porphyritic dacite in the Troy Peak Formation (Ttpd). Located at:

overlain by a 30-cm-thick, light-gray to white tuff bed overlain

by dark-gray basaltic volcaniclastic rocks (Ttbv) in the Troy Peak

Formation. Located at: 34.911090, -116.477385.

### MAP SHEET 68 California geologic maps are available at https://www.conservation.ca.gov/cgs

## GEOLOGIC MAP OF THE WESTERN CADY MOUNTAINS, SAN BERNARDINO COUNTY, CALIFORNIA

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## DESCRIPTION OF MAP UNITS

**QUATERNARY SURFICIAL DEPOSITS** 

Artificial fill (historic)—Anthropogenic deposits of earth materials that may be engineered or non-Wash deposits (late Holocene)—Unconsolidated, light-yellowish-brown sand and gravel deposited in recently active stream channels, including the Mojave River and its tributaries. Sediments are generally derived from local bedrock or older Quaternary deposits. Materials subject to localized reworking and new

with wind-blown sand (Qe). Alluvial fan deposits (late Holocene)—Unconsolidated to weakly consolidated, poorly sorted, lightyellowish-brown gravel, sand, and silt deposits forming active, essentially undissected, alluvial fans. Fan apices commonly occur at or upstream of mountain fronts or wash channel walls. Clasts are derived from upslope rock sources and reworked from adjacent older alluvial fan deposits. This unit may locally include younger alluvial fan deposits (Qyf) and other Quaternary units across multiple time periods due to

sediment deposition during storm events and only support local, sparse vegetation. Some washes are filled

differences in geomorphology and appearance on aerial imagery across the map area. Alluvium (late Holocene)—Unconsolidated to weakly consolidated, mostly undissected, sand and silt in valley areas, grading from sand with local subrounded pebbles and subangular to subrounded cobbles near hills, recently deposited parallel to localized stream valleys and/or spread more regionally onto broad alluvial valleys. Grades downslope into clay and grades outward into sand and silt in valley areas. Covered in a thin veneer of wind-blown sand in most areas.

silt from saline dry lakes that are periodically flooded. Alkaline in Troy Lake (usually dry). Eolian deposits (late Holocene)—Unconsolidated, loose, generally well-sorted, fine- to medium-grained, light-brownish-yellow wind-blown sand composed predominantly of quartz and feldspar (Dibblee and Bassett, 1966a), deposited by prevailing westerly winds. Commonly covers other Quaternary and bedrock units as a thin, unmapped veneer and as a thicker (>2m), mapped blanket, particularly in the center and northeast areas of the map. Fills washes in some areas.

Playa deposits of Troy Lake (late Holocene)—Moderately consolidated, stiff, cohesive, light-gray clayey

Younger wash deposits (middle Holocene to late Pleistocene)—Weakly consolidated silty sand, gravel, cobbles and local boulders. Commonly occurs as elongate deposits on the margins of active wash deposits, inactive channels that fed young alluvial fans, and canyons upstream of the mountain front. Sediments are generally derived from bedrock in upstream source areas or older Quaternary deposits. Sediments may be subject to mobilization and redeposition during large storm events. Vegetation may be sparse to moderately

Younger alluvial fan deposits (middle Holocene to late Pleistocene)—Unconsolidated to locally moderately consolidated, light-yellowish-brown silty sand, pebbly sand, and silt. Surfaces are undissected to slightly dissected. Locally overlain by thin eolian veneer or interlayered with eolian deposits such as sand sheets. Contains subrounded to subangular quartz, feldspar, and biotite. Clasts are locally derived from upslope or upstream source areas and reworked from adjacent older fan deposits. No carbonate precipitation, soil development, or cementation. Locally includes narrow active alluvial fan and wash deposits (Qf, Qw). In some areas, isolated older alluvial fan deposits (Qof) may be included in this unit. Wind-blown eolian sand (Qe) presents as a veneer on most of these surfaces, making distinguishing between Quaternary units difficult. This unit may locally include older alluvial fan deposits (Qof), active alluvial fan deposits (Qf), and other Quaternary units across multiple time periods due to differences in geomorphology and appearance on aerial imagery across the map area.

Younger playa deposits of Troy Lake (middle Holocene to Pleistocene)—Moderately consolidated, stiff, cohesive, light-gray clayey silt from saline dry lakes that are periodically flooded. Alkaline in Troy Lake (usually dry). This unit is distinguished from the active playa deposits of Troy Lake (Qp) because they are inundated less frequently, and the Pisgah basalt (Qb) overlies this unit.

