

Projection and 1,000-meter grid: Universal Transverse Mercator, Zone 13S, shown in blue. 10,000-foot ticks: New Mexico Coordinate System of 1983 (Western Zone), shown in re National Hydrography Dataset, 201 1000 0 1000 2000 3000 4000 5000 6000 7000 Feet .FWS National Wetlands Inventory 1977–2014 Public Land Survey System.. Contour Interval 20 Feet North American Vertical Datum of 1988 New Mexico

Quadrangle Location

New Mexico Bureau of Geology and Mineral Resources

New Mexico Tech

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Socorro, New Mexico

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New Mexico Bureau of Geology and Mineral Resources Open-File Geologic Map 251

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Geologic Map of the Williamsburg NW 7.5-Minute Quadrangle, Sierra County, New Mexico

June 2015

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

Comments to Map Users

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Third or middle-upper terrace deposit of Anthropogenic, hillslope, and landslide units **Disturbed or artificial fill (Quaternary)**—Sand and daf gravel that has been moved by humans to form earthen zdams or levees, or has been removed for construction. Colluvium and alluvium, undivided (Holocene to grade. 6-8 m thick.

middle Pleistocene)—Poorly sorted gravel with subordinate silt and sand forming aprons at the base of high angle slopes. Gravel are typically angular to subangular. Maximum thickness 6 m. Landslide deposit (late to middle Pleistocene?)-

Qls Unstratified/massive sand and gravel comprising translational slide material. Light yellowish brown to pale brown (2.5Y 6-7/3) matrix. Gravel is poorly sorted, angular to subrounded, and consists of pebbles, cobbles, and up to 20% boulders. Deposits are located on failure planes formed on weak volcaniclastic material or on over-steepened, fault-bound slopes. Maximum Terrace deposits of Palomas Creek thickness 8 m.

Correlation of Map Units

QTp and Tsml may be conformable toward basin center

Explanation of Map Units

Contact—The identity and existence are certain, or are

questionable where queried. Location is accurate where solid,

Gradational contact—The identity and existence are

certain. Location is accurate where solid and approximate

Intraformational contact—The identity and existence are

certain. The location is approximate. Showing dip of Trp

unknown or unspecified orientation or sense of slip)—The

identity and existence are certain, or are questionable where

queried. Location is accurate where solid, approximate

questionable where queried. Location is accurate where

solid, approximate where dashed, and concealed where

Oblique-slip fault, right-lateral offset—Identity and

existence are certain. The identity and existence are certain,

or are questionable where queried. Location is accurate

where solid, approximate where dashed, and concealed

where dotted. Arrows show relative motion; ball and bar on

Thrust fault—Identity and existence are certain. Location is

Scarp on normal fault—The identity and existence are

certain. Location is accurate where solid and approximate

where dashed. Ball and bar on downthrown block.

Fault in cross section showing local up/down offset—The

Anticline—Identity or existence are questionable. Location

Dike representing **Ti**—Identity and existence are certain.

Dike representing **Tia**—Identity and existence are certain.

Inclined fault—Showing dip value and direction.

Small, minor inclined joint—Showing strike and dip.

Small, minor vertical or near-vertical joint—Showing strike.

Small, minor inclined (dip direction indicated with tic)

joint, for multiple observations at one locality-Showing

Small, minor inclined (dip direction indicated with tic) joint,

for multiple observations at one locality-Showing strike

Small, minor vertical or near-vertical joint, for multiple

observations at one locality-Showing strike. Estimated

Inclined (dip direction to left) bedding, for multiple

Inclined bedding, where top direction of beds is known

Gently inclined (between 0° and 30°) bedding, as

determined remotely or from aerial photographs—Showing

Inclined flow banding, lamination, layering, or foliation in

Vertical flow banding, lamination, layering, or foliation in

Third event of inclined metamorphic or tectonic foliation.

Inclined slickenline, groove, or striation on fault surface (1st

Sediment transport direction determined from imbrication.

