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Digital layout and cartography by the NMBGMR Map Production Group: Phil L. Miller, Amy L. Dunn, Ann D. Knight, and Justine L. Nicolette

Open-File Geologic Map 294 he compilation of these six quadrangles was funded by a matching-funds grant from the STATEMAF ogram of the National Cooperative Geologic Mapping Act (Fund Number: G20AC00250), administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (I

105°40'0"W

Map of the Picuris Mount **Rio Arriba and Taos County, New Mexi Cross Sections**

November 2021

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105°32'30"W

105°35'0"W

105°37'30"W

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- deposits are poorly exposed, except in road cuts along the highway just north of Rinconada, where the deposits are arranged in thick, apparently tabular bodies with a range of compositions. 01-08-00-00-unit01-Qlb-Landslides of basalt-Landslide deposits containing intact blocks of Tertiary basalt flows and abundant, subangular to angular basalt blocks; mapped separately only on slopes below the Ocaté (Vadito) basalt (Tob). 01-09-00-00-unit01-Qe-Eolian deposits-Light-colored, well-sorted, fine- to medium-grained sand and silt deposits that are recognized as laterally extensive, lowrelief, sparsely vegetated, mostly inactive, sand dunes and sand sheets that overlie the Servilleta Basalt (Tsb) on the Taos Plateau; rare gravel lag; weak to moderate soil
- predominant wind direction was from the southwest; up to several meters thick. 01-10-00-00-unit01-Og-Alluvial and minor colluvial deposits a levels—Typically buff to brownish, rounded to well-rounded, crudely bedded, incemented, quartzite-rich conglomerate and sandy conglomerate; maximum clast 1 m but commonly about 60 cm; includes both primary Quaternary terrace ls and reworked deposits derived from them; mapped south of the Picuri nain types of Qg are present, one entirely dominated by quartzite Creek drainage (Trampas and Peñasco quadrangle); poorly exposed cludes multiple levels of closely spaced, small terrace remnants; estimated aximum thickness of about 10 m. 01-11-00-00-00-unit01-Qse-Slope wash and eolian deposits-Poorly exposed, light brown to tan, moderately well-sorted to moderately poorly sorted, massive(?) silt, fineto medium-grained sand, and rare pebble lenses/beds(?); overlies older rocks on Mesa de la Cejita (Velarde and Trampas quadrangles) and appears to be a combination of mostly reworked eolian material (silt and fine-grained sand) and locally derived, coarser material. 01-12-00-00-unit01-Qqg-Quartzite-rich alluvial and colluvial(?) deposits – Distinctive deposits composed of Proterozoic quartzite clasts from 2 m about 3 m in diameter, rare Pilar Formation (Ytp) slate clasts to about 7 cm, and extremely rare schist clasts to about 5 cm.

development; northeast-trending longitudinal dune-crest orientations indicate that the

- 01-13-00-00–00—heading02—Alluvial Fan Deposits—Alluvial Fan Deposits—Alluvial Fan Deposits 01-13-01-00-00—unit01—Qfy—Young alluvial fan deposits—Poorly sorted deposits of silt, sand, pebbles, cobbles, and boulders; deposits are typically clast-supported and poorly bedded; pebble and cobble clasts are typically imbricated; clasts consist primarily of sedimentary rocks, quartzite, slate, schist, metavolcanic rocks, granitic cks, and Tertiary granitic and volcanic units; uppermost sediments are commonly ty sand, probably overbank deposits; weak to moderate pedogenic development, ncluding A, Bw, Bwk and Bk soil horizons and Stage I to II calcium carbonate development; the terrace deposits of map unit Qty unconformably overlie the loca bedrock and are typically on valley floors of large to medium drainages, whereas Qf exists as young mountain-front fans and valley fill in small tributaries; up to 5 m thick. 01-13-02-00-00 – unit01 – Qfo – Alluvial fan deposits, undivided – Poorly sorted deposits of silt, sand, and pebbles; deposits are typically matrix-supported and poorly bedded; clasts consist primarily of Paleozoic sedimentary rocks and Proterozoi ranitic and metamorphic rock types; on Pilar Mesa the deposit is dominated by sla texture, and local vesicle pipes and segregation veins; forms thin, fluid, widespread pebbles and cobbles; between Arroyo del Alamo (Taos SW quadrangle) and Arroyo pahoehoe basalt flows of the Taos Plateau volcanic field erupted principally from large 03-02-03-01-00 – unit01 – Tc – Chamita Formation of the Santa Fe Group, ved on interfluves; moderate pedogenic development, including A, Bt, Btk ar horizons and Stage III and IV calcium carbonate development; upper sons are commonly affected by surface erosion; exists as mountain-front fa ably overlaps with units Qf2 through Qf4, but not assigned to o lack of well-defined age control, clear stratigraphic position, and distinct lithologic characteristics; up to 3 m thick. 01-13-03-00-00—unit01—Qf4—Alluvial fan deposits in canyons and arroyos—Poorl sorted silt, sand, pebbles, and boulders; clasts consist primarily of granitic and metamorphic rocks north of the Rio Pueblo de Taos (Taos SW quadrangle) and granitic, metamorphic and sedimentary rocks south of the Rio Pueblo de Taos; clasts also include basaltic rock types along the Arroyo Seco (Arroyo Seco, Taos, and Los Cordovas quadrangles) and along the Rio Pueblo de Taos downstream of Los Cordovas; associated soils have Stage III to IV calcium carbonate development and thick argillic Bt soil horizons with 7.5YR to 10YR hues; the upper soil horizons may b affected by surface erosion; modified from Kelson (1986); finer-grained to the north, away from the Picuris Mountains range front; grouped into unit Qfo northeast of the
- Rio Grande del Rancho (Ranchos de Taos quadrangle). 01-13-04-00-00—unit01—Qf3—Alluvial fan deposits in canyons and arroyos—Poorly sorted silt, sand, pebbles, and boulders; Stage II to III calcium carbonate developmen clasts consist primarily of quartzite, slate, and schist; granitic clasts also exist east of Arroyo del Alamo (Taos SW quadrangle). 01-13-05-00-00-unit01-Qf2-Alluvial fan deposits in canyons and arroyos-Poorly sorted silt, sand, pebbles, and boulders; clasts consist primarily of granitic and metamorphic rocks north of the Rio Pueblo de Taos (Taos SW guadrangle) and granitic, metamorphic and sedimentary rocks south of the Rio Pueblo de Taos; ssociated soils have Stage III to IV calcium carbonate development, thick argillic Bt soil horizons with 7.5YR to 10YR hues; upper soil horizons may be affected by surface rosion; modified from Kelson (1986); finer-grained to the north, away from the Picuris Mountains range front; grouped into unit Qfo northeast of the Rio Grande del Rancho (Ranchos de Taos and Tres Ritos quadrangles).
- 01-13-06-00-00-unit01-Qf1-Alluvial fan deposits in canyons and arroyos-Poorly sorted silt, sand, pebbles, and boulders; clasts consist primarily of quartzite, slate, and schist; granitic clasts are also present east of Arroyo del Alamo (Taos SW quadrangle); finer-grained to the north, away from the Picuris Mountains range front; Stage III to IV calcium carbonate development, although soil horizons are commonly affected by surface erosion; Qf1 is differentiated from the Lama formation of the Santa Fe Grou (QTI) by larger clast size (Kelson, 1986), less oxidation, poor sorting, absence of abundant manganese oxide staining, and clasts that are less weathered; ash probably within Qf1 deposits at locality near Stakeout Road (Ranchos de Taos quadrangle dated at 1.27 ± 0.02 Ma (40Ar/39Ar method, W. McIntosh, personal communication

1996); where exposed to the south the unit is up to 12 m thick.

surface erosion; modified from Kelson (1986); finer-grained to the north, away from

and schist; granitic clasts are also present east of Arroyo de

conly affected by surface erosion; where exposed to the south the unit is up to 12

calcium carbonate development, although soil hori[,]

as small remnants inset into Quaternary landslide deposits

rangle); finer-grained to the north, away from the Picuris

01-14-07-00-00—heading03—Terrace Deposits of the Rio Grande—Terrace Deposits of

01-14-07-01-00—unit01—Qtrg—Rio Grande terrace gravels—Pebble- to cobble-size

Formation (Xvg) clasts derived from the Pilar cliffs, just southwest of the village of

Pilar on the Carson quadrangle, and rounded cobbles of Servilleta Basalt (Tsb);

01-14-07-02-00—unit01—Qt2rg—Stream terrace deposits of the Rio Grande—Poorly

metamorphic, intermediate volcanic, basalt, and sedimentary rocks; locally clasts of

carbonate development, thick argillic Bt soil horizons, and 7.5YR to 10YR hues in soil

stone; overlies the Servilleta Basalt (Tsb) north of Pilar Mesa, but is inset into Tsb

n Pilar Mesa in the Carson quadrangle; locally may contain clasts of Tertiary Amalia

uff; where preserved, associated relict soils have Stage III to IV calcium carbonate

Bt horizons; upper soil horizons may be affected by surface erosion; may be mantled

Tertiary Amalia Tuff may be present; associated soils have Stage III to IV calcium

locally by unit Qe; modified from Kelson (1986); estimated at 1 to 10 m thick.

