

# Geologic Map of the Guadalupe Mountain Quadrangle, Taos County, New Mexico.

By

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*Open-file Digital Geologic Map OF-GM 169*

**Scale 1:24,000**

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**Unit Descriptions for Guadalupe Mountain, NM Quadrangle**  
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**Surficial Deposits**

- Qal**      **Stream channel and valley-floor alluvium, and active floodplains (Holocene)** - poorly to moderately sorted sand, pebbles, and boulders; clasts of granitic, metamorphic, volcanic, and sandstone rock types; clasts along Red River, Rio Grande, and tributaries draining the Sangre de Cristo range are dominated by granitic rock types, quartzite and basalt; clasts along tributaries draining the western side of the Rio Grande dominated by volcanic rock types; weak or no soil development.
- Qc**      **Colluvial mantle on slopes, undifferentiated (middle Pleistocene to Holocene)** - poorly-sorted sand, pebbles and boulders; mantles slopes in Red River gorge and northeastern side of Red River fault zone in eastern part of quadrangle; consists of thin mantle overlying volcanic bedrock.
- Qe**      **Eolian deposits (Pleistocene to Holocene)** – well sorted fine to medium sand with silt; rare gravel lag; poorly exposed except in small roadcuts; predominantly on eastern side of the Rio Grande; weak to moderate soil development.
- Qls**      **Landslide deposits (late Pleistocene to Holocene)** - poorly sorted sand to boulders, includes large rotational slide blocks within the Rio Grande gorge, which include large, rotated and detached beds of Servilleta Basalt (Tb); may also include areas underlain by Holocene colluvium in Rio Grande and Red River gorges.
- Qfy Qty**      **Young alluvial-fan and stream terrace deposits (latest Pleistocene to Holocene)** - poorly sorted silt, sand, pebbles, cobbles, and boulders; clasts primarily of quartzite, schist, granite, and volcanic rock types; associated soils have stage I calcium carbonate development.
- Qfyv:**      **Young alluvial-fan deposits from volcanic terrane (latest Pleistocene to Holocene)** - poorly sorted silt, sand, pebbles, cobbles, and boulders; clasts primarily of volcanic rock types; associated soils have stage I calcium carbonate development; source areas primarily volcanic terrane on west side of Rio Grande and drainages on Guadalupe Mountain
- Qt7rr**      **Stream terrace deposits (early to middle Holocene)** - poorly sorted silt, sand, pebbles, cobbles, and boulders; clasts primarily of quartzite, schist, granite, and volcanic rock types; associated soils have stage I calcium carbonate development; typically present as thin (< 5 m) alluvial deposit on strath surface cut on volcanic bedrock deposit; equivalent to Qt7 of Pazzaglia (1989) and Kelson (1986). (Qt7rr from Red River watershed).
- Qfv**      **Undifferentiated alluvial fan deposits (middle to late Pleistocene)** - probably correlative with alluvial units Qt2 through Qt6; poorly sorted silt, sand, pebbles, and cobbles; not correlated to other fan units because of lack of well-defined age control; commonly contains predominantly volcanic clasts derived from local Tertiary volcanic terrane.
- Qt5rr Qt4rr**      **Stream terrace deposits (late Pleistocene)** - poorly sorted silt, sand, pebbles, cobbles, and boulders; clasts primarily of quartzite, schist, granite, and volcanic rock types; associated soils have stage II to III calcium carbonate development; typically present as thin (< 5 m) alluvial deposit on strath surface cut on volcanic bedrock or Unit QTg (Lama Formation); equivalent to Qt5 and Qt4 of Pazzaglia (1989) and Kelson (1986). (Qt5rr and Qt4rr from Red River watershed).
- Qfu**      **Undifferentiated alluvial fan deposits (middle to late Pleistocene)** - probably correlative with alluvial units Qt2 through Qt6; poorly sorted silt, sand, pebbles, and cobbles; not correlated to other fan units because of lack of well-defined age control, clear stratigraphic position, and distinct lithologic characteristics. In Guadalupe Mountain quadrangle, composed primarily of intermediate and basaltic volcanic clasts.
- Qt3rr Qt2rr**      **Stream terrace deposits (middle? Pleistocene)** - poorly sorted silt, sand, pebbles, cobbles, and boulders; clasts primarily of quartzite, schist, granite, and volcanic rock types; associated soils have stage III calcium carbonate development; typically present as thin (< 5 m)

