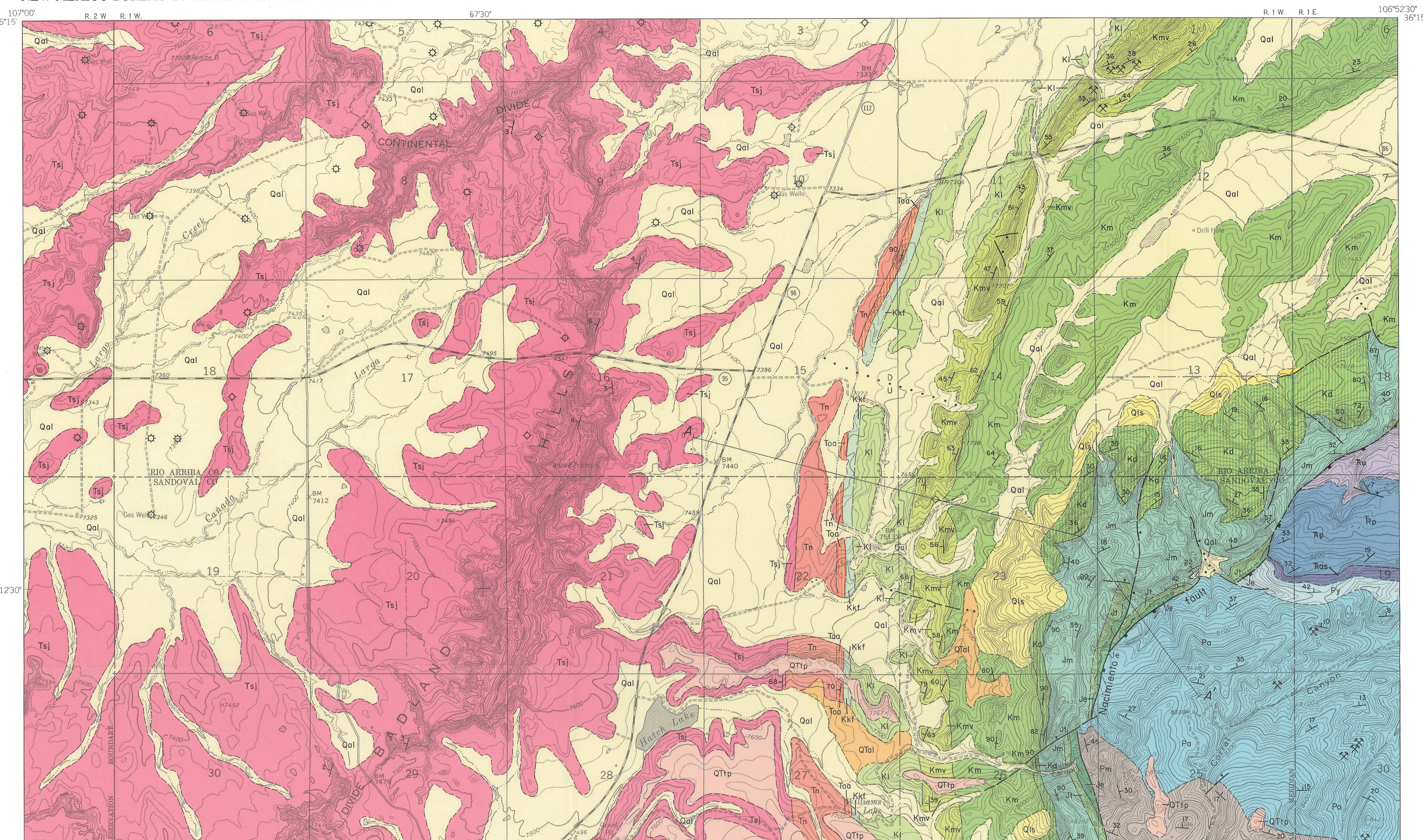
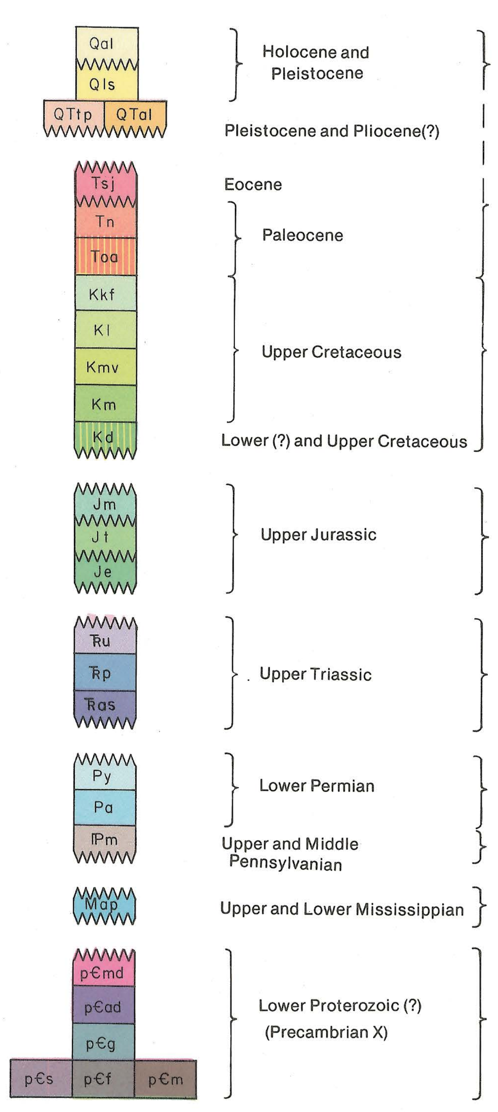