01-14-07-03-00—unit01—Qt1rg—Stream terrace deposits of the Rio Grande—Poorly

sorted sand, pebbles, and cobbles; clasts consist of basalt, quartzite, slate, schist and

other metamorphic rock types, volcanic rock types, and (rarely) sandstone and

01-14-07-04-00—unit01—Ot0rg—Stream gravel deposited by ancestral Rio

Grande—Poorly sorted sand, pebbles, and cobbles; clasts consist of basalt, quartzite

slate, schist, other metamorphic rock types, and volcanic rock types; very rare Am

02-00-00-00–heading01–Volcanic Rocks–Volcanic Rocks–Volcanic Rocks

02-01-00-00–heading02–Taos Plateau Volcanic Field–Taos Plateau Volcanic

shield volcanoes in the central part of the Taos Plateau (Lipman and Mehnert, 1979

aracterized by small olivine and tabular plagioclase phenocrysts, diktytaxitic

but also from several small shields and vents to the northwest of the map area near the

Colorado border (Thompson and Machette, 1989; K. Turner, personal communication,

2014); additional buried vents west of the Rio Grande are likely; flows typically form

columnar-jointed cliffs where exposed, with a maximum thickness of approximately 50

m in the Rio Grande gorge approximately 16 km northwest of Taos; locally subdivided

intervals as much as 70 m thick in the southern part of the map area (Leininger, 1982);

40Ar/39Ar ages from basalts exposed in the Rio Grande gorge (Cosca et al., 2014) range

in age from 4.78 ± 0.03 Ma for the lowest basalt near the Gorge Bridge (Los Cordovas

quadrangle), to 3.59 ± 0.08 Ma for the highest basalt flow at the Gorge Bridge, broadly

Guadalupe Mountain quadrangle: one at the base of the upper Servilleta Basalt lava

10RG05, M. Cosca, personal communication, 2014), whereas a lava flow at the base of

the section south of Cerro Chiflo yielded an 40Ar/39Ar age of 3.78 ± 0.08 Ma (sample

0-00-unit01-Tvto-Rhyodacite of Tres Orejas-Dark, phenocryst-poor,

ite basalt flow found on a high mesa east of the Village of Vadito in the east-

scattered exposures may indicate the original course of the basalt flow along a Pliocene

paleovalley; 40Ar/39Ar whole-rock date of 5.67 \pm 0.12 Ma confirms its time equivalence

02-03-00-00–heading02–VolSanJuan–San Juan Volcanic Field–San Juan Volcanic

ow layered rhyodacite; phenocrysts of augite and hypersthene are sparse and

flow section at La Junta Point yielded an 40 Ar/39 Ar age of 3.78 ± 0.08 Ma (sample

small; SiO2 is 62 to 64% (Lipman and Mehnert, 1979); the uppermost Servilleta Basalt

02-02-00-00–heading02–Ocaté Volcanic Field–Ocaté Volcanic Field–Ocaté

central map area, and as scattered, isolated remnants to the west; east-to-west traces of

to rocks of the ca. 5.7 Ma Ocaté volcanic field to the east; locally up to 10 m thick.

flows locally overlap the flanks of Tres Orejas on the Carson quadrangle.

RT08GM02, M. Cosca, personal communication, 2014).

Volcanic Field

consistent with previous results by Appelt (1998); two samples were analyzed from the

Basalt (Tsbu) by Dungan et al., (1984); flow packages are separated by sedimentary

uff clasts; associated with the broad, highest terrace west of the Rio Grande; up

soil horizons commonly affected by surface erosion; locally mantled by eolian sand;

sorted silt, sand, pebbles, and boulders; clasts consist primarily of granitic,

01-14-06-00-00-unit01-Ot1rp-Stream terrace deposits in canyons and

the Rio Grande–Terrace Deposits of the Rio Grande

arroyos – Poorly sorted silt, sand, pebbles, and boulders; clasts consist primarily o

the Picuris Mountains range front.

approximately 5 m thick.

Qe; estimated at 1 to 10 m thick.

estimated at several meters thick.

Field—Taos Plateau Volcanic Field

commonly crudely imbricated; imbrication suggests westerly flow direction in the area north of the Taos Municipal Airport (Los Cordovas quadrangle), and southerly flow direction in areas north and west of the Rio Pueblo de Taos, with northwesterly flow direction in areas southeast of the Rio Pueblo de Taos; well drillers records in the Questa area show clay layers in the shallow subsurface that are interpreted as lacustrine deposits; the unit is present between the Sangre de Cristo Mountains range front and the Rio Grande gorge over most of the area; correlative with 1) Lambert's (1966) two informal facies of the "Servilleta Formation" (the "sandy gravel facies" found south of the Rio Hondo, and the "gravelly silt facies" found between the Rio Hondo and the Red River), 2) Kelson's (1986) informal "Basin Fill deposit," 3) the unit previously informally called "Blueberry Hill formation" in the Taos area, and 4) Pazzaglia's (1989) late Neogene-Quaternary rift fill sequence (unit Q1) which he informally named the Lama formation; herein, for this study area, the Lama formation is defined as the uppermost, pre-incision, sedimentary rift fill, and, where extan represents the uppermost member of the Santa Fe Group; the unit therefore incl all of the basin fill between the oldest Servilleta Basalt at 5.55 ± 0.37 Ma near C zul (Taos Junction quadrangle, D. Koning, personal communication, 2015) ar dest Rio Grande (and tributary) terrace gravels (e.g., OtOrg, OtOrr); the Lan formation and the underlying Chamita Formation are texturally and compo ay be indistinguishable in boreholes, although Koning et al. of sediment (southwest of the map area) that roughly coincic f several laterally variable components of sediment rious provenance areas related to east- or west-flo been fairly persistent in the late Cenozoic; locally of phra from the lowermost Lama formation in a road cu ery (Guadalupe Mountain quadrangle, elevation ca. 7,1 from nearby ca. 5 Ma volcanic units (R. Thompson, pers ı, 2015); a tephra in the uppermost Lama formation yielded a sed on a chemical correlation with the 1.61 Ma Guaje Pumice Bed in t ness of about 25 m at the southwestern end of Blueberry Hill (Taos quadrangle), but may be considerably thicker in other parts of the map area. development, thick argillic Bt soil horizons, and 7.5YR hues in soil Bt horizons; upper 03-02-02-01-00 – unit02 – Tcc – Clay layer in the Lama formation of the Santa F soil horizons commonly affected by surface erosion; may be mantled locally by unit Group—Distinctive, thin, light-gray clay layer that is locally exposed in the walls of the Rio Grande gorge, downstream from the confluence with the Rio Pueblo de Taos; th v is composed of very small (20 to 50 microns), well-sorted crystals of quartz a