- alluvial deposit on strath surface cut on volcanic bedrock or Unit QTg (Lama Formation); equivalent to Qt3 and Qt2 of Pazzaglia (1989) and Kelson (1986). (Qt3rr and Qt2rr from Red River watershed).
- Qao3 Older alluvium (middle? Pleistocene)** - poorly sorted silt, sand, and pebbles; clasts primarily of granitic, metamorphic, basaltic, and intermediate volcanic rocks; distinctly smaller clast sizes than units Qt2rr, Qt1rr, and Qt0rr; upper soil horizons locally affected by surface erosion; may be mantled locally by unit Qe; typically present as thin (< 5 m) alluvial deposit on strath surface cut on volcanic bedrock near rim of Rio Grande gorge; located only upstream of the Red River fault zone; correlative with unit Qao3 in Sunshine quadrangle (Ruleman et al., 2007); subunit Qao3rg interpreted as axial Rio Grande deposits; subunit Qao3f interpreted as tributary-fan deposits derived from east of Rio Grande.
- Qao2 Older alluvium (middle? Pleistocene)** - poorly sorted silt, sand, and pebbles; clasts primarily of granitic, metamorphic, basaltic, and intermediate volcanic rocks; upper soil horizons locally affected by surface erosion; may be mantled locally by unit Qe; located only upstream of the Red River fault zone in Sunshine quadrangle as identified by Ruleman et al. (2007); subunit Qao2rg interpreted as axial Rio Grande deposits; subunit Qao2f interpreted as tributary-fan deposits derived from east of Rio Grande.
- Qf1 Alluvial fan deposits (middle Pleistocene)** - poorly sorted silt, sand, and rare pebbles; clasts primarily of granitic, intermediate volcanic, basaltic, and metamorphic rock types; stage III and IV calcium carbonate development where preserved, although soil horizons are commonly affected by surface erosion; correlative with Unit Q1p of Kelson (1986); differentiated from unit QTg by larger clast size, less oxidation, poor sorting, absence of abundant manganese oxide staining, and clasts that are less weathered.
- Qt1rr Stream terrace deposits flanking Red River (middle Pleistocene)** - poorly sorted silt, sand, pebbles, and boulders; clasts of basalt, quartzite, metamorphic rock types, volcanic rock types; soil development not documented but upper soil horizons probably affected by surface erosion; present only locally along rim of Red River gorge, inset into Qt0rr gravel deposits and Tertiary volcanic rocks along Red River gorge.
- Qt0rr Old stream terrace deposits flanking Red River (early? to middle? Pleistocene)** - poorly sorted sand, pebbles, and cobbles; clasts of basalt, quartzite, and many volcanic and metamorphic rock types; upper part commonly affected by surface erosion; present upstream and downstream of Red River Fish Hatchery and in confluence area between Rio Grande and Red River (Qt0rr); merges with unit Qt0rg in southernmost part of quadrangle and in Arroyo Hondo quadrangle.
- QTg Old alluvium (late Tertiary to middle Pleistocene)** - poorly sorted sand, pebbles, and cobbles; clasts of basalt, quartzite, metamorphic rock types, and volcanic rock types; locally high percentage of angular to subangular quartzite pebbles and cobbles; present along piedmont between Sangre de Cristo range front and Red River and Rio Grande gorges; underlies Garrapata Ridge and probably much of Cebolla Mesa in southeastern part of quadrangle; fills paleovalley on northeastern side of Red River fault zone at elevation of present-day Red River; in Questa quadrangle underlies mesa between villages of Questa and Cerro; correlative with Lama Formation of Lambert (1966); probably correlative with Blueberry Hill deposit in Arroyo Hondo and Taos quadrangles; contains ash layer in uppermost strata dated as 1.6 Ma (elevation ca. 7660 ft, M. Machette, USGS, personal comm., 2008); contains undated ash layer in roadcut near Red River Fish Hatchery (elevation ca. 7160 ft); contains undated ash layer in roadcut near Cerro Negro (UTM 439989, 4044603) on Arroyo Hondo quadrangle.

