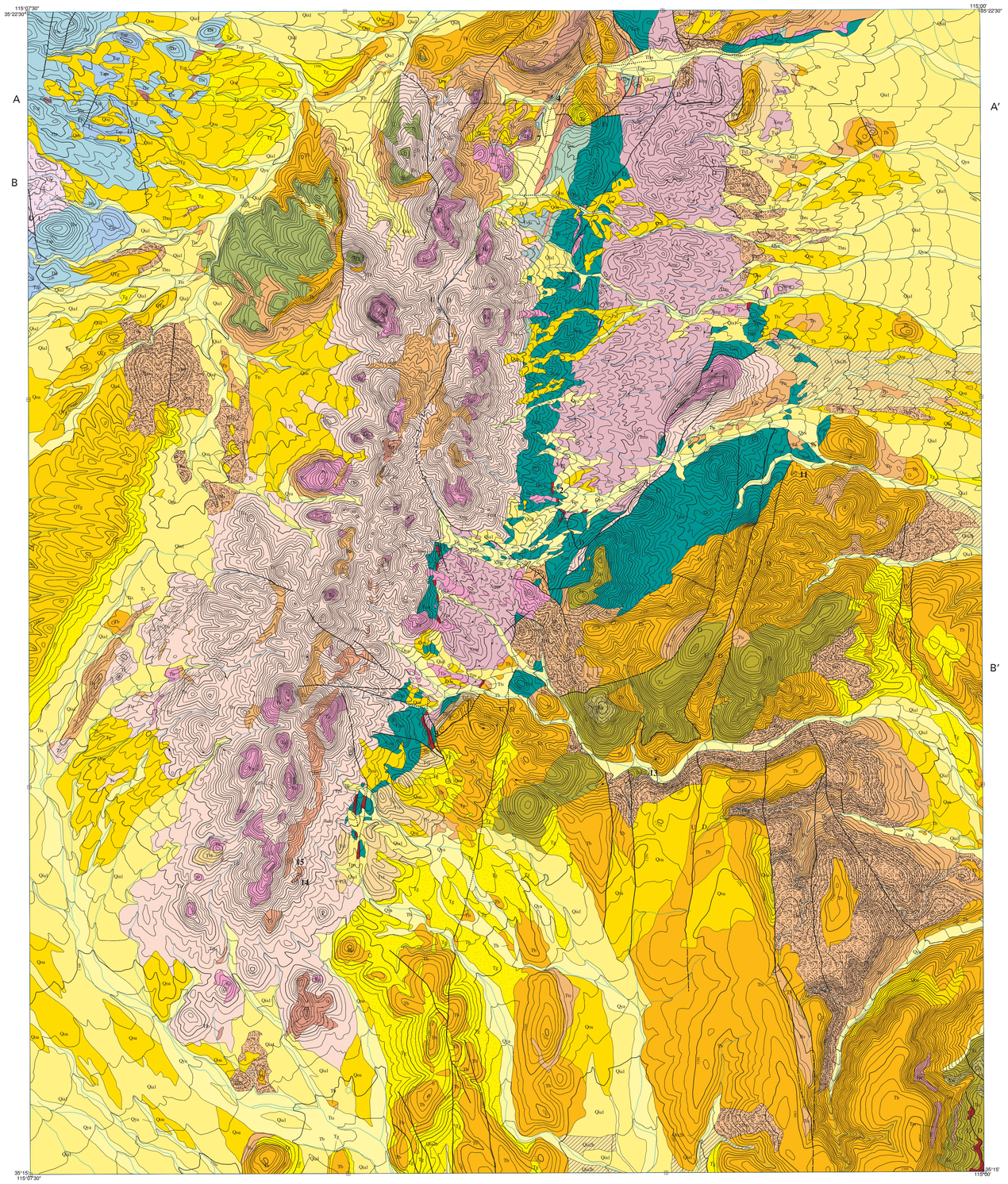
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT
99-34

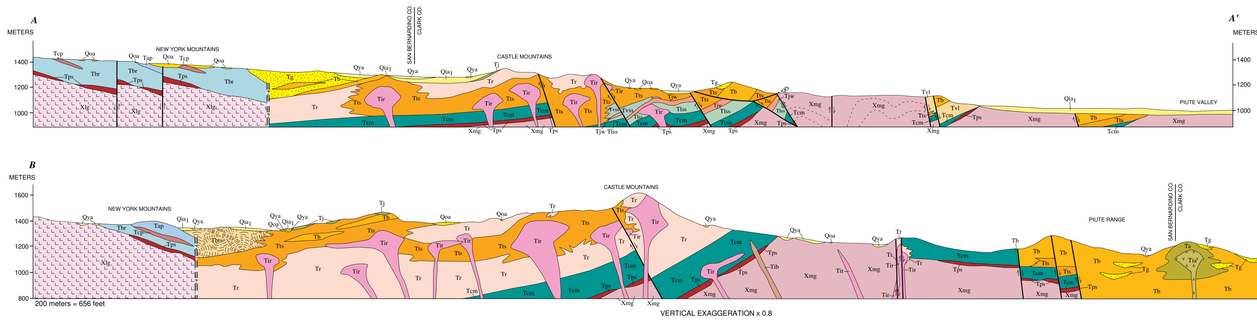


Base from U.S. Geological Survey,
Hart Peak (Provisional edition), 1984
Universal Transverse Mercator projection, zone 11