Radiometric sample locality—Showing age (if available at

observations at one locality—Showing strike and dip.

from local features—Showing strike and dip.

approximate strike and direction of dip.

igneous rock—Showing strike and dip.

option)—Showing bearing and plunge.

igneous rock—Showing strike.

Fluvial transport direction.

the time of publication).

Vertical or near-vertical fault showing strike.

and dip. Estimated from Mayer (1987).

from Mayer (1987).

Horizontal bedding

is accurate. Large arrowhead shows direction of plunge.

arrows show the relative motion along the fault plane

accurate. Sawteeth on upper (tectonically higher) plate.

where dashed, and concealed where dotted.

dotted. Ball and bar on downthrown block.

Hachures point downscarp.

Cross section line and label.

Location is accurate.

approximate where dashed, and concealed where dotted.

Valley-floor units dominated by modern and historical sediment (<50-600 yr old) ■ Modern alluvium (modern to ~50 years old)— Qam Unconsolidated sandy gravel and gravelly sand underlying channels and forming transverse to longitudinal bars with 0.7-1.25 m of local relief. Thickness likely no more than 3 m. Unit subdivided along two major

drainages in quad.

Modern alluvium of Cuchillo Negro Creek (modern to ~50 years old)—Dark grayish brown (10YR 4/2). Massive trough cross-bedded to well-imbricated. Clast lithologies are approximately 45% andesite+dacite, 30-35% Paleozoic carbonate and detrital sedimentary lithologies, 20% felsite, and 5-10% chert and conglomerate. Lithic sand grains are somewhat less heterogeneous than **Qamp**.

Modern alluvium of Palomas Creek (modern to ~50 years

old)-Gray to grayish brown (10YR 5/1-2). Massive to ippled to well-imbricated. Clast lithologies are approximately 40% andesite, 30% felsite, 15-20% diorite, and 10-15% basalt and Paleozoic sedimentary lithologies. Sand typically contains more mafic and chert grains than **Qamc**.

Modern and historical alluvium, undivided (modern to 600 years old)—Modern alluvium (Qam) and subordinate historical alluvium (**Qah**). See detailed

Historical alluvium (~50 to ~600 years old)—Pebbly sand and sandy gravel underlying very low terraces. Unconsolidated, clast-to-matrix-supported, and tabular to lenticular. Retains bar-and-swale topography with up to 50 cm of relief. May be horizontally laminated. Tread height up to 1.6 m above modern grade. Maximum thickness 3m. Unit subdivided along two major drainages in quad.

Historical alluvium of Cuchillo Negro Creek (~50 to ~600 years old)—Brown (10YR 4/3) matrix. Massive to well-imbricated to trough cross-stratified, sandy pebble-cobble gravel and clayey sand; latter may be norizontally laminated. Clast lithologies dominated b **Tba** and **Tkn** with subordinate **Pa**. Sandy beds typically thinner and more tabular than gravelly beds. Deposit is Terrace deposits of other streams capped by an A horizon (<10 cm thick).

Historical alluvium of Palomas Creek (~50 to ~600 years old)—Brown (10YR 4-5/3) matrix. Internally ripple cross-laminated to planar or trough cross-stratified, silty, very fine-to-fine-grained sand and pebble-cobble gravel; latter are imbricated. Upper 40 cm consists of moderately calcareous, sandy silt and 5-20% clay. Clast lithologies dominated by Tb, Tad, various Eocene-Oligocene

~600 **years** old)—Historical alluvium (**Qah**) and subordinate modern alluvium (Qam). See detailed descriptions for each individual unit. Historical and younger alluvium, undivided (~50 years

Historical and modern alluvium, undivided (modern to

old to early Holocene)—Historical alluvium (**Qah**) and ubordinate younger alluvium (Qay). Recent (historical + modern) and younger alluvium,

undivided (modern to early Holocene)—Recent alluvium

Younger alluvium (Holocene)—Sandy gravel underlying ow terraces. Dark yellowish brown (10YR 3/6). Jnconsolidated, strongly calcareous, tabular, and massive to moderately imbricated. Darker and browner than other valley floor units. Retains subdued bar-and-swale topography with <30 cm of local relief. Dark A horizon is

(Qah + Qam) and subordinate younger alluvium

Younger and modern alluvium, undivided (modern to early Holocene)—Younger alluvium (Qay) and subordinate modern alluvium (Qam). See detailed descriptions for each individual unit.

observed in upper 20 cm. Tread height 1.8-4 m above

Younger and historical alluvium, undivided (~50 years old to early Holocene)—Younger alluvium (Qay) and ubordinate historical alluvium (**Qah**). See detailed (<50-600 yr old) descriptions for each individual unit.

