U.S. Department of the Interior
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Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Sequoia & Kings Canyon National Parks and Manzanar National Historic Site

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Sequoia & Kings Canyon National Parks and Manzanar National Historic Site

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Geologic Resources Inventory Map Document for Sequoia & Kings Canyon National Parks

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Geologic Resources Inventory Map Document

Sequoia & Kings Canyon National Parks, and Manzanar National Historic Site, California

Document to Accompany Digital Geologic-GIS Data

seki_manz_geology.pdf

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This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Sequoia & Kings Canyon National Parks (SEKI), as well as Manzanar National Historic Site

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Map Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) **Map Unit List** – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

5) **Geologic Cross Sections** – Geologic cross section graphics with source geologic cross section abbreviations.

6) **Ancillary Source Map Information** – Additional source map information presented by source map.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you

need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Sequoia & Kings Canyon National Parks, California (SEKI). In addition to these maps being of relevance to %PARKNAME%> (SEKI, one map, the GRI Digital Geologic-GIS Map of Manzanar National Historic Site and Vicinity, California (*GRI MapCode MANZ*), is also relevant to nearby Manzanar National Historic Site.

Digital Geologic-GIS Map of Sequoia and Kings Canyon National Parks and Vicinity, California (*GRI MapCode SEKI*)

The above map was compiled from the following GRI digital geologic-GIS component maps listed below. Following each GRI digital geologic-GIS map is the source map used in that map's completion. For each source map the GRI used the full extent of the source map, and all geologic features within its extent were captured.

Digital Geologic-GIS Map of the Big Pine 15' Quadrangle, California (*GRI MapCode BIGP*)

Bateman, P.C., Pakiser, L.C., and Kane, M.F., 1965, Geology and Tungsten Mineralization of the Bishop District, California, with a Section on Gravity Study of Owens Valley and a Section on Seismic Profile, plate 4, USGS PP 470, scale 1:62,500 (Bishop District and Owens Valley). (*GRI Source Map ID 74452*).

Digital Geologic-GIS Map of the Blackcap Mountain 15' Quadrangle, California (*GRI MapCode BLMO*)

Bateman, P.C., 1965, Geologic Map of the Blackcap Mountain Quadrangle, Fresno County, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-428, scale 1:62,500 (Blackcap Mountain 15' Quadrangle). (*GRI Source Map ID 1896*).

Digital Geologic-GIS Map of the Giant Forest 15' Quadrangle, California (*GRI MapCode GIFO*)

Sisson, T.W., and Moore, J.G., 1994, Geologic Map of the Giant Forest Quadrangle, Tulare County, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-1751, scale 1:62,500 (Giant Forest 15' Quadrangle). (*GRI Source Map ID 1919*).

Digital Geologic-GIS Map of the Kern Peak 15' Quadrangle, California (*GRI MapCode KRPK*)

Moore, J.G., and Sisson, T.W., 1985, Geologic Map of the Kern Peak Quadrangle, Tulare County, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-1584, scale 1:62,500 (Kern Peak 15' Quadrangle). (*GRI Source Map ID 1915*).

Digital Geologic-GIS Map of Manzanar National Historic Site and Vicinity, California (*GRI MapCode MANZ*)

Stone, Paul, Dunne, G.C., Moore, J.G., and Smith, G.I., 2000, Geologic Map of the Lone Pine 15' Quadrangle, Inyo County, California: U.S. Geological Survey, Geologic Investigations Series Map I-2617, scale 1:62,500 (Lone Pine 15' Quadrangle). (*GRI Source Map ID 1920*).

Digital Geologic-GIS Map of the Marion Peak 15' Quadrangle, California (*GRI MapCode MPEK*)

Moore, J.G., 1978, Geologic Map of the Marion Peak Quadrangle, Fresno County, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-1399, scale 1:62,500 (Marion Peak 15' Quadrangle). (*GRI Source Map ID 1911*).

Digital Geologic-GIS Map of the Mount Goddard 15' Quadrangle, California (*GRI MapCode MTGD*)

Bateman, P.C., and Moore, J.G., 1965, Geologic Map of the Mount Goddard Quadrangle, Fresno And Inyo Counties, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-429, scale 1:62,500 (Mount Goddard 15' Quadrangle). (*GRI Source Map ID 1897*).

Digital Geologic-GIS Map of the Mount Pinchot 15' Quadrangle, California (*GRI MapCode MTPI*)

Moore, J.G., 1963, Geology of the Mount Pinchot Quadrangle, Southern Sierra Nevada, California: U.S. Geological Survey, Bulletin 1130, scale 1:62,500 (Mount Pichot 15' Quadrangle). (*GRI Source Map ID 1912*).

Digital Geologic-GIS Map of the Mount Whitney 15' Quadrangle, California (*GRI MapCode MTWT*)

Moore, J.G., 1981, Geologic Map of the Mount Whitney Quadrangle, Inyo And Tulare Counties, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-1545, scale 1:62,500 (Mount Whitney 15' Quadrangle). (*GRI Source Map ID 1910*).

Digital Geologic-GIS Map of the Olancha 15' Quadrangle, California (*GRI MapCode OLAN*)

Du Bray, E.A., and Moore, J.G., 1985, Geologic Map of the Olancha Quadrangle, Southern Sierra Nevada, California: U.S. Geological Survey, Miscellaneous Field Studies Map MF-1734, scale 1:62,500 (Olancha 15' Quadrangle). (*GRI Source Map ID 1904*).

Digital Geologic-GIS Map of the Southwestern Sequoia National Park, California (*GRI MapCode MINK*)

Sisson, T.W., and Moore, J.G., 2013, Geologic Map of Southwestern Sequoia National Park, Tulare County, California: U.S. Geological Survey, Open-File Report OF 2013-1096, scale 1:24,000 (Southwestern Sequoia National Park). (*GRI Source Map ID 75590*).

Digital Geologic-GIS Map of the Tehipite Dome 15' Quadrangle, California (*GRI MapCode TEHD*)

Moore, J.G., and Nokleberg, W.J., 1992, Geologic Map of the Tehipite Dome Quadrangle, Fresno County, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-1676, scale 1:62,500 (Tehipite Dome 15' Quadrangle). (*GRI Source Map ID 1913*).

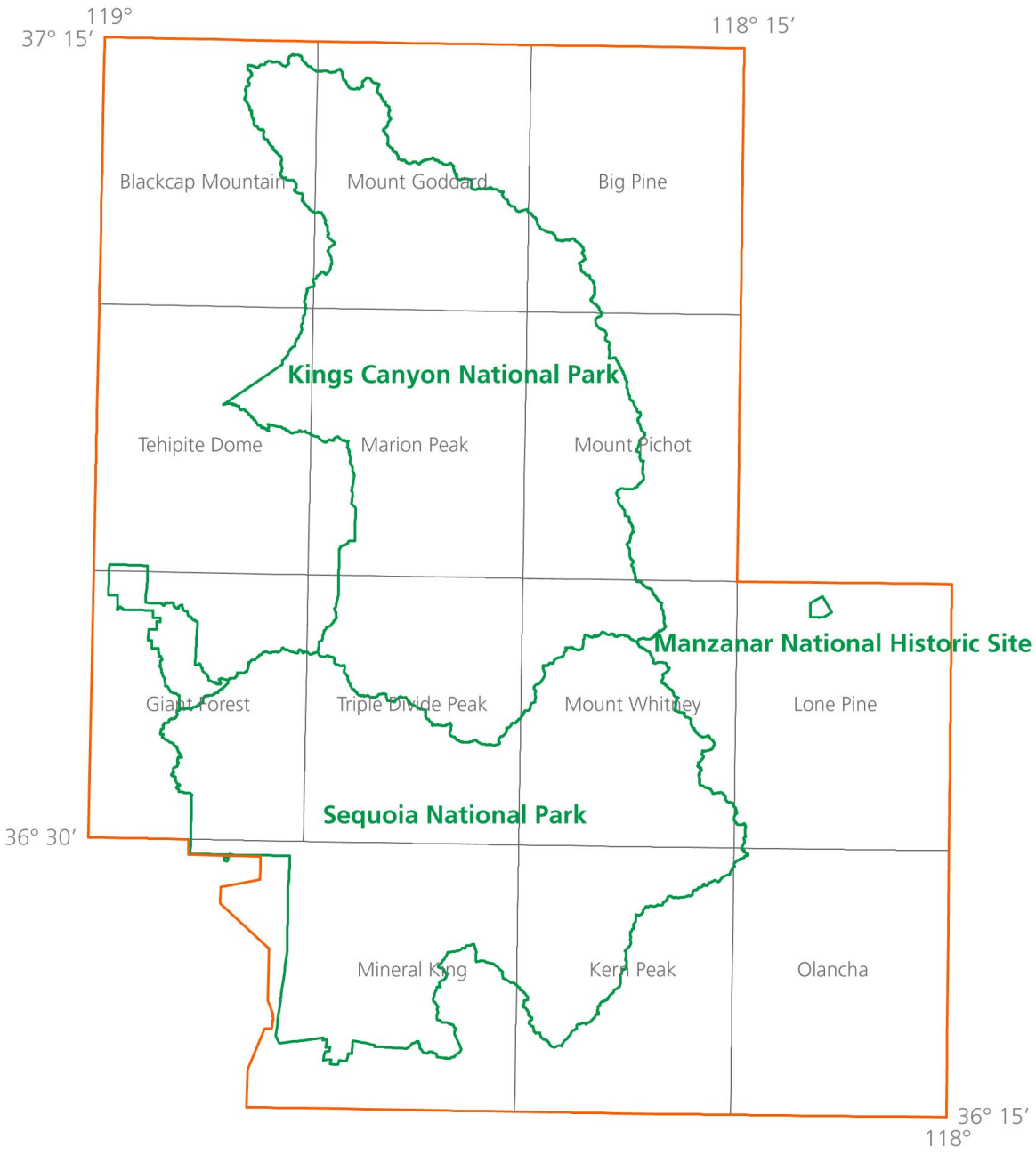
Digital Geologic-GIS Map of the Triple Divide Peak 15' Quadrangle, California (*GRI MapCode TRPD*)

Moore, J.G., and Sisson, T.W., 1987, Geologic Map of the Triple Divide Peak Quadrangle, Tulare County, California: U.S. Geological Survey, Geologic Quadrangle Map GQ-1636, scale 1:62,500 (Triple Divide Peak 15' Quadrangle). (*GRI Source Map ID 1914*).

Additional information pertaining to each source map is also presented in the GRI Source Map Information (SEKIMAP) table included with the GRI digital geologic-GIS data.

Index Map

The following index map displays the extents of the GRI digital geologic-GIS maps produced for Sequoia & Kings Canyon National Parks (SEKI), as well as for Manzanar National Historic Site (MANZ), The boundaries for both park units (as of September 2022) are outlined in green. The extent of the Digital Geologic-GIS Map of Sequoia & Kings Canyon National Parks and Vicinity is outlined in orange. The extent of the 15' quadrangles that comprise the park map are also shown. Of note, the Lone Pine 15' quadrangle is the extent of the GRI digital geologic-GIS map for Manzanar National Historic Site (MANZ).



Index map by James Winter (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Sequoia & Kings Canyon National Parks, California (SEKI) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qtf - Tufa). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (SEKIUNIT) table included with the GRI digital geologic-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in unit descriptions, correlation figures or other source map figures were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Qtf - Tufa
Qa - Active alluvium
Qs - Eolian sand
Qly - Younger lake deposits
Qr - Rock glaciers
Qvf - Valley fill and alluvial-fan material
Qal - Alluvial deposits
Qt - Talus
Qcl - Colluvium
Qf - Alluvial fan deposits
Qyf - Younger alluvial fan deposits
Qai - Inactive alluvium
Qgvl - Very large boulder gravels
Qgs - Grus and sand
Qtc - Talus and colluvium, undivided
Qls - Landslide deposits
Qg - Glacial deposits, undifferentiated
Qrp - Recess Peak Till
Qrpm - Recess Peak and Matthes Tills, undivided
Qdf - Debris-flow deposits
Qlo - Older lake deposits
Qsg - Stream gravels
Qtr - Mineral Spring Travertine Deposits
Qgh - Alkali basalt, lava and cinders of Groundhog cone
Qgy - Younger alluvial and debris-flow gravels
Qut - Undifferentiated till
Qtiy - Tioga Till, deposits of younger advances
Qti - Tioga Till
Qw - Tioga and Tahoe Tills, undivided
Qyb - Basalt flows and cinder cones
Qof - Older dissected alluvial fan and lakebed deposits
Qbs - Olivine basalt of Sawmill Canyon
Qta - Tahoe Till
Qtao - Tahoe till, deposits of older advance
Qrbp - Rhyolite south of Big Pine
Qob - Basalt dike and necks
Qrd - Rhyodacite
Qsh - Sherwin and older tills

Qm - Glacial moraines
Qgo - Older alluvial and debris-flow gravels
Qrl - Rhyolite of Long Canyon
Qpta - Pre-Tahoe Till deposits
Qsf - Alkali basalt, lava and cinders of Tunnel and South Fork cones
Qlw - Alkali basalt, lava and cinders of Little Whitney cone

Quaternary and Tertiary Periods
QTls - Landslide deposits
QTbo - Olivine basalt of Oak Creek
QTbd - Olivine basalt dikes of Division Creek

Tertiary Period
Tb - Basalt
Trt - Rhyolite of Templeton Mountain
Ttb - Trachybasalt
Td - Dacite
Tdd - Dacite dikes

Mesozoic Era

Cretaceous Period
Kgp - Granite porphyry dikes and sills
Kmdqd - Mafic diorite and quartz diorite dikes
Kw - Mount Whitney Intrusive Suite, Whitney Granodiorite
Kwm - Granite of White Mountain
Kao - Alaskite of Olancha Peak
Knd - Granodiorite of North Dome
Kgd - Granitic dikes
Kcrp - Cartridge Pass pluton
Kcy - Granodiorite of Coyote Flat
Kfgqm - Fine-grained quartz monzonite of Mount Shakspere
Kfm - Finer grained quartz monzonites
Kapa - Aplite, pegmatite, and alaskite
Kgdp - Granite of Dougherty Peak
Kmb - Granodiorite of Muro Blanco
Kalc - Alaskite of Evolution Basin and/or LeConte Canyon
Kevq - Alaskite of Evolution Basin and LeConte Canyon, quartz vein
Kp - Mount Whitney Intrusive Suite, Paradise Granodiorite
Kah - Alabama Hills Granite
Knm - Granite of North Mountain
Kpb - Plutonic breccia of Timosea Peak
Krr - Granodiorite of Redrock Meadow
Kgs - Granodiorite of Sugarloaf (of Mount Whitney Intrusive Suite)
Kbk - Porphyry of Black Kaweah
Kgc - Granodiorite of Chagoopa
Kmf - Mitchell Peak Granodiorite (of Mitchell Intrusive Suite) fine-grained facies
Kmpg - Mitchell Peak Granodiorite (of Mitchell Intrusive Suite) coarse-grained facies
Ka - Arrow pluton
Kpy - Pyramid pluton
Ksp - Spook pluton
Kglp - Granodiorite of Lookout Peak (of Mitchell Intrusive Suite)
Kwd - Granodiorite of White Divide
Kmd - McDoogle pluton
Kgcc - Granodiorite of Castle Creek (of Mitchell Intrusive Suite [Moore and Sisson, 1987])

Kcciz - Injection zone along margin of the Granodiorite of Castle Creek (of Mitchell Intrusive Suite [Moore and Sisson, 1987])
Kap - Aplite
Krsc - Rocks similar to Cathedral Peak Granite
Kcqm - Rocks similar to the Cathedral Peak granite, quartz monzonite
Kca - Rocks similar to the Cathedral Peak granite, alaskite
Kth - Tungsten Hills Quartz Monzonite
Ktha - Tungsten Hills Quartz Monzonite, albitized rock
Kgmh - Granodiorite of Mountain Home
Kmm - Granite of Maggie Mountain
Kym - Younger mafic plutonic rocks
Klw - Granodiorite of Little Whitney Meadow
Kac - Alaskite marginal to granodiorite of Chagoopa
Kmcp - Diorite associated with granite of Coyote Pass
Kgbc - Granodiorite of Brush Canyon
Kdm - Granite of Deer Meadow Grove
Kmc - Granodiorite of McKinley Grove
Khm - Granite of Mount Hoffman
Kmgg - Mount Givens Granodiorite (Bateman, in press)
Kmgq - Mount Givens Granodiorite, quartz mass
Kbx - Baxter pluton
Kl - Lamarck Granodiorite
Ks - Siberian pluton
Ksa - Sardine pluton
Ksav - Sardine pluton, related dikes
Kst - Striped pluton
Kc - Cotter pluton
Kg - Goodale pluton
Kmdl - Mafic dikes and lenses
Kkd - Granite of Kettle Dome
Kgtd - Granodiorite of Tehipite Dome
Klp - Mount Whitney Intrusive Suite, Granodiorite of Lone Pine Creek
Kk - Kern Knob Granite
Ksmd - Synplutonic mafic diorite intrusions
Kgtl - Granite of Tamarack Lake
Kes - Granite of Eagle Scout Peak
Ktd - Granite of Triple Divide Pass
Kgcp - Granite of Coyote Pass
Klkc - Granite of Little Kern Lake Creek
Kkp - Granite of Kern Peak
Klc - Granodiorite of Lightning Creek
Kmk - Granite of Mount Kaweah
Kwl - Granite of Weaver Lake (of Sequoia Intrusive Suite)
Kcr - Granite of Chimney Rock (of Sequoia Intrusive Suite)
Kcl - Granodiorite of Clover Creek (of Sequoia Intrusive Suite)
Kbm - Granite of Big Meadows (of Sequoia Intrusive Suite)
Kgf - Giant Forest Granodiorite (of Sequoia Intrusive Suite)
Kgfdc - Dome Creek facies of the Giant Forest Granodiorite (of Sequoia Intrusive Suite [Moore and Sisson, 1987])
Kkl - Granite of Kennedy lakes
Ktc - Granodiorite of Tombstone Creek
Kgtul - Granite of Tunemah Lake
Kgfp - Granite of Finer Peak
Kgac - Granite of Alpine Creek
Kubc - Granodiorite of upper Blue Canyon

Cretaceous and Jurassic Periods
KJlprc - Lineated quartz monzonite of Lost Peak and Round Corral Meadow
KJfp - Felsic quartz monzonite of Finger Peak
KJga - Alaskite
Kdcg - Dinkey Creek Granodiorite (Bateman, in press)
KJmr - Granodiorite of Mount Reinstein

Cretaceous Period
Kgmm - Granodiorite of McMurry Meadows

Cretaceous and Jurassic Periods
KJi - Inconsolable Granodiorite

Cretaceous Period
Kga - Garnet-bearing aplite-pegmatite dikes
Ksc - Granodiorite of Spring Creek
Kggd - Granite of Grand Dike
Kcpgd - Granodiorite dikes associated with the granite of Coyote Pass
Kcpp - Porphyritic core facies of the granite of Coyote Pass
Kcp - Equigranular facies of the granite of Coyote Pass
Kcm - Granite of Case Mountain
Kdp - Granite of Dennison Peak
Kmr - Granodiorite of Milk Ranch Peak
Kep - Granodiorite of Eshom Point
Khl - Granodiorite of Hartland
Ksq - Tonalite of Shadequarter Mountain
Kd - Diorite
Kss - Granodiorite of Shepherds Saddle
Kfp - Granite of Frys Point
Ksl - Granodiorite of Spring Lake
Kgapr - Granodiorite of Ash Peaks Ridge
Kmg - McGann pluton
Kb - Bullfrog pluton
Kyp - Quartz Diorite of Yucca Point
Kgg - Granite of Grant Grove
Ktp - Granite of Tharps Peak
Kdc - Granite of East Fork of Dry Creek
Kgpy - Granodiorite porphyry
Kgrm - Granodiorite of Redwood Mountain
Kmk - Granodiorite of Mankins Flat
Khp - Hypersthene granodiorite
Knk - Granodiorite of North Fork of Kaweah River
Kgge - Granite of Grant Grove, eastern mass
Kmdp - Metadacite porphyry
Kmhd - Hypersthene-bearing metadacite
Khg - Hypabyssal granodiorite stock
Kem - Quartz diorite of Empire Mountain
Kgb - Hornblende gabbro
Knp - Granodiorite of "Nev Point"
Kwr - Granodiorite of Windy Ridge
Kpc - Granodiorite of Pecks Canyon
Kwc - Granodiorite of White Chief Mine
Kgcr - Granodiorite of Camelback Ridge
Kbc - Granodiorite of Burnt Camp Creek
Kgpyd - Granodiorite porphyry dikes

Kf - Felsite
Kdr - Dragon pluton
Kt - Taboose pluton
Ktl - Twin Lakes pluton
Kdi - Diamond pluton
Kml - Mule Lake pluton
Krm - Red Mountain Creek pluton
Kta - Tinemaha granodiorite
Ki - Independence pluton
Kwf - White Fork pluton
Kan - Anorthosite
Km - Mafic plutonic rock
Kcc - Granite of Carroll Creek

Cretaceous and Jurassic Periods
KJcr - Quartz diorite of Cactus Ridge
KJsw - Granite of Skagway Grove
KJhr - Granite of Hospital Rock
KJpr - Granodiorite of Pattee Rocks
KJgb - Gabbro
KJf - Felsic dike
KJd - Mafic, intermediate-composition, and minor felsic dikes
KJgrd - Granodiorite
KJqd - Quartz diorite and other mafic plutonic rocks
KJmd - Mafic dikes
KJsmd - Sheared mafic dikes
KJlp - Granite of Lodgepole Campground
KJrp - Rhyolite porphyry dikes
KJsgd - Sheared granodiorite

Mesozoic Era
MZmm - Mafic metavolcanic rocks
MZma - Meta-andesite
MZmrd - Felsic metavolcanic rocks

Cretaceous and Jurassic Periods
KJmt - Metarhyolite and metadacite tuffs, undivided

Cretaceous Period
Kma - Meta-andesite
Kvbr - Metarhyolite and metadacite breccia
Kmrt - Metarhyolite tuff
Ksmr - Schistose metarhyolite
Kmrf - Metarhyolite lava
Kmsv - Metavolcanic sedimentary rocks
Kmrr - Metarhyolite
Kmap - Metarhyolite airfall ash

Cretaceous and Jurassic Periods
KJgd - Miscellaneous granodiorite
KJm - Mafic plutonic rock

Jurassic Period
Jmdt - Metadacite tuff
Jd - Mafic dikes
Jdi - Independence dike swarm

Jivu - Inyo Mountains Volcanic Complex of Dunne and others (1998), upper part
Javu - Volcanic complex of the Alabama Hills, upper part
Jivm - Inyo Mountains Volcanic Complex of Dunne and others (1998), middle part
Jpk - Pat Keyes pluton
Ji - Intrusive rocks marginal to Pat Keyes Pluton
Javl - Volcanic complex of the Alabama Hills, lower part
Jivl - Inyo Mountains Volcanic Complex of Dunne and others (1998), lower part
Jsm - Diorite of Schaeffer Meadow
Jkp - Alaskite of Kern Peak
Juf - Alaskite of Upper Funston Meadow
Jt - Granite of Toowa Range
Jhh - Alaskite of Hells Hole
Jdm - Granodiorite of Doe Meadows of Dubray and Dellinger
Jawc - Alaskite of Window Cliffs
Jwc - Granite of Window Cliffs
Jkcr - Granodiorite of Kern Canyon Ranger Station
Jrc - Granite of Rattlesnake Creek
Jmgf - Mafic Plutonic Rocks associated with Granite of Grasshopper Flat
Jgf - Granite of Grasshopper Flat
Jsc - Granodiorite of Sheep Creek
Jls - Granodiorite of Left Stringer
Jac - Granite of Angora Creek
Jlc - Granodiorite of Leggett Creek
Jmgd - Mafic granodiorite
Jcm - Granodiorite of Cold Meadows
Jm - Older mafic plutonic rocks
Jgd - Sheared granodiorite
Jym - Granodiorite of Yucca Mountain

Jurassic and Triassic Periods
JTRbs - Biotite-feldspar-quartz schist
JTRab - Meta-andesite and metabasalt
JTRm - Marble

Mesozoic Era
MZms - Metasedimentary rock

Jurassic and Triassic Periods
JTRch - Calc-hornfels
JTRqs - Quartz sericite hornfels
JTRq - Quartzite
JTRcs - Calc-silicate schist
JTRa - Amphibolite
JTRqbp - Quartz and biotite mylonitic phyllite
JTRbp - Biotite mylonitic phyllite
JTRabs - Andalusite-biotite schist
JTRlr - Granite of Lion Rock
JTRqp - Quartz porphyry
JTRd - Sheared diorite and gabbro

Mesozoic Era
MZmv - Metavolcanic rocks
MZmr - Metarhyolite

Jurassic and Triassic Periods
JTRscs - Silicated marble, calc-hornfels, and schist

JTRrh - Metavolcanic rocks, conspicuous layers of metarhyolite
JTRpd - Metavolcanic rocks, piedmontite-bearing layers
JTRmpr - Mafic plutonic rock
JTRosg - Older sheared granite
JTRg - Gneiss
JTRgf - Felsic gneiss
JTRrf - Metarhyolite lava flows
JTRrp - Piedmontite-bearing metarhyolite tuffs
JTRmp - Metawackes and pelitic hornfels
JTRms - Metasedimentary tuff
JTRrd - Metarhyolite and metadacite tuff
JTRmamd - Meta-andesite and metadacite, undifferentiated tuffs
JTRaw - Meta-andesite and metadacite, water-laid tuffs

Triassic Period
TRma - Meta-andesite

Mesozoic Era
MZm - Marble
MZccgl - Calc-silicate conglomerate
MZcs - Calc-silicate hornfels and schist
MZq - Quartzite
MZqb - Quartz-biotite schist and hornfels
MZqbcs - Quartz-biotite and calc-silicate schist and hornfels
MZslp - Slate and phyllite
MZslhf - Siliceous hornfels
MZvss - Volcaniclastic metasandstone
MZss - Metasandstone
MZtc - Tactite
MZmpr - Mafic plutonic rocks
MZvh - Hypersthene-bearing metadacite tuff
MZvp - Metaquartz porphyry

Triassic Period
TRu - Union Wash Formation
TRPc - Conglomerate Mesa Formation

Mesozoic and Paleozoic Eras
MZPZhs - Pelitic hornfels and schist
MZPZch - Calc-hornfels

Paleozoic Era
PZbs - Biotite schist
PZph - Pelitic hornfels and quartzite

Permian Period
Plu - Lone Pine Formation, upper part
Pll - Lone Pine Formation, lower part

Permian and Pennsylvanian Periods
PPNk - Keeler Canyon Formation

Paleozoic Era
PZms - Metasedimentary rocks

PZmqh - Micaceous quartzite and pelitic hornfels
PZsch - Siliceous calc-hornfels
PZcth - Metachert and andalusite-bearing pelitic hornfels
PZm - Marble
PZcph - Banded calc-hornfels and pelitic hornfels
PZmb - Marble
PZphm - Pelitic hornfels and interbeds of marble

Cambrian Period
Cp - Poleta formation
Cca - Campito formation, Andrews Mountain member

Unknown Age
g - unnamed unit

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. Many units listed were present on more than one source map and therefore a description is provided, along with the source map's unit symbol, unit name and unit age, for each source map the unit is present on. For some units the unit may have been present on only one source map, however, a unit symbol, unit name and unit age is also listed just before the unit description. This was done if the source map unit symbol, unit name and/or unit age differed from the unit symbol, unit name and unit age assigned by the GRI to that unit.

Qtf - Tufa (Holocene)

Porous travertine deposited from soda springs. Description from source map: Southwestern Sequoia National Park

Qa - Active alluvium (Holocene)

Sand and fine to coarse gravel of active washes and fan surfaces. Near Sierra Nevada front, forms floors of channels (too narrow to show at map scale) incised into older deposits. Description from source map: Lone Pine 15' Quadrangle

Qs - Eolian sand (Holocene)

Primarily plant-stabilized sand sheets that only locally are thicker than 2 m. In central Owens Valley, rests on older lake deposits (Qlo), which locally are exposed where sand has been removed by deflation. Description from source map: Lone Pine 15' Quadrangle

Qly - Younger lake deposits (Holocene)

Sediments of late Holocene age that form the floor of Owens Lake, consisting of bar and beach gravels, sand, silt, clay, and cemented ooliths. Deposited at elevations below about 3,600 ft (1,098 m). Uppermost 1 to 2 m locally composed of salts deposited since diversion of Owens River into Los Angeles Aqueduct in 1913. Description from source map: Lone Pine 15' Quadrangle

Qr - Rock glaciers (Holocene)

Qr - Rock glacier (Quaternary)
No further description provided. Description from source map: Kern Peak 15' Quadrangle

Qrg - Rock glaciers (Holocene)
Lobate masses of poorly sorted, angular boulders and finer material derived from cirque headwalls in Sierra Nevada, and containing interstitial ice or ice cores. Crests shown by dotted line. Present in southwest corner of quadrangle Description from source map: Lone Pine 15' Quadrangle

Qr - rock glaciers (Recent)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Qr - Rock glaciers (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map:

Mount Whitney 15' Quadrangle

Qr - Rock glaciers (Holocene)
Small active rock glaciers in cirques northwest of Florence Peak and southeast of Rainbow Mountain. Description from source map: Southwestern Sequoia National Park

Qr - Rock glaciers (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Triple Divide Peak 15' Quadrangle

Qvf - Valley fill and alluvial-fan material (Holocene)

Qal - valley fill and alluvial-fan material (Recent)
Valley fill and alluvial-fan material. Description from source map: Mount Pichot 15' Quadrangle

Qal - Alluvial deposits (Holocene and Pleistocene)

Qal - Alluvial fill (Recent)
May be, in part, of Pleistocene age. Description from source map: Bishop District and Owens Valley

Qal - Alluvial fill (Recent)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Qal - Alluvial deposits (Quaternary)
Alluvium underlying meadows; gravel in stream valleys. Description from source map: Giant Forest 15' Quadrangle

Qal - Alluvial deposits (Quaternary)
Alluvium underlying meadows; gravel in stream valleys. Description from source map: Kern Peak 15' Quadrangle

Qal - Alluvial deposits (Quaternary)
Alluvium underlying meadows, stream gravel, and locally some glacial deposits. Description from source map: Marion Peak 15' Quadrangle

Qal - Alluvial fill (Recent)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Qal - Alluvial deposits (Quaternary)
Alluvium underlying meadows, stream gravels of alluvial fans, and valley-fill deposits. Description from source map: Mount Whitney 15' Quadrangle

Qal - Alluvium (Holocene)
Lacustrine and stream deposits underlying meadows, alluvial fan deposits at the range front, and lake, beach, and evaporite deposits of Owens Lake. Description from source map: Olancha 15' Quadrangle

Qal - Alluvial deposits (Holocene and Pleistocene)
Alluvium underlying meadows; gravel, sand, and boulders in stream valleys. Description from source map: Southwestern Sequoia National Park

Qal - Alluvial deposits (Quaternary)
Alluvium underlying meadows: mainly sand ponded behind glacial moraines and gravel in stream valleys. Description from source map: Tehipite Dome 15' Quadrangle

Qal - Alluvial deposits (Quaternary)
Alluvium underlying meadows; largely sand ponded behind glacial moraines and gravel in stream valleys. Description from source map: Triple Divide Peak 15' Quadrangle

Qt - Talus (Holocene)

Qt - Talus (Holocene)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Qt - Talus (Holocene)
Weathered rock deposits at base of cliffs and in gullies. Description from source map: Olancha 15' Quadrangle

Qcl - Colluvium (Holocene)

Accumulations formed by downslope movement of rock and soil along the range front. Description from source map: Olancha 15' Quadrangle

Qf - Alluvial fan deposits (Holocene)

Qf - Alluvial fan deposits (Recent)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Qyf - Younger alluvial fan deposits (Holocene)

Qyf - Younger alluvial fan deposits (Recent)
May be, in part, of Pleistocene age. Description from source map: Bishop District and Owens Valley

Qai - Inactive alluvium (Holocene)

Fine to coarse gravels of inactive fan surfaces. Downslope from granitic bedrock, composed primarily of fine sand to pebble grus; downslope from sedimentary and metamorphic bedrock, composed of coarse, angular, poorly sorted gravel. Surface channels subdued or absent; dissected by channels that contain active alluvium (Qal). Overlies older lake deposits (Qlo) and younger alluvial and debris-flow gravels (Qgy). Description from source map: Lone Pine 15' Quadrangle

Qgvl - Very large boulder gravels (Holocene)

Gravels forming terraces 2 to 5 m above modern streams and alluvium and 5 to 30 m below surface of Pleistocene alluvial and debris-flow gravels (Qgy). Locally includes boulders 2 to 15 m across. Exposure ages on boulders about 2,000 to 1,200 yr. B.P. (Bierman and others, 1995). Description from source map: Lone Pine 15' Quadrangle

Qgs - Grus and sand (Holocene)

Accumulation of material resulting from in-place weathering of rock and sand found peripheral to alluvial deposits. Description from source map: Olancha 15' Quadrangle

Qtc - Talus and colluvium, undivided (Holocene and Pleistocene)

Qt - Talus (Recent)
Includes rock Glaciers and Recent moraines; ridge crest shown semidiagrammatically. Description from source map: Bishop District and Owens Valley

Qt - Talus and colluvium (Quaternary)
No further description provided. Description from source map: Giant Forest 15' Quadrangle

Qt - Talus, alluvial fan deposits, slope wash, and glacial deposits, undivided (Quaternary)
No further description provided. Description from source map: Kern Peak 15' Quadrangle

Qt - Talus, regolith, and colluvium (Holocene and Pleistocene)
Broken and decomposed rock debris that has been transported primarily by gravity. Upper surfaces slope 10° to 30°. Deposits at surface presumably are of Holocene age; underlying deposits probably are as old as Pleistocene, as indicated by the presence of fossil soil horizons that are locally exposed in deeply incised channels. Description from source map: Lone Pine 15' Quadrangle

Qt - Talus (Quaternary)
Slopewash and alluvial fan deposits. includes rock glaciers and young moraines; ridge crests are shown by dotted line. Description from source map: Marion Peak 15' Quadrangle

Qt - Talus (Recent)
Includes rock glaciers and moraines; ridge crest shown by dotted lines. Description from source map: Mount Goddard 15' Quadrangle

Qt - undifferentiated talus, slope wash, and locally some glacial deposits (Recent)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Qt - Talus, alluvial-fan deposits, slope wash, and undifferentiated glacial deposits (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Mount Whitney 15' Quadrangle

Qt - Talus and colluvium, undivided (Holocene and Pleistocene)
Steep slopes of angular talus blocks with little or no interstitial soil, commonly above 7,000 feet elevation; intermixed soil and rock fragments (colluvium) on gentler slopes, commonly forested. Description from source map: Southwestern Sequoia National Park

Qt - Talus and colluvium (Quaternary)
No further description provided. Description from source map: Tehipite Dome 15' Quadrangle

Qt - Talus, alluvial fan deposits, slope-wash, and glacial deposits, undivided (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Triple Divide Peak 15' Quadrangle

Qls - Landslide deposits (Holocene and Pleistocene)

Ql - Landslide deposits (Quaternary)
No further description provided. Description from source map: Giant Forest 15' Quadrangle

Ql - Landslide deposits (Quaternary)
Landslide on east wall of Kern Canyon. Hachured line indicates top of landslide scare. Description from source map: Kern Peak 15' Quadrangle

Qls - Landslide deposits (Holocene and Pleistocene)
Bouldery and hummocky landslide debris on south slope of Ash Peaks Ridge. Description from source map: Southwestern Sequoia National Park

Ql - Landslide deposits (Quaternary)
No further description provided. Description from source map: Tehipite Dome 15' Quadrangle

Qg - Glacial deposits, undifferentiated (Quaternary)

Qg - Glacial deposits (Pleistocene)
Crest of morainal ridges shown by dot pattern. Description from source map: Blackcap Mountain 15' Quadrangle

Qg - Glacial deposits, undifferentiated (Quaternary)
No further description provided. Description from source map: Tehipite Dome 15' Quadrangle

Qrp - Recess Peak Till (Quaternary)

Qrp - Recess Peak Till (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Mount Whitney 15' Quadrangle

Qrp - Recess Peak Till (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Triple Divide Peak 15' Quadrangle

Qrpm - Recess Peak and Matthes Tills, undivided (Holocene and late Pleistocene)

Small, non-vegetated tills with small, sharp moraine crests in cirques above ~10,000 feet elevation. Description from source map: Southwestern Sequoia National Park

Qdf - Debris-flow deposits (Holocene and Pleistocene)

Unsorted deposits composed primarily of angular clasts as much as 0.5 m in diameter and containing little matrix. Erosionally dissected to depths of 2 to 4 m. Present in northeast corner of quadrangle. Description from source map: Lone Pine 15' Quadrangle

Qlo - Older lake deposits (Holocene and Pleistocene)

Mostly light-tan silt and sand; includes some gravel deposits near paleoshorelines. Massive to well bedded. Well exposed along channel of Owens River. Some deflation basins in upper surface of unit are filled by playa deposits (not mapped). Maximum elevation about 3,760 ft (1,146 m) except west of Lone Pine Fault, where deposits have been uplifted. Could be as much as 2,500 m thick in structural depression between Owens Valley Fault Zone and Inyo-White Mountains Fault Zone. Probably includes deposits of late Tertiary age at depth. Description from source map: Lone Pine 15' Quadrangle

Qsg - Stream gravels (Quaternary)

No further description provided. Description from source map: Tehipite Dome 15' Quadrangle

Qtr - Mineral Spring Travertine Deposits (Quaternary)

No further description provided. Description from source map: Kern Peak 15' Quadrangle

Qgh - Alkali basalt, lava and cinders of Groundhog cone (Quaternary)

Alkali basalt lava and cinders of Groundhog cone. Postglacial basalt characterized by subaphanitic texture with dominant plagioclase phenocrysts (0.5-1.5 mm) and smaller olivine and clinopyroxene phenocrysts. Description from source map: Kern Peak 15' Quadrangle

Qgy - Younger alluvial and debris-flow gravels (Pleistocene)

Deposits of late Pleistocene age consisting of common to abundant, subangular to subrounded cobbles and boulders of plutonic rocks in a matrix of sand and fine gravel. Boulders 2 m or more in diameter are common; many clasts are porphyritic and contain mafic inclusions. Locally, deposits of two ages can be separated on basis of degree of weathering, decomposition, and iron-oxide staining of clasts. Dissected by Holocene streams. Description from source map: Lone Pine 15' Quadrangle

Qut - Undifferentiated till (Pleistocene)

Qtu - Undifferentiated till (Pleistocene)
Crest of moraines and other glacial ridges shown by dotted lines. Description from source map: Bishop District and Owens Valley

Qut - Undifferentiated till (Pleistocene)
Crest of moraines shown by dotted line. Description from source map: Marion Peak 15' Quadrangle

Qtu - Undifferentiated till (Pleistocene)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Qtiy - Tioga Till, deposits of younger advances (Pleistocene)

Deposits of younger advances delineated only along Bishop Creek. Crest of moraines shown by dotted lines. Description from source map: Mount Goddard 15' Quadrangle

Qti - Tioga Till (Pleistocene)

Qti - Tioga till (Pleistocene)
Crest of moraines and other glacial ridges shown by dotted lines. Description from source map: Bishop District and Owens Valley

Qti - Tioga Till (Quaternary)
Crest of moraines and other glacial ridges shown by dotted lines. Description from source map: Kern Peak 15' Quadrangle

Qti - Tioga Till (Pleistocene)
Crest of moraines shown by dotted line. Description from source map: Marion Peak 15' Quadrangle

Qti - Tioga Till (Pleistocene)
Crest of moraines shown by dotted line. Description from source map: Mount Goddard 15' Quadrangle

Qti - Tioga till (Pleistocene)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Qti - Tioga Till (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Mount Whitney 15' Quadrangle

Qti - Tioga Till (Pleistocene)
Innermost of large nested tills with well-defined moraine crests. Description from source map: Southwestern Sequoia National Park

Qti - Tioga Till (Quaternary)
Well-defined moraine morphology, largely unweathered boulders. Morainal crests shown by dotted line. Description from source map: Tehipite Dome 15' Quadrangle

Qti - Tioga Till (Quaternary)
Well-defined moraine morphology, largely unweathered boulders. Morainal crests shown by dotted line. Description from source map: Triple Divide Peak 15' Quadrangle

Qw - Tioga and Tahoe Tills, undivided (Pleistocene)

Qw - Tioga and Tahoe Tills, undivided (Quaternary)
Morainal morphology preserved. Morainal crests shown by dotted line. Description from source map: Giant Forest 15' Quadrangle

Qw - Tioga and Tahoe Tills, undifferentiated (Quaternary)
Morainal crests shown by dotted line. Description from source map: Kern Peak 15' Quadrangle

Qw - Tioga and Tahoe Tills, undivided (Pleistocene)
Tills generally with large, well-defined moraine crests. Description from source map: Southwestern Sequoia National Park

Qw - Tioga and Tahoe Tills, undivided (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Triple Divide Peak 15' Quadrangle

Qyb - Basalt flows and cinder cones (Pleistocene)

Qyb - Basalt flows and cinder cones (Pleistocene)
Probably of late Pleistocene age. Description from source map: Bishop District and Owens Valley

Qba - Olivine basalt west of Aberdeen (Pleistocene)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Qof - Older dissected alluvial fan and lakebed deposits (Pleistocene)

Older dissected alluvial fan and lakebed deposits. Description from source map: Bishop District and Owens Valley

Qbs - Olivine basalt of Sawmill Canyon (Pleistocene)

No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Qta - Tahoe Till (Quaternary)

Qta - Tahoe till (Pleistocene)
Crest of moraines and other glacial ridges shown by dotted lines. Description from source map: Bishop District and Owens Valley

Qta - Tahoe Till (Quaternary)
Crest of moraines and other glacial ridges shown by dotted lines. Description from source map: Kern Peak 15' Quadrangle

Qta - Taho Till (Pleistocene)
Crest of moraines shown by dotted line. Description from source map: Marion Peak 15' Quadrangle

Qta - Tahoe Till (Pleistocene)
Crest of moraines shown by dotted line. Description from source map: Mount Goddard 15' Quadrangle

Qta - Tahoe till (Pleistocene)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Qta - Tahoe Till (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Mount Whitney 15' Quadrangle

Qta - Tahoe Till (Quaternary)
Subdued moraine morphology, sandy, with weathered boulders. Morainal crest shown by dotted line. Description from source map: Tehipite Dome 15' Quadrangle

Qta - Tahoe Till (Quaternary)
Subdued glacial morphology, sandy, weathered boulders. Morainal crest shown by dotted line. Description from source map: Triple Divide Peak 15' Quadrangle

Qtao - Tahoe till, deposits of older advance (Pleistocene)

Deposits of older advance, delineated locally. Crest of moraines and other glacial ridges shown by dotted lines. Description from source map: Bishop District and Owens Valley

Qrbp - Rhyolite south of Big Pine (Pleistocene)

Qr - Rhyolite south of Big Pine (Pleistocene)
(Source symbol Qr) Stratigraphic position uncertain; may be of same age as Bishop Tuff. Description from source map: Bishop District and Owens Valley

Qob - Basalt dike and necks (Pleistocene)

Qob - Basalt dikes, necks, and dissected flows (Pleistocene)
May be of late Tertiary age. Description from source map: Bishop District and Owens Valley

Qob - Basalt necks (Pleistocene)
(North of Lake Sabrina) May be of late Tertiary age. Description from source map: Mount Goddard 15' Quadrangle

Qrd - Rhyodacite (Pleistocene)

(South boundary of quadrangle) May be of late Tertiary age. Description from source map: Mount Goddard 15' Quadrangle

Qsh - Sherwin and older tills (Pleistocene)

Qsh - Sherwin and older tills (Pleistocene)
Crest of probable morainal ridge shown by dotted lines. Description from source map: Bishop District and Owens Valley

Qsh - Sherwin and older tills (Pleistocene)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Qm - Glacial moraines (Pleistocene)

Qm - Glacial moraines (Pleistocene)
Massive, very poorly sorted, bouldery gravel deposits in Sierra Nevada. Includes both Tahoe and Tioga glacial till. Morainal crests shown by dotted line. Present in southwest corner of quadrangle. Description from source map: Lone Pine 15' Quadrangle

Qm - Glacial Moraine (Pleistocene)
Crests of morainal ridges shown by pattern. Description from source map: Olancha 15' Quadrangle

Qgo - Older alluvial and debris-flow gravels (Pleistocene)

Deposits of early to middle Pleistocene age consisting of rare cobbles and boulders of felsic plutonic rocks in a matrix of coarse sand and fine gravel that locally contains subhedral feldspar crystals 2 to 6 cm long. Horizontal exposures characterized by 0 to 10 percent boulders; vertical exposures show few undecomposed clasts. Most beds stained by iron oxides to colors ranging from grayish orange or deep reddish brown to greenish gray. Locally contains veins of calcium carbonate. In some areas, unit acts as an aquitard that forces ground water nearly to the surface, which supports thick stands of vegetation where windblown silt and fine sand (not mapped) have accumulated. Description from source map: Lone Pine 15' Quadrangle

Qrl - Rhyolite of Long Canyon (Pleistocene)

Porphyritic pumiceous rhyolite dome with associated pyroclastic flow lobes located at the head of Long Canyon and to the northeast. Bacon and Duffield (1979) reported a K-Ar age of 0.185±0.15 m.y. Description from source map: Olancha 15' Quadrangle

Qpta - Pre-Tahoe Till deposits (Quaternary)

Qpta - Pre-Tahoe Till deposits (Quaternary)
Morainal morphology subdued or absent; extensively weathered boulders. Morainal crest shown by dotted pattern. Description from source map: Giant Forest 15' Quadrangle

Qpta - Pre-Tahoe Till (Quaternary)
Morainal crest shown by dotted pattern. Description from source map: Kern Peak 15' Quadrangle

Qo - Older (pre-Tahoe) (Quaternary)
Morainal crest shown by dotted line. No further description provided. Description from source map: Mount Whitney 15' Quadrangle

Qpta - Pre-Tahoe Till deposits (Quaternary)
Glacial morphology highly subdued or absent; extensively weathered boulders. Morainal crest shown by dotted pattern. Description from source map: Triple Divide Peak 15' Quadrangle

Qsf - Alkali basalt, lava and cinders of Tunnel and South Fork cones (Quaternary)

Glaciated basalt characterized by porphyritic texture with plagioclase (1-3 mm) and olivine and clinopyroxene (1-2 mm) phenocrysts. K-Ar whole-rock age 176,000 ± 21,000 yr (M.A.Lanphere, written commun., 1982). Glacial erratics are common on lava flows. Description from source map: Kern Peak 15' Quadrangle

Qlw - Alkali basalt, lava and cinders of Little Whitney cone (Quaternary)

Extensively glaciated basalt characterized by prominent olivine phenocrysts (1-2 mm), and less common, smaller plagioclase and clinopyroxene phenocrysts. K-Ar whole-rock age 743,000 ± 11,000 yr (M.A. Lanphere, written commun., 1982). Description from source map: Kern Peak 15' Quadrangle

QTls - Landslide deposits (Quaternary or Tertiary)

Large, hummocky masses of unsorted rock debris interpreted to have been deposited as landslides; deeply dissected by modern streams. Mass at east-central edge of quadrangle is composed of monolithologic debris of fine-grained granite derived from the granite of French Spring (Dunne and Walker, 1993) exposed in the Inyo Mountains to the east. Largest mass near west edge of quadrangle composed of large boulders of plutonic rocks, many of which are gneissic or mafic. Age of slides uncertain, probably early Pleistocene or older. Arrows indicate inferred directions of debris movement. Description from source map: Lone Pine 15' Quadrangle

QTbo - Olivine basalt of Oak Creek (Quaternary or Tertiary)

Relation to earlier moraine questionable. Description from source map: Mount Pichot 15' Quadrangle

QTbd - Olivine basalt dikes of Division Creek (Quaternary or Tertiary)

No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Tb - Basalt (Pliocene)

Qb - Basalt (Pleistocene)
Some may be of late Tertiary age. Description from source map: Blackcap Mountain 15' Quadrangle

Tb - Basalt (Pliocene)
Alkalic olivine basalt lava and mud flow in the northwest corner of quadrangle. Probably an erosional remnant of basalt of Stony Flat west of the quadrangle. K-Ar age 3.4 Ma (Moore and Dodge, 1980). Description from source map: Giant Forest 15' Quadrangle

Tb - Basalt (Pliocene)
Many separate basalt flows and one near-vertical dike. Composition ranges from alkalic, potassic-alkalic, to ultra-potassic basalt (Moore and Dodge, 1980; Dodge and Moore, 1981). Description from source map: Tehipite Dome 15' Quadrangle

Trt - Rhyolite of Templeton Mountain (Pliocene)

Flow-banded and dense pumiceous rhyolite forming one large dome, Templeton Mountain, and a smaller dome adjacent on the northeast. Bacon and Duffield (1979) reported a K-Ar age of 2.4±0.3 m. y. Description from source map: Olancha 15' Quadrangle

Ttb - Trachybasalt (Tertiary)

Includes leucite phonolite south of Wildman Meadow. (*GRI Source Map ID 1911).* Description from source map: Marion Peak 15' Quadrangle

Td - Dacite (Tertiary)

Large mass of Windy Peak is largely intrusive volcanic complex. Other masses to south are flow remnants. Description from source map: Marion Peak 15' Quadrangle

Tdd - Dacite dikes (Tertiary)

Dikes of Tdd are shown by dark line. Description from source map: Marion Peak 15' Quadrangle

Kgp - Granite porphyry dikes and sills (Late Cretaceous)

Fine groundmass with phenocrysts of quartz and potassium feldspar. Numbers on Golden Bear dike [marked by Geologic Measurement Localities feature class] indicate width in meters. Shorter dike to south contains fragments of dark granitic rock. Sills on Mount Whitney are granite porphyry and aplite Description from source map: Mount Whitney 15' Quadrangle

Kmdqd - Mafic diorite and quartz diorite dikes (Cretaceous)

Kmd - Mafic diorite and quartz diorite dikes (Cretaceous)
Fine grained diorite dikes. Description from source map: Kern Peak 15' Quadrangle

Kmd - Mafic diorite and quartz diorite dikes (Late Cretaceous)
Remobilized mafic plutonic rock. Description from source map: Mount Whitney 15' Quadrangle

Kw - Mount Whitney Intrusive Suite, Whitney Granodiorite (Late Cretaceous)

Kw - Whitney Granodiorite (Cretaceous)
Porphyritic granodiorite and granite with large (4-8 cm) phenocrysts of potassium feldspar. U-Pb age 83 m.y. (Chen and Moore, 1982), average biotite K-Ar age 83 m.y. (Evernden and Kistler, 1970). Description from source map: Kern Peak 15' Quadrangle

Kw - Mount Whitney Intrusive Suite, Whitney Granodiorite (Late Cretaceous)
Porphyritic granodiorite and granite containing phenocrysts of potassium feldspar 4 to 8 cm long. Average biotite K-Ar age 83 Ma (Evernden and Kistler, 1970); Pb-U age 83 Ma (Chen and Moore, 1982). Contains an average of about 71 weight percent SiO2. Description from source map: Lone Pine 15' Quadrangle

Kw - Whitney Granodiorite (Late Cretaceous)
Porphyritic granodiorite and granite with large (4-8 cm) phenocrysts of potassium feldspar. Average biotite K-Ar age 83 m.y. Description from source map: Mount Whitney 15' Quadrangle

Kw - Whitney Granodiorite (Cretaceous)
Typically coarse-grained and strongly porphyritic granodiorite and granite. Biotite is the principal mafic

mineral, hornblende is minor. K-Ar ages range from 78.4 to 84 m.y. in four samples (Evernden and Kistler, 1970). Description from source map: Olancha 15' Quadrangle

Kwm - Granite of White Mountain (Late Cretaceous)

Kwm - Granite of White Mountain (Cretaceous)
Medium- to coarse-grained, coarsely porphyritic biotite granite with large (4-8 cm) phenocrysts of potassium feldspar. K-Ar biotite age 81 m.y. (R.M. Tosdal, written commun. 1982). Description from source map: Kern Peak 15' Quadrangle

Kwm - Granite of White Mountain (Late Cretaceous)
Medium-grained, coarsely porphyritic biotite granite with abundant, well-formed, potassium feldspar megacrysts (4-8 cm), and lacking mafic inclusions. U-Pb zircon age of 89.9±1.0 Ma. Description from source map: Southwestern Sequoia National Park

Kao - Alaskite of Olancha Peak (Cretaceous)

Fine- to coarse-grained equigranular alaskite containing less than two percent mafic minerals, principally biotite. Description from source map: Olancha 15' Quadrangle

Knd - Granodiorite of North Dome (Cretaceous)