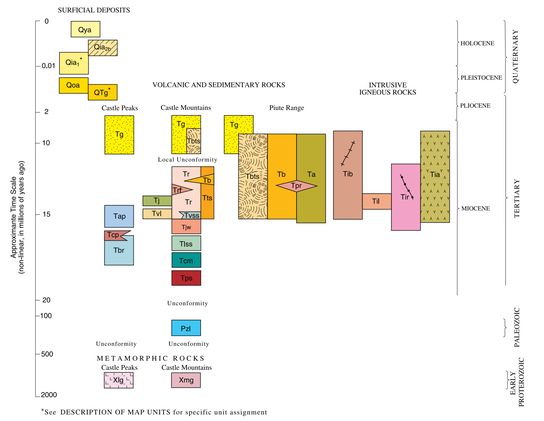
SCALE 1:24 000
1 0 1 MILE
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC DATUM OF 1929

Geology mapped by: Ryan D. Turner, 1982–84 (northern Castle Mts) assisted by Jacqueline Huntoon, 1982; and Jane E. Nielson, 1983–92 (southern Castle Mts and Piute Range), assisted by Jay S. Noller, 1984–86, and Cynthia A. Ardito, 1983.

G.I.S. database by David R. Bedford



CORRELATION OF MAP UNITS



*See DESCRIPTION OF MAP UNITS for specific unit assignment

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

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

Intermediate alluvium (Holocene and Pleistocene)—Sand, pebbly sand, and gravel deposits. Consists of:

Unit 2 (Holocene and Pleistocene)—Divided into:

Qls$_{2y}$ **Younger deposits (Holocene)**—Sandy overbank deposits in broad alluvial valleys. Matrix predominantly sand; where inventoried, clasts are composed of granite, gneiss, and volcanic rocks in about equal proportions. Grades laterally into active stream deposits (Qya) or low terrace deposits (Qls$_{2o}$, mapped in East of Grotto Hills quadrangle to the south). Limited bar-and-swale morphology with weak surface imbrication formed by network of thin stream-channel deposits containing pebble- to cobble-size clasts. Exposed thickness to 2 m

Qls$_1$ **Unit 1 (Holocene? and Pleistocene)**—Reddish, predominantly unsorted sand interspersed with clast-supported horizons of pebble- and cobble-size angular to subangular clasts composed of about equal amounts of granite, gneiss, and volcanic rock. Locally well developed soil at least 50 cm thick, sandy in upper 10 cm but clay-rich and vesicular below 20 cm; contains patchy calcareous zones. Forms terraces 2 to 4 m above deposits of 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 intermediate alluvium (Qls$_{2o}$, Qls$_{2y}$). Surfaces have no or poorly preserved bar-and-swale morphology. Surface pavements poorly developed and unvarnished, in part due to high proportion of granitic clasts and in part to mechanical erosion by range cattle. Exposed thickness to 4 m

Qoa **Older alluvium (Pleistocene)**—Clast- and matrix-supported gravel deposits. Consists of clay-rich matrix containing coarse sand grains and septa of calcium carbonate, as well as cobbles of angular to subangular granite or gneiss; common local concentrations of volcanic rocks; uncommon pebbly zones and large boulders. Soils thin or absent in most places. Surfaces light-colored due to litter of fragments from 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 deposits of stream channels (Qya). Surfaces display no depositional morphology; local clast concentrations interpreted as lag deposits. In general, varnish is observed on only 10 percent of surfaces; side slopes may have better pavement development and higher proportion (60 percent) of varnished clasts. Exposed thickness to 6 m

QTg **Gravel deposits (Pleistocene and Pliocene?)**—Light-colored sandstone, siltstone, and rounded to angular pebble- and cobble-size clasts. Unit poorly exposed; matrix composition and texture poorly known. Forms low rolling hills that are difficult to distinguish from, and probably depositionally continuous with, older alluvium (Qoa). Unit mapped on the basis of hill slope concentrations of rounded to subrounded cobbles. Exposed thickness to 5 m

VOLCANIC AND SEDIMENTARY ROCKS

[Compositions of selected volcanic units are listed in table 1]

