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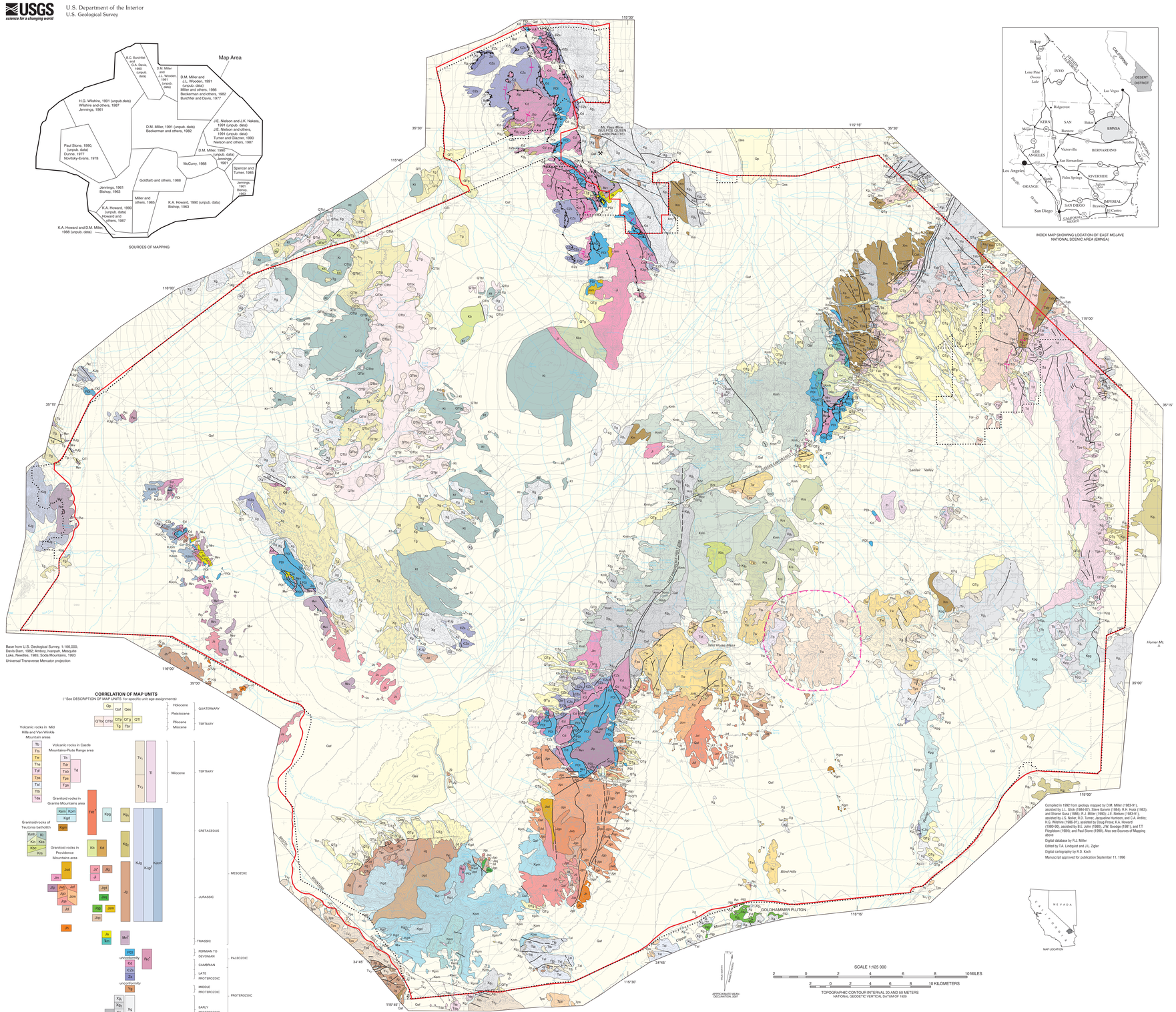

Geologic Map of the East Mojave National Scenic Area, California

Compiled by

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DESCRIPTION OF MAP UNITS

[Some unit exposures on the plotted map are too small to distinguish the color for unit identification. These units are labeled where possible; unlabeled units are attributed in the database]

Qp — **Playa deposits (Holocene)**—Unconsolidated clay, silt, and sand. Light colored and sparsely vegetated