r in a clay matrix that most likely formed in a lake that existed behind a bas

ammed ancestral Rio Grande; the clay lies within the clastic beds of the Lan

rmation (QTI), above the lowermost Servilleta Basalt; this clay layer has ce between the Taos Junction bridge and Pilar, as on the north slope it is spatially related to a series of small springs and seeps that of approximately 6,200 ft; the clay layer extends downstream, springs that emerge from the north gorge wall downstrea exposed lateral extent of the layer is a minimum of 17 km (nally, the clay likely extends up the Rio Pueblo de Taos, wh eral of the wells used in this study; estimated to be 1 to 3 m th the Explanation of Map Symbols for the symbology used in the map. 1-01-00-00 – unit01 – Tsb – Servilleta Basalt – Flows of dark-gray tholeiitic basalt 03-02-03-00-00 – heading03 – Chamita Formation – Chamita Formation of the Santa Fe Group—Chamita Formation of the Santa Fe Group on; typically rounded to subrounded pebble- to cobbleschist, quartzite, and amphibolite with lesser volca m the Latir volcanic field; locally, thin interbeds are typically dominated size clasts in a fine sand to silt matrix and commonly include the rock types a into lower Servilleta Basalt (Tsbl), middle Servilleta Basalt (Tsbm), and upper Servilleta addition to subangular and subrounded volcanic clasts derived locally from adjacent volcanic highlands of the Taos Plateau volcanic field; the top of Tc is herein defined as the sediments below the youngest Servilleta Basalt flows. 03-02-03-01-01—unit02—Tcpm—Pilar Mesa member of the Chamita Formation, Santa Fe Group—Very pale-brown to light-yellowish-brown, moderately to well-sorted, subangular to rounded, mostly tabular, thin- to thick-bedded, loose to weakly(?) cemented, very fine to coarse sand and silty sand interbedded with dark-colored, moderately to very poorly sorted, angular to subrounded (often platy), medium- to thick-bedded, mostly clast-supported lenses and beds of sandy conglomerate; conglomerates contain clasts of Proterozoic quartzite, Tertiary volcanic rocks, Pilar ormation slate (Ytp), Paleozoic sandstone, siltstone, and limestone, granitic rocks, and re amphibolite, carbonate nodules, and rip-ups of fines resembling adjacent

the Tesuque Formation by Leininger (1982); approximately 230 m thick.

Santa Fe Group

Tc and Tto undivided, see descriptions of individual units.

2-02-01-00-00—unit01—Tob—Ocaté (Vadito) basalt—Dark-gray, vesicular, olivine Member of the Tesuque Formation, Santa Fe Group, undivided—In cross section only.

and boulders.

03-02-04-00-00-heading03-Chamita and Tesuque Formations-Chamita and

03-02-04-01-00 – unit01 – Tc+Tto – Chamita Formation and Ojo Caliente Sandstone

Tesuque Formations of the Santa Fe Group—Chamita and Tesuque Formations of the

03-02-05-00-00—heading03—Tesuque Formation—Tesuque Formation of the Santa Fe

Group—Rio Grande rift related basin-fill deposits of clay, silt, sand, pebbles, cobbles,

(point-bar) foresets; contacts between beds are typically abrupt and the bases of sandstones and conglomerates are commonly scoured with from 0.01 to 1 m of relief; imbrication of clasts is locally moderately well developed; paleocurrent indicators (imbrications and the strikes of channel walls) indicate transport primarily from the south, east, and northwest; sandstones and conglomerates are preferentially cemented with calcium carbonate; carbonate cement locally forms a sparry white matrix between ains; in this area, Smith et al. (2004) demonstrated that the Dixon member and C Member of the Tesuque Formation are indistinguishable in the field where not separated by the Ojo Caliente Sandstone; age of ≈13 to 11.8 Ma (latest Barstovian) is based on fossils (Tedford and Barghoorn, 1993); minimum of 250 m thick. 03-02-05-05-00—unit01—Ttcu—Upper part of the Chama-El Rito Member of the Tesuque Formation, Santa Fe Group-Very pale-brown to light-yellowish-brown, moderately to poorly sorted, subangular to subrounded, thinly to thickly bedde tabular, loose to moderately carbonate-cemented, fine- to coarse-grained, silty sandstone interbedded with moderately to poorly sorted, subangular to subrounded, medium- to thick-bedded, tabular to broadly lenticular(?), sandy conglomerate composed of variable amounts of Proterozoic quartzite, Pilar Formation slate (Ytp), schist, Tertiary volcanic rocks, Paleozoic sandstone, limestone and siltstone, granitic 03-03-04-00-00 – unit01 – Tpa – Andesitic porphyry of the Picuris Formation – Poorly rocks, and rare rip-up clasts; the lower contact is gradational (interfingering?) with the exposed, reddish-gray, andesitic porphyry that is exposed only in a single small

rest of Chama-El Rito Member (Ttc); the lower contact is drawn at approximately 10% Paleozoic clasts; the upper contact is not exposed but is probably gradational and interfingering with the Ojo Caliente Sandstone Member (Tto); largely covered by Quaternary alluvium, however, some moderately good exposures overlie Ttc in Agua 03-03-05-00-00 – unit01 – Tpl – Lower member of the Picuris Formation – Mostly Caliente Canyon; some beds of Ttc near the contact contain anomalously high numbers poorly exposed, red, greenish, and yellowish, moderately to very poorly sorted, of sandstone and granitic clasts and some Pilar Formation slate which is similar to the subangular to subrounded, pebbly/silty sandstone and mudstone containing very Pilar Mesa member (Tcpm); these beds underlie the Ojo Caliente Sandstone, which defines the top of the Tesugue Formation of Galusha and Blick (1971) in the Carson quadrangle, so they are included in Ttc here rather than defining a separate member for these rocks; age range of 14 Ma to 11 Ma is based on the age of overlying and underlying units; where unfaulted the unit is at least 200 m thick. 1 ountains (elevation ca. 7,660 ft, M. Machette, USGS, personal communication, 03-02-05-06-00—unit01—Ttc—Chama-El Rito Member of the Tesuque Formation, Santa 8) to the southwest of the map area; thickness ranges from zero to an exposed Fe Group—Buff, whitish, pink, red and brownish, moderately to very poorly sorted, subangular to subrounded, tabular to lensoidal(?), thinly to very thickly bedded, massive, plane-bedded, or cross-bedded, loose to carbonate-cemented muddy siltstone o silty, very fine to very coarse sandstone interbedded with moderately to poorly orted, mostly subrounded, medium- to very thick-bedded tabular beds and broad lenses of silty/sandy and sandy pebble conglomerate; clasts consist mostly of Tertiary olcanic rocks and quartzite with lesser amounts of Paleozoic sandstone, granitic rocks, Pilar Formation (Ytp) slate, schist, and rare amphibolite; ranges in age regionally from possibly >22 Ma to ≈13 Ma (Aby, 2008); thickness unknown, but is expected to range considerably in the subsurface. 03-02-06-00-00—heading03—Other Deposits of the Santa Fe Group—Older Deposits of

the Santa Fe Group—Older Deposits of the Santa Fe Group 03-02-06-01-00—unit01—Tbca—Basal colluvial and alluvial deposits of the Santa Fe Group—Alluvial and colluvial material underlying Ttc, Ttd, and Tptc in many locations; clast compositions are variable but are primarily derived from local Proterozoic units; a ≈20-cm-thick tephra bed sampled from a road cut in the town of Frampas (13S 432003mE 3998789mN, NAD83) yielded a plagioclase 40Ar/39Ar date of 2.7 ± 0.4 Ma; approximately 3 to 30 m thick. 13-02-07-00–heading03–Tesuque and Picuris Formations–Tesuque Formation of the Santa Fe Group and Picuris Formation – Tesuque Formation of the Santa Fe Group Hinsdale Formation, Los Pinos Formation, and similar units. and Picuris Formation 03-02-07-01-00—unit01—Ttc+Tpt—Chama-El Rito Member of the Tesuque Formation, Santa Fe Group and/or tuffaceous member of the Picuris Formation, undivided—Interbedded and/or complexly faulted, poorly exposed, sparse outcrops of tuffaceous and pumiceous silty sandstones (Tpt) and volcaniclastic sandstone and conglomerate (Ttc); stratigraphic/temporal relations between the tuffaceous members of the Picuris Formation (Tpt) and the Chama-El Rito Member (Ttc) are discernible (and clearly 'layer cake') in the southern Picuris Mountains, however, locally the tuffaceous member is either absent or not exposed along most of the range front; along