Granodiorite with some granite, quartz diorite, and tonalite. Lighter colored in north-central part of unit. Description from source map: Marion Peak 15' Quadrangle

Kgd - Granitic dikes (Cretaceous)

Only large or conspicuous mapped. Description from source map: Mount Pichot 15' Quadrangle

Kcrp - Cartridge Pass pluton (Cretaceous)

Kcr - Granodiorite of Cartridge Pass (Cretaceous)
Concentrically zoned from quartz diorite in the margins to granodiorite in the interior. Description from source map: Bishop District and Owens Valley

Kcr - Cartridge Pass pluton (Cretaceous)
Granodiorite with slightly porphyritic granite in central part of unit (in adjacent Mt. Pinchot quadrangle). North east comer of quadrangle. Description from source map: Marion Peak 15' Quadrangle

Kcp - Granodiorite of Cartridge Pass (Cretaceous)
(Southeast corner of quadrangle). Description from source map: Mount Goddard 15' Quadrangle

Kcr - Cartridge Pass pluton (Cretaceous)
Dark granodiorite on margine and slightly porphyritic quartz monzonite in center. Description from source map: Mount Pichot 15' Quadrangle

Kcy - Granodiorite of Coyote Flat (Cretaceous)

Kcy - Granodiorite of Coyote Flat (Cretaceous)
No further description provided. Description from source map: Bishop District and Owens Valley

Kcy - Granodiorite of Coyote Flat (Cretaceous)
(Northeast corner of quadrangle). Description from source map: Mount Goddard 15' Quadrangle

Kfgqm - Fine-grained quartz monzonite of Mount Shakspere (Cretaceous)

No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kfm - Finer grained quartz monzonites (Cretaceous)

Kf - Finer grained quartz monzonites (Cretaceous)
No further description provided. Description from source map: Bishop District and Owens Valley

Kapa - Aplite, pegmatite, and alaskite (Cretaceous)

ap - Felsic dikes and masses (Cretaceous)
Chiefly aplite, pegmatite, and alaskite. Description from source map: Bishop District and Owens Valley

Kap - Aplite, pegmatite, and alaskite (Cretaceous)
Occurs as dikes and masses. Description from source map: Mount Goddard 15' Quadrangle

Kgdp - Granite of Dougherty Peak (Cretaceous)

Northern contact with White Divide pluton is indefinite because of zone of dikes and mixed rocks. Description from source map: Marion Peak 15' Quadrangle

Kmb - Granodiorite of Muro Blanco (Cretaceous)

Fine-grained granodiorite and granite. Description from source map: Marion Peak 15' Quadrangle

Kalc - Alaskite of Evolution Basin and/or LeConte Canyon (Cretaceous)

Kev - Alaskite of Evolution Basin (Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Klc - Alaskite of LeConte Canyon (Cretaceous)
Light-colored granite. Map list two units labeled Klc. Part of unit was assigned to Kevlc. Similar rocks where matched across quadrangle boundary. Description from source map: Marion Peak 15' Quadrangle

Kev - Alaskite of Evolution Basin and LeConte Canyon (Cretaceous)

No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kevq - Alaskite of Evolution Basin and LeConte Canyon, quartz vein (Cretaceous)

q - Alaskite of Evolution Basin and LeConte Canyon, quartz vein (Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kp - Mount Whitney Intrusive Suite, Paradise Granodiorite (Late Cretaceous)

Kp - Paradise Granodiorite (Cretaceous)
Porphyritic granodiorite and granite. Potassium feldspar phenocrysts (1-3 cm) are characterized by abundant. zonally arranged inclusions of biotite and hornblende. Biotite K-Ar age 78 m.y.; hornblende K-Ar age 84 m.y.(Evenden and KIstler, 1970); U-Pb ages 83-86 m.y. (Chen and Moore, 1982). Description from source map: Kern Peak 15' Quadrangle

Kp - Mount Whitney Intrusive Suite, Paradise Granodiorite (Late Cretaceous)
Porphyritic granodiorite and granite; contains potassium feldspar phenocrysts 1 to 3 cm long that are characterized by abundant, zonally arranged inclusions of biotite and hornblende. Biotite K-Ar age 78 Ma; hornblende K-Ar age 84 Ma (Evernden and Kistler, 1970). Pb-U ages 86 to 83 Ma (Chen and Moore, 1982). Contains an average of about 70 weight percent SiO2. Description from source map: Lone Pine 15' Quadrangle

Kp - Paradise Pluton (Cretaceous)
Porphyritic granodiorite with minor granite. Potassium feldspar phenocrysts are characterized by abundant, zonally arranged inclusions of biotite and hornblende. Description from source map: Marion Peak 15' Quadrangle

Kp - Paradise pluton (Cretaceous)
Porphyritic granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kp - Paradise Granodiorite (Late Cretaceous)
Porphyritic granodiorite and granite. Potassium-feldspar phenocrysts (1-3 cm) are characterized by abundant, zonally arranged inclusions of biotite and hornblende. Biotite K.-Ar age 78 m.y.; hornblende K-Ar age 84 m.y. (Evernden and Kistler, 1970). Pb-U age 86 m.y. (Chen, 1977). Description from source map: Mount Whitney 15' Quadrangle

Kp - Paradise Granodiorite (Cretaceous)
Together with the Whitney Granodiorite forms a composite intrusion. Porphyritic granodiorite with minor granite. Potassium-feldspar phenocrysts are characterized by abundant, zonally arranged inclusions of biotite and hornblende. Description from source map: Olancha 15' Quadrangle

Kp - Paradise Granodiorite (of Mount Whitney Intrusive Suite) (Cretaceous)
Porphyritic granodiorite and granite; potassium feldspar phenocrysts (1-3 cm) are characterized by abundant zonally arranged inclusions of biotite and hornblende. Biotite K-Ar age 78 Ma; hornblende K-Ar age 84 Ma.(Evernden.and Kistler, 1970). U-Pb ages 83-86 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kah - Alabama Hills Granite (Late Cretaceous)

Hypidiomorphic seriate to faintly porphyritic, medium-grained biotite monzogranite that locally contains equant, pale-pink phenocrysts of potassium feldspar as large as 1 cm. Outcrop color very pale orange to pinkish gray. Biotite K-Ar age 82 Ma (Evernden and Kistler, 1970); preferred Pb-U age 85 Ma (Chen and Moore, 1982) (Locality G–4). Description from source map: Lone Pine 15' Quadrangle

Knm - Granite of North Mountain (Cretaceous)

Heterogeneous fine-grained alaskite granite with admixed dark granitic rock. Description from source map: Marion Peak 15' Quadrangle

Kpb - Plutonic breccia of Timosea Peak (Cretaceous)

Complex intrusion including mafic plutonic rock, aplite, and granodiorite. All lithologies crosscut one another. Description from source map: Olancha 15' Quadrangle

Krr - Granodiorite of Redrock Meadow (Cretaceous)

Krr - Granite of Redrock Meadows (Cretaceous)
Coarse-grained biotite granite grading to hornblende granodiorite. Description from source map: Kern Peak 15' Quadrangle

Krr - Granodiorite of Redrock Meadow (Cretaceous)
Medium-grained light-colored granodiorite, locally porphyritic. Unmapped blocks of various sizes are contained within the alaskite of Kern Peak. Description from source map: Olancha 15' Quadrangle

Kgs - Granodiorite of Sugarloaf (of Mount Whitney Intrusive Suite) (Cretaceous)

Ks - Granodiorite of Sugarloaf (Cretaceous)
Dark granodiorite. Description from source map: Marion Peak 15' Quadrangle

Ks - Granodiorite of Sugarloaf (Late Cretaceous)
Dark granodiorite. Description from source map: Mount Whitney 15' Quadrangle

Ks - Granodiorite of Sugarloaf (of Mount Whitney Intrusive Suite) (Cretaceous)
Dark granodiorite with prominent euhedral hornblende. U-Pb age <88 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kbk - Porphyry of Black Kaweah (Cretaceous)

Flow-banded dikes and stocks of very fine grained plagioclase porphyry containing trace phenocrysts of hornblende and biotite. Description from source map: Triple Divide Peak 15' Quadrangle

Kgc - Granodiorite of Chagoopa (Late Cretaceous)

Kc - Granodiorite of Chagoopa (Cretaceous)
Chiefly granodiorite zoned from a marginal tonalite through an equal granular biotite granodiorite that is in sharply gradational contact with a younger(?) and inner granodiorite and granite containing small potassium feldspar phenocrysts (dotted). Description from source map: Kern Peak 15' Quadrangle

Kc - Granodiorite of Chagoopa (Late Cretaceous)
Includes fine-grained granodiorite and older porphyritic granite (dotted). Fine-grained granodiorite sill 12~240 m thick of Kaweah Peaks is
tentatively included. Description from source map: Mount Whitney 15' Quadrangle

Kc - Granodiorite of Chagoopa (Late Cretaceous)
Fine- to medium-grained hornblende-biotite granodiorite with indistinct plagioclase phenocrysts. U-Pb zircon age of 91.5±0.7 Ma. Description from source map: Southwestern Sequoia National Park

Kc - Granodiorite of Chagoopa (Cretaceous)
Fine-grained granodiorite locally containing small (1-2 cm) plagioclase phenocrysts. Forms large dikes and sills in rocks of the Kaweah Peaks Ridge. Description from source map: Triple Divide Peak 15' Quadrangle

Kmf - Mitchell Peak Granodiorite (of Mitchell Intrusive Suite) fine-grained facies (Cretaceous)

Km - Granodiorite of Mitchell Peak, fine-grained porphyritic granodiorite and quartz monzodiorite (Cretaceous)
Dark fine-grained porphyritic granodiorite and quartz monzonite. Description from source map: Marion Peak 15' Quadrangle

Km - Granodiorite of Mitchell Peak (Late Cretaceous)
Dark fine-grained porphyritic granodiorite. Pb-U age 91 m.y. (Chen, 1977). Description from source map: Mount Whitney 15' Quadrangle

Kmf - Mitchell Peak Granodiorite (of Mitchell Intrusive Suite) fine-grained facies (Cretaceous)
Fine-grained, porphyritic granodiorite containing abundant mafic inclusions. Phenocrysts include potassium feldspar, hornblende, biotite,and plagioclase. U-Pb age 91 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kmpg - Mitchell Peak Granodiorite (of Mitchell Intrusive Suite) coarse-grained facies (Cretaceous)

Km - Granodiorite of Mitchell Peak, coarse porphyritic facies (Cretaceous)
Coarse porphyritic facies on west margin shown by dotted pattern. Description from source map: Marion Peak 15' Quadrangle

Kmc - Mitchell Peak Granodiorite (of Mitchell Intrusive Suite) coarse-grained facies (Cretaceous)
Coarse-grained, porphyritic granodiorite containing phenocrysts of potassium feldspar and plagioclase. Found as marginal facies and as blocks within fine-grained facies of Mitchell Peak Granodiorite (Kmf). Description from source map: Triple Divide Peak 15' Quadrangle

Ka - Arrow pluton (Cretaceous)

Ka - Arrow pluton (Cretaceous)
Granodiorite and some granite. Description from source map: Marion Peak 15' Quadrangle

Ka - Arrow pluton (Cretaceous)
Granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kpy - Pyramid pluton (Cretaceous)

Kpy - Pyramid pluton (Cretaceous)
Dark granodiorite with some granite, quartz monzodiorite, and quartz diorite. Hachured lines are comb layering, teeth in direction of growth. Description from source map: Marion Peak 15' Quadrangle

Kpy - Pyramid pluton (Cretaceous)
Dark granodiorite. Divided into east and west masses. Description from source map: Mount Pichot 15' Quadrangle

Ksp - Spook pluton (Cretaceous)

Ksp - Spook pluton (Cretaceous)
Granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kglp - Granodiorite of Lookout Peak (of Mitchell Intrusive Suite) (Cretaceous)

Klp - Granodiorite of Lookout Peak (Cretaceous)
Coarse porphyritic granodiorite with some granite, quartz monzodiorite, and tonalite. Description from source map: Marion Peak 15' Quadrangle

Klp - Granodiorite of Lookout Peak (of Mitchell Intrusive Suite) (Cretaceous)
Coarse-grained, potassium feldspar porphyritic granite and granodiorite; tentatively correlated with coarse-grained facies of Mitchell Peak Granodiorite (Kmc). Crops out on north margin of map. U-Pb age 97 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kwd - Granodiorite of White Divide (Cretaceous)

Porphyritic granodiorite and granite. Description from source map: Marion Peak 15' Quadrangle

Kmd - McDoogle pluton (Cretaceous)

Dark granodiorite. Description from source map: Mount Pichot 15' Quadrangle

Kgcc - Granodiorite of Castle Creek (of Mitchell Intrusive Suite [Moore and Sisson, 1987]) (Late Cretaceous)

Kcc - Granodiorite of Castle Creek (of Mitchell Intrusive Suite [Moore and Sisson, 1987]) (Late Cretaceous)
Medium-grained hornblende-biotite granodiorite that has prominent grains of hornblende and titanite (sphene); locally contains indistinct plagioclase phenocrysts. Includes domains zoned to light-colored granodiorite. U-Pb zircon ages of 98+- 2 Ma (Busby-Spera, 1983), 97.8 ± 0.7, and 98.4 ± 1.3 Ma (this study) Description from source map: Southwestern Sequoia National Park

Kcc - Granodiorite of Castle Creek (of Mitchell Intrusive Suite) (Cretaceous)
Medium-grained, equigranular, hornblende-rich granodiorite, containing wispy schlieren layering at higher elevations. Marginal to coarse- and fine-grained facies of Mitchell Peak Granodiorite. U-Pb age 98±2 Ma (Busby-Spera, 1983), K-Ar age 91.1 Ma (Evernden and Kistler, 1970). Description from source map: Triple Divide Peak 15' Quadrangle

Kcciz - Injection zone along margin of the Granodiorite of Castle Creek (of Mitchell Intrusive Suite [Moore and Sisson, 1987]) (Late Cretaceous)

Steeply dipping sheets of fine-grained granodiorite, 1-3 m thick, closely interleaved with metamorphic rocks along eastern contact of granodiorite of Castle Creek (Kcc). Description from source map: Southwestern Sequoia National Park

Kap - Aplite (Late Cretaceous)

Kap - Aplite and felsic quartz monzonite (Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Kap - Aplite dikes and sills (Cretaceous)
Fine-grained, locally pegmatitic granite cutting all plutons in the quadrangle but especially common in parts of the Whitney Granodiorite Description from source map: Olancha 15' Quadrangle

Kap - Aplite (Late Cretaceous)
Fine-grained, very light colored aplitic granite with conspicuous blue-black tourmaline that intruded between the granodiorite of Castle Creek (Kcc) and the Mineral King pendant; lack of deformation and mafic dikes indicate late Cretaceous age. Also aplite dike swarm that intruded metavolcanic roof rocks of the granodiorite of Spring Lake (Ksl). Description from source map: Southwestern Sequoia National Park

Kap - Aplite (Cretaceous)
Mappable bodies of aplite concentrated along the margins of the granodiorite of Castle Creek, and as blocks within and dikes cutting the granodiorite of Mitchell Peak. Description from source map: Triple Divide Peak 15' Quadrangle

Krsc - Rocks similar to Cathedral Peak Granite (Cretaceous)

Kc - Rocks similar to Cathedral Peak Granite (Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kcqm - Rocks similar to the Cathedral Peak granite, quartz monzonite (Cretaceous)

Kc - Rocks similar to the Cathedral Peak granite, quartz monzonite (Cretaceous)
No further description provided. Description from source map: Bishop District and Owens Valley

Kca - Rocks similar to the Cathedral Peak granite, alaskite (Cretaceous)

No further description provided. Description from source map: Bishop District and Owens Valley

Kth - Tungsten Hills Quartz Monzonite (Cretaceous)

Kt - Tungsten Hills quartz monzonite (Cretaceous)
No further description provided. Description from source map: Bishop District and Owens Valley

Kt - Tungsten Hills Quartz Monzonite (Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Kt - Tungsten Hills Quartz Monzonite (Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Ktha - Tungsten Hills Quartz Monzonite, albitized rock (Cretaceous)

Kta - Tungsten Hills Quartz Monzonite, albitized rock (Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kgmh - Granodiorite of Mountain Home (Late Cretaceous)

Kmh - Granodiorite of Mountain Home (Late Cretaceous)
Medium-grained hornblende-biotite granodiorite near southwest corner of map area. U-Pb zircon age of 98.8 ± 0.9 Ma. Description from source map: Southwestern Sequoia National Park

Kmm - Granite of Maggie Mountain (Late Cretaceous)

(Source symbol Kmm) Coarse-grained, very light colored biotite granite, lacking mafic inclusions. U-Pb zircon age of 98.8±0.7 Ma. Description from source map: Southwestern Sequoia National Park

Kym - Younger mafic plutonic rocks (Cretaceous)

(Source symbol Km) Quartz diorite, diorite, and hornblende gabbro. Includes mafic hybrid rocks of granodiorite composition. Description from source map: Kern Peak 15' Quadrangle

Klw - Granodiorite of Little Whitney Meadow (Cretaceous)

Fine-grained biotite granodiorite with small, light-colored mafic inclusions and abundant aplite sills. Description from source map: Kern Peak 15' Quadrangle

Kac - Alaskite marginal to granodiorite of Chagoopa (Cretaceous)

Medium-grained alaskite bordering the southern and southeastern margins of the granodiorite of Chagoopa. Description from source map: Kern Peak 15' Quadrangle

Kmcp - Diorite associated with granite of Coyote Pass (Late Cretaceous)

Kmcp - Mafic diorite associated with granite of Coyote Pass (Cretaceous)
Fine-grained diorite stocks intrusive into the granite of Coyote Pass. Polycrystalline quartz xenocrysts rimmed with hornblende and sparse skeletal plagioclase phenocrysts are characteristic. Description from source map: Kern Peak 15' Quadrangle

Kmcp - Diorite associated with granite of Coyote Pass (Late Cretaceous)
Fine- and medium-grained hornblende diorite and quartz diorite intrusive into granite of Coyote Pass (Kcp); commonly includes angular granite blocks. Description from source map: Southwestern Sequoia National Park

JTRmm - Mafic metavolcanic rocks (Jurassic and (or) Triassic)
Weakly schistose metabasalt and (or) mafic meta-andesite flows, breccias, and shallow intrusives. Part of unit was assigned to Kmcp. Similar rocks where matched across quadrangle boundary. Description from source map: Triple Divide Peak 15' Quadrangle

Kgbc - Granodiorite of Brush Canyon (Cretaceous)

Porphyritic granodiorite and granite averaging about 6 percent mafic minerals and containing potassium-feldspar phenocrysts (1-2 cm) enclosed in a medium- to fine-grained ground mass. U-Pb age, 86 Ma (Chen and Moore, 1982). Description from source map: Tehipite Dome 15' Quadrangle

Kdm - Granite of Deer Meadow Grove (Cretaceous)

Chiefly medium grained biotite-hornblende granite. Forms small pluton in southeastern part of quadrangle. Averages 5-7 percent dark minerals. Description from source map: Tehipite Dome 15' Quadrangle

Kmc - Granodiorite of McKinley Grove (Cretaceous)

Medium-grained granodiorite containing perthite phenocrysts and about 10 percent mafic minerals. Description from source map: Tehipite Dome 15' Quadrangle

Khm - Granite of Mount Hoffman (Cretaceous)

Medium-grained equigranular granite averaging about 5% dark minerals. Description from source map: Tehipite Dome 15' Quadrangle

Kmgg - Mount Givens Granodiorite (Bateman, in press) (Cretaceous)

Kmg - Mount Givens Granodiorite (Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Kmg - Mount Givens Granodiorite (Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kmg - Mount Givens Granodiorite (Bateman, in press) (Cretaceous)
Medium-grained granodiorite grading locally to granite. Averages about 12 percent mafic minerals. K-Ar hornblende age, 88-89 Ma; U-Pb age, 88-93 Ma (Stern and others, 1981). Description from source map: Tehipite Dome 15' Quadrangle

Kmgq - Mount Givens Granodiorite, quartz mass (Cretaceous)

q - Mount Givens Granodiorite, quartz mass (Cretaceous)
quartz mass inclosed in Kmgi. Description from source map: Blackcap Mountain 15' Quadrangle

Kbx - Baxter pluton (Cretaceous)

Dark fine-grained granodiorite and quartz diorite. Description from source map: Mount Pichot 15' Quadrangle

Kl - Lamarck Granodiorite (Cretaceous)

Kl - Lamarck granodiorite (Cretaceous)
No further description provided. Description from source map: Bishop District and Owens Valley

Kl - Lamarck Granodiorite (Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Kl - Lamarck Granodiorite (Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kl - Lamarck granodiorite (Cretaceous)
Divided into the main Lamarck mass and the smaller Colosseum mass. Slightly porphyritic granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Ks - Siberian pluton (Cretaceous)

Uniform quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Ksa - Sardine pluton (Cretaceous)

Uniform alaskitic quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Ksav - Sardine pluton, related dikes (Cretaceous)

Related mineralized veins are shown by beaded line. Description from source map: Mount Pichot 15' Quadrangle

Kst - Striped pluton (Cretaceous)

Dark fine-grained granodiorite. Description from source map: Mount Pichot 15' Quadrangle

Kc - Cotter pluton (Cretaceous)

Dark fine-grained granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kg - Goodale pluton (Cretaceous)

Quartz poor quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kmdl - Mafic dikes and lenses (Cretaceous)

none - Mafic dikes (Cretaceous)
Pre-Cathedral Peak; precise age uncertain. Description from source map: Bishop District and Owens Valley

none - Mafic dikes and lenses (Cretaceous)
Dikes in Goddard pendant are probably older than the Lamarck and Mount Givens Granodiorites. Dikes in Lamarck Granodiorite are older than Tungsten Hills Quartz Monzonite. Only dikes enclosed in felsic rock and visible on aerial photographs are shown. Mafic dikes are also present in north end of pendant parallel to felsic dikes, which are generally older. Some dike-like mafic bodies in alaskite appear to be inclusions. Description from source map: Blackcap Mountain 15' Quadrangle

d - Mafic dikes (Cretaceous)
Dikes in sheared granite of Goddard pendant are probably older than Lamarck Granodiorite: dikes in Lamarck are older than Tungsten Hills Quartz Monzonite; still younger dikes intrude the alaskite of Evolution Basin and LeConte Canyon. Description from source map: Mount Goddard 15' Quadrangle

Kkd - Granite of Kettle Dome (Cretaceous)

Kk - Granite of Kettle Dome (Cretaceous)
Chiefly medium grained biotite-hornblende granite. Forms small pluton in southeastern part of quadrangle. Averages 5-7 percent dark minerals. Description from source map: Tehipite Dome 15' Quadrangle

Kgtd - Granodiorite of Tehipite Dome (Cretaceous)

Kt - Granite of Tehipite Dome (Cretaceous)
Granite and granodiorite. Description from source map: Marion Peak 15' Quadrangle

Ktd - Granodiorite of Tehipite Dome (Cretaceous)
Medium-grained granite and granodiorite averaging about 11 percent dark minerals. Description from source map: Tehipite Dome 15' Quadrangle

Klp - Mount Whitney Intrusive Suite, Granodiorite of Lone Pine Creek (Late Cretaceous)

Klp - Mount Whitney Intrusive Suite, Granodiorite of Lone Pine Creek (Late Cretaceous)
Dark granodiorite containing abundant mafic inclusions. Pb-U age 87 Ma (Chen and Moore, 1982). Contains an average of about 64 weight percent SiO2. Description from source map: Lone Pine 15' Quadrangle

Klp - Granodiorite of Lone Pine Creek (Late Cretaceous)
Dark granodiorite with abundant mafic inclusions. Description from source map: Mount Whitney 15' Quadrangle

Kk - Kern Knob Granite (Late Cretaceous)

Leucocratic, medium-grained biotite monzogranite having a hypidiomorphic inequigranular texture. Sparse varietal minerals include biotite, muscovite, fluorite, hematite, and garnet. Contains locally abundant, northwest-striking aplite dikes and pegmatite lenses and dikes that consist primarily of microcline and quartz, with less abundant amazonite. Biotite 40Ar/39Ar plateau age 91 Ma (Griffis and others, 1986). Exposed only at Kern Knob, which is at western base of Inyo Mountains and lies mostly east of quadrangle. Description from source map: Lone Pine 15' Quadrangle

Ksmd - Synplutonic mafic diorite intrusions (Cretaceous)

Km - Synplutonic mafic diorite intrusions (Cretaceous)
Fine-grained, plagioclase porphyritic, biotite-rich diorite, non-porphyritic appinitic diorite, and oikocrystic hornblende gabbro stocks and dikes associated with the granites of Tamarack Lake, Coyote Pass, Triple Divide Peak, Weaver Lake, and Big Meadows and the granodiorites of Chagoopa and Mitchell Peak. Description from source map: Triple Divide Peak 15' Quadrangle

Kgtl - Granite of Tamarack Lake (Cretaceous)

Ktl - Granite of Tamarack Lake (Cretaceous)
Medium- and fine-grained equigranular alaskitic granite associated with younger diorite and gabbro dikes and stocks. Description from source map: Triple Divide Peak 15' Quadrangle

Kes - Granite of Eagle Scout Peak (Cretaceous)

Medium-grained, equigranular to moderately porphyritic granite; potassium feldspar phenocrysts 1-3 cm. Description from source map: Triple Divide Peak 15' Quadrangle

Ktd - Granite of Triple Divide Pass (Cretaceous)

Medium-grained equigranular alaskitic granite containing sparse mafic dikes. Possibly correlative with granite of Coyote Pass. Description from source map: Triple Divide Peak 15' Quadrangle

Kgcp - Granite of Coyote Pass (Cretaceous)

Kcp - Granite of Coyote Pass (Cretaceous)
Equigranular biotite-hornblende and porphyritic (dotted) biotite granite and alaskite. Mafic inclusions and igneous layering define a synformal structure paralleling the zonation of the pluton. Cut by numerous diorite stocks. Average of 6 K-Ar biotite and hornblende ages: 92 m.y. (Evernden and Kistler, 1970); U-Pb age: 97 ± 2 m.y. (Cathy Busby-Spera, written commun., 1982). Description from source map: Kern Peak 15' Quadrangle

Kcp - Granite of Coyote Pass (Cretaceous)
Medium-grained, equigranular alaskitic granite. Mafic inclusions increase in abundance southward. U-Pb age 97±2 Ma (Busby-Spera, 1983). Description from source map: Triple Divide Peak 15' Quadrangle

Klkc - Granite of Little Kern Lake Creek (Cretaceous)

Porphyritic biotite granite and granodiorite, and granodiorite porphyry. Strongly foliated near the Coyote Peaks fault, elsewhere largely undeformed. Cut by two mafic dikes, but truncates dikes of Independence dike swarm. Description from source map: Kern Peak 15' Quadrangle

Kkp - Granite of Kern Peak (Cretaceous)

Coarse-grained equigranular unfoliated biotite granite. Description from source map: Kern Peak 15' Quadrangle

Klc - Granodiorite of Lightning Creek (Cretaceous)

Klc - Granodiorite of Lightning Creek (Cretaceous)
Medium-grained, dark granodiorite, locally with abundant pyroxene; located in northeast corner of the quadrangle. U-Pb age 100 Ma (Saleeby and others, 1990). Averages about 19 percent dark minerals. Description from source map: Giant Forest 15' Quadrangle

Klc - Granodiorite of Lightning Creek (Cretaceous)
Dark granodiorite. Southwest corner of quadrangle. Map has two units labeled Klc. This unit labeled Klc is assigned to the Granodiorite of Lookout Peak because of the close association with similar units in adjacent quadrangles. Description from source map: Marion Peak 15' Quadrangle

Klc - Granodiorite of Lightning Creek (Cretaceous)

Medium-grained, dark granodiorite in southeast corner of the quadrangle. U·Pb age, 108 Ma (Chen and Moore, 1982), 100 Ma (Saleeby and others, 1990). Averages about 19 percent dark minerals. Description from source map: Tehipite Dome 15' Quadrangle

Klc - Granodiorite of Lightning Creek (Cretaceous)
Medium-grained, dark granodiorite in northwest corner of the quadrangle. U-Pb age 99 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kmk - Granite of Mount Kaweah (Cretaceous)

Kmk - Granodiorite of Mankins Flat (Cretaceous)
(source symbol Kmk) Medium- and fine-grained, equigranular biotite granodiorite, locally sheared; located in southwest corner of quadrangle. Description from source map: Giant Forest 15' Quadrangle

Kk - Granite of Mount Kaweah (Early Cretaceous)
Fine-grained granite commonly containing pyrite. Description from source map: Mount Whitney 15' Quadrangle

Kmk - Granite of Mount Kaweah (Cretaceous)
Light colored rock. Fine-grained granite commonly containing pyrite. Description from source map: Triple Divide Peak 15' Quadrangle

Kwl - Granite of Weaver Lake (of Sequoia Intrusive Suite) (Cretaceous)

Kwl - Granite of Weaver Lake (of Sequoia Intrusive Suite) (Cretaceous)
Very light colored and fine grained potassium feldspar porphyritic granite commonly containing small, round, mafic inclusions. Forms dikes and sills intrusive into Giant Forest granodiorite (Kgf), granodiorite of Clover Creek (Kcl), and granite of Big Meadows (Kbm). Includes equigranular alaskite dikes. Rocks composing part of this unit were called Weaver Lake Quartz Monzonite by Ross (1958). U-Pb age 97-99 Ma (Chen and Moore, 1982. Description from source map: Giant Forest 15' Quadrangle

Kwl - Granite of Weaver Lake (of Sequoia Intrusive Suite) (Cretaceous)
Very light colored and fine-grained, potassium feldspar porphyritic granite dikes and sills intrusive into the Giant Forest Granodiorite, granodiorite of Clover Creek, and the granite of Big Meadows. Kwl mapped where more than 50 percent of area is underlain by dikes of granite of Weaver Lake. Includes equigranular alaskite dikes. Part of unit called Weaver Lake Quartz Monzonite by Ross (1958). U-Pb age 97-99 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kcr - Granite of Chimney Rock (of Sequoia Intrusive Suite) (Cretaceous)

Very light colored and fine grained granite, locally containing potassium feldspar phenocrysts. Strongly resembles and is tentatively correlated with granite of Weaver Lake (Kwl). Description from source map: Giant Forest 15' Quadrangle

Kcl - Granodiorite of Clover Creek (of Sequoia Intrusive Suite) (Cretaceous)

Kcl - Granodiorite of Clover Creek (of Sequoia Intrusive Suite) (Cretaceous)
Fine-grained dark granodiorite containing phenocrysts of plagioclase and potassium feldspar. Part of

unit called Clover Creek Granodiorite by Ross (1958). Description from source map: Giant Forest 15' Quadrangle

Kcl - Granodiorite of Clover Creek (of Sequoia Intrusive Suite) (Cretaceous)
Medium-colored rock. Fine-grained porphyritic granodiorite containing phenocrysts of potassium feldspar and plagioclase. Locally contains abundant mafic inclusions and quartz xenocrysts rimmed with amphibole. Parts of unit called Clover Creek Granodiorite by Ross (1958). Description from source map: Triple Divide Peak 15' Quadrangle

Kbm - Granite of Big Meadows (of Sequoia Intrusive Suite) (Cretaceous)

Kbm - Granite of Big Meadows (of Sequoia Intrusive Suite) (Cretaceous)
Mostly medium grained, equigranular biotite granite, locally containing small (1-2 cm) potassium feldspar phenocrysts. U-Pb age 98 Ma (Chen and Moore, 1982). Description from source map: Giant Forest 15' Quadrangle

Kbm - Granite of Big Meadows (of Sequoia Intrusive Suite) (Cretaceous)
Medium-colored rock. Mostly medium-grained, equigranular biotite granite, locally containing small (1-2 cm) potassium feldspar phenocrysts. U-Pb age 98 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kgf - Giant Forest Granodiorite (of Sequoia Intrusive Suite) (Cretaceous)

Kgf - Giant Forest Granodiorite (of Sequoia Intrusive Suite) (Cretaceous)
Medium-grained, equigranular, hornblende-rich granodiorite with abundant mafic inclusions. Contains about 17 percent dark minerals. Mafic inclusions are variable in size, shape, and texture. U-Pb age 97¬102 Ma (Chen and Moore, 1982). Description from source map: Giant Forest 15' Quadrangle

Kgf - Giant Forest Granodiorite (Cretaceous)
Medium-grained equigranular, hornblende-rich granodiorite with abundant mafic inclusions. Contains about 17 percent mafic minerals. Mafic inclusions are variable in size, shape, and texture. U-Pb age, 97-102 Ma (Chen and Moore, 1982). Description from source map: Tehipite Dome 15' Quadrangle

Kgf - Giant Forest Granodiorite (of Sequoia Intrusive Suite) (Cretaceous)
Medium-grained, equigranular, hornblende-rich granodiorite with abundant mafic inclusions. Mafic inclusions are notably variable in size, shape, and texture. U-Pb age 97-102 Ma (Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

Kgfdc - Dome Creek facies of the Giant Forest Granodiorite (of Sequoia Intrusive Suite [Moore and Sisson, 1987]) (Early Cretaceous)

Kgfdc - Dome Creek facies of the Giant Forest Granodiorite (of Sequoia Intrusive Suite [Moore and Sisson, 1987]) (Early Cretaceous)
Medium-grained, weakly gneissic granodiorite and granite. Interpreted as southward narrowing extension of Giant Forest Granodiorite north of map area. Description from source map: Southwestern Sequoia National Park

KJdc - Granite of Dome Creek (Cretaceous or Jurassic)
Fine- and medium-grained, locally porphyritic granite; weakly gneissic. Unit assigned to Kgfdc according to T. Sisson (2012 personal comm.). Description from source map: Triple Divide Peak 15' Quadrangle

Kkl - Granite of Kennedy lakes (Cretaceous)

Kk - Granite of Kennedy Lakes (Cretaceous)
Heterogeneous light-colored granite with admixed darker granitic rocks. Description from source map: Marion Peak 15' Quadrangle

Kkl - Granite of Kennedy lakes (Cretaceous)
Generally coarse grained, heterogeneous, light colored granite with admixed darker granitic rocks. Coarse-grained rock produces crags and spires. Description from source map: Tehipite Dome 15' Quadrangle

Ktc - Granodiorite of Tombstone Creek (Cretaceous)

Medium-grained dark granodiorite containing about 19 percent mafic minerals. U-Pb age, 99 Ma (Chen and Moore, 1982); 102 Ma (J. B. Saleeby, and others, 1990). Description from source map: Tehipite Dome 15' Quadrangle

Kgtul - Granite of Tunemah Lake (Cretaceous)

KJtl - Quartz monzonite of Tunemah Lake (Jurassic or Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

KJtl - Granite of Tunemah Lake (Jurassic or Cretaceous)
Light-colored granite and granodiorite. Description from source map: Marion Peak 15' Quadrangle

KJtl - Quartz monzonite of Tunemah Lake (Jurassic or Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Ktl - Granite of Tunemah Lake (Cretaceous)
Somewhat sheared light-colored granite and granodiorite containing about 7 percent dark minerals. Description from source map: Tehipite Dome 15' Quadrangle

Kgfp - Granite of Finer Peak (Cretaceous or Jurassic)

KJfp - Granite of Finer Peak (Jurassic or Cretaceous)
Granite and granodiorite. Northwest corner of quadrangle. Description from source map: Marion Peak 15' Quadrangle

Kgac - Granite of Alpine Creek (Cretaceous)

KJa - Granite of Alpine Creek (Jurassic or Cretaceous)
Fine- to medium-grained granite. Description from source map: Marion Peak 15' Quadrangle

Ka - Granite of Alpine Creek (Cretaceous)
Fine- to medium-grained biotite granite containing about 3 percent mafic minerals. Description from source map: Tehipite Dome 15' Quadrangle

Kubc - Granodiorite of upper Blue Canyon (Cretaceous or Jurassic)

KJbc - Granodiorite of upper Blue Canyon (Jurassic or Cretaceous)
Medium-grained granodiorite. Description from source map: Marion Peak 15' Quadrangle

KJbc - Granodiorite of upper Blue Canyon (Jurassic or Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

KJlprc - Lineated quartz monzonite of Lost Peak and Round Corral Meadow (Cretaceous or Jurassic)

KJlp - Lineated quartz monzonite of Lost Peak and Round Corral Meadow (Jurassic or Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

KJfp - Felsic quartz monzonite of Finger Peak (Cretaceous or Jurassic)

KJfp - Felsic quartz monzonite of Finger Peak (Jurassic or Cretaceous)
No further unit description given. Description from source map: Blackcap Mountain 15' Quadrangle

KJfp - Felsic quartz monzonite of Finger Peak (Jurassic or Cretaceous)
No further unit description given. Description from source map: Mount Goddard 15' Quadrangle

KJga - Alaskite (Cretaceous or Jurassic)

KJga - Alaskite (Jurassic or Cretaceous)
Rocks of the Goddard Pendant (Locally Sheared). No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Kdcg - Dinkey Creek Granodiorite (Bateman, in press) (Cretaceous)

KJdc - Granodiorite of Dinkey Creek type (Jurassic or Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

Kdc - Dinkey Creek Granodiorite (Bateman, in press) (Cretaceous)
Medium-grained dark granodiorite, generally strongly foliated with abundant mafic inclusions, averaging about 18 percent mafic minerals. K-Ar hornblende ages. 80-101 Ma; U·Pb agtl, 104 Ma (Stern and others, 1981). Description from source map: Tehipite Dome 15' Quadrangle

KJmr - Granodiorite of Mount Reinstein (Cretaceous or Jurassic)

KJmr - Granodiorite of Mount Reinstein (Jurassic or Cretaceous)
No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

KJmr - Granodiorite of Mount Reinstein (Jurassic or Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kgmm - Granodiorite of McMurry Meadows (Cretaceous)

Km - Granodiorite of McMurry Meadows (Cretaceous)
Concentrically zoned from quartz diorite in the margins to quartz monzonite in the interior. Post publication age of Middle Jurassic by Bateman (1992) of 171+/-2 Ma. Description from source map: Bishop District and Owens Valley

KJi - Inconsolable Granodiorite (Cretaceous or Jurassic)

Kin - Inconsolable granodiorite (Cretaceous)
No further description provided. Description from source map: Bishop District and Owens Valley

KJi - Inconsolable Granodiorite (Jurassic or Cretaceous)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Kga - Garnet-bearing aplite-pegmatite dikes (Cretaceous)

Subhorizontal, garnet-bearing, felsic dikes probably derived from residual melts during the solidification of the granodiorite of Spring Creek (unit Ksc). Rb-Sr age, 98 Ma, R. W. Kistler, written commun., 1988. Hachures on uphill side of line symbol. Description from source map: Tehipite Dome 15' Quadrangle

Ksc - Granodiorite of Spring Creek (Cretaceous)

Heterogeneous dark-colored granodiorite with irregular inclusions of mafic rock and abundant felsic dikes. Description from source map: Tehipite Dome 15' Quadrangle

Kggd - Granite of Grand Dike (Cretaceous)

KJgd - Granite of Grand Dike (Jurassic or Cretaceous)
Sheared granite. Description from source map: Marion Peak 15' Quadrangle

Kgd - Granite of Grand Dike (Cretaceous)
Sheared and gneissic granite commonly coarse grained and resistant. U-Pb age, 103 Ma (J. B. Saleeby and others, 1990). Description from source map: Tehipite Dome 15' Quadrangle

Kcpgd - Granodiorite dikes associated with the granite of Coyote Pass (Early Cretaceous)

Fine-grained, medium- and light-colored granodiorite dikes associated with diorite intrusions into granite of Coyote Pass. Interpreted to be diorite-granite hybrids. Description from source map: Southwestern Sequoia National Park

Kcpp - Porphyritic core facies of the granite of Coyote Pass (Early Cretaceous)

Coarse-grained biotite granite with indistinct potassium-feldspar phenocrysts and lacking mafic inclusions. Forms a central domain within the equigranular facies of the granite of Coyote Pass. Contacts with the surrounding equigranular facies are both gradational and as sills and dikes, hence is younger. Foliation and layering in the equigranular facies dips beneath the porphyritic core facies. U-Pb zircon age of 100.3±0.6 Ma. Description from source map: Southwestern Sequoia National Park

Kcp - Equigranular facies of the granite of Coyote Pass (Early Cretaceous)

Medium- and coarse-grained biotite-hornblende granite and alaskite. Mafic inclusions and igneous mineral layering dip shallowly inward and define a northwesterly trending magmatic synform cored by the porphyritic facies. Mafic inclusions are rare and mineral layering absent north of Lost Canyon and Cyclamen Lake where the rock is non-foliated alaskite. U-Pb zircon ages of 98.9±1.2 Ma (this study) and 97±2 Ma. (Busby-Spera, 1983); field relations indicate older than 100.3±0.6 Ma porphyritic core facies. Description from source map: Southwestern Sequoia National Park

Kcm - Granite of Case Mountain (Early Cretaceous)

Medium- and coarse-grained biotite granite, generally lacking in mafic inclusions; locally with indistinct potassium-feldspar phenocrysts. Weathers to broad slabs and domes; also forms extensive grus. U-Pb zircon ages of 101.6±1.6 and 102.3±2.1 Ma. Description from source map: Southwestern Sequoia National Park

Kdp - Granite of Dennison Peak (Early Cretaceous)

Medium-grained biotite-hornblende granite with sparse mafic inclusions (0-3 per square meter). Probably correlative with granite of Case Mountain. U-Pb zircon age of 102.8±2.0 Ma. Description from source map: Southwestern Sequoia National Park

Kmr - Granodiorite of Milk Ranch Peak (Early Cretaceous)

Kmr - Granodiorite of Milk Ranch Peak (Cretaceous)
Dark and very dark, medium-grained granodiorite with conspicuous hornblende crystals and abundant mafic inclusions; locally with plagioclase phenocrysts as large as 1.5 cm. U-Pb ages >97 Ma and <99 Ma (Chen and Moore, 1982). Description from source map: Giant Forest 15' Quadrangle

Kmr - Granodiorite of Milk Ranch Peak (Early Cretaceous)
Dark and very dark, medium-grained granodiorite with conspicuous hornblende crystals and abundant mafic inclusions; locally with plagioclase phenocrysts as large as 1.5 cm. U-Pb zircon age 103.2±1.5 Ma. Description from source map: Southwestern Sequoia National Park

Kep - Granodiorite of Eshom Point (Cretaceous)

Medium-grained, porphyritic granodiorite and granite containing 1-3 cm potassium feldspar phenocrysts. Description from source map: Giant Forest 15' Quadrangle

Khl - Granodiorite of Hartland (Cretaceous)

Medium-grained, equigranular and porphyritic dark granodiorite containing 1-2 cm plagioclase phenocrysts. U-Pb age<97 Ma (Chen and Moore, 1982). Description from source map: Giant Forest 15' Quadrangle

Ksq - Tonalite of Shadequarter Mountain (Cretaceous)

Medium- and coarse-grained, equigranular tonalite and granodiorite containing prominent biotite and few mafic inclusions. U-Pb ages <113 and <101 Ma (Chen and Moore, 1982). Description from source map: Giant Forest 15' Quadrangle

Kd - Diorite (Early Cretaceous)

Kd - Diorite (Cretaceous)
Chiefly medium grained, with minor fine-grained, hornblende-biotite quartz diorite and diorite. Commonly contains 20 percent or more dark minerals. Description from source map: Giant Forest 15' Quadrangle

KJm - Mafic plutonic rock (Jurassic or Cretaceous)
Diorite, tonalite, and hornblende gabbro. Includes mafic hybrid rocks of granodiorite composition and dikes of remobilized mafic plutonic rocks. Description from source map: Marion Peak 15' Quadrangle

Kd - Diorite (Cretaceous)
Small intrusions of fine- and medium-grained hornblende diorite and quartz diorite associated with the granite of Ash Peaks Ridge near the northwest corner of the map area, as well as isolated dioritic intrusions elsewhere. Description from source map: Southwestern Sequoia National Park

Kd - Diorite (Cretaceous)
Chiefly medium grained, and lesser fine grained, hornblende-biotite quartz diorite and diorite. Unit along west edge of quadrangle exhibits variable grain size and color index. Averages 20 percent or more dark minerals. Description from source map: Tehipite Dome 15' Quadrangle

Kss - Granodiorite of Shepherds Saddle (Early Cretaceous)

Kss - Granodiorite of Shepards Saddle (Cretaceous)
Medium-grained, equigranular hornblende granodiorite. Description from source map: Giant Forest 15' Quadrangle

Kss - Granodiorite of Shepherds Saddle (Cretaceous)
Medium-grained, equigranular hornblende-biotite granodiorite in northwestern part of map area; undated, but possibly darker-colored facies of the granite of Frys Point (Kfp) Description from source map: Southwestern Sequoia National Park

Kfp - Granite of Frys Point (Early Cretaceous)

Kfp - Granite of Frys Point (Cretaceous)
Medium- and coarse-grained, equigranular biotite granite that lacks mafic inclusions but is locally cut

by fine-grained diorite dikes and hybrid granodiorite dikes containing diorite blocks. Rocks making up part of this unit were called Cactus Point Granite by Ross (1958). U-Pb age <99 Ma (Chen and Moore, 1982). Description from source map: Giant Forest 15' Quadrangle

Kfp - Granite of Frys Point (Early Cretaceous)
Medium- and coarse-grained, equigranular biotite granite that lacks mafic inclusions but is locally cut by diorite and hybrid granodiorite dikes containing diorite blocks. U-Pb zircon age of granite is 105 m. y., late granodioritic intrusions are as young as 103 Ma (Holland and others, 2010). Description from source map: Southwestern Sequoia National Park

Ksl - Granodiorite of Spring Lake (Early Cretaceous)

Ksl - Granodiorite of Spring Lake (Cretaceous)
Medium- to fine-grained granodiorite with sparse mafic dikes; undated, but possibly lighter-colored facies of quartz diorite of Empire Mountain (Kem). Description from source map: Southwestern Sequoia National Park

Kgapr - Granodiorite of Ash Peaks Ridge (Cretaceous)

Kap - Granodiorite of Ash Peaks Ridge (Cretaceous)
Fine- and medium-grained equigranular granodiorite containing few mafic inclusions, possibly a dark facies of granite of Frys Point (Kfp). Unit includes masses of fine- and medium-grained quartz diorite as large as 15 m. Description from source map: Giant Forest 15' Quadrangle

Kmg - McGann pluton (Cretaceous)

Quartz-poor quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kb - Bullfrog pluton (Early Cretaceous)

Kb - Bullfrog pluton (Cretaceous)
Alaskitic quartz monzonite. Fine-grained facies present west of Mount Sago metavolcanic septum. Quartz-poor in southeastern part. Description from source map: Mount Pichot 15' Quadrangle

Kb - Bullfrog pluton (Early Cretaceous)
Granite and quartz monzonite. Pb-U age 103 m.y. (Chen and Moore, 1979). Description from source map: Mount Whitney 15' Quadrangle

Kyp - Quartz Diorite of Yucca Point (Cretaceous)

Medium-grained granodiorite and quartz diorite with prominent hornblende crystals and abundant mafic inclusions. U-Pb age. 110 Ma (Chen and Moore.1982). Averages about 21 percent dark minpri1ls. Description from source map: Tehipite Dome 15' Quadrangle

Kgg - Granite of Grant Grove (Cretaceous)

Kgg - Granite of Grant Grove (Cretaceous)
Medium-grained, light-colored biotite granite that commonly contains potassium feldspar phenocrysts and about 5 percent dark minerals. U-Pb age of garnet-free facies 128 Ma and garnet-bearing facies 106 Ma (Chen and Moore, 1982). Description from source map: Giant Forest 15' Quadrangle

Kgg - Granite of Grant Grove (Cretaceous)
Medium-grained, light-colored granite that commonly contains K-feldspar phenocrysts and about 5 percent dark minerals. U-Pb ages of two samples of western mass (unit Kgg) are 106 Ma and 128 Ma (Chen and Moore, 1982). Description from source map: Tehipite Dome 15' Quadrangle

Ktp - Granite of Tharps Peak (Cretaceous)

Medium-grained, muscovite-biotite granite containing local garnet and (or) tourmaline. Includes muscovite-biotite granite pegmatite dikes with local tourmaline. Rock is similar to, and assumed equivalent to, the informally named Tharps Peak granodiorite of Ligget (1990), a garnet-bearing 2-mica granodiorite that crops out 3 km south of the quadrangle, with a Rb-Sr age of 109 Ma. Description from source map: Giant Forest 15' Quadrangle

Kdc - Granite of East Fork of Dry Creek (Cretaceous)

Fine-grained granodiorite dikes lacking mafic inclusions; located in southwest corner of quadrangle. Description from source map: Giant Forest 15' Quadrangle

Kgpy - Granodiorite porphyry (Cretaceous)

Kpy - Granodiorite porphyry (Cretaceous)
Fine-grained, hypabyssal granodiorite with abundant 0.5-1.5 cm phenocrysts of potassium feldspar. Located at west margin of Big Baldy pendant. Description from source map: Giant Forest 15' Quadrangle

Kgrm - Granodiorite of Redwood Mountain (Cretaceous)

Krm - Granodiorite of Redwood Mountain (Cretaceous)
Fine-grained, hypabyssal quartz-plagioclase granodiorite porphyry and potassium feldspar-porphyritic granite. Forms dikes in Redwood Mountain metamorphic pendant. Probably correlative with granodiorite porphyry in Big Baldy pendant. Description from source map: Giant Forest 15' Quadrangle

Kmk - Granodiorite of Mankins Flat (Cretaceous)_2

Kmk - Granodiorite of Mankins Flat (Cretaceous)
(source symbol Kmk) Medium- and fine-grained, equigranular biotite granodiorite, locally sheared; located in southwest corner of quadrangle. Description from source map: Giant Forest 15' Quadrangle

Kk - Granite of Mount Kaweah (Early Cretaceous)
Fine-grained granite commonly containing pyrite. Description from source map: Mount Whitney 15'

Quadrangle

Kmk - Granite of Mount Kaweah (Cretaceous)
Light colored rock. Fine-grained granite commonly containing pyrite. Description from source map: Triple Divide Peak 15' Quadrangle

Khp - Hypersthene granodiorite (Cretaceous)

Fine-grained hypabyssal granodiorite distinguished by light- and dark-colored inclusions and local hypersthene; located at north end of Big Baldy pendant. Description from source map: Giant Forest 15' Quadrangle

Knk - Granodiorite of North Fork of Kaweah River (Cretaceous)

Medium-grained, dark granodiorite commonly containing small plagioclase phenocrysts 0.75¬1 cm; small masses in upper North Fork of Kaweah River. Description from source map: Giant Forest 15' Quadrangle

Kgge - Granite of Grant Grove, eastern mass (Cretaceous)

Eastern mass (unit Kgge) is commonly more porphyritic and may be of differing age. Description from source map: Tehipite Dome 15' Quadrangle

Kmdp - Metadacite porphyry (Cretaceous)

mdp - Metadacite porphyry (Cretaceous)
Chiefly metamorphosed, schistose, hornblende-biotite dacite porphyry. Contains plagioclase phenocrysts as long as 4 mm. Forms shallow intrusion in metasedimentary rocks. U-Pb age, 105 Ma (Saleeby and others, 1990) Description from source map: Tehipite Dome 15' Quadrangle

Kmhd - Hypersthene-bearing metadacite (Cretaceous)

mhd - Hypersthene-bearing metadacite (Cretaceous)
Subvolcanic intrusion of massive hypersthene-bearing, homogeneous metadacite with spindle-shaped small mafic inclusions. U-Pb age, 102 Ma (Saleeby and others, 1990). Description from source map: Tehipite Dome 15' Quadrangle

Khg - Hypabyssal granodiorite stock (Cretaceous)

hg - Hypabyssal granodiorite stock (Cretaceous)
(Source symbol hg) Medium-grained, weakly schistose, hornblende-biotite granodiorite, Forms small intrusion associated with metadacite subvolcanic mass on north side of Monarch Divide. U·Pb age, 103 Ma (Saleeby and others, 1990). Description from source map: Tehipite Dome 15' Quadrangle

Kem - Quartz diorite of Empire Mountain (Early Cretaceous)

Kem - Quartz diorite of Empire Mountain (Early Cretaceous)
Medium-grained quartz diorite cut by sparse mafic dikes.U-Pb zircon age of 107±1 Ma (Busby-Spera, 1983) and 106.2±1.1 Ma (this study). Description from source map: Southwestern Sequoia National Park

KJem - Quartz diorite of Empire Mountain (Cretaceous or Jurassic)
Dark-colored rock. Medium-grained, weakly schistose quartz diorite containing rare schistose mafic dikes. U-Pb age 107±2 Ma (Busby-Spera, 1983). Named for Empire Mountain 4 km south of quadrangle. Found only as small stock at south edge of quadrangle. Description from source map: Triple Divide Peak 15' Quadrangle

Kgb - Hornblende gabbro (Early Cretaceous)

Medium- and coarse-grained hornblende gabbro and diorite at Black Rock Pass and a sill intrusive into Mineral King metamorphic pendant. Mineral King sill is vuggy and finer grained to the west, and may be sub-volcanic equivalent of similar appearing Cretaceous meta-andesites (Kma) near Timber Gap. Description from source map: Southwestern Sequoia National Park

Knp - Granodiorite of "Nev Point" (Early Cretaceous)

Medium-grained, equigranular hornblende-biotite granodiorite with consistent north-northwest striking, near vertical post-magmatic foliation. U-Pb zircon age of 115.9±1.7 Ma. Description from source map: Southwestern Sequoia National Park

Kwr - Granodiorite of Windy Ridge (Early Cretaceous)

Fine-grained hornblende-biotite granodiorite with sheared mafic dikes. U-Pb zircon age of 120.1±2.1 Ma. Description from source map: Southwestern Sequoia National Park

Kpc - Granodiorite of Pecks Canyon (Early Cretaceous)

Medium- to coarse-grained granodiorite with indistinct potassium-feldspar phenocrysts. U-Pb zircon age of 121.6±1.6 Ma; probably younger than nearby granodiorite of Windy Ridge (Kwr). Description from source map: Southwestern Sequoia National Park

Kwc - Granodiorite of White Chief Mine (Early Cretaceous)

Sheared, medium-grained hornblende-biotite granodiorite with sheared and offset mafic and aplitic dikes. Contact with granodiorite of Castle Creek (Kcc) locally indistinct. Part of volcano-plutonic suite of Mineral King. U-Pb zircon age of 135±1 Ma. Description from source map: Southwestern Sequoia National Park

Kgcr - Granodiorite of Camelback Ridge (Early Cretaceous)

Kcr - Granodiorite of Camelback Ridge (Early Cretaceous)
(Source symbol Kcr) Sheared, medium-grained hornblende-biotite granodiorite with sparse sheared mafic dikes. Locally developed porphyry texture. Part of volcano-plutonic suite of Mineral King. U-Pb zircon age of 133±1 Ma. Description from source map: Southwestern Sequoia National Park

Kbc - Granodiorite of Burnt Camp Creek (Early Cretaceous)

Locally sheared, medium-grained hornblende-biotite granodiorite with sparse sheared mafic dikes. Part of volcano-plutonic suite of Mineral King. U-Pb zircon age of 134.8±1.5 Ma. Description from source map: Southwestern Sequoia National Park

Kgpyd - Granodiorite porphyry dikes (Early Cretaceous)

Kpy - Granodiorite porphyry dikes (Early Cretaceous)
Fine-grained porphyry dikes with abundant plagioclase phenocrysts intrusive into metamorphic rocks of the southern Mineral King pendant; probably correlative to granodiorite of Camelback Ridge (Kcr) of the volcano-plutonic suite of Mineral King. Description from source map: Southwestern Sequoia National Park

Kf - Felsite (Early Cretaceous)

Intrusion of fine-grained, very light colored granite or hypabyssal rhyolite exposed at outlet of lower Franklin Lake; cut by mafic dikes. Undated but probably correlative with meta-rhyolite tuffs of the volcano-plutonic suite of Mineral King. Description from source map: Southwestern Sequoia National Park

Kdr - Dragon pluton (Early Cretaceous)

Kd - Dragon pluton (Early Cretaceous)
Quartz monzodiorite and quartz monzonite. Pb-U age 103 Ma (Chen and Moore, 1982). Contains an average of about 69 weight percent SiO2. Description from source map: Lone Pine 15' Quadrangle

Kd - Dragon pluton (Cretaceous)
Quartz-poor granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kd - Dragon pluton (Early Cretaceous)
Quartz monzodiorite and quartz monzonite. Provisional Pb-U age 103 m.y. (Chen, 1977). Description from source map: Mount Whitney 15' Quadrangle

Kt - Taboose pluton (Cretaceous)

Quartz monzonite with fine- and coarse-grained rock. Description from source map: Mount Pichot 15' Quadrangle

Ktl - Twin Lakes pluton (Cretaceous)

Alaskitic quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kdi - Diamond pluton (Cretaceous)

Alaskitic quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kml - Mule Lake pluton (Cretaceous)

North and south masses. Porphyritic granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Krm - Red Mountain Creek pluton (Cretaceous)

Alaskitic quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kta - Tinemaha granodiorite (Cretaceous)

Ktn - Tinemaha granodiorite (Cretaceous)
type locality, post publication age by Ross (1969) indicates Early Jurassic, Bateman (1992) indicates age of 168+/-8 Ma. Description from source map: Bishop District and Owens Valley

Kta - Tinemaha granodiorite (Cretaceous)
Slightly porphyritic granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Ki - Independence pluton (Early Cretaceous)

Ki - Independence pluton (Early Cretaceous)
Light-colored granite. Pb-U age 112 Ma (Chen and Moore, 1982). Contains an average of about 74 weight percent SiO2**.** Description from source map: Lone Pine 15' Quadrangle

Ki - Independence pluton (Cretaceous)
Alaskitic quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Ki - Independence pluton (Early Cretaceous)
Granite. Provisional Pb-U age 112 m.y. (Chen, 1977). Description from source map: Mount Whitney 15' Quadrangle

Kwf - White Fork pluton (Cretaceous)

Sheared and gneissose granodiorite and quartz monzonite. Description from source map: Mount Pichot 15' Quadrangle

Kan - Anorthosite (Cretaceous)

No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Km - Mafic plutonic rock (Cretaceous)

Mafic granodiorite, quartz diorite, diorite, gabbro, and peridotite. Commonly intimately mixed with granitic material and metamorphic rocks and cut by granitic dikes. Includes dikes of remobilized mafic plutonic rock. Description from source map: Mount Pichot 15' Quadrangle

Kcc - Granite of Carroll Creek (Cretaceous?)