Base from USGS, 1963

Geology by M. A. Merrick and L. A. Woodward, 1979 and 1980

Drafting by Debra Vetterman

CORRELATION OF ROCK UNITS



DESCRIPTION OF ROCK UNITS

Qal — **Alluvium**—*Clay, silt, sand, and gravel present in valleys; also includes minor colluvium; maximum thickness 30 ft(?)*

Qls — **Landslide deposits**—*Angular debris composed primarily of Dakota Sandstone; maximum thickness approximately 75 ft*

QTal — **Older alluvium**—*Clay, silt, and sand found at the heads and along the sides of some valleys at higher levels than Quaternary alluvium; maximum thickness 30 ft(?)*

QTtp — **Terrace and pediment deposits**—*Gravel and cobbles of Precambrian, Paleozoic, or Mesozoic rock; includes minor lag gravel; maximum thickness 45 ft*

Tsj — **San Jose Formation**—*Basal, tan, poorly sorted, locally conglomeratic sandstone with overlying gray, yellow, purple, and green shale and minor conglomeratic sandstone; thickness 800–1,400 ft*

Tn — **Nacimiento Formation**—*Olive-green and gray, carbonaceous shale with minor tan, poorly sorted sandstone; thickness 1,000 ft*

Toa — **Ojo Alamo Formation**—*Tan-gray to orange, thick-bedded sandstone, locally contains conglomeratic lenses, feldspar, and silicified logs; thickness 100–130 ft*

Kkf — **Fruitland Formation and Kirtland Shale, undivided**—*Black, gray, and olive-drab shale with interbedded, gray to buff, poorly sorted sandstone; abundant wood fragments; thickness 100 ft*

Kl — **Lewis Shale**—*Gray, brown, and black shale with minor fine-grained sandstone, finely crystalline limestone, and fossiliferous limestone; thickness 1,500 ft*

Kmv — **Mesaverde Group**—*Consists of three units in ascending order: tan, fine-grained sandstone with salt and pepper appearance; gray and black shale with interbedded, carbonaceous shale, coal, and ironstone; tan, medium-grained sandstone with salt and pepper appearance; thickness 500 ft*

Km — **Mancos Shale**—*Dark-gray and black shale with thin beds of finely crystalline limestone and calcareous sandstone; local limestone concretions; thickness 2,000 ft*

Kd — **Dakota Formation**—*Consists of three units in ascending order: buff, medium-grained, carbonaceous sandstone; dark-gray, carbonaceous shale and thin beds of fine-grained sandstone; yellowish-tan, fine-grained sandstone; thickness 130 ft*

