Geologic Map of the Cerro Montoso 7.5-Minute Quadrangle, Socorro County, New Mexico

By

Bruce D. Allen[1], J. Michael Timmons[1], Amy L. Luther[2], Phil L. Miller[1], David W. Love[1],

[1]New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Place, Socorro, NM 87801
[2]Earth and Environmental Science Department, NMT 801 Leroy Place, Socorro, NM 87801

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Open-file Digital Geologic Map OF-GM 238

Scale 1:24,000

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801 Leroy Place, Socorro, New Mexico, 87801-4796

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[1]New Mexico Bureau of Geology and Mineral Resources, NM Tech, Socorro, NM 87801

[2]Department of Geology and Geophysics, Louisiana State University, Baton Rouge, LA, 70803

General Observations and Comments

The Cerro Montoso 7.5-minute quadrangle is located along the eastern margin of the Rio Grande Valley in Socorro County, central New Mexico and includes the southern part of the Los Pinos mountain range. Elevations range from approximately 1830 to 2270 m. The area exists today under a continental, semi-arid climate. The name "Cerro Montoso" is derived from the crest of a steep, north-facing escarpment in the northern part of the quadrangle. The area immediately to the south of this escarpment is a south-sloping mesa that is bounded on its east and west sides by faults, with Middle Pennsylvanian strata capping the mesa surrounded on three sides by Proterozoic metamorphic rocks at its base.

Rocks on the Cerro Montoso quadrangle contain evidence for two episodes of Cenozoic deformation – Paleogene Laramide compression and Neogene Rio Grande-rift related extension. In addition, some of the Paleozoic sedimentary rock units that are exposed accumulated during the Ancestral Rocky Mountains (ARM) orogeny, which probably influenced patterns of deposition in coeval strata. The Los Pinos Mountains expose a variety of meta-sedimentary rocks and large igneous intrusions (Los Pinos granite) that extend the exposed record of geological events in the region back into the Proterozoic.

Geologic maps of the quadrangle include Wilpolt et al. (1946) and Myers et al. (1986). The overall distribution of rock units and mapped structures depicted on the current map and these previous maps are similar, although differences will be noticed. The major structural features include 1) the Montosa fault system, a Laramide structure that resulted from rocks to the west being forced eastward, resulting in gentle folding in some areas and the formation of a sharp monoclinal flexure (Montosa monocline) in the sedimentary rock units just to the east of the main reverse fault, and 2) down-to-the-west, Rio Grande rift normal faulting that juxtaposes Paleozoic sedimentary rocks just to the west of the Los Pinos mountains against Proterozoic crystalline rocks along the mountain front.

Erosion of the Montosa monocline has resulted in the development of a narrow, rectilinear ridge (Gray Ridge) that is cored by overturned limestone beds of the Pennsylvanian Atrasado Formation and crosses the entire map area from north to south. Within the mountain block, in areas away from the dominant Laramide structure, Paleozoic rocks generally dip in a southerly direction, and the Los Pinos Mountains drop in elevation and essentially end near the southern edge of the Cerro Montoso quadrangle. A short distance eastward of the Montosa fault, sedimentary rock units flatten out to nearly horizontal, and continue east and southeastward relatively uninterrupted, except by Paleogene sills and dikes, toward the Chupadera Mesa. To the west of the quadrangle, piedmont deposits derived from the Los Pinos Mountains form a relatively flat surface that slopes gently westward toward the Rio Grande.

The oldest sedimentary rocks in the area are of Pennsylvanian age, and include in ascending order the Sandia, Gray Mesa, and Atrasado formations (Sandia and Madera formations of earlier workers), which were deposited in and adjacent to an extensive, epicontinental sea with associated local basins and ARM inter-basin uplifts that evolved tectonically in the region during middle to late Pennsylvanian and earliest Permian time.

