandstone. Middle limestone (<3 m; skeletal wackestone) contains irregular- shaped dark chert nodules in upper 2 meters. Upper limestone (<8 m; skeletal wackestone) contains large irregular-shaped light gray chert nodules. Upper 10's of meters of unit composed of recessed, 1-m thick limestone beds containing abundant dark brown chert nodules that weather light tan. Limestones contain phylloid algae, bivalves, crinoids, brachiopods, and abundant bioturbation. Slope-forming intervals composed of interbedded green and purple micaceous siltstone, sandstone, and mudstone. *Trinitites crekerensis* Thompson? fusulinids present (Myers, 1977). May be covered by thin veneer (<1 ft) of Qca where unit crops out on gentle slopes. Approximately 250 feet (76 m) thick.

**PIn4** Madera Group, Pine Shadow Member and lower La Casa Member of the Wild Cow Formation (Upper Pennsylvanian – Virgilian) — Base of unit mapped at the top of the last limestone cliff in underlying PIn-3. Slope-former (poorly exposed) composed of interbedded sandstone, siltstone, and mudstone with occasional laterally discontinuous limestone beds. A thick sandstone interval (10's m thick) is present just north of gas pipeline road in middle of quadrangle and southern part of quadrangle. Mud-siltstones contain ripple laminations and soft sediment deformation. Plan debris and cross-bedding observed in some sandstone beds. Base of unit marked by distinctive thin (<1 m) orange dolomite bed overlain by white sandstone (quartz arenite). Approximately 560 ft (170 m) thick. Thickness varies laterally within map area by 9 m and is thinner to north (Myers, 1977).

**PIn3** Madera Group, upper part of Sol se Mete Member of the Wild Cow Formation (Upper Pennsylvanian – Missourian) — Base of unit mapped at base of first limestone cliff overlying covered interval in lower portion of Sol se Mete Member (PIn-2). Thin- to thick-bedded cliff-forming limestone (wackestone through granitose) containing three persistent, mappable cliffs: 1) lower limestone that contains dark chert bands (0.5 m long, <20 cm thick), 2) middle limestone interbedded with orange-weathering siltstone and sparse chert bands, and 3) thick-bedded upper limestone with distinctive orange-brown mottling in upper 2 meters. Fossils include gastropods, bryozoa, rugose corals, phylloid algae, brachiopods, and abundant bioturbation. Approximately 65 ft thick (20 m).

**PIn2** Madera Group, lower portion of Sol se Mete Member of the Wild Cow Formation (Upper Pennsylvanian – Missourian) — Base of unit mapped as top of last limestone bed in underlying Los Moyos Limestone. Slope-former (poorly exposed) interpreted to be fine-grained silticlastic deposits (siltstone) interbedded with limestone beds (mudstone through granitose) with marl interbeds, rip-up clasts, and plane laminations, and laterally discontinuous white and green sandstones with local granules (sarkose) (1-2 m thick). About 100 ft thick (30 m).

**PIn1** Madera Group, Los Moyos Limestone (Middle Pennsylvanian – Desmoinesian) — Basal contact with underlying Sandia Formation placed at the base of the first limestone bed. Medium- to thick-bedded, cliff-forming limestones (lime mudstones through skeletal wackestones and granitoses). Individual limestone beds 1-2 m thick. Contains dark chert in small pods (<5 cm) in lower 40 meters, middle 20 meters, and in uppermost limestone bed. Minor amounts of interbedded sandstone (quartz arenite through micaceous lithic wacke), quartz and feldspar granule conglomerate, and poorly exposed siltstones and mudshales. Fossils include bivalves, bryozoa, crinoids, fusulinids, chonetes, and abundant bioturbation obscuring primary sedimentary structures. Weathers medium gray. About 560 ft thick (172 m).

**IPS** Sandia Formation (Middle Pennsylvanian – Desmoinesian) — Interbedded sandy, fossiliferous limestones, shales, siltstones, sandstones, and conglomerates. Fossil types include marine fossils and plant debris. Limestone in upper part weathers light to medium gray with dark brown chert. Basal beds are quartz-pebble conglomerates with angular pink feldspar grains. Lower contact is fault contact with Precambrian rocks. About 600 feet (183 m) thick.

### PROTEROZOIC ERATHIEM

**Ypp** Priest Pluton Granite — Gray to pink, megacrystic to coarse-grained biotite + quartz + feldspar + epidote granite with cm- scale microcline phenocrysts. Slightly foliated at the pluton margins and in discrete shear zones within the pluton, but overall exhibits little to no tectonic foliation. Variably-developed alignment of megacrysts is interpreted as magmatic foliation. U-Pb zircon ages on the pluton yield a ca. 1.43 Ga emplacement age (Bauer et al., 1993).

