Geologic Map of the Doña Ana 7.5-Minute Quadrangle and Adjacent Areas, Doña Ana County, New Mexico

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Open-file Digital Geologic Map OF-GM 267

Scale 1:24,000

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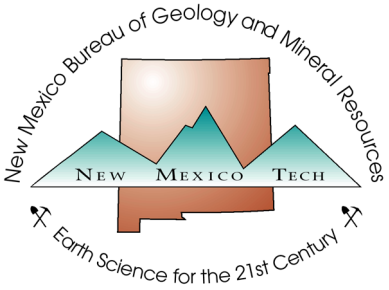

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Description of Rock Units

Northern Mesilla Valley of the Rio Grande

Qs--Eolian and colluvial sand. Qs/Qcrf indicates eolian and colluvial sand discontinuously mantling Camp Rice fluvial deposits; Qs/Qvo indicates a veneer of eolian and colluvial sand overlying Qvo deposits.

Qvy--Younger border-valley alluvium. Active arroyo channel, terrace, fan and pediment deposits graded to within a few meters of the Rio Grande floodplain. Mostly unconsolidated, poorly sorted, gravel, sand and silt-clay sediment with little or no soil development. As much as 70ft (21.3m) thick.

Qvyf--Younger valley-floor fluvial facies. River channel and overbank deposits of the modern Rio Grande and its floodplain. Interbedded sequences of well-sorted and rounded gravel, sand, and silt-clay. As much as 70ft (21.3m) thick.

Qvo--Older valley border alluvium. Arroyo and fan deposits and pediment veneers associated with a stepped sequence of geomorphic surfaces that are graded to former levels of the Rio Grande floodplain, the oldest of which is approximately 250ft (76.2m) above the present valley floor. Poorly sorted and rounded gravel, sand and loamy (sand-silt) sediment with local deposits of conglomerate, sandstone and mudstone. Pedogenic carbonate (stage II-III) is generally present at the constructional top of these deposits, especially in the higher (older) ones. As much as 130ft (39.6m) thick.

Qvou--Older valley border fluvial facies. River deposits of the Rio Grande that interfinger with or are inset against Qvo, or are inset against TQcc deposits, adjacent to the modern floodplain of the Rio Grande. Upslope limits of Qvou deposits are generally no higher than approximately 100ft (30 m) above the modern floodplain; locally, these limits are marked by cut-bank scarps in Qvo or Camp Rice deposits. The deposits are charachterized by well-rounded gravel, sand and silt-clay containing stage II or III pedogenic carbonates in uppermost parts. As much as 100ft (30 m) thick.

Qva--Undifferentiated Qvo and Qvy

Jornada del Muerto closed basin

Qpy--Younger piedmont-slope alluvium. Active arroyo channel, terrace and fan deposits graded to closed basin floors or playas of the southern Jornada del Muerto. Gravel, sand and silt-sand with little or no soil development. As much as 15ft (4.6m) thick.

Qpo--Older piedmont-slope alluvium. Alluvial-fan and arroyo-terrace deposits and pediment veneers that are inset below proximal parts of Camp Rice fans but generally overlap those fans downslope. At least two generations of Qpo fans can be distinguished locally by their inset relationships to older deposits. Gravel, sand, and silt-clay, usually cemented in lower parts by ground-water carbonate. Upper parts of Qpo contain well-developed (stage II- III) soil carbonate. As much as 40ft (12m) thick, thinning upslope to pediment veneers.

Qpa--Undifferentiated Qpo and Qpy

Qc--Colluvium. Hill-slope gravel and soil, grading locally to either Qcp, Qvo, Qpo, Qvy, or Qpy.

Qcp-- Camp Rice Formation, upper piedmont-slope facies. Pediment veneers and younger parts of broad alluvial fans along the eastern slopes of the Dona Ana Mountains. Boulder to cobble gravel and conglomerate and gravelly sand or sandstone. Uppermost strata are cemented by stage III-IV pedogenic carbonate. As much as 40ft (12m) thick in the headwaters of Dona Ana Arroyo but thinning upslope to pediment veneers. (Qcp probably includes oldest Qpo fans locally, especially in Dagger Flat and along the eastern piedmont slopes of the Dona Ana Mountains. Distinguishing the two ages of fans is difficult because inset or overlapping relationships are subtle and complete soil profiles are rarely exposed. Furthermore, oldest Qpo fans contain soil carbonate whose uppermost, visible profile is nearly as well developed as Qcp fans.)

