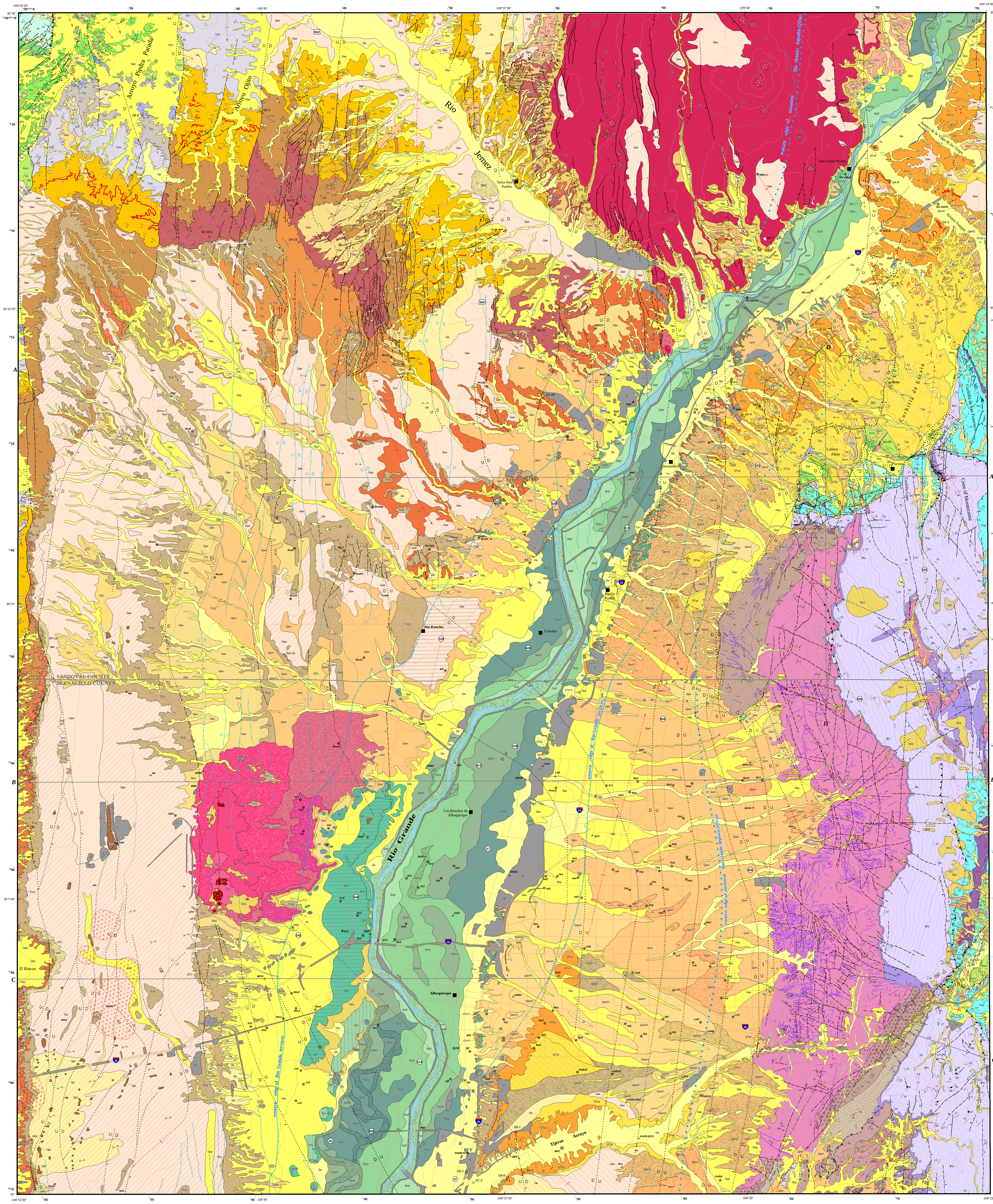


Topographic (elevation) Contour Interval = 150 feet

Explanation of Map Units

GEOMORPHIC SURFACES

Depositional

Unit	Description
▥	***Primero Alto terrace surface (upper Pleistocene)*** — depositional top of Arenal Formation (**Qra**); exhibits weakly developed calcic soils with stage I-II carbonate morphology developed on gravel; originally defined by Lambert (1968) for his Edith Formation on west side of Rio Grande; 15-21 m above Rio Grande flooplain.
☰	***Segundo Alto terrace surface (middle Pleistocene)*** — depositional top of Los Duranes Formation (**Qrd**) and intermediate stream-valley alluvium (**Qam**); exhibits weakly developed calcic soils with stage I-II carbonate morphology; defined by Lambert (1968); 42-48 m above Rio Grande floodplain.
▧	***Sunport and Las Huertas geomorphic surfaces complexes (lower Pleistocene)*** — local depositional top of Sierra Ladrones Formation (**QTsp**); exhibits strongly developed petrocalcic soils with stage III+ carbonate morphology; Sunport surface defined by Lambert (1968); Las Huertas surface defined by Connell and Wells (1999) north and northwest of Sandia Mountains; 92-122 m above Rio Grande floodplain.
▨	***Llano de Albuquerque geomorphic surface complex (upper Pliocene-lower Pleistocene(?))*** — depositional top of Ceja Formation (**Tc, Tcrg**); exhibits strongly developed petrocalcic soils with stage III+ to locally weak stage IV carbonate morphology; dashed hachures denote inferred relict surfaces; modified after Machette (1985); 215-110 m above Rio Grande floodplain.
▨	***Lomos Altos geomorphic surface (upper Pliocene)*** — depositional top of gravel of Lomos Altos (**QTta**), exhibits strongly developed petrocalcic soils with stage IV carbonate morphology; defined by Connell and Wells (1999); 21-92 m above local base level.

Erosional

Unit	Description
▩	***Pediment surface (upper Pliocene(?)-Pleistocene)*** — erosion surface, mostly cut on Sandia granite (**Ys**); common along southwestern flank of Sandia Mountains, Tijeras Canyon, and northern Manzanita Mountains.