Younger and recent (historical + modern) alluvium, undivided (modern to early Holocene)—Younger ılluvium (Qay) and subordinate recent alluvium (Qah +

Terrace deposits of Cuchillo Negro Creek Terrace deposit of Cuchillo Negro Creek (late to middle Pleistocene)—Imbricated, sandy gravel occurring in fill and strath terrace deposits with surfaces higher than those associated with Qay. Clast compositions are dominated by intermediate to felsic, Eocene-Oligocene volcanic lithologies derived from the Sierra Cuchillo to the west with subordinate Paleozoic sedimentary lithologies

(especially **Pa**). Locally subdivided into four deposits:

First or lowest terrace deposit of Cuchillo Negro Creek (late Pleistocene)—Sandy bebble-cobble-boulder gravel in mostly tabular beds. Yellowish brown (10YR 5/4) matrix. Stage I carbonate morphology (weak carbonate cement). Varnish on 10-15% of clasts at surface. Tread is 5-11 m above modern grade. 1.7-3.8 m thick.

Second or middle-lower terrace deposit of Cuchillo Negro Creek (late Pleistocene)—Sandy pebble-cobble gravel in tabular beds. Brown (7.5YR 4-5/4) matrix. Lower 40 cm moderately well-cemented by clay (bridges). Stage I+ carbonate morphology in upper 50 cm indicated by carbonate coats on 70-90% of clasts. Varnish on 55-70% of clasts at surface. Tread is 15-24 m above modern grade. 4-11 m thick.

Cuchillo Negro Creek (middle Pleistocene)— Sandy pebble-cobble gravel in tabular to lenticular beds. Reddish brown (5YR 5/4) matrix. May be planar cross-stratified. Soil development uncommon (likely eroded). Varnish on 40-45% of clasts at surface. Tread is 28-45 m above modern

Fourth or upper terrace deposit of Cuchillo Negro Creek (middle Pleistocene)—Sandy ebble-cobble-boulder gravel in lenticular to tabular beds. Strong brown (7.5YR 5/6) matrix. May feature vague trough cross-stratification. A 30 cm thick zone of stage III carbonate morphology is observed in places. Varnish on 40-80% of clasts at surface. Tread is 54-67 m above modern grade. 3-11 m thick.

Terrace deposit of Palomas Creek (late to middle **Pleistocene**)—Imbricated, sandy gravel occurring in fill and strath terrace deposits with surfaces higher than those associated with Qay. Clast compositions are dominated by Tad and other volcanic lithologies derived from the eastern Black Range and Garcia Peaks, with subordinate Paleozoic sedimentary lithologies (especially Pa). Locally subdivided into four deposits:

(late Pleistocene)—Sandy pebble-cobble-boulder gravel in broadly lenticular beds. Yellowish brown (10YR 5/4) matrix. Massive to well-imbricated to trough cross-bedded. Occasionally, beds have up to 35% clasts with whole or partial Mn-oxide coats. Stage I+ carbonate morphology observed in upper 1.3 m. Varnish on 10-15% of clasts at surface. Tread is 9-13 m above modern grade. 3-7 m thick.

First or lowest terrace deposit of Palomas Creek

Second or middle-lower terrace deposit of **Palomas Creek (late Pleistocene)**—Sandy pebble-cobble-boulder gravel in tabular beds. Brown (7.5YR 4/3) matrix. Occasional sand lenses. Matrix contains up to 5% clay films. Tread is 14-22 m above modern grade. 2-5 m thick.