faulted, outcrops of both tuffaceous and volcaniclastic rocks that indicate possible interfingering of the two units; elsewhere, these rocks were referred to as the middle tuffaceous member of the Picuris Formation (Aby et al., 2004); age is less than ≈25 Ma based on abundant clasts of 25 Ma Amalia Tuff, but minimum age is unknown; thickness in the map area is unknown. 03-03-00-00-heading02-PicurisFm-Picuris Formation-Picuris 03-03-01-00-00—unit01—Tp—Picuris Formation, undivided—In cross section only. In sandstone interbeds; this unit was informally described as the Cieneguilla member of the Picuris Mountains area (Aby et al., 2004) consists of an upper member of tuffaceous and pumiceous silty sandstones and volcaniclastic sandstone and conglomerate; a member of buff to white and/or pinkish, silty sandstone to fine cobble rounded to angular, massive- to very crudely bedded, sandy to silty conglomerate and 05-02-04-00-00 – unit01 – Ypqm – Peñasco quartz monzonite – Biotite quartz monzonite onglomerate and non-friable to strong, very fine-lower- to very coarse-upper-grained, ry poorly to moderately sorted, rounded to subangular, thinly to thickly bedded,

the northeastern edge of the map area are poorly exposed, and possibly complexly

silica-cemented silty to pebbly sandstone that locally contains a basal portion of poorly sorted pebbly/gravelly sandstone and/or cobble/boulder conglomerate composed exclusively of Proterozoic clasts; a member of light-buff, yellowish, and locally white, ich, quartzose, silty, fine sand to pebbly, pumiceous sandstone; a lower member of reenish, and yellowish, moderately to very poorly sorted, subangular to rounded, pebbly/silty sandstone and mudstone containing very thick(?) to thin and/or lenses and/or isolated clasts of subangular to rounded Prot nents indicate source to the north (Rehder, 1986); age range i e less than 25 Ma; thickness unknown, but at least 450 m thick in the Mountains area.

ame structures; rare paleocurrent indicators show transport from the northwest, orth, and northeast; age is probably between about 23 Ma and 20 Ma based on 40Ar/39Ar ages of pumice clasts in this unit, and a basalt clast in the overlying rocks (Aby et al., 2004); approximately 10 to 35 m thick. 03-03-03-00-00—unit01—Tplq—Llano Quemado breccia member of the Picuris—Lightgray to red, monolithologic volcanic breccia of distinctive extremely angular, poorly sorted, light-gray, recrystallized rhyolite clasts in a generally reddish 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; the unit shows both clast and matrix support; the beds are generally 1 to 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; the breccia is interpreted as a series of flows from a now-buried, nearby rhyolite vent (Rehder, 1986); 40Ar/39Ar date on sanidine from a rhyolite clast collected 1 km southwest of Ponce de Leon Springs is 28.35 ± 0.11 Ma; apparent thicknesses of 5 to 45 m, although subsurface extent is unknown.

exposure in northern Miranda Canyon where it appears to underlie Tplq; age unknown, although it may be related to the volcanic component of the Tplq. thick(?) to thin beds and/or lenses and/or isolated clasts of subangular to rounded Proterozoic quartzite (up to 3 m across) and massive quartzite conglomerate; commonly highly weathered with fractured clasts; most available exposures consist of very well-carbonate-cemented quartzite pebble and cobble conglomerate intervals xposed near mapped faults: the lower contact is placed at the first accumulation of se Proterozoic clasts (quartzite, Pilar Formation slate [Ytp], ± schist); the upper 10 140 241 05-01-00-00-unit01 – breccia – Mixed fault breccia – Fault breccia composed of a m in Agua Caliente Canyon (Carson to Peñasco quadrangles) is a well-exposed bed of 👘 🖓 🖓 🛱 🚛 mixture of Proterozoic Hondo Group (Xhu), Vadito Group (Xvu), and granitic rock well-sorted, quartzite-cobble conglomerate (Figure 7 of Aby et al., 2004); the rientation of 95 well-imbricated clasts in this interval suggest derivation from the rtheast (average paleo-transport direction is 143°), at odds with a previ erpretation that this unit was derived from the Picuris Mountains to the south Leininger, 1982); this unit was informally named the "Bradley conglomerate memb the Tesuque Formation (Leininger, 1982) for exposures near the Village of F me has been abandoned; this unit has also been referred to as the ate member" of the Picuris Formation (Aby et al., 2004) but, locally, 1 4.5 ± 1.2 Ma by 40Ar/39Ar (Aby et al., 2004); region e amounts of intermediate-composition volcanic rocks (date .t 32.4 to 28.8 Ma; Aby et al., 2007), and fluvially reworked Llano Que-.8.35 Ma); the oldest ashes are dated at 35.5 Ma and 35.6 Ma (Aby et a' the maximum age of the unit is unknown; where not faulted the unit is at least 250 03-04-00-00-heading02-Older Tertiary Units-Older Tertiary Units-Older 05-02-02-00-00-unit01-Yp-Pegmatite-Includes both simple (quartz-K-feldspr Tertiary Units 03-04-01-00-00—unit01—Th—Older Tertiary rocks—In cross section only. Volcanic,

04-00-00-00-00-heading01-Sedimentary Rocks of the Taos Trough-Sedimentary pegmatites are connected to plutons at depth; more than one generation of pegmatite ded—Poorly exposed; greenish, reddish, yellowish, buff, tan, black, and bro friable to firm; sandy to clayey; thinly to thickly bedded; poorly to modera remented(?), sandy to clayey siltstone, mudstone, and shale interbedded with ostly greenish and brownish, firm to very strong, poorly to moderately well-sorted, oorly to moderately well-rounded, thin- to very thickly bedded, moderately to very rell-cemented, quartzose, feldspathic, and arkosic, silty to pebbly sandstone and sandy conglomerate and less common thin- to thick-bedded, grayish and blackish limestone of the Alamitos and Flechado Formations; contains a rich assortment of fossils; sandstones commonly contain plant fragments that have been altered to limonite(?); contacts between beds are generally sharp, rarely with minor scour (less than ≈ 20 cm); the lower contact is sharp, planar(?), and disconformable(?) where it overlies Mississippian rocks; the lower contact is mapped at the top of the Del Padre Sandstone Member (Mdp) or highest Mississippian carbonate, or at the base of the lowest sedimentary bed where Mississippian rocks are absent; conglomeratic layers in the lower part of the unit locally contain rare, sometimes banded, chert pebbles; equivalent to the Sandia, Madera, and La Posada Formations to the south; colluvial deposits have not been mapped on the Tres Ritos quadrangle, but most of the Pennsylvanian rocks are covered by brown to nearly black, loose, very poorly sorted, and the random orientation of larger clasts within a matrix of usually dark, organicrich fines; windthrow (movement of soil by toppling of trees) is thought to be an active process in the map area, and is probably responsible for the pervasive colluvial mantle; fusulinids collected in the Taos quadrangle are Desmoinesian in age (Bruce Allen, personal communication, 2000); Miller et al. (1963) measured an incomplete section of 1,756 m along the Rio Pueblo near the Comales Campground (Tres Ritos quadrangle), and an aggregate thickness of Pennsylvanian strata in the map area of >1,830 m.

04-02-00-00-unit01-IPlst-Limestone, Pennsylvanian sedimentary rocks of the Taos Trough—Light-gray limestone in scattered discontinuous layers; fossiliferous t non-fossiliferous; fossils include phylloid algae, crinoids, brachiopods, and other s fragments; well-bedded to poorly bedded; outcrops are typically highly weathered and, locally, are highly fractured; limestone represents a very small percentage (<1%) of the volume of Pennsylvanian rock in the map area.