SURFICIAL DEPOSITS

Unit	Description
af	**Disturbed land and artificial fill (af, modern-historic)** — excavations and areas of artificially deposited fill and debris; delineated where areally extensive; includes deposits associated with floor of Jemez Reservoir.
Qpl	**Playa-lake deposits (Qpl, Holocene-upper Pleistocene)** — silt, mud, and sand in local depressions on low-relief surfaces; less than 2 m thick.
Qe	**Eolian sand, undivided (Qe, Holocene-upper Pleistocene)** — pink to light yellowish-brown, well-sorted sand recognized as laterally extensive, active and inactive sand sheets and discontinuous low-relief dunes; soil development is weak (stage I to II+ carbonate morphology) to nonexistent; north to northeast dune-crest orientations; 1-3 m thick
Qed	**Eolian sand dune (Qed, Holocene-upper Pleistocene)** — pink to light yellowish-brown, well sorted sand primarily recognized as moderate-relief narrow dunes; weakly developed soils with stage I to II carbonate morphology; 1-33 m thick.
Qls Tls	**Landslide debris (Qls, Pleistocene) and landslide megablock (Tls, Miocene(?) or Pliocene)** — massive to chaotically bedded sand, gravel, and mud derived from steep hill slopes; includes large Toreva blocks along margin of Santa Ana Mesa; older **landslide megablocks (Tls)** are large allocthonous blocks of Madera Group limestone resting on sheared Sandia granite (**Ys**) along the southwestern base of Sandia Mountains; 6-30 m estimated thickness.
Qca	**Colluvium and alluvium, undivided (Qca, Holocene-Pleistocene)** — sand and gravel from nearby hill slopes and along margins of mesa-capping lavas; weakly to strongly developed calcic soils (stage I to III+ carbonate morphology); up to 5 m estimated thickness.
Qae	**Eolian sand and alluvium, undivided (Qae, Holocene-upper Pleistocene)** — pale-brown to light reddish-brown, moderately sorted, sand and silt with scattered pebbles; weakly to moderately developed soils with stage I to II carbonate morphology and clay films; 1-3 m thick.
QTc	**Calabacillas Formation (QTc, upper Pliocene(?)-Pleistocene)** — pale-brown to yellowish-brown sand with interbedded pebbly sand, mud, and multiple buried calcic paleosols (stage I to III+ carbonate morphology); associated with hanging walls of intrabasinal faults (e.g., San Ysidro fault); generally poorly exposed; defined by Connell (*in preparation*); 0-30 m thick.

PIEDMONT-SLOPE

Unit	Description
Qpy	**Younger piedmont-slope alluvium (Qpy, Holocene-upper Pleistocene)** — light-brown sand, muddy sand, and pebble to cobble gravel; boulders locally present along front of the Sandia Mountains; weakly developed soils (up to stage I carbonate morphology); up to 12 m thick.
Qpm Qpm2 Qpm1	**Intermediate piedmont-slope alluvium (Qpm, middle Pleistocene)** — pale- to strong-brown silty sand, clayey sand and gravel; contains weakly to moderately developed soils (stage II, III+ carbonate morphology); divided into **older (Qpm1)** and **younger (Qpm2)** subunits; 9 m thick.
QTp	**Older eastern-slope alluvium, undivided (QTp, upper Pliocene(?)-lower Pleistocene)** — cobble and boulder gravel along eastern dip-slope of Sandia Mountains; dominated by rounded limestone clasts; surface is commonly partly stippled and locally exhibits stage III+ carbonate morphology; may be partly correlative to the Tuerto Formation; up to 10 m thick.

RIO GRANDE VALLEY GROUP (SEDIMENTARY)

Fluvial (terrace) deposits of the Rio Grande

Unit	Description
Qrp* Qrpc Qrpf Qrpy Qrpyc Qrpm Qrpmc Qrpo Qrpoc	**Las Padillas Formation (Qrp, historic-upper Holocene)** — fluvial deposits of the Rio Grande; pinkish-gray to grayish-brown sand and pebbly sand with lenses of reddish-brown silt and clay; contains paleochannel, point-bar, and overbank levee deposits; underlies modern (inner) valley of the Rio Grande; very weak to no soil development; base not exposed; 15-34 m thick in wells; proposed by Connell and Love (2001); divided into 8 units based largely on surface morphology (Kelson et al., 1999): **Modern channel deposits (Qrpc, historic)** — active channel and floodplain of Rio Grande since 1951. **Modern floodplain deposits (Qrpf, historic)** — channel and floodplain of Rio Grande prior to 1930s. **Younger channel and floodplain deposits (Qrpy) and younger channel (Qrpyc) deposits (historic-upper Holocene)** — sand, silt, and clay with gravelly interbeds. **Intermediate channel and floodplain (Qrpm) and intermediate channel (Qrpmc) deposits (upper Holocene)** — sand, silt, and clay with gravelly interbeds. (**Older channel and floodplain (Qrpo) and older channel (Qrpoc) deposits (upper Holocene)** — sand, silt, and clay with gravelly interbeds.
Qra	**Arenal Formation of (Qra, upper Pleistocene)** — pale- to yellowish-brown pebbly to cobbly sand; weakly developed soil (stage I to II+ carbonate morphology on gravel) on *Primero Alto terrace surface* ; inset against Los Duranes Formation (**Qrd**); proposed by Connell and Love (2001); 3-6 m thick.
Qrd	**Los Duranes Formation (Qrd, middle Pleistocene)** — pale-brown to light reddish-brown sand, sandy gravel and sandy clay; weakly developed soil (Stage I carbonate moprhology on sand) on *Segundo Alto terrace surface* ; inset against Lomatas Negras Formation (**Qrl**); locally subdivided into the Menaul Member (**Qrm**); defined by Lambert (1968); 40-52 m thick.
Qrm	**Los Duranes Formation, Menaul Member (Qrm, middle Pleistocene)** — yellowish-brown pebble gravel and pebbly sand; probably a coarse-grained lens of Los Duranes Formation; overlies intermediate stream-valley deposits (**Qam1**) and Edith Formation (**Qre**); typically overlain by intermediate stream-valley deposits of unit **Qam2**; originally defined as Menaul formation by Lambert (1968); 26-36 m above Rio Grande floodplain; less than 3 m thick.
Qre	**Edith Formation (Qre, middle Pleistocene)** — pale-brown to yellowish-brown pebble and cobble gravel, sand and sandy clay typically exhibiting a single upward-fining succession; locally contains white diatomite bed; disconformably overlain by intermediate stream-valley alluvium (**Qam, Qam2, Qam1, Qamt2**) and Menaul Member of the Los Duranes Formation (**Qrm**) deposits; 12-24 m above Rio Grande floodplain; defined by Lambert (1968); 2-12 m thick.
Qrl	**Lomatas Negras Formation (Qrl, middle Pleistocene)** — pale-brown to pink sandy pebble to cobble gravel that unconformably overlies a low-relief strath cut on the Ceja Formation (**Tc, Tcs**); disconformably overlain by older stream-valley alluvium; oldest inset terrace deposits of the ancestral Rio Grande; 65-75 m above Rio Grande floodplain; proposed by Connell and Love (2001); commonly 3-12 m thick, but locally reaches 18 m in thickness near the mouth of Arroyo de las Calabacillas.
Qru	**Undivided ancestral Rio Grande deposits (Qru, upper-middle Pleistocene)** — undivided fluvial deposits associated with the ancestral Rio Grande in the San Felipe Pueblo quadrangle; probably correlative to Los Duranes and Edith Formations (**Qrd, Qre**).