Manix Lake lacustrine deposits (late Pleistocene)—Light-greenish-gray, bedded, moderately sorted

lacustrine gravel and sand deposited in a nearshore environment, fan-delta deposits, and well-sorted, subrounded to rounded beach gravel, sand, silt, and clay (Reheis and others, 2014). Overlies older gravel (Ooa) and is overlain by silt and sand from alluvial fans (Oyf) (Dibblee and Bassett, 1966a). Contains late Pleistocene bird fossils (Howard, 1955). Radiocarbon dates indicate the deposits are >40-25 ka (Reheis and others, 2014). Forms lacustrine deposits in the northeast part of the map area and stranded shoreline bars in the southwest part of the map area, indicating an old paleoshoreline (Reheis and others, 2014). Older alluvial gravel (late to middle Pleistocene)—Gray beds of moderately sorted and rounded cobbles and pebbles composed mostly of Mesozoic metavolcanic and Tertiary andesitic rocks derived from hills to south (Dibblee and Bassett, 1966a). Maximum exposed thickness in the map area is ~25 meters (Dibblee

and Bassett, 1966a). **Older fan deposits (late to middle Pleistocene)**—Slightly to moderately consolidated, yellowish-brown silty sand with gravel. Surfaces are generally elevated at least several meters above active channel grade and not subject to historic flood inundation. Fans are composed of poorly sorted, subrounded fragments of predominantly volcanic rocks. This unit may locally include younger and very old alluvial fan deposits (Qyf, Qvof), and other Quaternary units across multiple time periods due to differences in geomorphology and appearance on aerial imagery across the map area.

Very old fan deposits (middle to early Pleistocene)—Moderately to well-consolidated yellowish-brown

silt, sand, gravel, cobbles, and boulders forming deposits up to 30-m-thick. Mixed alluvial fan deposits interstratified with lesser amounts of eolian sand (Bedrossian and others, 2012). This unit may locally include older alluvial fan deposits (Qof) and other Quaternary units across multiple time periods due to differences in geomorphology and appearance on aerial imagery across the map area. Fanglomerate deposits (middle to early Pleistocene)—Gray, massive, well indurated, multi-lithologic anglomerate deposits composed of 40-70% poorly sorted, subangular to rounded basalt, andesite, sandstone, tuff, and quartz monzonite clasts as large as 1 m in diameter, but average 5-10 cm in diameter, in a matrix of light-reddish-brown tuffaceous sand and mud. Local imbrication of pebbles and cobbles indicate a south to southwesterly paleoflow direction (Ross, 1994). Fanglomerate deposits (Ofg) are elevated and perched on units within the Barstow Formation (Tbs, Tbc), Hector Formation (Thtc), and Troy Peak Formation (Ttb). Fanglomerate deposits are older than very old fan deposits (Qvof) because the unit experienced uplift with bedrock units, unlike very old fan deposits (Qvof).

Index map showing U.S. Geological Survey

7.5-minute quadrangles. Map area shown in blue.

### **QUATERNARY VOLCANIC DEPOSITS**

Basalt flow of Pisgah Crater (late Pleistocene)—Fresh, hard, black vesicular microcrystalline basalt composed of calcic plagioclase (partly as laths), basaltic glass, pyroxene, disseminated magnetite, and small patches of olivine (Dibblee and Bassett, 1966a). Forms at least one single ropy lava flow (Dibblee and Bassett, 1966a) on playa deposits (Qp); erupted from Pisgah Crater to the southeast. Dated at 22.5 ± 1.3 ka using cosmogenic <sup>36</sup>Cl (Phillips, 2003).

### **TERTIARY VOLCANIC AND SEDIMENTARY UNITS**

Tertiary rocks within the field area consist of a sequence of volcanic strata, including tuff breccia, lava