Castle Peaks

Tg **Gravel deposits (Miocene)**—Subangular to rounded pebble- to cobble-size clasts of granite, gneiss, and volcanic and sedimentary rocks, in matrix of immature coarse- to medium-grained crystal-lithic sand; deposit clast-supported in most exposures. Grades locally into poorly consolidated sandstone and siltstone with gravel-filled channels. Granite clasts include foliated and unfoliated types; foliated garnetiferous cobbles probably derived from Proterozoic terranes; undeformed leucocratic clasts from Cretaceous sources. Local concentrations of clasts derived from underlying pyroxene andesite porphyry (Tap). Sedimentary-rock clasts include cobbles of gray Paleozoic limestone with stringers of brown chert. Matrix crystals are predominantly quartz, biotite, feldspar, and rarely pyroxene grains. Overlies pyroxene andesite porphyry (Tap) unit and underlies Pleistocene and Holocene deposits. Exposed thickness 10 to 30 m

Tap **Pyroxene andesite porphyry (Miocene)**—Vesicular, red-brown, blue-gray, or greenish-black, andesite porphyry flows and volcanic breccia. Flows are blocky in outcrop, commonly brecciated. Intruded by mafic or andesitic dikes. Contains 20 to 30 percent phenocrysts of plagioclase and square, deep-green clinopyroxene crystals (5 mm to 10 mm avg. dimension), in a microcrystalline matrix of plagioclase laths ± hornblende (Thompson, 1990). Blue-gray or purplish dikes locally are plagioclase rich and can be traced into flows; upward, massive-textured feeder dikes grade into eruptive breccia. Although rocks are plagioclase-phyric, compositions are trachyandesite, transitional to andesite; elevated alkali contents may be due to alteration (fig. 3; Thompson, 1990). Generally overlies volcanic breccia (Tbr) unit, locally overlies tuff of Castle Peaks (Tcp). Caps softer underlying tuff and breccia. Erodes as cliffs or steep slopes. Thickness <1 to 90 m

Tcp **Tuff of Castle Peaks (Miocene)**—Bedded to massive, white to tan, pumice-rich rhyolite tuff of ash-flow origin (fig. 3); crops out locally as a single 1-m-thick air-fall tuff related to eruption of the ash-flow deposit. Contains sanidine, plagioclase, and sparse biotite crystals (Thompson, 1990). Highly imprecise total fusion $^{40}Ar/^{39}Ar$ age on bulk sanidine of 21.4 ±1.6 Ma (table 4), suggests tuff is contaminated, perhaps by surface detritus during deposition. Overlies and locally interbedded with uppermost part of volcanic breccia (Tbr) unit; underlies andesite porphyry flows (Tap) wherever both units are exposed. Air-fall component of the tuff probably preserved rarely due to depositional disturbance by local eruption of either volcanic breccia unit or pyroxene andesite porphyry (Tap) unit. Erodes easily; preserved in slopes only where protected by overlying units. Thickness <1 to 5 m

Tbr **Volcanic breccia (Miocene)**—Gray to dark-bluish-gray monolithologic to hetero-lithologic volcanic breccia and megabreccia composed of seriate clasts of glassy to holocrystalline, vesicular to massive, rhyolite and trachyandesite. Monolithologic and volcaniclastic, whitish-tan to pink, matrix-supported, chaotic breccia composed of sand-size matrix of comminuted volcanic rocks, crystals, pumice, and volcanic ash that contains pebble-size pumice lumps, cobble-size volcanic bombs, and blocky clasts. Blocks and matrix composition are biotite-phyric rhyolite and dacite; locally contains zones of darker hornblende+biotite (±pyroxene) trachyandesite. Average size of blocks, 30 to 50 cm; may be as large as 10 m diameter. Bombs have breadcrust rinds and radial joints; blocks generally equant shapes and display chatter marks, radial internal cooling joints, internal flow-banding, and fluted joint surfaces. Divergent ages produced from a blocky clast collected in the Castle Peaks quadrangle, by two isotopic techniques (table 4): conventional K-Ar age of 14.7±0.4 on biotite probably too young due to alteration; extremely imprecise total fusion $^{40}Ar/^{39}Ar$ age on bulk sanidine of 17.5±10.4 Ma suggests contamination of magma prior to eruption. Overlies Proterozoic gneiss (Xlg); contact has 150 m of relief. Always underlies pyroxene andesite porphyry (Tap) unit; generally underlies, but may be locally interbedded with, tuff of Castle Peaks (Tcp). Forms steep-sided ridges and buttes. Thickness 30 to 100 m