Qaf — **Alluvial fan deposits and alluvium (Holocene and Pleistocene)**—Unconsolidated deposits of poorly sorted gravel, sand, and silt. Deposited as alluvial cones at mouths of canyons and gullies, as alluvial floodplains that border streams, and as braided-stream sediments in stream channels. Older deposits form piedmonts that flank mountain ranges, as well as typically underlie raised, paved, and varnished surfaces

Qes — **Eolian sand deposits (Holocene and Pleistocene)**—Unconsolidated, fine- and medium-grained sand that forms dunes and sand sheets. Most of unit is present in vicinity of Kelso Dunes

QTbc — **Basalt cinder deposits (Pleistocene to late Miocene)**—Unconsolidated deposits of basalt-scoria fragments, consolidated pyroclastic breccia, and tuffaceous conglomerate formed by phreatic eruption during vent opening.

QTba — **Basalt lava flows (Pleistocene to late Miocene)**—Alkaline basalt and hawaiite flows.

QTp — **Playa and pluvial-lake deposits (Pleistocene and Pliocene)**—Dissected deposits of playstone, fluvial siltstone, silty peat, sandstone, carbonate or siliceous tufa, and pebbly sandstone. Crops out east and west of southern Piute Range and north of Cima Dome

QTg — **Gravel (Pleistocene and Pliocene)**—Moderately consolidated pebble, cobble, and sand deposits. Typically underlies highly incised surfaces. Locally contains extensive pedogenic calcite

QTl — **Landslide and sedimentary-breccia deposits (Pleistocene and Pliocene)**—Displaced deposits of disaggregated rock and alluvium that form hummocky terranes. Composite of detached masses of brecciated bedrock west of Providence Mountains is probably made up of gravity-slide masses

Tg — **Gravel (Pliocene and Miocene)**—Moderately consolidated, crudely bedded, fluvial boulder to pebble gravel and sand interbedded with coarse to extremely coarse debris-flow deposits, avalanche breccia, and gravity-slide breccia. Sand is siliciclastic and volcaniclastic, locally arkosic. In and east of New York Mountains, typically forms highly incised raised terraces. Intercalated gravity-slide blocks between Cima Dome and Old Dad Mountain consist of breccias of dolomite, limestone, chert, quartzite, and volcanic, metamorphic, and granitoid rocks

Tbr — **Sedimentary-breccia deposits (Pliocene or Miocene)**—Deposits of disaggregated rock and alluvium that form hummocky terranes. Deposits lie along north flank of Granite Mountains

Tv_1 — **Younger volcanic rocks (Miocene)**—Rhyolite lava flows and ash flows, basalt flows, and dacite lava flows that overlie unit Tpa, Peach Springs Tuff of Young and Brennan (1974)

Tv_2 — **Older volcanic rocks (Miocene)**—Rhyolite lava flows and ash flows, tuffaceous sedimentary rocks, tuff breccia, basalt flows, and andesite flows

Ti — **Shallow-intrusive rocks (Miocene)**—Felsic, intermediate-composition, and mafic igneous rocks emplaced as shallow intrusions and domes. Present in Granite Mountains and Lanfair Valley

TKf — **Felsite (Tertiary and (or) Cretaceous)**—Fine-grained felsitic igneous rocks that form dikes and irregularly shaped intrusions

Kgg — **Porphyritic granodiorite (Cretaceous)**—Light-colored, coarse-grained biotite granodiorite and monzogranite that contains K-feldspar phenocrysts. Present in Fenner Hills, Piute Range, Homer Mountain, and nearby areas. Feldspar phenocrysts are 1-2 cm wide except in southern Piute Range, where they are 2–4 cm wide

Kg_1 — **Younger granitoid rocks (Cretaceous)**—Monzogranite and granodiorite probably of Late Cretaceous age. Crops out east of Piute Range and at northern end of Piute Mountains, just south of map area

Kg_2 — **Older granitoid rocks (Cretaceous)**—Monzogranite, granodiorite, and more mafic rocks that are similar to granitoids of the mid-Cretaceous Teutonia batholith

KJg — **Granitoid rocks (Cretaceous and Jurassic)**—Monzogranite, granodiorite, and more mafic rocks of Mesozoic age. Present in Soda, Ivanpah, and Kelso Mountains

KJgr — **Granite (Cretaceous and (or) Jurassic)**—White, medium- to coarse-grained granite present near Baker (Grose, 1959)