### **Tertiary Volcanic Rocks and Sedimentary Deposits**

- Tb Servilleta Formation, basalt (Pliocene)** - Flows of dark-gray tholeiitic basalt characterized by small olivine phenocrysts, diktytaxitic texture, and local vesicle pipes and segregation veins. Forms thin, fluid, widespread pahoehoe basalt flows of the Taos Plateau volcanic field erupted principally from five large shield volcanoes in the central part of the Taos Plateau (Lipman and Mehnert, 1979) but also from several small shields and vents to the northwest of the map area near the Colorado border (Thompson and Machette, 1989). These flows commonly form columnar-jointed cliffs where exposed with a maximum thickness of approximately 200m in the Rio Grande gorge south of the

- map area. Individual flows, up to 12 m thick, are grouped into packages of from one to ten flows (Peterson 1985; Dungan et al., 1984). These packages are separated by sedimentary intervals that are as much as 70 m thick in southern part of quadrangle (Leininger, 1982). Tabular plagioclase and sparse olivine are the only phenocrysts.  $^{40}\text{Ar}/^{39}\text{Ar}$  ages from basalts exposed in the Rio Grande gorge range in age from 4.81  $\pm$  0.03 Ma for the lowest basalt near the Gorge Bridge, to 3.12  $\pm$  0.13 Ma for the highest basalt flow at the Gorge Bridge (Appelt, 1998). In the map area, the lowermost Servilleta lava flows are overlain by dacites of Guadalupe Mountain and consequently may be greater than 5 million years old in the base of the Rio Grande gorge. Servilleta lava flows also cap the volcanic sequence in the map area and representing the youngest eruptive activity in the map area.
- Tg**      **Servilleta Formation, interbasalt gravel (Pliocene)** - Sedimentary intervals between basalt flow members (Leininger, 1982), as much as 70 m thick in southern part of quadrangle, as exposed in the Rio Grande gorge. Typically rounded to subrounded pebble- to cobble-size clasts in a sand to silt matrix. Thick sections in the southern part of the map area reflect Precambrian clast provenance and are dominated by schist, quartzite and amphibolite with lesser volcanic clasts derived from the Latir volcanic field (Lipman and Reed, 1989). Locally, thin interbeds are typically dominated by pebble-size clasts in a fine sand to silt matrix and commonly includes the lithologies above in addition to subangular and subrounded volcanic clasts derived locally from adjacent volcanic highlands of the Taos Plateau volcanic field.
- Tdm**      **Dacite of Unamed Cerito East of Montoso (Pliocene)** – Dark gray, sparsely phyrlic, low-silica, calc-alkaline dacite (64 wt%  $\text{SiO}_2$ , 6 wt%  $\text{Na}_2\text{O}+\text{K}_2\text{O}$ ) lava flows erupted from two vent areas east of Cerro Montoso. Contains rare skeletal pyroxene phenocrysts and resorbed, subhedral olivine and quartz xenocrysts in a microcrystalline to glassy groundmass. Locally includes small volume, aerially restricted andesite flows (McMillan and Dungan, 1988). Caps Rio Grande gorge forming thin veneer, rarely more than single flow thickness on underlying flows of Servilleta Formation basalt (unit Tb) and local interbedded sedimentary deposits (Leininger, 1982; Peterson, 1981); neither relations shown at the scale of this map due to extensive distribution of landslide deposits (unit Qls) in the southern part of the Rio Grande gorge in map area. Scoria and spatter agglutinate common near poorly defined vent areas.