Castle Mountains

Tg **Gravel deposits (Miocene)**—Subangular to rounded pebble- to cobble-size clasts of granite, gneiss, and volcanic and sedimentary rocks, in matrix of immature coarse- to medium-grained crystal-lithic sand. Basal part of unit is poorly consolidated crystal-lithic sandstone and siltstone with gravel-filled channels. Crystals in basal sandstone and matrix are predominantly quartz, biotite, feldspar, and rarely pyroxene. Clast types include foliated and unfoliated gneiss and granite, gray Paleozoic limestone with stringers of brown chert, and greenish metavolcanic rocks. Foliated garnetiferous granite probably derived from Proterozoic terranes, and undeformed leucocratic granite clasts and metavolcanic rocks from Mesozoic sources. Proportions of volcanic and sedimentary clasts generally low, increasing in upper part of unit. Near Hightower Well the basal interval of sandstone and siltstone overlies bentonitic paleosol at top of rhyolite tuff, flows, and intrusive rocks unit (Tr) (sec. 14, T. 14 N., R. 17 E.). Underlies late Tertiary(?) and Quaternary gravel and fluvial deposits (QTg, Qya). Gently dipping, forms rolling hills. Exposed thickness 5 to 100 m

Tj **Tuff of Juan (Miocene)**—Welded rhyolite tuff. Lower part of unit contains black vitrophyre 10 m thick, with well-developed color-banding parallel to subhorizontal flow planes; contains biotite and potassium feldspar in gray-brown glassy matrix of volcanic ash. Upper part contains sanidine and plagioclase feldspar, biotite, and hornblende crystals in light- to medium-gray, loosely indurated matrix. K-Ar age is 14.4±0.2 Ma (location 5, table 3). Overlies tuff, volcanic breccia, and sedimentary deposits (Tss), basalt flows (Tb), or rhyolite tuff, flows, and intrusive rocks (Tr) units. Forms cliffs. Thickness to 40 m

Tb **Basalt flows (Miocene)**—Vesicular and scoriaceous, porphyritic to aphyric, fine-grained to glassy dark gray to black flows, locally reddened by oxidation. Unit mostly consists of basalt and basaltic andesite, locally includes andesite and trachyandesite; rarely contains flow breccia, cinders, and scoria. Porphyritic flows normally contain 10 to 15 percent phenocrysts. Basaltic andesite may contain only plagioclase phenocrysts; basalt also contains sparse olivine and rare pyroxene. Individual flows 3 to 4 m thick commonly have massive cores and well-defined 1- to 2-m thick breccia zones at upper and lower margins. Overlies and interbedded with rhyolite tuff, flows, and intrusive rocks (Tr); tuff, volcanic breccia, and sedimentary deposits (Tts); and gravel (Tg) units, and underlies tuff of Juan (Tj). Forms steep cliffs or steep-sided ridges. Thickness 3 to 50 m

Tbs **Basalt flows, rhyolite tuff, and sedimentary rocks (Miocene)**—Thin basaltic flows interbedded with air-fall tuff, tuff breccia, ash-flow deposits, rhyolite flows, and fluvial sedimentary rocks; unit also includes feeder dikes of basalt flows. Unit mapped wherever silicic tuff and breccia ejecta and tuffaceous sedimentary rocks (Tss) too few to separate from interbedded basalt flows (Tb); also present southwest of Hart Peak where gravel of unit Tg is interbedded with basalt and air-fall tuff. Generally forms gentler slopes than those underlain by units Ts and Tb. Thickness 5 to 50 m

Tr **Rhyolite tuff, flows, and intrusive rocks (Miocene)**—Rhyolite ejecta of white, pink, and red rhyolite tuff and breccia; includes airfall and ash-flow tuff (welded and unwelded), extensive tuff breccia, and pumice breccia; locally includes intervals of bedded tuff and sedimentary deposits. Also includes rhyolitic flows and flow breccia fed by local intrusions. Contains 10 to 25 percent phenocrysts, mostly of biotite, sanidine, and quartz. Lithologically equivalent thick intervals of bedded tuff and sedimentary rocks mapped separately as unit Tts; thick rhyolite flows mapped separately as unit Trf. Laterally continuous bedded deposits grade into local eruptive breccia zones forming marginal carapaces of intrusive domes and larger dikes. Flows and smaller intrusions have well-defined 1- to 3-m-thick glassy chilled margins. In southern part of Castle Mountains, domes (Tir) are largest and most abundant, and mineralization, silicification, and alteration of tuff and breccia deposits to kaolinite is most intense. Uppermost breccia interval near Hightower Well (sec. 14, T. 14 N., R. 17 E.) marked by development of bentonitic paleosol. Unit ages (reported by Capps and Moore, 1991): rhyolite flow near Hart Peak, 16.3±0.5 Ma; tuff subunits near Hart town site, 14.7±0.3 Ma, 14.9±0.3 Ma, 15.7±0.6 Ma; rhyolite breccia east of Hart, 14.2±0.3 Ma; rhyolite breccia near Hightower Well, 14.9±0.3 Ma. Overlies the volcanic flows and breccia of the Castle Mountains unit (Tcm), tuff of Jacks Well (Tjw), or lahar (Tvl). Locally underlies basalt flows (Tb) or basalt flows, rhyolite tuff, and sedimentary rocks (Tbts) units. Forms steep slopes, locally cliffs. Apparent thickness is 10 to 250 m in northern part of Castle Mountains, perhaps as much as 1 km in southern part. True thicknesses difficult to estimate because internal faults are poorly exposed