flow, tuff, and possibly hypabyssal intrusion, interfingered with and capped by finer strata of nonmarine sedimentary rocks. Unconformably overlying Cretaceous quartz monzonite basement (Kqm) in the southern portion of the map area is a package of andesitic breccia, andesitic deposits, and tuff deposits of the Oligocene Poe Formation (Tptb, Tpt, and Tpa) (Ross, 1994). The Oligocene Poe Formation is overlain by two suites of Oligo-Miocene volcanic rocks: the Troy Peak Formation and the Hector Formation. The Troy Peak Formation was locally observed to interfinger with the Poe Formation in the middle portion of the map area, and the Hector Formation unconformably overlies the Poe Formation in the southern portion of the map area. The Hector Formation (unit Thtc) was locally observed to interfinger the Troy Peak Formation (unit Ttb) in the southern part of the map area. The Hector Formation consists of tuff breccia, reworked tuff, sandstone, tuffaceous volcanic conglomerate, and welded tuff (Thtc, Thts, and Thwt). The Troy Peak Formation consists of voluminous volcanic conglomerate, basaltic volcaniclastic rocks, basalt, and dacite deposits (Ttvc, Ttbv, Ttdb, Ttdt, Ttpd, and Ttb) (Woodburne and others., 1974; Ross, 1994). The Troy Peak Formation also directly overlies metavolcanic rocks (Mzmv) in the northern part of the map area (Dibblee and Bassett, 1966a). Overlying basalt of the Troy Peak Formation (Ttb) and tuffaceous conglomerate of the Hector Formation (Thtc) are sandstone, siltstone, limestone, reworked and altered tuff deposits (Tbs), and conglomerate (Tbc) of the Miocene Barstow Formation (Ross, 1994). Evidence of hydrothermal alteration is common in the field area, and plagioclase is frequently altered to white clay in most volcanic units. A quartz monzonite breccia (Tqmb) of uncertain age, presumably a landslide breccia (Dibblee and Bassett, 1966a), crops out in the northwest part of the field area.

Barstow Formation (middle Miocene)—The Barstow Formation is a sequence of fluvial and lacustrine sedimentary rocks, interbedded with tuff beds (Hershey, 1902; Merriam, 1919; Woodburne and others, 1990). The thickest and most continuous section of the Barstow Formation within the map area exposed in the southern portion is ~217-m-thick (Ross, 1994) and lies unconformably above the Troy Peak and Hector Formations. Here, sandstone, siltstone, limestone, tuff, and bentonite are observed (Tbs; ~162-m-thick) as well as a local, coarser cobble to boulder conglomerate (Tbc; ~55-m-thick) that underlies and locally Formation in the northwest part of the map area. The type section of the Barstow Formation is located ~40 km northwest of the map area in the Mud Hills (Woodburne and others, 1990). The Barstow Formation within the map area was sourced from the east and locally from the west (Woodburne, 2015). The package of fluvial and lacustrine sedimentary rocks observed within the map area (Tbs) is herein referred to as the Barstow Formation due to its correlation in age and similar lithologies to the sequence found in the type section at Mud Hills, even though it may have been deposited in a different depositional basin (Ross, 1994; Reynolds and others, 2010). The conglomerate facies (Tbc) are not found in the type section at Mud Hills, but are included in Barstow Formation herein due to similar age and stratigraphic relationships. The is interpreted as a local mass-wasting deposit. The age of Barstow Formation in the map area is 17.6-14 Ma based on fossils and ages of tuff beds within the formation (Reynolds and others, 2010; Ross, 1994; 1995). In the map area, the Barstow Formation was previously mapped as "Barstow Formation" by Ross (1994) and as an unnamed sandstone and claystone or limestone and claystone by Dibblee and Bassett (1966a).

Fine-grained facies—Sedimentary package including fine-grained sandstone, siltstone, limestone, tuff, bentonite, and chert. The exposed section is ~162-m-thick (Ross, 1994). The base of the section is marked by a 2 to 3-m-thick, dark-gray to brown, fossiliferous chert bed that rests unconformably above the tuff breccia of the Hector Formation (Thtc) and basalt of the Troy Peak Formation (Ttb). This basal chert bed is interpreted to be a limey-siltstone that has been totally replaced by silica (Ross, 1994). Overlying the basal chert bed are predominantly light-yellowish-gray limestone beds containing terrestrial fossil jaws, teeth, and bones, including teeth of Merychippus cf. M. carrizoensis, which has a reported age range of  $\sim 16.5 - 15.5$  Ma (Ross, 1994). Overlying the fossiliferous limestone beds are green, coarse-grained, sandstone beds and light-brown, fine-grained, carbonate-cemented sandstone and siltstone beds interbedded with finely laminated mudstone beds <1-cm-thick. The limestone and sandstone beds are interbedded with 1-m-thick, light-pink, nonwelded tuff beds. Biotite separates from two tuffs within the Barstow Formation were dated ( $^{40}$ Ar/ $^{39}$ Ar) at 17.6 ± 0.2 Ma and 14.0 ± 0.3 Ma (Ross, 1994; 1995). The sandstone beds are also interbedded with 3 to 10-m-thick beds of fine-grained, laminated, green tuff altered to bentonite, the largest of which was previously quarried for talc (Dibblee and Bassett, 1966a) and bentonite (Mason and Arndt, 1996). This deposit is also known as the National Lead locality and also contains fossils of P. carrizoensis, suggesting an age of 17-16 Ma (Reynolds and others, 2010). Overlying these sandstone beds are carbonate-cemented sandstone, siltstone, and tuff beds. Within this section, a marker bed of "brown-platy limestone" is deposited in siltstone (Reynolds and others, 2010). An inferred fault separates this sequence of outcrops from lower ridges to the south (Ross, 1994). These ridges contain outcrops of tufa, layered sinter and travertine deposits, bentonite deposits, and stromatolitic limestone. The stromatolitic limestone is similar in appearance to an outcrop of limestone in Tbs exposed on a ridge in the northwest part of the map area. The top of the section is