KJcm — **Granitoid rocks of Cowhole Mountain (Cretaceous and (or) Jurassic)**—Hornblende-bearing monogranite, quartz monzonite, and quartz monzodiorite that is pink to purplish pink, medium grained, and equigranular to porphyritic, having phenocrysts of K-feldspar (Dunne, 1972). Locally contains secondary epidote and chlorite (Novitsky-Evans, 1978). Age uncertain, but pinkish color suggests that it may be Jurassic (Miller and others, 1982)

Kb — **Biotite-rich granitoid rocks (Cretaceous)**—Gray, equigranular to porphyritic (contains small pink alkali-feldspar phenocrysts), biotite-rich granitoid rocks, generally medium or coarse grained. Biotite content 10 volume percent or greater; biotite-rich schlieren widely present, abundant in places. Mapped in Halloran Wash and to south. Considered Cretaceous in age by DeWitt and others (1984)

Kd — **Diorite (Cretaceous)**—Hornblende diorite present west of Cima Dome

Jg — **Granitoid rocks (Jurassic)**—Hornblende-biotite granodiorite, porphyritic granite and alkali granite, biotite-hornblende monzodiorite, and related rocks. K-feldspar phenocrysts in porphyritic granitoids are typically pink or purple

Js — **Sands Granite (Jurassic?)**—Unit of Hewett (1956). Pale-pink, coarse-grained, leucocratic alkali-feldspar granite that is characterized by perthitic K-feldspar phenocrysts and granophyric texture (Dunne, 1972; Novitsky-Evans, 1978). Crops out in Devils Playground area

Jlg — **Leucocratic granite (Jurassic)**—Pale-pink, medium-grained, leucocratic granite present in Granite Mountains

Ji — **Ivanpah granite of Beckerman and others (1982) (Jurassic)**—Informally named unit. Dark-pink to tan, coarse-grained, porphyritic biotite syenogranite to monzogranite that crops out in the Ivanpah Mountains and east of Cima Dome. Weakly developed magmatic foliation defined by aligned feldspar and biotite is common. Minor hornblende or muscovite is present. K–Ar ages of 136–138 Ma (Sutter, 1968) interpreted here as minimum ages; preliminary U–Pb data for zircon suggest crystallization age of 145 Ma (J.D. Walker, 1991, oral commun.)

Jgd — **Quartz diorite gneiss (Jurassic)**—Hornblende quartz diorite and quartz monzodiorite that contains megacrysts of K-feldspar. Age is about 160 Ma. Present in Granite Mountains

Jsq — **Spotted quartz monzonite (Jurassic)**—Buff, medium- to fine-grained hornblende-biotite quartz monzonite. Small mafic-mineral clots are conspicuous. Present in Granite Mountains

Jqg — **Quartz monzodiorite and granodiorite (Jurassic)**—Foliated medium-grained rocks that vary in composition from granodiorite to diorite. Locally porphyritic. Present in Clipper Mountains. Forms Goldhammer pluton

Jsm — **Striped Mountain pluton (Jurassic)**—Hornblende diorite that crops out on Striped Mountain. K–Ar age on hornblende is about 162–167 Ma, so we consider pluton to be similar in age to other Jurassic granitoids; however, Burchfiel and Davis (1971) suggested that it might be as old as 200 Ma

Jbp — **Brecciа pluton (Jurassic)**—Hornblende diorite in Mescal Range. K–Ar age on hornblende is ~190–200 Ma, which may indicate Triassic age for pluton (Burchfiel and Davis, 1971). Mapped unit includes similar rocks in Clark Mountain Range

Ja — **Aztec Sandstone (Jurassic)**—Prominently crossbedded quartz arenite that is typically red, yellow, or buff. Contains lenses of conglomerate in exposures at Old Dad Mountain, as well as interbeds of felsic volcanic rocks in several places. Also present at Cowhole Mountain and in Mescal Range