TQct--Camp Rice Formation, distal piedmont-slope/alluvial-flat facies. Interbedded red mudstone, pebbly mudstone and locally derived pebble gravel and conglomerate. Mapped only in upper Lucero Arroyo drainage. As much as 200ft (61m) thick.

Qcl-- La Mesa surface, constructional top of Camp Rice fluvial deposits. The surface is underlain by stage IV or V pedogenic carbonate, which modifies uppermost Camp Rice fluvial strata, and is discontinuously mantled by eolian sand. Surface is denoted by lined pattern on map.

TQcf--Camp Rice Formation, fluvial facies. Braid-plain channel and overbank deposits of the ancestral Rio Grande. May include distal piedmont-slope/alluvial-flat sediments locally. Mostly light gray to tan to cream- or ochre-colored sand, gravelly sand, conglomeratic sandstone and interbedded pale red or tan mudstone; well-rounded, siliceous pebbles and volcanic and granitic clasts from upstream sources are common, as is trough cross bedding. Two thin (1.5ft; 0.5m) beds of pumice clasts were derived from Jemez (1.6Ma) and Mt. Taylor (3.1Ma) eruptions and transported southward by ancestral Rio Grande floodwaters. As much as 300ft (91.5m) thick, thinning to pinchouts toward the Dona Ana Mountains. The constructional upper surface of these deposits is the La Mesa surface, a relict basin floor, and is denoted on the map by Qcl and a lined pattern.

TQcc--Camp Rice Formation, lower conglomerate facies. Well-cemented alluvial-fan deposits and rock-pediment veneers, mostly representing lower, older parts of Camp Rice fans; best exposed from the vicinity of Wagner Canyon northward. Consists mostly of poorly sorted, locally derived, tan conglomerate, sandy conglomerate and conglomeratic sandstone (fanglomerate); imbrication is common and cross beds are locally present. Generally cemented by ground-water carbonate. Angular unconformity with older bedrock. As much as 150 ft (46m) thick, thinning upslope to rock pediment veneers.

TQcu--Undifferentiated Qcp and TQcc.

Tb--Basalt. Small plugs (200ft; 61m, diameter) and narrow (6ft; 2m) dikes of black, olivine basalt cutting Panther Seep beds in Grande Dome and Lower Hueco beds along the East Robledo fault. Basaltic andesite bodies (Tbas) within Ts or cutting Tr northeast of Dagger Flat and elsewhere may be correlative with Tb.

Trv--Rincon Valley Formation. Pebble to cobble conglomerate consisting entirely of Middle Tertiary andesite and rhyolite clasts. Outcrops are confined to narrow fault slices along the East Robledo fault. Exposed thickness is 50 ft (15m).

Tbas-- Basaltic andesite. Irregular bodies of dark-gray basaltic andesite within Ts northeast of Dagger Flat; also, basaltic andesite dike cutting Tpc and Tr at southeastern edge of mountains. May be correlative with Tb or with Uvas Basaltic Andesite of the Sierra de las Uvas range, or they may be basaltic intrusions within the Dona Ana caldera cycle of igneous activity.

Tsmd--Summerford Mountain dikes. Light gray, very fine-grained felsite dikes that weather shades of pale tan to pale yellow brown; they transect the Summerford Mountain syenite. Sparse (<5 percent) k-feldspar phenocrysts. May be correlative with felsite dikes (Tf).

Ttg--Trachyte of Goat Mountain. Dark brownish-gray trachyte and trachyte porphyry containing approximately 5 percent crystals of quartz and equant K-feldspar, 2-3mm in length. Steep foliation near the perimeter of Goat Mountain appears to exhibit eutaxitic texture, at least locally, but interior parts of the mountain are either weakly foliated or non foliated. The trachyte appears to have been intruded/extruded as a volcanic dome, only the core and/or roots preserved today as Goat Mountain (“Twin Peaks Hill” on some maps).