01-00—unit02—Mdp—Del Padre Sandstone Member of the Espiritu Santo n, Arroyo Peñasco Group—White, tan, yellowish, green, red, and/or mottled,

ally laminated to low angle cross-bedded, quartz-overgrowth bebbly sandstone, sandy conglomerate, and n rp and parallel, although minor (<20 c osion, but is variable in general; lichens typically obscure sedin lding even where exposure is relatively good; unco terozoic rocks in much of the Sangre de Cristo Mountains of no Armstrong and Mamet, 1979); Miller et al. (1963) reported an unusually t section of the Del Padre north of the Rio Pueblo in Osha Canyon (Peñasco qua just west of the mica mine, however, a similar exposure reported by Miller et al. (contains Pennsylvanian fossils (Cather, et al., 2007), and therefore the exposure Osha Canyon, may also be Pennsylvanian; differentiating the Del Padre Sandstor from the Pennsylvanian basal sandstone is not feasible in areas of poor exposure; however, the presence or absence of the Espiritu Santo carbonates can be useful in distinguishing the two; the basal contact of the Del Padre is herein mapped at the Del Padre overlies the Ortega Formation (Xho) quartzite, as the two are similar; the upper contact is mapped at the top of the highest strongly cemented sandstone bed; in the Rio Pueblo section at Comales Campground, reported thicknesses are ≈19.5 m (Miller et al., 1963), ≈17 m (Armstrong and Mamet, 1979) and ≈8 m (Baltz and Meyers, 1999); this mapping supports the higher estimates. 05-00-00-00–heading01–Metamorphic and Plutonic Rocks of the Picuris Mountains-Metamorphic and Plutonic Rocks of the Picuris Mountains-Metamorphic and Plutonic Rocks of the Picuris Mountains along the Tertiary Picuris-Pecos fault; the unit is a distinct ridge former where the breccia is strongly solidified. 05-02-00-00–heading02–Plutonic & Metaplutonic Rocks–Plutonic & Metaplutonic Rocks—Plutonic & Metaplutonic Rocks 05-02-01-00-00-unit01-Zd-Diorite dike-Dark-green-gray quartz diorite dikes intruded into Proterozoic rocks; dikes are vertical, with strikes clustered around an

altered to chlorite and clay; pyroxene and feldspar show normal plutonic textures;

locally, dikes are laced with carbonate veins; generally less than 1 m wide; contacts

ry coarse-upper-grained, strong-to-very strong, moderately to ver

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 of the Picuris Mountains. See the Explanation of Map Symbols for the symbology used in the map. plagioclase-muscovite) pegmatites and complex zoned pegmatites containing rar minerals in the Trampas quadrangle; simple pegmatites are by far the most abunda in the map area; pegmatite bodies typically are dikes or lenses, locally aligned parallel to country rock foliation; 2 cm to 15 m thick; no apparent spatial relationship exists between pegmatite bodies and plutonic bodies, and no evidence exists to suggest the formation is represented, and at least one generation is younger than the youngest granite at 1,450 Ma (Long, 1976). See the Explanation of Map Symbols for the symbology used in the map. pegmatite body in the schists and amphibolite of the Vadito Group (Xvu, Jahns and Ewing, 1976) in the southern Picuris Mountains; the disk-shaped body is elongate down-dip and inclined in a plane that dips 10° to 15° south; the body is about 350 m ng, and its thickness ranges from 1 m at the edge to about 25 m at the core; maj nerals include quartz, albite, microcline, muscovite, lepidolite, and spodument her minerals have been identified (Jahns and Ewing, 1976); lath-sł rit, rose muscovite-cleavelandite unit, cleavelan e zone; replacement features are common; Northrup and the pegmatite is internally deformed, probably syntector emplaced in locally dilatant extension fractures that developed l le-ductile shearing history; an age of 1,366 Ma based on Rb-Sr o imples and mineral separates (Brookins et al., 1979) could be considered a minim age for crystallization.

where the foliation is well developed; generally concordant with country rock contacts garnet-bearing; approximately 25 m thick. mean 207Pb/206Pb zircon age of $1,450 \pm 10$ Ma. 05-02-04-01-00—unit02—Yppqm—Pegmatitic phase of the Peñasco quartz monzonite – Coarse-grained, quartz, K-feldspar, and plagioclase granitic body with pronounced myrmekitic texture; distinctive intergrowth of plagioclase and vermicular quartz is common; no visible foliation; located in the southeastern corner of the Trampas quadrangle, and probably represents a high-level phase of the Peñasco quartz monzonite (Ypgm).

mm sphene crystals are common; accessory minerals are muscovite, allanite, epidote,