In central New Mexico the Sandia Formation is typically dominated by siliciclastic sediment, with lesser amounts of limestone, whereas the overlying Gray Mesa formation typically contains a large proportion of thick marine carbonate beds. For mapping purposes the contact between the Sandia and Gray Mesa is assigned here to the first sequence of comparatively thick, commonly cherty, fossiliferous limestone above siliciclastic deposits of the Sandia Formation. The limestone beds in the lower part of the Gray Mesa as mapped here, however, are represented laterally and overlain by deposits dominated by siliciclastic sediment including thick beds of sand and pebbly sand. This is especially evident in good exposures just to the west of the quadrangle. A possible explanation for these apparent lateral facies changes is tectonism with accompanying transport and deposition of siliciclastic sediments derived from nearby ARM uplifts, making the boundary between the Sandia and Gray Mesa lithostratigraphic units somewhat ambiguous in this area.

Younger sedimentary rocks in the map area are representative of the lower Permian succession in central New Mexico. The top of the Bursum Formation is typically assigned to the highest marine limestone bed in the section beneath the Abo Formation. The small outcrop of Bursum shown in the northeast corner of the map reflects the highest limestone bed observed in that area, but the limestone is thin, the exposure is poor, and marine macrofossils were not observed. A more thorough examination of the limestone may indidicate that it is pedogenic rather than marine in origin, hence the boundary between Bursum and Abo formations may be better placed somewhat lower in the section. The Abo Formation is considerably thinner in the map area than at its type locality a short distance to the north, which again may be related to the proximity of ARM uplifts during the early Permian. Delineating the distribution of Yeso Group strata in the map area appears to be fairly straightforward, despite its thin cover of alluvial/eolian deposits.

The large drainages on the east side of the Los Pinos Mountains (Montosa and Entranosa draws) drain southward, turn west at the southern quad boundary, and join the large, incised drainage of Palo Duro Canyon. The incised walls of Palo Duro Canyon west of the map area contain scattered exposures of Neogene-Quaternary Santa Fe Group and older Paleogene-Neogene sedimentary strata. Similar exposures are not available on the Cerro Montoso quad, so sub-surface rift-related deposits are simply assigned on the cross section to undivided piedmont deposits of the Sierra Ladrones Formation, upper Santa Fe Group.

The Myers et al. (1986) map depicts different levels of alluvial terraces along Montosa Draw, and Treadwell (1996) discusses soils on terraces in the area. On the present map, low- to intermediate-level terraces along Monstosa Draw are included in map units Qay and Qac. Map unit Qam is delineated to show intermediate-level terraces with comparatively well-devolped soils in the vicinity of the middle reach of Montosa Draw, where they are particularly apparent. Interestingly, cobble-sized clasts of Abo Formation and Proterozoic crystalline rock types were found in a small area in alluvium on top of the south end of the Cerro Montoso mesa (UTM 357732E, 3800991N, NAD27), approximately 70 m above the modern Montosa Draw drainage just to the west.

The general pattern of faulting depicted on the current map is similar to that shown on previously published maps. Differences in the distribution of rock units and faults include areas around the two bends in the otherwise linear Montosa fault. For example, some maps depict a reverse fault on the *east* side of Gray Ridge extending for some distance southward from the northernmost bend. The current map offers an alternative interpretation with a series of splays or imbricate faults in the area of the northernmost bend that die out southward, with the main Montosa fault remaining on the west side of Gray Ridge.

A topic that commonly arises in discussions of the Montosa structure concerns reactivation of the Montosa fault during Neogene regional extension, resulting in backsliding along the fault with a down-to-the-west (normal) sense of displacement. At two localities faults with down-to-the-west displacements are present to the west of the main Montosa fault zone (both are depicted on the cross sections), and seem to indicate that Neogene displacements associated with crustal extension are not necessarily restricted to reactivation of the Montosa fault per se.

Description of Map Units

Quaternary

Alluvial and colluvial deposits

Qay Undivided modern channel deposits and valley-bottom alluvium (Holocene)—Channel deposits are poorly to moderately sorted, unconsolidated sand and gravel with local accumulations of cobbles and small boulders, and lesser amounts of silt and clay, commonly exhibiting waning-flow bedforms such as ripples, dunes, and longitudinal bars. Valley-bottom deposits are poorly to moderately consolidated clay, silt and pebbly sand with accumulations of clast- and matrix-supported gravel, cobbles and small boulders in buried channels, and are inset against older alluvial deposits included in map unit Qac. Incipient soils are poorly expressed in these deposits. Modern drainages are commonly incised into finer-grained valley-bottom deposits with vertical cuts up to 5m deep or more, but not all valley-floor areas are incised. Channel deposits are generally discontinuous and thin, ranging from less than 1 m to more than 2 m thick. Small unmapped areas of exposed bedrock in scoured reaches are locally present. Valley-bottom alluvium ranges from 1 to at least 5 m thick.