Conglomerate facies—Dark-greenish-gray boulder conglomerate, interpreted to be debris flow and alluvial deposits. Clasts comprise 30-75% of the deposit and consist of subrounded to angular cobbles of basalt, andesite, green altered tuff, tuff breccia of the Poe Formation (Tptb), and welded tuff of the Hector Formation (Thwt) in a sandy to silty gray matrix; clasts are ∼6 cm in diameter on average but range up to 0.5 m in diameter. Variably oriented brown siliceous veins locally cut the unit. Locally interbedded with 1 to 2-m-thick beds of reworked tuffaceous conglomerate of the Hector Formation (Thtc) and 1-m-thick, light-reddish-brown sandstone beds composed of very fine- to coarse-grained, subangular to subrounded lithic fragments, quartz, and feldspar grains. This unit overlies tuffaceous conglomerate of the Hector Formation (Thtc) and basalt of the Troy Peak Formation (Ttb) and is

interbedded with the lower portion of the fine-grained facies within the Barstow Formation (Tbs).

Hector Formation (Miocene and Oligocene)—Woodburne and others (1974) identified the Hector Formation within the western Cady Mountains, and the lithologies observed, including tuffaceous conglomerate (Thtc), tuffaceous sandstone (Thts), and welded tuff (Thwt), are similar to the type section of the Hector Formation ~3.5 km east of the map area (Woodburne and others, 1974). The type Hector Formation is a ~1,600-foot-thick (~488 m) series of volcaniclastic and tuffaceous strata (Woodburne and others, 1974). The basaltic volcaniclastic rocks within the Troy Peak Formation (Ttbv) look similar to the "andesitic lahar and agglomerate" underlying the type locality of the Hector Formation of Woodburne and others (1974). In the map area, Hector Formation (Thtc) unconformably overlies Poe Formation (buttress unconformity) and is interbedded with and overlain by Troy Peak Formation (Ttb), indicating the two units are contemporaneous in part. The Hector Formation is estimated to be 26-16 Ma (Woodburne, 2015; Woodburne and others. 1974; Ross, 1994) and overlaps in age with the Troy Peak Formation. The Hector Formation within the map area includes a sanidine-bearing welded tuff that looks macroscopically identical to a tuff in the northern Cady Mountains and similar to the Peach Spring Tuff, which has an overlapping age and has been previously mapped in numerous locations in the Barstow area (Ross, 1994; Neilson and

others, 1990; Glazner and others, 1986; Miller, 1980).

Welded tuff (Miocene)—Blocks of purplish-gray welded tuff exposed at two hills close to the eastern map boundary; no in-place outcrops were found, and no relationships with other units were observed. Crystal abundance 5-7% composed of 2% chatoyant euhedral sanidine, 3-4% plagioclase, and 1-2% mafic minerals in a glassy groundmass. Local reworked cobbles also present with similar mineralogy in a glassy, yellowish-gray matrix. Welded tuff contains rare (1%) subrounded to angular basalt clasts up to 5 cm in diameter. This welded tuff yielded a  ${}^{40}$ Ar/ ${}^{39}$ Ar isochron age on sanidine of  $18.6 \pm 0.2$  Ma (Ross, 1994), similar in age to other dates on the Peach Spring Tuff (Nielson and others, 1990).

**Tuffaceous sandstone (Miocene and/or Oligocene)**—Massive to bedded, whitish-gray tuffaceous sandstone. The contact between this unit and underlying tuffaceous conglomerate (Thtc) is gradational. No cross-bedding was observed. Composed of fine-grained, poorly to well-sorted, lithic-rich, mediumto coarse-grained sand grains and fine ash. Lithics are angular and up to 30% and are composed of basalt and andesite. Sand is composed of biotite, feldspar, and quartz. Interbedded with tuffaceous beds 0.5 to 10-cm-thick and pumice rich beds 0.2 to 3-cm-thick. Planar bedding with bedding ranging from 5 to 50-mm-thick. Local thin beds (2-6 cm) of light yellowish-green marl present.

