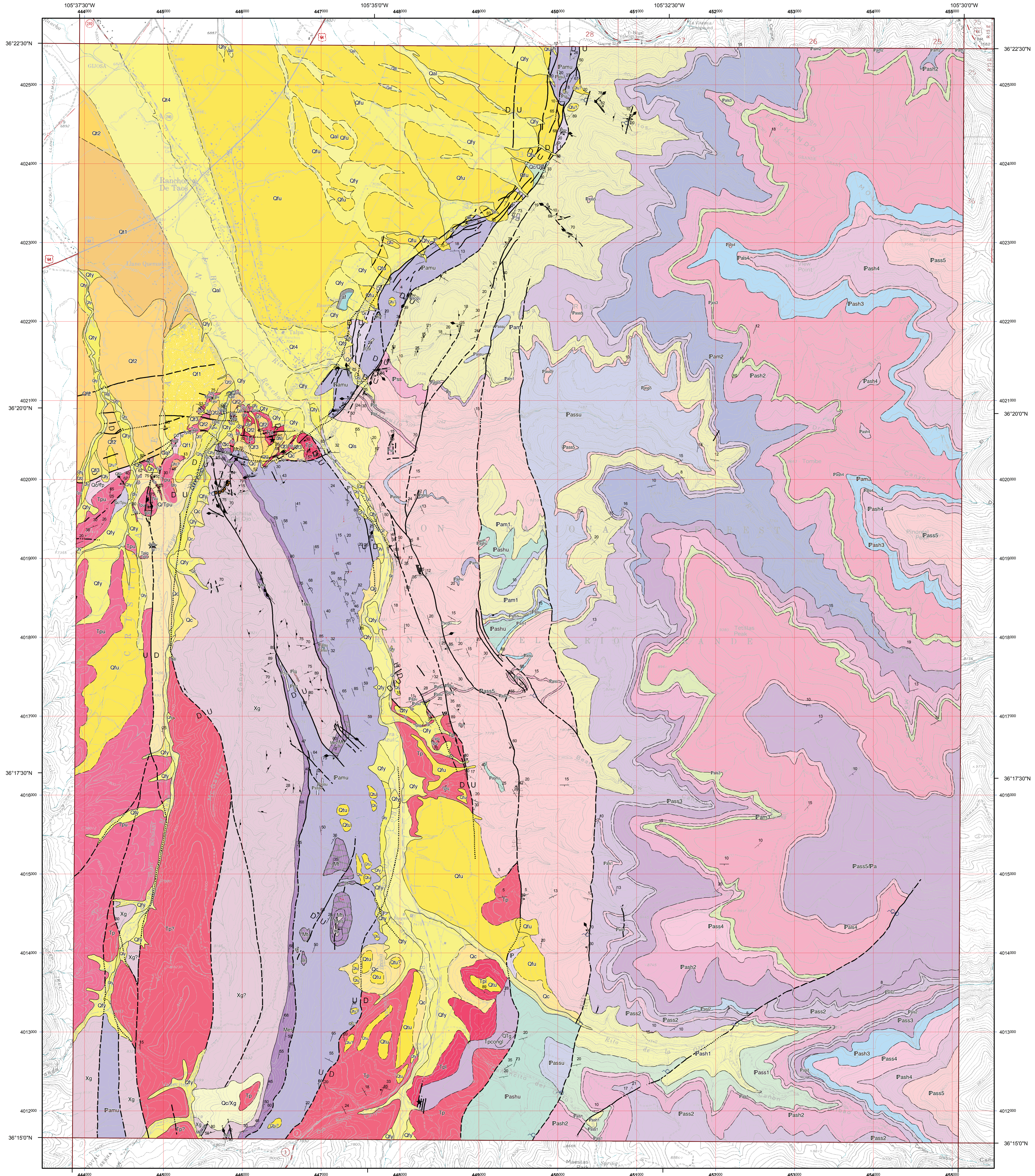
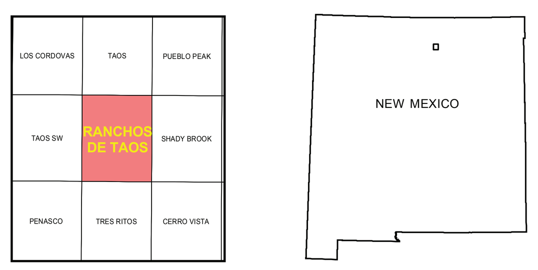
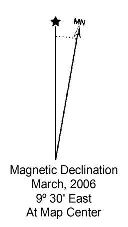


Base map from U.S. Geological Survey1964, from photographs taken 1961, field checked in 1964.
1927 North American datum, UTM projection -- zone 13N
1000-meter Universal Transverse Mercator grid, zone 13, shown in red

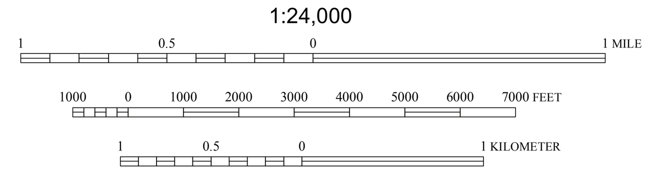


QUADRANGLE LOCATION



Magnetic Declination
March, 2006
9º 30' East
At Map Center

1:24,000



CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

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

New Mexico Bureau of Geology and Mineral Resources
Open-file Map Series
OFGM 33

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act, administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (Dr. Peter A. Scholle, *Director and State Geologist*, Dr. J. Michael Timmons, *Geologic Mapping Program Manager*).