Tts **Tuff, volcanic breccia, and sedimentary rocks (Miocene)**—Well-bedded silicic air-fall tuff and tuff breccia, pumice breccia, ash-flow tuff and flow breccia, as well as minor volcaniclastic sedimentary rocks, tuffaceous sedimentary materials, and volcanic conglomerate. In the northern part of the Castle Mountains, sedimentary rocks more common in lower part of unit and eruptive rocks more common in upper part. Sedimentary rocks are: siltstone; fine- to medium-grained, buff-colored sandstone; pebble to cobble conglomerate with abundant cobble-size and larger white pumice clasts grading upward to light-yellow-tan tuffaceous sandstone and siltstone, volcanic conglomerate, and ash-flow tuff. Eruptive rocks consist of orange-tan, thinly stratified air-fall tuff; welded lithic tuff; black, glassy, perlitic, vitrophyre flows; and fine-grained air fall tuff that locally contains black glassy bombs. Ages reported for tuff and tuff breccia (Capps and Moore, 1991) range from 14.2±0.3 to 15.7±0.6 Ma. Overlies volcanic flows and breccia of the Castle Mountains (Tcm) unit; in northern part of Castle Mountains, underlies and interbedded with basalt flows (Tb) unit. Forms steep to moderately steep slopes. Thickness 3 to 100 m

Trf **Rhyolite flows (Miocene)**—Pink and lavender, biotite- and sanidine-bearing, thick, stubby, aphanitic and vitrophyric rhyolite flows related to adjacent domes; rarely thick enough to be mapped separately from rhyolite tuff, flows, and intrusive rocks (Tr) unit. Forms steep slopes mantled with talus. Individual flows as much as 60 m thick

Tvl **Lahar of volcanic origin (Miocene)**—Chaotic volcaniclastic breccia (lahar). Varies from clast-supported, having volcanic blocks as much as 1.5 m in maximum dimension, to matrix-supported structure with clast sizes ranging from 5 to 50 cm. Largest clasts concentrated in uppermost part of unit; many have fluted or breadcrust surfaces and radial cooling joints. Purplish granulated matrix of sand-size andesite, and white volcanic ash containing feldspar, pyroxene, and biotite crystals. In outcrops east of Hart, angular clasts include leucocratic rhyolite, white pumice, and oxidized andesitic scoria; subrounded clasts of gneiss and granite also present. In northeastern part of quadrangle (NW ¼ sec. 2 and NE ¼ sec. 3, T. 30 S., R. 62 E.), angular clasts of dark hornblende trachyandesite more abundant than rhyolitic clasts. Generally preserved where interbedded with resistant rhyolite tuff, flows, and intrusive rocks (Tr) unit, or capped by basalt flows of unit Tb. Forms gentle slopes. Thickness 5 to 50 m

Tvss **Volcaniclastic sandstone and conglomerate (Miocene)**—Red, tan, or pinkish bedded sandstone and pebbly sandstone. Matrix is pumice, ash, and rounded quartz grains; spherical concretions developed locally. Clasts are subrounded volcanic pebbles and cobbles; maximum diameter, 9 cm. Beds are lensoid, normally graded, and cross bedded. Overlies tuff of Jacks Well (Tjw); forms locally thick interbeds in basal part of rhyolite tuff, flows and intrusive rocks (Tr) unit. Resistant beds form prominent ridges. Thickness 10 to 300 m

Tjw **Tuff of Jacks Well (Miocene)**—Light-gray to grayish-pink, nonwelded, crystal-lithic, ash-flow tuff. Contains sanidine, biotite, quartz, sphene, and minor pumice fragments in homogeneous ashy matrix. Sanidine K-Ar age of 16.1±0.4 (location 4, table 3; Turner and Glazner, 1990); age of 16.8±0.5 Ma reported by Capps and Moore (1991). Unit could be derived either from local eruption or from source outside Castle Mountains. Unit correlated by Bingler and Bonham (1973) with the Tuff of Bridge Spring, dated at 15.9±0.4 Ma (Faulds and others, 1990), which crops out to the north and east, mostly in Nevada. Overlies lacustrine and fluvial sedimentary rocks (Tlss) unit in the north- central part of the quadrangle. Underlies volcaniclastic sandstone and conglomerate (Tvss) unit and underlies tuff, volcanic breccia, and sedimentary deposits (Tts) unit, or rhyolite tuff, flows and intrusive rocks (Tr) unit. Forms classic hogback ridges of low relief that are locally intrused by rhyolitic domes (Tir), which affect dip and strike of unit. Thickness 3 to 25 m