Tributary stream-valley alluvium

Unit	Description
Qa	**Active stream-valley alluvium (Qa, historic-Holocene)** — light grayish- to yellowish-brown sand, silty to clayey sand, and gravel; boulders are common along the western flank of the Sandia Mountains; associated with modern incised stream valleys; very weakly developed (stage I carbonate morphology) to nonexistent soils; 1-12 m thick.
Qay	**Younger stream-valley alluvium (Qay, upper Pleistocene-Holocene)** — pale- to light-brown sand, muddy sand, and pebble to cobble gravel; boulders locally present along front of the Sandia Mountains; weakly developed soils (Stage I and II carbonate morphology); locally contains active stream-valley alluvium (**Qa**); radiocarbon dates on detrital charcoal yielded radiocarbon ages of 1790±90 and 4550±140 radiocarbon years (*SC-1* and *SC-2*, Table 1); up to 24 m thick.
Qam Qam2 Qam1	**Intermediate stream-valley alluvium (Qam, Qam1, Qam2, upper-middle Pleistocene)** — yellowish-brown to reddish-yellow sand, silty clay, and gravel; granite and limestone clasts dominant east of Rio Grande; variable lithology, dominated by chert and volcanic clasts west of the Rio Grande; surface is commonly mantled by eolian sand; variable soil development; divided into two subunits: **Younger subunit (Qam2)** contains moderately developed soils (stage II and III carbonate morphology); **Older subunit (Qam1)** contains weakly developed soils (stage II carbonate morphology); 5-43 m thick.
Qamt Qamt3 Qamt2 Qamt1	**Intermediate stream-valley alluvium of Tijeras Canyon (Qamt, Qamt1, Qamt2, Qamt3, middle Pleistocene)** — sand and gravel associated with former drainage courses of Tijeras Canyon; gravel composition more diverse than in intermediate stream-valley alluvium (**Qam**) and contains greenstone and sandstone; interfingers with intermediate stream-valley alluvium; divided into three subunits: **Younger subunit (Qamt3), Intermediate subunit (Qamt2)**, and **Older subunit (Qamt1)**; 5-43 m thick.
Qao Qao4 Qao3 Qao2 Qao1	**Older stream-valley alluvium (Qao, Qao1, Qao2, Qao3, Qao4, middle Pleistocene)** — light reddish-brown sand and gravel; soil development is variable and exhibits stage I to III carbonate morphology with few or no clay films; divided into four subunits based on surface morphology, soil development, and inset relationships (from youngest to oldest): **subunit 4 (Qao4), subunit 3 (Qao3), subunit 2 (Qao2), and subunit 1 (Qao1)**; 2-14 m thick.
Qaot2 Qaot1	**Older stream-valley alluvium of Tijeras Canyon (Qaot2, Qaot1, middle Pleistocene)** — sand and gravel derived from former drainage courses of Tijeras Canyon; divided into two subunits: **younger subunit (Qaot2)** and **older subunit (Qaot1)**; 0-15 m thick.

SANTA FE GROUP (SEDIMENTARY)

upper

Unit	Description
QTt QTta	**Tuerto Formation (QTt, QTta, upper Pliocene-lower Pleistocene)** — pale-brown pebbly to cobbly sandstone; unconformably overlies units **QTsp** and **Tsp**; locally capped by petrocalcic soils with stage III+ to IV+ pedogenic carbonate morphology; clasts are predominantly limestone; Tuerto gravels of Stearns (1953); includes the: **gravel of Lomos Altos of Connell and Wells (1999) (QTta)** west of the San Francisco fault, where the basal contact is 80-100 m above local base level; 4-18 m thick.
QTsa	**Sierra Ladrones Formation, axial-fluvial member (QTsa, Miocene(?), Pliocene-lower Pleistocene)** — light-gray to yellowish-brown sand, pebbly to cobbly sand, and sparse interbedded mud; clasts dominated by rounded othoquartzite and volcanic rocks; deposits associated with the ancestral Rio Grande; interfingers with piedmont member (**QTsp**); contains early Irvingtonian mammalian fossils (*SB-1*, Table 1); base not exposed; estimated thickness more than 300-800 m.
QTsp	**Sierra Ladrones Formation, piedmont member (QTsp, Miocene(?), Pliocene-lower Pleistocene)** — reddish- to yellowish-brown conglomerate, sandstone, and minor mudstone; contains weakly developed paleosols and upward-fining sequences of gravel, sand, and mud; contains limestone, sandstone and granite clasts; sparse hypabyssal intrusive clasts present at northeastern end of map area; generally poorly consolidated; interfingers with axial-fluvial member (**QTsa**); 0-600(?) m thick.
Tc Tcrg Tcau Tca Tcs	**Ceja Formation (Tc, Tcrg, Tcau, Tca, Tcs, Pliocene-lowest Pleistocene(?))** — sand, gravel, and mud derived from western and northwestern Albuquerque basin; disconformably overlies Arroyo Ojito Formation (**Ton** and **Top**) and generally coarsens upsection; defined by Kelley (1977); contains Blancan mammalian fossils (*SB-2*, Table 1); 20-700(?) m thick; divided into three members and one subunit: **Upper sand and gravel member (Tcrg), Pliocene-lower Pleistocene(?))** — pale-brown to yellowish-brown cobbly sand and gravel with scattered boulders; top is defined by *Llano de Albuquerque surface*; 20-260(?) m thick; generally less than 100 m thick west of Rio Grande Vallley. **Atrisco Member (Tca, Pliocene)** — pink to yellowish-brown sandstone, pebbly sandstone, and mudstone; interpreted to interfinger with Sierra Ladrones Formation (**QTsa**) to east; rests on Arroyo Ojito Formation (**Ton, Top**) and *Rincones paleosurface*; locally subdivided into **upper sandy subunit (Tcau)**; defined by Connell et al. (1998a); 20-600(?) m thick. **Santa Ana Mesa Member (Tcs, Pliocene)** — reddish-brown to yellowish-red sandstone, conglomerate, and mudstone; modified from Soister (1952) for exposures beneath Santa Ana Mesa; interfingers with axial-fluvial memeber of Sierra Ladrones Formation (**QTsa**); contains thin bed of fallout ash yielding a single-crystal $^{40}Ar/^{39}Ar$ date on hornblende of 3.81±0.29 Ma (*SA-15*, Table 1); 100-600(?) m thick.
QTct	**Cochiti Formation (QTct, upper Miocene-lower Pleistocene)** — light-brown sandstone and pebbly and cobbly sandstone; clasts are predominantly mafic and intermediate volcanic rocks; recognized below and above basaltic lavas of the San Felipe volcanic field; interfingers with axial-fluvial member of the Sierra Ladonres Formation (**QTsa**); usage after Smith and Kuhle (1998); base not observed, but more than 50 m thick.