Carlsbad-twinned microcline up to 9 cm in length; myrmekite and albite rims on

magnetite-hematite, apatite, and zircon; locally contains tabular megacrysts of

	01.01.01 Contact—Identity and existence are certain. Location is accurate.	G	03.01.03 E
	01.01.03 Contact—Identity and existence are certain. Location is approximate.		31.02.25 V used to es
?	01.01.04 Contact—Identity or existence are questionable. Location is approximate.	FI	31.02.26 V of a well
	01.01.17 Gradational contact—Identity and existence are certain. Location is accurate.	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	01.01.27 U Location
~~~~~~	01.01.25 Unconformable contact—Identity and existence are certain. Location is accurate.		01.01.11 I approxim
	02.01.01 Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—Identity and existence are		01.01.13 I inferred.
	certain. Location is accurate. 02.01.03 Fault (generic; vertical, subvertical, or high-angle; or unknown or		01.01.15 I concealed
	unspecified orientation or sense of slip)—Identity and existence are certain. Location is approximate.		01.01.18 C Location
~~~~~	02.14.01 Ductile shear zone or mylonite zone—May or may not be associated with mappable faults.	?	02.01.04 F unspecifi
	05.10.12 Fold axial trace in cross section.—Identity and existence are certain. Location is accurate.		questiona 05.10.13 F
1	02.11.16 Fault in cross section showing local up/down offset—The arrows show the relative motion along the fault plane.		certain. L
	02.11.17 Fault in cross section showing local up/down offset—The arrows show the relative motion along the fault plane.	1,	show the Laradmic
$\oplus \odot$	02.11.21 Strike-slip fault (in cross section) (2nd option)—Plus, away from observer; dot, toward observer.	$\oplus \odot$	02.11.21L observer; movemer
	01.01.13 Internal contact—Identity and existence are certain. Location is inferred.		01.01.20 C Location
~~~~~	01.01.27 Unconformable contact—Identity and existence are certain. Location is approximate.		

## 25 Well location (in cross section) – The location and depth of a well o establish stratigraphy and geologic unit depth. Vell location (in cross section) — The projected location and dep l used to establish stratigraphy and geologic unit depth. 27 Unconformable contact—Identity and existence are certain. on is approximate. Internal contact–Identity and existence are certain. Location is 3 Internal contact—Identity and existence are certain. Location is 5 Internal contact—Identity and existence are certain. Location is t. Gradational contact–Identity or existence are questionable. is accurate. 04 Fault (generic; vertical, subvertical, or high-angle; or unknown or fied orientation or sense of slip)—Identity or existence are

NMBGMR Open-File Geologic Map 2

Last Modified November 202

.6L Fault in cross section showing local up/down offset-The arrows e relative motion along the fault plane. Green color indicates ide-age fault movement. Strike-slip fault (in cross section) (2nd option)-Plus, away from dot, toward observer. Green color indicates Laradmide-age fault 20 Gradational contact—Identity or existence are questionable.

nic rock suggest an intrusive relationship between the two, althou lipping ductile faults may exist as well; contacts between graniti supracrustal rock invariably trend east, parallel to bedding in the country rock; this name supersedes the informally named Granite of Picuris Peak of Bauer (1988); Da et al. (2013) calculated a mean 207Pb/206Pb zircon age of 1,699 ± 3 Ma. 05-03-00-00–heading02–Metasedimentary Rocks–Metasedimentary Rocks-Metasedimentary Rocks 05-03-01-00-00—heading03—Marqueñas Formation—Marqueñas Formation—Marqueñas Formation 05-03-01-01-00—unit01—Ym—Marqueñas Formation, undivided—Fine- to mediumgrained, grayish, texturally immature, schistose quartzite; cross-beds are small-scale features defined by black mineral laminae; also includes a variety of

matrix; previously considered to be part of the ca. 1,700 Ma Vadito Group (Xvu), but U-Pb analyses of detrital zircons from a metaconglomerate were interpreted to constrain the basal unit to be less than about  $1,450 \pm 7$  Ma in depositional age (Gray et al., 2015). lowest identifiable clastic beds, although such a selection can be problematic where the 05-03-01-02-00 – unit01 – Ym3 – Northern metaconglomerate of the Marqueñas Hop 05-03-01-02-00 - unit01 - Ym3 - Northern metaconglomerate of the MarqueñasHondo Group - Interlayered cross-bedded quartzites and pelitic schists; a distinctiveFormation - Predominantly composed of flattened quartzite pods; micaceous quartzitemarker layer near the center of the unit is a 25-m-thick, white, thinly bedded, ridgenatrix contains scattered clasts, up to 10 cm long, of metasedimentary quartzite (66%), forming quartzite; sharp contact with Xhr4; approximately 75 m thick. felsic schist (34%), and traces of vein quartz; alternating lithologic layers that might indicate original bedding are absent; gradational with the Marqueñas Formation quartzite (Ym2) to the south; 207Pb/206Pb analyses on detrital zircons yielded peak thinly to thickly bedded registrant quartzite with abundant cross-beds ages of 1,716 Ma and 1,457 Ma (Daniel et al., 2013); on the Trampas quadrangle this unit is approximately 150 to 180 m thick. 05-03-01-03-00 – unit01 – Ym2 – Ouartzite of the Margueñas Formation – Fine- to Hondo Group – Locally includes two mappable layers of pelitic schist that resemble medium-grained, grayish, texturally immature, schistose quartzite; can be sub-divided Xhr4 and upper Xhr1/2. a lower massive gray quartzite and an upper cross-laminated quartzite (Scott 0); contains abundant cross-beds that range from small-scale features k mineral laminae to large festoons with cross-laminations several centi k; cross-beds consistently young to the north; pebble-rich layers also def dding; contacts with adjacent metaconglomerates are gradational; 207Pb/20 on detrital zircons yielded peak ages of 1,711 Ma, 1,697 Ma and 1,47 . et al., 2013); where exposed 0.5 km east of Cerro de las Marqueñas (Trampas adrangle) the unit is approximately 200 m thick. azimuth of 150°; composed of pale-green clinopyroxene (Cr-diopside?), zoned 05-03-01-04-00 – unit01 – Ym1 – Southern metaconglomerate of the Marqueñas plagioclase (labradorite?), and minor quartz, magnetite, and ilmenite; commonly Formation—Polymictic metaconglomerate containing rounded clasts of quartzite (54%), silicic metavolcanic rock and quartz-muscovite schist (40%), and white vein

metaconglomerates containing dominantly rounded quartzose clasts in a quartz-mica

up to 1 m long; the matrix averages about 30% of the volume of the rock; minor phases in the matrix include ilmenite, biotite, magnetite, hematite, zircon, and tourmaline; the contact with Vadito Group (Xvu) rocks may represent a 250 million-year-old angular 05-03-03-03-01 – unit01 – Xho – Ortega Formation of the Hondo Group, unconformity (Gray et al., 2015); 207Pb/206Pb analyses on detrital zircons yielded peak und ages of 1,716 Ma and 1,472 Ma (Daniel et al., 2013); U-Pb analyses of zircons in a metarhyolite clast yielded an age of  $1,450 \pm 7$  Ma, interpreted as a maximum depositional age for the base of Ym1 (Gray et al., 2015); 0.5 km east of Cerro de las Marqueñas (Trampas quadrangle) the unit is approximately 150 m thick. 05-03-02-00-00—heading03—Trampas Group (Informal)—Trampas Group (Informal)—Trampas Group (Informal) Schist, quartzite, metaconglomerate, phyllite, and slate deposits of the Piedra Lumbre 05-02-03-00-00-unit01-Yhp-Harding pegmatite-Complex, asymmetrically zoned (Ytpl) and Pilar Formations (Ytp); previously considered to be part of the ca. 1,680 to 1,700 Ma Hondo Group; this informal group name was proposed by Daniel et al (2013) based principally on ages of detrital zircons in the Piedra Lumbre and Pilar Formations. 05-03-02-02-00 – unit01 – Ytpl – Piedra Lumbre Formation of the Trampas sory minerals are beryl, garnet, microlite, and tantalite-columbite: about group—Includes several distinctive rock types: 1) quartz-muscovite-biotite-garne staurolite phyllitic schist with characteristic sheen on crenulated cleavage surfaces; euhedral garnets are 1 mm, biotite books are 2 mm, and scattered anhedral staurolites 05-03-03-03-03-03-04 unit01 – Xho5 – Kyanite quartzite of the Ortega Formation, Hondo are up to 5 mm in diameter; 2) finely laminated light-gray phyllitic quartz-muscovite- Group—Sugary to vitreous quartzite characterized by kyanite blades and distinctive biotite-garnet schist and darker bluish-gray fine-grained biotite quartzite to

quartz in a muscovite quartzite matrix; clasts are flattened and constricted in the

dominant foliation; aspect ratios average 1:2:3 to 1:2:6, with extremes of 1:2:16 or

greater; in general, clast size increases southward and westward; quartzite clasts are

metasiltstone; quartzite layers are 1 cm to 1 m thick; and 3) light-gray to gray garnet schist with lenses of quartzite to metasiltstone; calc-silicate layers exist locally; original sedimentary structures including graded bedding are preserved; well-developed cleavage parallel to both layering and axial surfaces of small intrafolial isoclinal folds; dominant layering in much of this unit is transpositional; in the core of the Hondo syncline, the unit is thicker, contains a greater variety of rock types, and is gradational with the Pilar Formation; U-Pb analyses of detrital zircons from a quartzite in the 05-03-03-04-unit01-Xho4-Massive gray quartzite of the Ortega Formation than about 1,470 Ma in depositional age (Daniel et al., 2013); apparent thickness is 200 to 400 m. 05-03-02-02-01—unit02—Ytplq—Quartzite of the Piedra Lumbre Formation, Trampas plagioclase are common; massive to weakly foliated, except locally along contacts group—Massive to layered, light-colored, cross-bedded micaceous quartzite; locally and rotation, no compositional border zone; matic microgranitoid inclusions are common, especially near borders; intrusive into the Rana quartz monzonite (Xrqm); U-Pb zircon isotopic age of about 1,450 Ma (Bell, 1985); Daniel et al. (2013) calculated a mean 207Pb/206Pb zircon age of 1.450 + 10 Ma