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
801 Leroy Place
Socorro, New Mexico
87801-4796

[505] 835-5490
http://geoinfo.nmt.edu

This and other STATEMAP quadrangles are (or soon will be) available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu/publications/maps/geologic/ofgm/home.html

Geologic map of the Ranchos de Taos quadrangle, Taos County, New Mexico.

May 2000

by
Paul Bauer [1], Keith Kelson[2], J. Lyman[3], M. Heynecamp[1], and Dave McCraw[1]

[1] *NMBGMR, 801 Leroy Pl., Socorro, NM, 87801*
[2] *William Lettis and Assoc., 1777 Botelho, Walnut Creek, CA 94596*
[3] *Department of Earth and Environmental Sciences, New Mexico Tech, Socorro, NM, 87801*

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.

Unit Descriptions for Taos Area Geologic Quadrangle Maps
(Carson, Taos SW, Ranchos de Taos, Taos, Los Cordovas Quads)

Paul W. Bauer and Keith I. Kelson
July 2003

Cenozoic Deposits

Af **Artificial fill and disturbed ground (Recent)** - Poorly sorted sand, silt and pebbles, primarily associated with drainage control and storage facilities along piedmont east of Taos.

Qal **Stream channel and valley-floor alluvium, and active floodplains (Holocene)** - Poorly to well-sorted, poorly sorted sand, pebbles, and boulders; clasts primarily of quartzite and slate in the *Carson* and *Taos SW* quadrangles, clasts of granitic, metamorphic, volcanic, and sandstone rock types in the *Taos*, *Ranchos de Taos*, and *Los Cordovas* quadrangles; with clasts along Rio Lucero dominated by granitic lithologies and quartzite; clasts along Rio Pueblo de Taos dominated by granitic, quartzite, and sandstone lithologies; clasts south and east of Rio Pueblo de Taos dominated by sandstone and other sedimentary rock types.

Qc ***(Taos)*: Colluvial mantle on slopes, undifferentiated (middle Pleistocene to Holocene)** - Poorly-sorted sand, pebbles and boulders; prevalent along bases of mountain-front facets; north of Rio Pueblo de Taos dominated by granitic lithologies and quartzite; south of Rio Pueblo de Taos dominated by sandstone and pebble conglomerate with minor limestone clasts; not shown in Rio Pueblo de Taos gorge in *Carson* and *Taos SW* quadrangles.

Qm **Marsh deposits (Holocene)** - Silt, sand and clay in low relief, saturated flatlands; probable high organic content; primarily between Highway 64 and Taos Pueblo, bordering Rio Lucero.

Qp **Playa deposits (Holocene and latest Pliestocene)** - Small playa deposits located on Quaternary landslide deposits along the northern canyon of the Rio Grande generally downstream of the village of Pilar.

Qe **Eolian deposits (late Pleistocene to Holocene)** - Poorly to well-sorted sand and silt occurring primarily as a mantle or blanket; locally contains pebbles of basalt and intermediate volcanic rock types; predominant wind direction from southwest; where unit *Qe* mantles units *Tb*, *Qt1rg*, and *Qt2rg*, shown as units *Qe/Tb*, *Qe/Qt1rg*, and *Qe/Qt2rg*, respectively.

Qtr **Travertine deposits (late Pleistocene to Holocene)** - Small travertine deposits that are located along faults. Travertine probably formed along now-extinct springs.

Qls **Landslide deposit (late Pleistocene to Holocene)** - Poorly sorted sand to boulders, includes large rotational slide blocks within the Rio Grande and Rio Pueblo de Taos gorges, which involve large, rotated and detached beds of Servilleta Basalt (*Tb*).

Qfy Qty **Young alluvial-fan and stream terrace deposits (late Pleistocene to Holocene)** - Poorly sorted silt, sand, pebbles, and boulders; stage I to II calcium carbonate development; clasts primarily of quartzite, slate, schist, granite, and volcanic rock types; includes unit *Qt6* of Kelson (1986).

Qf4 Qt4 **Alluvial-fan and stream terrace deposits (late Pleistocene)** - Poorly sorted silt, sand, pebbles, and boulders; associated soils have stage III calcium carbonate development, argillic Bt soil horizons and 10YR to 7.5YR hues in Bt horizons; clasts primarily of granitic and metamorphic rocks north of Rio Pueblo de Taos, and granitic, metamorphic, and sedimentary rock types south of Rio Pueblo de Taos; clasts also include basaltic rock types along Arroyo Seco and along Rio Pueblo de Taos downstream of Los Cordovas; modified from Kelson (1986).

Qf3 Qt3 **Alluvial - fan and stream terrace deposits (middle to Late Pleistocene)** - Poorly sorted silt, sand, pebbles, and boulders; stage II to III calcium carbonate development; clasts primarily of quartzite, slate, and schist; granitic clasts also present east of Arroyo del Alamo; possible *Qt3* remnant inset into terrace *Qt2* on western side of Taos may be artificial terrace related to residential development; modified from Kelson (1986).