**Tuffaceous conglomerate (Miocene and/or Oligocene)**—Predominantly whitish-gray to greenish-

gray, reworked tuffaceous conglomerate with lesser whitish-gray block-and-ash-flow tuff and tuff breccia. Tuff breccia and conglomerate are commonly green where chloritized or altered to zeolite. Clasts comprise 2-5% of the unit and are composed primarily of reddish subrounded cobbles and local boulders of andesite and basalt in a sandy, ashy matrix with grains up to 2 mm diameter. Unit appears to be locally reworked in areas with a sandier matrix. Interbedded with ~30-cm-thick quartz arenite sandstone beds that are predominantly composed of 1 mm diameter subrounded grains with 5% <1 mm diameter mafic minerals. Grades up section into Thts. In the southeast part of the map area, a 0.5-m-thick pink, unwelded tuff was observed. This tuff may be correlative to other pink tuffaceous units that croup out in the Daggett Ridge region, recognized as the Peach Spring Tuff (Reynolds and

porphyritic dacite (Ttpd), volcanic conglomerate (Ttvc), basaltic volcaniclastic rocks (Ttbv), welded tuff (Ttdt and Ttdb), and basalt (Ttb), first recognized by Ross (1994; 1995). The Troy Peak Formation overlies the Poe Formation in the middle and southern part of the map area and overlies metavolcanic rocks in the northern part of the map area. The contact between the metavolcanic rocks (Mzmv) and Troy Peak is irregular, suggesting there was paleotopography at the time the Troy Peak Formation was deposited. At the base of the section of the volcanic conglomerate unit (Ttvc) near the contact with the underlying Poe Formation, a bed of tuff breccia (Tptb) is interfingered within the volcanic conglomerate (Ttvc), suggesting the contact of these units is conformable where this relationship is observed. The relationships of dacite tuff (Ttdt), dacite block-and-ash-flow tuff (Ttdb), and basalt (Ttb) with underlying units suggest there is an unconformity within the formation. The Troy Peak Formation basalt (Ttb) also overlies and interfingers with tuffaceous conglomerate (Thtc) of the Hector Formation. The Troy Peak Formation is overlain by the Barstow Formation. The Troy Peak Formation likely geochronologically correlates to the early part of the Pickhandle Formation (Woodburne, 2015). Ross (1994) dated the Hector Formation tuffaceous conglomerate (Thtc) (interpreted as Troy Peak in by Ross but herein determined to be part of the Hector

Troy Peak Formation (Miocene and Oligocene)—The Troy Peak Formation is a volcanic package of

restricted to ~26 to 21.6 Ma (Woodburne, 2015; Ross, 1994). **Dacite welded tuff**—Light- to medium-gray, crystal poor, aphanitic dacite tuff. Up to 1-2% plagioclase (1-2 mm) laths and 1-2% mafic crystals (1-2 mm) and glomerocrysts (3 mm average) in an aphanitic gray to purplish-gray matrix. Mafic glomerocrysts are commonly rimmed with plagioclase. Where altered, plagioclase is altering to white clay and mafic minerals are oxidized. Localized flow banding. Geochemistry on one sample indicates this unit is a dacite.

Formation) at  $26.6 \pm 1.7$  Ma ( $^{40}$ Ar) $^{39}$ Ar); however, Ross (1994) is unsure of the validity of this age date

Ma (youngest age of the Poe Formation) and 17.6 Ma (age of Barstow Formation) but is possibly better

due to issues with the sample. The age of the Troy Peak Formation is constrained between 25 and 26

Dacite block-and-ash-flow tuff.—Brownish-purple, dacitic block-and-ash-flow tuff. Weathered surfaces are purplish-gray to light-gray. Subangular to subrounded welded dacitic clasts in a finegrained dacitic ash matrix; variable degree of welding overall. Clasts are up to 15 cm in diameter but 0.3-3 cm diameter on average. Clast supported with up to 80% blocks and 20% matrix. Smaller clasts under 3 mm diameter are subrounded and clasts over 3 mm diameter are subangular to angular. Unit contains roughly 4% mafic minerals of euhedral biotite and hornblende up to 1 mm. Some mafic minerals are weathering out with oxide rinds. Around 1% plagioclase phenocrysts alter to clay with a maximum diameter of ~1 mm. Minor subrounded lithics present (<1%). Geochemistry on one sample collected here indicates this unit is a dacite. Secondary calcite present in joints. Grades into dacite tuff (Ttdt). Crops out in the northwest part of the map area near a clay pit and is overlain by older alluvial