Tlss **Lacustrine and fluvial sedimentary rocks (Miocene)**—Grayish-yellow, light-gray, pale-greenish-yellow, and light-red; fine-grained; clastic; lacustrine siltstone grading upward into medium-grained fluvial deposits. The gray and pale-yellow basal lake deposits consist chiefly of silt and mudstone interbedded with minor limestone, arkosic sandstone, and water-laid tuff. Upper part of unit is interbedded fine-grained sandstone and granule to cobble conglomerate, having both parallel stratification and tabular and trough cross-stratification. Clast lithologies include scoriaceous basalt, nonvesicular basaltic andesite, and minor fragments of gneiss and granite. Overlies volcanic flows and breccia of the Castle Mountains (Tcm) unit, and underlies tuff of Jacks Well (Tjw) in northern part of Castle Mountains; overlain at southernmost exposure by rhyolite tuff, flows, and intrusive rocks (Tr) unit. Easily eroded, forms gentle slopes or badlands topography. Thickness 2.5 to 350 m

Tcm **Volcanic flows and breccia of the Castle Mountains (Miocene)**—Black, gray, or dark-purplish trachyandesite porphyry, with less common trachybasalt and dacite flows, flow breccia, and pyroclastic breccia. Upper part of unit includes poorly sorted but well-bedded sedimentary intervals containing both high-grade metamorphic and volcanic clasts. Individual bedding horizons show both parallel and trough cross-stratification; subrounded to subangular clasts vary in size from very coarse sandstone to open-framework boulder conglomerate. Flows are 2 to 5 m thick and commonly have massive cores grading into oxidized flow breccia tops and bases. Compositions are trachyandesite with minor dacite (table 1, fig. 3): trachyandesite contains olivine altered to red clay, plagioclase feldspar, and green pyroxene in aphanitic, light- to dark-green-gray matrix; dacite contains sanidine, biotite, and pyroxene. Unit probably equivalent in age, but is not directly correlative, to the Patsy Mine Volcanics (Longwell, 1963) mapped elsewhere in Nevada, contrary to interpretation of Bingler and Bonham (1973). Overlies either erosional surface developed on Early Proterozoic migmatitic gneiss (Xmg) unit or outcrops of the Peach Springs Tuff (Tps). Generally underlies rhyolitic ejecta (Tts, Tr), but in the northern Castle Mountains underlies either lacustrine and fluvial sandstone and conglomerate (Tlss) or volcanic lahar (Tvl) units. Contains ubiquitous rhyolite intrusions (Tir) related to eruption of unit Tr, and basalt dikes (Tib) related to eruption of unit Tb. Forms low rolling hills and steep sided valleys. Thickness 2.5 to 110 m

Tpe **Peach Springs Tuff of Young and Brennan (1974) (Miocene)**—Welded ash-flow tuff of alkali rhyolite composition with dominant adularescent sanidine and essential accessory sphene. Regionally extensive unit may also contain plagioclase, hornblende, biotite, and allanite. Accepted age, determined on sanidine from pumice sampled at Kingman, Arizona, is 18.5±0.2 Ma (Nielson and others, 1990). Ages determined on samples from the Castle Mountains include conventional K-Ar ages of 18.5±0.5 Ma (biotite) and 17.5±0.4 Ma (sanidine) (location 2, table 3; Turner and Glazner, 1990), and a single-crystal $^{40}Ar/^{39}Ar$ laser fusion age of 18.79±0.04 Ma (location 3, table 3; Nielson and others, 1993). Nonconformably overlies Early Proterozoic granite and gneiss (Xlg, Xmg); basal part commonly contains xenolithic fragments of gneiss and granite regolith. Also underlies basal units in the Castle Peaks and Piute Range (units Tbr and Ta; see below). Highly faulted and brecciated; forms thin resistant ledges in area east of Hart town site, where dips are as much as 65°. Thickness 15 to 50 m

Pzl **Limestone (Paleozoic)**—Gray, dolomitic, chert-bearing limestone that contains microscopic algal and possible echinoderm fragments. Isolated, fractured and altered outcrop of about 3 m by 10 m exposed in gully north of Nevada-California State line (sec. 16, T. 30 S., R. 62 E). Structural relations are obscure. If not part of a reworked deposit, limestone may be in fault contact with Early Proterozoic gneiss (Xmg) as proposed by Capps and Moore (1991).