Qf2 Qt2 **Alluvial-fan and stream terrace deposits flanking Rio Pueblo de Taos and tributaries (middle Pleistocene)** - Poorly sorted silt, sand, pebbles, and boulders; clasts primarily of granitic, metamorphic, volcanic, and sedimentary rocks; associated soils have stage III to IV calcium carbonate development, thick argillic Bt soil horizons, and 7.5YR to 10YR hues in soil Bt horizons; upper soil horizons may be affected by surface erosion; modified from Kelson (1986).

Qt2rg **Stream terrace deposits flanking Rio Grande (middle Pleistocene)** - Poorly sorted silt, sand, pebbles, and boulders; clasts primarily of granitic, metamorphic, intermediate volcanic, basalt, and sedimentary rocks; locally may contain clasts of Tertiary Amalia Tuff; associated soils have stage III to IV calcium carbonate development, thick argillic Bt soil horizons, and 7.5YR to 10YR hues in soil Bt horizons; upper soil horizons may be affected by surface erosion; may be mantled locally by unit *Qe*; modified from Kelson (1986).

Qf1 **Alluvial-fan deposits (middle Pleistocene)** - Poorly sorted silt, sand, pebbles, and boulders; stage III to IV calcium carbonate development, although soil horizons are commonly affected by surface erosion; clasts primarily of quartzite, slate, and schist; granitic clasts also present east of Arroyo del Alamo; finer grained to the north, away from the Picuris Mountains range front; in Taos SW quadrangle, ash probably within Qf1 deposits at locality near Stakeout Road dated at 1.27 ± 0.02 Ma ($^{40}Ar/^{39}Ar$ method, W. McIntosh, *personal communication*, 1996); in *Los Cordovas* quadrangle, clasts primarily of granitic, intermediate volcanic, basalt, and metamorphic rock types; in *Los Cordovas* quad, *Qf1* is correlative with Unit *Q1p* of Kelson (1986); *Qf1* surface on the *Los Cordovas* quadrangle is dissected by numerous southwesterly-trending arroyos; deposit is more than 12 m thick in northeastern part of quadrangle, and is thinner from northeast to southwest; directly southwest of Taos Municipal Airport, *Qf1* deposit is less than about 1 m thick and unconformably overlies unit *Tb*. Elsewhere, *Qf1* appears to overlie unit *QTbh* or unit *Tb*; in *Taos* quadrangle, clasts primarily of granitic and metamorphic rock types; slope of *Qf1* surface on the *Taos* quad is southwesterly, and is dissected by numerous southwesterly-trending arroyos; deposit is more than 12 m thick in northwestern part of quad, and is thinner from northeast to southwest; on Blueberry Hill, *Qf1* deposit is about 3 m thick at Highway 64, but is thinner (about 2 m) to the southwest, where it unconformably overlies unit *Qtbh*; *Qf1* is differentiated from *QTbh* by larger clast size (Kelson, 1986), less oxidation, poor sorting, absence of abundant manganese oxide staining, and clasts that are less weathered.

Qfo **Older alluvial-fan deposits (early? to middle Pleistocene)** - Poorly sorted silt, sand, pebbles, and boulders; clasts primarily of quartzite, slate, and schist; fan surface is highly dissected and eroded, soil characteristics unknown; on Pilar Mesa in *Carson* quadrangle, deposit is dominated by slate pebbles and cobbles.

Qfu **Undifferentiated alluvial fan deposits (middle to late Pleistocene)** - Probably correlative with units *Qf1* through *Qf4*, poorly sorted silt, sand, pebbles, and cobbles; mapped along majority of Sangre de Cristo range front, but nor correlated to other fan units because of lack of well-defined age control or distinct lithologic characteristics.

Qtu **Undifferentiated stream terrace deposits (middle to late Pleistocene)** - Probably correlative with units *Qt1* through *Qt4*, poorly sorted silt, sand, pebbles and boulders; mapped in *Taos* quad only locally at mouth of Rio Pueblo de Taos near Taos Pueblo, and at the mouth of the Rio Fernando.

Qt1rg **Fluvial gravel deposited by ancestral Rio Grande (early to middle? Pleistocene)** - Poorly sorted sand, pebbles, and cobbles; clasts of basalt, quartzite, slate, schist, other metamorphic rock types, other volcanic rock types, and (rarely) sandstone and limestone; overlies Tb north of Pilar Mesa, but is inset into *Tb* on Pilar Mesa in Carson quadrangle; locally may contain clasts of Tertiary Amalia Tuff; where preserved, associated relict soils have stage III to IV calcium carbonate development, thick argillic Bt soil horizons, and 7.5YR to 10YR hues in soil Bt horizons; upper soil horizons commonly affected by surface erosion; may be mantled locally by unit *Qe*.