> Third or middle-upper terrace deposit of **Palomas Creek (middle Pleistocene)**—Sandy pebble-cobble-boulder gravel in broadly lenticular beds. Brown to light brown (7.5YR 5-6/3) matrix. Well-imbricated with subordinate cross-stratification. Deposit exhibits stage I+ carbonate morphology. Varnish on 40-45% of clasts at surface. Tread is 27-40 m above modern grade. 2-7 m thick.

Fourth or upper terrace deposit of Palomas Creek (middle Pleistocene)—Sandy pebble-cobble-boulder gravel. Brown (7.5YR 4-5/3) matrix. Varnish on 55-75% of clasts at surface. Soil development uncommon (likely eroded). Tread is 48-53 m above modern grade.

Terrace deposit of other streams (late to middle Qtg Pleistocene)—Relatively thin sandy gravel underlying terraces alongside drainages other than Cuchillo Negro and Palomas Creeks. Surfaces typically feature weakly to moderately varnished clasts and exhibit topsoils with weak calcium carbonate accumulation (stage I to II carbonate morphology). Locally subdivided into four deposits:

First or lowest tributary terrace deposit of other streams (late Pleistocene)—Sandy pebble-cobble-boulder gravel in lenticular beds. Brown (7.5YR 4/4) matrix. Unconsolidated and very weakly calcareous. Tread is 5-8 m above modern grade. 3-4 m thick.

Second or middle-lower tributary terrace

Third or middle-upper tributary terrace

deposit of other streams (middle

other streams (middle Pleistocene)—Sandy

gravel in medium to thick, tabular to lenticular

deposit of other streams (late **Pleistocene**)—Sandy pebble-cobble gravel in tabular to lenticular beds. Brown (7.5YR 4/4) matrix. Unconsolidated and massive to imbricated. Surface features very weak desert pavement. Tread is 10-23 m above modern grade. 3-9 m thick.

Pleistocene)—Sandy gravel in medium to thick, tabular to lenticular beds. Unconsolidated and well-imbricated. Tread is 26-30 m above modern grade. 5-6 m thick. Fourth or upper tributary terrace deposit of

beds. Unconsolidated and well-imbricated. Tread is 34-38 m above modern grade. 3-7 m thick. Alluvial-fan units dominated by modern and historical sediment **Modern fan alluvium (modern to ~50 years old)**—Sandy gravel in channels and low-lying bars of modern fan

surfaces. Dark brown (10YR 3/3). Deposit typically contains up to 20% boulders. Unconsolidated and commonly imbricated. Generally inset against **Qfah** or **Qfay**. Maximum thickness 3 m. **Qam**). See detailed descriptions of each individual unit.

Modern and historical fan alluvium, undivided (modern Qfamn to ~600 years old)—Modern alluvium (Qfam) and ubordinate modern alluvium (**Qfah**) deposited on alluvial fans. See detailed descriptions of each individual unit.

Historical fan alluvium (~50 to ~600 years old)—Sandy gravel and pebbly sand underlying alluvial fans graded to he surface of **Qfah**. Brown (7.5YR 4/4) matrix. Unconsolidated, slightly calcareous, and clast-to-matrix-supported. Deposit features upper A horizon up to 11 cm thick; otherwise, little to no soil/carbonate development. 0.6 to perhaps 3 m thick.

Historical and modern fan alluvium, undivided (modern to ~600 years old)—Historical alluvium (**Qfah**) and ubordinate modern alluvium (**Qfam**) deposited on alluvial fans. See detailed descriptions of each individual unit.

> Historical and younger fan alluvium, undivided (~50 **years old to early Holocene)**—Historical alluvium (**Qfah**) and subordinate younger alluvium (Qfay) deposited on alluvial fans. See detailed descriptions of each Recent (historical + modern) and younger fan alluvium,

ary undivided (modern to early Holocene)—Recent fan

individual unit.

alluvium (Qfay). See detailed descriptions of each

Description of Map Units

Alluvial-fan units dominated by younger sediment (~600-11,000 vr old) Younger fan alluvium (Holocene)—Pebbly sand and gravel underlying alluvial fans graded to the surface of **Qfav**. Brown (10YR 4-5/3) matrix. Loose, clast-to-matrix-supported, and tabular to lenticular with wavy beds. Clasts may be in open-framework texture with weak clay films. Deposit is capped by topsoil with a weak 8-12 cm thick A horizon. Stage I+ carbonate morphology occasionally observed. Up to 3 m maximum thickness.