Basalt—Dark-gray to black, massive, aphanitic basalt. Crystal poor. Uncommon euhedral plagioclase laths, <1%, <1mm. 1-3% anhedral olivine altering to iddingsite. Uncommon subhedral oxides. Vesicular in places, but vesicle abundance ranges from 0-30%. Where vesicles are present, they are commonly stretched, amygdaloidal, and range in diameter from 2 mm to 1 cm. Vesicles are commonly filled with calcite. Geochemistry on one sample collected in this unit indicates this unit is basaltic trachyandesite in composition; however, the sample has vesicles partially filled with calcite, and this unit has been referred to as basalt by others (Dibblee and Bassett, 1966a; 1966b; Ross, 1994). Possibly sourced by aphanitic basaltic dikes of similar mineralogy and appearance that cut the volcanic conglomerate deposits (Ttvc). Caps ridges on underlying volcanic conglomerate deposits (Ttvc) and basaltic volcaniclastic deposits (Ttbv) in the middle and northern part of the map area, and crops out as lava flows, plugs, and breccia pipes in the southern part.

Basaltic volcaniclastic rocks—Dark-gray, massive to crudely bedded, monolithologic basaltic breccia and agglomerate, and bedded basaltic volcaniclastic rocks. Subangular to subrounded basalt clasts in a light- to medium-gray tuffaceous matrix. Locally altered to brownish red. Clasts range in size from 1 to 2 mm diameter up to 12 cm diameter. Clast abundance varies from 10-70% but averages 40%. Clasts contain 3-7% 1-2 mm euhedral plagioclase laths and 1-3% <1 mm subhedral iddingsite in an aphanitic, dark-gray matrix. The base of this unit is a bedded basaltic pebble conglomerate and sandstone. This unit overlies and interfingers with volcaniclastic conglomerate deposits (Ttvc). **Volcanic conglomerate**—Thick package (~175 m) of light-yellow-gray to light-gray, tuffaceous volcanic pebble to boulder conglomerate; interpreted to be a lahar deposit, with interbedded ~1 m-thick tuff beds. One bed of tuff breccia from the Poe Formation (Tptb) was observed interbedded within the lahar deposit close to the contact of the two units at the base of the section, suggesting the Poe Formation and Troy Peak Formation overlap slightly in age. Geochemistry from one sample of tuff within this unit indicates a dacite composition. The lahar deposits contain 0.3-6 cm diameter subrounded to subangular clasts of aphanitic basalt, plagioclase-rich basalt, aphanitic andesite, and porphyritic andesite in a sandy to tuffaceous matrix. Clast abundance varies from 5-10% in finergrained beds with 3-5 mm diameter subangular clasts up to 30% in coarser beds with 6 cm diameter clasts on average. Tuff beds are massive and have 4% subhedral, 3 mm diameter quartz and plagioclase phenocrysts, 3% euhedral 7 mm diameter biotite and hornblende phenocrysts, and 1% lithics up to 8 cm in a fine, gray, ashy matrix. Unit is overlain by basaltic pebble conglomerate at the base of basaltic

**Porphyritic dacite**—Massive, dark-gray to reddish-brown, porphyritic dacite. 5% euhedral 1 mm diameter biotite books and 15% subhedral plagioclase up to 1 cm diameter in a dark-gray matrix with red flow banding. Has 0.25-2 m-thick beds of whitish-gray, lightly welded tuff with 3-5% euhedral books of biotite, 3-5% 1-2 mm quartz, and 1-3% euhedral plagioclase laths. In the northeast part of the map area, porphyritic dacite (Ttpd) is interbedded with volcaniclastic conglomerate deposits (Ttvc), and porphyritic dacite cobbles are found in volcaniclastic conglomerate deposits (Ttvc) in other parts of the map area. Interbedded tuffs indicate this unit is extrusive, though texturally, this unit could be hypabyssal in places. Geochemistry on two samples in the porphyritic dacite indicate the unit is on the boundary between dacite and rhyolite. Geochemistry on a tuff bed within the unit is dacite in composition. New  $^{40}$ Ar/ $^{39}$ Ar dates on the porphyritic andesite are  $24.25 \pm 0.10$  Ma to  $22.96 \pm 0.17$ Ma, and a new  $Ar^{40}/Ar^{39}$  date of 24.14  $\pm$  0.08 Ma was obtained on an interbedded tuff. Analyses were conducted at the New Mexico Geochronology Research Laboratory (1 sigma reported error; Matt Heizler, written commun., 2024).

volcaniclastic deposits (unit Ttbv) but also interfingers with basaltic volcaniclastic deposits (Ttbv).