abundant cross-bedding; 5) blue and white streaked, thickly bedded, medium-grained quartzite with abundant cross-bedding; and 6) tan, thinly layered, micaceous quartzite 05-04-01-02-00 – unit01 – Xvf – Felsic schist of the Vadito Group, undivided – Inclu interlayered with quartz-rich quartz-muscovite schist; abundant cross-bedding; a variety of quartz-muscovite-plagioclase schists; coarser-grained felsic rocks gradational contact with Xhr6; approximately 75 m thick. 05-03-02-04 – unit01 – Xhr4 – R4 schist member of the Rinconada Formation, Hondo Group—Medium- to coarse-grained, silvery gray, quartz-muscovite-biotite-staurolitegarnet schist containing one or more distinctive 0.5- to 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. The latter four rock types are not present on the south limb of the Copper Hill anticline, but are present in 05-04-01-03-00 – unit01 – Xvg – Glenwoody Formation of the Vadito the Trampas quadrangle on both the upright and overturned limbs of the Hondo Group—Feldspathic quartz-muscovite schist and quartzose schist exposed in isolated syncline in Sections 7, 8, 9 and 10, T023N R011E; a well-exposed reference section of this thicker Xhr4 sequence can be found on the south-facing slope and crest of the ridge making up the northern half of the SW quarter of Section 8, T023N R011E in the Trampas quadrangle (Hall, 1988); sharp contact with Xhr5; about 50 to 175 m thick.

05-03-02-05—unit01—Xhr3—R3 quartzite member of the Rinconada Formation, thinly to thickly bedded, resistant quartzite with abundant cross-beds. 05-03-02-07—unit01—Xhr3s—R3 schist member of the Rinconada Format 05-03-02-08-unit01-Xhr1/2-R1/R2 schist member of the Rinconada Formation, Hondo Group—Lower unit of fine- to medium-grained, tan to silver, quartzmuscovite-biotite schist with small euhedral garnets (<2 mm) and scattered euhedral staurolite twins (<1.5 cm); near the base are black biotite books (<2 cm) and on the upright limb of the Hondo syncline in Section 7, T023N R011E are spectacular, andalusite porphyroblasts up to 8 cm across; an upper unit of gray to tan, redweathering, coarse-grained quartz-muscovite-biotite-staurolite-albite-garnet schist ontains interlayers of 1 to 10 cm, red-, gray-, or tan-weathering, fine-grained, iscovite-garnet quartzite; abundant staurolites are twinned, euhedral, and up to 3 diameter; abundant garnets are euhedral and small (<2 mm); the unit shows ting along foliation planes; sharp to gradational contact with Xhr3; lower it have previously been subdivided into R1 and R2 memb ctively, based on mineralogy (Nielsen, 1972); approximately 265 m thick. 5-03-03-03-00 – heading04 – Ortega Formation – Ortega Formation – Ortega

ivided – Gray to grayish-white, medium- to coarse-grained quartzite; generally sive and highly resistant to weathering; locally well-cross-bedded, with kyanite or limanite concentrated in thin, schistose, muscovite-rich horizons; cross-beds are l by concentrations of black iron-oxide minerals; common accessory minerals depositional age (Daniel et al., 2013); 800 to 1,200 m thick. Group—Clean, white to tan, sugary quartzite interlayered with lenses and layers of massive, foliated, grey knobby andalusite quartzite; layers range from centimeters to in the quartzite; andalusites are large, lentil-shaped, poikiloblastic grains, with up to 50% quartz inclusions, mantled by coarse muscovite crystals; matrix is fine quartz, coarse kyanite, fine muscovite, euhedral rutile, and minor hematite and tourmaline; equivalent to Oq3 of Williams (1982); mapped only on Copper Hill in the Trampas quadrangle where the unit is several meters thick. escent quartz eyes; bedding-parallel, kyanite-rich layers give unit a vague

n; fine muscovite grains are scattered between quartz grain boundaries; rutile is of 1,707 Ma (sample J10-PIC7 of Daniel et al., 2013). ne predominant heavy mineral; on Copper Hill, a foliated iron-stained rock quadrangle where the unit ranges from 3 to 5 m thick. upper part of the section (unit Ytplq?) were interpreted to constrain the unit to be less Hondo Group—Massive, light- to dark-gray, vitreous guartzite with dark layers of rutile, hematite, and ilmenite that define cross-bedding; fine muscovite is commonly Copper Hill and La Sierrita on the Trampas quadrangle; mineralization is related to vard migration of host fluids during Proterozoic retrograde metamorphism ams and Bauer, 1995); upper part is equivalent to Oq1 of Williams (1982 nly on Copper Hill in the Trampas quadrangle where the unit is approximately 30 m thick. 05-03-03-05-unit01-Xho3-Mixed quartzites of the Ortega Formation, Hondo Group–Various quartzites including reddish coarse-grained quartzite, brown

> medium-grained quartzite, gray quartzite, garnet-bearing dark quartzite, and tan cross-bedded quartzite; mapped only on La Sierrita ridge (Trampas and Peñasco quadrangles), where the unit is approximately 250 m thick. 05-03-03-06—unit01—Xho2—Black quartzite of the Ortega Formation, Hondo Group—Dark-gray to black, massive, medium-grained quartzite; commonly cr te; mapped only on La Sierrita ridge (Trampas and Peñasco quadrangles); approximately 200 m thick.

pinkish, quartz-plagioclase-muscovite-biotite, opaque, slightly schistose units with with ubiquitous scattered, rounded, and elongate, altered porphyroblast knots calline quartz eyes (2 to 8 mm); eyes are slightly flattened in foliation and bably represent relict phenocrysts of felsic volcanic rocks; trace minerals include ne, apatite, and tourmaline; finer-grained felsic rocks are similar in mineralogy to rser units, but lack the abundant quartz eyes; small, red, idioblastic garnets are rare; small, lensoidal bodies of tan to orange-red, garnet-bearing, quartz-muscovite, 05-04-01-15-00 – unit01 – Xvs1 – Pelitic schists of the Vadito Group, paque schist are found locally; many of the felsic schist bodies appear to be intrusive undivided – Includes a variety of pelitic to semi-pelitic schists; relatively mass into Vadito Group schists.

exposures along the northern flank of the Picuris Mountains and in the Pilar cliffs; white, light-gray, pink, or green; commonly contains megacrysts of feldspar and ounded and flattened quartz in a fine-grained matrix of quartz, muscovite and lspar; contact with overlying Ortega Formation (Xho) is a south-dipping of one; pervasive extension lineation in schist plunges south; upper 4 sh, and contains anomalous manganese and rare ( uch as piemontite, thulite, and manganese-andalusite (viridi a preliminary U-Pb zircon age of ca. 1,700 Ma (Bauer and Pollo valent to the Rio Pueblo Schist (Xvrp) and the ca. 1,700 Ma Burned Mour ion of the Tusas Mountains; base unexposed; minimum of about 200 m thick. consistently flattened in the dominant foliation plane; the Miranda granite (Xmg) trudes and crosscuts layering in the schists; along the southern contact with a assive gray quartzite; a manganese-rich horizon occurs stratigraphically below the quartzite; piemontite and altered porphyroblasts that might be pseudomorphs after anganese-andalusite are found along the schist-quartzite contact; this mineralized horizon is similar to that exposed in the Glenwoody Formation (Xvg) of the Pilar cliffs in the Carson and Trampas quadrangles. I-04-01—unit02—Xvrpw—Muscovite member of the Rio Pueblo Schist, Vadito

ıp—Well-bedded, white, muscovite-quartz schist exposed in isolated patches in the mica mine area of the Tres Ritos quadrangle; composed of coarse, white muscovite flakes in a matrix of granular quartz and feldspar; probably a highly altered part of the Rio Pueblo Schist; hosts the best mica deposits and all of the major mica mines; thickness unknown. 05-04-01-05-00 – unit01 – Xvht – Transitional rocks of the Vadito Group – Exposed or the east side of Picuris Canyon (Taos SW and Peñasco quadrangles); includes a of rock types intermediate in mineralogy and texture between the metavolcanic rock of the Vadito Group and metasedimentary rocks of the Hondo Group (Xhu); conglomeratic schistose quartzite, white quartz-muscovite feldspathic schist, grav artzite and metaconglomerate, conglomeratic quartzite and schistose quartzite with

s of bull quartz, quartzite, and fine-grained black rock, schistose

metaconglomerate, and quartz-eye conglomerate; gradational eastward along str with feldspathic schists (Xvf) of the Vadito Group: might be equivalent t transitional section south of Kiowa Mountain (Las Tablas quadrangle) nite, hematite, tourmaline, epidote, muscovite, and zircon; gradational contact Mountains (Bauer and Williams, 1989), however, in this map area it has been disrupted biotite schist, and various felsic to mafic schistose units. by the Plomo fault. .han about 1,700 Ma in 05-04-01-06-00—unit01—Xvq—Micaceous quartzites and metaconglomerates of the Vadito Group, undivided – Includes both lenticular micaceous quartzite bodies and schist; grades into more schistose rock in the southern area of exposure; coarse mainly of granoblastic quartz grains, aligned muscovite grains, and layered concentrations of opaque minerals; local conglomerate horizons delineate bedding; the meters thick; fine muscovite and scattered kyanite, sillimanite, and fuchsite are present major metaconglomerate units in the area crop out southwest of Cerro Alto (Trampas quadrangle, referred to as the Embudo Creek quartzite by Bell, 1985) and in the southeastern Picuris Mountains; the metaconglomerate consists of rounded, predominantly quartzite clasts in a quartz-muscovite matrix; sedimentary features