Piute Range

Tg **Gravel deposits (Miocene)**—Pebble- and cobble-size granite, gneiss, volcanic, and sedimentary clasts in matrix of immature coarse- to medium-grained crystal-lithic sand. Prominent clast types include foliated and unfoliated gneiss and granite, gray Paleozoic limestone with stringers of brown chert, garnetiferous granite, undeformed leucocratic granite clasts, vein quartz, granite, and minor scoria and basalt. Proportions of volcanic and sedimentary rocks generally small. Fills channels eroded into andesite and basalt flows (Ta, Tb). Thickness 5 to 100 m

Tb **Basalt flows (Miocene)**—Vesicular and scoriaceous, highly to moderately porphyritic, dark gray to black, fine-grained to glassy flows and flow breccia, cinders, and scoria, locally reddened by oxidation. Unit consists dominantly of basalt and basaltic andesite or trachyandesite compositions but locally includes few rhyolite flows. Basalt flows contain 10 to 15 percent phenocrysts, predominantly plagioclase, with sparse olivine and rare pyroxene. Dispersed basaltic andesite and trachyandesite flows and breccia generally are plagioclase-rich and contain hornblende phenocrysts; rhyolite flows also contain biotite. Dikes have steeply dipping or vertical flow-banding and high proportions of flow-aligned plagioclase crystals. Ages of samples from unit listed in tables 3 and 4 (see also Nielson and Nakata, 1993). Thickness as much as 410 m

Tbs **Basalt flows, rhyolite tuff, and sedimentary rocks (Miocene)**—Rhyolite flows, air-fall and ash-flow tuff and tuff breccia, and sedimentary rocks interbedded with thin basalt or andesite flows and dikes. Unit mapped wherever silicic tuff and breccia ejecta and tuffaceous sedimentary rocks (Tss) too few to separate from interbedded basalt flows (Tb) unit. Generally forms gentler slopes than unit Tb. Thickness 30 to 150 m

Tpr **Tuff of the Piute Range (Miocene)**—White biotite tuff composed of pebble-size biotite-bearing pumice in biotite-rich matrix of rhyolite ash. Poorly sorted tuff rarely contains large (30 cm across), lithic and pumice clasts. Where reworked, displays normal grading and crossbedding. Biotite-rich tuffaceous sandstone typically composes upper part of unit. Locally contains augen gneiss, dacite and andesite blocks, commonly underlain by soft-sediment sag features. Overlain and underlain by andesitic flows, breccia, and sedimentary rocks (Ta) unit. Forms steep slopes beneath cliffs. Thickness 3 to 10 m

Ta **Andesitic flows, breccia, and sedimentary rocks (Miocene)**—Dark- to light-gray, generally fine-grained to porphyritic andesite, trachyandesite, and dacite flows and flow breccia. Andesite and trachyandesite flows have fine-grained matrix with approximately 10 percent phenocrysts, mostly composed of plagioclase (grain size as much as 3 mm across), with less common pyroxene (avg. 0.2 mm across) and rarer olivine. Flow bases commonly brecciated, commonly pillowed, with granular glassy margins. Ages of samples from unit listed in tables 3 and 4 (see also, Nielson and Nakata, 1993). Interleaved with lenses of gravel and sandstone interbeds too small to map as separate gravel unit (Tg); gravel consists of Paleozoic limestone, gneiss (including garnetiferous types), vein quartz, granite, and minor scoria and basalt. Coarsest deposits found in channels within flows; locally, flows also filled stream channels. May be interleaved with either basalt flows (Tb), basaltic flows, rhyolite tuff and sedimentary rocks (Tbts), and gravel deposits (Tg) units, and overlain locally by basalt flows (Tb) and older alluvium (Qoa) units. Forms steep cliffs with 50 to 350 m of relief. Dips are gentle; relief generally corresponds to thickness, not accounting for paleotopographic variations of underlying units or fault repetition of indistinguishable flows

Tps **Peach Springs Tuff of Young and Brennan (1974) (Miocene)**—Welded ash-flow tuff of alkali rhyolite composition with dominant adularescent sanidine and essential accessory sphene; locally may contain plagioclase, hornblende, biotite, and allanite. Highly faulted and locally brecciated; basal volcanic unit underlying Piute Range lava deposits in West of Juniper Mine quadrangle, east of the map area. Crops out in southeastern part of Hart Peak quadrangle as low cliffs within andesite flows and flow breccia (Ta), indicating the presence of multiple, otherwise undetectable, faults. Thickness 15 to 50 m

INTRUSIVE IGNEOUS ROCKS

Tib **Basalt sills and dikes (Miocene)**—Aphanitic basalt and basaltic andesite dikes and rare holocrystalline sills intruded both gneiss and overlying volcanic rocks. Dikes, generally less than 3 m wide, form resistant ridges and spines. In northern part of map area, a dark-gray, homogeneous, fine- to medium-grained holocrystalline sill intruded both gneiss and overlying deposits (Tss) unit. Sill is locally coarse grained and contains hornblende and plagioclase feldspar; forms steep slope, thickness as much as 50 m