> Younger and modern fan alluvium, undivided (modern to early Holocene)—Younger alluvium (Qfay) and subordinate modern alluvium (**Qfam**) deposited on alluvial fans. See detailed descriptions of each individual unit.

> Younger and historical fan alluvium, undivided (~50 years old to early Holocene)—Younger alluvium (Qfay) and subordinate historical alluvium (**Qfah**) deposited on alluvial fans. See detailed descriptions of each individual unit.

Younger and recent (historical + modern) fan alluvium, ayr undivided (modern to early Holocene)—Younger fan alluvium (Qfay) and subordinate recent fan alluvium (Qfah + Qfam). See detailed descriptions of each

Alluvial-fan deposits graded to lower terraces (late **Pleistocene**)—Sandy pebble-cobble gravel in thin to thick, tabular beds. Light brown to light yellowish brown (7.5-10YR 6/4) matrix. Unconsolidated, strongly calcareous, clast-to-matrix-supported, and massive to weakly imbricated. Stage I carbonate morphology in upper 60 cm of deposit. 3-4 m thick.

Older alluvial fans graded to stream terraces (upper to middle

Alluvial-fan deposits graded to middle-lower terraces (late Pleistocene)—Sandy pebble-cobble-boulder gravel in tabular beds. Reddish brown (5YR 4/4) to brown (7.5YR 5/4) matrix. Unconsolidated, calcareous, and weakly imbricated. Varnish on 60-70% of clasts at the surface. Maximum thickness 4 m.

Alluvial-fan deposits graded to middle-upper terraces (middle Pleistocene)—Sandy pebble-cobble gravel in medium to very thick, tabular beds. Pinkish gray to light brown (7.5YR 6/2-3) matrix. Weakly consolidated, matrix-supported, and massive to weakly imbricated. Features stage II-III carbonate morphology in upper 70 cm. Maximum thickness 5 m.

Palomas Formation of the Santa Fe Group (early Pleistocene to latest Miocene)—Sandy gravel, pebbly sand, and subordinate sandy silt and mud in thin to thick, mostly tabular beds. Lower part is intercalated with basalt flows dated at 5.54-4.57 Ma (40Ar/39Ar). Maximum

> Upper, coarse-grained piedmont facies of the QTpuc Palomas Formation (early Pleistocene)—Sandy pebble-cobble-boulder gravel in medium to thick, tabular to lenticular beds. Yellowish red (5YR 5/6) matrix sand is fine-to-coarse-grained. Clast-supported and massive to imbricated. Rare pebbly sand lenses. Generally unconsolidated but locally features 1-1.5 m thick calcrete (stage IV carbonate morphology) in upper part. Basal contact is scoured. 12-52 m thick.

thickness 257 m. Locally subdivided into five units:

Upper piedmont facies of the Palomas QTpu Formation (early Pleistocene)—Sandy pebble-cobble gravel interbedded with very fine-to-medium-grained sand, silt, and mud. Thin to very thick, tabular to lenticular beds. Reddish brown (5YR 5/4) with minor brown (7.5YR 4/4) beds. Sandy beds may be planar cross-stratified; gravels are commonly imbricated and silt/mud is massive. Cambic and/or calcic paleosols occasionally observed. 20-60 m thick.

Middle piedmont facies of the Palomas QTpm Formation (early Pleistocene to late **Pliocene**)—Pebbly silt/mud to very fine-or fine-grained sand in eastern part of quad. Light brown to pink (7.5YR 6-7/3). Mostly unconsolidated. Massive with common stage II-III carbonate morphology. 20-81 m thick.