Kcc - Granite of Carroll Creek (Cretaceous?)
Coarse-grained granite. Contains an average of about 72 weight percent SiO2. Intruded by granodiorite of Lone Pine Creek. Exact age unknown. Description from source map: Lone Pine 15' Quadrangle

Kcc - Granite of Carroll Creek (Cretaceous)
Coarse-grained granite, locally porphyritic. Hornblende and biotite are subhedral. Description from source map: Olancha 15' Quadrangle

KJcr - Quartz diorite of Cactus Ridge (Cretaceous or Jurassic)

Medium-grained, equigranular quartz diorite and very dark granodiorite. Contains small masses of hornblende gabbro but lacks fine-grained mafic inclusions. Description from source map: Giant Forest 15' Quadrangle

KJsw - Granite of Skagway Grove (Cretaceous or Jurassic)

Coarse-grained granite and granodiorite commonly containing 1-3 cm potassium feldspar phenocrysts. Locally sheared and probably correlative with granite of Lodgepole Campground in adjacent Triple Divide Peak quadrangle to the east (Moore and Sisson, 1987). Description from source map: Giant Forest 15' Quadrangle

KJhr - Granite of Hospital Rock (Cretaceous or Jurassic)

Coarse-grained, sheared granodiorite containing potassium feldspar phenocrysts. Resembles and possibly correlative with granite of Skagway Grove (KJsw). Forms small mass in southeastern part of quadrangle. Description from source map: Giant Forest 15' Quadrangle

KJpr - Granodiorite of Pattee Rocks (Cretaceous or Jurassic)

Medium-grained, sheared dark granodiorite; located at north end of Sheep Ridge pendant.
Description from source map: Giant Forest 15' Quadrangle

KJgb - Gabbro (Cretaceous and (or) Jurassic)

Medium- and coarse-grained pyroxene hornblende gabbro and hornblende gabbro, locally containing olivine. Minor anorthositic gabbro, diorite, and olivine hornblendite. Cumulate layering locally present. Description from source map: Giant Forest 15' Quadrangle

KJf - Felsic dike (Cretaceous or Jurassic)

KJf - Felsic dikes and sills (Jurassic or Cretaceous)
Thinner dikes and sills in north end of Goddard pendant are offshoots of wedge-shaped mass in northeast side of pendant. Dikes are in two steeply dipping sets, one trending N 30 W and the other N 80 W. Only dikes enclosed in dark-colored rock and visible on aerial photographs are shown. Description from source map: Blackcap Mountain 15' Quadrangle

KJf - Felsic dike (Cretaceous or Jurassic)
Very light gray, aphanitic, felsic dike 4 m thick in Inyo Mountains. May correlate with Early Cretaceous (about 140 Ma) felsic dikes or the Late Jurassic (148 Ma) granite of French Spring east of quadrangle (Dunne and Walker, 1993). Description from source map: Lone Pine 15' Quadrangle

KJd - Mafic, intermediate-composition, and minor felsic dikes (Cretaceous? and Jurassic)

Aphanitic to fine-grained, commonly porphyritic dikes in Alabama Hills and Inyo Mountains that range in composition from diorite to granite. Mafic to intermediate compositions predominate. Majority of dikes are vertical to subvertical and strike northwest; a few strike east-northeast. Only the largest, most prominent dikes are shown. Interpreted primarily as part of the Independence dike swarm, which is considered mainly Late Jurassic in age (Chen and Moore, 1979) but locally contains dikes of Late Cretaceous age (Coleman and others, 2000). Pb-U age of one dike in northern Alabama Hills is 148 Ma (Chen and Moore, 1979) (Locality G–3). Includes some dikes similar in lithology to felsic dike mapped separately in Inyo Mountains (KJf); such dikes could be of Early Cretaceous age. In northern Alabama Hills, dikes and irregular hypabyssal intrusions constitute more than 50 percent, and locally as much as 90 percent, of the total rock volume over a large area (indicated by pattern). Some of these dikes may be genetically associated with the lower part of the volcanic complex of the Alabama Hills (Javl). Description from source map: Lone Pine 15' Quadrangle

KJgrd - Granodiorite (Cretaceous or Jurassic)

KJgd - Granodiorite (Jurassic or Cretaceous)
Rocks of the Goddard Pendant (Locally Sheared). No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

KJqd - Quartz diorite and other mafic plutonic rocks (Cretaceous or Jurassic)

Kd - Diorite, quartz diorite, and hornblende gabbro (Cretaceous)
Includes some hybrid rocks of granodiorite composition. Description from source map: Bishop District and Owens Valley

KJd - Quartz diorite and other mafic plutonic rocks (Jurassic or Cretaceous)
No further description provided. Description from source map: Description from source map: Blackcap Mountain 15' Quadrangle

KJd - Diorite, quartz diorite, and hornblende gabbro (Jurassic or Cretaceous)
Includes some hybrid rocks of granodiorite composition. Description from source map: Mount Goddard 15' Quadrangle

KJmd - Mafic dikes (Cretaceous and (or) Jurassic)

KJmd - Mafic dikes (Cretaceous and (or) Jurassic)
Fine-grained, dark-colored mafic discs of indeterminate age that cut metamorphic and granitic rocks. Description from source map: Southwestern Sequoia National Park

KJmd - Mafic Dikes, undivided (Cretaceous and Jurassic(?))
Dark-colored rock. Fine-grained hornblende gabbro and diorite dikes. Cretaceous dikes have plagioclase phenocrysts, are undeformed, and are geographically associated with light -colored granites. Jurassic(?) dikes are moderately to strongly schistose, have no hornblende phenocrysts, crop out within sheared intrusive and metamorphic rocks, and are tentatively assigned to the Independence dike swarm (U-Pb age of 148 Ma, Chen and Moore, 1982). Description from source map: Triple Divide Peak 15' Quadrangle

KJsmd - Sheared mafic dikes (Cretaceous and (or) Jurassic)

KJmd - Sheared mafic dikes (Cretaceous and (or) Jurassic)
Sheared, fine-grained mafic dikes cutting metamorphic rocks and associated sheared intrusive rocks, as well as granodiorite of Yucca Mountain (Jym). Description from source map: Giant Forest 15' Quadrangle

KJlp - Granite of Lodgepole Campground (Cretaceous or Jurassic)

Light-colored rock. Coarse-grained granite containing sparse mafic inclusions of widely variable size and texture. Description from source map: Triple Divide Peak 15' Quadrangle

KJrp - Rhyolite porphyry dikes (Cretaceous or Jurassic)

Fine-grained, light-colored rhyolite porphyry containing phenocrysts of plagioclase, biotite, and hornblende as large as 1 cm. Dikes commonly intrude granodiorite of Yucca Mountain (Jym) and metamorphic rock of Sheep Ridge pendant. Description from source map: Giant Forest 15' Quadrangle

KJsgd - Sheared granodiorite (Cretaceous or Jurassic)

KJgg - Finer-grained granite (Jurassic or Cretaceous)
Rocks of the Goddard Pendant (Locally Sheared). No further description provided.Description from source map: Blackcap Mountain 15' Quadrangle

KJg - Older sheared granodiorite (Jurassic or Cretaceous)
Associated with metamorphic rocks. Description from source map: Marion Peak 15' Quadrangle

KJgg - Sheared finer-grained granite of Goddard pendant (Jurassic or Cretaceous)

No further description provided. Description from source map: Mount Goddard 15' Quadrangle

KJgd - Sheared granodiorite (Cretaceous or Jurassic)
Schistose dark granodiorite near northeast corner of map area; cut by schistose mafic dikes. Correlative with Jurassic-Triassic sheared granodiorite in the Triple Divide Peak geologic quadrangle map, but reassigned to Cretaceous or Jurassic based on the discovery of Cretaceous sheared, diked granodiorites. Description from source map: Southwestern Sequoia National Park

JTRgd - Sheared granodiorite (Jurassic or Triassic)
Schistose dark granodiorite in the southeastern part of the quadrangle; cut by abundant schistose mafic dikes (KJmd). Description from source map: Triple Divide Peak 15' Quadrangle

MZmm - Mafic metavolcanic rocks (Mesozoic)

mm - Mafic metavolcanic rocks (Mesozoic)
Chiefly metarhyolite and metadacite tuffs, but includes metarhyolite and metadacite lava flows. Description from source map: Southwestern Sequoia National Park

MZma - Meta-andesite (Mesozoic)

ma - Meta-andesite (Mesozoic)
Metamorphosed andesitic lava flows and breccias, commonly schistose. Description from source map: Southwestern Sequoia National Park

MZmrd - Felsic metavolcanic rocks (Mesozoic)

mrd - Felsic metavolcanic rocks (Mesozoic)
Chiefly metarhyolite and metadacite tuffs, but includes metarhyolite and metadacite lava flows. Description from source map: Southwestern Sequoia National Park

KJmt - Metarhyolite and metadacite tuffs, undivided (Cretaceous and Jurassic)

KJmt - Metarhyolite and metadacite tuffs, undivided (Cretaceous and Jurassic)
Northern continuation of Cretaceous metarhyolite and Jurassic metadacite tuffs across Cliff Creek. Shown as Jurassic or Triassic metarhyolite on Triple Divide Peak geologic quadrangle map (Moore and Sisson, 1987). Description from source map: Southwestern Sequoia National Park

mdt - Metadacite and metarhyolite tuff (Cretaceous)
Tuff and volcanic-derived sedimentary rocks. Also contains meta-andesitic tuffaceous rocks. Description from source map: Tehipite Dome 15' Quadrangle

JTRmr - Metarhyolite (Jurassic and (or) Triassic)
Chiefly metarhyolite with relict pyroclastic texture, but includes massive, sheared, and migmatitic silicic metavolcanic rocks of uncertain origin. Part of unit assigned to KJmt according to T. Sisson (2012, personal comm. Description from source map: Triple Divide Peak 15' Quadrangle

Kma - Meta-andesite (Early Cretaceous)

Metamorphosed andesitic lava flows and breccias to the west of Timber Gap. U-Pb zircon lower-intercept concordia model age of 111 Ma from included felsic tuff (after Busby-Spera, 1983). Possibly correlative with similar appearing hornblende gabbro sill (Kgb) to south. Description from source map: Southwestern Sequoia National Park

Kvbr - Metarhyolite and metadacite breccia (Early Cretaceous?)

K?vbr - Metarhyolite and metadacite breccia (Early Cretaceous?)
Lenses and beds of felsic volcanic breccia with well preserved relict angular clasts. Description from source map: Southwestern Sequoia National Park

Kmrt - Metarhyolite tuff (Early Cretaceous)

JTRmr - Metarhyolite tuff (Triassic(?) and Jurassic)
Goddard Pendant. Strongly lineated. Description from source map: Blackcap Mountain 15' Quadrangle

KJmr - Metarhyolite tuff (Cretaceous and (or) Jurassic)
Chiefly metarhyolite with relict pyroclastic texture. Mass in Stoney Creek has U-Pb age of 110 Ma (J. Saleeby, written comm., 1991). Mass on Ash Peaks Ridge, associated with marble, is undated and may be older. Description from source map: Giant Forest 15' Quadrangle

MZr - Metarhyolite tuff (Mesozoic)
No further description provided. Description from source map: Marion Peak 15' Quadrangle

JTRmr - Metarhyolite tuff (Triassic(?) and Jurassic)
Goddard Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

JTRrt - Metarhyolite tuffs (Triassic and Jurassic)
Metarhyolite tuffs with some other metavolcanic rocks interbedded. Description from source map: Mount Pichot 15' Quadrangle

Kmrt - Metarhyolite tuff (Early Cretaceous)
Chiefly massive metarhyolite with relict pyroclastic texture; includes some inter-stratified metasedimentary rocks. U-Pb zircon lower-intercept concordia model ages of 131-140 Ma (after Busby-Spera, 1983); part of Mineral King volcano-plutonic suite. Description from source map: Southwestern Sequoia National Park

mrt - Metarhyolite tuff (Cretaceous)
Chiefly metamorphosed pyroclastic rhyolite and dacite. U-Pb age, 106 Ma (Saleeby and others, 1990). Description from source map: Tehipite Dome 15' Quadrangle

Ksmr - Schistose metarhyolite (Cretaceous?)

K?smr - Schistose metarhyolite (Cretaceous?)
Felsic schist with relict quartz and plagioclase phenocrysts (or coarse relict detrital grains) on west side of Farewell Gap. Foliation intensity decreases to the north and unit passes along strike into bedded volcaniclastic metasandstones (vss). Description from source map: Southwestern Sequoia

National Park

Kmrf - Metarhyolite lava (Cretaceous)

mrf - Metarhyolite lava (Cretaceous)
Chiefly metamorphosed massive, sheared. silicic volcanic rocks. Predominantly lava flows. Description from source map: Tehipite Dome 15' Quadrangle

Kmsv - Metavolcanic sedimentary rocks (Cretaceous)

MZvs - Metavolcanic rocks, volcanic derived sediments (Mesozoic)
Volcanic derived sediments. Part of unit was assigned to Kmsv. Similar rocks where matched across quadrangle boundary. Description from source map: Marion Peak 15' Quadrangle

msv - Metavolcanic sedimentary rocks (Cretaceous)
Water laid volcanogenic sediments and airfall ash. Description from source map: Tehipite Dome 15' Quadrangle

Kmrr - Metarhyolite (Cretaceous)

mrr - Metarhyolite (Cretaceous)
Distinctly red weathering, fine-grained, metamorphosed lapilli tuff and tuff breccia. U-Pb age. 104 Ma (Saleeby and others, 1990). Description from source map: Tehipite Dome 15' Quadrangle

Kmap - Metarhyolite airfall ash (Cretaceous)

map - Metarhyolite airfall ash (Cretaceous)
Fine-grained, commonly well bedded, airfall ash with well-preserved accretionary lapilli 2-20 mm in diameter. Description from source map: Tehipite Dome 15' Quadrangle

KJgd - Miscellaneous granodiorite (Cretaceous or Jurassic)

Small bodies of fine- to medium-grained dark-colored granodiorite found on the range front associated with the Whitney Granodiorite. Description from source map: Olancha 15' Quadrangle

KJm - Mafic plutonic rock (Cretaceous or Jurassic)

Includes fin-grained diorite and tonalite, poikilitic hornblende gabbro, and hybridized mafic granodiorites. Description from source map: Olancha 15' Quadrangle

Jmdt - Metadacite tuff (Jurassic)

Massive metadacite with relict pyroclastic texture between Timber Gap and Empire Mountain, and metadacite tuff and breccia above Spring Lake. Distinguished from metarhyolite tuff (Kmrt) by more abundant biotite and hornblende, and by absence of relict quartz phenocrysts. U-Pb zircon lower-

intercept concordia model ages of 171 and 189 Ma (after Busby-Spera, 1983). Description from source map: Southwestern Sequoia National Park

Jd - Mafic dikes (Jurassic)

Predominantly fine-grained diorite and granodiorite porphyry. Description from source map: Olancha 15' Quadrangle

Jdi - Independence dike swarm (Jurassic)

Jd - Dikes of Independence dike swarm(?) (Jurassic)
Dikes of fine-grained diorite and granodiorite porphyry with related felsic dikes (F) that may belong ro the to the Independence dike swarm, which has a U-Pb age of 148 m.y. (Chen and Moore. 1979). Description from source map: Kern Peak 15' Quadrangle

KJd - Independence dike swarm (Jurassic or Cretaceous)
Predominantly fine-grained diorite and granodiorite porphyry. Description from source map: Marion Peak 15' Quadrangle

Kdk - Independence dike swarm (Cretaceous)
Predominantly fine-grained diorite and granodiorite porphyry. Dikes shown diagrammatically. Each line represents approximately one 5-foot dike or equivalent. Description from source map: Mount Pichot 15' Quadrangle

Jd - Dikes of Independence dike swarm(?) (Jurassic)
Subvertical dikes of fine-grained diorite and granodiorite porphyry, tentatively assigned to the Independence dike swarm with a Pb-U age of 148 m.y. (Chen and Moore, 1979). Description from source map: Mount Whitney 15' Quadrangle

Jivu - Inyo Mountains Volcanic Complex of Dunne and others (1998), upper part (Late and Middle Jurassic)

Massive to faintly bedded, matrix-supported volcanogenic conglomerate (about 65–70 percent of unit), parallel-bedded to crossbedded sandstone and siltstone (about 30 percent), and rare lenses of felsic to intermediate-composition welded tuff that become more abundant southeast of quadrangle. Freshwater pelecypods and gastropods present locally (Dunne, 1986) (Locality F–1). Minimum thickness in quadrangle about 900 m, increasing to more than 2,200 m southeast of quadrangle. Andesite lava flow about 450 m above base of unit southeast of quadrangle has a Pb-U age of about 163 Ma; two samples of dacite tuff about 1,100 m below faulted top of unit southeast of quadrangle have minimum Pb-U ages of about 148 and 150 Ma (Dunne and others, 1998). Description from source map: Lone Pine 15' Quadrangle

Javu - Volcanic complex of the Alabama Hills, upper part (Middle Jurassic)

Consists chiefly of light- to medium-light-gray, massive, slightly welded tuff at least 450 m thick. Tuff contains 18 to 28 percent phenocrysts consisting of subequal amounts of quartz and potassium feldspar and sparse plagioclase and biotite. Flattened pumice lapilli generally rare but locally abundant near base of tuff. Medium- to dark gray, aphanitic lithic lapilli typically compose less than 2 percent of tuff but locally form diffuse clusters composing as much as 20 percent. Top of tuff intruded by Alabama Hills Granite. Basal part of unit locally consists of muscovite schist, quartzite, and rare

volcanogenic conglomerate having a maximum thickness of about 10 m. Lower contact of unit probably unconformable in southern exposure area but of uncertain character in northern exposure area. Minimum Pb-U age of tuff about 170 Ma (Dunne and Walker, 1993) (Locality G–1). Small part of northern outcrop area contains abundant dikes (KJd) as shown by pattern. Description from source map: Lone Pine 15' Quadrangle

Jivm - Inyo Mountains Volcanic Complex of Dunne and others (1998), middle part (Middle Jurassic)

Andesite and rhyolite lava flows (about 50 percent of unit), bedded to massive volcanogenic sandstone and conglomerate (about 30 percent), and welded rhyolite ash-flow tuff (about 20 percent). Conglomerate ranges from matrix supported to clast supported. Unit thickness about 750 m. In quadrangle, preferred Pb-U age of uppermost part of unit is 168 Ma (Locality G–5); preferred Pb-U ages of middle and uppermost parts of unit southeast of quadrangle are 169 and 168 Ma, respectively (Dunne and Walker, 1993). Description from source map: Lone Pine 15' Quadrangle

Jpk - Pat Keyes pluton (Middle Jurassic)

Medium- to light-gray, medium grained, hypidiomorphic granular to seriate plutonic rocks of variable composition. Main mass, exposed largely north and east of quadrangle, consists predominantly of ±clinopyroxene-biotite-hornblende monzogranite and quartz monzonite. These rocks grade irregularly into a relatively mafic border facies of clinopyroxene-biotite-hornblende quartz monzodiorite and less common quartz diorite, diorite, and monzodiorite (Ross, 1969; Dunne, 1970, 1971). Exposures in quadrangle are primarily of the mafic border facies. Hornblende K-Ar ages 178 and 163 Ma (Ross, 1969); Rb-Sr (whole-rock plus mineral separate) age 183 Ma (Dunne, 1970, 1971). Description from source map: Lone Pine 15' Quadrangle

Ji - Intrusive rocks marginal to Pat Keyes Pluton (Middle Jurassic?)

Primarily dark-gray, reddish-brown-weathering, fine-grained, altered and recrystallized diorite and tonalite that have been intensely sausseritized and sericitized. Composed principally of plagioclase, epidote, clinozoisite, calcite, and sericite; quartz in minor. Primary intrusive texture partly to completely destroyed by recrystallization. Includes minor light-colored intrusive rocks and small, irregular masses of metasedimentary rocks that are not mapped separately. Provisionally interpreted as cogenetic with mafic border facies of Pat Keyes pluton. Description from source map: Lone Pine 15' Quadrangle

Javl - Volcanic complex of the Alabama Hills, lower part (Middle Jurassic)

Consists of an upper subunit of volcanogenic sedimentary and volcanic rocks and a lower subunit of rhyolite tuff. Unit characterized by intense hydrothermal alteration over much of its exposure area, which obscures many details of its stratigraphy. Upper subunit consists primarily of weakly bedded to massive, predominantly matrix supported pebble to cobble conglomerate, siltstone, sandstone, and pebbly sandstone. These rocks are interlayered with about 10 percent felsic tuff and, in southernmost outcrops, rare vesicular lava flows. Rhyolite tuff of lower subunit, present in northeastern most exposures of unit, is grayish pink to yellowish gray, massive, and slightly welded. Tuff contains 15 to 35 percent phenocrysts consisting of subequal amounts of quartz and potassium feldspar and sparse plagioclase and biotite, and 1 to 2 percent volcanogenic lithic lapilli. Minimum Pb-U age of tuff about 167 Ma (Dunne and others, 1998) (Locality G–2). Unit cut by abundant dikes (KJd) as shown by pattern. Description from source map: Lone Pine 15' Quadrangle

Jivl - Inyo Mountains Volcanic Complex of Dunne and others (1998), lower part (Middle Jurassic?)

Faintly bedded to predominantly massive, mostly matrix supported, volcanogenic pebble, cobble, and rare boulder conglomerate (about 75–80 percent of unit), parallel-bedded to crossbedded volcanogenic sandstone and pebbly sandstone (about 20 percent), and sparse lenticular lava flows of vesicular basalt or basaltic andesite. Basal several meters consist of bedded conglomerate that contains clasts of sedimentary rocks. Unit thickness about 300 m. Undated; age is probably Middle Jurassic but could be as old as Middle Triassic. Lower contact with Union Wash Formation unconformable. Description from source map: Lone Pine 15' Quadrangle

Jsm - Diorite of Schaeffer Meadow (Jurassic)

Strongly sheared mafic granodiorite. Hornblende is subhedral to euhedral. Description from source map: Olancha 15' Quadrangle

Jkp - Alaskite of Kern Peak (Jurassic)

Fine- to coarse-grained equigranular alaskite containing less than five percent mafic minerals, principally biotite. Description from source map: Olancha 15' Quadrangle

Juf - Alaskite of Upper Funston Meadow (Jurassic(?))

Very light colored fine-grained granite. Mafic minerals consist of a trace of biotite, magnetite, and pyrite. Sheared and iron stained. Description from source map: Kern Peak 15' Quadrangle

Jt - Granite of Toowa Range (Jurassic(?))

Fine-grained sheared biotite granite. Description from source map: Kern Peak 15' Quadrangle

Jhh - Alaskite of Hells Hole (Jurassic(?))

Medium- to coarse-grained alaskite with abundant small bodies of mafic plutonic rock (not shown). Description from source map: Kern Peak 15' Quadrangle

Jdm - Granodiorite of Doe Meadows of Dubray and Dellinger (Jurassic(?))

Medium-grained mafic granodiorite-locally porphyritic and commonly sheared. Description from source map: Kern Peak 15' Quadrangle

Jawc - Alaskite of Window Cliffs (Jurassic(?))

Fine-grained alaskite stocks and dikes intrusive into the granite of Window Cliffs. Description from source map: Kern Peak 15' Quadrangle

Jwc - Granite of Window Cliffs (Jurassic(?))

Medium-grained granite and granodiorite containing 1 to 2-cm potassium feldspar phenocrysts, commonly cut by shear zones. Discordant U-Pb ages > 159 m.y., > 160 m.y. (Chen and Moore. 1982). Description from source map: Kern Peak 15' Quadrangle

Jkcr - Granodiorite of Kern Canyon Ranger Station (Jurassic(?))

Medium-grained biotite granodiorite with small (1-2 cm) potassium feldspar phenocryst. Description from source map: Kern Peak 15' Quadrangle

Jrc - Granite of Rattlesnake Creek (Jurassic(?))

Fine-grained sheared granite and granodiorite. Description from source map: Kern Peak 15' Quadrangle

Jmgf - Mafic Plutonic Rocks associated with Granite of Grasshopper Flat (Jurassic(?))

Small stocks of coarse-grained hornblende gabbro and finer hornblende gabbro, diorite, and minor quartz diorite intrusive into the granite of Grasshopper Flat. Description from source map: Kern Peak 15' Quadrangle

Jgf - Granite of Grasshopper Flat (Jurassic(?))

Coarse-grained, locally porphyritic biotite granite commonly cut by thin shear zones. Potassium feldspar phenocrysts range up to 3 cm. Granite is intruded by numerous irregular fine- and coarse-grained hornblende gabbro, diorite, and minor quartz diorite stocks. U-Pb age is >170 m.y. (Chen and Moore, 1982). Description from source map: Kern Peak 15' Quadrangle

Jsc - Granodiorite of Sheep Creek (Jurassic(?))

Heterogeneous dark-and medium-colored granodiorite. Description from source map: Kern Peak 15' Quadrangle

Jls - Granodiorite of Left Stringer (Jurassic(?))

Fine-grained, granodiorite, sparse potassium feldspar phenocrysts. Description from source map: Kern Peak 15' Quadrangle

Jac - Granite of Angora Creek (Jurassic(?))

Coarse-grained hornblende granite and granodiorite characterized by euhedral hornblende, white subhedral feldspars, and translucent gray anhedral quartz. Ductile and brittle shears are common. Description from source map: Kern Peak 15' Quadrangle

Jlc - Granodiorite of Leggett Creek (Jurassic(?))

Sparsely porphyritic (potassium feldspar phenocrysts) medium-grained granodiorite that grades to gabbro, diorite, and quartz diorite on its eastern and western margins. Description from source map: Kern Peak 15' Quadrangle

Jmgd - Mafic granodiorite (Jurassic(?))

Two small bodies of mafic hornblende granodiorite of unknown association. Description from source map: Kern Peak 15' Quadrangle

Jcm - Granodiorite of Cold Meadows (Jurassic(?))

Fine-and medium-grained granodiorite, locally containing 1- to 2-cm potassium feldspar phenocrysts. Commonly strongly foliated and veined, and locally indistinguishable from highly recrystallized metavolcanic rocks. Description from source map: Kern Peak 15' Quadrangle

Jm - Older mafic plutonic rocks (Jurassic(?))

Quartz diorite, diorite, and hornblende gabbro. Description from source map: Kern Peak 15' Quadrangle

Jgd - Sheared granodiorite (Jurassic(?))

Jsg - Sheared granodiorite (Jurassic)
Sheared, medium-grained, heterogeneous granodiorite and granite cut by numerous sheared mafic dikes and associated with metamorphic rocks west of Dorst Campgound. Description from source map: Giant Forest 15' Quadrangle

Jgd - Sheared granodiorite (Jurassic(?))
Strongly foliated, locally gneissic, medium-grained granodiorite; some tectonic slivers of porphyritic granodiorite are included. Description from source map: Kern Peak 15' Quadrangle

JTRgd - Older sheared granodiorite (Jurassic or Triassic)
No further description provided. Description from source map: Mount Whitney 15' Quadrangle

Jym - Granodiorite of Yucca Mountain (Jurassic)

Fine- and medium-grained biotite granodiorite and granite cut by numerous rhyolite porphyry dikes (KJrp). Dark minerals 6-15 percent; U-Pb age 162 Ma (J. B. Saleeby, written comm., 1991). Description from source map: Giant Forest 15' Quadrangle

JTRbs - Biotite-feldspar-quartz schist (Jurassic and (or) Triassic)

s - Biotite-feldspar-quartz schist (Jurassic and Triassic)
Reddish-brown weathering, biotite-feldspar-quartz schist with thin (10 cm or less) layers of micaceous quartzite. Includes minor calc-silicate schist layers and sparse marble. Thin to medium layered. Description from source map: Tehipite Dome 15' Quadrangle

JTRbs - Biotite-feldspar-quartz schist (Jurassic and (or) Triassic)
<insert unit description> Description from source map: Triple Divide Peak 15' Quadrangle

JTRab - Meta-andesite and metabasalt (Jurassic and (or) Triassic)

JTRab - Meta-andesite and metabasalt (Jurassic and (or) Triassic)
Mafic hornfels locally containing relict amygdules filled with amphibole, epidote, and garnet Some andesitic breccia. Description from source map: Kern Peak 15' Quadrangle

JTRb - Metabasalt and meta-andesite (Triassic and Jurassic)
Undifferentiated tuffs, breccias, and flows, with minor occurrences of interbedded basalt. Description from source map: Mount Pichot 15' Quadrangle

JTRm - Marble (Jurassic and (or) Triassic)

JTRmb - Marble (Jurassic and (or) Triassic)
Coarsely crystalline marble with highly contorted calc-silicate nodules and stringers. Description from source map: Kern Peak 15' Quadrangle

m - Marble (Jurassic and Triassic)
Coarsely crystalline, schistose to gneissose, white to light gray, commonly cavernous marble. Dolomitic in some places. Description from source map: Tehipite Dome 15' Quadrangle

MZms - Metasedimentary rock (Mesozoic)

Chiefly fine-grained biotite schist. Locally includes: Mzq, quartzite. Description from source map: Olancha 15' Quadrangle

JTRch - Calc-hornfels (Jurassic and (or) Triassic)

Calc-hornfels made up primarily of diopside, quartz, plagioclase, ± potassium feldspar, amphibole, garnet, wollastonite, and tremolite. Description from source map: Kern Peak 15' Quadrangle

JTRqs - Quartz sericite hornfels (Jurassic and (or) Triassic)

Pelitic and siliceous hornfels, phyllite, and schist. Sericite locally pseudomorphs andalusite. Description from source map: Kern Peak 15' Quadrangle

JTRq - Quartzite (Jurassic and (or) Triassic)

JTRq - Quartzite (Triassic(?) and Jurassic)
Goddard Pendant Includes pelitic and calcareous layers. Description from source map: Blackcap Mountain 15' Quadrangle

JTRq - Quartzite (Jurassic and (or) Triassic)
Fine- and medium-grained, schistose, white, micaceous, arkosic quartzite, quartzite, and lesser quartz-biotite schist. Medium- to massive-bedded; pebble conglomerate occurs locally. Part of unit was assigned to JTRq. Similar rocks where matched across quadrangle boundaries. Description from source map: Giant Forest 15' Quadrangle

JTRq - Quartzite (Jurassic and (or) Triassic)
Medium- to thick bedded, slightly micaceous quartzite. Description from source map: Kern Peak 15' Quadrangle

MZq - Quartzite (Mesozoic)
No further description provided. Description from source map: Olancha 15' Quadrangle

q - Quartzite (Jurassic and Triassic)
Fine- and medium-grained, schistose, white, micaceous, arkosic quartzite, quartzite, and lesser quartz-biotite schist. Medium to massive bedded. locally exhibiting crossbedding. Description from source map: Tehipite Dome 15' Quadrangle

JTRq - Quartzite (Jurassic and (or) Triassic)
Fine- and medium-grained, medium-bedded to massive, white, micaceous quartzite. Description from source map: Triple Divide Peak 15' Quadrangle

JTRcs - Calc-silicate schist (Jurassic and (or) Triassic)

JTRcs - Calc-silicate schist (Jurassic and (or) Triassic)
Calc-silicate schist and minor calc-hornfels adjacent to granitic plutons. Includes calc-silicate schist with up to 40 percent thin (2-4 cm) marble layers; also includes minor quartz-biotite schist, tactite, and marble not resolvable at map scale. Description from source map: Giant Forest 15' Quadrangle

cs - Calc-silicate schist (Jurassic and Triassic)
Calc-silicate schist and minor calc-hornfels adjacent to granitic plutons. Includes quartz-biotite schist and minor tactite and marble. Thin to medium layered. Description from source map: Tehipite Dome 15' Quadrangle

JTRcs - Calc-silicate schist (Jurassic and (or) Triassic)
Calc-silicate schist and hornfels. Includes tactite and minor marble. Description from source map: Triple Divide Peak 15' Quadrangle

JTRa - Amphibolite (Jurassic and (or) Triassic)

Massive and schistose amphibolite derived from mafic volcanic rocks, locally with relict plagioclase phenocrysts; also thin-layered amphibolite, biotite-amphibolite, and mafic biotite schist derived from volcanogenic sediments. Description from source map: Giant Forest 15' Quadrangle

JTRqbp - Quartz and biotite mylonitic phyllite (Jurassic and Triassic)

qbp - Quartz and biotite mylonitic phyllite (Jurassic and Triassic)
Chiefly thin layered to medium-layered. fine-grained quartz-, feldspar-, and biotite-rich mylonitic phyllite and mylonitic calc-phyllite. Local mylonite and and breccia zones. Contains Early Jurassic fossils near lower Boulder Creek. Description from source map: Tehipite Dome 15' Quadrangle

JTRbp - Biotite mylonitic phyllite (Jurassic and Triassic)

bp - Biotite mylonitic phyllite (Jurassic and Triassic)
Chiefly thin layered to medium-layered, fine-grained biotite-quartz mylonitic phyllite with lesser quartz-feldspar mylonitic phyllite. Description from source map: Tehipite Dome 15' Quadrangle

JTRabs - Andalusite-biotite schist (Jurassic and Triassic)

abs - Andalusite-biotite schist (Jurassic and Triassic)
Dark-gray. thin- to medium-layered, fine- to medium-grained, quartz-white mica-biotite-andalusite schist. Description from source map: Tehipite Dome 15' Quadrangle

JTRlr - Granite of Lion Rock (Jurassic or Triassic)

Medium-colored rock. Medium-grained granite and granodiorite containing small (1-2 cm) potassium feldspar phenocrysts. Weakly schistose and cut by both schistose and non-schistose mafic dikes (KJmd). Description from source map: Triple Divide Peak 15' Quadrangle

JTRqp - Quartz porphyry (Jurassic or Triassic)

Light-colored rock. Sheared quartz porphyry with abundant mafic dikes, locally gradational to equigranular granite. Small mass on Kaweah Peaks Ridge. Description from source map: Triple Divide Peak 15' Quadrangle

JTRd - Sheared diorite and gabbro (Jurassic or Triassic)

Dark-colored rock. Schistose diorite and gabbro cut by schistose mafic dikes (KJmd). Located west of Kaweah Peaks Ridge. Description from source map: Triple Divide Peak 15' Quadrangle

MZmv - Metavolcanic rocks (Mesozoic)

JTRmv - Undifferentiated metavolcanic rocks (Triassic(?) and Jurassic)
Goddard Pendant. Chiefly metarhyolite to metadacite tuff. Includes meta-andesite, metabasalt, and lenses of metasedimentary rocks. Calcareous beds are present in the metamorphic salient northeast of Emerald Peak. Description from source map: Blackcap Mountain 15' Quadrangle

MZv - Metavolcanic rocks (Mesozoic)
Chiefly metarhyolite and metadacite tuff includes meta-andesite and metabasalt. and layers of metasedimentary rocks. Description from source map: Marion Peak 15' Quadrangle

JTRmv - Metavolcanic rocks (Triassic(?) and Jurassic)
Goddard Pendant. Chiefly metarhyolite to metadacite tuff. Includes meta-andesite and metabasalt, and layers of metasedimentary rocks. Description from source map: Mount Goddard 15' Quadrangle

MZmv - Metavolcanic rocks (Mesozoic)
Chiefly fine-grained metamorphosed dacite and andesite tuffs and flows. Minor basalt. Locally includes: MZmr, metarhyolite. Includes felsic flows, tuffs, and ash deposits. Description from source map: Olancha 15' Quadrangle

MZmr - Metarhyolite (Jurassic and (or) Triassic)

JTRr - Flow-banded metarhyolite (Triassic(?) and Jurassic)
Goddard Pendant. No further description provided. Description from source map: Blackcap Mountain 15' Quadrangle

MZmr - Metarhyolite (Mesozoic)
Includes felsic flows, tuffs, and ash deposits. Description from source map: Olancha 15' Quadrangle

JTRscs - Silicated marble, calc-hornfels, and schist (Jurassic and Triassic(?))

JTRch - Silicated marble, calc-hornfels, and schist (Triassic(?) and Jurassic)
Goddard Pendant. Silicated marble, calc-hornfels, and schist. Description from source map: Blackcap Mountain 15' Quadrangle

JTRrh - Metavolcanic rocks, conspicuous layers of metarhyolite (Jurassic and Triassic(?))

rh - Metavolcanic rocks, conspicuous layers of metarhyolite (Triassic(?) and Jurassic)
Goddard Pendant. Conspicuous layers of metarhyolite including both tuff layers and dikes. Description from source map: Mount Goddard 15' Quadrangle

JTRpd - Metavolcanic rocks, piedmontite-bearing layers (Jurassic and Triassic(?))

pd - Metavolcanic rocks, piedmontite-bearing layers (Triassic(?) and Jurassic)
Goddard Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

JTRmpr - Mafic plutonic rock (Jurassic or Triassic)

JTRm - Mafic plutonic rock (Jurassic or Triassic)
<insert unit description> Description from source map: Mount Whitney 15' Quadrangle

JTRosg - Older sheared granite (Jurassic or Triassic)

JTRg - Older sheared granite (Jurassic or Triassic)
No further description provided. Description from source map: Mount Whitney 15' Quadrangle

JTRg - Gneiss (Jurassic and Triassic(?))

JTRg - Gneiss (Triassic(?) and Jurassic)
May be sheared granitic rock. Description from source map: Mount Goddard 15' Quadrangle

JTRgf - Felsic gneiss (Jurassic and Triassic(?))

JTRgf - Felsic gneiss (Triassic(?) and Jurassic)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

JTRrf - Metarhyolite lava flows (Jurassic or Triassic)

JTRrf - Metarhyolite lava flows (Triassic and Jurassic)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

JTRrp - Piedmontite-bearing metarhyolite tuffs (Jurassic or Triassic)

JTRrp - Piedmontite-bearing metarhyolite tuffs (Triassic and Jurassic)
Piedmontite-bearing metarhyolite tuffs. Description from source map: Mount Pichot 15' Quadrangle

JTRmp - Metawackes and pelitic hornfels (Jurassic and Triassic(?))

JTRms - Metawackes and pelitic hornfels (Triassic(?) and Jurassic)
Goddard Pendant. Locally includes marble and calc-hornfels. Description from source map: Mount Goddard 15' Quadrangle

JTRms - Metasedimentary tuff (Jurassic and Triassic(?))

JTRms - Metasedimentary tuff (Triassic(?) and Jurassic)
Goddard Pendant. Graded beds common. Rock is cleaved and lineated. Description from source map: Blackcap Mountain 15' Quadrangle

JTRrd - Metarhyolite and metadacite tuff (Jurassic and (or) Triassic)

JTRrd - Metarhyolite and metadacite tuff (Jurassic and (or) Triassic)
<insert unit description> Description from source map: Kern Peak 15' Quadrangle

MZv - Metavolcanic rocks (Mesozoic)
Chiefly metarhyolite and metadacite; minor metabasalt. Intruded by Independence pluton, Dragon pluton, and granodiorite of Lone Pine Creek. Most probable age is Late Triassic or Jurassic (Moore, 1981). Description from source map: Lone Pine 15' Quadrangle

JTRv - Chiefly metarhyolite and metadacite tuff (Jurassic or Triassic)
No further description provided. Description from source map: Mount Whitney 15' Quadrangle

JTRim - Intermediate to silicic metavolcanic rocks (Jurassic and (or) Triassic)
Chiefly massive metadacite containing abundant relict plagioclase phenocrysts. Includes metaquartz-plagioclase crystal-lithic tuffs of Black Kaweah. (*GRI Source Map ID 1914*) Description from source map: Triple Divide Peak 15' Quadrangle

JTRmamd - Meta-andesite and metadacite, undifferentiated tuffs (Jurassic or Triassic)

JTRa - Meta-andesite and metadacite, undifferentiated tuffs (Triassic and Jurassic)
Undifferentiated tuffs, breccias, and flows, with minor occurrences of interbedded basalt. Description from source map: Mount Pichot 15' Quadrangle

JTRaw - Meta-andesite and metadacite, water-laid tuffs (Jurassic or Triassic)

JTRaw - Meta-andesite and metadacite, water-laid tuffs (Triassic and Jurassic)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

TRma - Meta-andesite (Triassic)

Metamorphosed andesitic lava flows and breccias to the west of Mineral Peak in upper Crystal Creek and in adjacent basins. U-Pb zircon lower-intercept concordia model ages of 214 and 236 Ma (after Busby-Spera, 1983). Description from source map: Southwestern Sequoia National Park

MZm - Marble (Mesozoic)

JTRm - Marble (Jurassic and (or) Triassic)
Coarsely crystalline, schistose to gneissose, white to light-gray marble. Thin calc-silicate layers locally abundant. Conglomerate containing marble cobbles preserved on west side of Sheep Ridge. Description from source map: Giant Forest 15' Quadrangle

m - Marble (Mesozoic)
Coarsely crystalline, schistose to gneissose, white to blue-gray marble. Thin calc-silicate layers locally constitute up to 50 percent of exposures. Blue lines show marble bands too thin for map scale. Description from source map: Southwestern Sequoia National Park

MZccgl - Calc-silicate conglomerate (Mesozoic)

ccgl - Calc-silicate conglomerate (Mesozoic)
Dark weathering, well bedded calc-silicate conglomerate and pebbly sandstone with white felsite clasts. Underlies Cretaceous metarhyolite tuff and marks the nose of synclinorium through Vandever Mountain. Description from source map: Southwestern Sequoia National Park

MZcs - Calc-silicate hornfels and schist (Mesozoic)

cs - Calc-silicate hornfels and schist (Mesozoic)
Bedded, light-colored calc-silicate hornfels and schist after calcareous quartzo-feldspathic siltstone and sandstone. Commonly interstratified with subordinate argillaceous hornfels and schist, after mudstone, not resolvable at map scale. Description from source map: Southwestern Sequoia National Park

MZq - Quartzite (Mesozoic)

qz - Quartzite (Triassic(?) and Jurassic)
Goddard Pendant Includes pelitic and calcareous layers. Description from source map: Blackcap Mountain 15' Quadrangle

q - Quartzite (Mesozoic)
Medium- to coarse-grained quartzite, massive to medium-bedded. Description from source map: Southwestern Sequoia National Park

MZqb - Quartz-biotite schist and hornfels (Mesozoic)

JTRbs - Biotite-feldspar-quartz schist (Jurassic and (or) Triassic)
Reddish-brown weathering, biotite-feldspar-quartz schist commonly with andalusite or sillimanite. Schist is intercalated with thin (10 cm or less) layers of micaceous quartzite. Includes minor calc-silicate schist layers and sparse marble. Part of unit was assigned to MZqb according to T. Sission (2012, personal comm.). Description from source map: Giant Forest 15' Quadrangle

qb - Quartz-biotite schist and hornfels (Mesozoic)
Encompasses quartzo-feldspathic micaceous schist, phyllite, slate, and hornfels. Description from source map: Southwestern Sequoia National Park

MZqbcs - Quartz-biotite and calc-silicate schist and hornfels (Mesozoic)

JTRbs - Biotite-feldspar-quartz schist (Jurassic and (or) Triassic)
Reddish-brown weathering, biotite-feldspar-quartz schist commonly with andalusite or sillimanite. Schist is intercalated with thin (10 cm or less) layers of micaceous quartzite. Includes minor calc-silicate schist layers and sparse marble. Part of unit was assigned to MZqb according to T. Sission (2012, personal comm.). Description from source map: Giant Forest 15' Quadrangle

qbcs - Quartz-biotite and calc-silicate schist and hornfels (Mesozoic)
Undivided quartzo-feldspathic micaceous and calc-silicate schist and hornfels. Description from source map: Southwestern Sequoia National Park

MZslp - Slate and phyllite (Mesozoic)

slp - Slate and phyllite (Mesozoic)
Fissle slate, phyllite, and dark-colored argillaceous hornfels derived from mudstone. Description from source map: Southwestern Sequoia National Park

MZslhf - Siliceous hornfels (Mesozoic)

slhf - Siliceous hornfels (Mesozoic)
Thin-bedded, fine-grained siliceous hornfels with subordinate interstratified metaargillite after quartzo-feldspathic siltstone and fine-grained sandstone. Description from source map: Southwestern Sequoia National Park

MZvss - Volcaniclastic metasandstone (Mesozoic)

vss - Volcaniclastic metasandstone (Mesozoic)
Medium- to thin-bedded metasandstone, with rare interstratified lenses of volcaniclastic breccia, on the west side of Mineral King pendant; metasandstone contains relict detrital grains of felsite and of phenocryst fragments Description from source map: Southwestern Sequoia National Park

MZss - Metasandstone (Mesozoic)

ss - Metasandstone (Mesozoic)
Rhythmically bedded arkosic metasandstones after turbidity current deposits (Busby-Spera, 1985) on east side of Mineral King pendant. Description from source map: Southwestern Sequoia National Park

MZtc - Tactite (Mesozoic)

tc - Tactite (Mesozoic)
Dark brown, coarse-grained rocks consisting of calcic garnet, epidote, diopside, and idocrase, developed along contacts between granite and marble or calc-silicate rocks. Description from source map: Southwestern Sequoia National Park

MZmpr - Mafic plutonic rocks (Mesozoic)

MZm - Mafic plutonic rocks (Mesozoic)
Quartz diorite, diorite, and hornblende gabbro. Intruded by Independence pluton and granodiorite of Lone Pine Creek. Exact age unknown. Description from source map: Lone Pine 15' Quadrangle

MZvh - Hypersthene-bearing metadacite tuff (Mesozoic)

Chiefly metarhyolite and metadacite tuff includes meta-andesite and metabasalt. and layers of metasedimentary rocks. Hypersthene-bearing metadacite tuff. Description from source map: Marion Peak 15' Quadrangle

MZvp - Metaquartz porphyry (Mesozoic)

Chiefly metarhyolite and metadacite tuff includes meta-andesite and metabasalt. and layers of metasedimentary rocks. Metaquartz porphyry. Description from source map: Marion Peak 15' Quadrangle

TRu - Union Wash Formation (Middle? and Early Triassic)

Consists of an upper member of dark-gray micritic limestone, pink shale, and light-brown siltstone about 90 m thick; a middle member of medium- to dark-gray, thin bedded mudstone, siltstone, very fine grained to fine-grained sandstone, and micritic limestone about 680 m thick; and, in part of the area, a lower member of ledge-forming, light-gray to brown limestone and silty to fine-grained sandy limestone as much as 60 m thick (Stone and others, 1991). Ammonoids locally abundant in basal parts of middle and upper members. Basal 25 m of unit on ridge 1 km southeast of Fossil Hill consists of argillite, silty limestone, minor granule to pebble conglomerate, and hydrothermal or metamorphic talc; this sequence previously was interpreted as Permian in age and assigned to the Conglomerate Mesa Formation by Stone and Stevens (1987) and Stone and others (1991). Description from source map: Lone Pine 15' Quadrangle

TRPc - Conglomerate Mesa Formation (Early Triassic and Late Permian)

Consists of an upper and a lower unit equivalent to members C and B of Conglomerate Mesa Formation as defined by Stone and Stevens (1987). Upper unit (member C), about 40 m thick, consists of brown, ochre, and gray chert-pebble conglomerate, pebbly calcareous sandstone, and sandstone. Lower unit (member B), about 130 m thick with the base covered, consists of gray to brown limestone, silty to sandy limestone, and minor grayish-orange to maroon siltstone and shale. Limestone in member B contains locally abundant brachiopods, gastropods, bryozoa, and echinoderm debris. Member C is apparently conformable with lower member of Union Wash Formation and is here interpreted as Early Triassic in age. Formation was assigned a Late Permian age by Stone and Stevens (1987) on the basis of fossils in member B. Contact between members C and B (not shown) is interpreted as unconformable. Description from source map: Lone Pine 15' Quadrangle

MZPZhs - Pelitic hornfels and schist (Mesozoic or Paleozoic)

phq - Pelitic hornfels, micaceous quartzite, and schist (Paleozoic and Mesozoic)
No further description provided. Description from source map: Bishop District and Owens Valley

phq - Pelitic hornfels micaceous quartzite, and schist (Triassic(?) and Jurassic)
Pelitic hornfels, micaceous quartzite, and schist includes minor calc-hornfels. Description from source map: Blackcap Mountain 15' Quadrangle

hs - Pelitic hornfels and schist (Paleozoic or Mesozoic)
Pelitic hornfels and schist. Description from source map: Marion Peak 15' Quadrangle

phq - Pelitic hornfels, micaceous quartzite, and schist (Lower Paleozoic)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

MZPZch - Calc-hornfels (Mesozoic or Paleozoic)

ch - Calc-hornfels (Paleozoic and Mesozoic)
No further description provided. Description from source map: Bishop District and Owens Valley

ch - Calc-hornfels (Triassic(?) and Jurassic)
Includes minor marble and pelitic hornfels. Description from source map: Blackcap Mountain 15' Quadrangle

ch - Calc-hornfels (Paleozoic or Mesozoic)
No further description provided. Description from source map: Marion Peak 15' Quadrangle

ch - Calc-hornfels (Lower Paleozoic)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

PZch - Calc-hornfels (Paleozoic)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

PZbs - Biotite schist (Paleozoic)

No further description provided. Description from source map: Mount Pichot 15' Quadrangle

PZph - Pelitic hornfels and quartzite (Paleozoic)

No further description provided. Description from source map: Mount Pichot 15' Quadrangle

Plu - Lone Pine Formation, upper part (Early Permian)

Reward Conglomerate Member and member C, undivided. Reward Conglomerate Member, about 200 m thick, consists of dark-gray to brown, thick-bedded, medium- to coarse-grained quartzite and chert- and quartzite-pebble conglomerate; basal few meters consist of light-gray sandy limestone and marble. Member C, about 120 m thick, consists of dark brown, massive quartzose siltstone and hornfels interbedded with minor fine- to coarse-grained quartzite and rare chert- and quartzite-pebble conglomerate. Unit is truncated southeastward by angular unconformity beneath Union Wash Formation. Description from source map: Lone Pine 15' Quadrangle

Pll - Lone Pine Formation, lower part (Early Permian)

Members B and A, undivided. Member B, about 180 m thick, consists of greenish-gray to reddish-brown, thin-bedded calcareous mudstone, siltstone, and calc-hornfels, and a few widely spaced beds of gray bioclastic limestone or marble 1 to 3 m thick. Member A, about 500 m thick, generally is metamorphosed and consists primarily of gray to reddish-brown, thin-bedded argillite, siltite, fine-grained quartzite, and calc-hornfels. Metamorphic grade decreases near east edge of quadrangle, where member A consists of light- to medium-gray, siliceous to calcareous mudstone, calcareous siltstone to very fine grained sandstone, and silty limestone. Description from source map: Lone Pine 15' Quadrangle

PPNk - Keeler Canyon Formation (Early Permian and Pennsylvanian)

Light- to medium-gray, medium- to thick-bedded limestone and silty to sandy limestone, generally metamorphosed to marble and calc-hornfels. Thickness about 500 m; base not exposed. Description from source map: Lone Pine 15' Quadrangle

PZms - Metasedimentary rocks (Paleozoic?)