middle

Unit	Description
Tpc	**Cochiti Formation and Peralta Tuff Member of the Bearhead Rhyolite (Tpc, upper Miocene)** — pale-brown, tuffaceous conglomerate and sandstone; contains pumice-bearing intervals, Apache tears obsidian, and lapilli and ash of the Peralta Tuff; single-crystal $^{40}Ar/^{39}Ar$ date on sanidine of 7.05±0.06 Ma (*SA-24*, Table 1); 0-200 m thick.
To* Top Tob Ton	**Arroyo Ojito Formation (1999) (To, Ton, Tob, Top, upper Miocene)** — gravel-bearing fluvial deposits derived from north and northwest of the Albuquerque basin; defined by Connell et al. (1999) and modified by Connell (*in preparation*); 437-456 m thick at type section in Arroyo Ojito; divided into three conformable members: **Picuda Peak Member (Top)** — pinkish-gray to reddish-yellow cobbly sandstone and conglomerate; contains abundant red granite clasts; locally capped by petrocalcic soil with stage III+ and V pedogenic carbonate morphology (*Rincones paleosurface*); 10-50 m thick; **Loma Barbon Member (Tob)** — pink to reddish-yellow sandstone, mudstone, and pebble to cobble conglomerate; contains scattered sandstone boulders and abundant granite clasts; contains fallout of Peralta Tuff (single-crystal $^{40}Ar/^{39}Ar$ dates on sanidine range from 6.85-7.14 Ma, *SA-20* through *SA-23*, Table 1); 200 m thick; **Navajo Draw Member (Ton)** — yellowish-brown to pale-brown pebbly sandstone and yellow to reddish-yellow mudstone; contains abundant rounded chert and intermediate volcanic tuff clasts; contains Oligocene tuff cobbles (Connell et al., 1999); 230 m thick.
Tcc	**Cerro Conejo Formation (Tcc, middle-upper Miocene)** — pink to very pale-brown tabular and cross-stratified sandstone with thin to medium bedded mudstone; contains sandstone concretions and volcanic fallout ashes (11.3-10.8, *SA-25* through *SA28*, Table 1), and late Barstovian mammalian fossils (*SB-3, SB-4*, Table 1); base is probably disconformable with the Zia Formation; top may be disconformable with Arroyo Ojito Formation to west, but interfingers with Navajo Draw Member to east; originally defined as Cerro Conejo Member (Zia Formation) by Connell et al. (1999), but elevated to formation rank based on mappability; 245-316 m thick.

lower

Unit	Description
Tz* Tzr Tzm Tzp	**Zia Formation (Tz, lower-middle Miocene)** — cross-stratified sandstone and mudstone; unconformably overlies Galisteo and Menefee Formations (**Tg, Kvm**) and unit of Isleta well #2 (**Tis**, in subsurface, see Plate 2); defined by Galusha (1966) and Gawne (1981) and contains late Arikareean through Hemmingfordian mammalian fossils (*SB-5*, Table 1; Galusha, 1966) and divided into three members: **Cañada Pilares Member (Tzr, middle Miocene)** — red mudstone and sandstone; discontinuously exposed; defined by Gawne (1981); 8-75 m thick. **Chamisa Mesa Member (Tzm, middle Miocene)** — pale-brown to light reddish-brown cross-stratified fluvial and eolian sandstone and mudstone; 30-200 m thick. **Piedra Parada Member (Tzp, lower-middle Miocene)** — whitish-gray to pinkish-gray cross-stratified sandstone, eolian in origin; 70-122 m thick.
Tsp	**Eastern basin-margin piedmont deposits, undivided (Tsp, upper Oligocene(?)-Miocene)** — pale-brown to reddish-brown conglomerate and sandstone with minor mudstone; contains abundant clasts of limestone and sandstone in northern Sandia Mountains; dark-gray hornfels and hypabyssal intrusive clasts from the Ortiz Mountains increase in abundance to the north; contact with overlying Sierra Ladrones Formation piedmont member deposits (**QTsp**) is indistinct and approximate; 150-800 m thick.

PRE-SANTA FE GROUP SEDIMENTARY

Unit	Description
Tg	**Galisteo Formation (Tg, Eocene)** — variegated red, green, purple and gray mudstone with intercalated thin beds of yellowish-brown, cross-bedded, arkosic sandstone and conglomerate; defined by Stearns (1943); unconformably overlies Menefee Formation; upper contact gradational with Espinaso Formation exposed northeast of map area; contains Duchesnean (Eocene) fossils; exposed thickness is 133 m; regional thickness ranges from 22 to 979 m.
Td	**Diamond Tail Formation (Td, Paleocene(?)-Eocene)** — dark-red and gray variegated sandstone and mudstone with scattered pebbly sandstone; defined by Lucas et al. (1997); unconformably overlain by Galisteo Formation; contains Wasatchian (late Paleocene-early Eocene) fossils; exposed thickness is 133 m; regional thickness ranges from 100 to 442 m.

Mesaverde Group

Unit	Description
Kvp	**Mesaverde Group, Point Lookout Sandstone (Kvp, Upper Cretaceous)** — grayish-tan to light-yellow, very fine- to fine-grained, massive, quartzose sandstone with limonitic sandstone lenses and interbedded thin gray shale; 73 m thick.
Kvm	**Mesaverde Group, Menefee Formation (Kvm, Upper Cretaceous)** — white to light-yellow fine- to medium-grained, well sorted, lenticular, cross-stratified, quartzose sandstone with interbeds of dark-gray to black siltstone and carbonaceous shale and coal; 205-365 m thick.

Mancos Shale

Unit	Description
Kms	**Mancos Shale, Semilla Sandstone (Kms, Upper Cretaceous)** — dark-gray shale and tan to yellow, planar laminated siltstone overlain by well sorted, well rounded, fine-grained and horizontally bedded sandstone; in lower part of Mancos Shale; 20 m thick.
Kmh	**Mancos Shale, Hosta-Dalton Sandstone (Kmh, Upper Cretaceous)** — yellowish-gray to yellowish-tan, very fine- to medium-grained, weakly cemented, fossiliferous sandstone with olive-brown sandstone lenses; 64-112 m thick.
Km	**Mancos Shale, undivided (Km, Upper Cretaceous)** — medium- to dark-gray to olive-gray, shale, silty shale and calcareous shale; divided into lower and upper shale by Hosta-Dalton Sandstone (**Kmh**); upper shale includes thin, regionally recognizable marker beds such as the Greenhorn Limestone and Juana Lopez Member; upper shale is correlative to the Graneros-Niobrara interval of the southern High Plains and San Juan Basin; total thickness ranges between 330-675 m.