Jm — **Morrison Formation**—*Consists of four units in ascending order: maroon-brown siltstone, sandstone, and shale; olive-tan, arkosic sandstone and interbedded green shale; green and brick-red mudstone with gray sandstone and minor nodular limestone; white sandstone, locally arkosic, conglomeratic, kaolinitic; thickness 750–800 ft*

Jt — **Todilto Formation**—*Basal, gray-brown, laminated limestone approximately 8 ft thick, overlain by massive crystalline gypsum; total thickness 100-150 ft*

Je — **Entrada Sandstone**—*Yellow to white, fine-grained, crossbedded sandstone; maximum thickness approximately 170 ft*

Ꞧu — **Upper shale member of Chinle Formation**—*Red, green, and purple shale with interbedded siltstone and argillaceous sandstone; thickness approximately 560 ft with the lower 175 ft exposed in this quadrangle*

Ꞧp — **Poleo Sandstone Lentil of Chinle Formation**—*Yellow-gray, fine-grained sandstone, locally micaceous, conglomeratic; thickness 80 ft*

Ꞧas — **Agua Zarca Sandstone Member–Salitral Shale Tongue of Chinle Formation**—*Purple-maroon shale with lenses of buff, poorly sorted, crossbedded sandstone; thickness 100 ft*

Py — **Yeso Formation**—*Orange-tan, well-sorted, crossbedded sandstone; thickness 160–170 ft*

Pa — **Abo Formation**—*Red-maroon, silty shale with interbedded, lenticular, arkosic sandstone, conglomerate, and nodular limestone; thickness 1,600–1,800 ft*

ℙm — **Madera Formation**—*Interbedded, gray, coarsely crystalline, fossiliferous limestone, arkosic sandstone, red shale, and arkosic limestone; basal, white, coarse-grained sandstone; thickness 0–1,775 ft*

Map — **Arroyo Peñasco Formation**—*Gray, fine-grained, cherty limestone with minor interbedded shale and fine-grained sandstone; basal coarse-grained sandstone; thickness 120 ft*

p€md — **Mafic dikes**—*Dark-green, fine- to medium-grained; composed of hornblende and plagioclase with minor quartz, pyrite, and magnetite*

p€ad — **Aplite dikes**—*Pink, fine-grained, saccharoidal; composed of quartz, microcline, plagioclase, and minor biotite*

p€g — **Gneiss**—*Pink to gray, poorly to well-foliated, medium- to coarse-grained, granite to granodiorite gneiss*

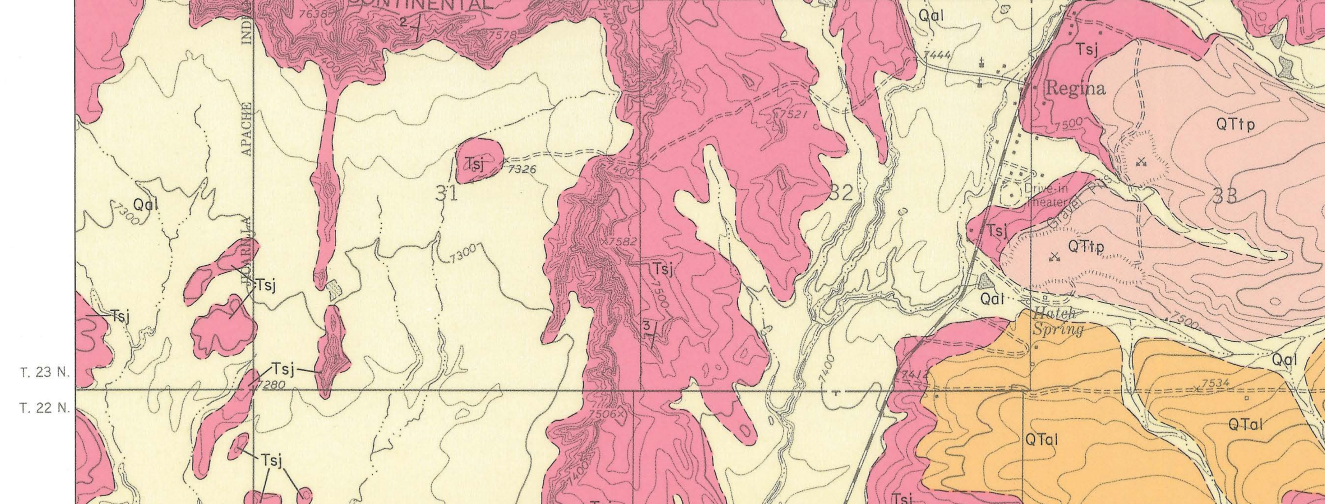
p€m — **Mafic metavolcanic rocks**—*Dark-green, fine- to medium-grained, poorly foliated; composed of chlorite, plagioclase, quartz, pyrite, epidote, and calcite*