QTbh **Blueberry Hill deposit (late Tertiary? to middle Pleistocene)** - Poorly sorted silt, sand and pebbles; commonly cross-bedded, and stained with black manganese oxide and yellowish-orange iron oxide coatings; oxidized; clasts are weathered or grussified; contains distinct discontinuous sandy interbeds; clasts are granitic rock types, quartzite, metamorphic rock types, volcanic rock types and rare sandstone; commonly crudely imbricated; imbrication suggests southwesterly flow direction in areas south and east of Taos Municipal Airport; westerly flow direction in area north of Taos Municipal Airport; northwesterly flow direction in area southeast of Rio Pueblo de Taos; based on exposures at southwestern end of Blueberry Hill, unit thickness exceeds 25 m and may be considerably more; deposit may interfinger with unit *Qt1rg* in northwestern part of *Los Cordovas* quadrangle (relationship unknown); deposit overlies or is inset into unit *Tb* in southern part of quadrangle. Unit also referred to as "Basin Fill deposit" by Kelson (1986).

TQg ***(Carson)*: Older alluvium (Pliocene and early Pleistocene)** - Poorly sorted sand and gravel deposits, preserved as remnant gravel on ridge tops and hill tops, commonly composed of large, rounded to subrounded quartzite boulders up to several meters in diameter; in *Carson* quadrangle, present on high erosional surfaces, and along the Pilar-Vadito fault; maximum thickness unknown but at least 10 m.

Tertiary Rocks

Tr **Rhyodacite cone of Tres Orejas (Pliocene)** - Dark, phenocryst-poor, locally flow layered rhyodacite that crops out in northern *Carson* Quadrangle. Phenocrysts of augite and hypersthene are sparse and small; SiO_2 is 62-64% (Lipman and Mehnert, 1979). Uppermost *Tb* flows locally overlap the flanks of Tres Orejas. Older *Tb* flows lie below rhyodacite volcanoes elsewhere on the Taos Plateau, so rhyodacite and olivine basalt (Tb) eruptions overlapped in time. $^{40}Ar/^{39}Ar$ ages from pyroxene dacites of Tres Orejas are 4.84 ± 0.02 Ma (Appelt, 1998).

Tb ***(Carson and Taos SW)*: Servilleta Formation, basalt (Pliocene)** - Dark-gray, diktytaxitic olivine tholeiite which forms thin, fluid, widespread pahoehoe basalt flows of the Taos Plateau volcanic field. These flows commonly form columnar-jointed cliffs in the Rio Grande Gorge. Tabular plagioclase and sparse olivine are the only phenocrysts. Individual flows, which are up to 12 m thick, are grouped into packages of from one to ten flows. These packages are separated by 0.3-4.5 m thick sedimentary intervals (Leininger, 1982). The mesa east of Pilar displays four basalt flows north of the Embudo fault and only one flow south of the fault. Five central volcanic vents to the north are sources for the Servilleta Formation (Lipman and Mehnert, 1979). $^{40}Ar/^{39}Ar$ ages from basalts exposed in the Rio Grande gorge range in age from 4.81 ± 0.03 Ma for the lowest basalt near the Gorge Bridge, to 3.12 ± 0.13 Ma for the highest basalt flow at the Gorge Bridge (Appelt, 1998).

***(Los Cordovas)*: Basalt (Pliocene)** - Primarily Servilleta Basalt of Peterson (1984). Along western edge of quadrangle, may include other Tertiary basaltic rocks derived from Tres Orejas, west of the *Los Cordovas* quadrangle. In addition to source vents to the north identified by previous workers (Lipman et al., 1979; Peterson 1984; Dungan et al., 1984), newly postulated source vents are located near Taos Municipal Airport (N4034125, E0439650), within Taos Pueblo Tract A (N4033850, E0437550), and in the northeastern part of the *Tres Orejas* quadrangle (N4036350, E0432475). $^{40}Ar/^{39}Ar$ ages from basalts exposed in the Rio Grande gorge range in age from 4.81 ± 0.03 Ma for the lowest basalt near the Gorge Bridge, to 3.12 ± 0.13 Ma for the highest basalt flow at the Gorge Bridge (Appelt, 1998).

***(Ranchos de Taos and Taos)*: Servilleta Formation, basalt (Pliocene)** - *In cross section only*. Dark-gray, diktytaxitic olivine tholeiite, which forms thin, fluid, widespread pahoehoe basalt flows of the Taos Plateau volcanic field. These flows commonly form columnar-jointed cliffs in the Rio Grande Gorge. Tabular plagioclase and sparse olivine are the only phenocrysts. Individual flows, which are up to 12 m thick, are grouped into packages of from one to ten flows. These packages are separated by 0.3-4.5 m thick sedimentary intervals (Leininger, 1982). Five central volcanic vents to the north are sources for the Servilleta Formation (Lipman and Mehnert, 1979). $^{40}Ar/^{39}Ar$ ages from basalts exposed in the Rio Grande gorge range in age from 4.81 ± 0.03 Ma for the lowest basalt near the Gorge Bridge, to 3.12 ± 0.13 Ma for the highest basalt flow at the Gorge Bridge (Appelt, 1998).

Tch **Chamita Formation of Santa Fe Group (Miocene and Pliocene)** - Composition ranges vertically. Lower section consists of buff-colored, moderate to poorly sorted sands with clasts of intermediate volcanic rock, quartzite, and other metamorphic rocks. Middle section contains fewer volcanic clasts and more metamorphic clasts. Upper section is devoid of volcanic clasts. Overall, unit coarsens upwards, and dips decrease from 30º NW at base to horizontal at top. Exposure just north of Pilar contains an internal angular unconformity of about 15º near top of exposure. Interfingering basal contact with Ojo Caliente Sandstone. Thickness about 230 m.