Qac Undivided colluvium and alluvium (Holocene to Upper Pleistocene)—Colluvial deposits include poorly consolidated, poorly sorted and stratified, fine- to coarse-grained, clast- and matrix-supported deposits derived from a variety of mass-movement hillslope processes, including debris flow, shallow slump, and creep, and overlie, interfinger, and grade into alluvial deposits that include undivided inset terraces along larger drainages at low to intermediate levels above modern channels. Soils are essentially lacking in younger deposits and exhibit stage I-II pedogenic carbonate horizons in older deposits. Clasts are typically rounded to subangular pebbles and cobbles reworked from proximal and distal bedrock sources and older Quaternary units. Colluvium on hillslopes contains a large proportion of locally derived bedrock clast types, whereas terrace alluvium commonly includes a large proportion of clasts transported from upstream areas. Thickness of Qac is variable, ranging from less than 1 m to at least 5 m.

Qam Alluvial deposits underlying abandoned interfluvial ridges and highs (Upper (?) to Middle Pleistocene)—Moderately consolidated clay, silt, sand and gravel at intermediate levels between lower and upper Montosa wells, largely in the area to the west of Montosa Draw. Gravels are commonly concentrated on the surface of the deposit, and cobbles and scattered boulders are present. Associated soils exhibit Stage III pedogenic carbonate development. Lower flanks of Qam highs are commonly colluviated and are truncated and inset by younger Qac/Qay alluvium. Deposits are probably less than 10 m thick.

Qls Landslide (Pleistocene)—Two relatively large landslides comprised of granite derived from the west face of the Los Pinos Mountains are mapped as such to the southwest of the mouth of Bootleg Canyon. The larger of the two landslides appears to represent a large, relatively intact block of granite that may have rotated backward as it moved down the steep mountain front. Field relations suggest that the smaller landslide lies on top of Pennsylvanian-age rocks that are present immediately to the west of the mountain-front normal fault. The larger landslide block may rest on Pennsylvanian rocks as well.

Alluvial aprons and fans from the Los Pinos Mountains

Qfp Undivided alluvium deposited on the fan debouching from the Los Pinos Mountains at Bootleg Canyon (Holocene to Upper Pleistocene)—Poorly to moderately sorted, unconsolidated pebble to cobble alluvium and fine- to coarse-grained sand with local accumulations of cobbles and small boulders in longitudinal bars, and silt and clay in longitudinal areas of low slope. Includes both active broad shallow channels and interchannel areas. Younger deposits lack soils, while inter-channel highs exhibit incipient soils. Higher interfluves exhibit stage I-II pedogenic carbonate horizons. Deposits range from 1 m to at least 7 m thick and may be considerably thicker away from the mountain front.

Qfi Undivided interfan alluvial aprons from small drainages along the Los Pinos Mountain front (Holocene to Upper Pleistocene)—Poorly to moderately sorted, unconsolidated pebble to cobble alluvium, fine- to coarse-grained sand with local accumulations of cobbles and small boulders, and silt and clay in areas of low slope. Unit is overlain by younger Qfp and Qac deposits and interfingers with older deposits. Thickness and degree of pedogenic carbonate development similar to Qfp.