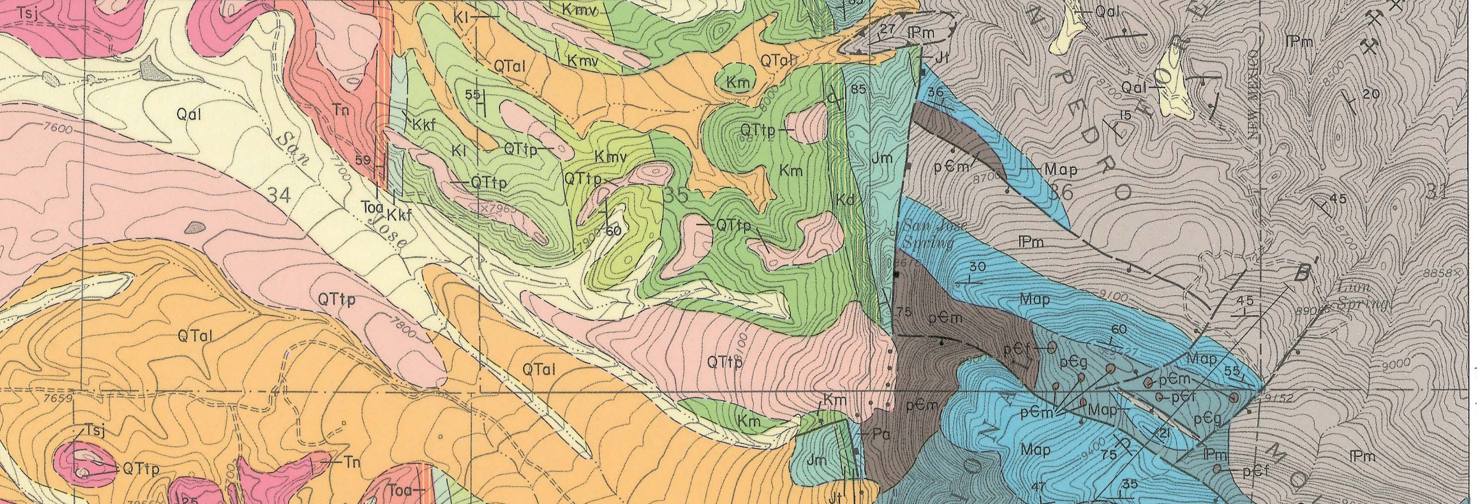
p€f — **Felsic metavolcanic rocks**—*Pink, fine- to medium-grained, poorly foliated; rhyodacite to dacite*

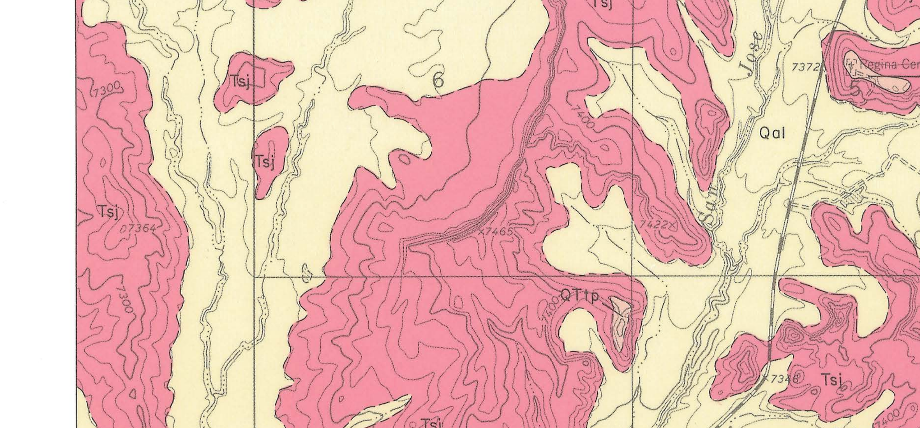
p€s — **Metasedimentary rocks**—*Fine-grained, foliated, meta-feldspathic graywacke, meta-lithic arkose, meta-quartz wacke*