To ***(Carson, Taos SW, and Ranchos de Taos)*: Ojo Caliente Sandstone of Tesuque Fm of Santa Fe Group (Miocene)** - Buff to white, well-sorted eolian sandstone. Dominant grain size is fine sand. Abundant 1.3-5.0 cm thick brown $CaCO_3$ concretions. QFL proportions average 62% quartz, 28% feldspar, and 10% lithics. LvLsLm ratio averages 82% Lv, 8% Ls, and 10% Lm. Thin reddish-brown, finely laminated siltstone horizons are found locally. Tabular crossbeds are common, with sets over 4 m in height. Transport was from southwest to northeast. Deposited at 13-12 Ma (Steinpress, 1980). Best exposures are in roadcuts along NM-68, northeast of Pilar. About 250 m thick.

Tce **Chama-El Rito Member of Tesuque Fm of Santa Fe Group (Middle Miocene)** - Volcanic-rich, non-fossiliferous sandstone (50%) and conglomerate (42%), with minor mudrock interbeds (8%). Conglomerates are generally purplish to gray due to predominance of pebble-size Tertiary volcanic clasts. Sandstones are pinkish-gray to buff, poorly to moderately sorted, with highly variable grain size. Sandstones are transitional between arkoses and volcanic arenites. Siltstone and clayey siltstone beds are reddish-brown and generally less than 1 m thick. Sandstone QFL percentages average 39% quartz, 31% feldspar, and 30% lithics. LvLsLm percentage averages 80% volcanic lithics. White beds of calcareous, pyroclastic volcanic ash, less than 2 m thick, are found locally. Fluvial and alluvial sedimentary structures are common. Represents braided stream deposits on a distal alluvial fan derived from a volcanic terrain to the northeast. Lower part contains 10-m-thick weakly consolidate, coarse, cobble to boulder conglomerate composed of rounded, white to gray quartzite clasts (up to 2 m) and subordinate granite clasts. Age is about 18-14 Ma (Steinpress, 1980). Pinches out to the southeast. Thickness up to 480 m.

Tp **Picuris Formation, undivided (Oligocene)** - Light gray to pinkish gray, immature, pumice-rich conglomeratic sandstone.

Tpu ***(Ranchos de Taos and Taos SW)*: Picuris Formation, upper member (Oligocene)** - Light gray to pinkish gray, immature, pumice-rich, ashy, polylithologic, conglomeratic sandstone. Consists mainly of sandstones with gravel-sized clasts of pumice and silicic volcanic rocks (mostly 26 Ma Amalia Tuff), and minor Precambrian quartzite and intermediate composition volcanic rocks (including the Latir Peak quartz latite). Most of gravel-sized fraction is pumice, with some clasts up to 25 cm in diameter. Most clasts are rounded to well rounded. Imbrication of clasts is common, although bedding features are indistinct due to the homogeneous nature of lithology and grain size, and the weak induration. Mostly, unit is matrix cemented, with local minor silica cement. Poorly to well lithified. Contains layers and lenses of resistant, well cememted, cobble conglomerates interlayered with easily eroded, weakly cemented pebble conglomerates. Generally gray weathering. Paleoflow measurements indicate source to the north (Rehder, 1986). Total thickness of upper member is 200-250 m. Interpreted as an alluvial fan deposit derived from the Latir volcanic field at around 26 Ma (Rehder, 1986).

Tplq ***(Ranchos de Taos)*: Picuris Formation, Llano Quemado breccia member (Oligocene)** - Light gray to red, monolithologic volcanic breccia of distinctive extremely angular, poorly sorted, light-gray, recrystallized rhyolite clasts in a generally redddish matrix. Rhyolite clasts contain phenocrysts of biotite, sanidine, and quartz. Highly lithified, due to partial welding of the matrix rather than silica or carbonate cement. Ridge-former. Unit shows both clast and matrix support. Beds are generally 1-8 m thick. Clasts are up to 15 cm in diameter, and overall clast size decreases southward. Less than 1% of clasts are Proterozoic slate and weathered Tertiary volcanic rocks. 5-45 m thick. Described by Rehder (1986). New $^{40}Ar/^{39}Ar$ date on sanidine from a rhyolite clast from exposure 1 km southwest of Ponce de Leon spring is 28.35 ± 0.11 Ma. The breccia is interpreted as a series of flows from a now-buried, nearly rhyolite vent (Rehder, 1986).

Tpl ***(Ranchos de Taos)*: Picuris Formation, lower member (Oligocene)** - Boulder and cobble conglomerates and conglomeratic sandstones interbedded with thinly bedded sandstones. Boulder unit is distinctive, composed of well rounded, poorly sorted, mostly clast supported, Proterozoic quartzite clasts, with minor altered, intermediate Tertiary volcanics (Latir volcanics) and Paleozoic sedimentary rocks. The boulder unit grades (fines) upward to less indurated pebble conglomerate and conglomeratic sandstone, and variegated green, red, and white siltstone and claystone. Bedding is locally discontinuous, with multiple minor erosional unconformities. Carbonate cement is pervasive. Local layers of primary air fall ash that are well sorted, contain biotite crystals, and are yellow-gray to light olive brown, to gray-white.20-50 m thick. New $^{40}Ar/^{39}Ar$ ages of ashes from near Pete Tafoya's house and 1 km southwest of Ponce de Leon springs are 34.64 ± 0.16 Ma and 27.93 ± 0.08 Ma. Interpreted as a sequence of debris flow and alluvial fan deposits derived from Sangre de Cristo Mountains and Latir volcanic field to north and northeast (Rehder, 1986).