Santa Fe Group

QTsp Sierra Ladrones Formation, piedmont deposits (upper Santa Fe Group, Middle Pleistocene to Pliocene?)—Shown on cross section A-A'; description based on observations from exposures along Palo Duro Canyon west of "five points", a short distance west of the map area. Unconsolidated to moderately consolidated, uncemented to cemented, mudstone and sandstone with moderately sorted tabular sandstone and scattered, irregular pebbly sandstone and conglomeratic sandstone lenses. Beds commonly form upward-fining sequences with a basal conglomerate that fines upward into sand and mud that is locally capped by calcic paleosols. May include older Neogene deposits toward the base of the unit. Scattered exposures on divides between Palo Duro and Cibola Canyons to the southwest suggest that deposits assignable to the Popatosa Formation (Miocene) are minor this close to the mountain front. The well-driller's log from the water well at Nunn Ranch suggests that QTsp overlies Permian bedrock (lower Yeso Gp.) at a depth of ~45 m at that locality.

NEOGENE

Tb Basalt flow of Black Mesa (Pliocene)—Light to dark gray olivine basalt. According to Weber (1963), the basalt is light gray with a slightly trachytic texture in the center of the flow, and grades outward to dark gray and finer grained near the margins. Apparently originated from two or three vents in proximity to the Montosa fault zone (Weber, 1963; Lueth et al., 2008, p. 60-61). A K-Ar age of 3.5 +/- 0.2 Ma was reported by Bachman and Menhert (1978). Only a small outcrop of the flow is present on the southern edge of the map area, where its base is covered by deposits of map unit Qay.

PALEOGENE

Ti Igneous intrusions (Oligocene)—Light to dark gray intrusive rocks (dikes) in the southeast corner of the quad. Bates et al. (1947) distinguished phaneritic and aphanitic sills and dikes in the area. Both consist primarily of plagioclase feldspar, with phenocrysts of hornblende or very altered pyroxenes. Mafic phenocrysts and feldspars in phaneritic rocks generally range from approximately 1 to 3 mm. Biotite and magnetite is present in some samples. Bates et al. (1947) identified the phaneritic rocks as hornblende diorite based on thin-section petrology of samples just to the east of the quad, and noted that quartz and orthoclase are present in small (<5%) amounts in that area. Aphanitic rocks were identified texturally as diabases, and, using the volcanic rock name, are probably basaltic andesite in composition. Mapped where surface exposures are readily apparent on aerial photographs; additional near-surface exposures that are probably present in the area are obscured by the mantle of alluvium/loessal deposits that cover the flat terrain on the east side of the quad. Inferred Oligocene age is based on the widespread distribution of similar intrusions of this age in central New Mexico. Dikes are generally less than 60 m wide, and intrude relatively incompetent, gypsiferous rocks of the Yeso Group that have been locally deformed by the intrusions (see Bates et al., 1947). Thus, the widest (~180 m), N-NE trending intrusion in the map area may reflect lateral spreading from a narrower feeder dike into surrounding, relatively weak Yeso strata.

PALEOZOIC

PERMIAN

Yeso Group (Lower Permian)—Orange, pink, and yellowish sandstone and siltstone; white to gray gypsum; and yellowish-gray dolomite, gray limestone, and gypsiferous silt and fine sand. Subdivided into two formations after Lucas et al. (2005). Unit is generally poorly exposed in the map area, with a thin cover of mixed alluvium and loess that locally exhibits a well-developed calcic soil as seen in borrow-pit exposures.

Pyl Los Vallos Formation (includes Joyita, Cañas, and Torres Mbrs)—interbedded fine-grained, reddish and yellowish sandstone, siltstone, and mudstone, gypsiferous siltstone, gypsum, and gray to yellowish-brown carbonate (limestone and dolomite). Base of unit is mapped at the first laterally continuous carbonate bed above siliciclastic deposits of unit Pya, which is followed upward in succession by several more carbonate beds separated by redbed muds and sand that are commonly gypsiferous. Unit contains increasing amounts of gypsiferous siltstone and bedded gypsum (Cañas Mbr.) upward through the section, commonly culminating in a sequence of siliciclastic redbed sandstone beds (Joyita Member) that mark the regressive stage of the early Leonardian Los Vallos transgressive-regressive cycle. Unit appears to be poorly fossiliferous in the area, containing some macroinvertebrate fragments including brachiopods and gastropods. Approximately 30 m of the lower part of the Los Vallos is present in the map area; Total thickness is about 215 m on the Becker SW quad to the west (Wilpolt et al., 1946).