Tr--Undifferentiated rhyolite. The unit includes several occurrences: 1)small intrusions, including narrow, short dikes and sills; 2)thick flows, including possible block and ash flows, and numerous landslide or crumble-breccia blocks within the Red Hills graben; 3)bodies of rhyolite adjacent to syenite porphyry (Ts) dikes, the rhyolite likely a weakly or non-foliated facies of Tfr (also, see Ts description). Variable in color from light gray to reddish brown to pale purplish gray, this rhyolite typically is without flow banding; locally, however, flow banding is a prominent feature.

Tfr--Flow-banded rhyolite. Unit includes (1) dikes and discontinuous intrusives associated with the northern margin of the Dona Ana caldera (also, see Ts description); and (2) circular or somewhat elongated bodies of intrusive rhyolite in the Red Hills graben, which may be interpreted as the “roots” of intrusive/extrusive rhyolite domes. Typically light gray to pale-purplish gray, some dikes are dark-brownish gray. Flow banding is revealed by closely spaced, platy foliation or, more commonly, by alternating light and dark banding; occasionally the foliation is contorted into steeply plunging folds. Equant K feldspar phenocrysts 1-2mm in length are generally present. Black vitrophyre is conspicuous along the margins of some rhyolite domes in the Red Hills graben.

Tf--Felsite. Dikes apparently sourced from the Summerford Mountain sill; they extend from the sill into and transect adjacent outcrops of folded Paleozoic limestone as well as less-deformed Cleofas Andesite. Light gray to pale yellow-orange, the fine-grained rock contains 2-3mm long, altered (clay/sericite) K-feldspar phenocrysts. Locally, thicker dikes become phaneritic or porphyritic in texture whereas the thinnest dikes or terminal parts of dikes may exhibit flow banding. Ubiquitous spots of limonite are formed by the alteration of tiny mafic minerals. May be correlative with Summerford Mountain dikes (Tsmd).

Tt--Trachyte porphyry. Light-colored to melanocratic dikes containing conspicuous blocky crystals of K feldspar and lesser plagioclase. Larger dikes appear to be satellite plutons of the larger syenite porphyry (Ts) dike systems, branching from or paralleling those larger dikes (see also Ts description). Elsewhere, narrower dikes are typically melanocratic with scattered K-feldspar phenocrysts and a very fine-grained matrix.

Ts--Syenite and syenite porphyry. Forms prominent dikes and sills that anchor the highest peaks and ridges in the range. Medium gray, equigranular to porphyritic rock, generally coarse grained and crowded with tan to pale-orange, blocky K-feldspar phenocrysts within a finer-grained matrix of K feldspar and minor amounts of plagioclase and mafic minerals. Chilled dike margins may be fine-grained, locally flow-banded, and exhibit prominent K-feldspar phenocrysts. Along the northern, inner margin of the Dona Ana caldera sizable bodies of rhyolite (Tr; Tfr) and trachyte porphyry (Tt), some flow banded, are adjacent to the syenite but cross cutting relationships were not observed; some of these may be a chilled or compositional facies of Ts. Isolated dikes of trachyte and trachyte porphyry (Tt) are also probably a facies of Ts. Commonly weathers to clusters of rounded outcrops and boulders shaped by spheroidal weathering, as well as rounded, joint-enclosed “fins”. Summerford Mountain sill is at least 1,500 ft (457 m) thick, and dikes range up to .35 mi (0.5 km) in width.

Ta--Andesite. Map unit includes dikes cutting Cleofas Andesite as well as bodies of gray, reddish-gray, or purple-gray, intermediate-composition (?) intrusive or volcanic rock locally present in the Red Hills graben. The latter bodies are surrounded by rhyolite or flow-banded rhyolite, and may be either large engulfed blocks or small plugs. Others are embedded in megabreccia/altered tuff units (Tc) and may be interpreted as either small intrusions or flows, parts of block and ash flows, or landslide blocks.