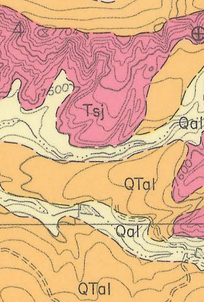
MAP SYMBOLS

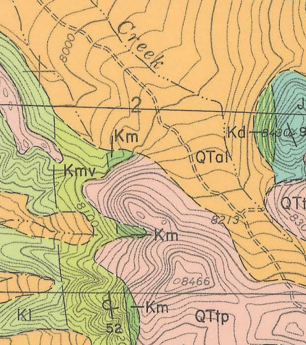
- Prospect pit
- Gas well
- Dry well
- Reverse fault, *dashed where approximately located, dotted where concealed, block on upthrown side*
- High-angle fault, *dashed where approximately located, ball on downthrown side; D, down, U, up*
- Gravity slide, *teeth on upper plate*



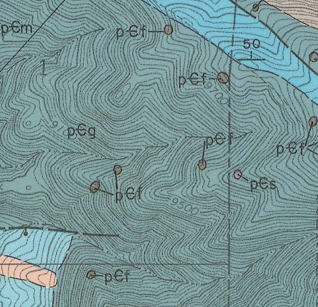








Major tectonic features of Regina quadrangle.



INDEX MAP OF NEW MEXICO

REFERENCES

Baltz, E. H., 1967, Stratigraphy and regional tectonic implications of part of Upper Cretaceous and Tertiary rocks, east-central San Juan Basin, New Mexico: U.S. Geological Survey, Prof. Paper 552, 101 p.

Brookins, D. G., 1974, Summary of recent Rb-Sr age determinations from Precambrian rocks of north-central New Mexico: New Mexico Geological Society, Guidebook 24th field conference, p. 119–121

Chenoweth, W. L., 1974, Uranium occurrences of the Nacimiento–Jemez region, Sandoval and Rio Arriba Counties, New Mexico: New Mexico Geological Society, Guidebook 25th field conference, p. 309–313

DuChene, H. R., Kues, B. S., and Woodward, L. A., 1977, Osha Canyon Formation (Pennsylvanian), a new unit of Morrowan age in north-central New Mexico: American Association of Petroleum Geologists, Bull., v. 61, p. 1,513–1,522

Hutson, O. C., 1958, Geology of the northern end of the San Pedro Mountains, Rio Arriba County, New Mexico: M.S. thesis, University of New Mexico, 55 p.

Merrick, M.A., 1980, Geology of the eastern half of the Regina quadrangle, Sandoval and Rio Arriba Counties, New Mexico: M.S. thesis, University of New Mexico, 91 p.

Renick, B. C., 1931, Geology and ground-water resources of western Sandoval County, New Mexico: U.S. Geological Survey, Water-Supply Paper 620, 117 p.

Santos, E. S., Hall, R. B., and Weisner, R. C., 1975, Mineral resources of the San Pedro Park Wilderness and vicinity, Rio Arriba and Sandoval Counties, New Mexico: U.S. Geological Survey, Bull. 1385-C, p. C14–C19

Wood, G. H., and Northrop, S. A., 1946, Geology of the Nacimiento Mountains, San Pedro Mountain, and adjacent plateaus in parts of Sandoval and Rio Arriba Counties, New Mexico: U.S. Geological Survey, Oil and Gas Inv., Prelim. Map 57, scale 1:95,040

Woodward, L. A., McLelland, D., Anderson, J. B., and Kaufman, W. H., 1972, Geologic map and section of Cuba quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geol. Map 25, scale 1:24,000

Woodward, L. A., Kaufman, W. H., and Schumacher, O. L., 1974, Sandstone copper deposits of the Nacimiento region, New Mexico: New Mexico Geological Society, Guidebook 24th field conference, p. 295–299