Unit	Description
Kd	**Dakota Fm (Kd, Upper Cretaceous)** — light- to yellowish-gray and brown, silica-cemented quartzose sandstone; overlain by and interbedded with dark-gray to olive-gray shale of the Mancos Shale; 8-40 m thick.
Ju	**Jurassic sedimentary rocks, undivided (Ju, Middle-Upper Jurassic)** — light-brown to pale-orange cross-stratified sandstone, dark-gray, thinly laminated limestone, gray gypsum, brown silty sandstone, pale-orage to grayish-red, variegated feldspathic cross-stratified sandstone, conglomerate and mudstone; includes deposits of the *San Rafael Group (Entrada, Todilto, and Summerville Formations)* and *Morrison Formation*; 310 m thick.
ŦRu	**Triassic sedimentary rocks, undivided (ŦRu, Middle-Upper Triassic)** — red mudstone, trough cross-bedded sandstone, and conglomerate with petrified wood overlain by pale-orange, mica-bearing fluvial sandstone; includes deposits of the *Chinle Group* and *Moenkopi Formation*: 400-500 m thick.
Psg	**San Andres and Glorieta Formations, undivided (Psg, Upper Permian)** — light-gray to tan, locally karstic limestone and grayish-white cross-stratified quartzose sandstone; 15-77 m thick.
Pay	**Abo and Yeso Formations, undivided (Pay, Lower Permian)** — pale-red and grayish-red mudstone and grayish-white to light-orange lenticular, cross-stratified arkosic sandstone, siltstone, claystone and beds of gypsum and gypsiferous sandstone; 500 m thick.
IPm	**Madera Group, undivided (IPm, Pennsylvanian)** — gray, ledge-forming, cherty limestone with interbedded argillaceous limestone of the *Gray Mesa Formation*; overlain by fossiliferous limestone with interbedded sandstone and mudstone of the *Atrasado Formation*; uppermost part of unit includes mixed marine carbonate and nonmarine clastic sediments; 385-402 m thick.
IPs	**Sandia Formation and Arroyo Peñasco Group, undivided (IPs, Pennsylvanian-Mississippian)** — quartz-pebble conglomerate, sandstone, and dolostone (Arroyo Peñasco Group) and interbedded brown claystone and gray limestone (Sandia Formation); 37-81 m thick.

CENOZOIC VOLCANIC & IGNEOUS

includes Santa Fe Group volcanic

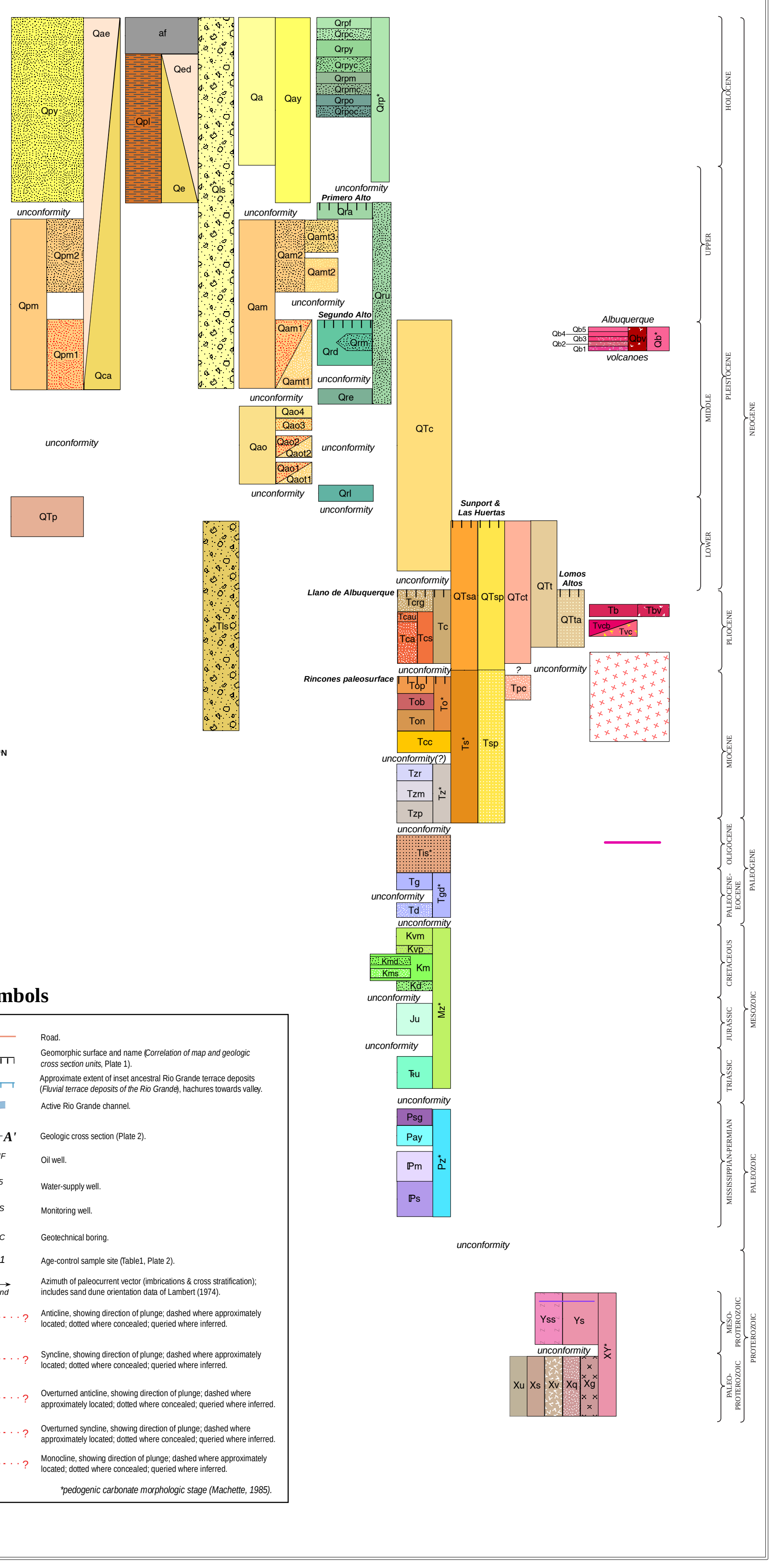
Unit	Description
Qb* Qb5 Qb4 Qb3 Qb2 Qb1	**Basaltic lavas of the Albuquerque volcanoes (Qb, middle Pleistocene)** — vesicular olivine tholeiite lava flows locally divided into five flows (**Qb1-Qb5**) based on surface morphology and stratigraphic position (modified from Kelley and Kudo, 1978; and Thompson et al., *in preparation*); whole-rock $^{238}U/^{230}Th$ date of 0.156±0.02 Ma (Peate et al., 1996); generally less than 15 m thick.
Qbv *	**Vents of the Albuquerque volcanoes (Qbv, middle Pleistocene)** — larger cinder and spatter cones of Albuquerque volcanoes volcanic field; smaller vents denoted by asterisk (*).
Tb Tbv	**Basaltic lavas of Santa Ana Mesa (San Felipe volcanic field) (Tb, upper Pliocene)** — tholeiitic flood basalts and vents (**Tbv**) forming Santa Ana Mesa; whole-rock $^{40}Ar/^{39}Ar$ dates of 1.78±0.21 and 2.60±0.11 Ma (*SA-7* and *SA-8*, Table 1); ; 6-30 m thick.
Tvc Tvcb	**Tuff of Canjilon Hill (Tvc, upper Pliocene)** — oval-shaped tuff-breccia diatreme that intrudes Santa Ana Mesa Member (**Tcs**, Ceja Formation) south of Santa Ana Mesa; includes basaltic lavas, dikes, and brecciated lava flows (**Tvcb**); whole-rock $^{40}Ar/^{39}Ar$ date on basaltic dike of 2.54±0.43 Ma (*SA-9*, Table 1).
× × ×	**Buried igneous rocks inferred from aeromagnetic anomalies (Miocene-Pliocene)** — probable buried intrusive or volcanic rocks recognized by areas of higher relative value (>180 nT) on high-resolution aeromagnetic anomaly maps (Kucks et al., 2001) and locally encountered in drillholes; buried features may extend beyond lateral limit of unit.
—	**Mafic dike (Paleogene)** — dark-gray, steeply dipping dike of mafic to intermediate composition; whole-rock $^{40}Ar/^{39}Ar$ date of 31.1±0.5 Ma (*SA-29*, Table 1) for dike on Placitas quadrangle; up to 8 m thick.