Tpa **Picuris Formation, andesite (Oligocene)** - Andesite porphyry exposed in small outcrop south of Llano Quemado in the Ranchos de Taos quadrangle.

Tpc ***(Carson and Taos SW)*: Picuris Formation, quartzite-boulder conglomerate (Oligocene)** - Weakly consolidate, coarse, cobble to boulder conglomerate composed of rounded, white to gray quartzite clasts (up to 2 m) and subordinate granite clasts. Poorly sorted and unstratified. Sand matrix.$^{40}Ar/^{39}Ar$ age of 34.5±1.2 Ma for a white ash adjacent to a conglomerate layer is a good estimate of the depositional age of the unit. Probably equivalent to a Picuris Formation quartzite conglomerate that is near a 34.6 Ma white ash in the *Ranchos de Taos* quadrangle. Equivalent to the Bradley Conglomerate of Leininger (1982). Estimated thickness is 450m (Leininger, 1982).

Paleozoic Rocks

IP ***(Taos)*: Undivided Pennsylvanian sedimentary rocks of the Alamitos Formation (late Desmoinesian) and Flechado Formation (Morrowan-Atokan-Desmoinesian)** - Consists chiefly of poorly exposed, olive, brown, red, and dark gray shale and siltstone plus fine- to coarse-grained sandstone with lesser amounts of conglomerate and limestone. Limestone (*IPlst*) is less than 1% of the formation. Distinctive, rounded quartz cobble conglomerate (*IPcon*) is less than 1% of the formation. Alamitos Formation is equivalent to the "upper arkosic limestone member" of the Madera Formation to the south. Flechado Formation is equivalent to La Posada Formation to the south, which is equivalent to the Sandia Formation and the "lower gray limestone member" of the Madera Formation. Fusilinids collected from the exposures southeast of Taos Pueblo are Desmoinesian in age (B. Allen, 2000, *personal communication*). In general, the volume of limestone decreases northward within the map area. Crossbeds examined in the *Taos* quad in coarse-grained sandstones all show a generally westward paleoflow. Thickness unknown, but a minimum of approximately 2000 m.

IPlst **Nodular/brecciated limestone of the Alamitos(?) Formation** - Bluish-gray, packestone with cross-cutting calcite veins. Contains fossils of fusilinids, crinoids, brachiopods, bryozoans, Rugose corals, and algae. Generally round-weathering outcrops. Fusilinids are Desmoinesian in age (B. Allen, 2000, *personal communication*). Interpreted as cyclic deposits in shallow, fully marine environment within the photic zone.

IPcq **Distinctive conglomerate** - Poorly sorted, clast-supported, thin, isolated beds of conglomerate containing 99% round quartzite pebbles (2-20 cm in diameter) with a fine-grained matrix. Ledge former. Discontinuous along strike due to channel- and lens-shapes. Occurs as isolated beds that range from 2-10 m in thickness.

IPa **Alamitos Formation (Pennsylvanian, late Desmoinesian)** - Consists chiefly of coarse-grained arkosic sandstone with lesser amounts of conglomerate, limestone, and gray and red shales. Grades upward from clastic-rich to limestone-rich. Equivalent to the "upper arkosic limestone member" of the Madera Formation to the south. Approximately 1200 m thick.

IPf **Flechado Formation (Pennsylvanian, Morrowan-Atokan-Desmoinesian)** - Thick sequence of olive, brown, and dark gray shales and siltstones, with low-feldspar sandstones and conglomerates. Limestone is only 5-10% of the formation. Equivalent to La Posada Formation to the south, which is equivalent to the Sandia Formation and the "lower gray limestone member" of the Madera Formation. Approximately 760 m thick.

Mt ***(Ranchos de Taos)*: Tererro Formation of Arroyo Penasco Group (Mississippian, Meramecian and Chesterian)** - Near Ponce de Leon springs, consists of 1-2 m of basal stromatilitic limy sandstone overlain by about 7 m of dolomitic limestone, overlain by about 12 m of calcitic dolomite with stromatilites and bedded and nodular chert (Armstrong and Mamet, 1990). Thickness is approximately 20 m.

Mes ***(Ranchos de Taos)*: Espiritu Santo Formation of Arroyo Penasco Group (Mississippian, Osagean)** - Consists of basal Del Padre Sandstone member of thin basal conglomerate, quartz sandstone, and minor limestone beds at top. Grades into overlying Tererro Formation. Upper, carbonate-rich part of Espiritu Santo Formation is mostly absent from the Ponce de Leon springs area.

Mdp ***(Taos SW)*: Del Padre member of Espiritu Santo Formation of Arroyo Penasco Group (Mississippian)** - Quartz sandstone, local quartzite conglomerate, siltstone, and shale. Interfingers with Espititu Santo Formation carbonates.