Calcitic marble and calc-hornfels forming small pendant in northern part of Alabama Hills Granite (Kah). Description from source map: Lone Pine 15' Quadrangle

PZmqh - Micaceous quartzite and pelitic hornfels (Lower Paleozoic)

mqh - Micaceous quartzite and pelitic hornfels (Lower Paleozoic)
Bishop Creek Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

PZsch - Siliceous calc-hornfels (Lower Paleozoic)

sch - Siliceous calc-hornfels (Lower Paleozoic(?))
Bishop Creek Pendant. No further description provided. Description from source map: Bishop District and Owens Valley

sch - Siliceous calc-hornfels (Lower Paleozoic)
Bishop Creek Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

PZcth - Metachert and andalusite-bearing pelitic hornfels (Lower Paleozoic)

cth - Metachert and andalusite-bearing pelitic hornfels (Lower Paleozoic(?))
Bishop Creek Pendant. No further description provided. Description from source map: Bishop District and Owens Valley

cth - Metachert and andalusite-bearing pelitic hornfels (Lower Paleozoic)
Bishop Creek Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

PZm - Marble (Lower Paleozoic)

m - Marble (Paleozoic and Mesozoic)
No further description provided. Description from source map: Bishop District and Owens Valley

m - Marble (Lower Paleozoic)
No further description provided. Description from source map: Mount Goddard 15' Quadrangle

PZm - Marble (Paleozoic)
No further description provided. Description from source map: Mount Pichot 15' Quadrangle

PZcph - Banded calc-hornfels and pelitic hornfels (Lower Paleozoic)

cph - Banded calc-hornfels and pelitic hornfels (Lower Paleozoic)
Bishop Creek Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

PZmb - Marble (Lower Paleozoic)

mb - Marble (Lower Paleozoic)
Bishop Creek Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

PZphm - Pelitic hornfels and interbeds of marble (Lower Paleozoic)

phm - Pelitic hornfels and interbeds of marble (Lower Paleozoic(?))
Bishop Creek Pendant. No further description provided. Description from source map: Bishop District and Owens Valley

phm - Pelitic hornfels and interbeds of marble (Lower Paleozoic)
Bishop Creek Pendant. No further description provided. Description from source map: Mount Goddard 15' Quadrangle

Cp - Poleta formation (Cambrian)

Sedimentary rocks of the White Mountains. No further description provided. Description from source map: Bishop District and Owens Valley

Cca - Campito formation, Andrews Mountain member (Cambrian)

Sedimentary rocks of the White Mountains. No further description provided. Description from source map: Bishop District and Owens Valley

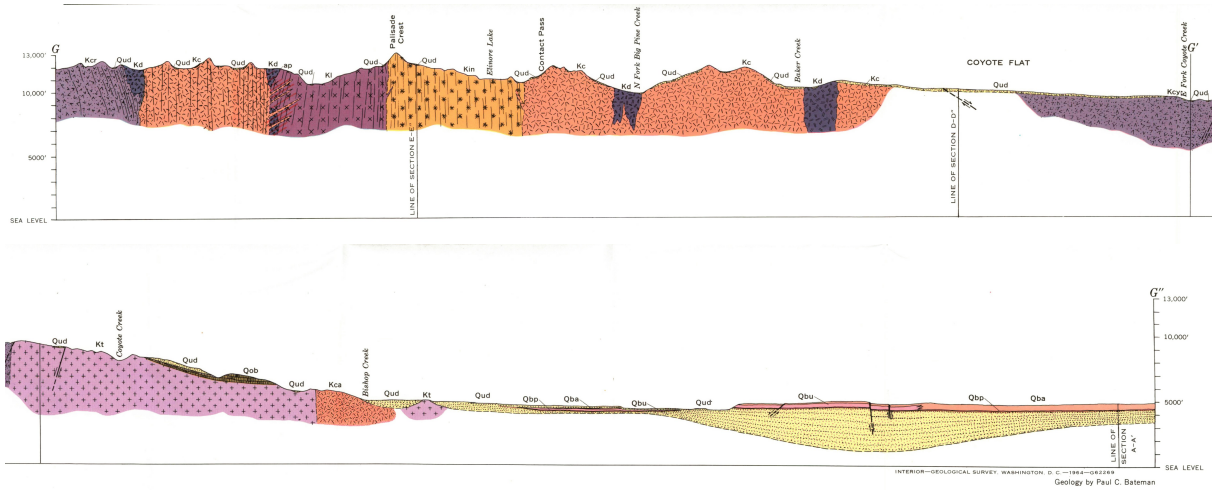
q - unnamed unit (age unknown)

Unit not listed in source map Description of Map Units. Lithology and composition assumed. No further description provided. Description from source map: Olancha 15' Quadrangle

Geologic Cross Sections

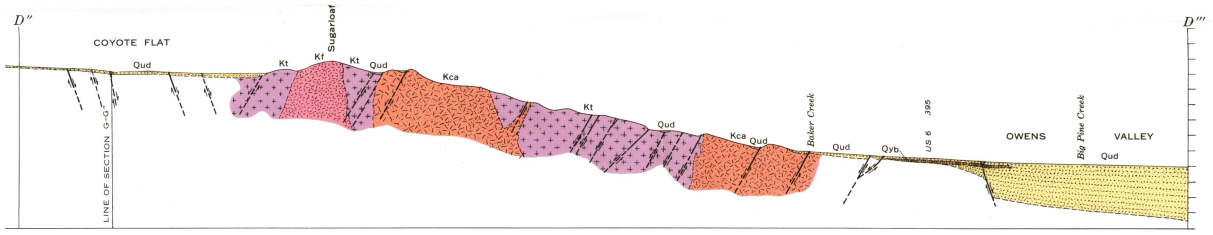
The geologic cross sections present in the GRI digital geologic-GIS data produced for Sequoia & Kings Canyon National Parks, California (SEKI) are presented below. Note that most cross section abbreviations (e.g., A - A') have been changed from their source map abbreviation in the GRI digital geologic-GIS data so that each cross section abbreviation is unique. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



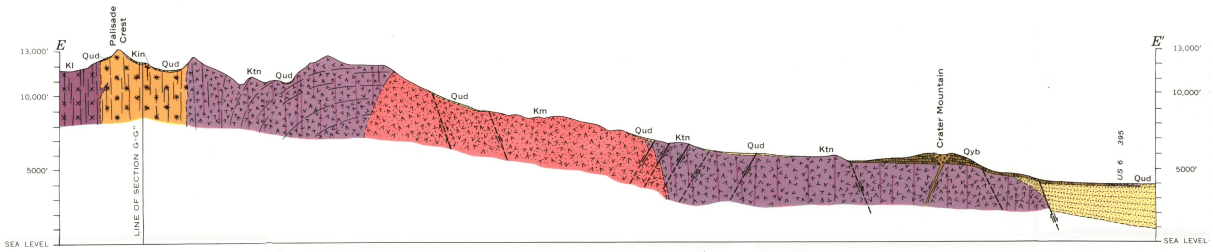
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Cross Section B-B'



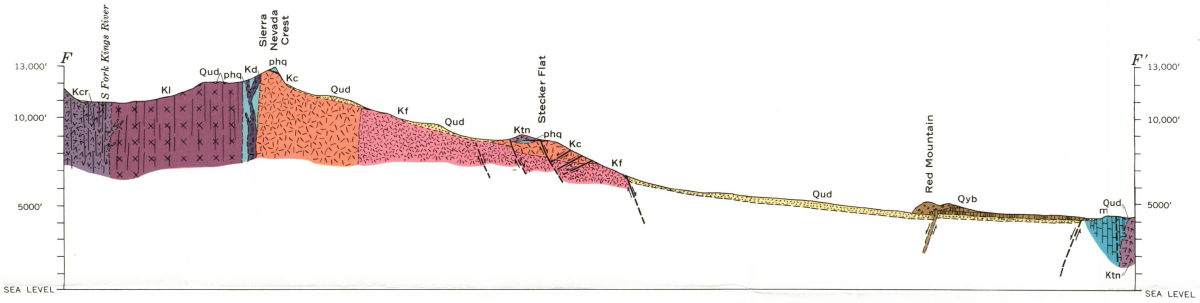
Cross section D"-D"' on source map. Graphic from source map: Bishop District and Owens Valley.

Cross Section C-C'



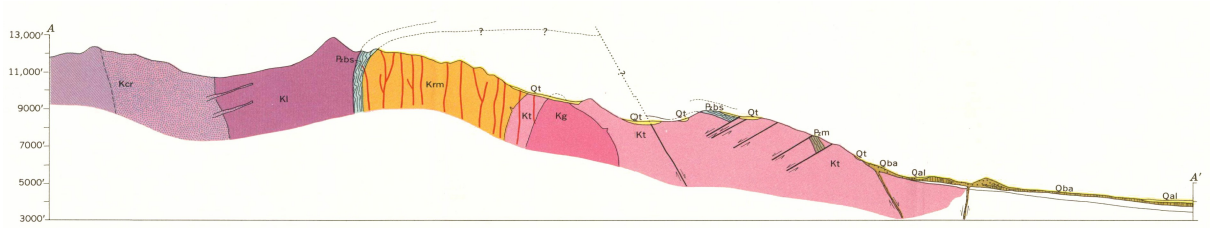
Cross section E-E' on source map. Graphic from source map: Bishop District and Owens Valley.

Cross Section D-D'



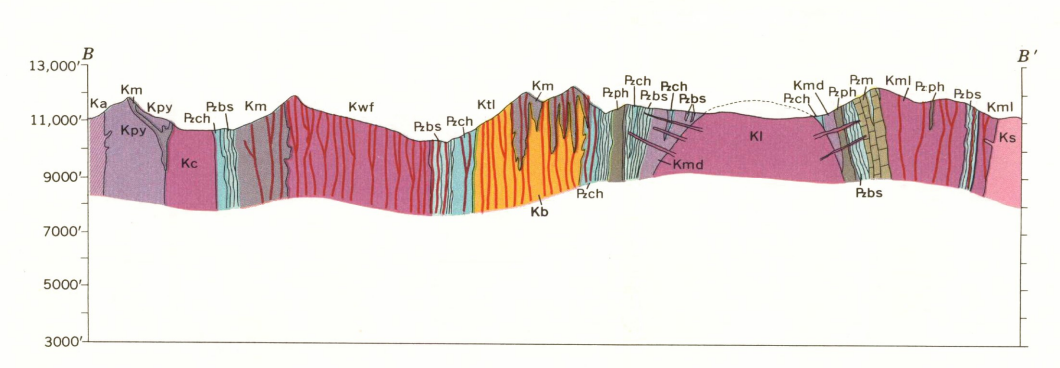
Cross section F-F' on source map. Graphic from source map: Bishop District and Owens Valley.

Cross Section E-E'



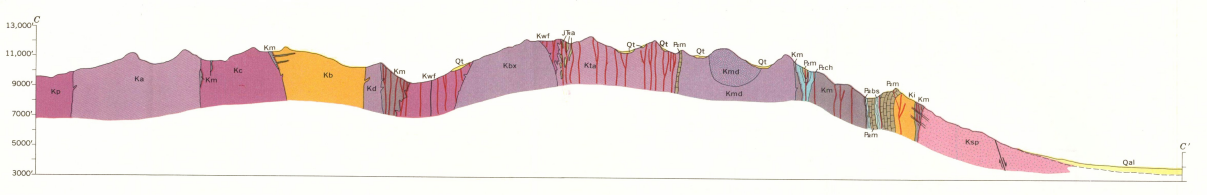
Cross section A-A' on source map. Graphic from source map: Mount Pichot 15' Quadrangle.

Cross Section F-F'



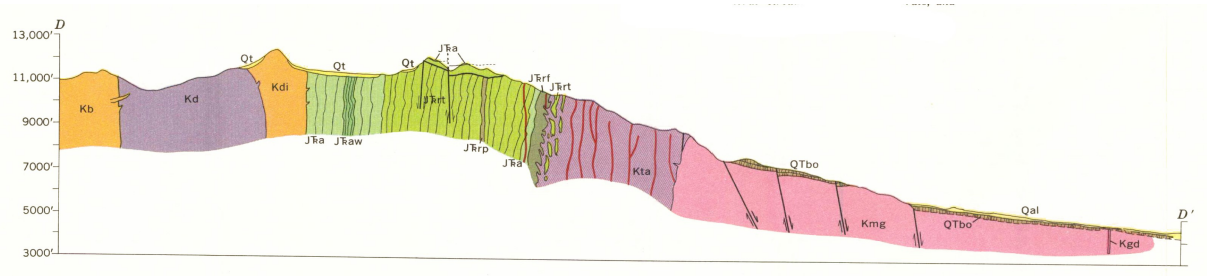
Cross section B-B' on source map. Graphic from source map:Mount Pichot 15' Quadrangle.

Cross Section G-G'



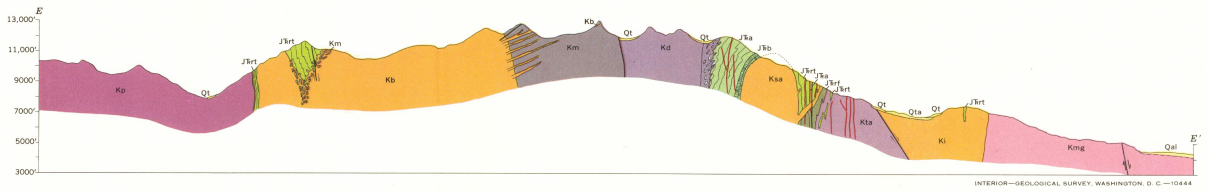
Cross section C-C' on source map. Graphic from source map: Mount Pichot 15' Quadrangle.

Cross Section H-H'



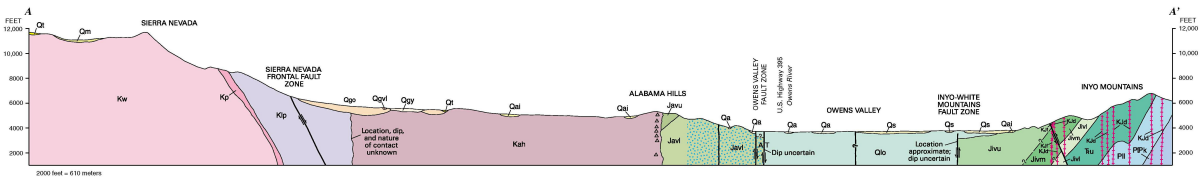
Cross section D-D' on source map. Graphic from source map: Mount Pichot 15' Quadrangle.

Cross Section I-I'



Cross section E-E' on source map. Graphic from source map: Mount Pichot 15' Quadrangle.

Cross Section J-J'



Cross section A-A' on source map. Graphic from source map: Lone Pine 15' Quadrangle.

Ancillary Source Map Information

The following sections present ancillary source map information associated with source maps used for this project.

Bishop District and Owens Valley

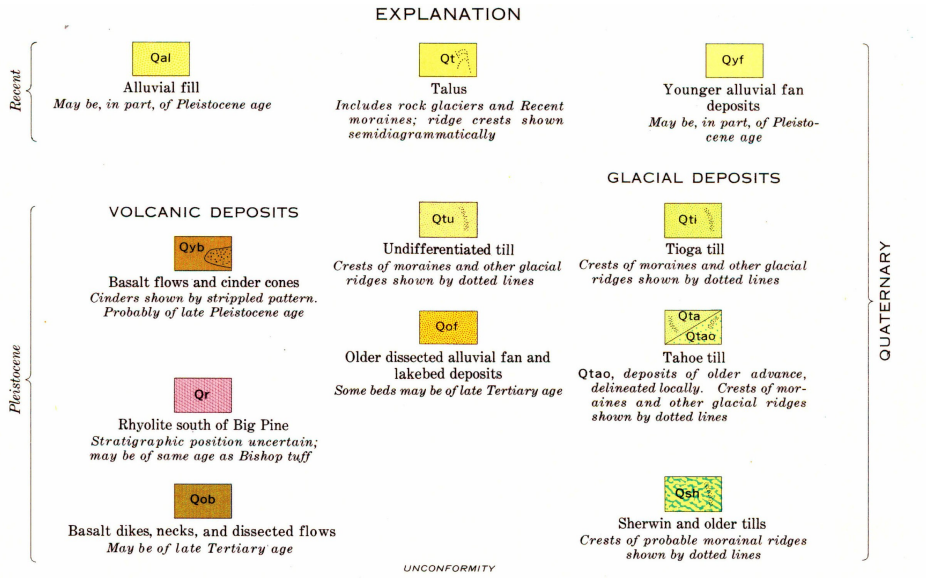
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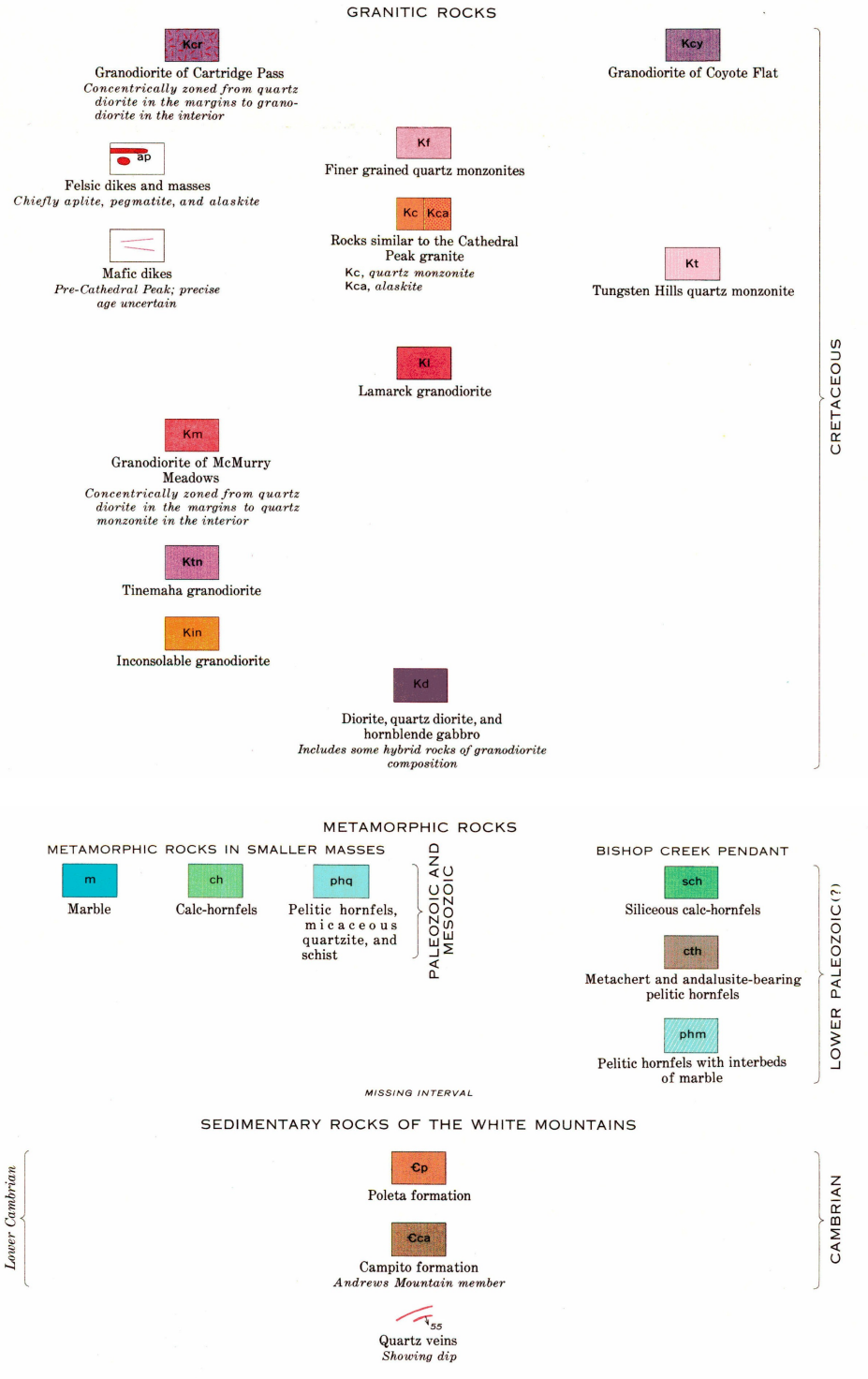
> Bateman, P.C., Pakiser, L.C., and Kane, M.F., 1965, Geology and Tungsten Mineralization of the Bishop District, California, with a Section on Gravity Study of Owens Valley and a Section on Seismic Profile, Plate 4, U.S.Geological Survey, PP 470, 1:62,500 scale.(*GRI Source Map ID 74452*).

U.S. Geological Survey PP 470 includes a report and 11 plates (see Big Pine Report below). For the GRI digital geologic-GIS map only Plate 4, Geologic Map of the Big Pine 15-minute Quadrangle, was used. Thus, what is presented in the GRI digital geologic-GIS data, and this document, is only a subset of the full source publication.

Prominent graphics and text associated with this source:

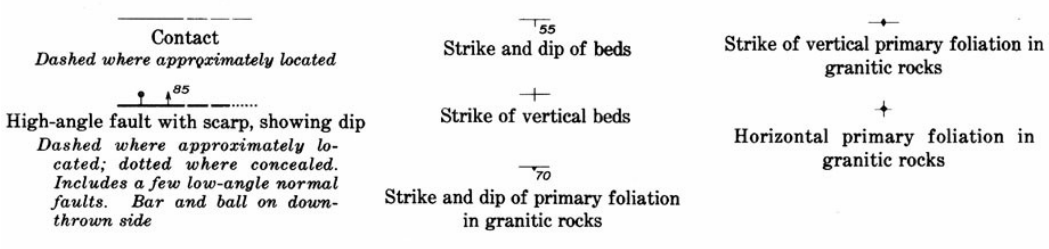
Correlation of Map Units





Graphic from source map: [Bishop District and Owens Valley]

Map Legend



Graphic from source map: Bishop District and Owens Valley

Index Map

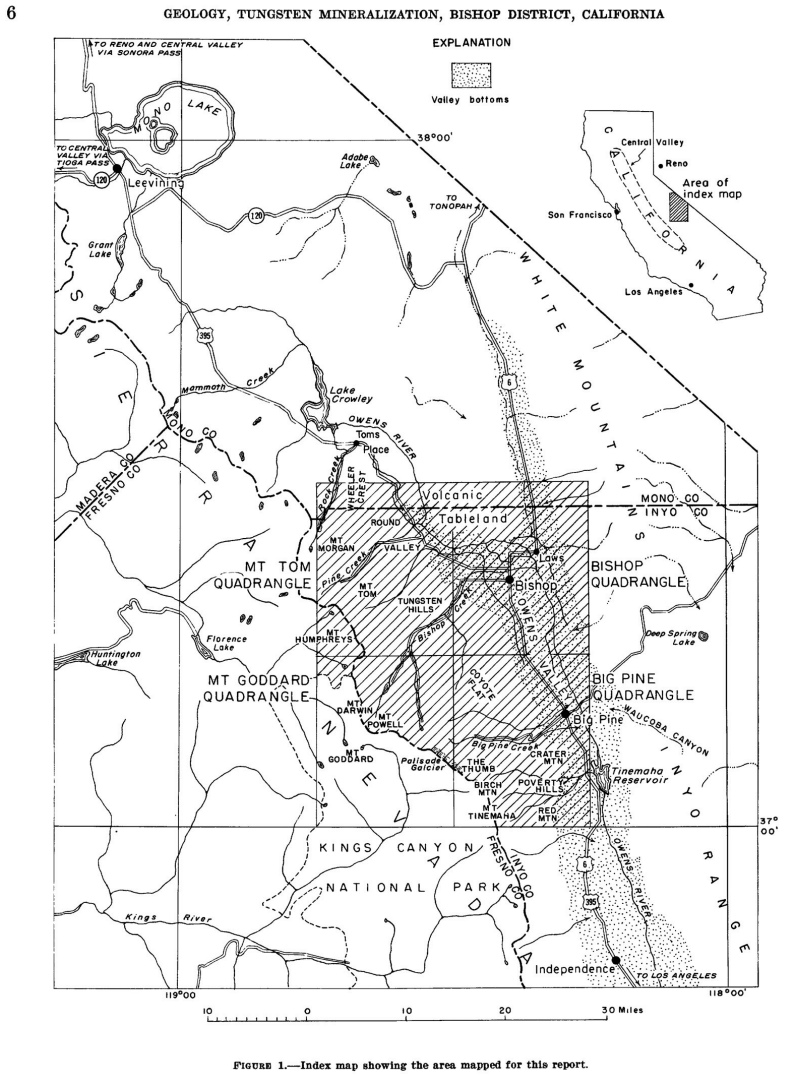


FIGURE 1.—Index map showing the area mapped for this report.

Graphic from source map: Bishop District and Owens Valley

Report

The complete USGS report and plates are available for download from the USGS Publication Warehouse web page. A full-text PDF version of the report is available, as well as, the 11 accompanying plates.

Publication Warehouse web page; http://pubs.er.usgs.gov/publication/pp470

National Geologic Map Database web page: http://ngmdb.usgs.gov/Prodesc/proddesc_4474.htm

PP 470 Plate Index

- Plate 1. Geologic Map Of Part of the Mount Goddard 15-Minute Quadrangle.
- Plate 2. Geologic Map of the Mount Tom 15-Minute Quadrangle.
- Plate 3. Geologic Map of the Bishop 15-Minute Quadrangle.
- Plate 4. Geologic Map of the Big Pine 15-Minute Quadrangle.
- Plate 5. Geologic Cross Sections In The Mount Tom, Bishop, Big Pine, And Part of the Mount Goddard 15-Minute Quadrangles.
- Plate 6. Block Diagram Showing An Interpretation of the Structure of the White Mountains In The Bishop Quadrangle.
- Plate 7. Structure Map of the Mount Tom, Bishop, Big Pine, And Part of the Mount Goddard 15-Minute Quadrangles.
- Plate 8. Map Of Structures Attributed To Forcible Emplacement Of Granitic Rocks.
- Plate 9. Block Diagram of the Pine Creek Mine.
- Plate 10. Cross Section From San Andreas Rift Eastward Across San Joaquin Valley And Sierra Nevada To Panamint Valley.
- Plate 11. Gravity Profiles And Interpreted Structure Sections

Of note, for the GRI digital geologic-GIS data only plate 4, Geologic Map of the Big Pine 15-minute Quadrangle, was used, and thus what is presented in the GRI digital geologic-GIS data and this document is only a subset of the full source map publication.

Report from source map: Bishop District and Owens Valley

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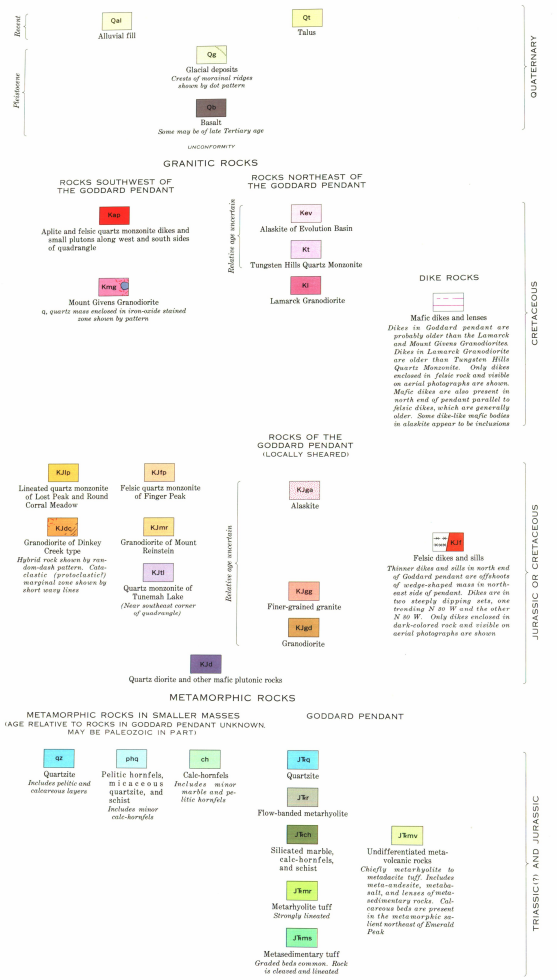
Blackcap Mountain 15' Quadrangle

The formal citation for this source.

Bateman, P.C., 1965, Geologic Map of the Blackcap Mountain Quadrangle, Fresno County, California, U.S. Geological Survey, GQ-428, 1:62,500 scale. (*GRI Source Map ID 1896*).

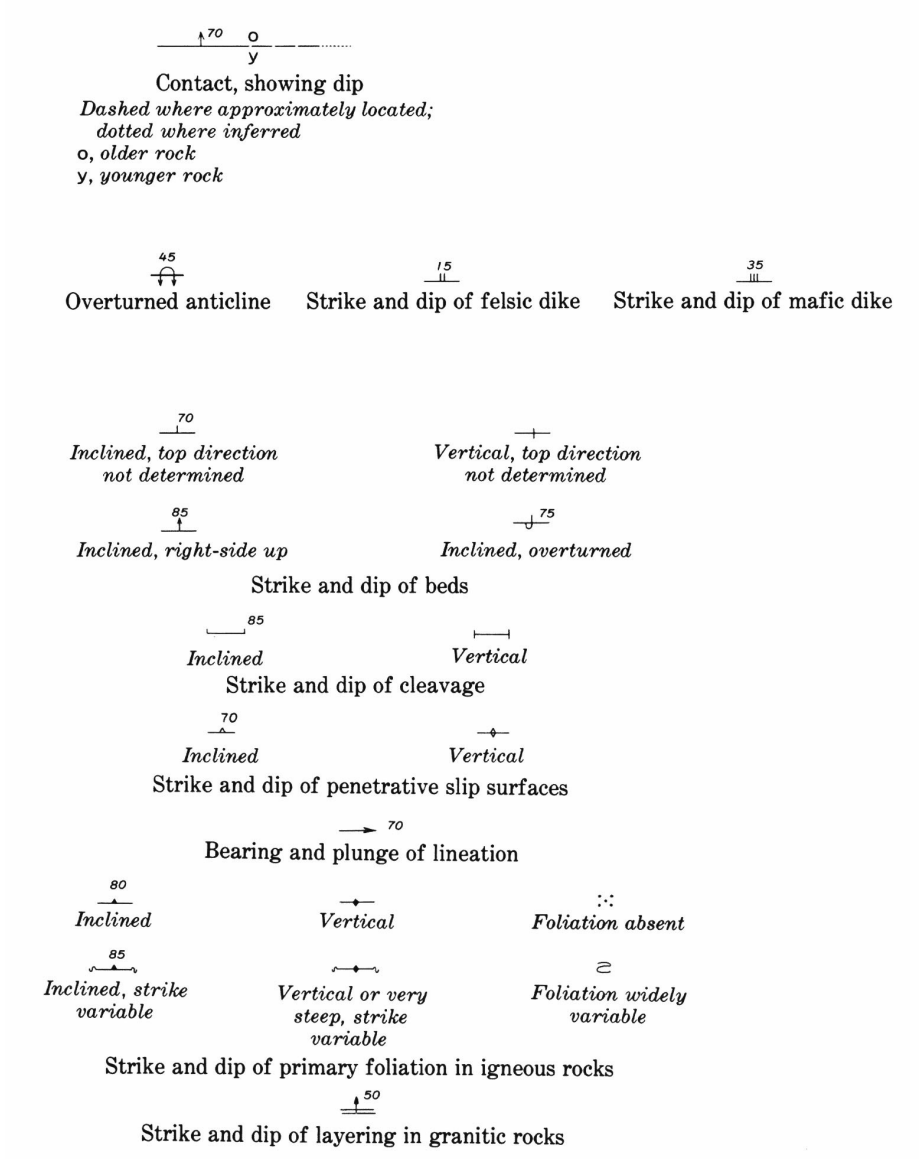
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Correlation of Map Units



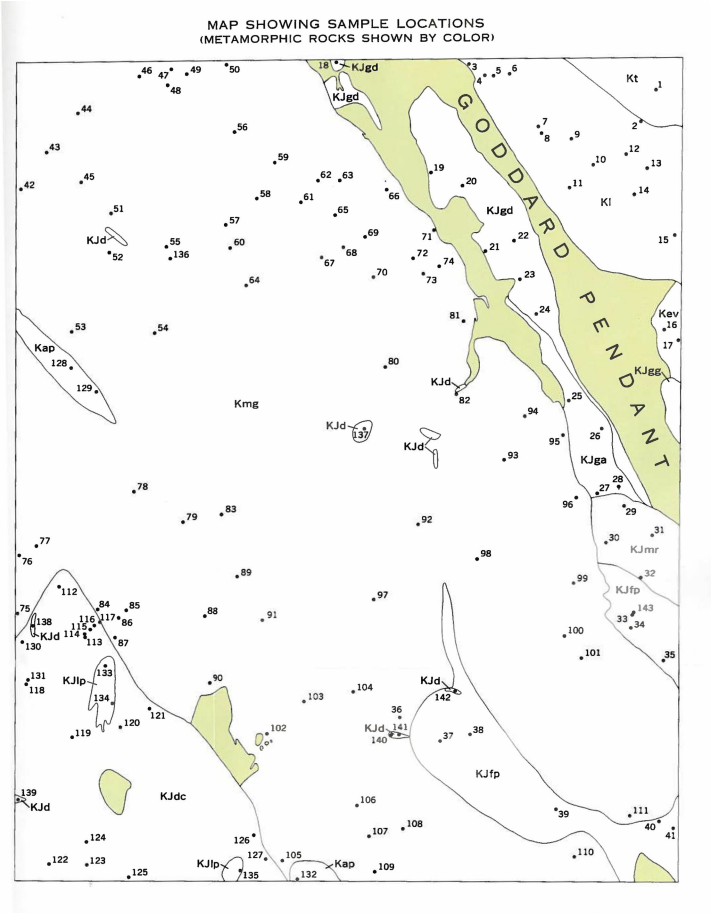
Graphic from source map: [Blackcap Mountain 15' Quadrangle]

Map Legend



Graphic from source map: Blackcap Mountain 15' Quadrangle

Location of Rock Samples



Graphic from source map: Blackcap Mountain 15' Quadrangle

Modal Analytical Results

MODAL ANALYSES OF GRANITIC ROCKS
(1000 TO 2000 point counts on a stained slab of at least 6 square inches)

Analyst: M. B. Norman

Tungsten Hills Quartz Monzonite (Kt)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
1	2.68	24.5	24.6	40.5	10.4
2	2.73	20.0	17.1	46.6	16.3

Lamarck Granodiorite (KI)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
3	2.67	23.0	20.1	45.6	11.2
4	2.73	22.9	11.3	43.0	22.8
5	2.67	17.4	9.2	53.7	19.7
6	2.69	18.1	8.6	53.5	19.8
7	2.69	23.8	12.2	45.2	18.8
8	2.71	16.7	9.3	50.3	23.7
9	2.74	11.5	6.7	54.9	26.9
10	2.69	21.6	13.1	46.9	18.4
11	2.68	29.6	26.8	32.1	11.5
12	2.75	11.6	6.3	50.9	31.2
13	2.75	10.6	6.7	48.7	34.0
14	2.67	19.3	19.4	41.2	20.1
15	2.72	18.4	8.5	49.5	23.6

Alaskite of Evolution basin (Kev)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
16	2.60	38.8	37.9	21.7	1.6
17	2.60	37.0	37.7	22.6	2.7

Granodiorite of Goddard pendant (KJgd)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
18	2.62	17.4	33.4	40.6	8.6
19	2.71	20.2	14.2	48.1	17.5
20	2.64	26.3	26.0	39.3	8.4
21	2.74	20.7	9.1	45.0	25.2
22	2.68	20.4	14.0	43.8	21.8
23	2.65	30.5	18.4	33.5	17.6
24	2.69	15.2	11.3	51.8	21.7

Alaskite of Goddard pendent (KJga)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
25	2.61	32.9	35.1	30.6	1.4
26	2.63	27.8	18.9	45.8	7.5
27	2.61	34.1	35.6	29.4	0.9
28	2.62	26.3	28.9	42.0	2.8

Granodiorite of Mount Reinstein (KJmr)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
29	2.73	18.4	10.8	50.7	20.1
30	2.70	23.0	21.2	42.9	12.9
31	2.75	16.9	10.8	50.4	21.9
32	2.68	25.9	21.4	40.8	11.9

Felsic quartz monzonite of Finger Peak (KJfp)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
33	2.64	30.8	29.8	35.8	3.6
34	2.63	32.7	26.5	36.5	4.3
35	2.63	35.5	29.1	32.7	2.7
36	2.61	34.9	32.8	30.6	1.7
37	2.64	32.1	26.7	38.0	4.2
38	2.63	28.7	26.8	38.4	6.1
39	2.63	31.7	30.4	34.1	3.8
40	2.63	29.5	26.9	39.1	4.5
41	2.63	33.3	28.7	34.3	3.7

Mount Givens Granodiorite (Kmg)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
42	2.68	25.2	13.3	48.2	13.3
43	2.68	22.7	21.2	37.7	13.4
44	2.61	28.6	22.1	39.2	10.1
45	2.71	25.0	14.5	43.2	17.3
46	2.71	23.4	7.8	47.2	21.6
47	2.65	27.2	22.9	35.6	14.3
48	2.69	25.3	12.8	45.4	16.5
49	2.67	26.5	11.4	42.7	19.4
50	2.73	22.6	6.7	52.4	18.3
51	2.69	22.2	19.3	42.6	15.9
52	2.68	24.4	14.8	49.2	11.6
53	2.63	24.5	25.9	42.8	6.8
54	2.65	28.3	23.1	40.9	7.7
55	2.67	29.3	18.2	40.6	11.9
56	2.67	24.2	24.4	37.8	13.6

Mount Givens Granodiorite (Kmg)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
57	2.63	29.0	19.2	38.0	13.8
58	2.68	27.3	13.9	46.2	12.6
59	2.68	24.1	20.7	40.4	14.8
60	2.64	27.2	22.7	42.9	7.2
61	2.69	24.9	17.2	40.9	17.0
62	2,70	27.0	16.4	40.5	16.1
63	2.72	26.2	13.1	45.1	16.6
64	2.66	24.3	18.3	42.4	15.0
65	2.72	24.6	14.9	45.3	15.2
66	2.68	25.0	15.7	44.5	14.8
67	2.78	17.2	18.2	34.2	30.4
68	2.68	23.5	20.8	44.7	11.0
69	2.71	19.1	12.8	48.1	20.0
70	2.71	24.9	12.0	46.1	17.0
71	2.67	24.8	14.3	50.6	10.3
72	2.73	22.4	13.7	45.4	18.5
73	2.72	21.5	11.0	49.9	17.6
74	2.73	24.4	14.0	46.9	14.7
75	2.71	23.3	14.4	49.3	13.0
76	2.68	25.3	15.8	47.7	11.2
77	2.65	28.4	23.4	40.2	8.0
78	2.62	32.6	24.4	37.6	5.4
79	2.60	29.6	28.6	37.7	4.1
80	2.72	18.9	11.9	49.8	19.4
81	2.65	24.3	26.4	42.2	7.1
82	2.68	24.7	15.9	47.9	11.5
83	2.62	28.9	30.3	33.6	7.2
84	2.66	23.1	17.1	49.0	10.8
85	2.67	27.0	18.1	45.5	9.4
86	2.70	28.1	19.0	39.0	13.9
87	2.67	20.2	17.1	45.9	16.8
88	2.64	25.9	24.5	43.9	5.7
89	2.62	25.5	23.2	40.7	10.6
90	2.68	24.5	17.1	45.7	12.7
91	2.66	27.0	20:09	43.3	8.8
92	2.69	25.2	13.8	43.4	13.6
93	2.63	28.4	24.7	41.9	5.0
94	2.64	25.4	25.7	43.0	5.9
95	2.68	19.3	26.1	42.3	12.3
96	2.67	24.7	19.7	45.9	9.7
97	2.66	27.5	22.2	44.0	6.3
98	2.68	25.3	19.8	43.7	11.2
99	2.66	29.9	21.8	41.1	7.2
100	2.67	24.8	25.5	42.1	7.6
101	2.67	24.3	26.6	40.4	8.7
102	2.70	25.0	16.8	46.5	11.7
103	2.67	25.4	20.4	44.4	9.8
104	2.67	25.4	16.8	47.2	10.6
105	2.70	23.8	14.2	49.1	12.9
106	2.68	24.8	21.8	43.8	9.6

Mount Givens Granodiorite (Kmg)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
107	2.67	25.7	17.0	48.9	8.4
108	2.67	28.2	20.9	42.1	8.8
109	2.65	30.0	20.8	42.0	7.2
110	2.70	25.2	15.6	46.8	12.4
111	2.69	20.0	19.3	46.5	14.2

Granodiorite of Dinkey Creek type (KJdc)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
112	2.68	30.8	20.8	37.5	10.9
113	2.69	23.3	23.1	40.7	12.9
114	2.70	26.6	19.6	38.4	15.4
115	2.72	23.3	16.4	44.0	12.3
116	2.72	28.5	17.0	38.3	16.2
117	2.72	19.2	11.9	48.4	20.5
118	2.65	27.7	30.8	35.4	6.1
119	2.70	23.8	20.5	40.4	15.3
120	2.77	18.7	7.7	49.3	24.3
121	2.72	20.5	11.5	47.4	20.6
122	2.75	20.5	7.8	46.8	24.9
123	2.70	28.5	20.3	36.7	14.5
124	2.79	19.0	6.4	45.3	29.3
125	2.78	20.0	6.5	50.5	23.0
126	2.71	25.0	12.8	42.9	19.3
127	2.74	24.5	11.4	45.2	18.9

Aplite and felsic quartz monzonite dikes and small plutons along the west and south sides of the quadrangle (Kap)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
128	2.63	29.8	27.0	37.8	5.4
129	2.59	34.4	24.1	37.8	3.7
130	2.63	30.4	32.8	32.2	4.6
131	2.64	29.0	28.3	37.7	5.0
132	2.63	33.8	20.5	41.8	3.9

Lineated quartz monzonite of Lost Peak and Round Corral Meadow (KJlp)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
133	2.62	31.2	31.7	32.4	4.7
134	2.63	32.8	32.8	29.3	5.1
135	2.63	27.9	35.6	31.6	4,9

Quartz diorite and other mafic plutonic rocks (KJd)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals

136	2.78	10.8	2.5	53.0	33.7
137	2.74	12.3	7.5	52.8	27.4
138	2.71	22.3	14.5	49.3	13.9
139	2.74	24.6	7.1	45.8	22.5
140	2.78	19.4	11.0	46.8	22.8
141	2.76	21.9	7.8	47.0	23.3
142	2.77	19.2	0.1	55.3	25.4
143	2.76	18.2	0.1	56.1	25.6

Tables from source map: Blackcap Mountain 15' Quadrangle

Chemical Analyses

Standard Chemical Analyses Analyst Dorthy F. Powers Standard rock analyses - analyst: Vertie C. Smith			
	Mt Givens Granodiorite		Granodiorite of Dinkey Creeh
Sample No.	47	84	122
SiO2	67.36	68.42	61.68
Al203	14.72	14.36	15.94
Fe203	1.42	1.80	0.97
Fe0	2.61	1.94	5.12
Mg0	1.74	1.45	2.75
Ca0	3.90	3.65	5.73
Na20	3.07	3.59	2.82
K20	3.45	2.80	2.34
H,o+	0.40	0.33	0.87
H 20 -	0.07	0.06	0.05
Ti02	0.57	0.61	0.88
P205	0.13	0.19	0.17
Mn0	0.09	0.07	0.11
CO2	0.08	0.02	0.03
Cl	0.01	0.00	0.03
F	0.03	0.04	0.05
Sub-total	99.65	99.33	99.54
Less O	0.01	0.02	0.03
Total	99.64	99.31	99.51

Table from source map: Blackcap Mountain 15' Quadrangle

CIPW Norms

C.I.P.W Norms			
	Mt Givens Granodiorite		Granodiorite of Dinkey Creek
Sample No.	47	84	122
Q	24.76	23.04	18.96
or	20.57	16.68	13.34
ab	36.20	30.39	23.58
an	15.85	14.73	24.19
di	2.47	3.95	3.57
by	5.71	5.18	12.30
mt	2.09	0.70	1.39
it	1.22	1.22	1.67
Total	99.89	98.89	99

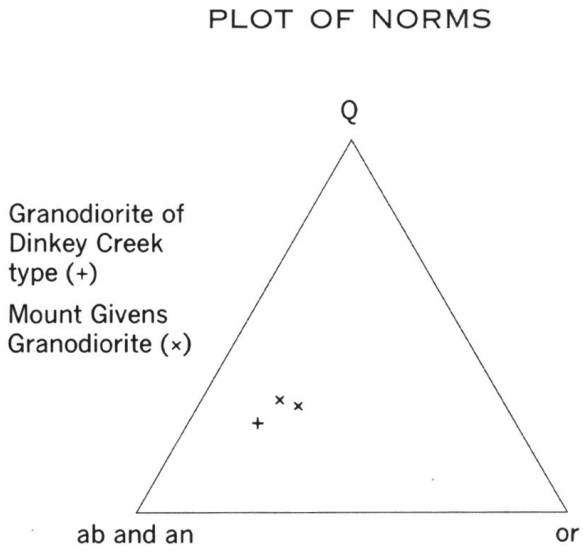


Table and graphic from source map: Blackcap Mountain 15' Quadrangle

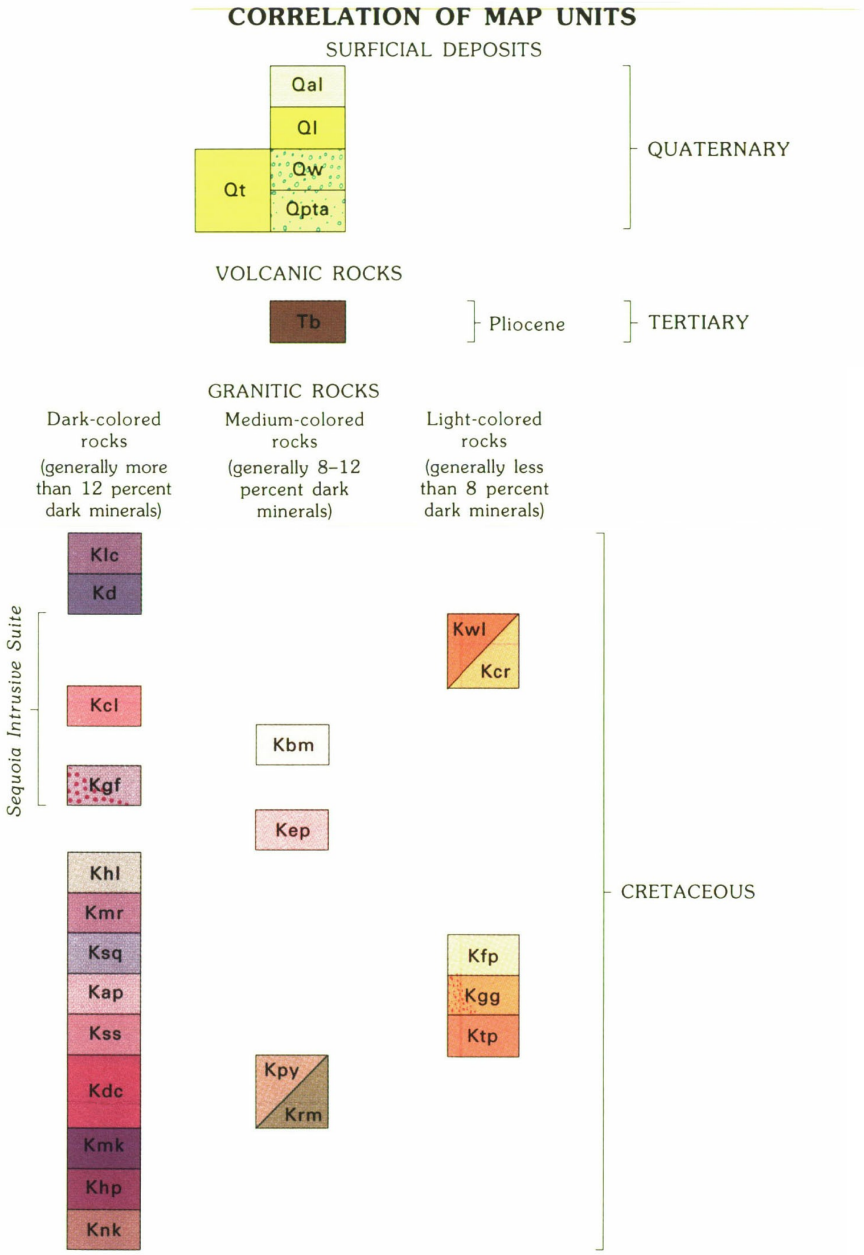
Giant Forest 15' Quadrangle

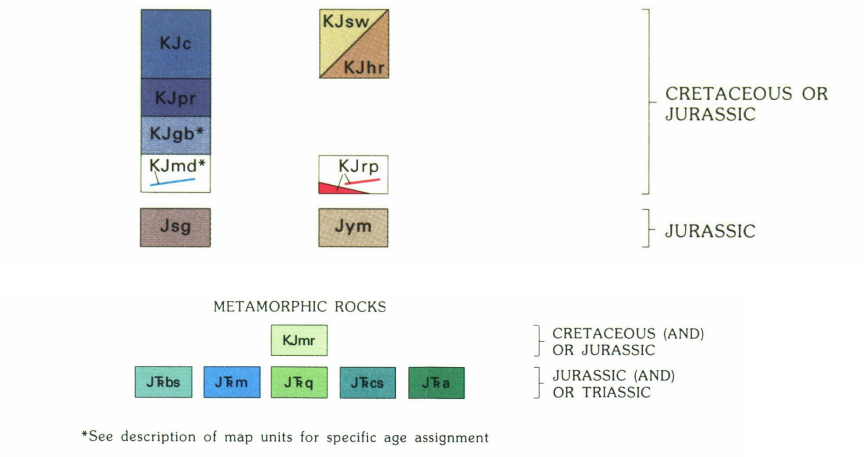
The formal citation for this source.