Transitional piedmont facies of the Palomas Formation (early Pleistocene to late **Pliocene**)—Pebbly sand and sandy pebble gravel in thin to thick, mostly tabular beds. Commonly brown (7.5YR 4-5/3). Moderately to strongly cemented by calcite, forming prominent ledges. Sand and gravel are massive to planar cross-stratified with occasional pebble imbrication. Little to no clay in matrix. Paleosols uncommon. Maximum thickness 43 m.

Lower, coarse-grained piedmont facies of the QTplc Palomas Formation (late or middle to early Pliocene)—Pebble-cobble gravel/conglomerate. Light brownish gray to pale brown (10YR 6/2-3). Unconsolidated to moderately cemented by calcite. Imbricated and/or planar or trough

cross-stratified. Maximum thickness 73 m. Santa Fe Group basin-fill predating the Palomas

Lower-middle Santa Fe Group, undivided (late to early Miocene)—Pebbly sandstone and conglomerate in thin to thick, tabular to lenticular beds. Yellowish red (5YR 5/6) to light brown (7.5YR 6/4) or very pale brown (10YR 7/3). Moderate silica or calcite cementation. Massive to imbricated to cross-stratified. Likely correlative, in part, to the Rincon Valley Formation of Seager et al. (1971). 150 m thick (Mayer, 1987).

Oligocene)—Dikes, sills, small stocks, and plugs composed of varying mafic to felsic lithologies. → Commonly form prominent ledges or buttes. Andesitic dike (middle Eocene)—Light gray, weathering

Undivided intrusive lithologies (Eocene to

orange-tan, fine-to-medium-grained, intrusive andesite forming dikes up to 30 m wide. Phenocrysts include 3-14% plagioclase, 4-9% hornblende, and trace-2% pyroxene. Chilled margins are 1.5-2.5 m wide.

Andesite-quartz diorite stock (middle Eocene)-Light Tad gray (N 7/), weathering gray to brown (7.5YR 5/1-2), porphyritic, fine-to-coarse-grained, intrusive andesite to guartz diorite. Phenocrysts include 8-10% hornblende, 5% biotite, trace-3% plagioclase, and trace-2% quartz. Forms main body of Garcia Peaks stock. An 40Ar/39Ar-dated sample returned an age of 40.35 +/- 0.05 Ma. Equivalent to units **Td** and **Tqd** of Mayer (1987). Thickness unknown.

Volcanic and volcaniclastic units Basalt flows (early Pliocene to latest Miocene)-Dark gray (N 4/), weathering gray to grayish brown (10YR 5/1-2), aphanitic to aphanitic-porphyritic, very fine-to-medium-grained basalt. Phenocrysts include 2-5% pyroxene and 2-3% olivine. Dense to somewhat vesicular or scoriaceous; commonly contains amygdules filled by calcite, silica, and/or zeolites. Dated at 5.54-4.57 Ma $(^{40}\text{Ar}/^{39}\text{Ar})$. 12-20 m thick.

Basaltic andesite (late Oligocene?)—Aphanitic to aphanitic-porphyritic basaltic andesite; observed phenocrysts are fine-grained. Likely correlates to unit **Tba2** of Jochems et al. (2014) in the Hillsboro quadrangle and Ta units of Jahns et al. (2006) in the Chise quadrangle.

Subdivided into two units:

Upper basaltic andesite (late Oligocene?)— Very dark gray to gray (N 3-5/), weathering ight brown to grayish brown (10YR 4/3 to 6/2). Dense/non-vesicular and occasionally foliated (flow layering). Phenocrysts include 2-4% pyroxene and trace-2% olivine. Contains trace glass and disseminated magnetite. Correlates to unit Tyaf of Heyl et al. (1983). 10-20 m thick.

| Lower basaltic andesite (late Oligocene?)-Black (10YR 2/1) to very dark gray or dark gray (10YR-2.5Y 3-4/1), weathering grayish brown (10YR 4-5/2) to gray (2.5Y 6/1). Typically vesicular and thinly foliated (flow layering). Phenocrysts include trace-2% pyroxene and trace olivine and plagioclase set in a slightly glassy groundmass. Up to 5% amygdules filled by calcite or silica. Correlates to unit Tb of Heyl et al. (1983). 32-57 m thick.