Proterozoic Rocks

dd ***(Carson)*: Dacite dike (age unknown, but probably Middle Proterozoic)** - Dark green-gray quartz diorite dikes intruded into Proterozoic rocks only. Dikes are vertical, with strikes clustered around an azimuth of 150º. Composed of pale green clinopyroxene (Cr-diopside?), zoned plagioclase (labradorite?), and minor quartz, magnetite, and ilmenite. Commonly altered to chlorite and clay. Pyroxene and feldspar show normal plutonic textures. Locally, dikes are laced with carbonate veins. Dikes are generally less than 1 m wide. Contacts between diorite and country rock are sharp and commonly contain zones of brecciation and faulting. Faults are sub-vertical with dip slip fault striations. Dikes are parallel to the Pilar-Vadito fault and other southeast-striking faults.

xxx **Pegmatite** - Simple pegmatites of quartz-K-feldspar-plagioclase-muscovite. Pegmatite bodies typically are dikes or lenses, locally aligned parallel to country rock foliation and fold hinges. Thicknesses range from a few centimeters to several meters.

Xmg **Miranda granite (informal name)** - East of the Picuris-Pecos fault. Generally consists of pink to white, medium-grained, mica-rich granitic rock with euhedral megacrysts of feldspar. These granitic rocks are everywhere weathered looking, fairly equigranular, and commonly crumbly. Appears to intrude the Rio Pueblo schist along southern contact. Pegmatites are locally voluminous. Contains at least one tectonic foliation. Three closely-spaced, orthogonal joint sets cause this rock to weather into small, angular blocks. Age unknown, but similar in occurrence and texture to the 1.6 Ga Tres Piedras Granite of east-central Tusas Mountains.

Xu **Undifferentiated Proterozoic** - Supracrustal metamorphic rocks and plutonic and metaplutonic rocks of the Taos Range.

Xhpl ***(Carson and Taos SW)*: Piedra Lumbre Formation, Hondo Group** - Exposed only in two small areas northeast of the Pilar-Vadito fault. Includes quartz-muscovite-biotite-garnet-staurolite phyllitic schist with characteristic sheen on crenulated cleavage surfaces, and finely laminated, light gray, phyllitic quartz-muscovite-biotite-garnet schist and darker bluish gray fine-grained biotite quartzite to metasiltstone. Euhedral garnets are 1 mm, biotite books are 2 mm, and scattered anhedral staurolites are up to 5 mm in diameter. Calc-silicate layers exist locally. Original sedimentary structures such as graded bedding are locally preserved. Contact with underlying Pilar Formation is gradational. Apparent thickness is 200-400 m.

Xhplq ***(Carson and Taos SW)*: Piedra Lumbre Formation quartzite, Hondo Group** - Massive to layered, light-colored, crossbedded micaceous quartzite. Locally garnet-bearing. Approximate thickness of 25 m.

Xhplp ***(Carson)*: Piedra Lumbre Formation phyllite, Hondo Group** - Dark gray to black, fine-grained, garnet-bearing phyllite. Crops out only in the core of the Hondo syncline east of the Pilar-Vadito fault.

Xhp ***(Carson and Taos SW)*: Pilar Formation, Hondo Group** - Exposed northeast of the Pilar-Vadito fault. Dark gray to black, carbonaceous phyllitic slate. Extremely fine-grained homogeneous rock except for rare 1- to 2-cm thick light colored bands of quartz and muscovite that may represent original sedimentary bedding. In thin section, fine-grained matrix consists of quartz (50-70%), muscovite (15-30%), and prominent streaky areas of graphitic material. Lenticular porphyroblasts (0.1 to 0.5 mm) are altered to yellow-brown limonite. Pervasive slaty cleavage is locally crenulated. Small isoclinal folds locally. Basal 1.5 m-thick, black to blue-black, medium-grained, garnet quartzite is distinctive. Garnets are anhedral, oxidized, and red-weathered. Gradational with *Hpl*. Thickness unknown due to extreme ductile deformation.

Xhr6 ***(Carson and Taos SW)*: Rinconada Formation, R6 schist member, Hondo Group** - Tan, gray, silver quartz-muscovite-biotite-staurolite-garnet schistose phyllite interlayered with fine-grained garnetiferous muscovite quartzite. Euhedral staurolites (<5 cm) abundant in some layers. Small euhedral garnets (<2 mm) throughout. Strong parting along well-developed foliation. Sharp contact with *Hp*. Thickness is approximately 90 m.

Xhr5 ***(Carson and Taos SW)*: Rinconada Formation, R5 quartzite member, Hondo Group** - Variety of white to blue medium-grained quartzites interlayered with fine-grained schistose quartzites and quartzose schists. Measured section by Hall (1988) from an area just to the south, from top to bottom: 1) tan to white, friable, thinly layered, crossbedded micaceous quartzite; 2) blue, medium-grained, thickly layered, resistant saccharoidal quartzite; locally crossbedded; 3) white to tan, friable schistose quartzite layered with blue, medium-grained saccharoidal quartzite; thin layers of fine-grained quartz-muscovite-biotite schist; basal 1.5 m massive blue medium-grained quartzite; 4) tan, thinly layered, micaceous quartzite layered with quartz-rich muscovite schist; abundant crossbedding; 5) blue and white streaked, thickly bedded, medium-grained quartzite with abundant crossbedding; and 6) tan, thinly layered, micaceous quartzite interlayered with quartz-rich quartz-muscovite schist; abundant crossbedding. Gradational contact with Hr6. Thickness is approximately 75 m.