Sisson, T.W. and Moore, J.G., 1994, Geologic Map of the Giant Forest Quadrangle, Tulare County, California, U.S. Geological Survey, GQ-1751, 1:62,500 scale. (*GRI Source Map ID 1919*).

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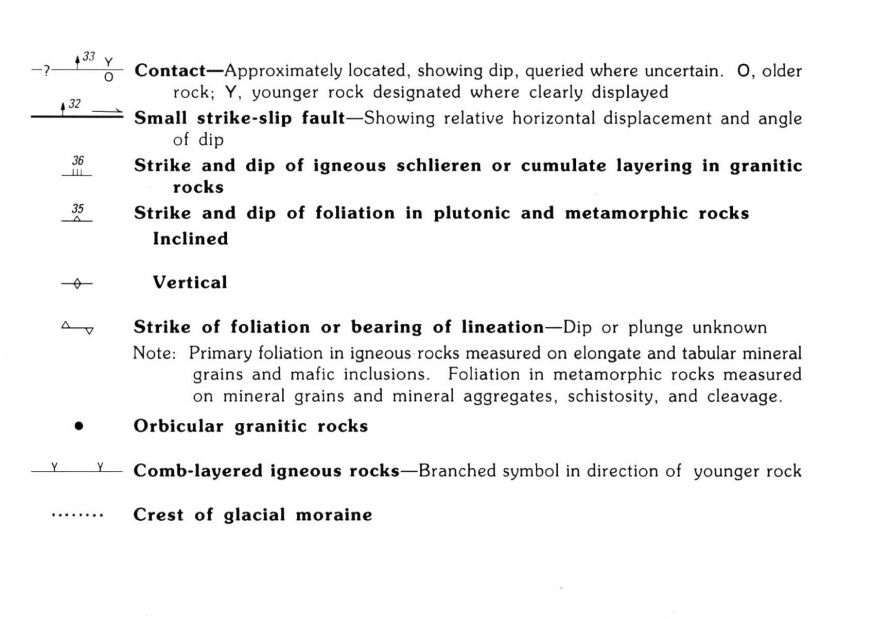
Correlation of Map Units





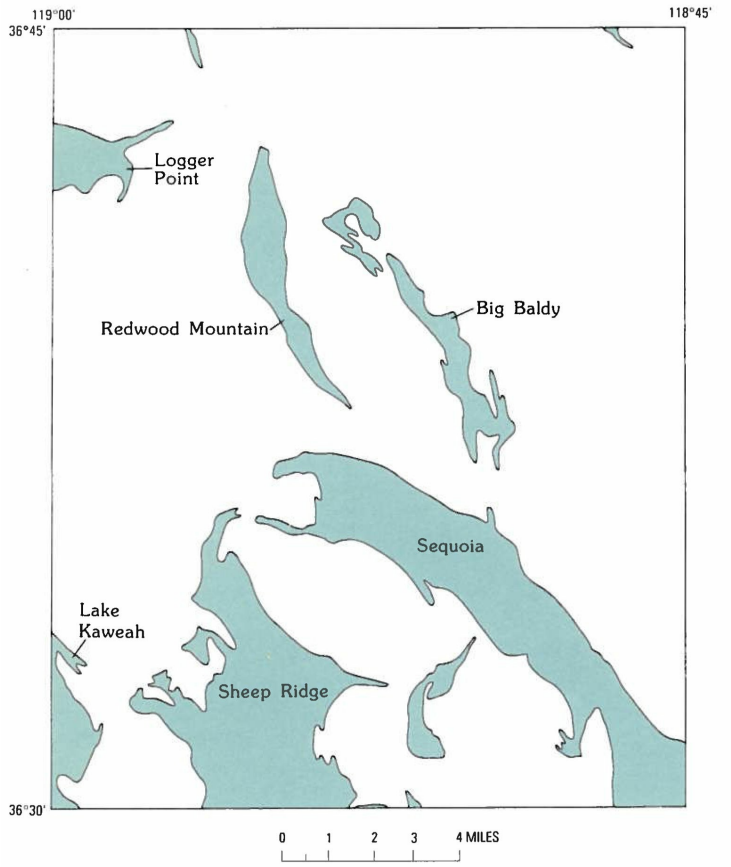
Graphic from source map: Giant Forest 15' Quadrangle

Map Legend



Graphic from source map: Giant Forest 15' Quadrangle

Location of Roof Pendents



LOCATION OF METAMORPHIC ROOF PENDANTS IN THE GIANT FOREST QUADRANGLE, CALIFORNIA

Graphic from source map: Giant Forest 15' Quadrangle

Report

INTRODUCTION

The Giant Forest quadrangle includes about 620 hm2 (240-nrii on the-west slope of the Sierra Nevada largely within the drainages of the Middle, Marble, and North Forks of the Kaweah River. The extreme north part of the quadrangle is drained by tributaries of the Kings River. About half of the area is within Sequoia National Park and the General Grant Grove Section of Kings Canyon National Park, and all the map area is within Tulare County except for a narrow strip along the north, and part of the west quadrangle borders, which are within Fresno County. Elevations range from 1,200 feet at the southwest corner to 9,594 feet on Shell Mountain in the northeast. Most of the area is rugged and heavily vegetated with chaparral and oak trees in the lower regions and conifers at higher elevations. Some 13 groves of giant sequoia trees occur within the quadrangle between 6,000 and 7,000 feet elevation. The largest of these groves is the Giant Forest along the southeast margin of the quadrangle and for which the quadrangle is named. The most important road is the Generals Highway which extends from the northwest to the southeast corners of the quadrangle; the central section of this highway is closed by snow for much of the winter season. Primary settlements in the quadrangle are at Giant Forest and Wilsonia. Scattered habitations, including ranches, homes, and summer camps are mainly in the lower, western part of the quadrangle.

PREVIOUS WORK

The Geological Survey of California conducted the first topographic and geologic reconnaissance of the northern part of the map area in 1864 under the leadership of William Brewer. The field party included topographer Charles Hoffmann, and geologists James Gardner and Clarence King (Farquhar, 1965). One of the earliest detailed studies of metamorphic rocks in the Sierra Nevada was that of Cordell Durrell (1940) in the southwestern part of the quadrangle. D. C. Ross (1958) first identified, mapped, and studied individual granitic intrusions in the eastern part of the map area. R. W. Tracy (written communication, 1967) extended the mapping of Ross to include the northwest corner of the quadrangle and analyzed the mineral abundances of many granitic rock samples. J. H. Chen and J. G. Moore (1982) determined the ages of many of the granitic intrusions in the quadrangle using U-Pb radiometric techniques. Geologic quadrangle mapping has been completed to the east (Triple Divide Peak quadrangle, Moore and Sisson, 1987) and to the north (Tehipite Dome quadrangle, Moore and Nokleberg, 1992).

METAMORPHIC ROCKS

Six large masses of metamorphic rock (commonly called roof pendants) are present partly or entirely within the quadrangle. The metamorphic rock is intruded by, and is therefore older than, the surrounding granitic rock. Most of the metamorphic rock was once shale and thin interbedded sandy layers that have been recrystallized to biotite schist. In places, sandstone and pebble conglomerates accumulated in sufficient thickness to form bodies that can be shown at the scale of the map; these masses have been recrystallized to quartzite. Limestone was also present as layers and lenses that are now metamorphosed to coarse-grained marble. Although most of these pregranitic rocks were originally deposited as marine sediment, no fossils have yet been found in them. Fossils found in similar metamorphic rocks of the Boyden Cave pendant 7 km north of the quadrangle are Early Jurassic in age (Jones and Moore, 1973); fossils from the Mineral King pendant 18 km southeast are Late Triassic and Early Jurassic; fossils from the Yokohl Valley pendant 30 km southwest are Late Permian (Saleeby and others, 1978). Most of the metamorphic rocks of the quadrangle have been assigned to the Triassic to Jurassic Kings sequence (Bateman and Clark, 1974; Saleeby and others, 1978) or the Kings terrane (Nokleberg, 1983).

The three eastern metamorphic masses were previously referred to as the Sequoia Park pendants, and the three in the southwest as the Lower Kaweah pendants (Saleeby and others, 1978). For ease of discussion we have given separate names to the individual metamorphic masses (see inset map). The Logger Point pendant in the northwest corner extends west of the quadrangle border about 1 km and is composed primarily of quartz-biotite schist interlayered with quartzite. The 10-km-long, north-trending Redwood Mountain pendant is likewise mostly quartz-biotite schist, but contains thicker and more continuous layers of quartzite and marble.

Another 10-km-long pendant lies east of the Redwood Mountain pendant and extends south from Big Baldy Ridge across the North Fork Kaweah River to Pine Ridge. This, the Big Baldy pendant, differs from most metamorphic pendants in the quadrangle by the presence of several masses of metamorphosed silicic volcanic rock and sub-volcanic intrusive rock in association with metamorphosed shaley sedimentary rock. Preliminary U-Pb dating of the metavolcanic rocks indicates a mid-Cretaceous age (J. B. Saleeby, oral communication, 1991). Silicic metavolcanic rock associated with metamorphosed sediment is also found in a small pendant along Ash Peaks Ridge in the southern part of the quadrangle, but its age is unknown.

The large metamorphic mass that extends from the center to the southeast corner of the quadrangle is here called the Sequoia pendant because it is the largest roof pendant that lies entirely within Sequoia National Park, although the Mineral King pendant, 10 km east, which extends out of the park to the south, is larger. The Sequoia pendant, like the Redwood Mountain pendant, is primarily quartz-biotite schist, but includes tabular mappable masses of marble and quartzite.

West of the Sequoia pendant, and well exposed on Sheep Ridge, is the Sheep Ridge pendant, a broad mass of metamorphic rock that extends 11 km north into the quadrangle and about 3 km south of the quadrangle boundary. In addition to the common biotite schist, the Sheep Ridge pendant is characterized by abundant bedded marble and calc-silicate layers, which probably aggregate about

40 percent by area of the metamorphic rocks. Metamorphism has destroyed sedimentary structures in nearly all of the metamorphic rocks, but marble cobble conglomerates are locally preserved on the west slope of Sheep Ridge. Basaltic and andesitic lavas, and mafic-rich sedimentary rock derived from them, have been recrystallized to amphibolite and biotite amphibolite, forming layers within the metamorphosed shaley sedimentary rocks.

A gabbroic intrusion about 4 km across separates the Sheep Ridge pendant from another major metasedimentary pendant on the west, here called the Lake Kaweah pendant that crops out only in a small area in the southwest quadrangle corner (Durrell, 1940). This pendant extends 11 km south of the quadrangle boundary to Lake Kaweah, and more than 15 km northwest of the west boundary.

Mineral assemblages within the metamorphic rocks provide information on the pressures, and hence depths, at which the rocks were recrystallized. The aluminum silicate minerals sillimanite and andalusite occur commonly in the biotite schist. Since andalusite exists stably at pressures no greater than 4.2 kilobars (Bohlen and others, 1991), the exposed metamorphic rocks were recrystallized at depths beneath the Earth's surface shallower than 11-12 km (6.8-7.5 mi).

MESOZOIC GRANITIC ROCKS

About 80 percent of the quadrangle is underlain by Mesozoic granitic rocks. The granitic rocks are separable into discrete masses or plutons on the basis of their composition and texture; the individual plutons generally have sharp intrusive contacts with one another and with metamorphic rocks. These plutons were formed by intrusion and solidification of magma (hot and largely molten rock) beneath the Earth's surface from Middle Jurassic to mid-Cretaceous time but chiefly in the mid-Cretaceous about 100 million years ago (Ma).

The Sequoia Intrusive Suite (Moore and Sisson, 1987) in the northeastern part of the quadrangle consists of the Giant Forest Granodiorite (oldest) and three younger and smaller granitic masses--the granite of Big Meadows, the granodiorite of Clover Creek, and the granite of Weaver Lake (youngest), and tentatively the granite of Chimney Rock. These plutons were emplaced sequentially, generally toward the central part of the intrusive suite in the order listed. They also generally became lighter colored and more silicic with time, except for the granodiorite of Clover Creek which is more mafic than the older granite of Big Meadows. The youngest and lightest-colored unit, the granite of Weaver Lake, forms a central saucer or funnel-shaped mass about 7 km in diameter which sent out radially inward-dipping sills intrusive into the surrounding granite of Big Meadows. Tabular masses and blocks of the granite of Big Meadows are isolated between these intrusive sheets, and the largest of these masses and blocks are shown on the map. The magmas of the Sequoia Intrusive Suite were emplaced and cooled about 99 Ma. The period of emplacement of the individual intrusions was sufficiently brief that age differences between the intrusive units could not be resolved by U-Pb radiometric techniques (Chen and Moore, 1982). The nested succession and chemical coherence of the units of the Sequoia Intrusive Suite indicate that they are genetically related and formed from a common magma through successive intrusions as temperatures systematically decreased.

The belt of metamorphic rocks including the Redwood Mountain, Big Baldy, and Sequoia pendants separates the Sequoia Intrusive Suite on the east from a group of intrusive rocks on the west dominated by the tonalite of Shadequarter Mountain and the granodiorite of Hartland. These western plutons differ markedly from those in the east by their much lower content of the iron-oxide mineral magnetite. The average abundance of opaque iron-oxide minerals, chiefly magnetite (Fe304), in the granodiorite of Hartland is 0.025 volume percent, whereas that in the similar-appearing Giant Forest Granodiorite is 0.36 percent--a 14-fold increase (Tracy, written commun. 1967). The abundance of magnetite cannot be easily measured in the field, but since magnetite is by far the most magnetic mineral in granitic rocks, its abundance can be estimated by field measurement of the magnetic susceptibility of rock samples. The granodiorite of Hartland has a susceptibility of 15-200 x10-5 SI units; in contrast, the Giant Forest Granodiorite has a susceptibility of 500-3000x10-5 SI units. The tonalite of Shadequarter Mountain contains even less magnetite and has a susceptibility of 15-40x10-5 SI units. The increase in magnetite content eastward, and in magnetic susceptibility, suggests that the western plutons formed from significantly less oxidized magmas than those of the Sequoia Intrusive Suite.

The granite of Grant Grove in the northwest corner of the quadrangle, is bordered along much of its margin by quartz-biotite schist. An outer zone of the granite containing garnet and minor sillimanite, as well as scattered inclusions of schist, has developed near the adjacent metamorphic rocks. This garnet-bearing zone probably was formed by contamination of the granitic magma by assimilation of the quartz-biotite schist.

Numerous small plutons composed of mafic intrusive rock were intruded at several different times during the period of igneous activity. The larger mafic bodies contain rock that is locally layered and was formed by the accumulation of early-grown crystals, chiefly pyroxene, hornblende, and Ca-rich plagioclase. Olivine is present in some of the more iron- and magnesium-rich varieties of gabbro and in olivine-hornblendite.

The granodiorite of Yucca Mountain is among the oldest granitic plutons in the quadrangle, and has yielded a U-Pb age of 162 Ma (J. B. Saleeby, oral communication, 1991). This pluton lies between the Sequoia and Sheep Ridge pendants and is cut by a large number of northwest-trending rhyolite porphyry dikes.

CENOZOIC DEPOSITS

The only known Cenozoic volcanic deposit in the Giant Forest quadrangle is a small erosional remnant of a basaltic lava flow and mudflow at 4,900-ft elevation in the Mill Creek valley near the state highway 69 bridge in the northwest corner of the quadrangle. This olivine basalt is similar in composition to the extensive lava flows (base at about 4,100 ft) that cap Stony Flat 2 km west of the quadrangle boundary and yielded a K-Ar age of 3.4 Ma (Moore and Dodge, 1980). The basalt in Mill Creek is apparently a higher part of the Stony Flat flows closer to the eruptive vent, which has not been found.

The higher eastern parts of the quadrangle were glaciated during the Pleistocene. Small icefields occupied the upper parts of Shell Mountain and the Kings-Kaweah divide. Glaciers active during the Tahoe and Tioga glaciations quarried the basins of Weaver and Jennie Lakes, and deposited small moraines with well-preserved crests. Earlier glaciers were more extensive, but their moraines have been eroded and are exposed only in protected areas on the slopes of Shell Mountain. Major snow fields in the upper drainage of the Marble Fork of the Kaweah River east of the quadrangle fed a large glacier which flowed west down the river canyon; moraines deposited at its terminus are as low as 6,560 ft, slightly inside the east margin of the quadrangle. Likewise, an icefield blanketing the basin occupied by Rowell Meadow east of the quadrangle fed a glacier that terminated at 8,400 ft in a tributary of Boulder Creek on the northeast margin of the quadrangle.

Several landslides have been mapped on the steeper slopes. A notable series of prehistoric debris avalanches slid off the steep west wall of Moro Rock, in the southeast quadrangle corner, and moved south nearly 3 km down to the gorge of the Middle Fork of the Kaweah River. Boulders as large as 10 m derived from the Giant Forest Granodiorite have choked the gulches in the Sequoia pendant and spread out on the flat near the former site of the Hospital Rock Ranger Station. Hospital Rock itself is one of these giant landslide boulders, which has cracked and split open after coming to rest. Indians, who previously occupied camps in this region before the arrival of Europeans, painted pictographs on the flat wall of this crack.

STRUCTURE

Nearly all of the metamorphic rocks in the Giant Forest quadrangle have been folded and strongly deformed by flattening. Their compositional banding and planar mineral fabrics (schistosity) are commonly subvertical and strike subparallel to the major pendant-granite contacts. Clasts are moderately to intensely flattened parallel to the banding and schistosity in the relict conglomerates. Likewise, the prominent dark inclusions in the large granitic plutons are commonly flattened and subparallel to the contacts with nearby large metamorphic pendants. The dark inclusions and surrounding minerals are not, however, sheared or broken and the granites were apparently partly plastic when the flattening occurred. Together, these features suggest that it was emplacement and inflation of the plutons that squeezed, flattened, and sheared the metamorphic rocks and also the

partly solidified granite magmas along the walls of the plutons. The mid-Cretaceous age of the deformed metavolcanic rocks of the Big Baldy pendant strongly supports this conclusion. These metavolcanic rocks were erupted on the Earth's surface, buried several kilometers, strongly deformed, and intruded by large granitic plutons within several million years. Saleeby and others (1990) have reached similar conclusions regarding the deformation of metamorphic pendants north and northeast of the quadrangle.

Durrell (1940) proposed that the rocks of the Sheep Ridge pendant had been folded into a major syncline whose fold axis lay in the bed of Sheep Creek. While many outcrop-scale folds were discovered in the course of mapping, particularly at the terminations of marble layers, no evidence was found to indicate the presence of a large syncline in the area indicated by Durrell (1940).

Faults within the quadrangle are restricted to small-scale shears, commonly with strike-slip offsets of only a few centimeters or meters. These small faults are part of a regional set documented by Lockwood and Moore (1979). The relatively steep west slope of the Sierra Nevada in this region does not appear to be the result of uplift along faults.

Report from source map: Giant Forest 15' Quadrangle

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Reference from source map: Giant Forest 15' Quadrangle

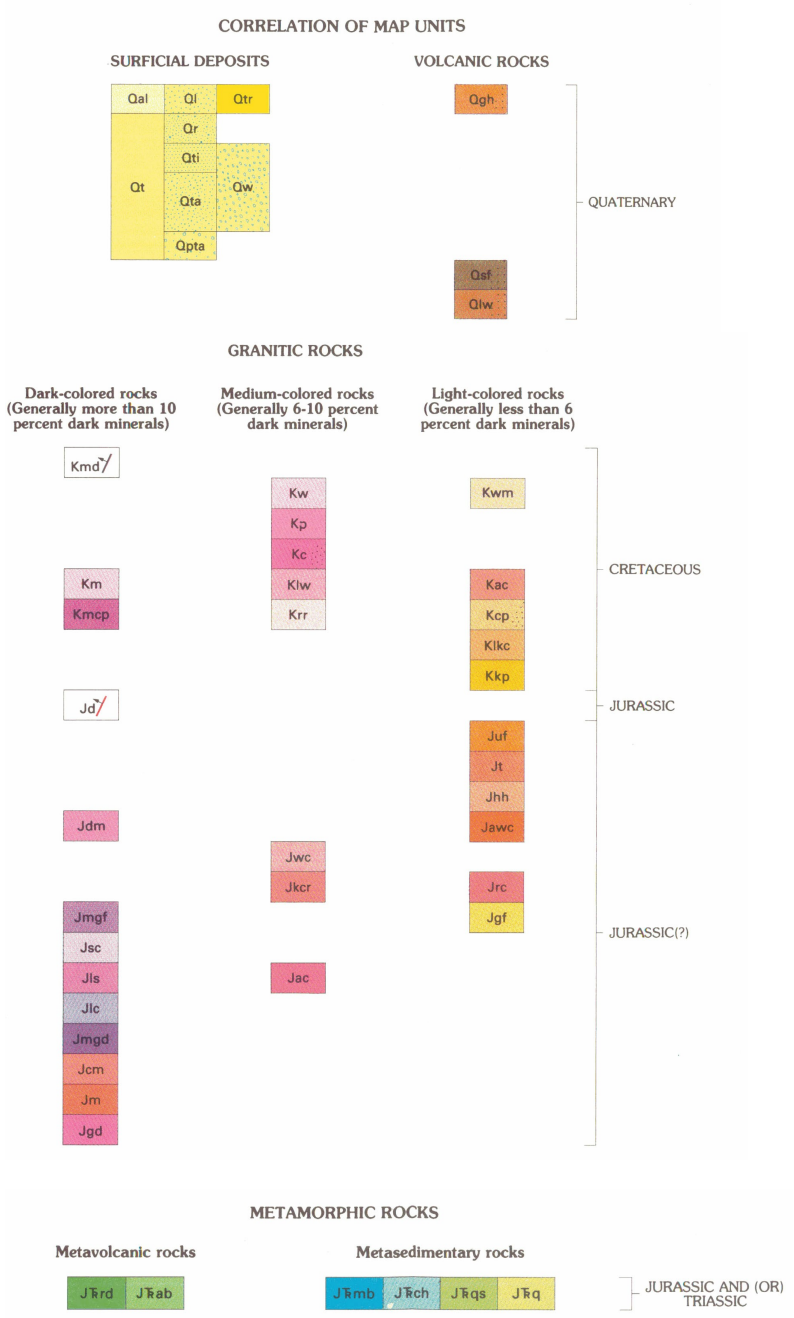
Kern Peak 15' Quadrangle

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Moore, J.G. and Sisson, T.W., 1985, Geologic Map of the Kern Peak Quadrangle, Tulare County, California, U.S. Geological Survey, GQ-1584, 1:62,500 scale. (*GRI Source Map ID 1915*).

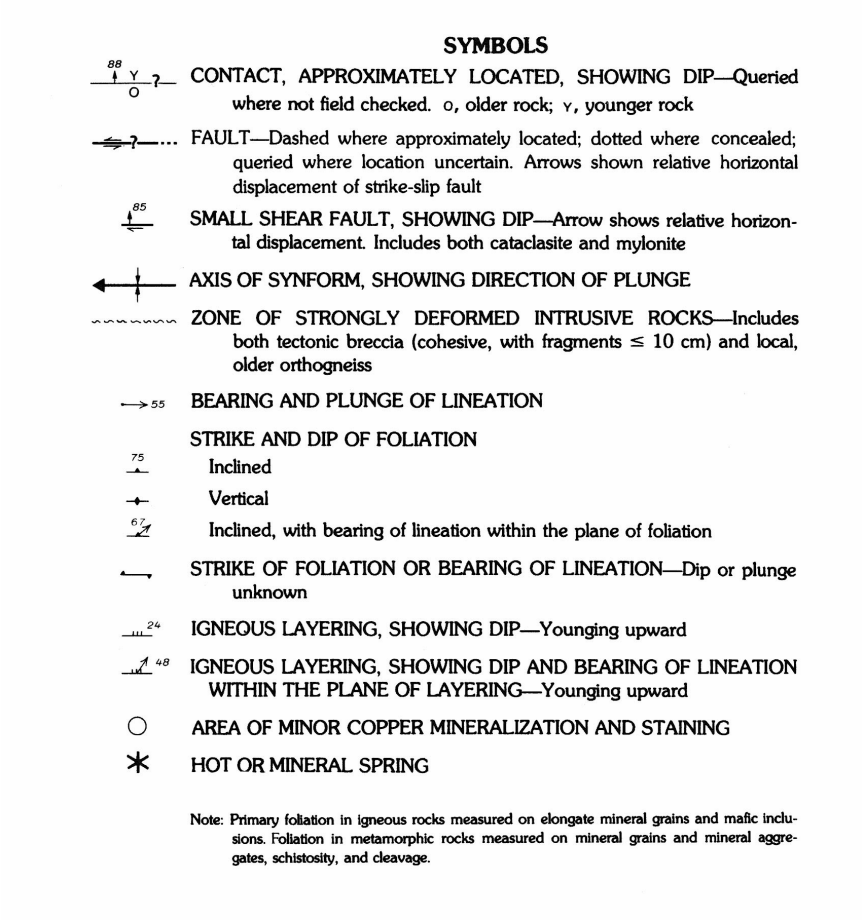
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Correlation of Map Units



Graphic from source map: Kern Peak 15' Quadrangle

Map Legend



Graphic from source map: Kern Peak 15' Quadrangle

Report

INTRODUCTION

The Kern Peak quadrangle includes about 620 km2 of the southern Sierra Nevada west of the range crest. The quadrangle is dominated by the great north-trending glacial canyon of the Kern River, which was eroded along a major fault. Much of the northwestern part of the quadrangle is within Sequoia National Park, and the remainder is in the Golden Trout Wilderness of Sequoia and Inyo National Forests (du Bray and Dellinger, 1981).

No roads extend into the quadrangle. The nearest road access is from Mineral King, 8 km west, Pyles Camp, 12 km south, and Horseshoe Meadow, 8 km east. The Kern Canyon is well served by trails over the main Sierra crest on the east at Army Pass and Cottonwood Pass, and over the Great Western Divide on the west at Colby Pass, Kaweah Gap, Black Rock Pass, Sawtooth Pass, Franklin Pass, and Coyote Pass. A dirt airstrip, usable by small aircraft during the summer, is located in the east-central part of the quadrangle at Tunnel Meadows.

METAMORPHIC ROCKS

Small elongate masses of metamorphic rocks, generally in the hornblende-hornfels facies, are scattered across the quadrangle as screens between various granitic plutons. A screen 6 km long in

the west-central part of the quadrangle separates Cretaceous granitic rocks on the west from Jurassic granitic rocks on the east and contains metasedimentary rocks that were originally thin-bedded limy and siliceous argillites, with minor beds of limestone and quartzite. To the south, also on the west side of the canyon, is a smaller mass composed of both metavolcanic and metasedimentary rock. The metamorphic screen entering the quadrangle near the southwest corner is the southeast end of the large Mineral King roof pendant, which extends 30 km to the northwest. The relatively large metamorphic mass in the southeast part of the quadrangle extending south from Kern Peak consists of minor metasedimentary rocks and abundant felsic metavolcanic rocks, some of which have been so highly sheared, veined, and recrystallized that they are best termed migmatitic biotite granofels. Some intrusive rocks may be included.

No fossils have been found in the metamorphic rocks of the quadrangle, but fossils of Late Triassic and Early Jurassic age have been recovered from sedimentary rocks interbedded with similar metavolcanic rocks in the Mineral King roof pendant about 5 km west of the quadrangle (Saleeby and others, 1978).

GRANITIC ROCKS

Mesozoic granitic rocks that are part of the Sierra Nevada batholith dominate the bedrock of the quadrangle. Most of the granitic masses or plutons were intruded as magma (largely molten rock) and cooled and crystallized below the surface 170 to 80 m.y. ago. The granitic intrusions occurred in two distinct episodes separated by a period of several tens of millions of years. The older plutons are assigned to the Jurassic and are commonly intruded by abundant dark-colored dikes that probably belong to the Independence dike swarm (Moore and Hopson, 1961) of Late Jurassic age (Chen and Moore, 1979). Some of the pre-dike plutons may be pre-Jurassic in age. A few related felsic dikes are also present. The younger series of plutons are Late Cretaceous in age; they rarely contain mafic dikes but commonly truncate the older plutons that contain mafic dikes of the Independence dike swarm.

The porphyritic granite of Window Cliffs is the largest Jurassic pluton in the quadrangle. This pluton, cut by swarms of mafic dikes and extensively sheared in places, is confined to the east side of the Kern Canyon fault although its north end approaches within 1 km of the fault. The pluton is about 30 km long; du Bray and Dellinger (1981) have mapped its south end 7 km south of the quadrangle.

Another major predike pluton is the coarse-grained granite of Grasshopper Flat (Unit 6 of Moore and du Bray, 1978). This granite mass is cut by numerous mafic dikes as well as stocks of gabbro, diorite, and quartz diorite. The pluton is about 28 km long and the northern contact is offset about 11 km on the Kern Canyon fault.

The Cretaceous granite of Coyote Pass is more than 30 km long and flanks the Mineral King roof pendant on the east. It contains abundant pancake-shaped mafic inclusions that define a north-northwest-trending synform or canoe-shaped structure. Locally developed, rhythmic schlieren layering parallels the synform structure. Small stocks of distinctive diorite and mafic quartz diorite (Kmcp) intrude the granite and in turn are intruded by leucogranite dikes from the pluton. Approximately one-third of the mafic inclusions within the granite of Coyote Pass have the same distinctive character as the mafic intrusions (abundant quartz xenocrysts mantled by amphibole locally with prominent skeletal plagioclase phenocrysts). These conflicting apparent age relationships indicate contemporaneous mafic-felsic magmatism and suggest that the mafic inclusions originated as mafic magma intruded into a crystallizing felsic magma chamber. The trough like structure of the pluton and the subhorizontal contact with the granodiorite of Sheep Creek suggest that the present level of exposure is near the downsagged floor of a composite magma chamber.

The granodiorite of Chagoopa is zoned from an outer equigranular biotite granodiorite (with a plagioclase- and hornblende-rich marginal facies) to a sharply defined, younger porphyritic biotite granodiorite in the center. These two units are truncated and offset by the Kern Canyon fault, but relations are complicated because a central diorite mass occurs in the pluton only west of the fault and a marginal alaskitic mass occurs only east of the fault. Comb-layering (Moore and Lockwood, 1973) is locally developed along the pluton margins.

The Late Cretaceous pulse of igneous activity culminated in the intrusion of a series of large plutons in the eastern Sierra. One of the largest is the composite pluton (Whitney and Paradise Granodiorites) in the northeastern part of the quadrangle. This composite pluton is about 83 km long and was emplaced as a single intrusion 83-86 m.y. ago. Before complete solidification, the partly molten and somewhat more siliceous core (the Whitney Granodiorite) surged upward and intruded its solidified margin (the Paradise Granodiorite).

A second very large and young Cretaceous pluton is the granite of White Mountain in the southwest corner of the quadrangle. This granite contains large K-feldspar phenocrysts (4-8 cm in length), and is similar in age to the Paradise-Whitney mass. Although not entirely mapped, this intrusion is more than 70 km long, and its northern contact is offset about 13 km by the Kern Canyon fault (Unit 8 of Moore and du Bray, 1978).

GLACIATION

During parts of the Pleistocene the many-branched Kern glacier occupied much of the higher elevations of the quadrangle and was the most southerly of the great glacier systems of the Sierra Nevada. The chief tributary glaciers from the west were those in the valleys of Big Arroyo, Rattlesnake Creek, and Laurel Creek, and from the east, in Rock Creek and Golden Trout Creek. These tributaries joined the Kern trunk glacier, which flowed southward down the fault-controlled Kern Canyon for the entire length of the quadrangle.

Glacial deposits of four ages - pre-Tahoe, Tahoe, Tioga, and post-Tioga ages - are distinguished, but in many places have not been separated and are shown on the map as undifferentiated units. The oldest deposits, of pre-Tahoe age, are thoroughly weathered and rarely show well-developed morainal crests, even though the most extensive glaciation occurred before Tahoe time. The pre-Tahoe Kern trunk glacier extended about 2 km south of the southern quadrangle boundary to about lat 36°14' N. (Matthes, 1965).

Well-developed paired Tahoe and Tioga lateral-moraine crests can be distinguished and mapped separately along the margins of Rock Creek Canyon as was possible in several areas to the north in the Mount Whitney quadrangle (Moore, 1981). However, more extensive fieldwork is necessary to distinguish the Tahoe and Tioga Tills in many parts of the mapped region, and they have been combined as a single mapped unit. Till believed to be of this general age makes up the symmetrical recessional moraines on the main canyon floor at the junction of Golden Trout Creek.

The youngest glacial deposits, of post-Tioga age, include Holocene rock glaciers within north- to northeast-facing cirques. All of the lake basins in the quadrangle except for Kern and Little Kern Lakes were scooped from bedrock by ice erosion or dammed by glacial moraines. The Kern Lakes were dammed by landslides from the steep east wall of the Kern Canyon.

VOLCANISM

Four episodes of Quaternary alkali olivine basaltic volcanism (Moore and Dodge, 1980; Dodge and Moore, 1981) have erupted small cinder cones and related lava flows in the drainage basin of Golden Trout Creek (Webb, 1950). The basalts, which are among the youngest volcanic extrusions in the Sierra Nevada, cover an area of about 10 km2 and represent a total volume of less than 1 km3.

Field relations, whole-rock K-Ar dating, and paleomagnetic measurements indicated the following chronology: The Little Whitney cone was erupted 743,000 ± 11,000 years ago (Marvin Lanphere, written commun., 1982), and its lava flows are the only ones that are reversely magnetized. The lava flows were glaciated, and ice overtopped the cone and eroded most of the lava flows or covered them with glacial deposits. The South Fork cone was erupted 176,000 ± 21,000 years ago (Marvin Lanphere, written commun., 1982) and fed the largest lava flow of the field, which flowed 10 km west, probably down to the floor of the Kern Canyon. The base of the flow is now 61 m above the floor of the canyon, and the flow has been extensively glaciated over much of its extent, although ice did not override the vent cinder cone. The undated Tunnel cone lies just north of the South Fork cone and erupted a short flow of welded spatter which overlies cinders of the South Fork cone. The Tunnel lava,

which is overlain by glacial deposits, is petrographically similar to that of the South Fork cone and is considered roughly contemporaneous.

The Groundhog cone and lava flow are the youngest in the area and can readily be distinguished from earlier lavas, because they are the only ones that are nearly nonporphyritic. The Groundhog as lava flow poured 6 km west down Golden Trout Creek on top of the flow from the South Fork cone. This lava flow is clearly unglaciated and in no place do glacial erratics lie atop it. The lava has not been dated but is estimated to be 5,000-10,000 years old.

Extensive travertine hot-spring deposits are related to the Groundhog flow and were deposited from springs issuing from the base of the distal part of the flow. The travertine extends 1.5 km downstream beyond the lower limit of the flow to the floor of the Kern Canyon, where post-travertine downcutting of Golden Trout Creek is less than 2 m. Spring action and seepage of water beneath travertine layers have produced the Natural Bridges at 2,400 m elevation on a tributary of Golden Trout Creek.

All of the volcanic vents occur in topographically low areas, and, consequently, the cones and flows have locally blocked and diverted the previous drainage. The most profound volcanic change was caused by eruption of the South Fork cone, which dammed a previously west-flowing tributary of Golden Trout Creek and caused it to reverse direction, overtop a low divide several kilometers east, and join the South Fork of the Kern River. This diversion was further intensified when glacial moraines blocked the Tunnel Meadow drainage, which previously flowed into Golden Trout Creek, and diverted it into the South Fork Kern drainage. In the late 1800's a tunnel was dug through the moraine to divert Tunnel Meadow water back to Golden Trout Creek for irrigation purposes. However, landowners on South Fork Kern River objected, the tunnel was blocked, and the water returned to the South Fork.

FAULTING

The dominant physiographic feature of the quadrangle is the great, north-trending glaciated canyon of the Kern River. This canyon is roughly 1.5 km wide and 500 m deep and is excavated along a major fault on which displacement has been primarily right lateral strike slip (Moore and du Bray, 1978). The subvertical contacts between granitic plutons can be matched across both sides of the fault. Right-lateral offset of these contacts within the quadrangle is 7-11 km, increasing toward the south. The time of offset along the fault can be constrained only between 8386 m.y. (the intrusive age of the offset Paradise Granodiorite) and 3.5 m.y. (the eruptive age of a basalt flow that lies astride the fault 7 km south of the map area, and is not offset; Dalrymple, 1963; Moore, 1981).

The zone of intensely sheared rock along the principal fault strands is generally less than 10 m thick. Rocks along the main fault trace and sub-parallel faults contain the synkinematic mineral assemblage sericite, epidote, chlorite, sphene, ± tourmaline, ± pale biotite. Relict plutonic minerals include quartz, microcline, plagioclase (albitized), sphene, zircon, allanite, and magnetite. Calcite and prehnite are postkinematic minerals.

Tourmaline is locally abundant in intensely sheared zones up to a few centimeters thick. It imparts a black (or blue black) color to the rock, and, in thin section, the tourmaline is blue green and extremely fine grained. Some fibrous tourmaline is bent around quartz and feldspar clasts of the cataclastic matrix. The mineralogy and texture of rocks along the fault indicate that the area has been uplifted and deeply eroded since the fault was active.

Zones of brittle shear cut the otherwise massive plutonic rocks within about 2 km of the main fault. These zones are commonly subparallel to the main fault and are a few centimeters or decimeters thick and a few meters apart. They consist of many interconnected fracture planes, usually with one dominant, and with strike-slip offsets ranging up to a few meters. Brittle shears locally coalesce into crush-breccia zones up to 10 m thick that can be traced parallel to the main fault for several kilometers. Some crush-breccia zones narrow into minor right-lateral faults with mappable displacements. The breccia and shears weakened the otherwise massive plutonic rock causing streams, and later glaciers, to follow the fault zone and erode and shape the great canyon.

Kern Hot Spring is situated in the upper Kern Canyon near the main trace of the Kern Canyon fault.

Travertine from currently inactive hot springs lies at the head of Grasshopper Flat and in the lower reaches of Little Kern Lake Creek; a soda spring is located near the mouth of Golden Trout Creek. The fault zone apparently still acts as a conduit for various hydrothermal fluids.

The Coyote Peaks fault is a second major right-lateral strike-slip fault west of the Kern Canyon. The trace of the Coyote Peaks fault is sinuous, and the fault is truncated at each end by structures related to the Kern Canyon fault. Apparent right-slip offset along the Coyote Peaks fault amounts to as much as a few kilometers. Deformation of rocks along the fault is also brittle, except where the fault intersects the granite of Coyote Pass. Several sets of closely spaced conjugate foliations are developed in this granite within 100 m of the Coyote Peaks fault. The foliations involve biotite, quartz, and feldspars and impart a swirled appearance to the granite. Leucogranite dikes from the granite of Coyote Pass locally cut the fault zone and are variably deformed. These relations indicate that some displacement on the Coyote Peaks fault was contemporaneous with the later stages of crystallization of the granite of Coyote Pass.

North to northeast-trending mylonitic shear zones are present only in those granites cut by dikes of the Independence dike swarm. The mylonitic shears are usually less than a decimeter thick, cut both granites and mafic dikes, and have right-lateral displacements of up to a few meters. The largest such zone seen is 4 m thick and shows right-lateral displacement of 250 m. Mylonitic shear zones near the Kern Canyon are commonly overprinted by cataclastic brittle shears related to the Kern Canyon fault. The absence of mylonites in rocks lacking Independence dikes is taken as evidence that some minor right-lateral displacement took place within the Sierra Nevada batholith after the emplacement of the Independence dike swarm, but prior to the onset of Cretaceous plutonism.

Both Jurassic and Cretaceous granitic rocks are also fractured and sheared by two nearly vertical sets of small strike-slip faults that are not directly related to the Kern Canyon fault and are of regional extent (Lockwood and Moore, 1979). Within the quadrangle, the right-lateral set clearly trends nearly north-south (parallel to the right-lateral Kern Canyon fault), and the left-lateral set, which is more common and better developed, trends northwest-southeast.

Report from source map: Kern Peak 15' Quadrangle

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Reference from source map: Kern Peak 15' Quadrangle

Lone Pine 15' Quadrangle

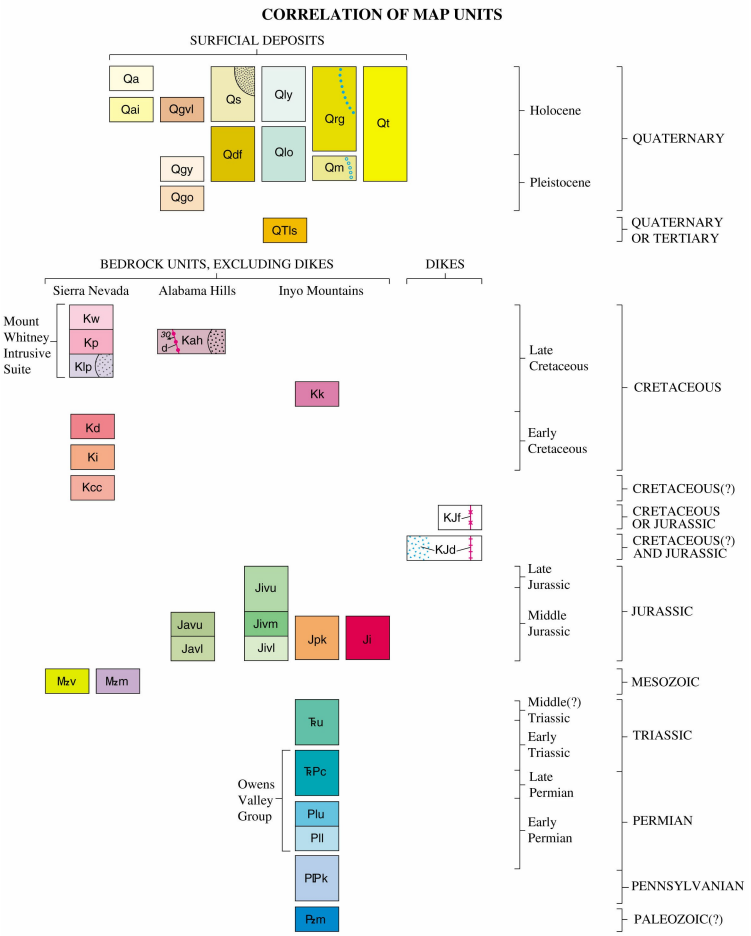
The formal citation for this source.

> Stone, Paul, Dunne, G.C., Moore, J.G., and Smith, G.I., 2000, Geologic Map of the Lone Pine 15' Quadrangle, Inyo County, California, U.S. Geological Survey, I-2617, 1:62,500 scale. (*GRI Source Map ID 1920*).

Of note, Manzanar National Historic Site is located in the northern portion of the Lone Pine 15-minute quadrangle.

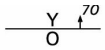
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Correlation of Map Units



Graphic from source map: Lone Pine 15' Quadrangle

Map Legend



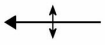
Contact—Showing dip where known. Dashed where approximate; dotted where concealed; queried where inferred or not field-checked. Y, younger plutonic rock; O, older plutonic rock



Fault—Showing dip where known. Dashed where inferred; dotted where concealed; queried where uncertain. Arrows show relative horizontal displacement (in cross section: A, movement away from viewer; T, movement toward viewer). Bar and ball on downthrown side; direction of downthrown side locally changes along scarps that mark the Owens Valley Fault Zone, probably as a result of horizontal offset that has influenced vertical separation (Beanland and Clark, 1994)



Small shear fault—Showing dip. Arrow shows direction of relative horizontal displacement



Anticline—Showing trace of axial surface and direction of plunge of axis where known



Syncline—Showing trace of axial surface and direction of plunge of axis where known

Strike and dip of beds

Inclined

Vertical



Strike and dip of foliation

Strike of foliation or bearing of lineation—Dip or plunge unknown

Strike and dip of intersecting joints—Indicated by two or more symbols joined at point of observation



Inclined



Vertical



Zone of intermixed plutonic and country rocks

Landslide—Unit QTls. Arrow indicates inferred direction of debris movement



Copper mineralization locality



Fossil locality



Geochronologic (Pb-U, zircon) sample locality

Graphic from source map: Lone Pine 15' Quadrangle

Geographic Features

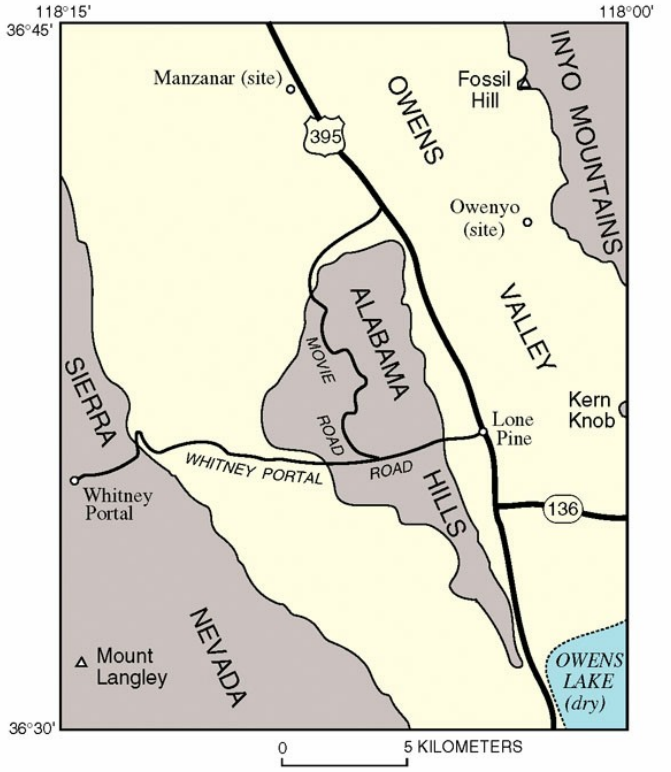


Figure 1. Index map showing selected geographic features in the Lone Pine 15' quadrangle.

Graphic from source map: Lone Pine 15' Quadrangle

Triangular Diagrams

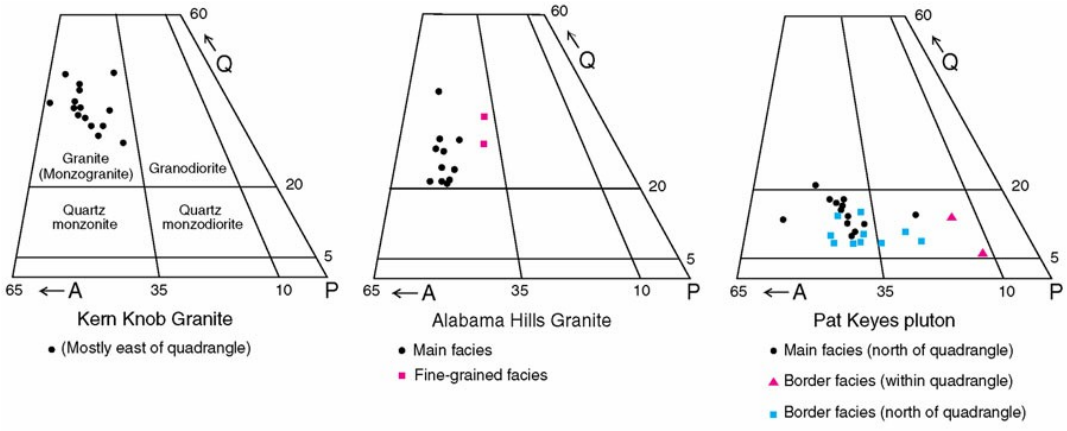


Figure 4. Triangular diagrams showing volume proportions of quartz (Q), alkali feldspar (A), and plagioclase feldspar (P) of samples from the Pat Keyes pluton, Alabama Hills Granite, and Kern Knob Granite.

Graphic from source map: Lone Pine 15' Quadrangle

Report

INTRODUCTION

The Lone Pine 15' quadrangle encompasses an area of about 620 km2 that extends from the Sierra Nevada on the west across the Alabama Hills and Owens Valley to the Inyo Mountains on the east (Geographic Features Index Map). Owens Valley, a closed depression, is the westernmost basin of the Basin and Range physiographic province, and the Sierra Nevada forms the western bounding range of this province. A small part of Owens Lake, a playa that marks the low point and southern end of Owens Valley, is in the southeast corner of the quadrangle. Elevations in the quadrangle range from about 3,560 ft (1,085 m) on the floor of Owens Lake to 14,027 ft (4,275 m) at Mount Langley on the Sierran crest. Mount Whitney (14,494 ft; 4,418 m), highest point in the conterminous United States, is 4 km west of the quadrangle boundary. Elevations in the Inyo Mountains are as high as about 9,700 ft (2,957 m) in the quadrangle.

U.S. Highway 395 crosses the quadrangle from north to south along the west side of Owens Valley, passing through the town of Lone Pine at the base of the Alabama Hills. California State Highway 136 branches east from U.S. 395 2 km south of Lone Pine. Another well-traveled paved road, the Whitney Portal Road, leads west from Lone Pine to Whitney Portal at the head of the Mount Whitney Trail (Geographic Features Index Map). Numerous additional roads, most of which are light-duty or unimproved, provide access to many localities in Owens Valley and along the flanking range fronts. Most of the mountainous parts of the quadrangle are not accessible by road.
The geology of the quadrangle was mapped by a combination of field methods and the interpretation of aerial photographs. Individual responsibilities for the geologic mapping are as follows: Moore, Sierra Nevada; Dunne, Alabama Hills; Stone and Dunne, Inyo Mountains; and Smith, Owens Valley, including the piedmont slopes flanking the Sierra Nevada and Inyo Mountains. Some traces of the Owens Valley Fault Zone were taken from the more detailed mapping of Beanland and Clark (1994).

The 15' topographic quadrangle map, used as a base for the geologic map, is out of print and has been superseded by four 7.5' topographic quadrangle maps at a scale of 1:24,000 (Quadrangle Index Map). These maps should be consulted for more recent information on the locations of roads and other cultural features than is shown on the 15' map. The location of the Lone Pine 15' quadrangle in relation to adjacent and nearby 15' quadrangles is also shown.

PALEOZOIC AND TRIASSIC SEDIMENTARY ROCKS

The oldest widespread rocks in the quadrangle are sedimentary rocks of Pennsylvanian, Permian, and Triassic age that underlie much of the western slope of the Inyo Mountains. These rocks are part of the Cordilleran miogeocline, a thick and extensive assemblage of mostly marine sedimentary rocks that accumulated along the North American continental margin from late Precambrian through early Mesozoic time. Rocks in the Inyo Mountains represent one of the most southwesterly preserved segments of the miogeocline.

Miogeoclinal rocks in the quadrangle represent a range of depositional environments and a complex geologic history (Stone and Stevens, 1984, 1987; Stone and others, 1991; Stevens and others, 1997). The Keeler Canyon Formation and lower part of the Lone Pine Formation consist of turbidites and related fine-grained sediments deposited in a deep marine basin during the Pennsylvanian and Early Permian. The coarse-grained, conglomeratic upper part of the Lone Pine Formation, in contrast, reflects an abrupt change to a shallow-water, probably nonmarine depositional setting in late Early Permian time. This change likely resulted from uplift of the continental margin. The area remained relatively high during deposition of the overlying Conglomerate Mesa Formation of Late Permian and Early Triassic age, which is exposed at Fossil Hill (fig. 1). Limestone in member B of this formation contains fossils and sedimentary features indicating a shallow-water marine setting, and the overlying conglomerate and sandstone (member C) indicate nonmarine deposition. The fine-grained calcareous rocks of the overlying Union Wash Formation reflect renewed subsidence of the continental margin in Early and Middle(?) Triassic time and a return to open-marine deposition.