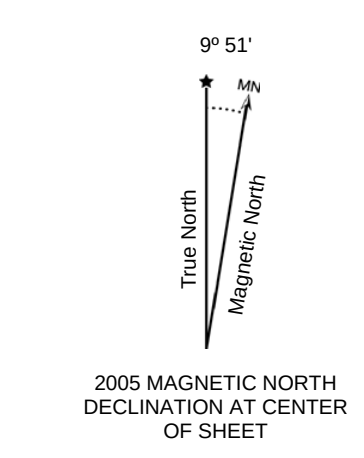
PROTEROZOIC CRYSTALLINE

Unit	Description
Ys Yss	**Sandia granite (Ys, Mesoproterozoic)** — pink megacrystic biotite monzogranite and granodiorite; includes zones of sheared megacrystic biotite monzogranite and granodiorite of the Seven Springs shear zone (**Yss**) just north of trace of Tijeras fault zone; U-Pb dates on zircon indicate age of crystallization between 1455±12 Ma and 1446±26 Ma.
—	**Felsic dike (Mesoproterozoic)** — pegmatite and aplite dikes, pods and lenses; coeval with emplacement of Sandia granite (**Ys**); thickness ranges from 30 cm to over 15 m; up to 1600 m in length.
Xg	**Older granite, undivided (Xg, Paleoproterozoic)** — isolated screens and xenoliths of banded biotite-rich granitic gneiss intruded by the Sandia granite; also contains leucocratic and aplitic granite and biotite-poor granite; includes Manzanita granite and Cibola granite (gneiss) with U-Pb dates on zircon indicate age of crystallization of 1645±16 Ma and 1653±21 Ma, respectively (Karlstrom et al., 2004).
Xv	**Metavolcanic rocks, undivided (Xv, Paleoproterozoic)** — Metarhyolite, felsic metavolcanic, mafic metavolcanic, and metamorphosed dacitic tuff; intruded by older granite (**Xg**); not dated in map area, but U-Pb date on zircon from the nearby Monte Largo Hills metarhyolite indicate an age of crystallization of 1700±20 Ma (Karlstrom et al., 2004).
Xs	**Schist, undivided (Xs, Paleoproterozoic)** — pelitic, locally quartz-bearing, schist and phyllite; commonly crenulated with zones of quartz-muscovite and andalusite-to sillimanite and biotite-bearing schist; includes Juan Tabo series; intruded by Sandia granite with contact aureole on Rincon Ridge; whole-rock Rb-Sr age of metamorphism is 1640±40 Ma (Brookins and Majumdar, 1983, cited in Kirby et al., 1995).
Xq	**Metasedimentary rocks, undivided (Xq, Paleoproterozoic)** — gray to white, thick-bedded to massive, cross-stratified quartzite with pelitic partings and interbeds; includes Isleta metasediments, and Cerro Pelon, Coyote, and Cibola quartzite, U-Pb age on zircon of metamorphism is 1423±2 Ma.

Correlation of Map and Geologic Cross Section Units

Asterisk (*) denotes units shown on geologic cross section only (Plate 2)





2005 MAGNETIC NORTH
DECLINATION AT CENTER
OF SHEET

Preliminary Geologic Map of the Albuquerque—Rio Rancho Metropolitan Area and Vicinity, Bernalillo and Sandoval Counties, New Mexico

Sean D. Connell

2006

New Mexico Bureau of Geology and Mineral Resources

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PLATE 1, version 2.0

1 0 1 2 3 4
Miles

1 0 1 2 3 4
Kilometers

NATIONAL GEODETIC VERTICAL DATUM OF 1929

1:50,000

Mapping of the Alameda, Albuquerque East, Albuquerque West, Arroyo de las Calabacillas, Bernalillo, Placitas, Sandia Crest, San Felipe Pueblo, and Tijeras quadrangles was financed by matching-funds grants from the STATEMAP component of the National Cooperative Geologic Mapping Program coordinated by the U.S. Geological Survey and the New Mexico Bureau of Geology and Mineral Resources (Dr. P.A. Scholle, Director and State Geologist). Geologic mapping of the Cerro Conejo quadrangle was funded by the EDMAP component of the National Cooperative Geologic Mapping Program (Dr. F.J. Pazzaglia, Principal Investigator). Geologic Mapping of the Bernalillo NW, La Mesita Negra SE, Loma Machette, Santa Ana Pueblo, and The Volcanoes quadrangles were conducted by the U.S. Geological Survey. Additional mapping and supplemental stratigraphic work, including reconnaissance geologic mapping of Los Griegos quadrangle and the western half of the map area, was funded by the New Mexico Bureau of Geology and Mineral Resources.