Dacitic lava flows and tuffs (late Oligocene?)—Aphanitic to porphyritic, fine-to-medium-grained, dacitic flows, tuffs, tuff breccia, and minor interbedded volcaniclastic sediment. Correlates to Td units of Jahns et al. (2006) in the Chise quadrangle. Includes four subunits:

Upper dacitic tuff and tuff breccia, with subordinate flows (late Oligocene?)—Weak red (10R 4/4) to very dark gray (5YR 3/1), weathering reddish brown (2.5YR 4-5/4) or dark reddish gray (5YR 4/2). Dense to vesicular and porphyritic; phenocrysts include 2-16% plagioclase, 1% quartz, and trace amounts of biotite, sanidine, and pyroxene. Tuff and tuff breccia contain 10-20% fragments of pumice, typically non-to-weakly welded. 18-25 m thick.

Vitrophyre (late Oligocene?)—Black (N 2.5/), weathering dark grayish brown to grayish brown (10YR 4-5/2), aphanitic-porphyritic, fine-to-medium-grained vitrophyre at base of Tdu. Phenocrysts include 3-6% plagioclase set in a glassy groundmass. Contains deformed xenoliths of dusky red (10R 3/3), flow-banded, aphanitic lava. 2-11 m thick.

Siltstone to very fine-grained sandstone in thin beds. Light grayish olive (10Y 6/2) and non-calcareous. Exhibits planar cross-stratification with foresets 15-20 cm thick. Fills paleovalleys cut into Tdl. Maximum thickness 20 m.

Lower dacitic flows (late Oligocene?)—Dark gray (7.5YR 4/1), weathering brown (7.5YR 4/2). Vesicular and aphanitic-porphyritic; phenocrysts include 2-4% plagioclase, 2% hornblende, 1-2% biotite, and trace pyroxene. Contains 5-10% amygdules filled by calcite or silica. 15 m thick.

| Kneeling Nun and Sugarlump Tuffs, undivided (late **Eocene**)—Mapped by vantage reconnaissance and air photo interpretation due to land access restrictions.

■ Kneeling Nun Tuff (late Eocene)—Pinkish gray (5YR 6/2), weathering brown (7.5YR 4-5/3), non-welded, slightly vesicular, porphyritic, fine-to-medium-grained, rhyolitic tuff. Phenocrysts include 12-15% sanidine, 7-10% quartz, and trace-2% biotite. Contains 1-2% lithic fragments and pumice. 40Ar/39Ar-dated at 35.34 +/- 0.10 Ma (McIntosh et al., 1991). 12-18 m thick.

Sugarlump Tuff (late Eocene)—White (N 8.5-9/), weathering grayish brown (10YR 5/2), non-welded, aphanitic-porphyritic, fine-to-medium-grained, lithic tuff. Phenocrysts include 1-6% biotite and trace-2% hornblende. Contains 7-8% andesitic fragments and 5-8% pumice fragments. 40Ar/39Ar-dated at 35.63 +/- 0.15 Ma (McIntosh et al., 1991). Maximum thickness 33 m.

Rubio Peak Formation (late to middle Eocene)—Laharic breccia, conglomerate, and tuffaceous sandstone in thin to very thick beds. Minor laminated mudstone. Variable color, including light reddish brown (2.5YR 6/3) to dark gray (2.5Y 4/1). Weakly to strongly consolidated, clast-to-matrix-supported, and massive to imbricated Commonly silica-cemented. Maximum thickness >1000 m. Frequently interbedded with andesite:

Andesitic flows of the Rubio Peak Formation oa (late to middle Eocene)—Light gray, weathering buff, porphyritic, fine-to-medium-grained, equigranular

andesite. Phenocrysts include 10-12% plagioclase and 5-7% hornblende. Typically around 4 m thick.