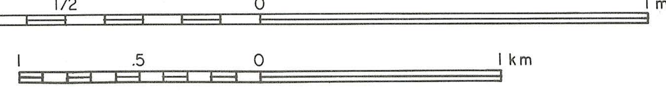
Woodward, L. A., Gibson, G. G., and McLelland, D., 1976, Geology of Gallina Quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geol. Map 39, scale 1:24,000

Geology of Regina quadrangle, Rio Arriba and Sandoval Counties, New Mexico

by Margaret A. Merrick and Lee A. Woodward

1982

scale 1:24,000



PREVIOUS AND PRESENT WORK

The Regina quadrangle is located in Rio Arriba and Sandoval Counties in north-central New Mexico. The two major tectonic features in the quadrangle are the San Juan Basin on the west and the Nacimiento uplift on the east. Reconnaissance maps by Renick (1931) and Wood and Northrop (1946) included the Regina quadrangle; a reconnaissance map by Baltz (1967) covered the western part of the quadrangle. The northeast part of the quadrangle was included in a thesis by Hutson (1958). Merrick mapped the east half of the quadrangle and Woodward mapped the west half. The mapping by Merrick was part of an M.S. thesis (1980) under the supervision of Woodward.

ROCK UNITS

Metasedimentary and metavolcanic rocks in the eastern part of the quadrangle were intruded by gneissic granites to granodiorites that subsequently were intruded by mafic and leucocratic dikes. Brookins (1974) reported a radiometric date of 1,840 ± 170 m.y. for leucogranodiorite of gneissic appearance that intrudes tonalite in the southeast part of the Regina quadrangle. Brookins (1974) did not give a precise location for the dated rock, but it probably is from an aplite dike; on the basis of this date we have assigned the Precambrian rocks of this quadrangle to the middle Precambrian (Precambrian X of the Geologic Names Committee, U.S. Geological Survey).

The Precambrian rocks in this quadrangle were mapped in greater detail than were those in the quadrangles to the east (Gallina quadrangle; Woodward and others, 1976) and to the south (Cuba quadrangle; Woodward and others, 1972); therefore, there are some differences in mapping Precambrian rock units where these quadrangles adjoin the Regina quadrangle.

Mississippian strata (*Map*) are present only locally, because much of the area was uplifted and eroded prior to deposition of Pennsylvanian rocks (ℙ*m*). Pennsylvanian strata also are present only locally because the area to the south and southeast was positive during Pennsylvanian time (DuChene and others, 1977); the Permian Abo Formation (*Pa*) rests directly on Precambrian rocks in the southeast part of the quadrangle. Thus, Mississippian, Pennsylvanian, and Permian strata rest directly on Precambrian rocks in different parts of the Regina quadrangle.

The upper contact of the Madera with the Abo Formation was placed at the top of the stratigraphically highest thick limestone bed containing marine fossils of Pennsylvanian age. Lateral intertonguing between the Madera and the Abo occurs where the uppermost limestone beds of the Madera pinch out toward the east. Thus, the Madera–Abo contact is stratigraphically lower in the Gallina quadrangle to the east.

Strata in the lower part of the Chinle Formation were mapped as Agua Zarca Sandstone Member–Salitral Shale Tongue (undivided) because this interval is composed of intercalated shale and sandstone with laterally discontinuous, conglomeratic sandstone lenses at various horizons, rather than basal, whitish sandstone (Agua Zarca) overlain by maroon shale (Salitral).

The upper part of the Morrison Formation (Jurassic) in the Regina quadrangle is lithologically identical to the Jackpile sandstone of economic usage in the Grants mineral belt and can be traced continuously in the surface and subsurface from the type area to the Regina quadrangle. Some workers in the Chama Basin have suggested that the Burro Canyon Formation (Early Cretaceous) occurs between the Morrison and Dakota Formations (Cretaceous) of northern New Mexico and extends into the Regina area. Because the Burro Canyon has the same lithology as the Jackpile, it is impossible to map these units separately. In view of the demonstrated lateral continuity of the Jackpile in this region, we prefer to include Jackpile sandstone strata below the Dakota Formation in the Morrison rather than arbitrarily choosing a contact separating the lithologically identical Jackpile from the supposed Burro Canyon.