This geologic map graphically displays information on the distribution, character, orientation, and stratigraphic relationships of rock and surficial units, and structural features. Data were compiled at a scale of 1:50,000 from geologic field mapping conducted at scales of 1:12,000, 1:24,000, and 1:50,000; therefore, significant variations in map detail may be expected. Additional data were derived during interpretation of available aerial photography, satellite imagery, examination and interpretation of available drill-hole data, and compilation of data from numerous published and unpublished works. Locations of geologic unit contacts are not surveyed and the accuracy of contact locations depends on the scale of mapping and field conditions. Any enlargement of this map may cause significant misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Geologic cross sections (Plate 2) can aid in understanding the general geologic framework of the map area. Construction of geologic cross sections are based on interpretations of geologic mapping, available geophysical data (e.g., aeromagnetic, gravity, gamma ray), and available drill-hole data (published and unpublished well reports, examination of lithologic cuttings, and interpretation of borehole geophysical log data). Geologic cross sections and maps should not be the sole source of information for use in locating wells or other man-made structures.

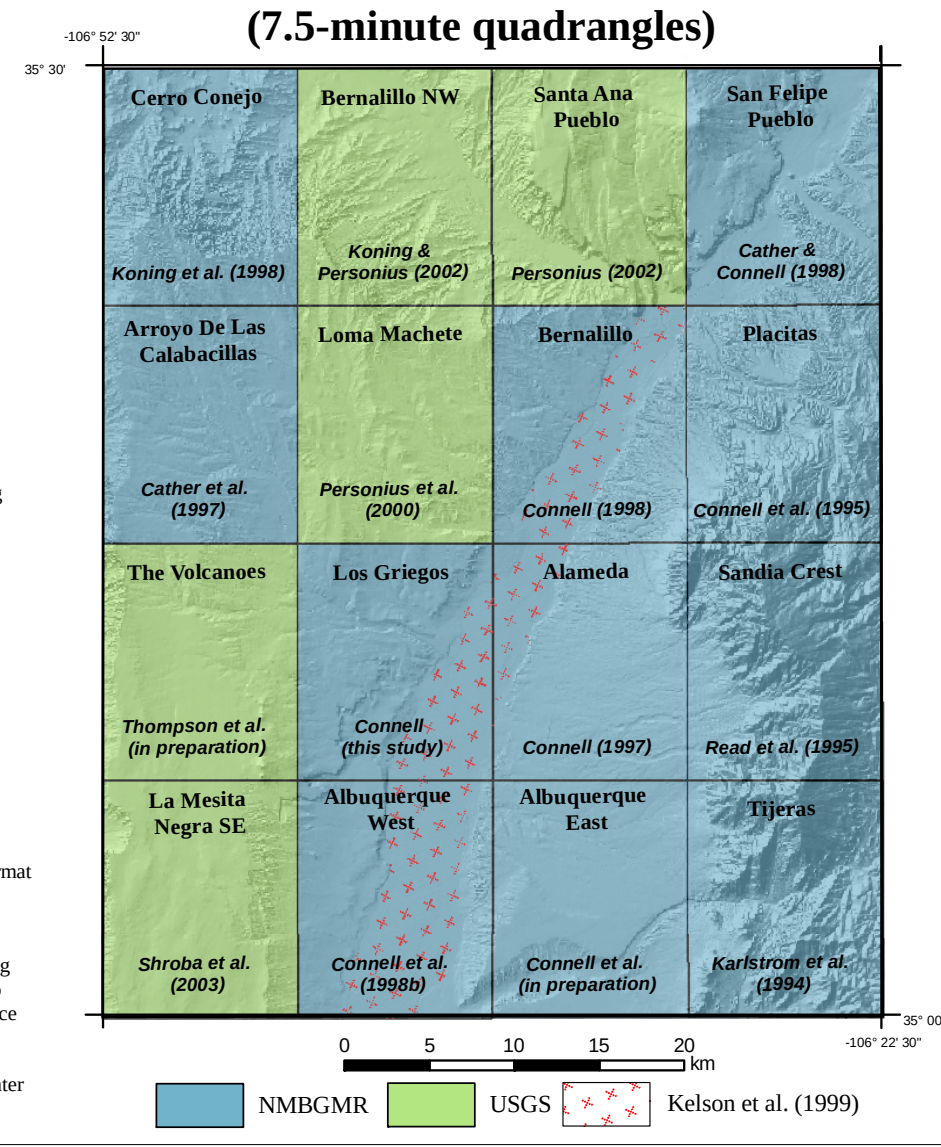
This map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources editorial standards and revision of the map is likely. The contents of this map and report should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document are those of the compiler and should not be interpreted as necessarily representing official policies, either expressed or implied, of the State of New Mexico or the U.S. Government.

Base maps from U.S. Geological Survey 7.5-minute topographic series, Polyconic and Universal Transverse Mercator (UTM) projections, North American Datum of 1927 and 1983. Reprojected to Universal Transverse Mercator, Zone 13, North American Datum of 1983. Grid ticks at 5,000 m in UTM, zone 13, NAD 1983, shown in blue. Property boundaries on the Major Physiographic and Cultural Features Map inset are generalized from data from the New Mexico Earth Data Analysis Center (http://edac.unm.edu/).