Tid--Ignimbrite dike. Pale grayish-orange dike with the eutaxitic texture of an ignimbrite. Near-vertical foliation is produced by large (2-4in; 5-10cm), flattened pumice fragments in a matrix of crystals, ash and lithic fragments. Dike is approximately 800ft (244 m) long and 100 ft (30.5 m) wide and intrudes Cleofas Andesite flows.

Tc; Tct; Tct1;Tct2--Younger caldera fill. Occurs in two settings within the Dona Ana caldera: 1) syn-tectonic-volcanic deposits in the actively subsiding Red Hills graben, which formed on the caldera floor after eruption of the Dona Ana Rhyolite, and 2) air-fall and ash-flow tuffs deposited on the caldera floor outside the Red Hills graben. Within the graben, basal(?) beds of Tc, approximately 30ft (9m) thick, are sedimentary breccias and conglomeratic sandstone of lahar or fan origin, derived from adjacent footwalls of the Red Hills graben. The bulk of the unit consists of chaotic, non-stratified

megabreccia in a matrix of altered, pale yellow-green tuff and tuff breccia; clasts range up to house size and consist of slabs and blocks of Dona Ana Rhyolite as well as a variety of textures and colors of flow-banded or non-foliated rhyolite, and locally, andesite. Some of the blocks are clearly of landslide origin; others may be clasts in block and ash flows or crumble breccia clasts. Thickness is at least 300ft (91m). In the southern Red Hills graben, many rhyolite bodies (Tr; see description above), some with discontinuous flow banding , appear to overlie, interfinger with, and/or intrude the megabreccia. Collectively, flows may approach 300ft (91)m or more in thickness. The 'roots' of several deeply eroded, flow-banded rhyolite domes (Tfr; see description above) also intrude the megabreccia within the Red Hills graben; these domes are possible sources for the rhyolite flows and at least some of the clasts in the megabreccia. Outside the Red Hills graben, post-caldera rocks included in the Tc map unit comprise deposits of air-fall tuff (Tct) locally, at least 1,000 ft (305m) thick, as well as at least two ash-flow tuffs (Tct1; Tct2); greenish, altered air-fall tuffs are associated with Tct1 and Tct2.

Td, Tdt-- Dona Ana Rhyolite. Eruption of Dona Ana Rhyolite triggered collapse of the Dona Ana caldera. Basal parts of the formation (Tdt) include a discontinuous sequence of well-bedded tuffs and breccia, less than 100 ft (30.5m) thick, pale tan to cream or pale yellow in color Air-fall ash, pumice and lithic fragments comprise the bulk of these beds; clasts seldom exceed cobble size. Above the basal tuffs, the Dona Ana Rhyolite consists of massive, thick units of ash-flow tuff. Moderately to densely welded, the tuffs range in color from reddish-brown to brown, to gray or purplish-gray, the latter colors typical of more densely welded parts of the formation. Crude, thick and massive stratification in the formation is created by stacked sequences of columnar jointing followed upward by very thick zones of moderate to dense welding; no distinct contacts between tuff layers were observed suggesting that the formation comprises a multiple flow, compound cooling unit. Platy foliation and eutaxitic textures are generally well developed. Locally, streaky eutaxitic textures have aspect ratios of flattened pumice that resemble flow banding in rhyolite. Less flattened pumice is obvious in less welded parts of the tuff, especially in upper parts of the formation; lithic fragments of andesite and latite as well as a variety of rhyolites are also locally abundant. Spherulitic textures are present locally. Phenocrysts of equant sanidine and quartz 2-4mm in length, often altered to clay/sericite, comprise 5-10 percent of the tuff. Groundmass hematite and magnetite in tuffs in the Red Hills gives the rock a reddish-brown color and notable magnetism. Intense sheeting, created by parallel fractures spaced one centimeter or less apart, resembles flow banding in some outcrops, whereas brecciation is significant in others. Because of faulting and erosion, complete sections of the tuff were not identified. Partial sections were measured in the cliffs beneath Dona Ana Peak (900ft; 274 m, or 1,500ft ;457m) if uncertain faulting is not present), and 600ft (183 m) in the Red Hills area along the western foothills of the range. Along the eastern slopes of the range a complete or nearly complete section is 1,450ft (442m) thick.