Intruded by dark-gray, aphanitic, crystal-poor, basaltic dikes, which are possibly source dikes for basalt

**Poe Formation (Oligocene)**—The Poe Formation is a sequence of unwelded tuff (Tpt), tuff breccia (Tptb), and andesitic lava or intrusions (Tpa). The Poe Formation unconformably overlies Cretaceous intrusive rocks (Kqm) and is overlain by both the Hector and Troy Peak Formations. It is unclear whether the andesitic volcanic rocks (Tpa) are in intrusive or depositional contact with the rest of the formation. Ross (1994) noted the Poe Formation could be as old as 28.1 Ma, but Woodburne (2015) reported and age of 25-

**Andesitic volcanic rocks**—Purplish-gray to gray, fine-grained, aphanitic andesitic rocks. Basal breccias were not observed, but this unit could be hypabyssal or extrusive. Ross (1994) mapped this unit as andesite flows, and Dibblee and Bassett (1966a; 1966b) mapped this unit as andesite. Plagioclase abundance varies from 2-15% euhedral laths, commonly trachytic. <1% mafic minerals <1 mm. Commonly has Liesegang banding and other evidence of hydrothermal alteration including hydrothermal breccias, silicified veins, opal, calcite veins, and sinter deposit textures. **Tuff**—White to light greenish-gray to pinkish-gray nonwelded tuff. Contains 5% sericitized plagioclase laths, <1% anhedral to euhedral mafic minerals weathering to chlorite, and 5-7% subrounded to subangular, 2-3 cm-diameter pumice fragments in a coarse ash matrix. Commonly

has Liesegang banding. Commonly weathered and altered to greenish-gray, devitrified and waxy, friable tuff and has silica-filled fractures and gypsum. Exhibits minor fluvial reworking in some areas (Ross, 1994). Interbedded with, and grades into tuff breccia (Tptb) and depositionally overlies quartz monzonite (Kqm). The best age for the base of this unit at the contact with quartz monzonite (Kqm) is an  $^{40}$ Ar/ $^{39}$ Ar total gas determination of  $28.1 \pm 1.0$  Ma; however, this age is described as having a low confidence of accuracy (Ross, 1994). **Tuff breccia**—Gray to pinkish-red tuff breccia. Clast abundance varies from 5-25%, and clasts consist

predominantly of subrounded to angular, light-gray, 0.2-30 cm tuff (0.2-2 cm diameter on average) with lesser greenish altered aphanitic andesite and scoria in a reddish ashy matrix. Unit grades into 15 cm in diameter within an ashy sandy matrix. Local beds, up to 60-cm-thick, of coarse-grained sandstone that grades up section into siltstone. This unit also contains a green, friable volcaniclastic conglomerate, interpreted as a debris flow deposit, with andesitic clasts and lithics up to 4 cm in diameter in a sandy matrix where it was locally observed in fault contact with quartz monzonite (Kqm). This debris flow deposit could be a local landslide deposit (Ross, 1994). This unit commonly

### **TERTIARY BRECCIA**

exhibits Liesegang banding.

contain any clasts from any other unit besides Kqm.

Quartz monzonite breccia (Oligocene or older?)—Massive, medium-gray breccia composed of nonolithologic, poorly-sorted, angular cobbles and boulders of Kqm in a matrix of finer-grained quartz monzonite and granitic debris. Average clast size is 0.2-10 cm in diameter, and rare 5 cm-wide mafic enclaves are present in boulders. Probably a landslide breccia deposit (Dibblee and Bassett, 1966a). The timing of this unit is unclear but was probably deposited sometime in the early Tertiary (Dibblee and Bassett 1966a). This is supported by the lack of volcanic clasts in this breccia, suggesting the breccia was deposited and lithified before the volcanic units were deposited. Also, there is no granitic debris intermixed in any overlying volcanic rocks. This unit is observed in the northwest part of the map area and does not

### INTRUSIVE AND METAVOLCANIC UNITS - MESOZOIC

Quartz monzonite (Early Cretaceous)—Medium-gray, coarse-grained, equigranular quartz monzonite to granite. Approximately 30% quartz, 67% subhedral plagioclase and potassic feldspar, and 3% subhedral to euhedral biotite. Grain size is 3 mm on average, but biotite is 1-2 mm. Minor sphene, zircon, apatite, and magnetite (Dibblee and Bassett, 1966a). Geochemistry from one sample from this report indicates the sampled unit is quartz monzonite but ranges to granite in composition (Dibblee and Bassett, 1966b; Ross, 1994). Displays hypidiomorphic granular and local rapakivi textures (Ross, 1994). This unit is intruded by small (up to 1 m), fine-grained dioritic and aplitic dikes (Ross, 1994). The contact with overlying Tertiary volcanic strata is undulatory, probably due to paleotopography. Dated at  $139 \pm 2$  Ma via K/Ar dating of biotite (Armstrong and Suppe, 1973; Ross, 1994).