Pya Arroyo de Alamillo Formation (equivalent to Mesita Blanca Mbr)—Pinkish red, to pale orange and yellowish to greenish gray fine-grained sandstone, siltstone, and mudstone, commonly thinly laminated or ripple laminated. Carbonate beds (dolomite and limestone) and gypsum are present in minor amounts. In better exposures to the west of the map area yellowish and greenish-gray fine-grained beds containing abundant well preserved casts of hopper-shaped halite crystals are present, suggesting deposition in sabkha or saline mudflat environments at various times. Ichnofossils including invertebrate traces and tetrapod tracks, and poorly preserved plant fossils are beginning to receive some scientific study in the area east of Socorro. Unit appears to gradationally overlie the Abo Formation, and is thought to have been deposited near the beginning of a marine transgression that spread northward into the region during early Leonardian time. Approximately 65 m thick on the Becker SW quadrangle just to the west of the map area (Wilpolt et al., 1946).

Pa Abo Formation (Lower Permian)—Distinctive monochromatic brick-red mudstone, fine-grained sandstone and siltstone with lesser shale and intraformational conglomerate. Unit contains some greenish- and reddish-gray fine-grained sandstones in addition to the characteristic dark red deposits, and exhibits greenish-gray reduction spots and mottling in some beds that seems to be ubiquitous in the Abo Formation over much of New Mexico. Unit is interpreted as representing deposition of overbank muds and associated fluvial sands on a widespread lower Permian alluvial plain interrupted by eroded hills remaining from ancestral Rocky Mountain uplifts. Intervals containing nodular non-fossiliferous carbonates are interpreted as representing paleosols. Upper part of unit contains numerous sheet-like sandstone bodies, lower part is predominantly mudstone, with lesser lenticular and cross-bedded fine-grained sands. Tetrapod tracks and other trace fossils as well as terrestrial plant remains are relatively common and have received increasing scientific attention in recent decades. Approximately 125 thick on the Cerro Montoso quadrangle; unit is considerably thicker (~280 m) to the north at its type locality near Abo Pass (Needham and Bates, 1942).

Pennsylvanian-Permin

lPb Bursum Formation (Upper Pennsylvanian to Lower Permian)—Interstratified red to maroon and greenish gray mudstone and shale, reddish- to yellowish-brown sandstone, gray fossiliferous limestone, and minor intraformational (limestone-clast) conglomerate beds. Unit represents the transition from dominantly marine (Atrasado Fm) to terrestrial (Abo Fm) depositional environments. Unit is poorly exposed along the east side of Gray Ridge, just east of the Montosa fault. Allen et al. (2013) measured approximately 40 m of Bursum Formation southwest of the map area on the Sierra de la Cruz quadrangle, where Schwagerinid fusulinds midway up in the section suggest a lowermost Wolfcampian (Permian) age for the formation in this area.

Pennsylvanian

lPa Atrasado Formation (Upper Pennsylvanian)**—**Gray, fossiliferous (normal marine) cliff-forming thin- to thick-bedded limestone and intervening intervals dominated by slope-forming greenish gray to reddish brown siliciclastic mudstone, siltstone, and calcareous shale. Crossbedded and planar laminated silty sandstone to pebbly sandstone, including thick, lenticular channel fills, are common. The stratigraphic nomenclature in current use for the Atrasado Formation in central New Mexico (Nelson et al., 2013a) identifies 8 lithostratigraphic members in the Atrasado Formation, the lower 6 of which are readily identified in the map area. An apparent merging of the upper two limestone-dominated members (Story and Moya) in the area makes precise placement of the contacts between the uppermost members less obvious. About 240 m thick just west of the southwestern part of the quadrangle; unit appears to be thinner (~180 m thick) in places along Gray ridge, but this apparent thinning seems likely to be a result of structural thinning in the immediate vicinity of the Montosa fault zone.