Tia, Tib **Andesitic intrusive rocks (Miocene)**—Black, gray, or purplish domes, as well as sills of hornblende- and (or) biotite-plagioclase andesite, trachyandesite, and oxidized intrusive breccia. Domes have carapaces of hard, silicified breccia, locally composed of angular black and bright-red fragments in dark-gray matrix. A steep-sided dome 300 m across, located in northern Piute Range on the north side of major east-west canyon, forms a promontory within basaltic and andesitic flows and breccia (Ta, Tia).

Tir **Rhyolite domes and dikes (Miocene)**—White to light-pink or lavender, intrusive domes and dikes of biotite rhyolite. Interiors of thicker domes are strongly flow-banded; margins grade into zones of intrusive breccia consisting of platy fragments of flow-banded rhyolite; flow banding dips steeply. Compositions listed in table 1 (see also, Turner and Glazner, 1990). Conventional K-Ar age of 12.8 ±0.2 Ma determined on small, apparently unrifted, dome with symmetrical radial dips in northern Castle Mountains (location 7, table 3) establishes upper age limit of local deformation; Capps and Moore (1991) reported ages of 14.9±0.4 Ma to 16.5±0.7 Ma for rhyolite dikes and domes in southern part of Castle Mountains and near Hart Peak. Intrudes rhyolite flows, tuff, and sedimentary rocks (Tr, Tts, Tvss) units. Smaller dikes and sills present in volcanic flows and breccia of the Castle Mountains (Tcm) and underlying migmatitic gneiss (Xmg) units. Domes form steep-sided prominences and peaks of the Castle Mountains; most prominent are Hart Peak (sec. 31, T. 15 N., R. 18 E.) and a broad unnamed peak (NW ¼ sec. 6, T. 14 N., R. 18 E.). Southern part of Castle Mountains contains densest concentration of dikes and domes

Til **Latite dike (Miocene)**—Lead-gray vitrophyric porphyry dike discontinuously exposed for more than 4 km in southwest part of quadrangle; main continuous exposure 2.8 km long. Dark aphanitic matrix contains 10 to 20 percent phenocrysts; locally concentrated; composed of plagioclase, hornblende, biotite, and quartz. K-Ar ages (14, 15, table 3) of 14.3±0.4 and 14.1±0.4 Ma (biotite), and 14.6±0.5 Ma (plagioclase) compare favorably with those reported by Capps and Moore (1991: 14.5±0.5 and 15.1±0.4 Ma on biotite). Forms steep-sided ridges or spines within host unit of rhyolite tuff, flows, and intrusive rocks (Tr); contains banded chill zone at contact with oxidized tuff. Dike segments strike north-northeast; dips near vertical; width varies from 10 to 150 m. North of northwest-striking fault zone, dike forms thin, discontinuous, parallel ridges ranging from 20 to 50 m in width.

METAMORPHIC ROCKS

Castle Peaks

Xlg **Leucocratic granite and granitic gneiss (Early Proterozoic)**—Porphyroclastic to megaporphyroclastic biotite-rich augen gneiss, locally banded and intruded by foliated to unfoliated garnet-bearing leucogranite. Granitic assemblage consists of leucogranite, hornblende-biotite granite, biotite quartz monzonite and granodiorite. Aplitic dikes, as much as 3 m wide, intrude medium-grained hornblende-biotite granite

Castle Mountains

Xmg **Migmatitic gneiss (Early Proterozoic)**—Varicolored foliated and compositionally layered metamorphic rocks of amphibolite to granulite facies. Includes tan, medium-grained quartzofeldspathic gneiss; dark-gray to black, medium- to coarse-grained amphibolite; gray to brown quartz-mica schist and gneiss; and leucocratic garnet-mica gneiss and biotite-sillimanite gneiss

Contact

Fault—Dashed where approximately located, dotted where concealed; queried where uncertain. U, upthrown side; D, downthrown side. Arrow indicates dip. In cross section, half arrows indicate direction of relative movement. Cross-bars indicate direction of down-thrown side of normal faults.

Dike—Cross-bars indicate unit Tib, balls indicate unit Tir. See Description of Map Units for descriptions.

Inferred fault (cross section only)

Strike and dip of inclined bedding or contacts

Strike and dip of inclined foliation

Strike and dip of vertical foliation

Strike and dip of inclined joints

Zone of shearing and alteration—Area of Hightower Well

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

GEOLOGIC MAP OF THE HART PEAK 7.5 MINUTE QUADRANGLE, CALIFORNIA AND NEVADA: A DIGITAL DATABASE

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