■ **Abo** Formation (Wolfcampian)—Sandstone and siltstone in thin beds. Red to yellow where altered Rippled to cross-stratified. 84 m thick [Description modified from Mayer, 1987].

Bar-B Formation (Desmoinesian to Virgilian)— Pb Limestone and mudstone with subordinate shale and conglomerate. Limestone is typically thin-bedded and nodular with brachiopods, bryozoans, crinoids, and gastropods. Mudstone is red, calcareous, and interbeds with chert to quartz-rich pebble conglomerate in the upper part of the unit. 116 m thick [Description modified from Mayer, 1987].

Nakaye Formation (Atokan to Desmoinesian)-Pn Grainstone to micritic wackestone and packstone. Lacy to globular chert occurs in micritic beds, whereas chert lenses/beds and nodules occur in grainstone and packstone. Fossils include horn corals, forams, crinoids, brachiopods, and bryozoans. 105 m thick [Description modified from Mayer, 1987]. Cross section only.

Red House Formation (Morrowan to Atokan)—Shale and subordinate limestone, siltstone, and conglomerate Shale is black, red, or green and fissile. Limestone features lacy chert near top of unit and contains forams and phylloid algae among other fossils. Conglomerate is cross-stratified and quartzose, and occurs in the upper part of the unit. 151 m thick [Description modified from Mayer, 1987]. Cross section only.



FIGURE 1—Pliocene basalt flow (unit **Tb**, above) resting on reddish lower, coarse-grained facies of the Palomas Formation (unit **QTplc**, below) southwest of San Miguel church (sec. 10, T. 13 S., R. 6 W.). Note nearly horizontal beds of **QTplc**, deposited in proximal environments of the paleo-Palomas Creek alluvial fan complex. An 40Ar/39Ar sample from nearby **Tb** exposures yielded an age of 4.57 ± 0.02 Ma for the lowest flow.

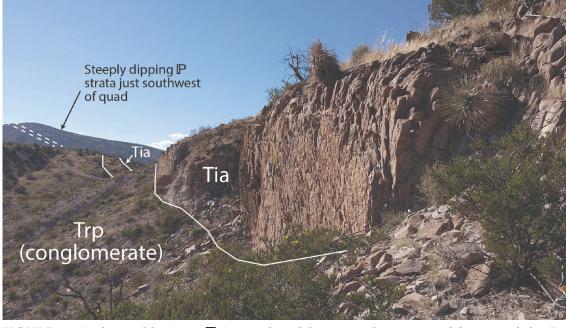
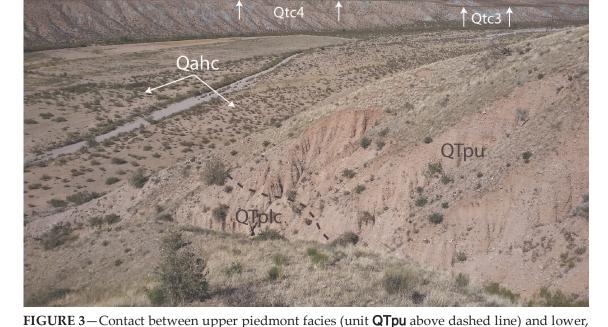


FIGURE 2—Andesite dike (unit Tia) intruding laharic conglomerate and breccia of the Rubio Peak Formation (unit **Trp**) in sec. 31, T. 13 S., R. 6 W. Plagioclase- and hornblende-bearing dike is up to 30 m wide and does not intrude strata younger than Eocene in age. Dipping Pennsylvanian beds just southwest of quad boundary are located in the footwall of a north-vergent thrust fault in the Salado Mountains.



coarse-grained piedmont facies of the Palomas Formation (unit QTplc, below). Contact may be sharp and scoured or planar to gradational over ~3-5 m. Cuchillo Negro Creek flows through middle ground (looking downstream toward east-northeast). Historical alluvium nit **Qahc**) and middle to late Pleistocene terrace deposits (units **Qtc4** and **Qtc3**, treads above white arrows) are also shown. Sec. 25, T. 12 S., R. 6 W.