lPg Gray Mesa Formation (Middle Pennsylvanian)—Cliff-forming, fossiliferous (normal marine) medium- to thick-bedded cherty limestone and slope-forming siliciclastic deposits consisting of mudstone, shale, and sandstone. The base of the Gray Mesa in parts of the map area consists of two or three intervals dominated by medium to thick bedded, cliff-forming limestone, which are interbedded with and overlain by slope-forming intervals containing a relative abundance of siliciclastic sediment. These basal, mixed carbonate-siliciclastic strata are in turn overlain by a thick sequence of thin- to thick-bedded and massive limestones that form a bold cliff, recognizable throughout the map area where it is present, that pertains to the Whiskey Canyon Member of the formation as delineated elsewhere in central New Mexico (see Nelson et al., 2013b, for a discussion of Gray Mesa Formation lithostratigraphy). The upper part of the Gray Mesa Formation contains limestone beds up to a few meters thick, some of which are intercalated with thin shaley partings, and lesser interbeds of siliciclastic mud and sand. The base of the overlying Atrasado Formation is generally a covered slope containing siliciclastic muds and thick lenticular sandstone beds. More detailed stratigraphic work is needed, but in areas the thick limestone beds near the base of the Gray Mesa appear to be represented laterally by siliciclastic deposits including thick beds of sandstone and pebbly sand, that for mapping purposes could arguably be assigned to the Sandia Formation. Approximately 120 m thick.

lPs Sandia Formation (Middle Pennsylvanian)—Greenish-gray, reddish-brown, and yellowish mudstone to silty sandy shale and calcareous shale, yellowish and reddish-brown, gray, and greenish-gray planar laminated and crossbedded sandstone to pebble conglomerate, and fossiliferous (normal to restricted marine) gray to brownish-gray limestone and sandy limestone. Terrestrial plant fossils have been known for some time to be present in shales from the Sandia Formation in the area east of Socorro; within the map area hematitic fragments of terrestrial plants are common. The deposits are of mixed terrestrial, marginal marine, and normal marine origin. The base of the Sandia in the area is commonly a pebble to cobble conglomerate containing white quartz clasts. Approximately 70 m to more than 100 m thick, depending in part on where the contact with the overlying Gray Mesa Formation is chosen.

Proterozoic

Xlp Los Pinos Granite—Pale reddish gray to pink and red, massive, medium- to coarse-grained, microcline + orthoclase + quartz + albite granite in Los Pinos Mountains. Has a distinctive myrmekite texture in some locations. Los Pinos Mountains granite yielded radiometric ages of 1653 to 1658 million years (Karlstrom et al., 2004).

Xg Granite of Sepultura Canyon—Medium reddish brown to pink, medium- to fine-grained, quartz, biotite, microcline, and minor plagioclase granite located in Sepultura Canyon. This strongly foliated granite and locally granite mylonite, intrudes the Bootleg Canyon sequence but does not appear to come in contact with the Los Pinos granite. The relative deformation of this unit relative to the Los Pinos granite suggests that this granite is older and predates the main deformational events that affect all metasedimentary and metavolcanic units.

Xbsu Blue Springs Upper Schist—Green to white, chlorite + muscovite schist. Locally, thin k-feldspar veins cut foliation. The apparent uppermost unit of the Manzano Peak (F2) synclinorium, found east and northeast of the Los Pinos granite (Xlp) in the eastern region of the quadrangle. Equivalent to the Metaclastics Series pCm of Myers and McKay (1974).

Xbr Blue Springs Rhyolite—Black and brown to gray with lenticular quartz-feldspar pink colored stripes within darker layers. Interpreted as a metarhyolite due to the presence of potassium feldspar in the felsic lenses and a geochemical composition close to rhyolite. Equivalent to the part of pCa, the argillite of Myers and McKay (1972); Blue Springs Quartzite (bq1) of Bauer (1983). The Blue Springs Rhyolite yielded a U-Pb zircon date of 1601 +4/-3 Ma (Luther et al., 2005; J. Jones, unpublished data).

Xbs Blue Springs Schist—Green to white, garnet + chlorite + quartz + muscovite schist. Crenulated with well-preserved garnet.

Xbq Blue Springs Quartzite Member (of Blue Springs Schist)—Thinly-bedded, medium-grained quartzites, interbedded with chlorite-muscovite schist and quartz-muscovite schist.