STRUCTURE

Precambrian deformation

Gneiss (*p€g*), interpreted to be of igneous origin, was intruded into the protoliths of the metasedimentary (*p€s*) and metavolcanic (*p€f* and *p€m*) rocks. All of these rocks have undergone low-grade, regional synkinematic metamorphism. The youngest episode of Precambrian deformation involved emplacement of mafic and aplitic dikes, probably by dilation.

Paleozoic deformation

Following deposition of the Arroyo Peñasco Formation during the Mississippian, high-angle faulting resulted in the erosion of the Arroyo Peñasco from the upthrown blocks. Such a fault occurs in NE¼ sec. 1, T. 22 N., R. 1 W., where Mississippian rocks, present on the northwest side of the fault, are missing to the southeast. Pennsylvanian strata (ℙ*m*) occur on both sides of the fault, indicating that the fault occurred prior to deposition and had renewed movement after deposition, probably in the Cenozoic.

Isopach maps by Wood and Northrop (1946) show that the Nacimiento area was a positive structural element during Pennsylvanian time. Our mapping indicates that the Regina quadrangle lies along the northwest corner of the Pennsylvanian high, because Pennsylvanian strata, present in the northern part of the quadrangle, are missing in the southeast part where Permian beds (*Pa*) rest directly on Precambrian rocks.

Cenozoic deformation

The major tectonic features of this quadrangle, the Nacimiento uplift and San Juan Basin, began to form during the early Cenozoic and probably underwent rejuvenation during the late Cenozoic. Maximum structural relief between the Nacimiento uplift and San Juan Basin is approximately 11,000 ft. The high-angle, reverse Nacimiento fault separates the uplift from the basin and cuts a monocline that also marks the northwest corner of the uplift. The Nacimiento fault has up to 3,000 ft of stratigraphic separation in this quadrangle. Northwest- and northeast-trending high-angle faults that cut the uplift and adjacent part of the basin probably formed during Cenozoic uplifting. Where the Nacimiento fault curves toward the northeast along the northern end of the uplift, a normal fault splays northward; these two faults define a small graben that formed in response to stretching along the anticlinal bend of the monocline. A small gravity-slide plate of Madera Formation (ℙ*m*) in NW¼ sec. 36, T. 23 N., R. 1 W. probably is due to downslope movement of competent rock from the uplift.

MINERAL RESOURCES

Numerous small, sandstone copper prospects occur in the Abo (*Pa*) and Madera (ℙ*m*) Formations where carbonaceous plant remains and minor copper sulfides are surrounded by halos of malachite and chrysocolla. The genesis of these deposits has been discussed by Woodward and others (1974).

Minor uranium mineralization is present in the Regina quadrangle in the Madera, Abo, and San Jose Formations. Santos and others (1975) reported that in 1956, 20 tons of ore that assayed 0.03 percent U_3O_8 and 0.06 percent V_2O_5 were shipped from sec. 25, T. 23 N., R. 1 W., and 4 tons of ore that assayed 0.08 percent U_3O_8 were shipped from sec. 30, T. 23 N., R. 1 E. in 1954. In addition, a few truckloads of ore were produced from a small mine in sec. 19, T. 23 N., R. 1 E. (Hutson, 1958). Chenoweth (1974) reported an occurrence of possible meta-autunite in the mudstone of the San Jose Formation north of Regina.

Gypsum in the Todilto Formation (*Jt*) is exposed in hogbacks in secs. 24 and 26, T. 23 N., R. 1 W., but small tonnages, a low unit value, and distance from a market make these deposits uneconomic.

Thin seams of coal in the Mesaverde Group (*Kmv*) have been mined on a small scale, presumably for local use. Steep dip of the Mesaverde, thinness of the coal seams, and the amount of overburden covering most of the Mesaverde subcrop make conventional mining uneconomic at this time.

The South Blanco gas field in the northwest corner of the Regina quadrangle produces from the Pictured Cliffs Sandstone (Upper Cretaceous), a unit that is present only in the subsurface in this quadrangle.

Terrace and pediment deposits (*QTtp*) have been mined extensively for aggregate. Clasts consist mostly of pebbles, cobbles, and boulders of Precambrian crystalline rocks.