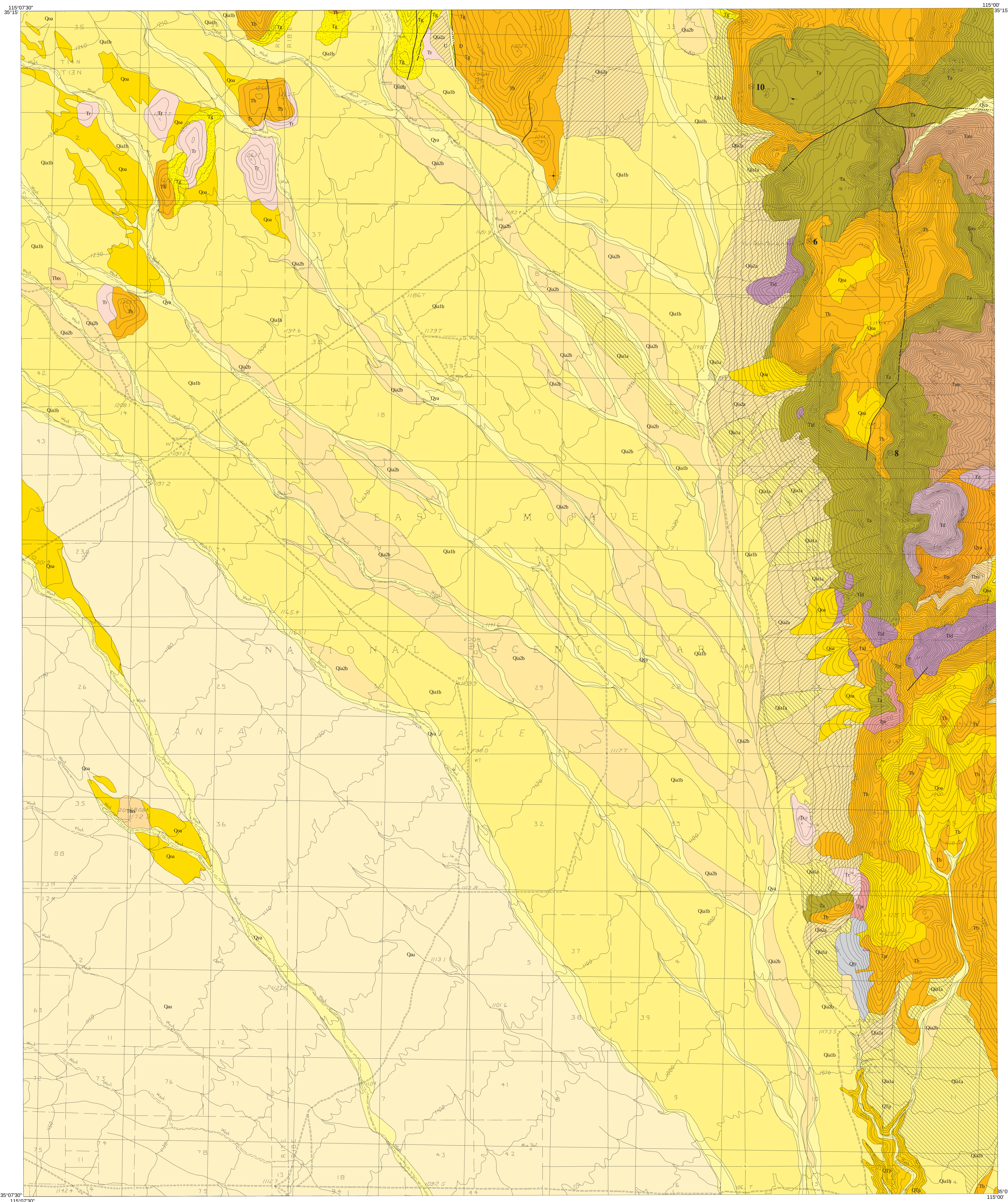
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT
99-35



Base from U.S. Geological Survey,
East of Grotto Hills (Provisional edition), 1984
Universal Transverse Mercator projection, zone 11

APPROXIMATE MEAN DECLINATION, 1995

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC DATUM OF 1929

INTERIORGEOLOGICAL SURVEY, RESTON, VA1995

QUADRANGLE LOCATION

Geology mapped by: Jane E. Nielson, 1983–92 (southern Castle Mts and Piute Range) and Jay S. Noller, 1984–86; assisted by Cynthia A. Ardito,1983.