Xsq Sais Quartzite—Thinly-bedded, reddish, schistose quartzite. Bedding planes commonly show mica concentrations. Grains range in size from very fine to coarse. Primary structures include preserved cross bedding.

Xes Estadio Canyon Schist—Coarse-grained, staurolite + garnet + biotite schist. Equivalent to the Lower part of the Pine Shadow Springs of Myers and McKay (1972); called the White Ridge schist (ws1) of Bauer (1983).

Xwq White Ridge Quartzite—Coarse-grained, impure, orange to gray, thinly-bedded, quartzite. Fairly immature metasedimentary rock with well preserved cross bedding. The upper part of the unit has a distinctive red, andalusite + muscovite, foliated, schistose layer. Detrital zircons from the Estadio quartzite (correlative to the White Ridge quartzite in the Los Pinos) have a maximum age of ~1630 Ma based on the youngest zircon although the error on these analyses is large (~50 Ma; Luther et al., 2005; J. Jones, unpublished data).

Xla Abajo Lithic Arenite—Composed of a variety of metasedimentary rocks including meta-pelite, meta-arkose and impure quartzite. Contains thin layers of chlorite schist, quartzite and metarhyolite. Massive quartzite domains are locally dominant. Also includes garnet staurolite schist, which may be related to the intrusion of gabbro dikes (now amphibolites). A 5-10 meter wide amphibolite layer (**Xa**) is interbedded within the Abajo Lithic Arenite. This relatively fine grained unit typically contains hornblende, epidote, and biotite. Relic pillow features are also preserved within this unit suggesting this was a basalt that flowed and is interbeded within the lithic arenites.

Interbedded

Xsru Sevilleta Metarhyolite, Upper member—Brown to pink, finely-banded sericitic metarhyolite with with fine-grained quartzo-feldspatic matrix, minor biotite aligned in foliation, ± carbonate;; 0.5-3.5 mm feldspar and quartz crystals with sphene and epidote inclusions, and rare sertization K-Feldpar in tails of porphyroclasts. Porphyoclasts in Upper member appear much more rounded than other members.

Xsrm Sevilleta Metarhyolite, middle member—Dark gray to black, felsic, meta-igneous rocks with 0.5 to 2 mm quartz and feldspar phenocrysts. Texture ranges from thin, well developed compositional banding to massive. Quartz veins, pegmatite and massive schistose units and up to 3 cm long flattened lapilli are present locally and generally parallel foliation.

Xsrl Sevilleta Metarhyolite, Lower member—Medium gray to black, dense, finely-banded metarhyolite with minor white mica, oxides, epidote and biotite; speckled with 1.0-2.5 mm white feldspar crystals that have been sericitized.

Xbc: Bootleg Canyon sequence—Interbedded layers of coarse-grained amphibolite, pelitic schists, quartzites and "layered" schists described previously by Shastri (1992). Coarse-grained amphibolite is black-and-white to greenish-grey to black depending on the mineral content, which is typically hornblende, epidote, biotite, chlorite and actinolite with similar accessory minerals as the finer grained unit and appears similar to that found in Xla. Light-green to beige pelitic schist layers contain garnet, biotite, ± chlorite, muscovite, plagioclase, quartz, Fe-Ti oxides, ± K-feldspar, and ± tourmaline. Greenish (epidotized?) quartzite layers are thinly-bedded, micaceous and contain fine-grained, epidote-rich 0.5-2 cm-scale pods of calc-alkaline material. The layered schist is an interbedded mafic and granitic schist, suggesting that amphibolite supracrustal rocks were complexly intruded by granite (Shastri, 1992). Located with Sepultura Canyon, and proximal to the Los Pinos Granite (**Xd**) is an amphibolitic unit that is in intrusive contact with the Bootleg Canyon sequence. This amphibolite exhibits a variety intrusive features including cross cutting relationships with the Bootleg Canyon sequence and mingled magma textures (Figure X). This unit is composed of hornblend, biotite and may also include pyroxene. Plagioclase feldspar and very minor quartz are also observed. Mingled magmatic textures indicate that this unit represents a metamorphosed gabbro and diorite suite.

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