Mvr — **Volcanic and sedimentary rocks (Mesozoic)**—Volcanic flows, flow breccia, tuff, volcaniclastic rocks, quartzite, and conglomerate. Includes rocks (termed "Delfonte volcanic rocks" locally) that interfinger with or overly Aztec Sandstone (Ja), as well as metavolcanic rocks that lie above Moenkopi Formation (Ŧrŧ) and its laterally equivalent sedimentary rocks. Volcanic rocks that lie above Aztec Sandstone at Cowhole Mountain were dated at 167 Ma by Busby-Spera (1988). Metavolcanic rocks that lie below Moenkopi Formation are considered Triassic or Jurassic in age (Dunne, 1977). Locally includes hypabyssal rocks. Unit in central New York Mountains consists of felsic metavolcanic rocks and lesser amounts of sedimentary rocks, all underlain by basal conglomerate (Burchfiel and Davis, 1977). Sedimentary rocks included with this unit in Providence Mountains are shale, sandstone, conglomerate, and impure limestone; part of this section probably correlates with Moenkopi Formation (Hazzard, 1954). Also present in Soda Mountains and Ivanpah Mountains

Ŧrm — **Moenkopi Formation (Triassic)**—Thin-bedded limestone, sandy and silty limestone, calcareous shale, and sandstone present at Old Dad Mountain and in Mescal Range. Metamorphosed calc-silicate rocks in New York Mountains are described as "tentatively correlated with the Triassic Moenkopi Formation" (Burchfiel and Davis, 1977)

PCᵢ — **Limestone (Permian to Devonian)**—Carbonate rocks that consist of Pennsylvanian and Permian Bird Spring Formation (thick-bedded cherty, sandy, and pure limestone), Mississippian Monte Cristo Limestone (massive pure, coarse limestone, cherty in lower part), and Devonian Sultan Limestone (medium-bedded, interlayered limestone and dolomite)

Pzc — **Carbonate rocks (Paleozoic)**—Dolomite, limestone, and marble; metamorphosed in many places

Ꞓd — **Dolomite (Cambrian)**—Buff and gray, generally thin bedded dolomite; argillaceous in lower part. Consists of Nopah and Bonanza King Formations. Widely distributed over map area

Ꞓzs — **Siliciclastic rocks (Cambrian and Late Proterozoic)**—Interbedded limestone, siltstone, and shale in upper part of unit and quartzitic rocks in lower part. Includes Zabriskie Tarrara Formation, Zabriskie Quartzite, Wood Canyon Formation, and Stirling Quartzite. Probably includes thin stratigraphic equivalents of Johnnie Formation and (or) Noonday Dolomite in Old Dad Mountain and Providence Mountains (Stewart, 1970; Dunne, 1977)

Zs — **Sedimentary rocks (Late Proterozoic)**—Shale, siltstone, diamictite, and dolomite. Stratigraphically equivalent to Johnnie Formation, Noonday Dolomite, and Kingston Peak Formation. Outcrop makes up thrust sheets of Ivanpah Mountains, Mescal Range, and Clark Mountain Range

Yg — **Granitoids (Middle Proterozoic)**—Alkalic igneous rocks that include granite, syenite, shonkinite, and carbonatite in Mountain Pass area. Age is ~1,400 Ma (DeWitt and others, 1987)

Xg_1 — **Younger granitoids (Early Proterozoic)**—Granite, granodiorite, and diorite dated between 1,660 and 1,695 Ma (Wooden and Miller, 1990). Common rock types are strongly porphyritic biotite granite, inequigranular leucocratic granite, and hornblende-biotite granodiorite. Locally foliated. Crops out widely from northern New York Mountains south to Ventrigger Hills

Xg_2 — **Intermediate-age granitoids (Early Proterozoic)**—Augen gneiss and subequigranular gneiss of biotite-granite and biotite-granodiorite composition; dated ~1,700–1,715 Ma (Wooden and Miller, 1990). One pluton crops out in northern New York Mountains, and an igneous suite of this age crops out in northern Providence Mountains. Orthogneiss of this age was identified in the hills near Halloran Spring (DeWitt and others, 1984) but is mapped herein with surrounding undivided gneiss and granitoids (Xg_1)

Xg_3 — **Older granitoids (Early Proterozoic)**—Pyroxene diorite, biotite-hornblende tonalite, and biotite granodiorite augen gneiss >1,730 Ma (Wooden and Miller, 1990). Crops out as mafic rocks suite west of Ivanpah Valley

Xg — **Gneiss and granitoids (Early Proterozoic)**—Undivided migmatite, granitoid gneiss, and granitoids mapped in many poorly known locations across map area. Also includes quartzite and quartzo-feldspathic paragneiss at Old Dad Mountain