**Xbsu** Blue Springs Schist, upper schist — green to white, chlorite + muscovite schist. The apparent uppermost unit of the Manzano Peak (F2) synclinorium, found west of the Priest pluton (Ypp) in the western region of the quadrangle. Equivalent to the Metaclastics Series pCm of Myers and McKay (1972).

**Xbr** Blue Springs Schist, rhyolite — Black and brown to gray, with lenticular quartz-feldspar pink colored stripes within darker layers. Interpreted as a metarhyolite due to the presence of potassium feldspar in the felsic lenses and a geochemical composition close to rhyolite. Contains numerous folds, some of which may be remnant of a rhyolitic flow folds; others are clearly F1 folds that are refolded by later generations of deformation. Equivalent to the part of pCa, the argillite of Myers and McKay (1972), named the Blue Springs Granitic (bq1) by Bauer (1983).

**Xbs** Blue Springs Schist — Green to white, garnet + quartz + muscovite schist. Just west of the synclinorium, this unit is highly linked with well preserved garnet. Near the Priest pluton schistite nodules are common and probably formed during retrograde metamorphism after emplacement of the pluton. Equivalent to the part of pCa, the argillite of Myers and McKay (1972) and the Sais Quartzite (sq3) of Bauer (1983)

**Xbq** Blue Springs Schist, Quartzite Member — Thinly-bedded, medium-grained quartzites, interbedded with chlorite-muscovite schist and quartz-muscovite schist. Partly equivalent to Sais Formation and lower part of the Pine Shadow Springs of Myers and McKay (1972); mapped as Blue Springs Formation (bs1) by Bauer (1983).

**Xsq** Sais Quartzite — Thinly-bedded, reddish, schistose quartzite. Bedding planes commonly show mica concentrations. Grain sizes range from very fine to coarse sand. Primary structures include preserved cross-bedding. Originally called the White Ridge and Sais quartzites of Myers and McKay (1972), called the White Ridge Quartzite 2 (sq2) of Bauer (1983).

### PRINCIPAL GEOLOGIC AND PHYSIOGRAPHIC FEATURES

The geology of the Scholle quadrangle is dominated by gently dipping (<10°) Pennsylvanian-Permian deposits (limestones and sandstones) cropping out as flat to low-lying benches and mesas within the central and eastern portions. Along the western edge of the quadrangle, vertical to locally overturned ridges of Pennsylvanian limestones are faulted against steep, more rounded hills of Precambrian rocks along the north-northeast-trending Montosa fault. There, the Pennsylvanian Sandia Formation and Madera Group form gently folded monoclines against the Montosa fault; beds immediately adjacent to the fault are vertical to overturned, while those ~1500 feet (457 m) away from the fault dip <10° to the east. These vertical beds of limestone form a persistent set of ridges that trends north-northeast along the western edge of the map area. Associated with this laterally extensive fault are abundant northwest-west trending faults; although most offsets along these faults are too small to appear at this map scale, the fault locations are included on the current map.

Gently dipping beds of Upper Pennsylvanian limestone and Permian limestone and sandstone form extensive dip-slopes east of the Montosa fault, with unit contacts that are present just a few feet beneath the land surface. Small changes in topography (<5 feet) superimposed on these gentle dip slopes allow small islands and ridges of overlying units to be exposed at the surface; this trend forms a somewhat unusual map pattern composed of fingers and circles of the younger unit superimposed by large washes of the older unit. These surfaces, in turn are often covered by <1 ft of Quaternary-aged colluvium. A prominent feature in the landscape is a long, fairly continuous northeast trending mesa with 300+ feet of relief composed of red sandstones of the Permian Abo Formation.

Precambrian units outcrop exclusively in the northwest portion of the quadrangle and consist of a ~1.43 Ga granitic pluton (Priest Canyon Pluton) and its aureole rocks that include ~1.66 Ga schist, rhyolite, and quartzite. These rocks have complex deformational fabrics that are interpreted to result from deformations ~1.65 Ga and ~1.43 Ga.

Quaternary deposits include valley floor and piedmont slope alluvium, including significant deposits of inset and stranded, isolated terrace gravels of metamorphic clasts, originating from the Manzano Mountains to the north. Major drainages in the map area include Abo Arroyo and Priest Canyon.