Xhr4 ***(Carson and Taos SW)*: Rinconada Formation, R4 schist member, Hondo Group** - Medium- to coarse-grained, silvery gray, quartz-muscovite-biotite-staurolite-garnet schist containing one or more distinctive, 0.5-2.0 m thick, layers of glassy blue quartzite, rusty red weathering garnetiferous white quartzite, massive, extremely hard, red weathering, olive-brown biotite-staurolite-garnet-orthoamphibole rock, white, glassy, hornblende quartzite, gray biotite-hornblende calc-schist, mylonitic blue to pink and blue, glassy quartzite, and white to gray calcite marble. In this area, *Hr4* is a transitional sequence of interlayered schist and quartzite, making the contacts with *Hr3* and *Hr5* indistinct. Thicknesses range from 50-175 m.

Xhr3 ***(Carson and Taos SW)*: Rinconada Formation, R3 schist member, Hondo Group** - White, gray, bluish-green and blue, medium-grained, thinly to thickly bedded, resistant quartzite with abundant crossbeds (*Hr3q*). Locally includes two mappable layers of pelitic schist (*Hr3s*) that resemble *Hr4* and upper *Hr1/2*. Distinctive marker layer near center of unit is 25 m-thick, white, thinly bedded, ridge-forming quartzite. Sharp contact with *Hr4*. Thickness is approximately 75 m.

Xhr12 ***(Carson and Taos SW)*: Rinconada Formation, R1-R2 schist member, Hondo Group** - Lower unit of fine- to medium-grained, tan to silver, quartz-muscovite-biotite schist with small euhedral garnets (<2mm) and scattered euhedral staurolite twins (<1.5cm). Near base are black biotite books (<2cm). Locally contains andalusite porphyroblasts up to 8 cm across. Upper unit of gray to tan, red weathering, coarse-grained quartz-muscovite-biotite-staurolite-albite-garnet schist containing interlayers of 1-10 cm, red, gray, or tan weathering, fine-grained muscovite-garnet quartzite. Abundant staurolites are twinned, euhedral, up to 3 cm; abundant garnets are euhedral and small (<2mm). Strong parting along foliation plane. Sharp to gradational contact with *Hr3*. Lower and upper units have previously been subdivided into *R1* and *R2*, respectively, based on mineralogy (Nielsen, 1972). Thickness is approximately 265 m.

Xhr ***(Carson)*: Rinconada Formation, undivided, Hondo Group** - Undivided schists and quartzites near the Pilar-Vadito fault that are extensively fractured and faulted.

Xho ***(Carson and Taos SW)*: Ortega Formation, Hondo Group** - Gray to grayish-white, medium- to coarse-grained quartzite. Generally massive and highly resistant to weathering. Locally well-crossbedded, with kyanite- or sillimanite-concentrated in thin, schistose, muscovite-rich horizons. Crossbeds are defined by concentrations of black iron-oxide minerals. Common accessory minerals are ilmenite, hematite, tourmaline, epidote, muscovite, and zircon. Gradational contact with Rinconada Formation. Thickness is approximately 800-1200 m.

(Taos SW): Xh0r, Xh0w, Xh0s.

Xvg **Glenwoody Formation, Vadito Group** - Feldspathic quartz-muscovite schist and quartzose schist exposed in cliffs southwest of Pilar and locally along the northern flank of the Picuris Range on the west side of the Picuris-Pecos fault. White, light gray, pink, or green. Commonly contains megacrysts of feldspar and rounded and flattened quartz in a fine-grained matrix of quartz, muscovite and feldspar. Contact with overlying Ortega Formation is a south-dipping ductile shear zone. Pervasive extension lineation in schist plunges south. Upper 40 m of schist is pinkish, and contains anomalous manganese and rare earth elements, and unusual minerals such as piemontite, thulite, and Mn-andalusite (viridine). L.T. Silver reported a preliminary U-Pb zircon age of *ca.* 1700 Ma (Bauer and Pollock, 1993). May be equivalent to the *ca*. 1700 Ma Burned Mountain Formation of the Tusas Mountains. Probably equivalent to the Glenwoody Formation of the southeast Picuris Mountains. Base unexposed; minimum thickness is about 200 m.

Xrp ***(Taos SW)*: Rio Pueblo Schist, Vadito Group** - Feldspathic quartz-muscovite schist and quartzose schist exposed in isolated exposures in the southeast map area, on the east side of the Picuris-Pecos fault. White, light gray, pink, or green. Commonly contains megacrysts of feldspar and rounded and flattened quartz in a fine-grained matrix of quartz, muscovite and feldspar. Probably equivalent to the Glenwoody Formation of the northern Picuris Mountains. Thickness unknown.

Xa ***(Taos SW)*: Amphibolite** - Includes a variety of amphibolite bodies, lenses, and layers within the Miranda granite. The predominant rock type is fine- to medium-grained, dark gray-green to black, weakly foliated amphibolite composed of blue-green to olive-green hornblende, interstitial quartz and plagioclase, sphene, and epidote. Faint compositional layering is formed by 1-2 mm thick white layers. Epidote veins and zones are common.