Xa — **Amphibolite (Early Proterozoic)**—Massive amphibolite and layered amphibolite gneiss that contains amphibole, pyroxene, garnet, and biotite in varying ratios. Includes granite-facies mafic rocks that contain orthopyroxene. Intrudes older granitoid rocks (Xg_2) and is interlayered within migmatite (Xm)

Xm — **Migmatite (Early Proterozoic)**—Highly metamorphosed, compositionally layered rocks of supracrustal protoliths. Includes quartzo-feldspathic gneiss, garnet-bearing leucocratic layers and dikes, pelitic biotite-sillimanite-K-feldspar gneiss, tonalitic gneiss, and biotite-garnet gneiss. Compositional range for many rocks is similar to intermediate-composition volcanic rocks such as dacite or immature sedimentary rocks such as graywacke (Wooden and Miller, 1990)

VOLCANIC ROCKS IN MID HILLS AND VAN WINKLE MOUNTAIN AREAS

Tb — **Basalt flows (Miocene)**—Alkali basalt and andesite lava flows. Olivine andesite that overlies unit Tls, Tortoise Shell Mountain Rhyolite of McCurry (1988), is ~10 Ma in age (McCurry, 1988)

Tls — **Tortoise Shell Mountain Rhyolite of McCurry (1988) (Miocene)**—Rhyolite lava flows and plugs, as well as interbedded pyroclastic material. Aphyric to porphyritic and has sparse sanidine. Rhyolite was dated at 15.8 Ma (McCurry, 1988) and is chemically similar to upper cooling unit (Tw) of Wild Horse Mesa Tuff of McCurry (1988)

Tw — **Wild Horse Mesa Tuff of McCurry (1988) (Miocene)**—Prominently layered sanidine rhyolite ash-flow tuff that contains abundant sanidine phenocrysts and rare quartz, biotite, clinopyroxene, and magnetite phenocrysts. Mostly welded; consists of three compound cooling units that total as much as 320 m thick. Locally rich in lithic fragments. Forms conspicuous mesas in Woods Mountains area. Dated at ~15.8 Ma in age (McCurry, 1988). Probable source is trap-door caldera in western Woods Mountains

Ths — **Hackberry Spring Volcanics of McCurry (1988) (Miocene)**—Interlayered lava flows, domes, ash flows, and dikes and plugs of trachyte, trachydacite, and rhyolite. Dated at ~16 Ma in age (McCurry, 1988). Crops out widely on Hackberry Mountain

Tdf — **Domes and flows (Miocene)**—Extrusive domes and related lava flows composed of rhyodacite. Crops out near Wild Horse Mesa

Tps — **Peach Springs Tuff of Young and Brennan (1974) (Miocene)**—Widely distributed, welded rhyolite ash-flow tuff that contains conspicuous sanidine, ubiquitous but minor amounts of sphene, and variable amounts of biotite and hornblende. Age is 18.5 Ma (Nielson and others, 1990). Includes underlying thin deposits of arkosic gravel in New York Mountains and limestone-clast conglomerate in Providence Mountains

Tal — **Air-fall tuff and lava flows (Miocene)**—White to buff, bedded rhyolite air-fall tuff and thin rhyolite lava flows. Includes distinctive flow-banded rhyolite at Van Winkle Mountain. Locally, olivine-pyroxene basalt flows form uppermost part of unit

Ttb — **Tuff breccia (Miocene)**—Light-colored deposits of tuff breccia and minor amounts of both air-fall tuff and tuffaceous sedimentary rocks. Locally includes rhyolite, basalt, dacite, and andesite flows. Sedimentary rocks include water-laid tuffaceous rocks, conglomerate, and lacustrine siltstone and sandstone. Crops out at Van Winkle Mountain and south of Granite Mountains

Tda — **Dacite and andesite flows (Miocene)**—Thin lava flows and associated domes of intermediate composition. Crops out south of Granite Mountains

VOLCANIC ROCKS IN CASTLE MOUNTAINS-PIUTE RANGE AREA

Tb — **Basalt flows (Miocene)**—Crops out in Homer Mountain area

Td — **Dacite (Miocene)**—Dacite to andesite breccia, domes, and lava flows

Tdr — **Dacite and rhyolite (Miocene)**—Shallow intrusions and extrusive plugs and domes and adjacent flows and breccia composed of rhyolite, rhyodacite, and dacite. Crops out mainly in Castle Mountains. Age of unit dated between 16.1±0.4 and 12.8±0.2 Ma (Turner and Glazner, 1990)