such as cross-beds and ripple marks are well preserved; numerous thin lenses of

quartzite and metaconglomerate, too thin to subdivide, are also found scattered within the amphibolite and schist units of the Vadito Group; a cross-bedded, feldspathic quartzite in the southeastern Picuris Mountains yielded a detrital zircon age peak of 1,715 Ma (sample CD10-10 of Daniel et al., 2013); detrital zircons collected from a quartz pebble metaconglomerate near the Harding Pegmatite Mine yielded a peak age ontaining kyanite and staurolite grains (<0.5 cm), overlies the kyanite quartzite; 05-04-01-07-00 – unit01 – Xvqb – Quartz-biotite rock of the Vadito Group – Lenses and equivalent to Oq2 of Williams (1982); mapped only on Copper Hill in the Trampas discontinuous layers of gray, quartz-biotite rock found in schist and amphibolite; lightto medium-gray, fine-grained quartz-biotite-(± muscovite) rock with local green epidote pods and veins; other minerals visible in thin section include plagioclase, microcline, sphene, garnet, hematite, and ilmenite; these rocks are similar to sills of the Cerro Alto metadacite (Xvcam). esent on guartz grain boundaries and kvanite is commonly associated with dark 05-04-01-08-00 – unit01 – Xvcam – Cerro Alto metadacite of the Vadito Group – Gray s; this unit is host to much of the fracture-filling, oxidized copper mineralization metadacite composed of fine-grained quartz, plagioclase, microcline, biotite, and

muscovite: relict phenocrysts of quartz and/or feldspar are <4 mm long; accessor minerals are epidote, allanite, sphene, magnetite, and zircon; the main mass of etadacite is a stock-like body with sharp intrusive contacts with the country rock, ally along the western margin; abundant isolated sills are contained in adjacent ibolites; the unit is crosscut by other plutonic rocks, and found as xenoliths moderately well-developed foliation is parallel to the regional ay be the remnant of a larger subvolcanic complex originally emplaced at a low level within the Vadito Group; Daniel et al. (2013) calculated a mean Pb zircon age of  $1,710 \pm 10$  Ma that is interpreted to represent the age of 05-04-01-09-00-unit01-Xvs7-Fine-grained quartz-muscovite-chlorite schist of the Vadito Group–Includes several varieties of schist; fine-grained quartz-muscovite

schist with scattered porphyroblasts of staurolite and biotite (<3 cm); grades to finegrained, pale olive-green quartz-muscovite-chlorite schist with 1 to 2 mm garnets, 2 to 25 mm staurolites, and 0.5 to 2 mm biotites; locally shows compositional layers of 1mm-thick, gray quartz-rich rock and <6-mm-thick, greenish, quartz-muscovite-chlorite schist; small grains (0.1 mm) of tourmaline, apatite, and sphene or monazite.

randomly oriented; local compositional layers, 0.5 to 2 cm thick, of white quartzite and silver-blue phyllitic schist; 20- to 40-cm-long elongate pods of granular quartz, chlorite, muscovite, and minor copper oxides are aligned in the foliation. 05-04-01-11-00—unit01—Xvs5—Streaky schist of the Vadito Group—Dark-g fine-grained quartz-muscovite-biotite, opaque schist; streaky look results fro to 2-mm-thick, lens-shaped bodies of white quartz-plagioclase-muscovite schist an gray, biotite-quartz-muscovite-chlorite, opaque schist; locally, <2 mm biotite porphyroblasts are present; lenses are strongly folded and transposed; micr 05-04-01-12-00—unit01—Xvs4—Streaky knotty phyllitic schist of the Vadito Group-Silver-gray to silver-green, very fine-grained to phyllitic, quartz-muscovite

and probably transposed; contains altered knots of muscovite and green chlorite, and distinctive pods of fine- to medium-grained granular quartz; gradational contact with streaky schist. -13-00-unit01-Xvs3-Andalusite-biotite phyllitic schist of the Vadi ue to gray-green, very fine-grained, quartz-muscovite-chlor t with black, biotite porphyroblasts and coarse-grained, andalusite kno itional layering is defined by lenses and layers of light and dark phyllite and e slightly flattened in the plane of foliation, and contain included inter ation trails; black, randomly oriented biotite porphyroblasts average 4 mm eter; minerals such as staurolite, plagioclase, and garnet are present local inctive marker horizon of cordierite-bearing, quartz-muscovite schist is pres ear the main amphibolite body; cordierite porphyroblasts are gray, up to 20 cm lo and typically exhibit an orthorhombic (pseudohexagonal) crystal habit; the foliati wraps around the cordierite porphyroblasts; in thin section, cordierites are optic ntinuous, and contain abundant quartz inclusions that define two relict incluc oliations; gradational with Xvs1 to the northeast. 05-04-01-14-00 - heading04 - KnotSchist - Knotty quartz-muscovite-(±biotite) sch (Xvs2) of the Vadito Group—Common rock type is divided into three mappable subunits (Xvs2a, Xvs2b, Xvs2c,), each displaying gradational contacts with the others 05-04-01-14-01—unit01—Xvs2a—Knotty quartz-muscovite-(±biotite) schist of the speckles of biotite and opaque minerals; the most phyllitic unit in Xvs2; in general, units contain altered knots of fine-grained muscovite, chlorite, and quartz. 3 05-04-01-14-02 – unit01 – Xvs2b – Knotty quartz-muscovite-(±biotite) schist of th Vadito Group—Contains a variety of fine-grained, quartz-muscovite-biotite schisu e 05-04-01-14-03—unit01—Xvs2c—Knotty quartz-muscovite-(±biotite) schist of the Vadito Group—Similar to Xvs2b with the exception of less abundant knots of altered muscovite-chlorite-quartz; knots may be altered cordierite porphyroblasts. th-gray, fine-grained, quartz-muscovite schist with scattered flakes of black biotite mm) and compositional layers defined by alternating quartz-rich and mica-rich are 1 to 25 mm thick; quartz-muscovite schist with porphyroblasts otite, garnet, and andalusite; fine-grained quartz-muscovite schist with scatte

05-04-01-16-00 - unit01 - Xvsa - Andalusite schist of the Vadito Group - Distinctive black, biotite schist containing large knobs of andalusite; this unit is only a few meters thick and appears to pinch out laterally in both directions. g—Amphibolite in granite of the Vadito Group ite bodies, lenses, and layers within the Miranda granite rstitial quartz and plagioclase, sphene, and epidote; faint compositional layering formed by 1- to 2-mm-thick white layers; epidote veins and zones are common muscovite quartz-eye schist; locally composed of up to 40% coarse, white muscovite 05-04-01-18-00 – unit01 – Xva – Amphibolite of the Vadito Group – Includes a wid flakes in a matrix of granular quartz and feldspar; quartz-eyes are abundant and are variety of amphibolite bodies, lenses, layers, and textures; the large amphibolite bod south and east of the Harding pegmatite is a complex unit containing metamorphose and deformed volcanic, sedimentary, and volcaniclastic rocks; the predominant roc type is fine- to medium-grained, dark-gray-green to black, weakly foliated amphibol composed of blue-green to olive-green hornblende (0.1 to 0.7 mm), interstitial qua and plagioclase (0.1 mm), sphene, and epidote; faint compositional layering is form by 1- to 2-mm-thick white layers; epidote veins and zones are common, especially ne uton margins; fragmental amphibolites containing white felsic fragments and g hic fragments, elongated and flattened in the foliation of the fine-grained hornb natrix, exist locally; subangular, gray, quartzite clasts, black, basaltic fragments, epidote clasts also exist within the matrix; other rock types within the larg amphibolite body include biotite schist, metadacite, felsic schists, guartzite, netagabbro, and various schists; smaller layers and lenses scattered throughout t Vadito schists are mainly fine- to medium-grained amphibolites that range siderably in texture and mineralogy. -04-01-19-00—unit01—Xvb—Fragmental biotite schist of the Vadito Group—Dar se matrix of biotite-quartz-plagioclase contains varying percentages of clasts of 1) white, gray, red, and black subrounded quartzite pebbles (1 to 15 cm); 2) dark-olive green to brown, fine-grained, lithic fragments that are strongly flattened in foliation; 3 white, felsic fragments that are extremely flattened in foliation; and 4) boulder-sized dark-green-black, fine-grained amphibolites; this unit also contains lensoidal bodies metadacite. -20-00—unit01—Xvmix—Mixed metavolcanic rocks of the Vadito

porphyroblasts of biotite; also includes local horizons of interlayered amphib

-Undivided amphibolites, fragmental amphibolites, biotite schist, fragment 05-04-01-21-00—unit01—Xvd—Gneiss of the Vadito Group—Gneissic dioritic rock nterlayered quartz-biotite gneiss felsic gneiss and quartz-muscovite-bio 05-03-02-01-00 - unit01 - Ytu - Trampas group, undivided - In cross section only. 05-03-03-02 - unit01 - Xho6 - Andalusite quartzite of the Ortega Formation, Hondo it is intruded by Rana quartz monzonite. 05-05-00-00—heading02—Proterozoic—Proterozoic—Proterozoic

> 05-05-01-00-00 – unit01 – XYu – Proterozoic rocks, undivided – Supracrustal etamorphic rocks and plutonic and metaplutonic rocks.