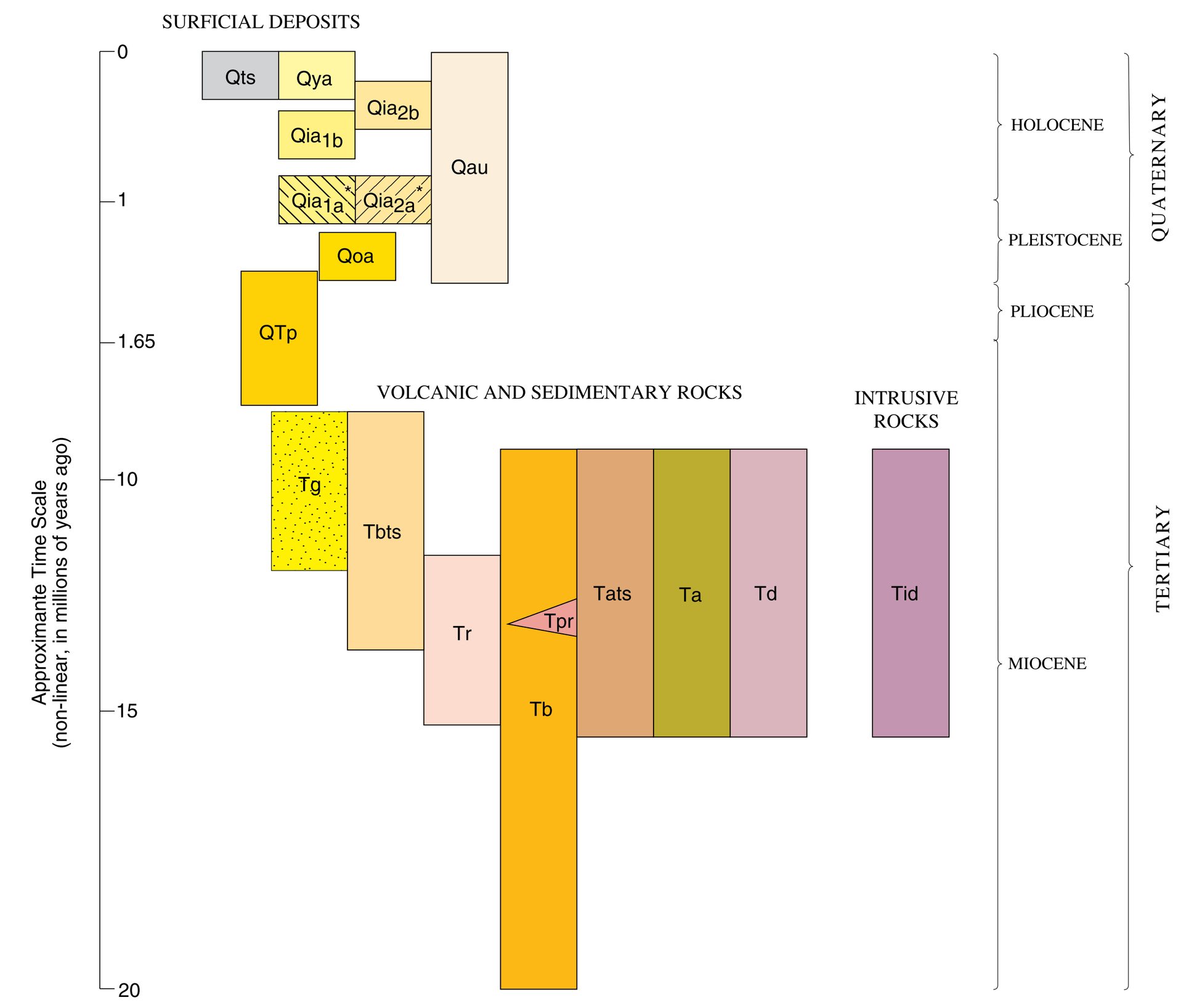
GEOLOGIC MAP OF THE EAST OF GROTTO HILLS QUADRANGLE, CALIFORNIA: A DIGITAL DATABASE

Geology By
Jane E. Nielson

Digital Database By
David R. Bedford

1999

CORRELATION OF MAP UNITS*



DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qts **Talus and scree (Holocene)—**Regolith of basalt talus, cobbles, and boulders. Mapped only at one site in southeast corner of quadrangle on steep slope where underlying stratigraphic and structural relations are obscured. Thickness as much as 5 m