Tab — **Andesite and basalt (Miocene)**—Lava flows and breccia composed of hornblende-pyroxene andesite and basaltic andesite. Includes sedimentary-breccia deposits composed largely of andesite. Locally, also includes interbedded conglomerate, fanglomerate, sandstone, and siltstone. Present in New York Mountains and Piute Range

Tps — **Peach Springs Tuff of Young and Brennan (1974) (Miocene)**—Widely distributed, welded rhyolite ash-flow tuff that contains conspicuous sanidine, ubiquitous but minor amounts of sphene, and variable amounts of biotite and hornblende. Age is 18.5 Ma (Nielson and others, 1990). Includes underlying thin deposits of arkosic gravel in New York Mountains and limestone-clast conglomerate in Providence Mountains

Tga — **Arkosic gravel (Miocene)**—Generally coarse, locally derived fluvial conglomerate and grus, mainly consisting of Proterozoic and Mesozoic gneiss and granite materials. Variably indurated. Present in Piute Range

GRANITOID ROCKS IN GRANITE MOUNTAINS AREA

Kem — **Equigranular monzogranite (Cretaceous)**—Interior unit of zoned pluton in eastern Granite Mountains. Consists of medium-grained biotite monzogranite

Kpm — **Porphyritic monzogranite (Cretaceous)**—Light-gray, coarse-grained biotite monzogranite that contains K–feldspar phenocrysts. Crops out widely in eastern Granite Mountains and part of Providence Mountains. These rocks were called granite of Arrowweed in southern Providence Mountains by Miller and others (1985). Locally fine grained

Kgd — **Granodiorite (Cretaceous)**—Granodiorite that forms exterior unit on south side of zoned pluton in eastern Granite Mountains and also forms sheetlike pluton in western Granite Mountains. Consists of equigranular hornblende-biotite granodiorite. Intruded by porphyritic monzogranite (Kpm)

Kgm — **Garnet two-mica monzogranite (Cretaceous)**—Medium-grained syenogranite to monzogranite that crops out east of Blind Hills. Minimum age is suggested by K–Ar age of 83 Ma on apparently primary muscovite

GRANITOID ROCKS OF TEUTONIA BATHOLITH

Kmh — **Mid Hills adamellite of Beckerman and others (1982) (Cretaceous)**—Informally named unit. Medium- to coarse-grained, porphyritic to equigranular, light-tan leucocratic monzogranite. Locally contains minor amounts of hornblende. Contains common aplite and pegmatite dikes. Crops out over much of Mid Hills and southern New York Mountains. Unit also includes intrusive breccia and brecciated felsite plugs in northern Providence Mountains. Dated ~93 Ma in age by U–Pb methods on zircon (Ed DeWitt, 1985, oral commun.)

Kt — **Teutonia adamellite of Beckerman and others (1982) (Cretaceous)**—Informally named unit. White to light-tan, equigranular to porphyritic (contains pink alkali-feldspar phenocrysts) biotite monzogranite, generally medium and coarse grained. Locally varies in composition to syenogranite and quartz monzonite. Minor muscovite present in places. These rocks were called granitic rocks of Kelso Peak by Dunne (1972). Crops out over much of Cima Dome, where it was dated at 97 Ma in age by U–Pb methods on zircon (DeWitt and others, 1984)

Klo — **Live Oak Canyon granodiorite of Beckerman and others (1982) (Cretaceous)**—Informally named unit. Equigranular, medium- to coarse-grained, light gray biotite granodiorite. Crops out in central New York Mountains. Contains rare hornblende. Contacts with Mid Hills adamellite are gradational

Kks — **Kessler Springs adamellite of Beckerman and others (1982) (Cretaceous)**—Informally named unit. White, strongly porphyritic biotite monzogranite and granodiorite. Phenocrysts of pink alkali-feldspar are set in gray, medium-grained groundmass. Contains minor hornblende. Crops out northeast of Cima Dome. K–Ar age on biotite is ~92–93 Ma (Burchfiel and Davis, 1971) and on hornblende is 92.1±0.5 (Beckerman and others, 1982)