Tba--Basaltic andesite. Discontinuous dark-gray flows overlying Cleofas Andesite member of the Palm Park Formation. As much as 40ft (12m) thick.

Tpl, Tpls--Palm Park Formation, lahar member. The Palm Park Formation is almost exclusively lahar deposits along the western slopes of the Dona Ana Mountains, becoming interbedded lahar and lava flows in west-central reaches of Cleofas and Wagner canyons, then becoming almost exclusively lava flows (Cleofas Andesite member) farther east in the central and eastern parts of those canyons. Lahars are light gray, purple, grayish-purple to reddish-gray, muddy breccia (mostly angular clasts) and muddy conglomerate (mostly rounded clasts) that are commonly matrix supported. Breccia and conglomerate clasts include a variety of intermediate-composition porphyries that closely resemble nearby and interbedded flows of Cleofas Andesite member; some are monolithologic, others notably heterolithologic. Clasts range up to 5ft (1.5m) in length. Lahars locally are interbedded with 1)well-sorted pebble and cobble conglomerate often associated with thin layers of coarse sandstone; these lack imbrication or crossbeds and probably were deposited by hyperconcentrated flows; and 2) well-sorted, imbricated, and rarely crossbedded granule, pebble, or cobble conglomerate deposited by streams. The volcaniclastic beds locally contain thin (1ft; 0.3m) beds of air-fall tuff. Near the base of the formation two beds of lacustrine limestone (Tpls), each approximately 4ft (1.2m) thick, are interbedded with lahar deposits. At least one tongue of limestone boulder conglomerate of the Love Ranch Formation (Tlr), approximately 30ft (9m) thick also occurs in the lower part of the lahar member. The lahar member is at least 1,800 ft (549m) thick (top not exposed) in the northwestern part of the Dona Ana Mountains.

Tpc--Palm Park Formation, Cleofas Andesite member. Flows of aphanitic to porphyritic andesite and dacite, generally pale tan to dark-gray to purplish-or bluish-gray; large areas of hematite or goethite-stained rocks give the flows a brownish-gray color over a half square mile area between Wagner and Cleofas canyons. Phenocrysts of plagioclase, biotite, and hornblende, 2-4mm in length, comprise 3-30 percent of the flows; feldspars typically are altered to sericite, clay, calcite, oxides and epidote, mafic minerals to mixtures of chlorite, epidote, clinozoisite, epidote, and hematite. Flows are generally more than 200 ft (61m) thick and most lack conspicuous flow banding. However, prominent, steeply dipping flow banding is well developed locally and may indicate either local intrusive bodies or laminar flow of interior or frontal parts of lava flows. Contacts between individual flows were seldom identified; however, scattered beds of lahar breccia and conglomerate between flows both supports their origin as lavas and provides strike and dip data for the lava sequence. Between Wagner and Cleofas canyons a partial section is at least 1,400 ft (427m) thick, both base and top being unexposed.

Tlr--Love Ranch Conglomerate. Reddish-gray boulder conglomerate and conglomeritic sandstone at the base of the Palm Park Formation; also includes a local tongue of conglomerate (20ft; 6m thick) within the Palm Park Formation approximately 60ft (18m) above the base. Clasts consist entirely of Hueco Limestone and Abo redbeds which outcrop unconformably beneath the conglomerate and in adjacent hills. Clasts range up to 6ft (1.8m) in length, averaging 0.6-1ft (0.2-0.3m). One block of fusulinid-bearing limestone 20ft (6m) or more in length may be a landslide(?) clast in Love Ranch conglomerate in Lucero Arroyo (designated P IP on map). As much as 60ft (18m) thick, locally absent.