- Tdmc**      **Dacite of Unamed Cerito East of Montoso near vent deposits (Pliocene)** – Near vent deposits associated with lava flows of map unit Tdm. Predominantly cinder, spatter agglutinate and volcanic bombs locally.
- Tao**      **Andesite of Cerro de la Olla (Pliocene)** - Dark gray to black, porphyritic olivine andesite (58.5 wt%  $\text{SiO}_2$ , 6.9 wt%  $\text{Na}_2\text{O}+\text{K}_2\text{O}$ ) lava flows erupted from vents near summit of Cerro de la Olla, one of the largest, petrologically uniform, shield volcanoes of the Taos Plateau volcanic field (Lipman and Mehnert, 1979). Contains 2-3 percent phenocrysts of olivine in a microcrystalline groundmass of plagioclase, olivine, augite, Fe-Ti oxides. The lower slopes of Cerro de la Olla in the northwestern part of the map area are often mantled in colluvium and rarely preserve well-developed flow morphology. Instead outcrops typically reflect blocky flow tops and remnants of numerous discontinuous and aerially restricted flow lobes. Appelt (1998) reports  $^{40}\text{Ar}/^{39}\text{Ar}$  ages of 4.97 $\pm$ 0.06 Ma for a groundmass separate from the west side of Cerro Montoso.
- Tvr**      **Volcanic deposits of Red River volcano (Pliocene)** – Includes a sequence of volcanic rocks and near vent pyroclastic deposits of moderate relief on the south side of Guadalupe Mountain and in canyon exposures in the middle and upper reaches of the Red River in the map area. Lava flows of the Red River volcanic sequence include a series of lower, predominantly basaltic andesite and andesite lava flows overlain by dacite lava flows capping the gorge sequence on both sides of the Red River. Near vent spatter, agglutinate and volcanic bombs are common near hill 7590' on the south side of the Red River and capping dacite lavas exposed on both side of the Red River appear to have been fed locally by dikes exposed on both side of the canyon. McMillan and Dungan (1986) report chemical compositions for the basaltic andesite to dacite suite ranging from 52-61 wt%  $\text{SiO}_2$  and 4.2-7.4 wt%  $\text{Na}_2\text{O}+\text{K}_2\text{O}$ . Dark grey basaltic andesite and andesite lava flows typically contain 5-10% phenocrysts of olivine and plagioclase; olivine phenocrysts can be large (up to 6mm) exhibiting well-developed skeletal overgrowths (McMillan and Dungan, 1986). Medium grey dacite lavas are porphyritic, containing 5-15% phenocrysts of augite and bronzite with common olivine xenocrysts in a fine grained to glassy groundmass of plagioclase, glass, pyroxenes and titanomagnetite (McMillan and Dungan, 1986). Andesite lava flows with aa flow tops and well exposed basal flow breccias tend to be thin, a few meters to 10 meters in thickness, and are

laterally continuous based on exposures in the Red River canyon. In contrast, dacite lavas are typically thick, up to tens of meters locally, and are characteristically discontinuous and aerially restricted. Locally, deposits of the Red River volcano overlie and in rare cases are intercalated with dacite lava flows of Guadalupe Mountain and consistently overlie basalt and rare andesite of the Servilleta Fm near the base of the Red River gorge, not differentiated at the map scale.