Qya **Younger alluvium (Holocene)—**Clay, sand, pebbly sand, and gravel. Matrix is clay-rich and clasts are mostly subangular to subrounded volcanic rocks close to mountain fronts and in canyons. Elsewhere, matrix is predominantly sand, and clasts are about equal proportions of granite, gneiss, and volcanic rocks. Forms in active stream channels and flanking bar-and-swale zones. Estimated thickness less than 2 m

Qau **Older, intermediate, and younger alluvium, undivided (Holocene and Pleistocene?)—**Deposits present in areas of low, finely dissected ridges made of older matrix-supported gravel deposits (Qoa), flanked by planar terraces (Qia_{1b}), and thin active channels (Qya) and overbank flood deposits with bar and swale morphology (Qia_{2b}). Shown in broad alluvial valleys where component units cannot be mapped separately

Intermediate alluvium (Holocene and Pleistocene?)—Slightly lithified to lithified sand, pebbly sand, gravel, and cobbles. Divided into:

Unit 2—Consists of:

Qia_{2b} **Younger deposits (Holocene)—**Overbank deposits with sandy matrix having bar-and-swale morphology, mostly found in broad alluvial valleys. Bar-and-swale morphology includes network of thin pebbly to cobble-rich stream-channel deposits with weak surface imbrication. Clasts consist of granite, gneiss, and volcanic rocks in about equal proportions. Grades laterally into active stream deposits (Qya) or low terraces underlain by unit Qia_{1b} deposits. Exposed thickness 0 to 2 m

Qia_{2a} **Older deposits (Holocene and Pleistocene?)—**Debris-flow and distributary alluvial-fan and braided-channel deposits, which have bar-and-swale morphology. Chiefly volcanic-clast boulder conglomerate of well-sorted sand, as well as granitic and gneissic rocks derived from reworking of older alluvium. Imbrication of surface clasts strong in bars and swales; pavement development is weak. Found on lower slopes of Piute Range. Surfaces and boulder trains are black due to high content of dark volcanic lava: basalt, andesite, and basaltic andesite; some clasts may acquire part of their varnish after deposition. Surfaces are dissected, standing 1 m or more above younger surfaces underlain by unit Qia_{1b}. Exposed thickness 0 to 2 m

Unit 1—Consists of:

Qia_{1b} **Younger deposits (Holocene)—**Reddish, predominantly unsorted sand and pebbles. Horizons of clast-supported pebble- and cobble-size, angular to subangular gravel that consists of about equal amounts of granite, gneiss, and volcanic clasts. Soil well developed locally, at least 50 cm thick; sandy in upper 10 cm but clay-rich and vesicular below 20 cm, with patchy calcareous zones. Forms terraces 2 to 4 m above active washes (Qya); deposits overlap and, in places, partly bury dissected ridges of older alluvium (Qoa). Terraces in the broad valleys merge laterally into deposits of unit Qia_{2b}. Surfaces have no preserved bar-and-swale morphology; surface pavements appear poorly developed and unvarnished. The lack of development may be due in part to destruction of surface by range cattle, and lack of varnish may reflect the high proportion of granitic materials. Exposed thickness 0 to 3 m

Qia_{1a} **Older deposits (Holocene and Pleistocene?)—**Inactive deposits of reworked talus, scree, and older alluvial fans (Qoa) on lower slopes of Piute Range. Surfaces smoother and lighter colored than those of adjacent and surrounding deposits of unit Qia_{2a}, indicating erosion of surfaces. Surfaces are 1 m or more above channel-margin terraces underlain by unit Qia_{1b}. Exposed thickness 0 to 3 m

Qoa **Older alluvium (Pleistocene)—**Clast- or matrix-supported gravel deposits. Consists of clay-rich matrix, coarse sand grains with calcium carbonate septa, and cobbles of angular to subangular granite or gneiss; local concentrations of volcanic rock types common. Pebbly zones and large boulders are not common. Soils thin or absent in most places. Surfaces light-colored due to litter of fragments from exhumed petrocalcic horizon at shallow depth (10- to 12-cm maximum depth), as shown by concentrations of small pebbles around ant hills. Forms steep-sided spurs at mountain fronts and wide alluvial ridges 5 to 6 m above active stream channels (Qya). Surfaces display no depositional morphology; local concentrations of clasts interpreted as lag deposits. Exposed thickness 0 to 5 m