Pa-- Abo Formation. Interbedded red to tan, sandstone, shale, and siltstone (Abo beds); green to gray to purplish-gray shale, fossiliferous, gray, grayish-orange, olive-gray, marine (Hueco) limestone; and tan to yellowish-gray lagoonal, intertidal, and supratidal dolomicrite. Sandstone and siltstone beds are channel shaped, as much as 40ft (12m) thick, exhibit ripple cross-laminations, trough cross beds, desiccation cracks and plant remains locally; they are fluvial to fluvio-estuarine in origin. Beds of red shale,with interbeds of red siltstone are overbank and crevasse-splay deposits, respectively. Limestone beds are generally less than 10ft (3m) in thickness, micritic in texture, and contain varying amounts of gastropods, echinoid spines, ostracodes, bryozoans, brachiopods, and pelecypods, including dark shells of Aviculapinna, either as nearly whole fossils or more commonly parts of a bioclastic assemblage; mud-filled burrows are common. Beds of gray shale are marine and locally have thin, storm-deposited beds of tan sandstone or siltstone that display hummocky stratification and oscillation ripple marks. A partial section of the Abo Formation exposed in the vicinity of Lucero Arroyo is 267 ft (81m) thick, top not exposed.

Hueco Limestone, shelf facies. Middle and lower members of the Hueco Formation in the westernmost Dona Ana Mountains are nearly identical to the same map units in the Robledo Mountains, both in terms of thickness and overall lithology. These similar sections are interpreted to have been deposited on the Robledo shelf. (Upper Hueco beds, above the Abo Formation and present in the Robledo Mountains, are absent from the Dona Ana Mountains due to Laramide erosion). In the Dona Ana Mountains the middle member of the Hueco shelf strata was divided into upper "gastropod limestone" beds and underlying "middle Hueco, lower beds".

Phmg--Hueco Limestone, middle member, "gastropod-limestone" beds. Dark to medium-gray limestone generally containing a conspicuous fauna of planispiral gastropods, brachiopods, nautiloids, bryozoans, pelecypods, and echinoid spines, many of which are unbroken or nearly so. At least one thin (6in; 0.2m) algal limestone bed is present. Bedding is thin to medium, often wavy or nodular. Shale beds up to 20ft (6m) thick, several with thin storm-deposited sandstone or siltstone beds, are interbedded with the limestone but generally poorly exposed. Two or three Abo-like sandstone-siltstone beds, each up to 8ft (2.4m) thick, are also interbedded. Gastropod limestone beds are approximately 400ft (122m) thick in the northwestern part of the range, but, due to faulting, only 70 ft (21m) of the lower part of the map unit is exposed on the western flank of Grande Dome.

Phm--Hueco Limestone, middle member, lower beds. Predominantly pale yellow, pale yellow-brown, light to medium-gray, and olive-gray micrite and lagoonal-supratidal dolomicrite interbedded with poorly exposed gray shale and soft, marly limestone. Carbonate beds range from 2-10ft (0.6-3m) thick, shale units up to 20ft (6m) thick. Micrite and dolomicrite generally contain sand to granule size allochems, including pelloids, rare oolites, and common bioclastic grains. Ostracodes are present in some beds. Calcite blebs and fenestral fabric are common in dolomicrite beds. Forms ledgy dip slope. Approximately 252 ft (77m) thick.

Phl--Hueco Limestone, lower member. Lower 240ft (73m) of the lower member is cliff-or hogback-forming, medium-to dark-gray limestone. At least four phylloid algae beds are

present in the section, including a basal, cliff-forming bed approximately 15ft (5m) thick. Above this basal bed, approximately 15ft (5m) of distinctive, alternating dark gray limestone and tan, siliceous or chert beds, each 4 to 6 in (10-15 cm) thick, form slopes or dip slopes, or cliffs in canyon walls. Limestones contain abundant bryozoans, ostracodes, brachiopods, corals, crinoids, fusulinids (Schwagerina andresensis and Pseudoscwagerina) and other fossils. Chert nodules are abundant in some beds, and limestone-pebble conglomerate and sandy zones are present locally. Thin shale or soft, marly limestone units are interbedded with limestone. The upper 180 ft (55m) of the lower Hueco consists primarily of yellow-, cream-, tan-, or light-gray weathering micrite and lagoonal to supratidal dolomicrite interbedded with shale or soft limestone beds. Micrite-dolomicrite beds are medium to thin bedded and together with shale intervals form a ledgy dip slope. Thin siliceous streaks, blebs, and laminae are common. The top of the lower Hueco member was picked at the highest of two bright orange-brown weathering dolomicrite beds. Total thickness is approximately 420 ft (128m). East of Grande Dome strata assigned tentatively to the lower Hueco are variably metamorphosed into massive marble beds, sandy, laminated marble, and siliceous porcellanites. Fossils are either lacking or obliterated by recrystallization. Whether these rocks are shelf or basinal facies is unclear.