- Tvp **Undivided pyroclastic deposits (Pliocene)** –Pyroclastic deposits of near vent origin exposed in Rio Grande gorge. Predominantly fragmental deposits including cinder, ash and volcanic lithic fragments.
- Tag **Dacite of Guadalupe Mountain (Pliocene)** – Predominantly trachydacite lava flows (62 wt% SiO<sub>2</sub>, 6.3 wt% Na<sub>2</sub>O+K<sub>2</sub>O) and associated near-vent pyroclastic deposits. Contains sparse, small phenocrysts of plagioclase, hypersthene and augite in a pilotaxitic glassy groundmass. Distal lava flows exposed in the Rio Grande gorge and the Red River gorge (not shown at this map scale) are highly elongate and individual flows are laterally restricted, typically forming overlapping finger-like lobes characterized by radial cooling fractures and concentric brecciated carapaces where exposed in cross-section. Flows exposed in Rio Grande gorge vary considerably in thickness from a few meters to several tens of meters in thickness. Lava flow flow directions exposed in the Rio Grande gorge appear to be predominantly from east to west suggesting a primary source area at Guadalupe Mountain. Near-vent pyroclastic deposits consisting mostly of spatter and agglutinate are most abundant near the steep-sided geographic north and south peaks of Guadalupe Mountain. Spatter and cinder deposits are found locally in association with flank lavas and may represent remobilized central vent deposits or mark the location of satellite vents on the flanks of Guadalupe Mountain. Guadalupe Mountain dacite lava flows overlie both Cerro Chiflo dome deposits and lower Servilleta Formation basalt lava flows in the Rio Grande gorge and locally underlie and are intercalated with lava flows of the Red River volcano. Appelt (1998) reports <sup>40</sup>Ar/<sup>39</sup>Ar ages of 5.11±0.08 and 5.34±0.06 Ma for groundmass separates from the south side of Guadalupe Mountain.
- Tvc **Trachyandesite of Cerro Chiflo (Pliocene)** – Eroded remnants of large lava dome of porphyritic trachyandesite (63 wt% SiO<sub>2</sub>, 7.7 wt% Na<sub>2</sub>O+K<sub>2</sub>O; rock designation based on IUGS classification (Le Bas and others, 1986); formerly described by Lipman and Mehnert (1979) as quartz latite) at Cerro Chiflo, forms prominent cliff outcrops along Rio Grande gorge in northern part of map area. Light brown to gray, weakly to strongly flow laminated, contains phenocrysts of plagioclase, hornblende, and sparse biotite in a devitrified groundmass. Xenoliths of Precambrian schist, gneiss, and granite are common. Flow breccias preserved around margins of dome and ramp structures common throughout the exposed interior. Appelt (1998) reports <sup>40</sup>Ar/<sup>39</sup>Ar ages of 5.31±0.31 and 5.32±0.08 Ma for groundmass separates from the west and east sides of the dome, respectively.
- Tam **Andesite of Cerro Montoso (Pliocene)** – Dark gray to black, porphyritic olivine andesite (57.6 wt% SiO<sub>2</sub>, 8 wt% Na<sub>2</sub>O+K<sub>2</sub>O) lava flows erupted from vents on Cerro Montoso, one of the largest, petrologically uniform, shield volcanoes of the Taos Plateau volcanic field (Lipman and Mehnert, 1979). Contains 2-3 percent phenocrysts of olivine in a microcrystalline groundmass of plagioclase, olivine, augite, Fe-Ti oxides. The lower slopes of Cerro Montoso in the western side of the map area are often mantled in colluvium and rarely preserve well-developed flow morphology. Instead outcrops typically reflect blocky flow tops and remnants of numerous discontinuous and aerially restricted flow lobes. Appelt (1998) reports <sup>40</sup>Ar/<sup>39</sup>Ar ages of 5.88±0.18 Ma for a groundmass separate from the west side of Cerro Montoso.
- Tat – **Amalia Tuff (Oligocene)** – Light gray to light brown moderately welded porphyritic, peralkaline rhyolite ash-flow tuff. Consists primarily of quartz and sanidine phenocrysts in a devitrified matrix; Fe-Ti oxides, sphene, and alkali amphibole phenocrysts are minor. Forms low erosional hills of distal outflow in the northwest part of the map area. Miggins and others (2002) report a <sup>40</sup>Ar/<sup>39</sup>Ar sanidine age of approximately 25.1 Ma. Erupted from the Questa caldera approximately 15 km to the east (Lipman and Reed, 1989).
- Tvb – **Volcanic deposits of Brushy Mountain (Oligocene)** – Volcanic rocks and deposits consisting primarily of andesite to dacite lava flows and flow breccias and rhyolite block-and-ash flows and