An angular unconformity that is well exposed 1 km southeast of Fossil Hill reflects northwestward tilting and subaerial erosion of the Lone Pine Formation before deposition of the overlying Triassic

strata, probably as part of a regional tectonic event. Stone and Stevens (1987, 1988) interpreted this event to have predated deposition of Upper Permian limestone in member B of the Conglomerate Mesa Formation, which was thought to be present above the unconformity. Fossils (conodonts) from the lowest limestone beds above the unconformity, however, were later identified as Early Triassic (B. R. Wardlaw, written commun., 1996). These beds and a thin underlying sequence directly above the unconformity, consisting primarily of argillite and hydrothermal or metamorphic talc, are therefore reassigned to the Union Wash Formation. At Fossil Hill, the unconformity is now interpreted to separate the Upper Permian limestone unit (member B) of the Conglomerate Mesa Formation from the overlying conglomerate and sandstone unit (member C) of the same formation, which is herein considered to be Early Triassic. Thus, the age of tectonism represented by the unconformity is now interpreted as latest Permian or earliest Triassic (Stevens and others, 1997).

Calcareous metasedimentary rocks that form a very small pendant in the Alabama Hills Granite (NE1/4 sec. 13, T. 15 S., R. 35 E.) probably are miogeoclinal strata of Paleozoic age, but these rocks are too thoroughly metamorphosed and limited in areal extent to permit a definite unit or age assignment.

MESOZOIC PLUTONIC AND VOLCANOGENIC ROCKS, EXCLUDING DIKES

Plutonic, volcanic, and volcanogenic sedimentary rocks exposed in the quadrangle are in the eastern fringe of the Sierran magmatic arc that was active in this region throughout much of middle to late Mesozoic time. In the quadrangle, most of these rocks are of two broad age groups, Middle to Late Jurassic and late Early to Late Cretaceous. Some metavolcanic and mafic plutonic rocks (Mzv, Mz m) enclosed as small pendants by Cretaceous plutons in the Sierra Nevada could be as old as Triassic, but these are not included in the following discussion because of their limited outcrop area and lack of age control.

Volcanic and volcanogenic sedimentary rocks of Middle to Late Jurassic age are widespread in the Inyo Mountains and Alabama Hills (Dunne and Walker, 1993; Dunne and others, 1998). The sedimentary rocks accumulated in various subaerial environments, mostly by fluvial and debris-flow processes in alluvial-fan and river-floodplain settings, and less commonly in slightly evaporative lakes and as eolian dunes. Sparse paleocurrent indicators reflect northerly to northeasterly directions of sediment transport. Episodic volcanism during this time consisted mainly of explosive eruptions of silicic ash deposited as welded ash flows. Lava flows are less abundant and are primarily of intermediate composition; silicic and mafic flows are rare. The principal phase of volcanic activity took place during the Middle Jurassic and was broadly coeval with a widely recognized period of intense magmatism reported from many parts of the Sierran igneous arc (Evernden and Kistler, 1970; Saleeby and Busby-Spera, 1992).

The Pat Keyes pluton, an intrusive representative of this Middle Jurassic magmatic episode, has been described in detail by Ross (1969) and Dunne (1970). An accompanying triangular diagram (fig. 4) shows the proportions of quartz, alkali feldspar, and plagioclase feldspar in 25 samples from this unit as determined by thin-section point counts; the samples examined are largely from areas north of the quadrangle. Most samples fall within the quartz monzonite and quartz monzodiorite fields of Streckeisen (1973).

Later magmatic activity in the quadrangle is represented by granitic plutons that were emplaced during late Early and Late Cretaceous magmatic episodes also widely represented elsewhere in the Sierra Nevada (Evernden and Kistler, 1970). Several plutons in the Sierra Nevada extend eastward into the quadrangle from the adjacent Mount Whitney 15' quadrangle, where they have been described by Moore (1981).

A prominent Late Cretaceous pluton that underlies an area of about 35 km2 in the Alabama Hills has not been described previously. Although broadly coeval with the predominantly granodioritic plutons of the Mount Whitney Intrusive Suite in the Sierra Nevada, this pluton is distinctly less mafic and is interpreted to represent a separate intrusive mass. This lithologically distinctive pluton, bold outcrops of which have served as background scenery in many motion pictures, is herein named the Alabama Hills Granite. Its type locality is in S1/2 sec. 30, T. 15 S., R. 36 E., on the north side of Whitney Portal Road 400 m east of the junction with Movie Road (fig. 1; see Lone Pine 7.5' topographic quadrangle map for detailed road information). Modal analyses of 13 samples determined from thin-section point

counts indicate a composition of monzogranite (fig. 4).

Another intrusive mass of Late Cretaceous age, previously referred to as the Kern Knob pluton (Griffis, 1986, 1987), makes up a prominent hill at the base of the Inyo Mountains. This hill is mostly just east of the quadrangle boundary in secs. 19 and 30, T. 15 S., R. 37 E., and is designated Kern Knob on the adjacent New York Butte 15' quadrangle. The hill is named Haystack on the newer Dolomite 7.5' quadrangle, but it is referred to herein by the older name Kern Knob. The pluton has a total outcrop area of about 2.5 km2, the westernmost part of which is in the Lone Pine 15' quadrangle. The pluton belongs to a small group of petrologically distinctive, extremely leucocratic plutons in eastern California that contain unusual varietal and accessory minerals such as muscovite, garnet, and fluorite (Miller and Bradfish, 1980). Because of its petrologic significance, we formally name this pluton the Kern Knob Granite. Its type locality is designated as a small quarry at the northern base of Kern Knob in the New York Butte 15' quadrangle, in SW1/4NE1/4 sec. 19, T. 15 S., R. 37 E., about 500 m east of the boundary with the Lone Pine 15' quadrangle. Modal analyses of 15 samples determined from stained-slab and thin-section point counts indicate that the unit is composed of monzogranite (fig. 4). Additional description and interpretation of this unusual pluton are provided by Griffis (1986, 1987).

The voluminous Mount Whitney Intrusive Suite (Moore and Sisson, 1987) was emplaced near the end of the Late Cretaceous pulse of igneous activity in the Sierra Nevada (about 85 Ma). This suite, which constitutes most of the granitic rocks in the Sierran part of the quadrangle, makes up a massive, nested, northwest-trending composite intrusion that becomes progressively younger and more silicic inward. The suite also is exposed to the south in the Olancha 15' quadrangle (duBray and Moore, 1985), to the west in the Mount Whitney and Triple Divide Peak 15' quadrangles (Moore, 1981; Moore and Sisson, 1987), and to the northwest in the Mount Pinchot and Marion Peak 15' quadrangles (Moore, 1963, 1978) (fig. 3). After emplacement, this 1,100-1(m2 mass began solidifying from the walls inward. Before complete solidification, the partly molten, and somewhat more differentiated, siliceous core surged upward, twice intruding its older, outer shell. Initially, the outer part of the composite pluton solidified as the granodiorite of Lone Pine Creek on the east and the granodiorite of Sugarloaf (Moore, 1981) on the west. The next surge emplaced the Paradise Granodiorite. The final surge emplaced the Whitney Grano-diorite in the center such that only a thin shell of Paradise Granodiorite remained on the east, adjacent to the granodiorite of Lone Pine Creek. In places, this shell of Paradise Granodiorite is no thicker than about 100 m.

JURASSIC AND CRETACEOUS(?) DIKES

Jurassic and older rocks of the Alabama Hills and Inyo Mountains are intruded by numerous dikes (KJd) of mafic, intermediate, and, less commonly, felsic composition. Most of these dikes probably belong to a regionally extensive, northwest-striking family of dikes known as the Independence dike swarm (Moore and Hopson, 1961). The Independence swarm includes several dikes that have been isotopically dated as Late Jurassic (148 Ma) (Chen and Moore, 1979), including one in the Alabama Hills (Locality G-3), and many dikes in the quadrangle probably are of this age. Chen and Moore (1979) interpreted the Independence dikes to have been emplaced along fractures produced by a regional crustal extension event in Late Jurassic time (Chen and Moore, 1979). Recently, however, the Independence swarm has been shown to contain dikes of Late Cretaceous as well as Late Jurassic age (Coleman and others, 2000), so it is no longer possible to relate the origin of the entire swarm to a single magmatic event.

Some dikes in the northern Alabama Hills could be significantly older than 148 Ma and not genetically related to the Late Jurassic dikes of the Independence swarm. In this area, dikes are abundant in the lower part of the volcanic complex of the Alabama Hills (Javl), but are almost absent except locally in the upper part (Javu). This outcrop distribution suggests that many of these dikes are Middle Jurassic in age and may predate the upper part of the volcanic complex. Such dikes could have originated at volcanic centers where magma rose to the surface during deposition of the lower part of the volcanic complex.

A prominent aphanitic dike of felsic composition in the Inyo Mountains is shown as a separate unit (KJf). Dikes of this type just east of the quadrangle cut across relatively mafic dikes of presumed Late

Jurassic age, and one such felsic dike has been dated as about 140 Ma (Early Cretaceous) (Dunne and Walker, 1993). The mapped dike may be coeval with these dikes, or it may be an offshoot of the Late Jurassic (148 Ma) granite of French Spring, which also crops out just east of the quadrangle (Dunne and Walker, 1993).

LATE JURASSIC AND CRETACEOUS DEFORMATION

Pre-Cretaceous rocks in the quadrangle were subjected to episodic contractional deformation beginning in Late Jurassic time, during which these rocks were compressed and shortened in a northeast-southwest direction (Dunne, 1986). This deformation took place in a zone called the East Sierran thrust system that trends southeastward through the quadrangle (Dunne and others, 1983). In the earliest phase of deformation, Mesozoic volcanogenic strata in the Inyo Mountains and Alabama Hills were tilted southwestward and locally were folded and cleaved along northwest trends. The age of this event is tightly bracketed in areas just southeast of the quadrangle, where deformation involved 150- to 148-Ma volcanic rocks and preceded emplacement of northwest-striking mafic dikes interpreted to represent the Late Jurassic (148 Ma) part of the Independence dike swarm (Dunne and others, 1998). The northwest-striking, northeast-dipping dip-slip fault that cuts the volcanic complex of the Inyo Mountains east of Owenyo probably formed at this time, because it is interpreted to be intruded by the 148-Ma granite of French Spring just east of the quadrangle (Dunne and Walker, 1993). Following their emplacement, some Independence dikes and their host rocks were affected by additional deformation. Cleavage was imposed on some dikes, and some are cut by a post-140 Ma thrust fault a short distance southeast of the quadrangle (G.C. Dunne and J.D. Walker, unpub. data, 1995)

QUATERNARY DEPOSITS

Nearly half the quadrangle is covered by surficial deposits of Quaternary age. Coarse-grained alluvial and debris-flow deposits derived from erosion of the Sierra Nevada, Alabama Hills, and Inyo Mountains are areally the most abundant, and most of these deposits are of Pleistocene age. Eolian sands of Holocene age and lake deposits of late Pleistocene and Holocene age are widespread in Owens Valley on both sides of the Owens River. Other surficial deposits, including a few glacial moraines in the Sierra Nevada, are of relatively limited areal extent.

Large landslide masses, some of which may be late Tertiary in age, are the oldest surficial deposits in the quadrangle. These deposits consist of jumbled masses of large and small rock fragments that are located downhill from steep outcrops of similar rock types, and most have hummocky surfaces.

Interbedded alluvial and debris-flow gravels of Pleistocene age form broad, gentle slopes between the eastern base of the Sierra Nevada and the flat floor of Owens Valley. These deposits are particularly well exposed where cut by creeks in the Alabama Hills, especially along Lone Pine Creek, and where dissected by deep channels near the Sierran range front 5 to 6 km north of Lone Pine Creek. Most of the alluvial gravels are distinctly bedded and contain moderately rounded clasts, rarely more than 0.5 m across, that rest in a matrix of finer material. Debris-flow gravels, usually considered a product of massive floods, most commonly are clast supported, indistinctly bedded, and characterized by angular fragments as much as 1 or 2 m across. Many or most of these deposits are inferred to be related to glaciation in the Sierra Nevada.

The Pleistocene alluvial and debris-flow gravels are divided into older and younger deposits on the basis of weathering characteristics, especially on the surfaces of biotitebearing plutonic-rock boulders. Many boulders in the younger gravels are porphyritic, and these characteristically have weather-resistant potassium feldspar phenocrysts and small mafic inclusions that project 2 to 5 cm above weathered surfaces. Boulders of similar lithology in the older gravels, by contrast, generally are partially or totally weathered to loose grus. Boulders in some of the oldest deposits are entirely decomposed, and these sediments can be identified only by the high percentage of loose subhedral potassium feldspar phenocrysts, 2 to 6 cm long, derived from areas exposing the porphyritic Whitney Granodiorite or Paradise Granodiorite in the Sierra Nevada.

Glacial moraines of the Sierra Nevada in the quadrangle extend nearly to the range front but do not reach it. Most of the moraines have easily identified crests and consist of totally unsorted angular

debris that ranges in size from sand to clasts several meters long. Good exposures of moraine gravels can be seen in cuts along Whitney Portal Road at an elevation of about 7,600 ft (2,317 m).

Lake deposits crop out along the Owens River and along the edges and floor of Owens Lake. Lake deposits also underlie the thin layer of windblown sand that covers much of the notably flat center of the valley, and they are exposed where wind has excavated holes in that sand layer. Most of the lake deposits are well bedded and consist of light-tan clay, silt, and fine sand. Lake deposits in the quadrangle, and for another 10 km to the north, lie primarily at elevations below about 3,760 ft (1,146 m), the maximum elevation of the overflowing lake that filled the south end of Owens Valley during much of the late Pleistocene. That lake began to shrink sometime between 8,000 and 5,000 years ago (Smith and others, 1997). Fossil clams and snails are present locally in lake sediments at elevations just below 3,760 ft (1,146 m). West of the Owens Valley Fault Zone, lake sediments extend to slightly higher elevations because of fault-related uplift.

Rock glaciers, talus, regolith, and colluvium in the quadrangle are largely products of gravity acting on unconsolidated materials. Definitions of these deposits overlap somewhat, but the sediment size, upper-surface slope, and geologic setting usually provide a basis for the chosen name.

Active and inactive alluvial deposits in the quadrangle were formed by running streams. Active alluvium is found 1 to 2 m above the late summer stream levels because the most active deposition and transport have taken place during floods that followed exceptionally wet winters or intense summer and autumn storms. Inactive alluvium is litho-logically similar to nearby active alluvium but is characterized by surfaces that commonly are 0.5 to 3 m higher than the active alluvium and are almost free of channels. Very thin desert varnish has coated the surfaces of many clasts in the inactive alluvium, making these deposits somewhat darker than the active alluvium.

Conspicuous gravels containing very large boulders 2 to 15 m across (QgvI) form narrow terraces along several modern streams that drain the Sierra Nevada in the quadrangle. Because of the very large size of the boulders, their deposition might seem to be the product of debris-flow processes associated with glaciation. The deposits that contain these boulders, however, are deeply inset into the youngest Pleistocene gravel deposits (Qgy), suggesting that they are Holocene in age. This age is confirmed by radiometric-exposure dating of large boulders adjacent to Lone Pine Creek 4.5 km east of the mountain front, which indicates that these boulders last came to rest about 2,000 to 1,200 years ago (Bierman and others, 1995). There is no evidence of major glaciation in the Sierra Nevada that recent. The inference that the transport and deposition of very large boulders did not require glaciation is further supported by the presence of debris-flow boulders 1 to 2 m across on fan surfaces east of the Sierra Nevada 27 km south of the quadrangle, 10 to 15 km south of the southernmost conspicuous Sierran glacial cirque at Olancha Peak.

LATE TERTIARY AND QUATERNARY FAULTING

The quadrangle is traversed by three major northwest-striking fault zones that have been active in late Tertiary and Quaternary time: the Sierra Nevada Frontal Fault Zone, the Owens Valley Fault Zone, and the Inyo-White Mountains Fault Zone. Cumulative displacements on these faults during about the last 6 m.y. are responsible for the present physiography of the quadrangle and for the subsurface structure of Owens Valley (Gillespie, 1991; Hollett and others, 1991). The Sierra Nevada Frontal Fault Zone separates the western part of Owens Valley, including the Alabama Hills, from the Sierra Nevada block of pre-Quaternary basement rocks on the west. The Owens Valley Fault Zone (Carver, 1970; Beanland and Clark, 1994) separates the western part of Owens Valley, in which bedrock generally is within 300 m of the land surface, from a structurally much deeper eastern graben, in which bedrock is as much as 2,500 m below the surface (Pakiser and others, 1964; Hollett and others, 1991). The buried Inyo-White Mountains Fault Zone is inferred to separate this deep graben from the Inyo Mountains block of pre-Quaternary basement rocks to the east.

The Sierra Nevada Frontal Fault Zone, which is poorly exposed along much of its trace in or adjacent to Sierran plutonic rocks, is mapped as a discontinuous series of exposed segments that dip 60° to 80° E. Along some fault segments that cut Quaternary sediments, a scarp 1 to 3 m high is developed, with the east side down, but in other places the fault zone has little surface expression. Overall, the

fault zone is interpreted to have normal, east-side-down displacement with little or no strike-slip component (Hollett and others, 1991). Total vertical displacement on the fault zone is thought to be about 3 km (Beanland and Clark, 1994).

The most active fault zone in the quadrangle is the Owens Valley Fault Zone, movement on which caused the Lone Pine earthquake of March 26, 1872. This great earthquake (Richter magnitude about 8) is one of California's largest historic earthquakes, exceeded only by the 1857 Fort Tejon and the 1906 San Francisco earthquakes (Beanland and Clark, 1994). The Owens Valley Fault Zone extends north-northwestward across the quadrangle near the eastern base of the Alabama Hills and can be traced about 55 km north and 25 km south of the quadrangle for a total of about 110 km. The surface trace of the fault zone is marked by a nearly continuous zone of scarps, depressions, pressure ridges, and other linear features, some of which coincide with differences in ground-water level across the fault zone (Hollett and others, 1991; Beanland and Clark, 1994; Danskin, 1998). Most of the fault traces shown on the map are readily identified on the ground or aerial photographs; some were taken from Beanland and Clark (1994), who also describe the fault features in detail at many localities. Many of the scarps and other surface features that define the fault zone experienced movement or were initiated at the time of the 1872 earthquake.

Most traces of the Owens Valley Fault Zone in the quadrangle cut inactive alluvium (Qai) and older lake deposits (Q1o). Some scarps, however, cut active alluvial deposits (Qa) that fringe the Alabama Hills north of Lone Pine, and the most southeasterly trace of the fault zone mapped in the quadrangle is a scarp that cuts younger lake deposits (Q1y) on the floor of Owens Lake; the locations of these scarps are from Beanland and Clark (1994). In addition, two inferred faults are mapped in an area of ground-water seepage north of the Alabama Hills; the locations of these faults are from Hollett and others (1991) and Danskin (1998).

The Owens Valley Fault Zone shows evidence of dominantly right-lateral displacement, with a subordinate vertical component that is generally down to the east. Scarps commonly show several meters of vertical displacement, with most but not all scarps facing east. The Lone Pine Fault, a major western strand of the Owens Valley Fault Zone, is marked by a prominent east-facing scarp as high as 6.5 m and has undergone 10 to 18 m of late Quaternary right-lateral offset (Lubetkin and Clark, 1987, 1988). Total right-lateral displacement on the Owens Valley Fault Zone is estimated as 10 to 20 km, as compared with about 2.5 km of total down-to-the-east vertical displacement (Beanland and Clark, 1994). The dip of the fault zone, although presumably steep (Beanland and Clark, 1994), is not accurately known at depth, and it is shown as vertical in cross section A–A'.

Near the southeast corner of the quadrangle, the Owens Valley Fault Zone includes a west-facing scarp on the floor of Owens Lake that has been interpreted as resulting from vertical displacement during the 1872 earthquake (Beanland and Clark, 1994). This scarp is in an area that lay submerged beneath as much as 7 m of water (Gale, 1914) until shortly after the Los Angeles Aqueduct was completed in 1913, when the lake began to desiccate. It is surprising that this scarp, if formed in 1872, could have been preserved despite being exposed to subaqueous erosion for more than 40 years prior to construction of the aqueduct. Instead, this scarp may have developed after 1913, conceivably during a moderate earthquake that shook southern Owens Valley on July 6, 1917 (Townley and Allen, 1939). It is likewise possible that other traces of the fault zone have undergone similarly recent displacement, although such displacement would be minor compared to that of 1872.

The Inyo-White Mountains Fault Zone was identified by Pakiser and others (1964) on the basis of gravity data that require a sharp, steeply dipping boundary between the Owens Valley depression and the mountain block to the east. This fault zone has no known surface expression in the quadrangle and apparently has undergone no significant Holocene displacement. Because of its lack of exposure, the subsurface location and vertical dip of the fault zone as shown on the map and cross section A–A' should be considered approximate.

Geodetic measurements of active crustal deformation in the Owens Valley area and adjoining parts of eastern California have been made by several methods in recent years (Dixon and others, 1995; Miller and others, 1995; Savage and Lisowski, 1995). These measurements reveal that the map area

is undergoing active right-oblique extension by combined dip-slip and strike-slip motions of the Sierra Nevada Frontal Fault Zone and Owens Valley Fault Zone. The general pattern of deformation established in the area as early as 6 Ma is thus continuing today.

Report from source map: Lone Pine 15' Quadrangle

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Reference from source map: Lone Pine 15' Quadrangle

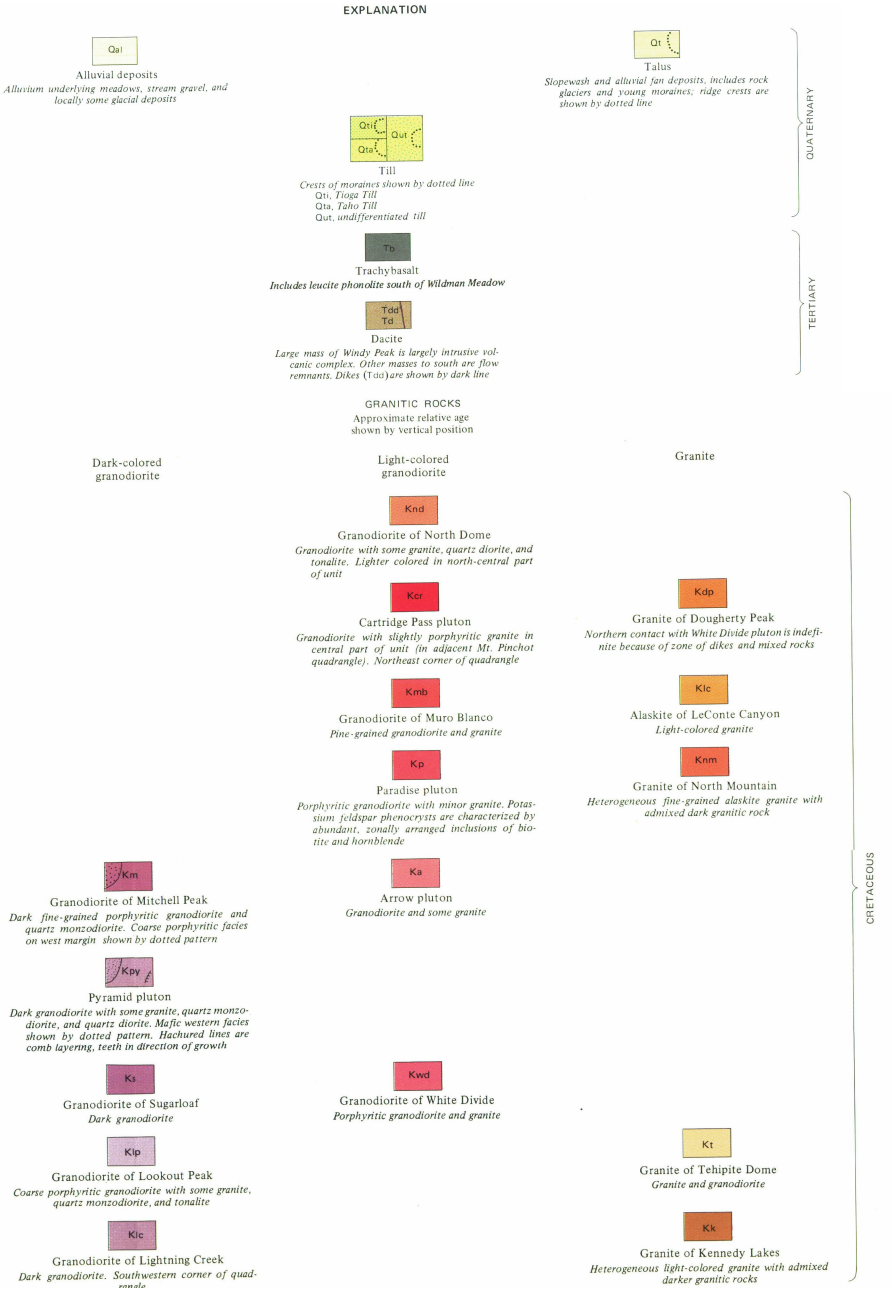
Marion Peak 15' Quadrangle

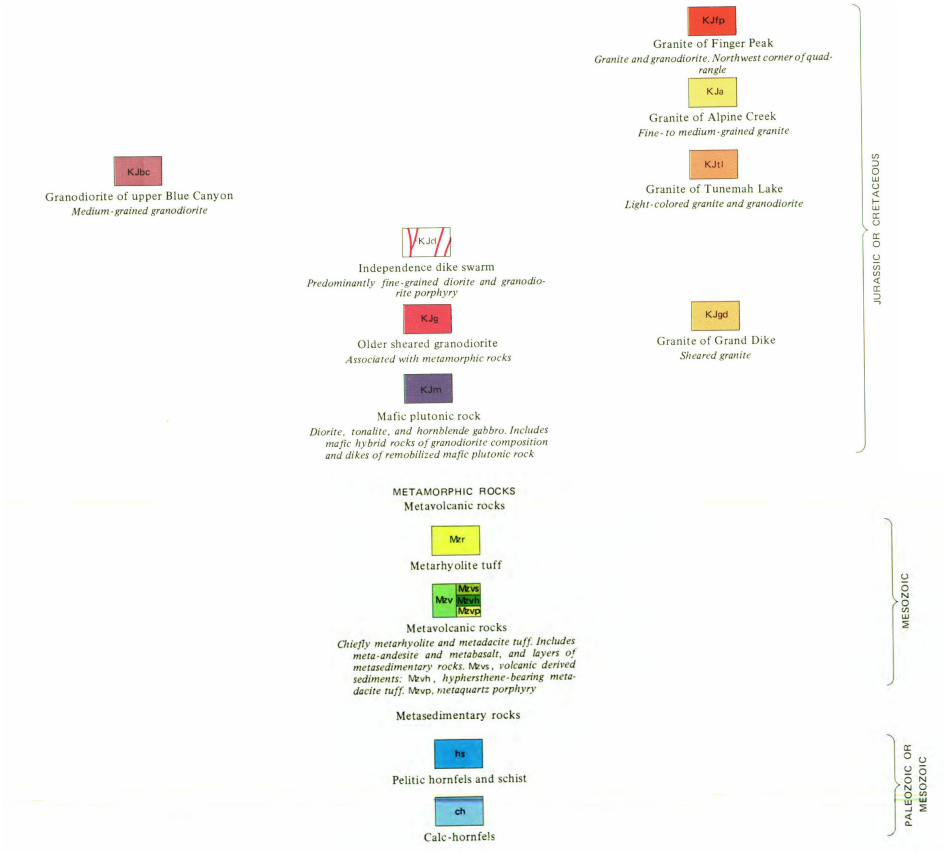
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Moore, J.G., 1978, Geologic Map of the Marion Peak Quadrangle, Fresno County, California, U.S. Geological Survey, GQ-1399, 1:62,500 scale. (*GRI Source Map ID 1911*).

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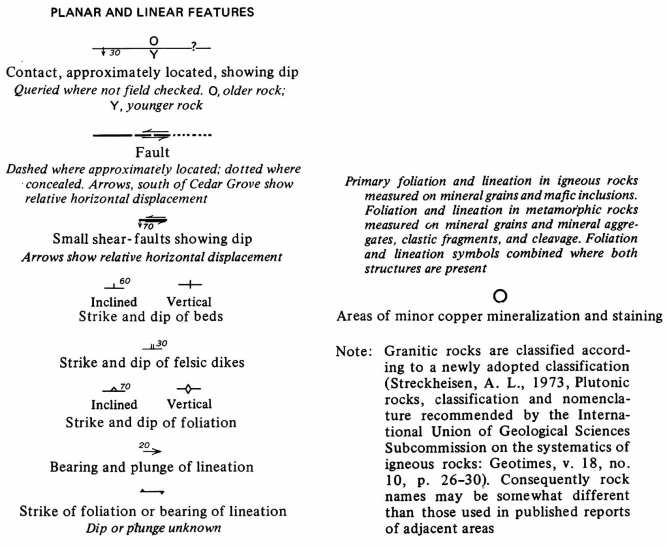
Correlation of Map Units





Graphic from source map: Marion Peak 15' Quadrangle

Map Legend



Graphic from source map: Marion Peak 15' Quadrangle

Report

INTRODUCTION

The Marion Peak quadrangle includes about 620 km2 (240 mi2) on the upper west slope of the Sierra Nevada largely between the Middle and South Forks of the Kings River. All but about 50 km2 (19 mi2) of the quadrangle lies in Kings Canyon National Park. The physiography is dominated by the great canyons of the Middle and South Forks of the Kings River. These glacially carved canyons, resembling Yosemite Valley 120 km (72 mi) to the northwest, provide spectacular scenery with steep walls rising 1,000-1,500 m (3 ,0005,000 ft) above the river bed. Eleven kilometers west of the quadrangle these two forks of the river join, a few kilometers farther downstream the combined river has cut one of the deepest canyons in the United States, flowing about 2,400 m (7,900 ft) below the summit of Spanish Mountain to the north. Glacially carved peaks, including Marion Peak, dominate Monarch Divide and Cirque Crest which form the drainage divide between the two river forks. The only road in the quadrangle is California State Route 180, which terminates in the canyon of the South Fork of the Kings River near Cedar Grove. At the end of the road, trails connect with the John Muir Trail, which threads near the crest of the Sierra Nevada about 10 km (6 mi) east of the quadrangle.

GEOLOGIC HISTORY

The quadrangle is underlain predominantly by granitic rocks belonging to the Sierra Nevada batholithic complex. This granitic material was intruded at depth as magma(largely molten rock) into preexisting sedimentary and volcanic rocks mainly during the Jurassic (?) and Cretaceous Periods. Later the area was repeatedly uplifted and deeply eroded so that most of the pregranitic rocks were eroded away, exposing a variety of granitic intrusive rocks. Much later, small volcanic vents erupted basalt and dacitic volcanic materials on top of the granitic rocks. Continued strong uplift and faulting shaped the present Sierra Nevada. During the Pleistocene, glaciers covered much of the higher parts of the range and fed down into the main drainages carving the great canyons of the Middle and South Forks of the Kings River.

Metamorphic Rocks

Small masses of both metasedimentary and metavolcanic rocks are preserved only as narrow screens between the granitic plutons in the quadrangle. The metasedimentary rocks were originally shaly and limy beds that were laid down as horizontal strata in an ancient sea. The metavolcanic rocks are generally younger than the metasedimentary rocks and were originally beds of silicic volcanic ash (tuff), lava flows, shallow intrusions, and volcanic-derived sediments. Much of the volcanic material was deposited on land, but some was reworked by water and deposited in a near-shore environment. Comparative studies in nearby areas to the north and east suggest that these rocks were erupted and deposited in the Triassic, Jurassic, and perhaps Early Cretaceous Periods (about 225-100 m.y. ago). Subsequently, all the pregranitic rocks were folded, sheared, and recrystallized largely as the result of the intrusion of the enormous volumes of hot granitic magma. These ancient rocks are metamorphosed to phyllite, schist, and hornfels; their original horizontal bedding is now nearly vertical.

The largest area of metasedimentary rocks occurs in a narrow screen around the north end of the granodiorite of North Dome in the west-central part of the quadrangle. A second narrow screen of biotite schist surrounds the granite of North Mountain and is well exposed on the walls of the canyon of the South Fork of the Kings River. The largest mass of metavolcanic rock, in the northeast corner of the quadrangle, is the southern end of the Goddard roof pendant, the largest mass of Mesozoic metavolcanic rock in the eastern Sierra Nevada. A second mass, composed of silicic metavolcanic rock, occurs in the center of the quadrangle where it forms a screen continuous with the more northern meta-sedimentary screen around the east side of the granodiorite of North Dome. A third mass of metavolcanic rock, in the west-central part of the quadrangle, is continuous with larger masses on to the west. The rocks in this mass include pyroxene -bearing metatuff and water-laid volcanogenic deposits.

Granitic Rocks

A great number of separate masses or plutons of granitic rock have been mapped. In the field they can be distinguished from one another by texture, structure, and composition despite the fact that

rocks within a single mass may show a range in these features. The granitic rocks have been divided into three general compositional groups, dark -colored granodiorite, light-colored granodiorite, and granite, and these are shown by general color shades on the map.

The relative age relations of the various granitic masses can commonly be determined where they are in contact. Aside from mutual contact relations, the age sequence of the granitic bodies is also dependent on the fact that an important group of dark-colored dikes, the Independence dike swarm, is known in adjacent areas (Moore and Hopson, 1961) to cut an older sequence of granitic masses and in turn to be truncated by a younger sequence of granitic plutons. In the quadrangle, the sheared granodiorite of Goddard pendant, is the only granitic pluton that is clearly cut by these dikes. In addition other apparent older masses of granitic rock are characterized by: (1) close association with pregranitic metamorphic rocks, (2) occurrence in long, thin masses, and (3) extensive shearing and recrystallization. The youngest granitic intrusions are characterized by rounded, elliptical shapes and unsheared igneous textures.

Radiometric age data are available for many granitic rocks in the Sierra Nevada (Evernden and Kistler, 1970), but only two plutons within the quadrangle have been dated by radiometric methods. The Cartridge Pass pluton in the northeastern corner of the quadrangle cooled about 81 m.y. ago (Dodge and Moore; 1968), and the alaskite of LeConte Canyon, 80 m.y. ago (Evernden and Kistler, 1970). Both are among the youngest granitic masses in the quadrangle. From these several lines of evidence, a provisional age sequence (shown on the map explanation) has been developed for all the granitic rocks, ranging in age from the Jurassic Period. (195-136 m.y.) into the Cretaceous Period (136-65 m.y. ago), but age data are quite incomplete.

One curious feature, associated with the granodiorite of the Pyramid pluton, is the 'development of extensive comb-layered rocks near Volcanic Lakes in the center of the quadrangle. These comb-layered rocks are believed to have crystallized from high-temperature water-rich fluids that streamed upward on the margins of the solidifying granitic intrusion (Moore and Lockwood, 1973).

After all the granitic intrusions had been emplaced and had cooled to the point that they were largely brittle, the entire region was subjected to stresses that fractured the rocks and produced a nearby vertical system of cracks or joints. The most prominent set of these joints trends about N. 70° E. and consistently shows a small amount of left-lateral shear. A second more poorly developed set of joints trends about north-south. The more prominent joint set was locally mineralized by hot fluids at depth which used the cracks as channels and deposited quartz and epidote, as well as minor amounts of pyrite, chalcopyrite, and molybdenite. Later oxidation of the chalcopyrite has produced the green copper stain of Copper Creek and Grand Sentinel. Other occurrences of this rather minor mineralization are shown on the map.

Erosion, volcanic eruption, and glaciation

The history of the Sierra Nevada since the intrusion and cooling of the granitic rocks has been dominated by uplift and erosion, largely by flowing water, and later during the ice ages, by grinding ice. Vast volumes of the former roof into which the granitic masses were intruded have been stripped off and carried west by streams to be deposited as bedded sedimentary layers in the Great Valley of California. By the beginning of the Tertiary

Period (65 m.y. ago), streams had stripped off much of the roof rock and exposed the granitic basement. At that time the area was characterized by gentle, rolling terrain and broad valleys. Uplift, westward tilting, and stream erosion continued through the Tertiary and Quaternary Periods to the present time.

Near the close of the Tertiary Period isolated volcanic eruptions occurred in several places within the quadrangle. Dacite magmas broke through to the surface in the northern part of the quadrangle, built a small volcano, and spread lava flows over a considerable area. Probably somewhat later; highly alkalic basalt lavas were erupted from several vents and flowed down the ancestral canyons of the Middle and South Forks of the Kings River.

After these eruptions, uplift and westward tilting of the range accelerated and the range began to acquire its present rugged aspect. During the Pleistocene Epoch (2 million to 10,000 years ago), the weather became colder. and extensive glaciers repeatedly formed and retreated. The glacial ice shaped the high alpine peaks and glacial cirques and carved the deep U–shaped valleys, particularly those of the Middle and South Forks of the Kings River. The dacitic volcano in the northern part of the quadrangle was carried away except for a few flow remnants and the eroded volcanic neck, the former conduit of the volcano. The basalt flows were largely eroded away except for small remnants now exposed on benches S00-1,200 m (1,600-3,900 ft) above the canyon floors.

During the retreat of the glaciers in the later part of the ice ages, renewed surges of advancing ice piled up morainal ridges of broken rock debris. The glacial deposits of two of these later advances are shown on the map as Tahoe and Tioga Tills. The Tioga Till was deposited by the last major ice advance about 24,000-11,000 years ago. Since then, after the ice retreated, there have been only minor changes in the glacially modified landscape.

Report from source map: Marion Peak 15' Quadrangle

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Reference from source map: Marion Peak 15' Quadrangle

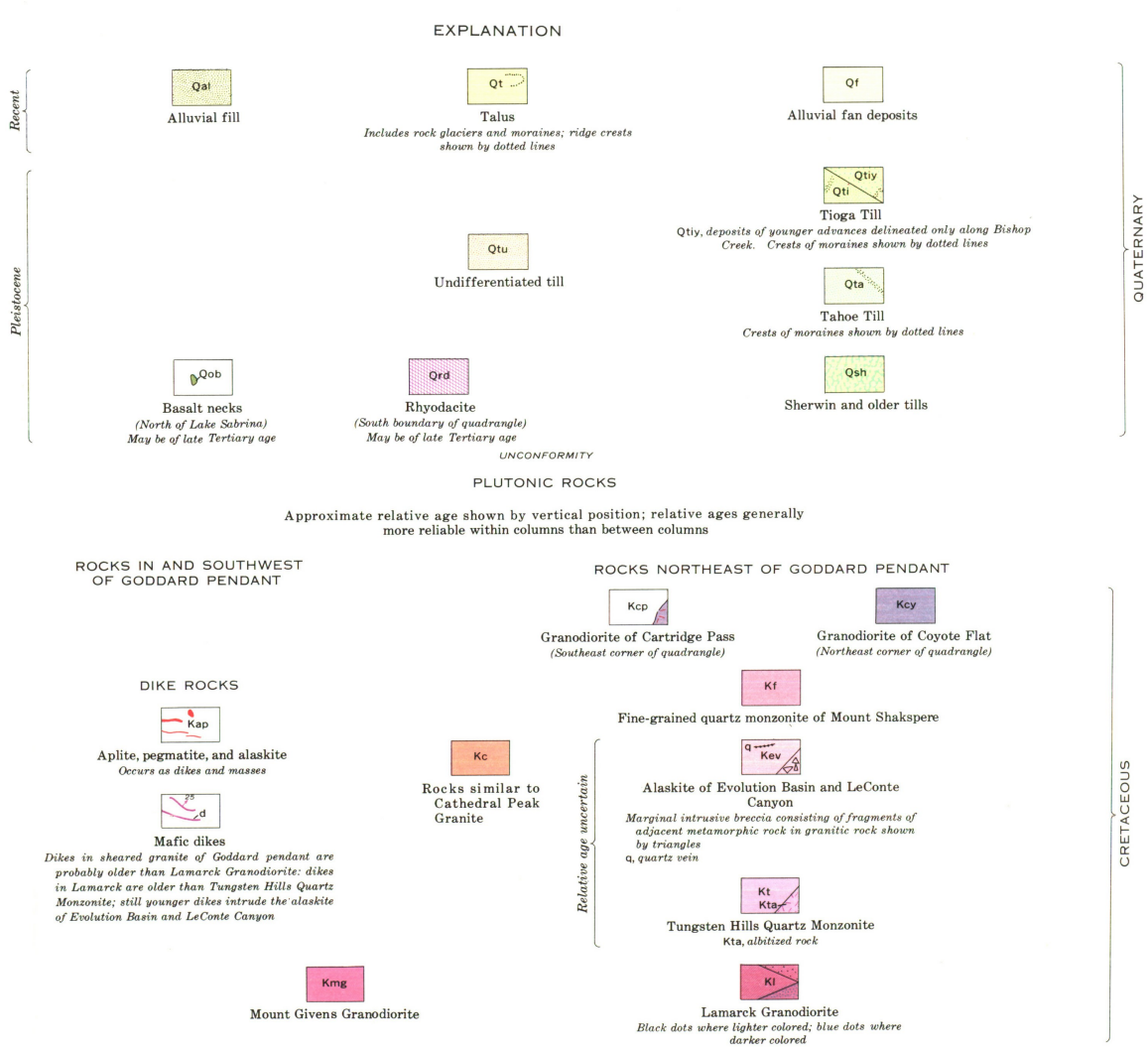
Mount Goddard 15' Quadrangle

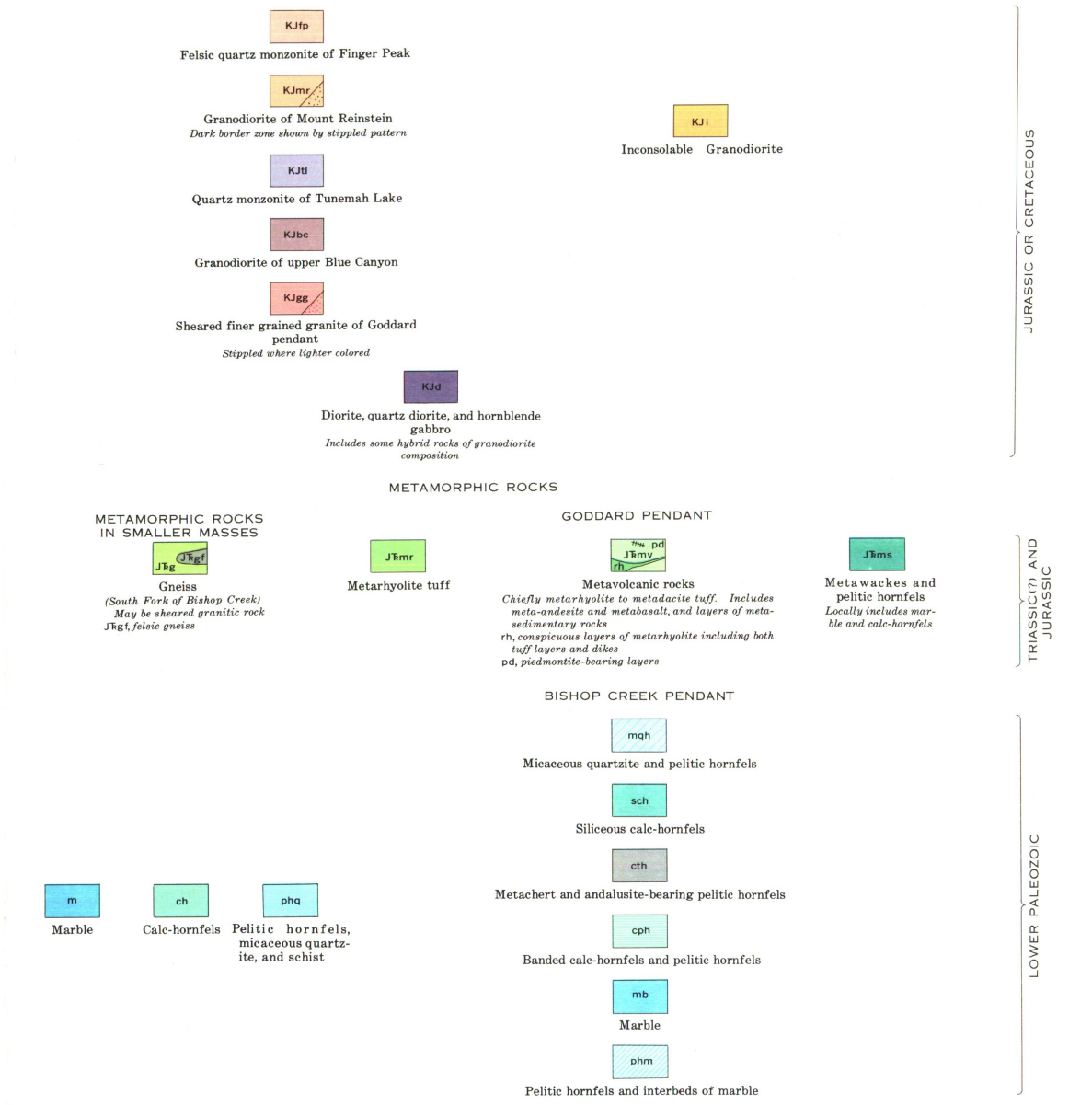
The formal citation for this source.

Bateman, P.C. and Moore, J.G., 1965, Geologic Map of the Mount Goddard Quadrangle, Fresno And Inyo Counties, California, U.S. Geological Survey, GQ-429, 1:62,500 scale. (*GRI Source Map ID 1897*).