Middle Hueco Limestone, basin facies. West of Summerford Mountain a wide tract of middle Hueco strata underlies the "gastropod limestone" beds. These rocks appear to be thicker than and include facies not present at Grande Dome and in the Robledo Mountains.

Comment [1]:
Bill Seager Jul 30, '16, 6:46 PM

Phmb--Hueco Limestone, middle member, basin facies. Black shale and several beds of tan to reddish-brown, Abo-like sandstone distinguish this facies from the shelf facies exposed at Grande dome. Channels of Abo-like strata, each as much as 20ft (6m) thick, occur in the upper part of the section, interbedded with fossiliferous, gray limestone and gray shale. Sandstones exhibit horizontal laminae and ripple cross-laminations, as well as a few trough cross beds and desiccation cracks; they are interbedded with olive-gray siltstone with flaser bedding. The Abo-like strata are interpreted to be fluvial to fluvio-estuarine in origin. The black shale section, approximately 197 ft (60m) thick, is present in the middle part of the section; black shale beds are interbedded with thin-to medium-bedded limestone and interpreted to be pro-delta deposits. Below the black shale section, the lower part of the middle member is mostly interbedded sandy micrite, siliceous shale, minor sandstone and siliceous dolomicrite, variably affected by thermal metamorphism, especially as one approaches the Summerford Mountain sill. Black shale is converted to hornfels; limestone and dolomicrite to marble; and fine-grained, siliceous rocks to porcellanite. Total thickness is uncertain because of metamorphism and structure; at least 400ft (122m) thick, perhaps 600ft (183m).

Pb--Bursum Formation (?). Interbedded marine limestone and shale, forming ledgy slope. Identified only along the western edge of Grande Dome beneath Lower Hueco shelf strata. Limestones include medium to dark gray micrite, stromatolitic micrite, bioclastic micrite, oolitic limestone, phylloid algal limestone, hummocky stratified, sandy limestone, and chert and limestone-pebble conglomerate. Limestones are generally 1 to 6ft (0.3 to 2 m) thick. Shale beds are mostly covered, but gray to black, fissile to nodular shale and very thin-bedded, marly limestone are locally exposed. The

Bursum(?) appears to change facies along both the northwestern and southwestern flanks of Grande Dome into typical Panther Seep facies. Approximately 200 ft (61m) thick.

IPps--Panther Seep Formation. Cyclically interbedded calcareous, tan-to brown-weathering sandstone and quartzite, laminated micrite, sandy and silty limestone, gray to black shale and porcellanitic shale; stromatolitic limestone and gypsum beds are present approximately 200 (61) below the top of the formation. Limestones are generally micritic, poorly fossiliferous, contain sandy laminae, and are generally thin (<3 ft; <1m), although marble beds as thick as 30ft (9m) are present in parts of the section in upper reaches of the Wagner Canyon drainage. Sandstones exhibit common horizontal laminae and range from coarse to fine grained. East of Grande Dome, thermal metamorphism has converted most of the Panther Seep beds into gray to white marble with abundant brown, siliceous streaks and laminae, porcellanite, and locally, quartzite. At least 2,000ft (610m) thick.

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Symbols

Geologic contact, dashed where approximately located, dotted where buried

Horizontal bedding

Strike and dip of bedding

Estimated strike and dip of lava flows

Strike and dip of foliation or flow banding

Anticlinal hinge, dashed where approximately located, dotted where buried

Overturned anticlinal hinge, dashed where approximately located, dotted where buried

Synclinal hinge, dashed where approximately located, dotted where buried

Overturned synclinal hinge, dashed where approximately located, dotted where buried

Normal fault, dumbbell on downthrown side, arrow shows direction and amount of dip; dashed where approximately located or where presence is uncertain, dotted where buried

Thrust or reverse fault, barbs on upthrown side, dashed where approximately located or uncertain, dotted where buried

Landslide blocks