QTp **Playa and lacustrine deposits (Pleistocene? to Miocene)—**Buff, dark-tan, and reddish-brown, horizontally bedded, soft claystone, siltstone, sandstone, and pebbly sandstone with gypsum and calcite beds, capped by soil horizon with thick petrocalcic layer. Contains dispersed pebbles of basaltic scoria, massive basalt, and andesite. Basaltic flows intersected beneath playa strata in a water well located south of the quadrangle and west of any outcrops has been interpreted as Quaternary lava interbedded with playa sediments (Environmental Solutions, 1989) but may be the top of a downfaulted Miocene section. Deeply dissected deposits: about 60 m thick in East of Grotto Hills quadrangle. In Signal Hill quadrangle at western end of Piute Gorge (fig. 1), 80-m thickness exposed in buttress unconformity with faulted basaltic and andesitic volcanic rocks that have low dips to the west

VOLCANIC AND SEDIMENTARY ROCKS

Tg **Gravel deposits (Miocene)—**Conglomerate and interbedded sandstone and siltstone. Consists of immature coarse- to medium-grained crystal-lithic sand matrix containing subangular to rounded clasts. Matrix crystals are predominantly biotite and feldspar, with rarer pyroxene grains. Clasts are generally granite, gneiss, massive quartz, and gray Paleozoic limestone containing stringers of brown chert. Proportions of volcanic and sedimentary clasts are generally small. Overlies or locally interbedded with middle and upper Miocene rhyolite tuff and flows (Tr), and basalt flows (Tb). Exposed thickness 0 to 5 m

Tbts **Basalt flows, rhyolite tuff, and sedimentary rocks (Miocene)—**Air-fall tuff, tuff breccia, flows, and ash-flow tuff, interbedded with thin basaltic flows and dikes, and local conglomerate. Mapped where silicic tuff and breccia ejecta and basalt flows (Tb) are indistinguishable. Generally forms gentler slopes than either tuff or basalt (Tb). Thickness 10 to 150 m

Tb **Basalt flows (Miocene)—**Vesicular and scoriaceous, porphyritic, fine-grained to glassy flows and flow breccia; dominantly composed of basalt and basaltic andesite, with local andesite, trachyandesite, and rare rhyolite flows. Commonly brecciated; includes local interbeds of cinder and scoria. Flows are dark gray to black, locally reddened by oxidation. Unit contains about 15 percent phenocrysts: basalt mostly contains felted plagioclase feldspar, pyroxene, and sparse (commonly altered) olivine; basaltic andesite may contain only plagioclase phenocrysts or include sparse pyroxene. Dispersed andesite and trachyandesite flows and breccia are plagioclase-rich, and contain hornblende and biotite phenocrysts. Conventional K-Ar age on rhyolite flow at location 10 (fig. 2, map) is 13.3±0.3 Ma (biotite); on basalt at location 6 is 12.2±0.3 Ma (fig. 2, map) (Nielson and Nakata, 1993). Rock compositions in Nielson and Turner (1998, table 2). In northern part of map area, overlies or interbedded with rhyolite (Tr), layered tuff, and gravel (Tg). In eastern and southern parts, either interbedded with gravel (Tg) or overlies and interbedded with andesite flows (Ta). Forms steep cliffs or steep-sided ridges. Thickness in northern part of map area, 3 to 50 m; in eastern part, as much as 250 m

Tats **Andesitic flows and intrusions, silicic tuff, and sedimentary rocks (Miocene)—**Blue-gray and light-gray plagioclase-pyroxene and plagioclase-pyroxene hornblende flows and breccia, and local intrusions of same composition. Flows interbedded with thin air-fall and ash-flow tuffs, reworked tuffaceous sedimentary rocks, and stream-channel conglomerate. Widespread fanglomerate lenses separate individual flows, whereas conglomerate is limited to channels incised into underlying flows. Locally, flows also filled stream channels. Conglomerate clasts include Paleozoic limestone, gneiss (locally garnetiferous), granite, and minor volcanic rock types. Interbedded with gravel (Tg) or underlies basalt flows (Tb). Forms moderately steep slopes interrupted by short cliffs where flows crop out. Thickness 0 to 375 m