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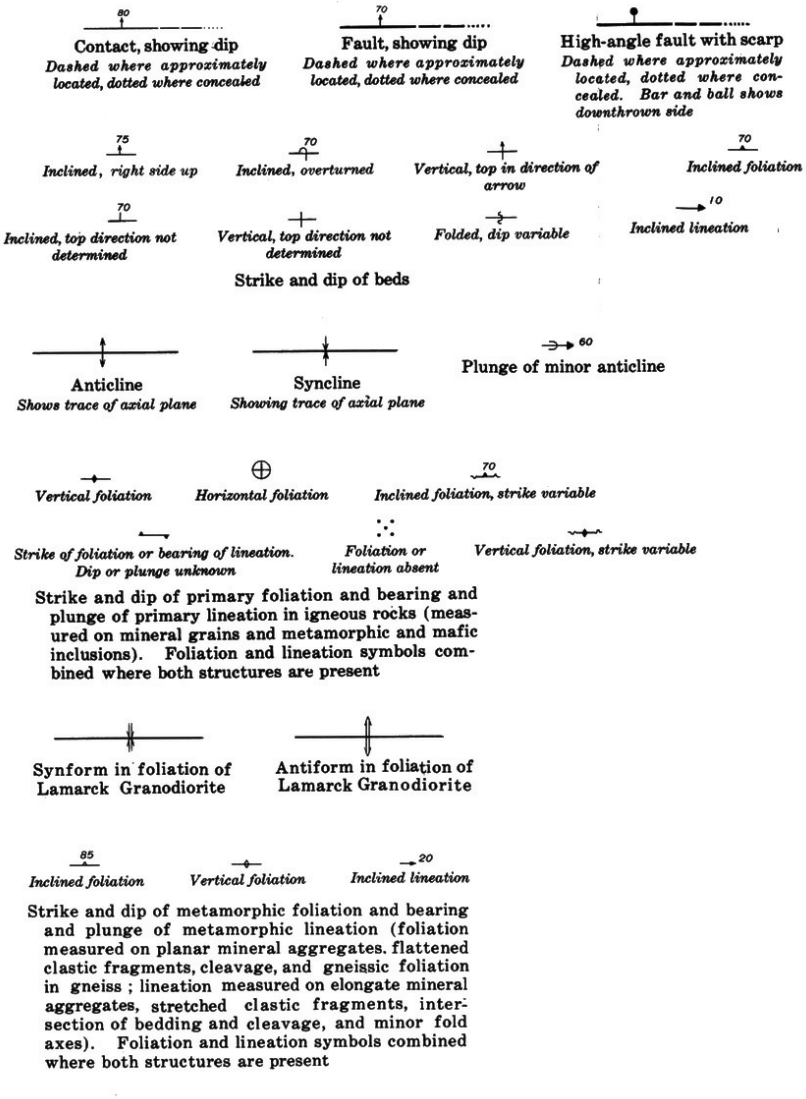
Correlation of Map Units





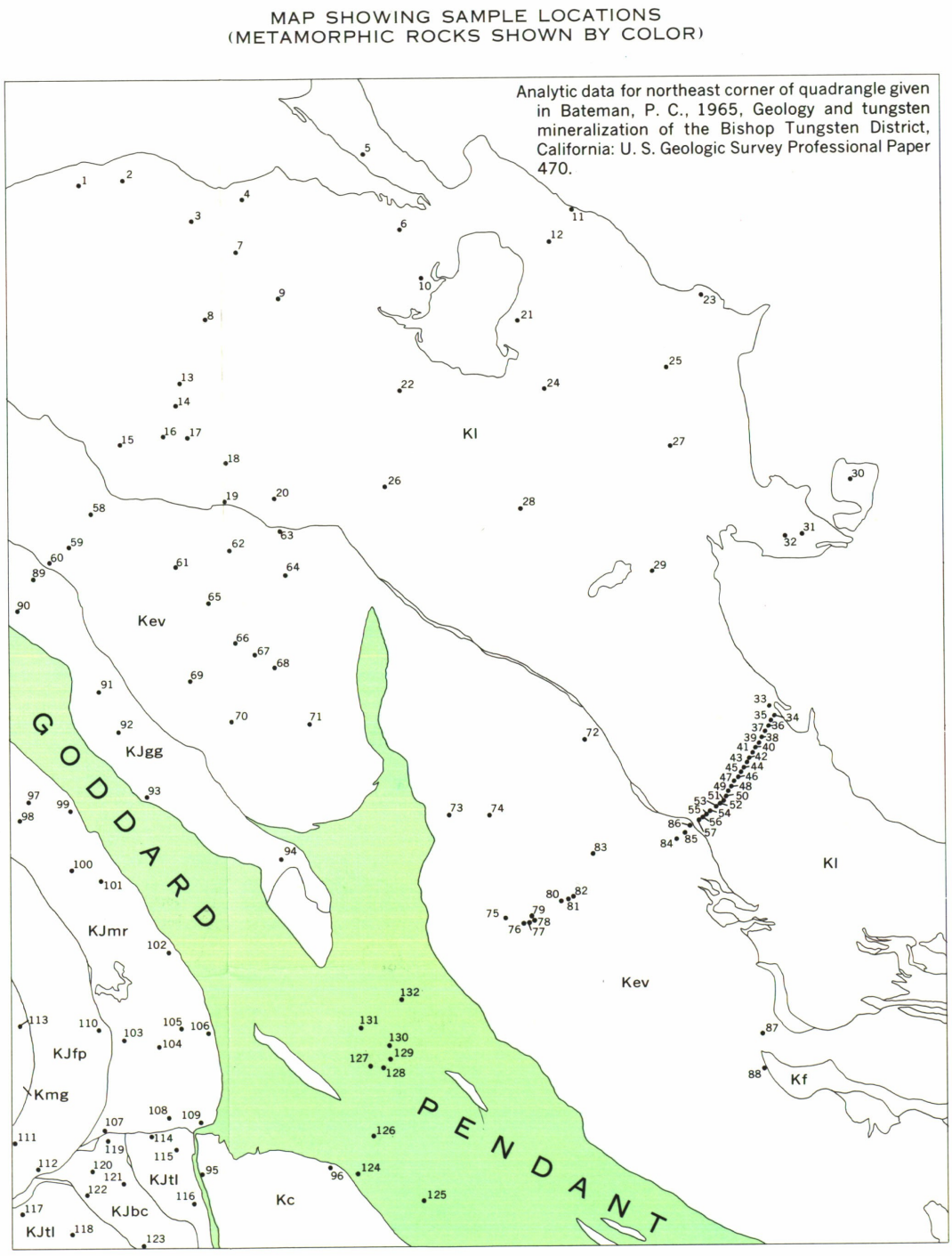
Graphic from source map: [Mount Goddard 15' Quadrangle]

Map Legend



Graphic from source map: Mount Goddard 15' Quadrangle

Sample Locations



Graphic from source map: [Mount Goddard 15' Quadrangle]

Modal Analyses

MODAL ANALYSES OF GRANITIC ROCKS
(1000 TO 2000 point counts on a stained slab of at least 6 square inches)

Lamarack Granodiorite (Ki)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
1	2.72	25.3	12.3	43.8	15.5
2	2.70	22.9	22.2	40.0	10.8
3	2.72	23.0	18.3	43.1	15.6
4	2.69	23.1	24.7	37.8	14.4
5	2.71	24.1	19.1	44.1	12.7
6	2.65	25.1	35.1	33.8	6.5
7	2.70	26.9	12.3	44.0	16.8
8	2.76	16.7	11.0	50.8	21.5
9	2.73	21.5	17.8	51.4	11.3
10	2.65	28.9	29.5	28.8	12.8
11	---	27.8	14.6	41.5	16.1
12	2.72	26.5	18.6	44.6	10.3
13	2.70	19.2	8.7	49.1	23.0
14	2.78	15.5	6.5	55.8	22.2
15	2.63	22.7	26.9	45.1	5.3
16	2.62	26.9	23.4	43.3	6.4
17	2.69	18.8	21.1	51.9	8.2
18	2.65	18.0	6.8	65.7	9.5
19	2.65	19.5	16.0	54.9	9.6
20	2.64	24.2	20.0	49.8	6.0
21	2.67	29.4	21.2	45.5	8.9
22	2.72	23.5	17.7	45.5	13.7
23	2.71	15.4	17.9	55.9	15.8
24	2.68	25.6	19.0	41.4	14.0
25	2.68	18.5	20.9	44.4	16.0
26	---	22.9	23.9	39.0	14.2
27	2.67	24.9	22.6	38.2	14.3
28	2.67	23.6	24.0	42.5	9.7
29	2.71	23.3	18.6	47.5	10.6
30	2.72	14.7	26.5	39.2	19.6
31	2.70	23.3	20.6	41.4	14.7
32	2.73	20.3	16.4	47.0	16.3
33	2.66	25.2	18.8	49.0	7.0
34	2.63	24.7	22.6	46.2	6.5
35	2.58	24.1	23.5	48.0	4.4
36	2.65	23.4	13.1	53.9	9.6
37	2.58	20.3	13.4	49.5	16.8
38	2.70	21.0	12.6	49.4	17.0
39	2.72	18.0	10.1	53.9	18.0
40	2.72	18.1	12.5	50.1	19.3
41	2.69	22.5	11.6	44.1	21.8
42	2.71	18.9	14.3	50.4	16.4
43	2.69	20.6	12.4	48.5	18,5
44	2.70	17.4	10.8	54.8	17.0
45	2.69	21.5	10.7	48.2	19.6

Lamarack Granodiorite (Ki)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
46	2.69	19.1	12.5	52.2	16.2
47	2.72	19.8	12.1	46.9	21.2
48	2.71	18.5	10.9	52.9	17.6
49	2.73	21.1	9.8	50.7	18.4
50	2.70	14.6	15.0	50.8	19.6
51	2.71	16.2	12.2	53.0	18.6
52	2.71	15.2	8.7	55.2	20.9
53	2.71	20.9	14.5	47.5	17.1
54	2.72	23.3	15.6	42.4	18.7
55	2.69	18.0	15.4	43.5	23.1
56	2.71	20.8	12.6	51.1	15.5
57	2.71	21.3	13.4	47.7	17.6

Alaskite of Evolution Basin and LeConte Canyon (Kev)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
58	2.61	25.9	35.1	35.7	3.3
59	2.59	31.9	43.4	23.7	1.0
60	2.60	32.9	43.9	21.9	1.3
61	2.63	30.9	33.2	30.8	5.1
62	2.60	28.2	34.2	34.3	3.3
63	2.62	36.7	34.6	26.8	1.9
64	2.62	43.0	36.2	20.5	0.3
65	2.60	34.7	33.9	30.1	1.3
66	2.60	34.1	43.1	21.3	1.5
67	2.63	39.4	43.2	15.7	1.7
68	2.60	30.4	36.6	31.0	2.0
69	2.61	32.6	43.7	22.4	1.3
70	2.62	31.9	33.8	32.0	2.3
71	2.61	30.9	43.9	24.5	0.7
72	2.62	30.9	42.1	25.0	2.0
73	2.62	27.5	30.6	41.0	0.9
74	2.60	27.2	30.5	40.1	2.2
75	2.64	23.1	30.6	44.4	1.9
76	2.63	28.9	29.9	39.5	1.7
77	2.60	27.2	26.4	45.1	1.3
78	2.61	28.2	24.9	42.8	4.1
79	2.62	29.1	34.2	34.1	2.6
80	2.60	38.1	40.0	20.2	1.7
81	2.60	35.8	42.9	20.6	0.7
82	2.60	38.0	35.4	25.7	0.9
83	---	32.2	24.0	42.6	1.2
84	---	28.4	12,7	47.6	11.2
85	---	31.2	20.6	43.9	4.3
86	---	29.5	14.6	47.5	8.4
87	2.57	24.9	39.3	34.6	1.2
88	2.58	32.9	36.4	29.4	1.3

Sheared, finer-grained granite of Goddard pendant (KJgg)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
89	---	13.6	56.3	20.7	9.4
90	---	5.7	63.1	19.4	11.8
91	---	19.7	51.2	18.8	10.3
92	---	20.6	61.7	12.8	4.9
93	---	11.5	37.6	34.4	16.5
94	---	29.8	35.1	29.8	5.4

Rocks similar to the Cathedral Peak Granite (Kc) (Mass east of Tunemah Lake only)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
95	2.59	29.5	28.8	38.9	2.8
96	2.62	34.7	18.4	42.1	4.8

Granodiorite of Mt. Reinstein (KJmr)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
97	2.74	18.1	11.6	48.1	22.2
98	---	23.2	19.4	42.2	15.2
99	2.75	18.1	9.6	51.9	20.4
100	2.63	34.8	10.3	36.4	18.5
101	2.70	22.3	25.3	37.2	15.2
102	2.74	18.9	0	60.3	20.8
103	2.68	16.2	8.0	62.4	13.4
104	2.68	33.4	2.7	46.5	17.4
105	2.69	23.9	18.8	42.4	14.9
106	2.73	22.1	10.9	44.4	22.6
107	2.70	19.0	0.1	60.5	20.4
108	2.72	13.5	7.4	57.6	21.5
109	2.70	17.2	9.4	46.6	26.8

Felsic quartz monzonite of Finger Peak (KJp)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
110	2.62	31.0	21.9	42.0	5.1
111	2.62	36.2	23.1	35.2	5.3
112	2.62	22.7	31.2	41.4	4.7

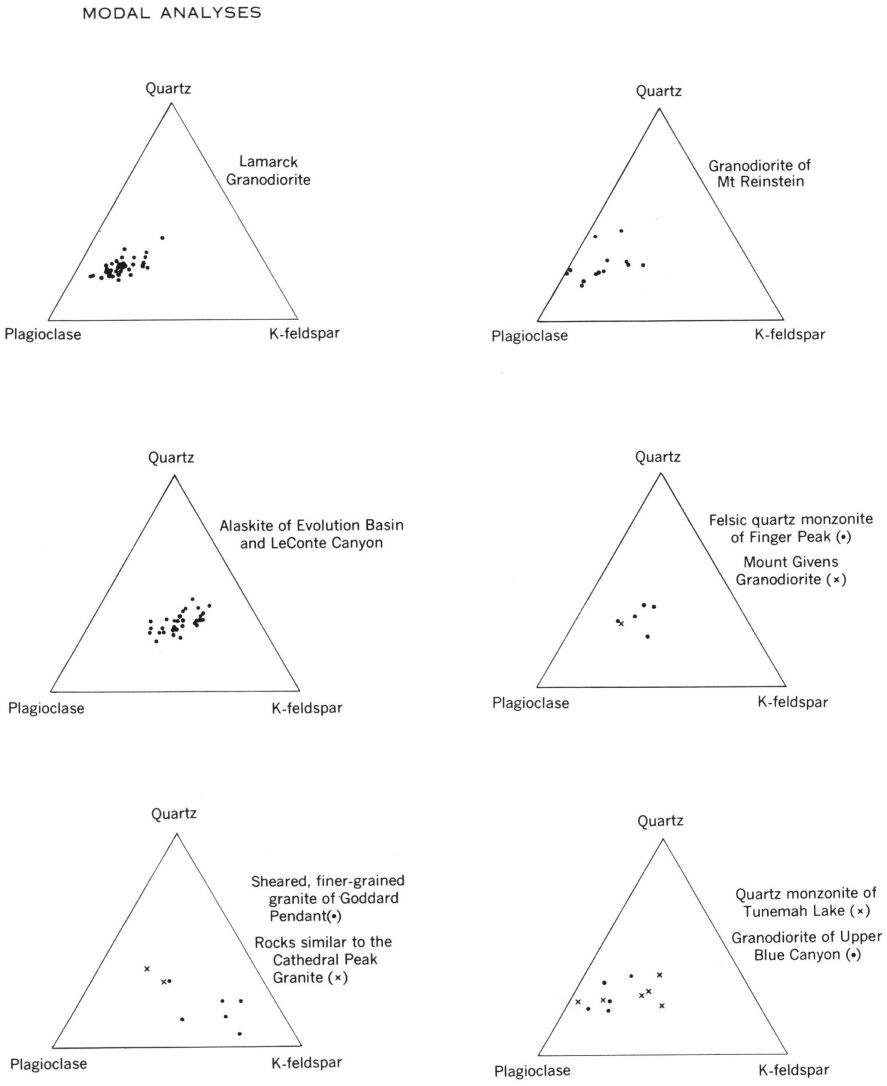
Mount Givens Granodiorite (Kmg)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
113	2.65	27.0	16.3	45.6	11.1

Quartz monzonite of Tunemah Lake (KJtl)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
114		18.8	10.0	47.1	24.1
115	2.62	27.7	27.5	38.0	6.8
116	2.63	26.7	26.6	43.5	3.2
117	2.59	21.4	35.3	36.8	6.5
118	2.62	36.2	28.6	31.5	3.7

Granodiorite of Upper Blue Canyon (KJbc)					
No.	Specific Gravity	Quartz	K-feldspar	Plagioclase	Mafic Minerals
119	2.63	33.7	16.8	40.0	9.5
120	2.65	29.4	8.0	49.4	13,2
121	2.68	21.2	13.5	49.7	15.6
122	2.68	17.2	7.2	55.5	20.1
123	2.70	18.1	15.0	53.3	13.6

Tables from source map: Mount Goddard 15' Quadrangle

Triangular Diagrams



Graphic from source map: Mount Goddard 15' Quadrangle

Chemical Analyses for Lamarck Granodiorite

Chemical Analyses of Lamarck Granodiorite		
(Granodiorite analyzed by standard rock analysis; analysts, L. M. Kehl (sample 28) and D. F. Powers (sample 11).)		
Chemical analysis (percent)		
Sample No.	28	11
	Lamarck Granodiorite	Lamarck Granodiorite
Si02	66.92	64.76
Al203	15.19	15.77
Fe203	1.45	1.70
FeO	2.52	2.97
MgO	1.74	2.14
CaO	3.79	4.50
Na20	3.16	3.23
K20	3.82	3.30
H20 -	0.06	0.02
H20 +	0.48	0.51
TiO2	0.47	0.59
CO2	0.02	0.02
P205	0.18	0.18
MnO	0.08	0.10
CI-	---	0.02
F-	---	0.04
Total	99.88	99.85

Note: Sample 28 was previously published in Bateman, P. C., 1961, Granitic formations in the east-central Sierra Nevada near Bishop: Geol. Soc. America Bull., v. 72, p. 1525 (Table 1) and in Bateman and others, 1963, The Sierra Nevada batholith-a synthesis of recent work across the central part: U.S. Geol. Survey Prof. Paper 414 D

Table from source map: Mount Goddard 15' Quadrangle

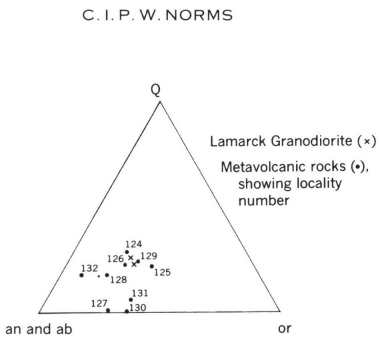
Chemical Analyses for Metavolcanic Rocks

Chemical Analyses of Metavolcanic Rocks									
(Metavolcanic rock's analyzed by rapid rock analysis; analysts, P. L. D. Elmore, I. H. Barlow, S. D. Botts, and Gillison Chloe)									
Chemical analysis (percent)									
Sample No.	124	125	126	127	128	129	130	131	132
	Meta-rhyodacite	Meta-rhyodacite	Meta-rhyodacite	Meta-andesite	Meta-dacite	Meta-rhyodacite	Meta-andesite	Meta-andesite	Metabasalt
Si02	70.7	64.0	67.7	53.0	61.8	67.4	51.8	58.4	50.7
Al203	15.3	17.9	16.2	18.3	16.3	15.8	18.5	18.3	19.3
Fe203	0.35	0.75	0.85	5.2	3.2	0.55	4.7	1.6	5.0
FeO	2.2	2.9	2.5	4.9	3.5	2.8	5.9	4.3	3.8
MgO	0.75	1.4	1.0	3.3	1.8	1.1	2.4	2.7	4.5
CaO	1.0	2.1	1.6	2.9	3.8	2.0	2.8	3.1	9.3
Na20	4.8	3.3	4.7	5.1	4.3	4.0	4.8	4.0	1.1
K20	3.4	5.4	3.8	3.8	2.8	4.3	4.7	4.8	1.1
H20 -/+	1.1	1.2	1.0	1.3	1.0	0.95	1.2	1.4	2.8
TiO2	0.47	0.72	0.63	0.92	1.1	0.85	1.3	0.87	0.81
CO2	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	0.21
P205	0.13	0.25	0.18	0.36	.40	0.35	0.47	0.25	0.18
MnO	0.13	0.15	0.12	0.16	.10	0.14	0.24	0.19	0.16
Cl-	---	---	---	---	---	---	---	---	---
F-	---	---	---	---	---	---	---	---	---
Total	100	100	100	99	100	100	99	100	99

Table from source map: Mount Goddard 15' Quadrangle

Norms for Lamarck granodiorite and Metavolcanic

C.I.P.W. norms											
Sample No.	28	11	124	125	126	127	128	129	130	131	132
Q	22.62	19.92	25.68	18.86	19.98	---	15.18	21.06		4.26	13.02
or	22.76	19.46	20.02	31.69	22.24	22.24	16.68	25.58	27.80	28.36	6.67
ab	26.72	27.25	40.35	27.77	39.82	42.97	36.15	34.06	37.20	34.06	9.43
an	15.84	18.90	4.17	8.62	7.23	11.68	16.96	7.23	10.29	13.34	44.20
di	1.83	2.72	---	---	---	---	---	---	---	---	---
by	6.18	7.11	4.94	7.20	5.40	2.63	6.60	6.23	---	12.34	12.62
mt	2.09	2.55	0.70	1.16	1.39	7.66	4.64	0.93	6.73	2.32	7.19
it	0.90	1.22	0.91	1.37	1.22	1.67	2.13	1.67	2.43	1.67	1.52
ap	0.35	---	0.34	0.67	0.34	1.01	1.01	1.01	1.34	0.67	0.34
of	---	---	---	---	---	6.58	---	---	8.28	---	---
ne	----	---	---	---	---	---	---	---	1.70	---	---
C	---	---	2.24	3.47	1.73	1.53	---	1.84	1.73	1.53	---
Total	99.29	99.13	99.35	100.81	99.35	97.97	99.35	99.61	97.50	98.55	95.88



Graphic from source map: Mount Goddard 15' Quadrangle

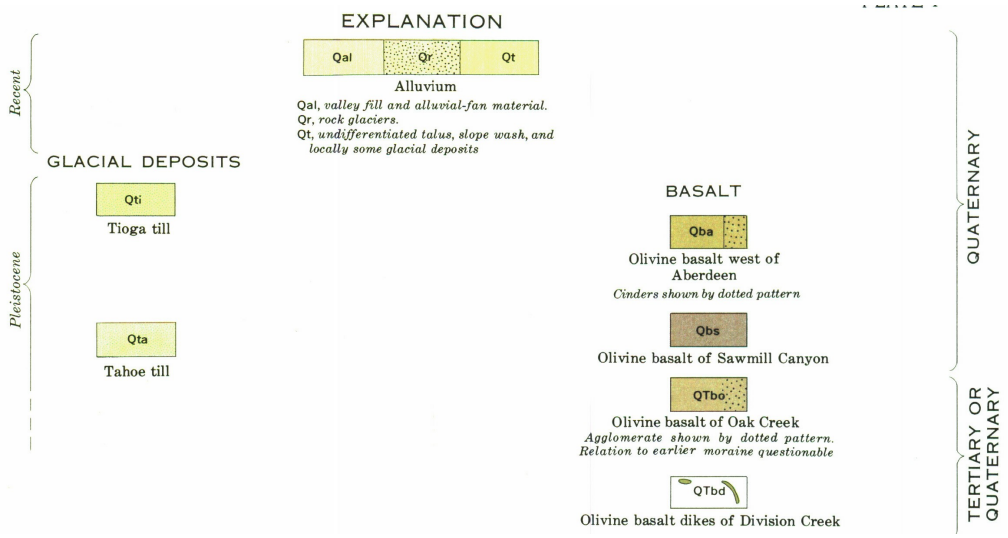
Mount Pinchot 15' Quadrangle

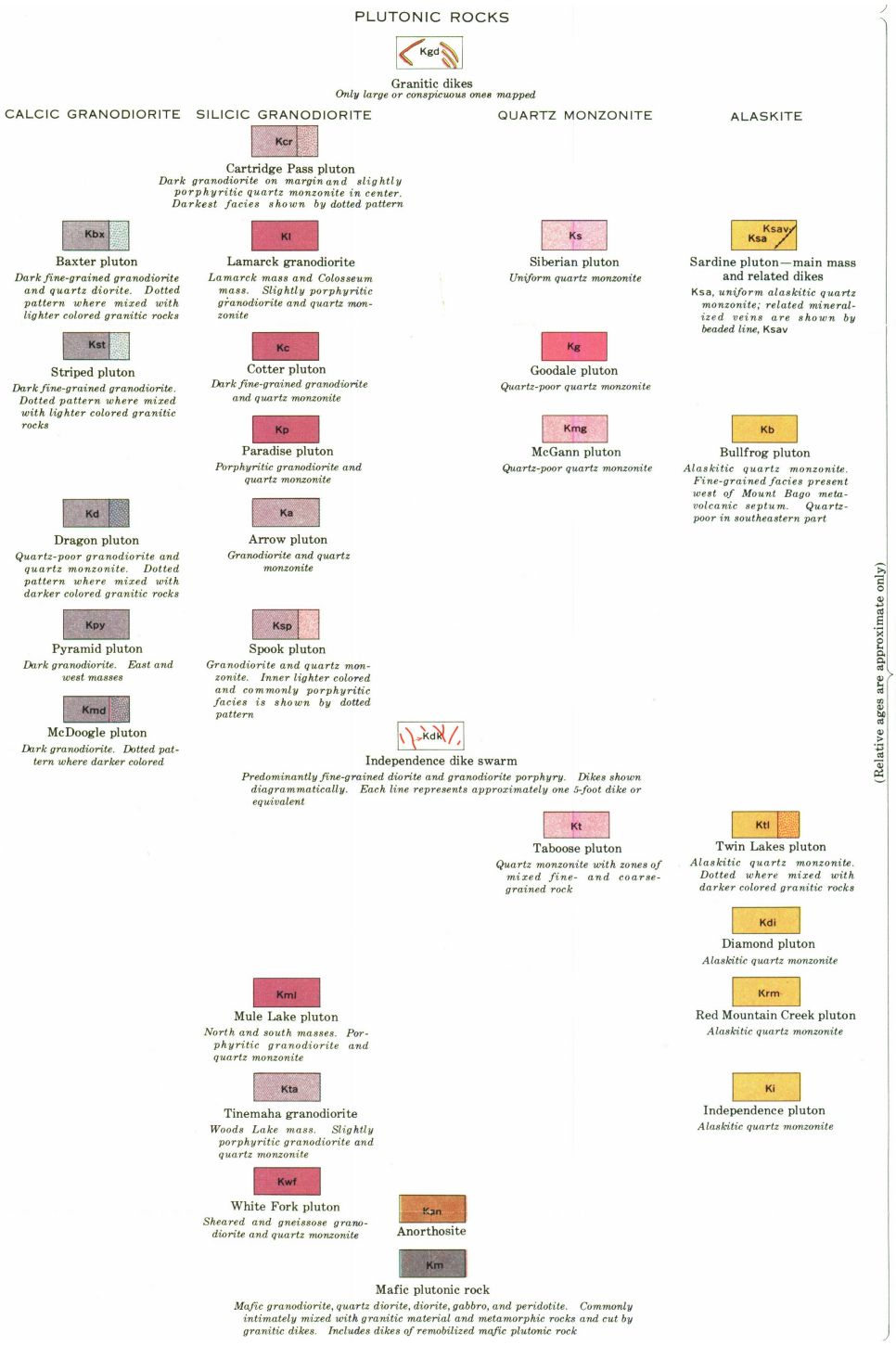
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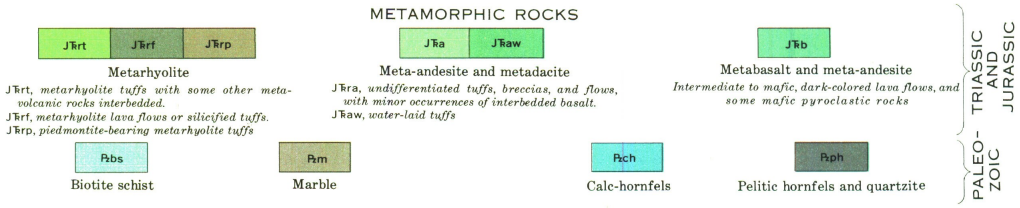
Moore, J.G., 1963, Geology of the Mount Pinchot Quadrangle, Southern Sierra Nevada, California, U.S. Geological Survey, Bulletin 1130, 1:62,500 scale. (*GRI Source Map ID 1912*).

Prominent graphics and text associated with this source:

Correlation of Map Units

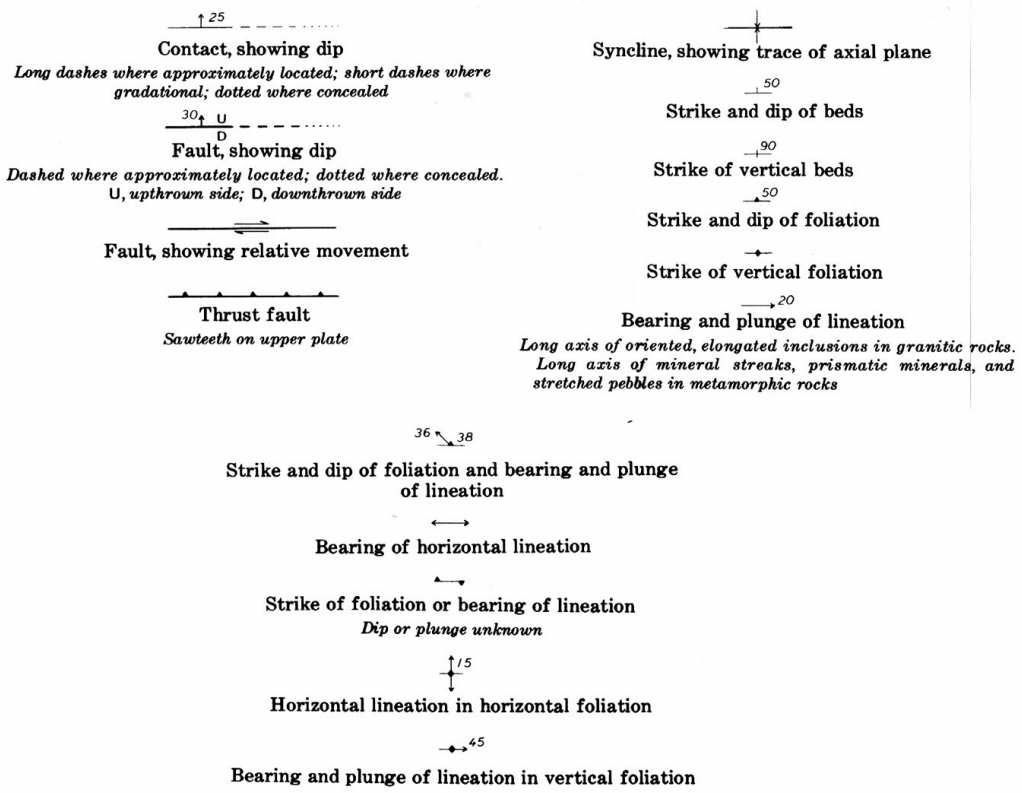



PLUTONIC ROCKS
Kgd
Granitic dikes
Only large or conspicuous ones mapped
CALCIC GRANODIORITE
SILICIC GRANODIORITE
QUARTZ MONZONITE
ALASKITE
Kcr
Cartridge Pass pluton
Dark granodiorite on margin and slightly porphyritic quartz monzonite in center. Darkest facies shown by dotted pattern
Kbx
Baxter pluton
Dark fine-grained granodiorite and quartz diorite. Dotted pattern where mixed with lighter colored granitic rocks
Kl
Lamarck granodiorite
Lamarck mass and Colosseum mass. Slightly porphyritic granodiorite and quartz monzonite
Ks
Siberian pluton
Uniform quartz monzonite
Ksav
Ksa
Sardine pluton—main mass and related dikes
Ksa, uniform alaskitic quartz monzonite; related mineralized veins are shown by beaded line, Ksav
Kst
Striped pluton
Dark fine-grained granodiorite. Dotted pattern where mixed with lighter colored granitic rocks
Kc
Cotter pluton
Dark fine-grained granodiorite and quartz monzonite
Kg
Goodale pluton
Quartz-poor quartz monzonite
Kp
Paradise pluton
Porphyritic granodiorite and quartz monzonite
Kmg
McGann pluton
Quartz-poor quartz monzonite
Kb
Bullfrog pluton
Alaskitic quartz monzonite. Fine-grained facies present west of Mount Bago metavolcanic septum. Quartz-poor in southeastern part
Kd
Dragon pluton
Quartz-poor granodiorite and quartz monzonite. Dotted pattern where mixed with darker colored granitic rocks
Ka
Arrow pluton
Granodiorite and quartz monzonite
Kpy
Pyramid pluton
Dark granodiorite. East and west masses
Ksp
Spook pluton
Granodiorite and quartz monzonite. Inner lighter colored and commonly porphyritic facies is shown by dotted pattern
Kmd
McDoogle pluton
Dark granodiorite. Dotted pattern where darker colored
Kdk
Independence dike swarm
Predominantly fine-grained diorite and granodiorite porphyry. Dikes shown diagrammatically. Each line represents approximately one 5-foot dike or equivalent
Kt
Taboose pluton
Quartz monzonite with zones of mixed fine- and coarse-grained rock
Ktl
Twin Lakes pluton
Alaskitic quartz monzonite. Dotted where mixed with darker colored granitic rocks
Kdi
Diamond pluton
Alaskitic quartz monzonite
Kml
Mule Lake pluton
North and south masses. Porphyritic granodiorite and quartz monzonite
Krm
Red Mountain Creek pluton
Alaskitic quartz monzonite
Kta
Tinemaha granodiorite
Woods Lake mass. Slightly porphyritic granodiorite and quartz monzonite
Ki
Independence pluton
Alaskitic quartz monzonite
Kwf
White Fork pluton
Sheared and gneissose granodiorite and quartz monzonite
Kan
Anorthosite
Km
Mafic plutonic rock
Mafic granodiorite, quartz diorite, diorite, gabbro, and peridotite. Commonly intimately mixed with granitic material and metamorphic rocks and cut by granitic dikes. Includes dikes of remobilized mafic plutonic rock
(Relative ages are approximate only)
CRETACEOUS



Graphic from source map: Mount Pichot 15' Quadrangle

Map Legend



Graphic from source map: Mount Pichot 15' Quadrangle

Near-Vertical Joints and Faults

An illustration of prominent near-vertical joints and faults in the Mount Pinchot quadrangle is available as a separate PDF. Mt Pinchot Joints and Faults

Graphic from source map: Mount Pichot 15' Quadrangle

Index Map

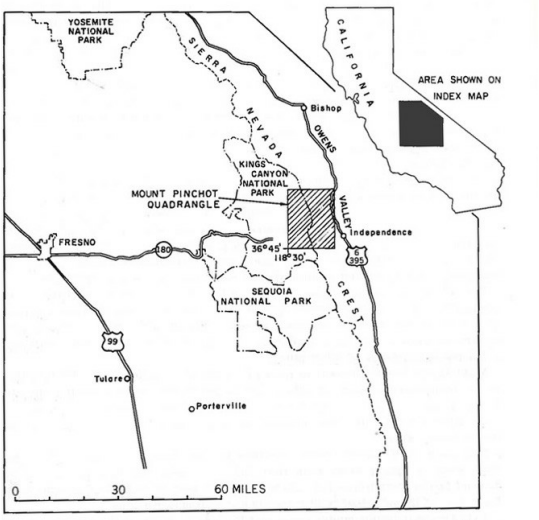


FIGURE 1.—Index map showing location of the Mount Pinchot quadrangle, Inyo and Fresno Counties, Calif.

Graphic from source map: Mount Pichot 15' Quadrangle

Report and Plates

The USGS report and plates are available for download from the USGS Publication Warehouse web page. A full-text PDF version of the report is available, as well as, the accompanying plates.

Publication Warehouse web page; http://pubs.er.usgs.gov/publication/b1130

National Geologic Map Database web page: http://ngmdb.usgs.gov/Prodesc/proddesc_20845.htm

Plate Index

- Plate 1. Geologic map and sections of the Mount Pinchot quadrangle, California.
- Plate 2. Prominent near-vertical joints and faults in the Mount Pinchot quadrangle

Report from source map: Mount Pichot 15' Quadrangle

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Reference from source map: Mount Pichot 15' Quadrangle

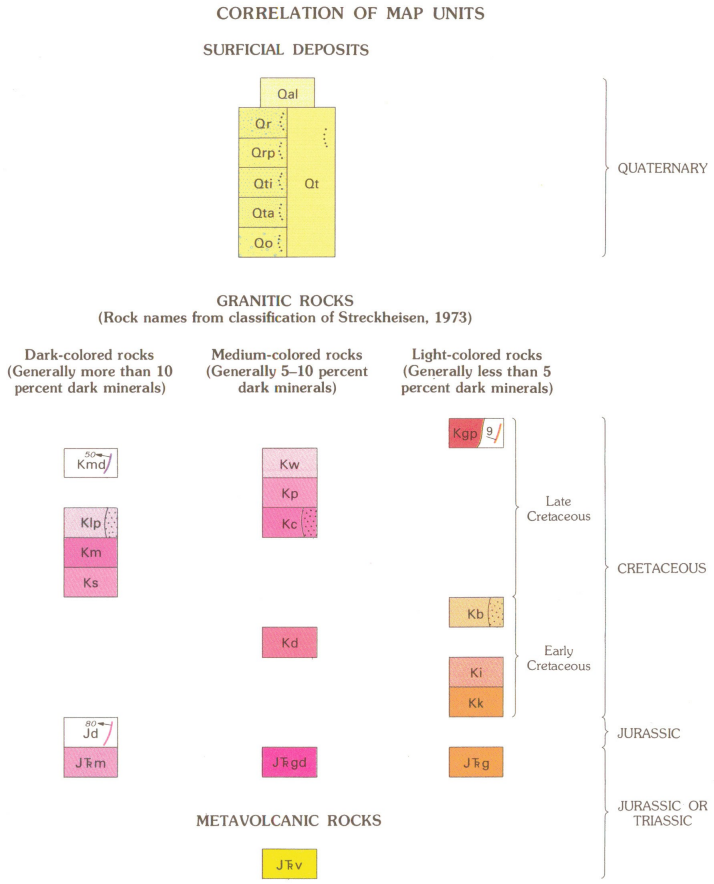
Mount Whitney 15' Quadrangle

The formal citation for this source.

Moore, J.G., 1981, Geologic Map of the Mount Whitney Quadrangle, Inyo And Tulare Counties, California, U.S. Geological Survey, GQ-1545, 1:62500 Scale. (GRI Source Map ID 1910)

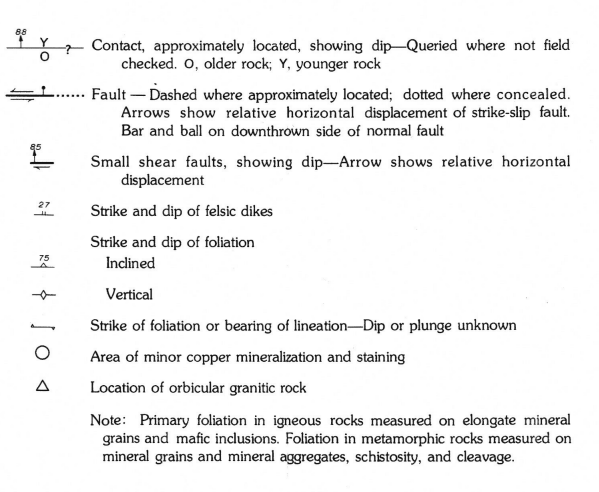
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Correlation of Units



Graphic from source map: Mount Whitney 15' Quadrangle

Map Legend



Graphic from source map: Mount Whitney 15' Quadrangle

Triangular Diagrams

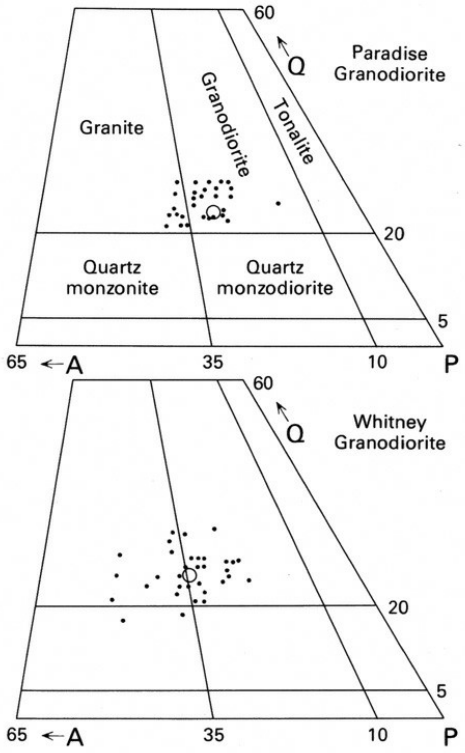


Figure 1. *Triangular diagrams showing volume proportions of quartz (Q), alkali feldspar (A), and plagioclase feldspar (P). Dots are individual analyses; circles, averages of analyses.*

Graphic from source map: Mount Whitney 15' Quadrangle

Report

INTRODUCTION

The Mount Whitney quadrangle includes about 620 km2 of the crestal region of the Sierra Nevada. All of the quadrangle west of the Sierra Nevada crest is within Kings Canyon and Sequoia National Parks. That part east of the crest includes the steep eastern escarpment of the range and a small part of the west side of Owens Valley. Mount Whitney, the highest point in the conterminous United States at an elevation of 4418 m, is on the range crest in the southeastern part of the quadrangle. The great north-trending glacial canyon of the Kern River lies between the Sierra crest to the east and the Great Western Divide to the west. The only roads in the quadrangle are dirt roads in the northeast corner that approach the base of the eastern range escarpment. However, the John Muir Trail threads southward east of the Kern Canyon and west of the Sierra crest and terminates at the summit of Mount Whitney. The High Sierra Trail enters the quadrangle in the south, follows the Kern River north, and joins the John Muir Trail at Wallace Creek.

METAMORPHIC ROCKS

Small elongate masses of metavolcanic rocks are preserved largely as narrow screens between

granitic plutons. Originally, these rocks were chiefly silicic metavolcanic tuffs and breccias, but they are extensively sheared and recrystallized, largely by the intrusion of the enormous masses of hot granitic magma, to phyllite and schist. No fossils have been found in the metamorphic rocks of the quadrangle, but fossils of Late Triassic and Early Jurassic age have been recovered from sedimentary rocks interbedded with similar metavolcanic rocks in the Mineral King roof pendant 10 km southwest of the quadrangle (Saleeby and others, 1978).

GRANITIC ROCKS

Granitic rocks that belong to the Sierra Nevada batholithic complex dominate the bedrock of the quadrangle. Most of the granitic masses or plutons were intruded as magma (largely molten rock) during the Late Cretaceous Period as shown by radiometric age dating of the time of cooling and crystallization. Age dates utilizing the potassium-argon method have been recalculated on the basis of the new, revised constants (Steiger and Jager, 1977). Several small sheared plutons in the southwestern part of the quadrangle are intruded by abundant mafic dikes that appear to belong to the Independence dike swarm, which is of regional extent (Moore and Hopson, 1961). The dikes of this swarm 15 km to the east have been dated as Late Jurassic (Chen and Moore, 1979). The granitic masses cut by them are tentatively assigned to the Triassic or Jurassic Period.

The Late Cretaceous pulse of igneous activity culminated in the intrusion of one of the largest and youngest granitic sequences in the Sierra Nevada—the nested sequence of the Paradise pluton intruded in its center by the Whitney pluton. This composite intrusion extends 83 km southeastward from the central part of the Marion Peak quadrangle on the northwest (Moore, 1978), through the Mount Whitney quadrangle, to the southeastern part of the Olancha quadrangle on the southeast (Moore and du Bray, 1978). The sequence attains a width of 23 km south of the Mount Whitney quadrangle. Because of the great extent and distinctive character of the rocks in this sequence, they are here formally designated the Paradise Granodiorite and the Whitney Granodiorite. The type locality of the Paradise Granodiorite is on the east side of Paradise Valley in the east-central Marion Peak quadrangle (Moore, 1978); that of the Whitney Granodiorite is 200 m north of the summit of Mount Whitney. Modal analyses have been made of 63 stained rock samples collected from these units across the quadrangle, and the proportions of quartz, alkali feldspar, and plagioclase feldspar are shown in the accompanying triangular diagrams (fig. 1). The average rock type of each unit is granodiorite in the classification system employed (Streckheisen, 1973), although individual specimens also range into the granite field as well as, to a minor extent, into the quartz monzonite and quartz monzodiorite fields.

The massive (1100 km2) northwest-trending Paradise-Whitney nested sequence was emplaced as a single intrusion about 85 m.y. ago. After emplacement, the mass began solidifying from the walls inward. Before complete solidification, the partly molten and somewhat more differentiated siliceous core of the intrusive mass (the Whitney Granodiorite) surged upward and burst through its solidified wall on the southeast side, largely southeast of the quadrangle (Moore and du Bray, 1978). The pluton of the Whitney Granodiorite is distinctly domical in profile, and the present level of exposure is apparently not far below its top. Within the quadrangle, its western and eastern contacts dip under the Paradise Granodiorite, and the pluton axis plunges north beneath the Paradise. After solidification of the upper marginal parts of the Whitney Granodiorite, granite porphyry dikes and sills probably originating from deeper, still molten parts of the pluton were emplaced in fractures at its northern limits and near Mount Whitney. The most remarkable of these intrusions is the Golden Bear granite porphyry dike in the north, which extends 14 km in a N. 40° E. direction from near the northern part of the Whitney Granodiorite to the eastern range front in the Mount Pinchot quadrangle (Moore, 1963).

This intrusive sequence is very similar to other large young granitic intrusions in the Sierra Nevada, particularly the Tuolumne Intrusive Suite 120 km to the northwest (Bateman and Chappell, 1979). The Tuolumne Intrusive Suite is large (62 km long), includes the youngest plutons in the region (90-79 m. y., Evernden and Kistler, 1970), and occurs in the crestal region of the Sierra Nevada. Moreover, the three intrusive pulses of the sequences in the Mount Whitney quadrangle—the Paradise Granodiorite, Whitney Granodiorite, and granite porphyry dikes and sills—are matched in composition and texture by the three late pulses of the Tuolumne—the Half Dome Granodiorite, Cathedral Peak Granodiorite, and Johnson Granite Porphyry, respectively.

FAULTING
Two of the range-front normal faults that bound the Sierra Nevada block on the east side are shown in the northeast corner of the quadrangle. The longer of these, the Independence fault, has been traced 13 km north into the Mount Pinchot quadrangle. (Moore, 1963).

The right-lateral strike-slip Kern Canyon fault is 14 km long within the quadrangle but extends more than 100 km to the south (Moore and du Bray, 1978). Secondary subparallel faults and shear zones are common within 1 km of the fault on each side but are not mapped because they occur on the steep cliffs of the Kern Canyon. Five small right-lateral faults in the northern part of the quadrangle may represent distributed strain where displacement on the Kern Canyon fault system is small. Toward the south, horizontal displacement increases systematically to about 13 km, 35 km south of the quadrangle. Most of the Kern Canyon fault offset occurred prior to 3.5 m.y. ago because a basalt flow of that age astride the fault shows little or no offset (Moore and du Bray, 1978).

The granitic rocks are commonly fractured and sheared by two nearly vertical sets of small strike-slip faults. The average strike of the left-lateral set is east-northeast. and the right-lateral set, northeast. These conjugate fault sets suggest tectonic extension in a N. 34° W. direction, which is compatible with the late Cenozoic extension direction of the Great Basin to the east (Lockwood and Moore, 1979). These small shear faults are commonly mineralized by quartz and epidote and contain sulfides of iron, copper, and molybdenum. The mapped areas of minor copper mineralization occur in these small shear faults, which have undergone displacement of a few centimeters to a few meters.

GLACIATION
Because of the high elevation of much of the quadrangle, extensive glaciation occurred during the Pleistocene and Holocene Epochs, and glacial deposits are well preserved on the high uplands of Chagoopa Plateau as well as in the drainage basins of Tyndall, Wright, Wallace, and Whitney Creeks east of the Kern Canyon (Matthes, 1965). Small glaciers descended part way down the canyons of the east range front. but their deposits have been largely removed or modified by later stream action. Five ages of glacial deposits are distinguished where possible by reconnaissance mapping and aerial photograph interpretation. The oldest pre-Tahoe moraines are thoroughly weathered, and rarely show morainal crests. Tahoe and Tioga moraines (referred to as the Wisconsin Glacial Stage by Warhaftig and Birrnan. 1965) show well-developed lateral moraines in which about 50-70 percent of the boulders are weathered. Recess Peak moraines occur within 2 km of cirque headwalls and contain fresh boulders. The youngest glacial deposits are represented by more than 70 rock glaciers. which rarely exceed 1 km in length within north- to northeast-facing cirques. They contain interstitial ice and are characterized by steep, unstable toes. The quadrangle contains about 700 mapped lakes and ponds all formed by glacial action. The lake basins are dammed by moraines or are scooped from bedrock by ice erosion.

Report from source map: Mount Whitney 15' Quadrangle

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Reference from source map: Mount Whitney 15' Quadrangle

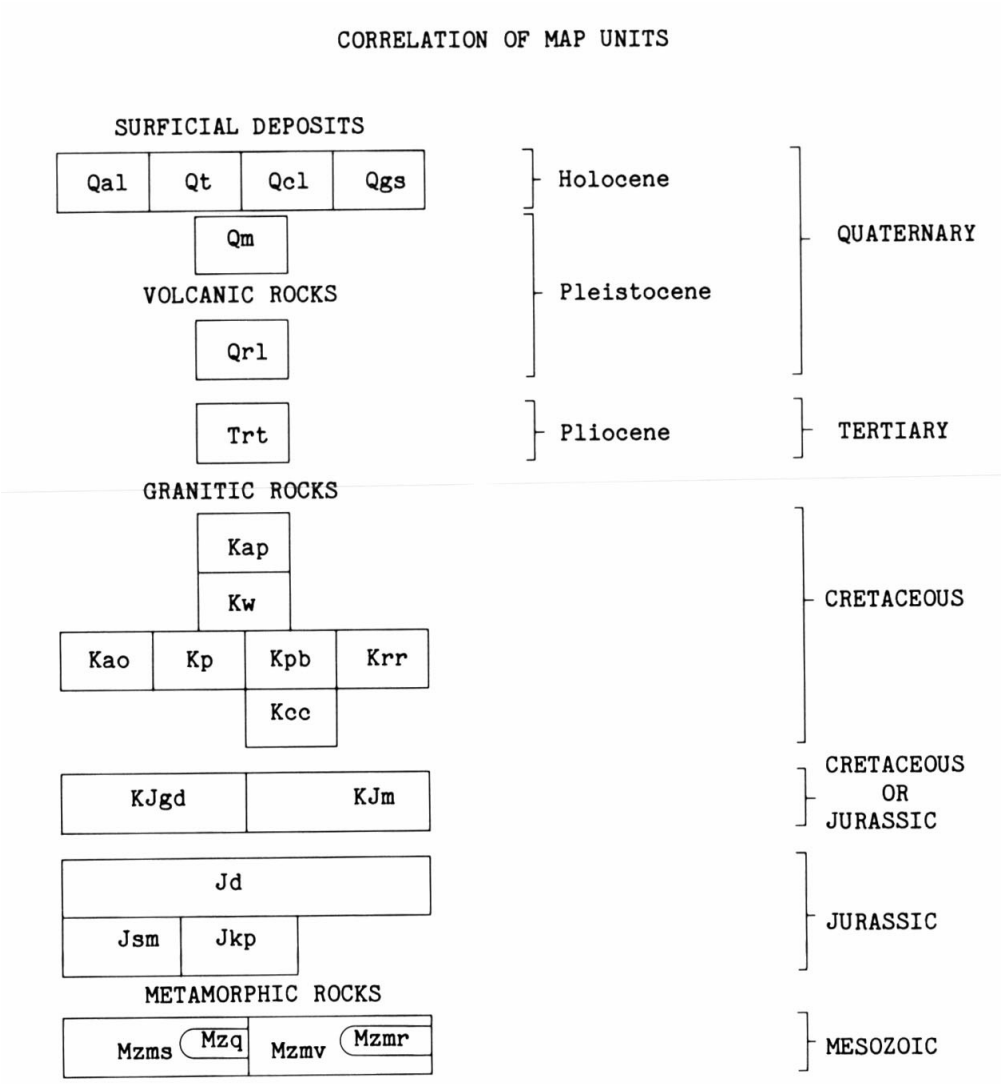
Olancha 15' Quadrangle

The formal citation for this source.

du Bray, E.A. And Moore, J.G., 1985, Geologic Map of the Olancha Quadrangle, Southern Sierra Nevada, California, U.S. Geological Survey, MF-1734, 1:62500 scale. (GRI Source Map ID 1904)

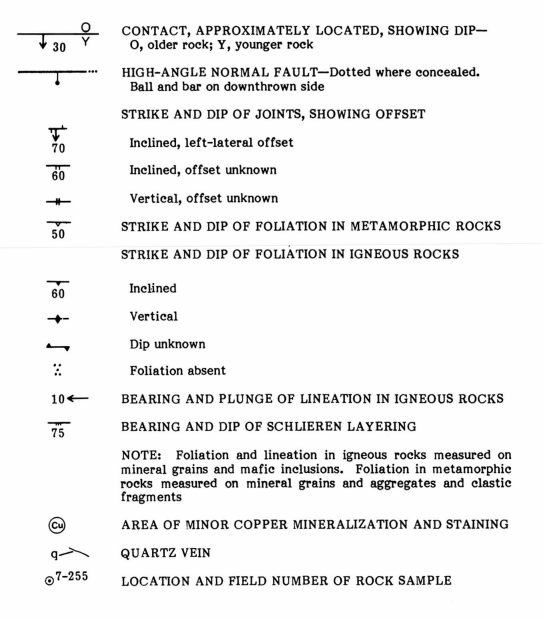
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Correlation of Units



Graphic from source map: Olancha 15' Quadrangle

Map Legend



Graphic from source map: Olancha 15' Quadrangle

Analytic Data for Granitoid Rocks

Analytical Data For Granitoid rocks						
(Between 1,000 and 2,000 points counted for each sample)						
		Modes				
Sample Number	Unit	Plagioclase	Potassium feldspar	Quartz	Mafics	Specific Gravity
9-62	Jkp	49.1	23.6	25.9	1.4	2.630
DJ74	Jkp	36.7	30.6	28.5	4.9	2.640
DJ75	Jkp	47.2	24.9	23.3	4.6	2.650
9113c	Jkp	40.5	25.4	26.3	7.7	2.665
9-70	Jsm	68.4	0.0	11.2	20.4	2.720
DJ59	Jsm	59.2	9.0	11.7	20.2	2.732
9156	Jsm	69.5	0.0	5.0	25.5	2.745
7-68	KJgd	42.9	22.8	21.2	13.1	2.66
9126	KJgd	57.7	5.70	19.4	17.3	2.695
9147	KJgd	49.6	22.3	10.9	17.2	2.695
9-52	KJgd	54.4	17.7	8.3	19.6	2.725
9104	KJgd	56.7	5.40	6.3	31.5	2.805
DJ63	KJm	46.8	0.0	1.8	51.4	2.923
7-33	Kao	32.0	42.1	25.0	0.9	2.600
DJ51	Kao	30.7	63.9	2.1	3.3	2.605
9-71	Kao	36.1	32.4	31.0	0.5	2.610
DJ49	Kao	7.4	60.6	29.6	2.5	2.610

Analytical Data For Granitoid rocks						
(Between 1,000 and 2,000 points counted for each sample)						
		Modes				
Sample Number	Unit	Plagioclase	Potassium feldspar	Quartz	Mafics	Specific Gravity
9159	Kao	34.5	29.6	29.9	5.9	2.615
9-61	Kao	23.1	49.5	23.5	3.9	2.627
9158	Kao	48.8	24.4	23.4	3.4	2.640
9157	Kao	83.0	10.4	4.4	2.2	2.650
DJ60	Kao	46.1	22.1	22.0	9.9	2.700
DJ26	Kap	32.0	39.4	28.6	0.0	2.590
9-51	Kcc	27.7	37.8	32.8	1.7	2.600
9150	Kcc	30.1	39.5	26.8	3.5	2.602
9-47a	Kcc	37.6	25.3	28.0	9.1	2.610
9151	Kcc	39.1	29	28.4	3.6	2.610
9152	Kcc	31.8	34.8	28.7	4.7	2.619
9122	Kcc	43.2	32.4	18.4	6.1	2.620
9148	Kcc	42.5	27.2	21.1	9.1	2.620
9153	Kcc	34.1	34	28.3	3.7	2.620
7-253	Kcc	38.0	32.9	24.2	4.9	2.638
9149	Kcc	28.0	37	27.2	7.0	2.638
7-87	Kcc	44.5	21.3	26.5	7.7	2.640
9-11	Kcc	38.6	27.8	26.2	7.5	2.640
9-49	Kcc	39.0	28.5	24.1	7.6	2.640
9-47b	Kcc	38.5	35.2	14.7	11.7	2.645
7-69	Kcc	42.7	26.7	23.6	6.9	2.65
7-319	Kcc	40.4	29.5	23.6	6.5	2.655
9-12	Kcc	43.6	27.5	18.7	10.2	2.655
9112	Kcc	33.2	29.9	26.4	10.4	2.655
9-6	Kcc	43.0	27.1	21.3	8.6	2.660
9111	Kcc	33.2	37.9	20.4	8.5	2.660
9-54	Kp	49.9	20.7	14.9	14.5	2.675
7-247	Kp	44.0	14.4	18.7	22.9	2.680
7-249	Kp	46.9	14.6	20.2	18.3	2.685
DJ24	Kp	52.5	18.7	21.3	7.5	2.690
7-37	Kp	52.5	11.8	18.6	17.0	2.700
9113b	Krr	32.6	36.2	22.6	8.6	2.640
DJ64	Krr	51.3	21.0	17.7	10.0	2.648
DJ76	Krr	34.7	32.5	26.3	6.5	2.650
9113a	Krr	47.8	15.8	13.7	22.7	2.715
9-9	Kw	47.4	26.4	19.4	6.8	2.595
9-50	Kw	46.4	22.9	21.9	8.8	2.595
9145	Kw	52.4	19.4	21.8	6.4	2.595
6-166	Kw	44.5	21.5	30.4	3.6	2.610
9-48	Kw	42.9	29.1	24.1	3.9	2.610
9110	Kw	39.6	33.5	22.2	4.6	2.610

Analytical Data For Granitoid rocks						
(Between 1,000 and 2,000 points counted for each sample)						
		Modes				
Sample Number	Unit	Plagioclase	Potassium feldspar	Quartz	Mafics	Specific Gravity
9-5	Kw	39.2	31.3	23.2	6.3	2.615
9-3	Kw	41.4	26.4	25.7	6.4	2.620
9-10	Kw	44.1	21.7	27.2	7.0	2.620
9-24	Kw	40.5	26.4	23.6	9.5	2.620
9101	Kw	39.9	26.8	27.1	6.2	2.620
6-364	Kw	53.7	19.2	22.1	4.9	2.625
6-368	Kw	52.6	24.4	17.3	5.6	2.625
9-4	Kw	41.4	23.4	27.4	7.8	2.625
3-23	Kw	42.2	26.9	16.3	14.6	2.625
9-53	Kw	44.4	20.5	26.9	8.1	2.625
6-163	Kw	47.4	25.2	20.9	6.5	2.63
9102	Kw	35.3	31.1	27.2	6.4	2.63
DJ25	Kw	51.3	18.4	25.9	4.4	2.63
6-167	Kw	51.0	22.7	20.4	6.0	2.635
6-366	Kw	49.7	16.8	25.9	7.7	2.635
6-369	Kw	49.8	23.5	19.7	7.0	2.635
7-254	Kw	44.3	26.5	23.0	6.2	2.635
7-273	Kw	45.0	25.5	24.2	5.2	2.635
6-365	Kw	41.4	28.7	23.0	6.9	2.64
6-637	Kw	48.4	25.8	21.0	4.8	2.64
7-70	Kw	42.1	29.5	24.1	4.2	2.64
6-164	Kw	51.6	21.6	19.5	7.2	2.645
7-245	Kw	42.1	22.9	28.5	6.5	2.645
6-162	Kw	44.0	26.7	23.1	6.2	2.65
7-14	Kw	40.5	32.2	19.1	8.2	2.66
7-255	Kw	50.0	17.4	22.6	9.9	2.66
9124	Kw	49.8	17.3	22.5	10.4	2.675

Table from source map: Olancha 15' Quadrangle

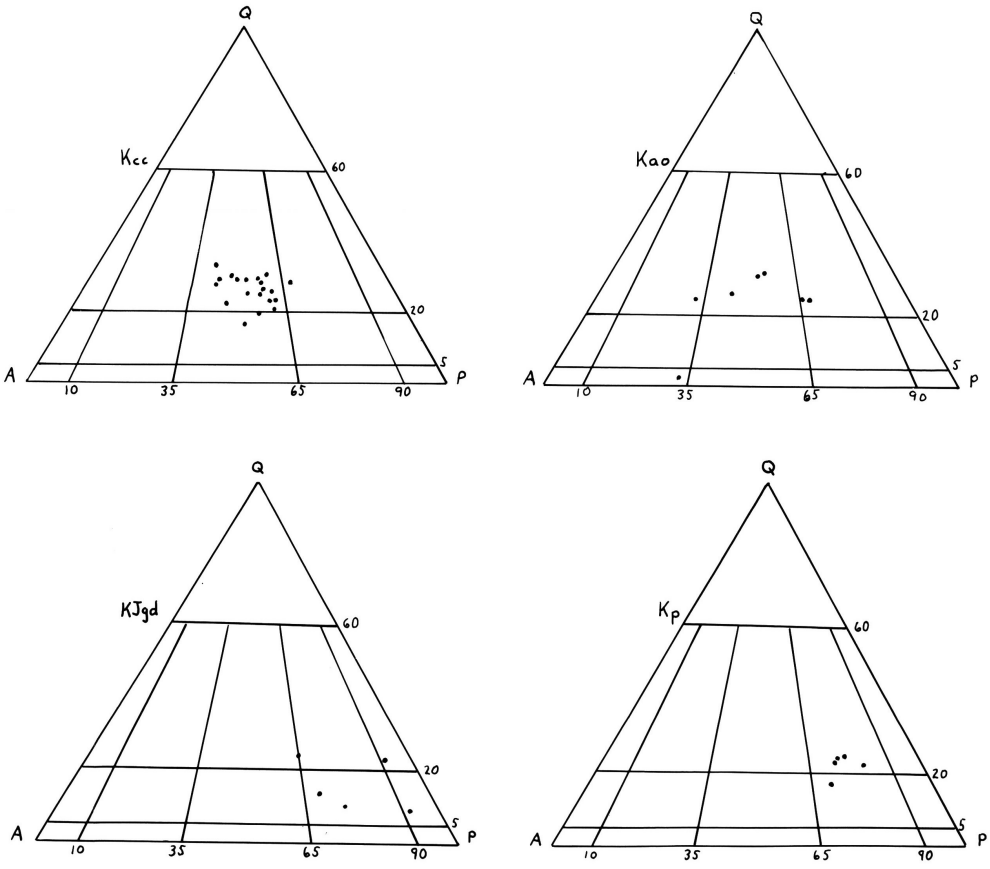
Analytic Data for Volcanic and Metamorphic Rocks

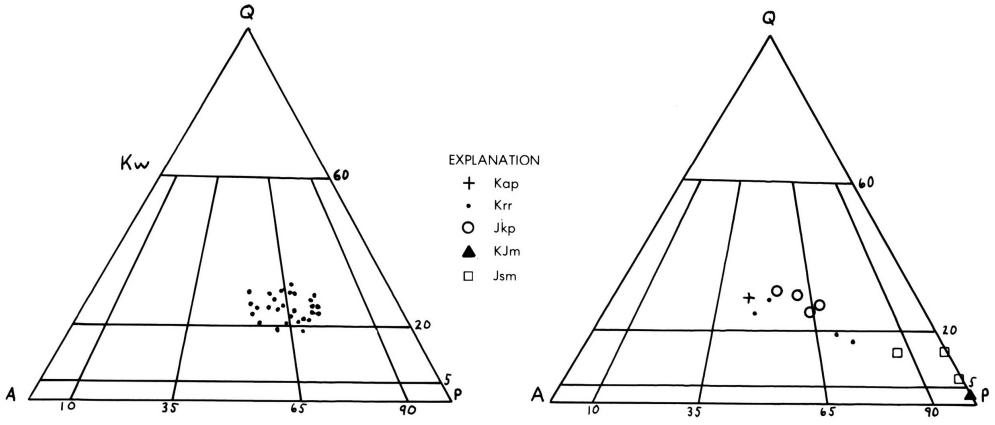
Analytic data For Volcanic Rocks		
Sample Number	Unit	Specific Gravity
7-252	Qrl	<2.000
9-8	Qrl	<2.000
DJ63a	Qrl	<2.000
DJ65	Qrl	2.045
7-36	Trt	2.095
7-35	Trt	2.360

Analytical Data For Metamorphic Rocks		
Sample Number	Unit	Specific Gravity
Sep-60	Mzmv	2.555
7-34	Mzmv	2.595
7-38	Mzmv	2.600
7-84	Mzmr	2.615
9127	Mzmv	2.635
DJ52	Mzmv	2.635
7-256	Mzms	2.770

Tables from source map: Olancha 15' Quadrangle

Q-A-P Ternary Diagrams for Granitoid Rocks





Graphic from source map: Olancha 15' Quadrangle

References

Bacon, C. R., and Duffield, W. A., 1979, Late Cenozoic rhyolites from the Kern Plateau, southern Sierra Nevada, California Labs]: Geological Society of America, Abstracts with Programs, Cordilleran Section Meeting, 1979.