ash-flow tuff with volumetrically minor air-fall deposits (Thompson and others, 1986; Thompson and Schilling, 1988). Light tan, poorly welded, lithic-rich, rhyolite ash-flow tuff forms base of section near low saddle of Brushy Mountain. Lower rhyolite contains phenocrysts of plagioclase and altered biotite, light brown altered pumice and angular to subangular vitrophyric inclusions (<0.5 cm to several cm) containing plagioclase phenocrysts and reddish-brown dacite inclusions (2 cm to several cm). Locally overlain by thin outflow deposits of Amalia Tuff (unit Tat). Post Amalia Tuff deposits include light-grey to white rhyolite dome deposits including locally, block-and-ash flows, ash-flow tuffs and air-fall deposits. All deposits are mineralogically similar containing sanidine, quartz and minor biotite phenocrysts in a devitrified glass matrix. K-Ar dating of sanidine yielded an age of  $22.3 \pm 0.08$  (Lipman and Mehnert, 1979). Exposed in quarry on south side of Brushy Mountain and north side of Cerro Montoso. Thin (< 2-3m) andesite lava flows locally overlie rhyolite dome deposits and consist of medium- to dark-brown porphyritic flows and flow remnants containing olivine, clinopyroxene, and plagioclase phenocrysts, plagioclase glomerocrysts, and minor orthopyroxene microphenocrysts in a fine- to medium-grained trachytic groundmass composed predominantly of plagioclase, clinopyroxene, and Fe-Ti oxides. The upper part of the section consists of light- to dark-grey, aphyric to porphyritic dacite lava flows and flow breccias containing variable amounts of hornblende, plagioclase, clinopyroxene, Fe-Ti oxides and minor orthopyroxene, sanidine, sphene and zircon in a fine grained to microcrystalline groundmass. Lava flows are locally variable in thickness, discontinuous and commonly delineated on the basis of blocky rubble deposits and float.

**Tvt – Volcanic deposits of Timber Mountain (Oligocene)** - Volcanic rocks and deposits consisting primarily of andesite to dacite lava flows and flow breccias and lesser rhyolite flows and ash-flow tuff (Thompson and others, 1986; Thompson and Schilling, 1988). Light-brown, lithic-poor, densely welded rhyolite ash-flow tuff forms base of section and contains moderately to highly flattened pumices, phenocrysts of plagioclase, sanidine, quartz, and biotite with subordinate amounts of Fe-Ti oxides, clinopyroxene and orthopyroxene in a glassy to partially devitrified matrix. K-Ar dating of biotite and sanidine separates yielded ages of  $26.5 \pm 1.3$  and  $24.4 \pm 0.9$  Ma, respectively (Lipman and Mehnert, 1979). Rhyolite ash-flow tuff is overlain by a lower sequence of moderately porphyritic lava flows and pyroclastic deposits containing variable amounts of plagioclase, clinopyroxene, Fe-Ti oxides hornblende plus or minus biotite and sanidine xenocrysts. Locally contains abundant micropillows of basaltic lava and dacite xenoliths as much as 10 cm in diameter. Lower dacite sequence is separated from an upper dacite sequence locally by medium- to dark-brown, porphyritic lava flow remnants containing olivine, clinopyroxene, and plagioclase phenocrysts, plagioclase glomerocrysts, and minor orthopyroxene microphenocrysts in a fine- to medium-grained trachytic groundmass composed of plagioclase, clinopyroxene, and Fe-Ti oxides. Upper dacite sequence contains medium- to light-gray porphyritic, glassy lava flows and lava dome remnants containing phenocrysts of hornblende, biotite, plagioclase, clinopyroxene and Fe-Ti oxides in variable proportion.

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