Kbc — **Black Canyon hornblende gabbro of Beckerman and others (1982) (Cretaceous)**—Informally named unit. Texturally and compositionally variable, black hornblende gabbro, which contains minor amounts of quartz diorite, and monzodiorite. Medium grained and equigranular. Contains abundant hornblende and lesser amounts of clinopyroxene or biotite

Krs — **Rock Spring monzodiorite of Beckerman and others (1982) (Cretaceous)**—Informally named unit. Porphyritic, dark-gray to brown, compositionally variable rocks that make up a zoned pluton in Mid Hills. Common rock types are hornblende-biotite monzodiorite, quartz monzodiorite, and quartz monzonite; mafic hornblende-clinopyroxene diorite is present along north edge of pluton. Contains abundant mafic inclusions. Considered to be Jurassic in age by Beckerman and others (1982), but dated ~97 Ma by U–Pb methods on zircon (Ed DeWitt, 1985, oral commun.). Intruded by unit Kmh, Mid Hills adamellite of Beckerman and others (1982)

GRANITOID ROCKS IN PROVIDENCE MOUNTAINS AREA

Jsd — **Sheeted dikes (Jurassic)**—Felsic to intermediate-composition dikes in complex sheeted mass located along west side of southern Providence Mountains

Jfs — **Granite of Tough Nut Spring (Jurassic)**—Dark-pink to medium-brown, coarse-grained, subequigranular to porphyritic biotite syenogranite and monzogranite. K–feldspar phenocrysts typically pink or purple. Originally mapped as Ivanpah granite of Beckerman and others (1982) by Goldfarb and others (1988), but these rocks are less porphyritic

Jfp — **Fountain Peak Rhyolite of Hazzard (1954) (Jurassic)**—Dark-pink, hypabyssal granite and siliceous, generally aphyric, flow-banded rhyodacite. Locally contains biotite. Feeder dike for rhyodacite dated as Jurassic (J.D. Walker, 1988, oral commun.)

Jwb — **Quartz syenite of Winston Basin (Jurassic)**—Coarse-grained, melanocratic quartz syenite, syenogranite, and monzogranite. Strongly porphyritic; contains purple to pink phenocrysts. Contains augite, hornblende, and biotite

Jcf — **Felsic rocks of Colton Hills (Jurassic)**—White, coarse-grained, porphyritic biotite monzogranite and gray, finer grained felsic rocks. Includes yellow to pink, quartz-rich, coarse-grained biotite monzogranite near Bonanza King Well on east side of Providence Mountains

Jqo — **Quartz monzonite of Goldstone (Jurassic)**—Dark, medium- and coarse-grained, porphyritic to subequigranular rocks; predominant composition is quartz monzonite but also includes quartz syenite and quartz monzodiorite. Mafic phases are biotite, hornblende, and augite. K–Ar age on biotite is 157.0±3.9 Ma; U–Pb age on zircon is ~162–164 Ma (Miller and others, 1985)

Jcm — **Mesoscratic rocks of Colton Hills (Jurassic)**—Dark, fine- to coarse-grained, complexly variable suite of rocks that includes monzonite, quartz monzonite, quartz syenite, monzogranite, and minor amounts of gabbro. Biotite, hornblende, and augite are main mafic minerals. Rocks are commonly altered

Jqs — **Syenogranite of Quail Spring (Jurassic)**—Dark, medium- to coarse-grained, hornblende-biotite syenogranite; varies in composition to quartz monzonite and quartz monodiorite. Commonly extensively altered

Jd — **Diorite (Jurassic)**—Dark-brown to black hornblende diorite, hornblende-biotite monzodiorite, and mafic porphyritic hornblende-biotite quartz monzonite

Jh — **Hypabyssal and metavolcanic rocks (Jurassic)**—Dark-weathering, strongly chloritized, quartz-poor hypabyssal and volcanic rocks. Crops out in southeastern Providence Mountains

Contact—Dashed where approximately located

Lava flow front—Hachures on upper flow

Normal fault—Dashed where inferred; dotted where concealed

Thrust fault—Dotted where concealed. Sawteeth on upper plate

Low-angle normal fault—Dotted where concealed. Hachures on upper plate

Fold

Anticline

Overturned anticline

Syncline

Overturned syncline

Approximate boundary of Woods Mountains caldera—Hachures point into caldera (McCurry, 1988)

Boundary of East Mojave National Scenic Area (EMNSA, this report)

Boundary of Mojave National Preserve (current as of March 2007)

Mine

Mountain summit

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