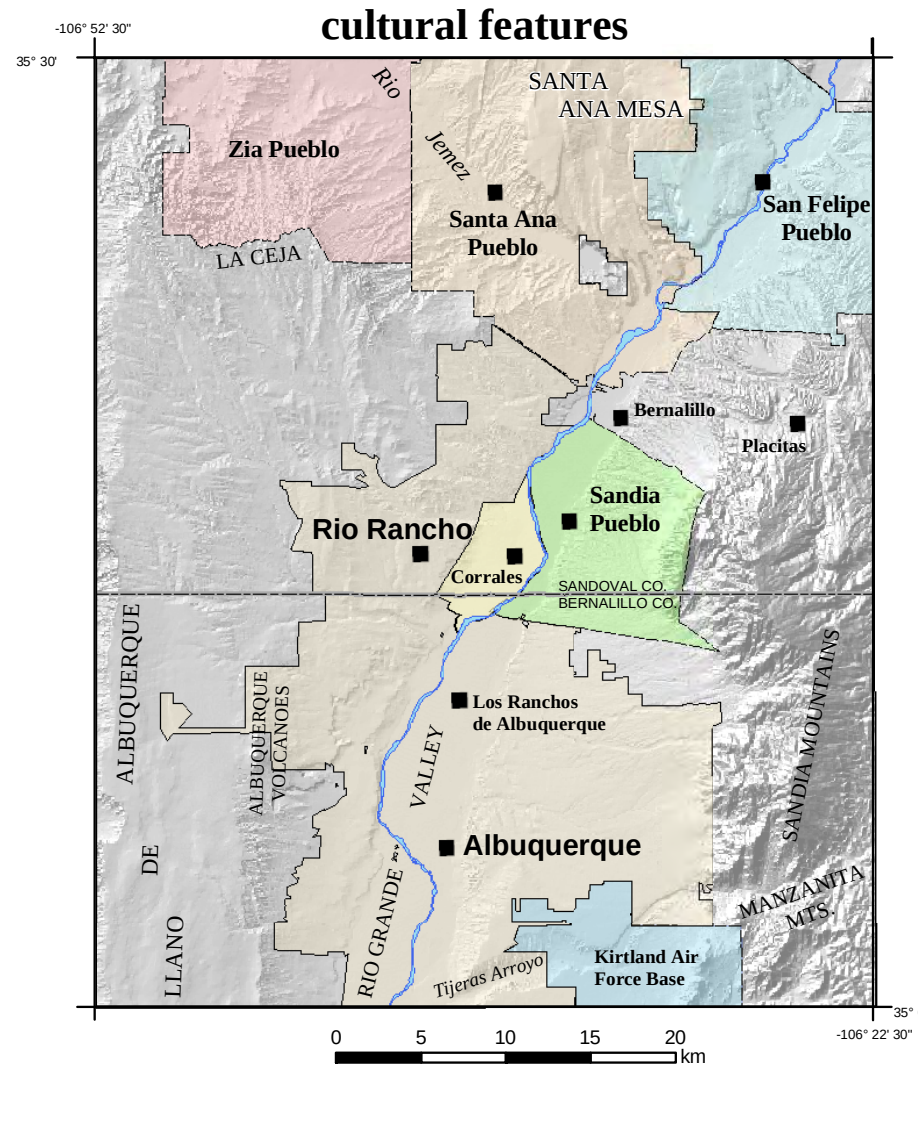
Geology compiled by Sean D. Connell based on mapping conducted during 1994-2005. Map editing, digital database construction, and digital cartography by Mark M. Mansell and Sean D. Connell using ARC-GIS (ARC/INFO) versions 8.2 and 9.1. Initial release March 2006 (version 1.0). Version 2.0 release November 2006. This map and digital database data are available in ARC/INFO and portable document format at: http://geoinfo.nmt.edu/publications/openfile/496. Plots may be purchased on request at New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Place, Socorro, New Mexico USA, 87801-4796; phone: (505) 835-5420.

The information presented on this map resulted from the collective efforts of numerous scientists and public and private institutions, including (but not limited to) the Geologic and Water Resources divisions of the U.S. Geological Survey, University of New Mexico, and New Mexico Institute of Mining and Technology. I am grateful to the following organizations and individuals for facilitating property access and subsurface information: Albuquerque Academy, Bernalillo County, Black Ranch, City of Albuquerque, Intel Corp., King Ranch, New Mexico Utilities, Rio Rancho Utilities, Westland Corporation, and the Pueblos of Sandia, San Felipe, Santa Ana, and Zia. Assistance was provided by Hawley Geomatters, John Shomaker and Associates, Glorieta Geosciences, Geohydrology Associates, GRAM Inc., Metric Corporation, and Westwater Associates. Reviews by Bruce Allen, Steve Cather, Richard Chamberlin, Spencer Lucas, Greg Mack, and David Sawyer are appreciated.

Index to geologic mapping (7.5-minute quadrangles)



Major physiographic and cultural features



Explanation of Symbols

Symbol	Explanation
40	Major highway.
——— - - -?	Geologic contact, including approximately located boundaries; queried where inferred.
━━	Tephra bed: Cerro Conejo (Tc), Arroyo Ojito (Tob), Cochiti (Tpc), and Sierra Ladrones (QTsa) Formations.
▭	Petrocalcic soils of Rincones surface (white dots; stage* III+ (on Ton) and V (on Top) carbonate morphology).
· · · · · · ·	Petrocalcic soils of Sunport and Las Huertas surfaces (gray dots; stage* III+ carbonate morphology).
• • • • • • •	Petrocalcic soils of Llano de Albuquerque surface (black dots; stage* III+ to locally weak stage IV carbonate morphology).
● ● ● ●	Approximate lateral (buried) limit of axial-fluvial member (ancestral Rio Grande deposits) of the Sierra Ladrones Fm (QTsa).
⊕	Horizontal bedding.
5 98	Strike and dip of inclined and overturned bedding.
10	Strike and dip of inclined and vertical foliation.
75	Strike and dip of inclined joint.
U D	Aeromagnetically defined fault, interpreted from data of Kucks et al. (2001); symbols U and D denote inferred upthrown and downthrown sides, respectively. Linear anomalies mark probale location of fault (Grauch et al., 2001).
75 U D ?	Normal fault, showing dip; ball and bar on dowthrown side; dashed where approximately located; dotted where concealed; queried where inferred.
U D ?	Reverse fault; bar on upthrown side; dashed where approximately located; dotted where concealed; queried where inferred.
▲ ?	Thrust fault (ductile deformation); barb on upthrown side; dashed where approximately located; dotted where concealed; queried where inferred.
⇄ ?	Strike-slip fault, showing relative horizontal separation; dotted where concealed; queried where inferred.
━━	Road.
Sunport	Geomorphic surface and name (*Correlation of map and geologic cross section units*, Plate 1).
┬┬┬	Approximate extent of inset ancestral Rio Grande terrace deposits (*Fluvial terrace deposits of the Rio Grande*), hachures towards valley.
～	Active Rio Grande channel.
A ——— A'	Geologic cross section (Plate 2).
⌖ WMF	Oil well.
⊙ Th5	Water-supply well.
△ SCS	Monitoring well.
▣ MPC	Geotechnical boring.
× S1	Age-control sample site (Table1, Plate 2).
→ stream X→ wind	Azimuth of paleocurrent vector (imbrications & cross stratification); includes sand dune orientation data of Lambert (1974).
?	Anticline, showing direction of plunge; dashed where approximately located; dotted where concealed; queried where inferred.
?	Syncline, showing direction of plunge; dashed where approximately located; dotted where concealed; queried where inferred.
?	Overturned anticline, showing direction of plunge; dashed where approximately located; dotted where concealed; queried where inferred.
?	Overturned syncline, showing direction of plunge; dashed where approximately located; dotted where concealed; queried where inferred.
?	Monocline, showing direction of plunge; dashed where approximately located; dotted where concealed; queried where inferred.

**pedogenic carbonate morphologic stage (Machette, 1985).*