Ta **Andesitic flows, breccia, and sedimentary rocks (Miocene)—**Dark- to light-gray andesite, trachyandesite, and dacite flows and flow breccia. Andesite and trachyandesite flows have fine-grained matrix with approximately 10 percent phenocrysts, mostly of plagioclase (grain size as much as 3 mm across), less common pyroxene (average 0.2 mm across), and rarer olivine. Flow bases commonly brecciated. Flows and breccia form two distinct intervals; in the East of Grotto Hills quadrangle only the upper interval crops out. Composed mostly of flows and intrusions with fine-grained matrix and sparse phenocrysts. Dips gently west in quadrangle, but to the east, gently east-dipping flows are displaced by near-vertical faults. Some andesitic flows drape over thick dacitic or rhyolitic flows and plunge gently north or south. A trachyandesite flow at location 8 yielded K-Ar age of 12.7±0.8 Ma (fig. 2, map). Other samples from northern part of the Piute Range (fig. 2) were dated at 12.4±1.4 Ma (trachyandesite, location 9), 10.4±0.7 Ma (trachybasalt breccia, location 12); and 8.0±0.6 Ma (dacite flow, location 13). Flows interbedded with stream-channel conglomerate, fanglomerate, sandstone, and siltstone and, locally with monolithologic megabreccia of Proterozoic augen gneiss. Conglomerate clasts include Paleozoic limestone, gneiss (locally garnetiferous), granite, and minor volcanic rock types. East of quadrangle, overlies Proterozoic augen gneiss, arkosic sedimentary rocks, or lenses of the Peach Springs Tuff of Young and Brennan (1974). In quadrangle, interbedded with tuff of the Piute Range (Tpr), and mixed unit of andesitic flows, tuff, and sedimentary rocks (Tats). Underlies basalt flows (Tb). Forms steep cliffs with 50 to 350 m of relief: relief may be equivalent to range of exposed thickness, but this does not account for the possibility of unexposed paleotopographic variations or fault repetition of indistinguishable flows

Td **Dacite flows and intrusions (Miocene)—**Light gray biotite and hornblende-biotite dacite flows interleaved with intrusive domes, which have marginal breccia zones. Predominantly biotite-bearing porphyritic rocks. Steep-sided domes enclosed by andesite flows (Ta). Thickness 5 to 100 m

Tr **Rhyolite tuff and flows (Miocene)—**Rhyolite ejecta, including silicic lava, air-fall tuff and tuff breccia, pumice breccia, ash-flow tuff (welded and unwelded), and flow breccia, volcaniclastic tuff breccia, and pumice breccia containing angular pumice fragments as much as 3 cm across. Thin air-fall tuff beds probably erupted from dacitic domes on east flank of Piute Range. Interbedded with basalt flows and breccia (Tb), and minor volcaniclastic sedimentary rocks, tuffaceous rocks, and volcanic conglomerate. Sedimentary parts of unit consist of lenses of siltstone; fine- to medium-grained sandstone; and pebble to cobble conglomerate, predominantly of volcanic clasts but also containing granite and gneiss pebbles and cobbles. Mostly forms isolated outcrops in northwestern part of quadrangle. Outcrops near west margin of Piute Range, southeastern part of map area, are ash-flow tuff of unknown source. Underlies gravel (Tg), or is mixed with basalt and sedimentary rocks (Tbts). Thickness 0 to 50 m

Tpr **Tuff of the Piute Range (Miocene)—**White biotite tuff of pebble-size biotite-bearing pumice in biotite-rich matrix of rhyolite ash. Contains rare, large (30 cm across), lithic and pumice clasts; poorly sorted. Where reworked, unit displays normal grading and crossbedding. Biotite-rich tuffaceous sandstone typically forms upper part of unit. Locally, clasts of augen gneiss, dacite, and andesite blocks are present; blocks commonly underlain by soft-sediment sag features. Exposed on steep slopes or cliffs; overlain and underlain by trachyandesite flows and breccia (Ta). Thickness 3 to 10 m

INTRUSIVE ROCKS

Tid **Dacitic intrusions (Miocene)—**Light-gray hornblende-biotite dacite and biotite rhyodacite domes, dikes, and associated intrusive breccia, enclosed within resistant andesite flows, intrusions, and breccia (Ta). Mapped where intrusions can be distinguished from surrounding flow rocks. Forms elongate or oval zones with gentle slopes. Width of exposed intrusions, 10 to 500 m

Contact

?····—— Fault—Dashed where approximately located, dotted where concealed; queried where uncertain.

20 Strike and dip of inclined bedding or contacts

32 Strike and dip of inclined joints

8 ⊗ Dated sample locality—See figure 2 and Description of Map Units

For sale by U.S. Geological Survey, Denver, Colorado 80225 or Reston, Virginia 22092