Metavolcanic rocks (Mesozoic)—Massive, blocky, silicified, foliated to porphyritic metavolcanic rocks. Varies in color from light yellowish gray to red to gray to greenish gray to bluish. Andesite to quartz latite in composition (Dibblee and Bassett, 1966a). Foliated facies have 1-3-mm-thick alternating silicified bands of light and dark minerals. Porphyritic facies have 7% anhedral plagioclase (1-3 mm) and 3-5% subangular to subrounded lithics (2-3 mm) and minor oxidized biotite in a microcrystalline, gray, flowbanded groundmass. Plagioclase is commonly altered to white clay. Minor amounts of potassium feldspar and quartz (Dibblee and Bassett, 1966a). Minerals and lithics are stretched with flow banding and foliation. Contains fracture coatings and veinlets of secondary epidote (Dibblee and Bassett, 1966a). Probably metamorphosed tuff breccias, flow breccias, flows (?), and intrusions (?) (Dibblee and Bassett, 1966a). This unit may be correlative to the Sidewinder volcanic rocks (Schermer and others, 2002).

# **SOURCES OF MAP DATA** 1. Bedrossian and Myers, 2012 2. Dibblee and Bassett, 1966a 3. Dibblee and Bassett, 1966b 4. Reheis and others, 2014 5. Ross, 1994

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Classification of plutonic rock types (from Streckeisen, 1973; 1976).

A, alkali feldspar; P, plagioclase feldspar; Q, quartz.

QAPF modal classification of volcanic rock types (based on Le Maitre, 2002).

This diagram must not be used for rocks in which the mafic mineral content, M, is greater than 90%.

A, alkali feldspar; P, plagioclase feldspar; Q, quartz

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This geologic map is based upon work supported by the U.S. Geological Survey under Cooperative Agreement No. G23AC00509. The views and conclusions contained in this

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MAP SYMBOLS Contact between map units – Solid where accurately Strike and dip of geologic structure; number located; long dash where approximately located; indicates dip angle in degrees ,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet short dash where inferred; queried where identity or existence is uncertain 1 0.5 0 1 Kilometers Bedding, approximate Fault – Solid where accurately located; long dash where approximately located; short dash where Contour Interval for Manix and Troy Lake Quadrangles: 20 Feet Foliation, primary (flow banding) inferred; dotted where concealed; queried where Contour Interval for Hector and Hidden Valley West Quadrangles: 40 Feet Approximate Mean Foliation, secondary identity or existence is uncertain. Arrow and National Geodetic Vertical Datum of 1988 Declination, 2025 number indicate direction and angle of dip of fault → Foliation, secondary, vertical plane. Relative horizontal movement shown by arrows parallel to fault. \_\_\_\_ Joint Universal Transverse Mercator, Zone 11N, Basaltic dike – Accurately located Joint, vertical △ <sup>40</sup>Ar/<sup>39</sup>Ar Geochronology point (3 samples) Area of mining disturbance Topographic base from U.S. Geological Survey Hector, Hidden Valley West, Manix, and Troy Lake 7.5-minute

Photo 3: Light-gray to white, massive chert bed in which quartz

has replaced the original strata with 1-2 cm gray laminations in

unit Tbs at the base of the Barstow Formation near the contact of

bentonite bed within unit Tbs in the Barstow Formation. Located

left of the person touching the outcrop) with cut and fill channels

standing straight) in unit Tbs in the Barstow Formation. Located

Field Observations and Sample Locations

 Field data location Photo location

Geochemistry sample location

filled with brown conglomerate (to the lower left of the person

at: 34.820912, -116500373.

at: 34.821641, -116.502481.

Coordinate System:

Quadrangles, 2021.

North American Datum 1983

Shaded relief imagery derived from USGS lidar DEMs, 2017 and 2023

underlying basalt (Ttb). Located at: 34.824972, -116.500855.

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Authorship Documentation and Product Limitations

(Thtc) in the Hector Formation. Andesitic and basaltic clasts

up to 30 cm in an ashy, sandy matrix. Located at: 34.864806,

Photo 7: Light-red to light-pink tuff breccia (Tptb) in the Poe

Formation. Located at: 34.845636, -116.500813.

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Map Sheet 68

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This authorship document accompanies the geologic map with the following citation:

Wesoloski, C.E., Garvue, M.M. and Key, E.L., 2025, Geologic map of the western Cady Mountains, San Bernardino County, California: California Geological Survey Map Sheet 68, scale 1:24,000.