Evernden, J. F., and Kistler, R. W., 1970, Chronology of emplacement of Mesozoic batholith complexes in California and western Nevada: U.S. Geological Survey Professional Paper 623, 42 p.

Reference from source map: Olancha 15' Quadrangle

Southwestern Sequoia National Park

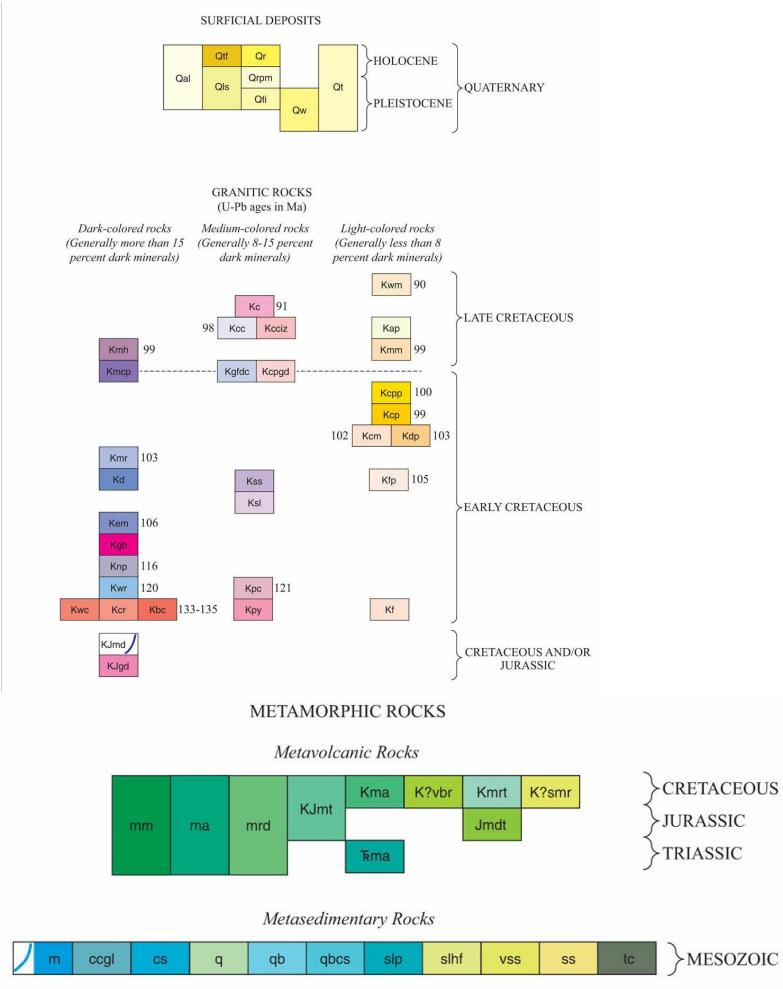
The formal citation for this source.

> Sisson, T.W. and Moore, J.G., 2013, Geologic Map of Southwestern Sequoia National Park, Tulare County, California, U.S. Geological Survey, Open-File Report 2013-1096, 1:24,000 scale. (*GRI Source Map ID 75590*).

The source map covers the southwestern portion of Sequoia National Park including all of the Mineral King 15-minute quadrangle and a portion of the Kaweah 15-minute quadrangle within Sequoia National Park. In this document, the map is referred to as the Mineral King quadrangle.

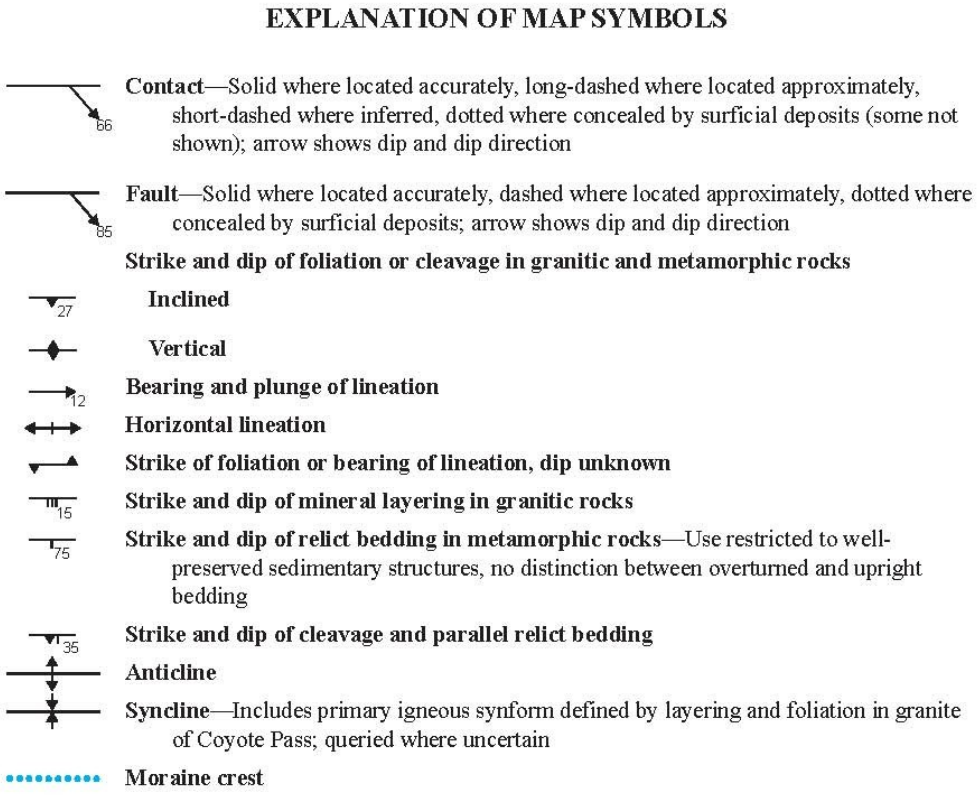
Prominent graphics and text associated with this source:

Correlation of Map Units



Graphic from source map: Southwestern Sequoia National Park

Map Legend



Graphic from source map: Southwestern Sequoia National Park

Figure 1

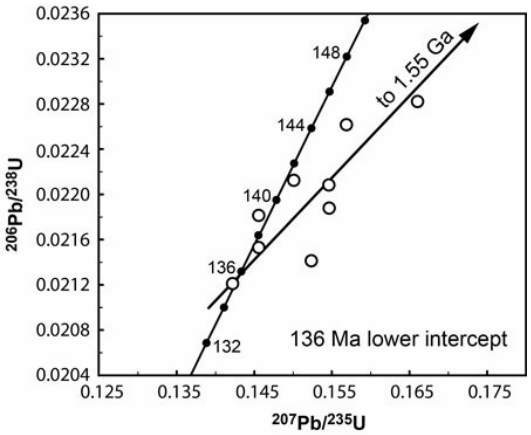


Figure 1. Concordia plot of U-Pb zircon results for Mineral King pendant metarhyolites (Busby-Spera, 1983). Curve with solid dots is U-Pb concordia with ages in millions of years (Ma). Open circles are thermal-ionization U-Pb results for individual zircon splits from metarhyolite tuffs (Kmrt), and a metarhyolite sill, collected from the Mineral King pendant. Regression line (arrow) intersects concordia at 136 Ma and 1.55 billion years (Ga), interpreted respectively to be the approximate ages of a period

of Early Cretaceous rhyolitic eruptions and of a widespread Proterozoic inherited zircon component.

Graphic from source map: Southwestern Sequoia National Park

Table 1

Table 1. Lower-intercept concordia ages for Mineral King metavolcanic rocks derived from U-Pb zircon results of Busby-Spera (1983)

Sample described in Table 1 are included in GIS data in Geologic Sample Localities feature class and are listed by Sample number. The samples locations are plotted using N Latitude and W Longitude values from the table. Thus, the positional accuracy is approximate.

Sample	Map Unit	N Latitude	W Longitude	age (Ma)	+2σ	-2σ	n
MK-540	TRma	36.4550	118.5843	235.8	5.8	5.6	3
MK-1700	TRma	36.4396	118.5758	214.2	5.6	6.2	2
MK-910	Jmdt	36.4650	118.5898	188.8	5.4	5.4	2
MK-980	Jmdt	36.4718	118.5667	170.9	4.7	5.1	2
MK-530	Kmrt	36.4555	118.5878	140.3	5.4	6.3	1
MK-822	Kmrt-sill	36.4082	118.5647	138.	3.	3.	2
MK-900	Kmrt	36.4605	118.5900	137.9	3.6	3.6	2
MK-1	Kmrt	36.3987	118.5743	135.2	4.1	5.6	2
MK-520	Kmrt	36.4536	118.6050	131.0	4.2	4.9	2
MK-920	Kma	36.4673	118.6027	110.6	2.4	2.9	3
MK-1010	Kmrt	36.3625	118.5493	101.7	3.4	4.9	2

Comments: lower intercept ages and 2σ uncertainties by Monte Carlo regression using Isoplot 3.4.1 (Ludwig, 2001) assuming a 1.6±0.3 Ga inherited zircon component, 2σ uncertainties of 3.7% and 1.2% on 207Pb/235U and 206Pb/238U, and Pb/U error correlations of 0.25; n is number of zircon splits; sample coordinates are NAD27 datum.

Table from source map: Southwestern Sequoia National Park

Table 2

Table 2. Weighted-mean 206Pb/238U zircon ages of Mineral King region plutonic rocks, measured by ion-microprobe

Sample described in Table 2 are included in GIS data in Geologic Sample Localities feature class and are listed by Sample number. The samples locations are plotted using N Latitude and W Longitude values from the table. Thus, the positional accuracy is approximate.

Sample	Map Unit	N Latitude	W Longitude	n	206Pb/238U age (Ma)	2σ	MSWD
08SMK035	Kwc*	36.4234	118.5992	9	135	1	1.2
09SMK049	Kcr*	36.3386	118.5492	14	133	1	1.3
04MMK10	Kbcc*	36.3512	118.7792	10	134.8	1.5	1.5
06SMK018	Kwr	36.3054	118.6208	8	120.1	2.1	1.9
06SMK021	Kpc	36.3035	118.6024	8	121.6	1.6	.6

Sample	Map Unit	N Latitude	W Longitude	n	206Pb/238U age (Ma)	2σ	MSWD
06SMK025	Knp	36.2502	118.5798	9	115.9	1.7	1.5
09SMK050	Kem	36.4693	118.5754	14	106.2	1.1	1.7
04MMK007	Kmr	36.4533	118.7889	12	103.2	1.5	2.6
04SMK002	Kdp	36.2924	118.7202	8	102.8	2	2.4
04MMK004	Kcm	36.4375	118.732	12	101.6	1.6	3.5
04MMK008	Kcm	36.453	118.8136	8	102.3	2.1	4.7
04SMK003	Kcp	36.4489	118.5608	11	98.8	1.2	2.4
09SMK054	Kcpp	36.3937	118.5009	13	100.3	.6	.6
04SMK006	Kmm	36.2616	118.6522	9	98.8	.7	1.9
04SMK005	Kmh	36.2515	118.7382	9	98.8	.9	1.4
04SMK001	Kcc	36.3085	118.6918	11	97.8	.7	1.4
04MMK006**	Kcc	36.4606	118.631	11	96.2	.8	.6
06SMK017**	Kcc	36.4606	118.631	8	98.4	1.3	.4
06SMK024	Kcc	36.3341	118.5882	7	98.2	1.5	1.3
08SMK036***	Kcc	36.424	118.6022	10	98.4	.5	1.6
09SMK052	Kc	36.4626	118.5019	13	91.5	.7	1.5
07MMK011	Kwm	36.2639	118.5064	6	89.9	1	Tuffzire

Comments: * volcano-plutonic suite of Mineral King; ** MMK006 locality was resampled and redated as SMK017; *** folded aplite in wallrock to Kcc. Averaged ages are 207Pb-corrected 206Pb/238U results from Isoplot (Ludwig, 2001), which projects U-Pb values to the concordia from a present-day 207Pb/206Pb common lead component. Sample coordinates are NAD27 datum.

Table from source map: Southwestern Sequoia National Park

Report

INTRODUCTION

This map encompasses 675 km2 (260 mi2) on the west slope of the Sierra Nevada, California, mainly in Sequoia National Park and Sequoia National Forest. The area includes the Mineral King 15-minute topographic quadrangle (sheet 1) and strips along the east and northeast edges of the Kaweah 15-minute topographic quadrangle (sheet 2), all in Tulare County. Mapping was performed mainly on the 1:24,000 scale Mineral King, Silver City, Quinn Peak, Moses Mountain, Case Mountain, and Dennison Peak topographic bases. The map was produced by the U.S. Geological Survey at the request of the National Park Service to complete the geologic map coverage of Kings Canyon and Sequoia National Parks.

Rocks within the study area are chiefly Cretaceous granites and granodiorites of the Sierra Nevada batholith that intruded coherent masses of Mesozoic metasedimentary and metavolcanic rocks. Quaternary till and talus are the principal surficial deposits, with the exception of a large bouldery alluvial apron near the southwest corner of the map area. The study area includes the headwaters of the Kaweah River's East and South Forks, the Tule River's North Fork and North Fork of the Middle Fork, and the Little Kern River. Relief is considerable, with elevations spanning from 1,500 feet along the Middle Fork of the Kaweah River to 12,432 feet at the summit of Florence Peak along the crest of the Great Western Divide.

PREVIOUS WORK

The map area abuts previously mapped areas to the north (Giant Forest and Triple Divide Peak quadrangles: Sisson and Moore, 1994; Moore and Sisson, 1987) and east (Kern Peak quadrangle: Moore and Sisson, 1985). Metamorphic rocks near the village of Mineral King in the headwaters of the East Fork of the Kaweah River were mapped in reconnaissance by Knopf and Thelen (1905), and in detail by Christensen (1959, 1963), Dillon (1969, unpublished), and Busby-Spera (1983, 1984a, 1984b). These maps agree in the distribution and general types of metamorphic rocks, but differ in purpose and emphasis. The Christensen map (1959, 1963) highlights structures and metamorphic assemblages; the Dillon map (1969, unpublished) groups metamorphic rocks into informal formations based on their protoliths, and recognizes additional map-scale folds not shown by Christensen (1959, 1963); the Busby-Spera map (1983, 1984a, 1984b) emphasizes eruptive and depositional environments of the metamorphic protoliths. The present map benefits from those previous studies, as well as from 1:24,000 scale topographic bases and high-resolution orthophoto quadrangles that were unavailable for the earlier efforts. Other previous work includes geologic mapping by Sawlan and Ort (1982, unpublished) in the headwaters of the Tule River related to USGS mineral-resource assessments, and by du Bray and Dellinger (1981) in the Golden Trout Wilderness in the southeast part of the map area. Matthes (1965) discusses the Pleistocene glacial history and landforms of Sequoia National Park and vicinity, including the headwaters of the East and South Forks of the Kaweah, the Little Kern, and Kern Rivers. Previous work on paleontology and mineral deposits are addressed in following sections.

METAMORPHIC ROCKS

Five large areas of metamorphic rock, commonly referred to in the Sierra Nevada as “metamorphic roof pendants” or “pendants”, underlie about 15 percent of the map area. Like elsewhere in the Sierra Nevada, these are steep-sided, elongate masses of diverse metamorphic rocks that lie between, and are intruded by, granitic rocks. The Mineral King pendant spans the north-south length of the map near its eastern margin, extending short distances north into the Triple Divide Peak 15-minute quadrangle (Moore and Sisson, 1987), and south into the Camp Nelson 7.5-minute quadrangle (du Bray and Dellinger, 1981). The southern ends of the Sequoia and Sheep Ridge pendants enter the map area from the north and northwest, respectively, near Paradise Ridge and Ash Peaks Ridge (Sisson and Moore, 1994), and the north end of the Tule River pendant enters the map area from the south at Mountain Home State Forest. The South Fork Kaweah pendant is the only large mass of metamorphic rocks wholly enclosed in the map area, flanked between resistant granites that support Homer’s Nose and Dennison Mountain. Previous workers assigned the metamorphic rocks to the Triassic to Jurassic Kings sequence (Bateman and Clark, 1974; Saleeby and others, 1978), or to the Kings terrain (Nokleberg, 1983), but recent results discussed herein indicate that metamorphic rocks with Cretaceous protoliths are also present.

Metasedimentary rocks

Most metamorphic rocks within the map area were deposited as mudstones, siltstones, and sandstones, with thin bands of limestone, and local areas of quartz-rich sandstone. Graded and rippled sedimentary bedding and primary clastic textures are well preserved in metasandstones and metasiltstones in the Mineral King pendant (Busby-Spera, 1985). Elsewhere, metamorphism and deformation have variably destroyed primary sedimentary structures, but relict bedding is widely preserved as compositional bands, typically centimeters-to-tens of centimeters thick. Mudstone and siltstone were metamorphosed to slate, phyllite, and argillaceous hornfels (slp); areas of abundant thin-bedded fine-grained sandstone and siltstone, with subordinate mudstone, were metamorphosed to siliceous hornfels (slhf); appreciably calcareous sandstones and siltstones were metamorphosed to calc-silicate hornfels and schist (cs). Thick sections of metasandstone with well-preserved clastic textures and sedimentary structures are present on the east and west sides of the Mineral King pendant. The region on the east, from Franklin Lakes through Tulare Peak to Bullfrog Lakes, consists of folded thin-and medium-bedded turbidity current deposits from a submarine fan complex (Busby-Spera, 1985) (ss). To the southeast these sandstones grade to fine-grained and thin-bedded metasandstone and metasiltstone with interstratified metaargillites and calc-silicate rocks (qbcs: undivided quartzofeldspathic-micaceous and calc-silicate metasedimentary rocks). Metasandstones

on the west side of the pendant are thin-to-medium bedded with well-preserved metavolcanic felsite grains (vss) and locally interstratified metavolcanic breccia beds. These volcaniclastic metasandstones appear to grade northward to thin-bedded siliceous hornfels (slhf) that crosses the ridge west of Timber Gap, although the connection between these rocks is concealed by till. To the south, the volcaniclastic metasandstones grade to, or are closely interstratified with, schistose metarhyolite on the west side of Farewell Gap (K?smr).

Marbles (m), recrystallized after limestones, are present in all of the metamorphic pendants. Calc-silicate interbands are common in marble and in some areas constitute as much as half regions mapped as marble. Marbles are distinctly continuous along strike, but their thickness vary considerably; in some cases, meter-thick bands of marble, or of mixed marble and calc-silicate rock, stretch across hillsides for hundreds of meters and connect thicker marble exposures. Marble bands also divide or merge along strike, enclosing areas of other metasedimentary rocks, probably due to tight folding. Marble dissolves and weathers cavernously to karst, particularly where marble bands cross or follow stream beds, producing sinkholes, dry stream beds, springs, and caves. Karst is not well developed where marbles cross hillsides and ridge crests, probably indicating that the present configuration of ridges and valleys has great, though unquantified, antiquity.

Metasedimentary rocks have not been subdivided in detail outside of the Mineral King region due to poorer exposure and greater degrees of metamorphic recrystallization. Quartzo feldspathic biotite schist and hornfels encompass metaargillites with interstratified metasiltstones and metasandstones in some areas (qb). In other areas, metasedimentary sections include appreciable but subordinate calc-silicate hornfels and schist (qbcs).

Fossils

Fossils are rare in metamorphic rocks of the Sierra Nevada, but marine invertebrates of Late Triassic age have been found at several places within the northeastern part of the Mineral King pendant. Reported locations are restricted to narrow belts of siliceous and calc-silicate hornfels with lesser slate, argillaceous hornfels, and marble along the east wall of the Mineral King and uppermost Little Kern Valleys, spanning from Crystal Creek south to Bullfrog Lakes (Franklin and Crystal Creek units of Busby-Spera, 1984). Before metamorphism the fossiliferous deposits were chiefly thin-bedded fine-grained sandstones and siltstones, subordinate mudstone, and minor limestone (Christensen, 1963), interpreted to have been deposited in a marine continental-shelf environment (Busby-Spera, 1984); pebble conglomerate is present near the southern end of the belt. Fossils have not been reported from the other metamorphic pendants in the map area.

Turner (1894) and Durrell (1940) report ammonites and the pelecypod *Halobia* at about 9,000 feet elevation along the creek draining Franklin Lakes. Christensen (1959) reports fossils from eight localities in this belt including the ammonite *Clionites* (?) sp., pelecypods *Halobia superba, Halobia sp., Monotis (?), and Paleoneilo sp*., and brachiopod *Spiriferina sp*. Busby-Spera (1984) collected Late Triassic brachyopods along Crystal Creek from the first marble west of the thick metarhyolite tuff (about 9,000 feet elevation). Slate containing the pelecypod Monotis (identified by S. Starratt, USGS) and indeterminate weakly deformed ammonites was found during the present work at 10,480 feet elevation on the southwest side of the small basin northwest of Tulare Peak. Smith (1927) also reports *Pseudomonotis subcircularis*? and *Paleoneilo*? from Mineral King but does not provide locations.

Metavolcanic rocks

The Mineral King area is notable for the abundance, diversity, degree of preservation, and accessibility of metamorphosed volcanic rocks. Accordingly, these rocks have been studied and interpreted in considerable detail (Christensen, 1959; Busby-Spera, 1983, 1984b, 1986). Major units consist of (1) thick sections of light-colored metarhyolite tuffs, commonly with relict pyroclastic textures and relict quartz and plagioclase phenocrysts; (2) metadacite tuffs, lava flows, and breccias that are darker colored than the metarhyolites due to greater biotite and amphibole abundances, and lack relict quartz phenocrysts; and (3) even darker colored metaandesites that include coarse, thick-bedded breccias and lava flows, commonly with prominent relict phenocrysts of plagioclase. Metavolcanic units characteristically grade into interstratified volcaniclastic and non-volcanic

metasedimentary rocks, leading to somewhat arbitrary contact locations, but indicating subaqueous depositional environments (Busby-Spera, 1984b, 1986).

The ages of Mineral King metavolcanic rocks and the structure of the pendant are considerably revised based on the present and other recent investigations (Starnes and others, 2010; Klemetti and others, 2011). Busby-Spera (1983, 1984b, 1986) interpreted the Mineral King pendant as an eastward-younging homocline of Triassic to Early Jurassic metavolcanic and metasedimentary rocks. This conclusion was based on Triassic fossils, interpreted statigraphic continuity between metasedimentary and metavolcanic rocks, concordant U-Pb zircon ages from metavolcanic rocks in upper Crystal Creek (Late Triassic) and upper Cliff Creek (Early Jurassic), and multiple low-precision 206Pb/207Pb zircon age estimates. Concordia plots of the U-Pb results (Busby-Spera, 1983), however, are consistent with ~135 million year (Ma) eruption ages (Early Cretaceous) for the thick metarhyolite tuffs that pass through Mineral King Village, Vandever Mountain, and Timber Gap-lower Monarch Creek, and for a metarhyolite sill intrusive into metasandstones near Tulare Peak (Figure 1). Age discordance can be attributed to a minor inherited zircon component of ~1.6 billion years (Ga) old, similar to ages inferred for inherited zircons in other Sierra Nevada igneous rocks (Saleeby and others, 1990). Direct redating of the major metarhyolite tuffs by ion-microprobe U/Pb zircon methods confirms their ~135 m.y. eruption ages and Proterozoic (1.6 Ga) inheritance (Starnes and others, 2010; Klemetti and others, 2011). Additional age revisions are summarized in Table 1, based on concordia plots assuming that discordance is due to a common 1.6±0.3 Ga inherited zircon component. These revisions indicate that the majority of Mineral King metavolcanic rocks are Cretaceous and Jurassic, although Triassic rocks (^ma) are present in the eastern part of the pendant. Hence, there is no simple age progression across the pendant, indicating that substantial structural (and possibly stratigraphic) complexity exists, although this complexity is only partly resolved at the present map scale.

Structure

Compositional banding in the metamorphic rocks, relict after bedding, has predominantly steep-to-vertical dips with strikes of north ten-to-thirty degrees west, matching the overall outcrop trends of the metamorphic pendants and their steep contacts with flanking granites. Foliation in schists and slates, and cleavage in hornfels, are parallel to compositional banding. Outcrop-scale tight folds can be seen locally in well bedded units (Christensen, 1963); folds with steeply plunging hinges are readily recognized on near-horizontal exposures, but folds with near-horizontal hinges are also present. Map scale folds are present in the Mineral King pendant in metasandstones between Frankin and Bullfrog Lakes, and in calc-silicate metasandstones and metasiltstones near Monarch Lakes and Mineral Peak (Christensen, 1963; Dillon, 1969, unpublished; Busby-Spera, 1983, 1984b, 1986).

Folds are less easily recognized in metavolcanic rocks due to their obscure bedding and lateral facies changes. Nevertheless, Dillon (1969, unpublished) identified a large internally folded synform passing through Vandever Mountain, confirmed by the present mapping. The nose of this synform lies north of Vandever Mountain and is marked by a distinctive unit of dark-colored, thin-to-medium bedded carbonate-silicate pebble conglomerates with interstratified thin-bedded pebbly sandstones (ccgl) that wraps around the nose of the fold. A Cretaceous metarhyolite tuff (Kmrt) that caps Vandever Mountain cores the synform and overlies this bedded metacongomerate-sandstone unit. A subordinate syncline and anticline in the metaconglomerate and metatuff are well exposed on the north ridge of Vandever Mountain, and a south-plunging anticline within interstratfied metatuffs and metasediments is well exposed on Vandever Mountain’s upper southwest slope. The northward termination of the metarhyolite tuff at Vandever Mountain had been interpreted as a caldera margin (Busby-Spera, 1984a), but a proposed caldera ring fault could not be located during the present mapping, and the fine clast size and well-bedded character of the conglomerate-sandstone unit are dissimilar to caldera-margin megabreccias.

The thick Cretaceous metarhyolite tuff (Kmrt) that spans from Timber Gap Creek south-southeast across Monarch Creek and Crystal Creek may also core a syncline, at least near its southern end. This interpretation is based on the Late Triassic age, established by fossils, of metasedimentary rocks that flank the Cretaceous metatuff directly to its east and west (Christensen, 1959; Busby-Spera, 1983), as well as a concordant Late Triassic U-Pb zircon age for a metavolcanic rock (^ma) east of

the metatuff in upper Crystal Creek (Busby-Spera, 1983). The nose of the syncline would lie about 0.5 km north of Franklin Creek where marble with interlayered calc-silicate bands wraps the southern end of the metarhyolite tuff. No fold hinge has been observed in the metatuff, however, so juxtaposition against Triassic strata by faulting cannot be ruled out.

All previous geologic maps of Mineral King identify a shear zone running down the bed of upper Farewell Canyon within slates and phyllites (Farewell fault of some authors). Thin, discontinuous sections of marble lie along this zone. Shearing is well exposed in slates at Farewell Gap and in a zone of schistose metarhyolite shortly west of the pass (K?smr). The total displacement on this fault is inferred to be small (less than a kilometer?) because slates and argillaceous hornfels in the bed of lower Farewell Canyon are not strongly sheared, instead having folded but well preserved relict bedding, and metarhyolite tuffs of closely similar age (~135 m.y.), unusual for the Sierra Nevada, are present on both sides of the fault. The northward continuation of this fault or fracture system is marked by active soda springs and tufa deposits near Aspen Flat, and by modest shearing in a thin belt of slate to the west of Timber Gap. A parallel minor fracture system transects slate in the next gully west, and fluids exploiting this fracture probably created the now inactive tufa knob beside the Mineral King road at 7,700 feet elevation. The shear's continuation south of Farewell Gap is also limited, as shown by Cretaceous metarhyolite tuff and a pluton of tourmaline-bearing aplite that cross the projected trace of the fault without displacement. Instead, the fault zone may step about 1 km southwest to a parallel fault along the margin of the Mineral King pendant, but that fault also fails to offset rock units that cross its southern projection along the Little Kern River. Numerous small soda springs and tufa deposits along the bed of the upper Little Kern River indicate fluid flow along a north-south striking joint system, but rock exposures in the bed of the river are not sheared, and contacts between rock units cross the river without mappable offsets, indicating minimal displacement.

A northeast dipping fault crosses the upper west slope of Mineral Peak and the upper Crystal Creek basin and separates metaandesites in the footwall from chiefly calc¬silicate metasandstones in the hanging wall. Busby-Spera (1983, 1984a) connects this fault with a shear zone to the east of Timber Gap at about 10,100 feet elevation. At that location a roughly 10 m thick, vertically dipping section of strong foliated-to-mylonitic rock separates Cretaceous metarhyolite, on the west, from Jurassic metadacite tuffs, on the east. Although stongly foliated metamorphic rocks are locally exposed between the two faults, as well as elsewhere, a continuous structure could not be traced during the present mapping.

Timing of deformation

Near-vertical dips of Early Cretaceous metarhyolite tuffs and metaandesite, and the involvement of metarhyolite tuffs in folding, show that some of the deformation in the metamorphic rocks is of Cretaceous or younger age. Some deformation is demonstrably associated with emplacement of the large, Late Cretaceous plutons. A locality on the west side of the Mineral King pendant close to its contact with the 98 Ma granodiorite of Castle Creek (Kcc) exposes vertically dipping metasedimentary rocks that contain isoclinally folded aplite dikes. A U-Pb zircon age of 98 Ma was also obtained from one of these dikes (Table 2), indicating that they must have been intruded and tightly folded at about the time of pluton emplacement. Similar tightly folded aplite-pegmatite dikes cut metaandesite on the east side of the pendant adjacent to the large ~99 Ma granite of Coyote Pass (Kcp), but did not yield zircons, so their age is unknown. Transposition of Cretaceous metavolcanic rocks to vertical dips during emplacement of Cretaceous plutons has also been described for metamorphic pendants elsewhere in the Sierra Nevada (Saleeby and others, 1990).

Metamorphism and metamorphic assemblages

Mineral assemblages are indicative of metamorphism at low pressures, corresponding to shallow depths, and at moderate to locally high temperatures due to the emplacement of voluminous hot granitic magmas. The rocks can be assigned to the upper greenschist and amphibolite metamorphic facies. Most metapelitic rocks consist of quartz, plagioclase, biotite, muscovite, and opaque oxides, sporadically accompanied by minor andalusite, and by either chlorite or cordierite. Accessory minerals include apatite, tourmaline, zircon, and secondary titanite where biotite has partially retrograded to chlorite. Cordierite (altered to pinite), or less commonly andalusite, locally forms prominent ovoid porphyroblasts visible in outcrop. Close to granitic contacts metapelites may contain minor garnet and

fiberous sillimanite instead of andalusite, but such rocks are uncommon. Discontinuous granitic veins in metapelitic rocks on the west side of the South Fork Kaweah pendant may result from local partial melting. The widespread presence of andalusite and cordierite, as opposed to kyanite and garnet, are diagnostic of low-pressure metamorphism (Spear, 1995) corresponding to depths of less than about 12 km beneath the surface.

Calc-silicate rocks range widely in appearance and mineral assemblage. The purest calc-silicates are white-to-cream-colored porcelaneous rocks consisting of fine-grained quartz, plagioclase, and colorless amphibole, commonly with diopside. Minor phases may include carbonate, scapolite, zoisite, and epidote. Carbonate-rich calcsilicate rocks typically have pitted weathered surfaces due to preferential dissolution of carbonate. Some metasiltstones have compositions intermediate between metapelites and calc-silicates, or consist of thinly interlayered metapelitic and calc-silicate bands. Calc-silicate assemblages in such rocks consist chiefly of quartz, plagioclase, and pale green amphibole, accompanied by opaque oxides, and variable amounts of biotite.

Metaandesites through amphibolites (metabasalts and metabasaltic andesites) consist of plagioclase, quartz, green-to-brown amphibole, biotite, and opaque oxides. Biotite is commonly partly retrograded to chlorite, with accompanying precipitation of granular titanite. Metarhyolites consist mainly of fine-grained granoblastic quartz and plagioclase, with minor biotite and muscovite, and accessory opaque oxides, apatite, and zircon. Relict phenocrysts of quartz and plagioclase are scarce but widespread. Some metarhyolites contain isolated clusters of epidote grains, probably after calcareous vug fillings. Volcaniclastic sandstones contain sub-angular detrital grains of quartz, felsite (granoblastic quartz plus plagioclase), and plagioclase, accompanied by biotite, muscovite, opaque oxides, and in some samples, interstitial carbonate.

GRANITIC ROCKS

Mesozoic granitic rocks of the Sierra Nevada batholith underlie about 85 percent of the map area. The granitic rocks form discrete, spatially extensive masses known as “plutons” that are relatively uniform in texture and composition, and that have sharp contacts against adjacent plutons and metamorphic rocks. Crosscutting intrusive relations between plutons are indicative of their relative ages. Individual plutons are interpreted as the cooled and soldified products of magmas (hot, molten rock) of restricted composition and age that accumulated in particular areas beneath the Earth’s surface. Plutons in the map area are about evenly divided between light-colored granites and medium-colored granodiorites, with only about 2 percent of the region consisting of dark-colored intrusions encompassing gabbros, diorites, and quartz diorites (Streckeisen, 1976). The granites are similar in composition to rhyolites and rhyodacites, and the granodiorites are similar to dacites and silicic andesites (Table 3). The darker intrusive rocks are compositionally similar to andesites, basaltic andesites, and basalts. Ages of the larger plutons were determined by the U-Pb zircon method, using the USGS-Stanford ion-microprobe facility (Table 2); all of the plutons dated in this study are Cretaceous.

The oldest plutons are three small bodies of deformed granodiorite that lie along the west edges of the Mineral King and South Fork Kaweah pendants. These are the granodiorites of White Chief Mine (Kwc), Camelback Ridge (Kcr), and Burnt Camp Creek (Kbcc). These plutons are younger than but resemble Jurassic intrusions mapped elsewhere in the Sierra Nevada in their degree of deformation and the presence of sheared and offset mafic dikes (Chen and Moore, 1982; Moore and Sisson, 1985); however, their U-Pb zircon ages cluster at 133-135 (±1-1.5) Ma (Early Cretaceous), similar to the 130¬140 Ma ages of the voluminous metarhyolite tuffs of the Mineral King pendant. Rocks of this age are rare in the Sierra Nevada batholith, which grew over two protracted periods, the first mainly during the Jurassic but spanning from the Late Triassic to the Early

Cretaceous (~215-145 Ma), and the second during the Cretaceous (~125-80 Ma) (Chen and Moore, 1982; Irwin and Wooden, 2001). The minimum in Sierra Nevada igneous activity is centered at 130-140 Ma, so the presence of plutonic and volcanic rocks of ~135 Ma in this spatially restricted region is evidence that those igneous rocks are related. The ~135 Ma plutonic and metavolcanic rocks are here informally named the volcano-plutonic suite of Mineral King, after the Mineral King pendant that contains most of the known exposures. Parts of the granodiorite of Camelback Ridge have porphyry textures, suggestive of shallow emplacement, and resemble dacite porphyry dikes that cut nearby

metamorphic rocks.

The next plutons intruded the southern part of the map area, bounded between the Tule River and southern Mineral King pendants. These are the 120-122 Ma granodiorites of Windy Ridge (Kwr) and Pecks Canyon (Kpc), whose U-Pb ages overlap each other within analytical uncertainty (Table 2). Till conceals their contact, but the Windy Ridge pluton is probably the older of the two based on the presence of common mafic dikes that are absent in the granodiorite of Peck's Canyon. The granodiorite of Windy Ridge is atypically fine-grained for a Sierra Nevada granodiorite pluton and was probably emplaced at subvolcanic depths. The granodiorite of Nev Point (Knp) then intruded on their south flank at about 116 Ma. The granodiorites of Nev Point and Pecks Canyon are cut by near-vertical post-magmatic shears and foliations, striking north 20-to-40 degrees west, with mainly down-dip lineations. Magmatic foliation has a similar attitude in the adjacent southern portion of the large ~98 Ma granodiorite of Castle Creek, possibly indicating that the granodiorites of Nev Point and Pecks Canyon were deforming while the magmas that produced the granodiorite of Castle Creek intruded and solidified. In the adjacent Kern Peak Quadrangle, the east margin of the ~100 Ma granite of Coyote Pass is cut by the late-plutonic Coyote Peaks fault (Moore and Sisson, 1985), which may have formed during the same tectonic event. The granodiorite of Windy Ridge is also deformed, but in a brittle and irregular fashion.

The quartz diorite of Empire Mountain (Kem) then intruded at the north end of the Mineral King pendant. Busby-Spera (1983) reports concordant U-Pb ages of 108 and 106 Ma for two zircon splits from a single sample. The present study obtained an age of 106±1 Ma (Table 2). The quartz diorite of Empire Mountain is cut by sparse mafic dikes, as is the adjacent but undated granodiorite of Spring Lake (Ksl) which is provisionally interpreted to be a light-colored (felsic) facies of the quartz diorite of Empire Mountain. Nearby coarse-grained hornblende gabbro at Black Rock Pass is also undated and is cut by all flanking intrusive rocks, but may also be part of the Empire Mountain intrusive event. If so, the intrusive event shows an exceptional degree of compositional zoning. An undated gabbro sill on the lower east wall of the Mineral King valley is variably deformed and probably is not related to the gabbro at Black Rock Pass.

Most of the younger plutons are considerably larger and are part of an irregular but overall west to east progression of granitic magmatism across the Sierra Nevada (Chen and Moore, 1982). The granite of Frys Point (Kfp) intruded the far northwest part of the map area mainly at 105 Ma, with phases of activity as young as 103 Ma (Holland and others, 2010). This was followed eastward by the granodiorite of Milk Ranch Peak (Kmr, 103±1.5 Ma), which was then intruded on its east and south margins by the light-colored granite of Case Mountain (Kcm, 102±2 Ma) that is probably related to the similar looking granite of Dennison Peak (Kdp, 103±2 Ma), a short distance to the south across the South Fork Kaweah pendant. Evernden and Kistler (1970) report biotite and hornblende K-Ar cooling ages of 88.5-87.4 Ma and 87 Ma, respectively, for samples now known to be of the granite of Case Mountain.

Plutonism then shifted to the east side of the Mineral King pendant with emplacement of the large, zoned granite of Coyote Pass (Kcp). The granite of Coyote Pass is an elongate pluton spanning 32 km on a north 20 degrees west axis from the southwest Kern Peak quadrangle to the southeast Triple Divide Peak quadrangle (Moore and Sisson, 1985, 1987). This pluton is distinctive in many respects: (1) unlike most light-colored granites of the Sierra Nevada batholith, it has common dark-colored mafic inclusions; (2) the granite has a faint igneous layering defined by intermittent thin (cm) variations in the abundance of dark-and light-colored minerals; (3) the mineral layering and disk-shaped mafic inclusions dip inward toward the axis of the intrusion, defining a trough or synformal structure; (4) an indistinctly K-feldspar porphyritic facies with few-to-no mafic inclusions (Kcpp) occupies the core of the intrusion and the synform; and (5) masses of fine-grained hornblende quartz diorite to hornblende gabbro (Kmcp) intrude the granite at various locations and are themselves intruded by small-volume fine-grained granodiorites of presumed hybrid granite-diorite origin (Kcpgd). Mafic inclusions, layering, and the synformal structure are absent north of Big Five Lakes. A sample from the porphyritic core of the pluton yields a concordant U-Pb age of 100.3±0.6 Ma, whereas a sample from the equigranular margin resulted in 98.9±1.2 Ma (Table 2). These overlap within analytical uncertainty, and the preferred age for the intrusion is 99¬100 Ma, although Busby-Spera (1983) also reports a concordant

age of 97-99 Ma for a sample from the margin of the pluton (“Sawtooth Peak granite”). Biotite and hornblende K-Ar cooling ages obtained from the granite of Coyote Pass are 93.2-87.4 Ma, and 93.0-86.4 Ma, respectively (Evernden and Kistler, 1970). Two additional plutons emplaced at about this time in the south part of the map area are the granodiorite of Mountain Home (Kmh, 99±0.9 Ma) and the very light-colored granite of Maggie Mountain (Kmm, 99±0.7 Ma), flanking the Tule River pendant on the west and east, respectively.

The Mineral King pendant was then intruded on the west by the large granodiorite of Castle Creek (Kcc). This is the outer and oldest member of the zoned Mitchell Intrusive Suite of Moore and Sisson (1987) that is centered to the north in the Triple Divide Peak quadrangle. Total north-south mapped extent of the pluton is 45 km. The granodiorite of Castle Creek is a medium colored hornblende-biotite granodiorite with about 3-7 flattened mafic inclusions per square meter, typical for hornblende-biotite granodiorites of the Sierra Nevada. Samples of the granodiorite of Castle Creek were dated from three widely separated localities (Table 2). Two samples yielded ages of 98±0.7 Ma and 98±1.5 Ma. The age of the third sample was 96±0.8 Ma, but recollection and redating of that outcrop yielded an age of 98±1.3 Ma, suggesting an analytical issue with the first result. Folded aplite dikes intruded the eastern metamorphic wall of the pluton at 98±0.5 Ma, and Busby-Spera (1983) also reports 98-99 Ma for a sample near the east edge of the Castle Creek pluton (“Eagle Lake quartz monzonite”). These results indicate that, despite its large size, the granodiorite of Castle Creek intruded over a relatively brief period at 98 Ma. A single K-Ar hornblende cooling age for a sample now known to be of the granodiorite of Castle Creek is 88.9 Ma (Evernden and Kistler, 1970). A sample of tourmaline-bearing aplite (Kap) from an intrusion on the southeast flank of the granodiorite of Castle Creek did not yield zircons, but is interpreted to be associated with that intrusion.

Magmatic activity then ceased in the area for six or seven million years until the granodiorite of Chagoopa (Kc) intruded at 91.5±0.7 Ma on the east side of the granite of Coyote Pass. This is a hornblende-biotite granodiorite that forms the outer, equigranular member of a zoned composite intrusion centered to the east in the Kern Peak quadrangle (Moore and Sisson, 1985). The youngest dated pluton is the coarsely K-feldspar porphyritic granite of White Mountain (Kwm) that lies near the southeast corner of the map area. Contact relations show that flanking metamorphic rocks overlie the granite along a shallowly dipping roof, now partially dissected. Erosion into the granite of White Mountain created the broad basin of the Little Kern drainage. Zircon age results for the granodiorite of White Mountain sample are more scattered than for the other dated plutons, but the TuffZirc routine of the Isoplot dating analysis program (Ludwig, 2001) indicates an age of 90±1 m.y., and a concordia age of 92±2 m.y. is obtained assuming an inherited zircon component of ~1.6 Ga.

MINERAL DEPOSITS

Construction of the trans-Sierra Hockett Trail up the south fork of the Kaweah, commencing in 1862, eased access to the Mineral King area, but mineral exploration did not begin in earnest until 1873 when James Crabtree and associates filed a mining claim in the headwaters of White Chief Creek. Prospectors quickly found many additional mineralized areas, mostly consisting of combinations of galena (lead sulfide) and sphalerite (zinc sulfide), as well as pyrite (iron sulfide) or arsenopyrite (arsenic-rich pyrite) (Goodwin, 1958). Silver can be associated with galena and sphalerite, which prompted the prospecting boom, but silver and gold concentrations in Mineral King ores proved to be low, the ores difficult to refine, and the mineralized veins small. The largest excavations were the White Chief, Lady Franklin, and Empire mines, but many small, hopeful prospects decorate the slopes and ridges of the Mineral King Valley (Goodwin, 1958). All sizeable mines and prospects in the Mineral King area are in or associated with marble. Mineralization at the Empire and White Chief mines developed where granitic magmas intruded marble and created dark-colored reddish brown rocks known as tactite (tc) that consist chiefly of coarse crystals of garnet, epidote, idocrase, and pyroxene. Large isolated masses of tactite also cap Empire Mountain and the crest of its northwest summit ridge. Although the tungsten mineral scheelite (calcium tungstate) is common in tactite and has been reported from the Empire Mine locality, it was not sought during the 1870s Mineral King prospecting boom. Additional minerals reported from the Mineral King area include chalcopyrite and pyrrhotite (copper-iron sulfides), stibnite (antimony sulfide), and minute amounts of gold. Pyrite is also widespread in the metamorphic rocks, causing many to weather rusty brown. Concerted mining activity ended at Mineral King by 1881. Small galena-sphalerite occurrences are also known in the

metasedimentary rocks of the upper Tule River metamorphic pendant in Mountain Home State Forest (Goldfarb and others, 1985; Goodwin, 1958). The last mining activity in the map area was at the Pine Tree tungsten mine in the southern portion of the Mineral King metamorphic pendant where scheelite was extracted from thin marble bands and calc-silicate rocks close to the contact with the porphyritic granite of White Mountain. This mine operated as recently as 1982 (Dellinger and others, 1983).

SURFICIAL DEPOSITS

Glaciation

Ice fields and glaciers widely covered regions higher than about 7,000 feet elevation during the Pleistocene Epoch (commonly known as the “Ice Age”). Glacially eroded cirques, U-shaped valleys, and ground-mantling deposits of unconsolidated bouldery till are the principal records of those glaciers. Ridges of till, known as moraines, mark the positions of the sides and lower ends of former glaciers in many high-elevation valleys. Ice advanced and retreated multiple times during the Pleistocene, and nested sets of moraine crests record successive glacial events. Locally, exposures and landforms are sufficiently developed to subdivide the glacial deposits by age, allowing the extent of the last major Pleistocene ice advance, referred to in the Sierra Nevada as the Tioga glaciation (Qti), to be distinguished from the older Tahoe and earlier glaciations. Tioga¬aged deposits are probably also widespread in areas mapped as undivided Pleistocene till (Qw). Small glacial deposits with minimal-to-no vegetation and well-preserved moraines (Qrpm) are generally restricted to north-facing slopes and cirques above 10,000 feet elevation. These are products of both the latest Pleistocene Recess Peak and late Holocene Matthes (“Little Ice Age”) ice advances recognized elsewhere in the Sierra Nevada (Clark and Gillespie, 1996). High-elevation talus fields merge with these young tills and probably mainly grew during times of more abundant ice.

Landslides and debris flows

Landslide and debris-flow deposits (Qls) form a bouldery mantle on the steep south slope of Ash Peaks Ridge above Sequoia National Park’s Ash Mountain headquarters. The deposits follow current topography, so post-date uplift of the Sierra Nevada and incision of the Kaweah drainage, but the deposits are themselves incised indicating that they are not recent. A broad, gently dipping alluvial apron of bouldery debris (Qal) fills the headwaters of the Tule River’s North Fork in the southwest part of the map area. Some boulders, up to ~10 meters across, are much larger than could be carried by historic stream flows. Neither the Ash Peaks landslide nor the North Fork Tule River debris flow apron head in extensively glaciated drainages, so enhanced meltwater discharge from Pleistocene glaciers can not account for these deposits. Possibly, the deposits were generated by high rainfall during the Pleistocene.

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Report from source map: Southwestern Sequoia National Park

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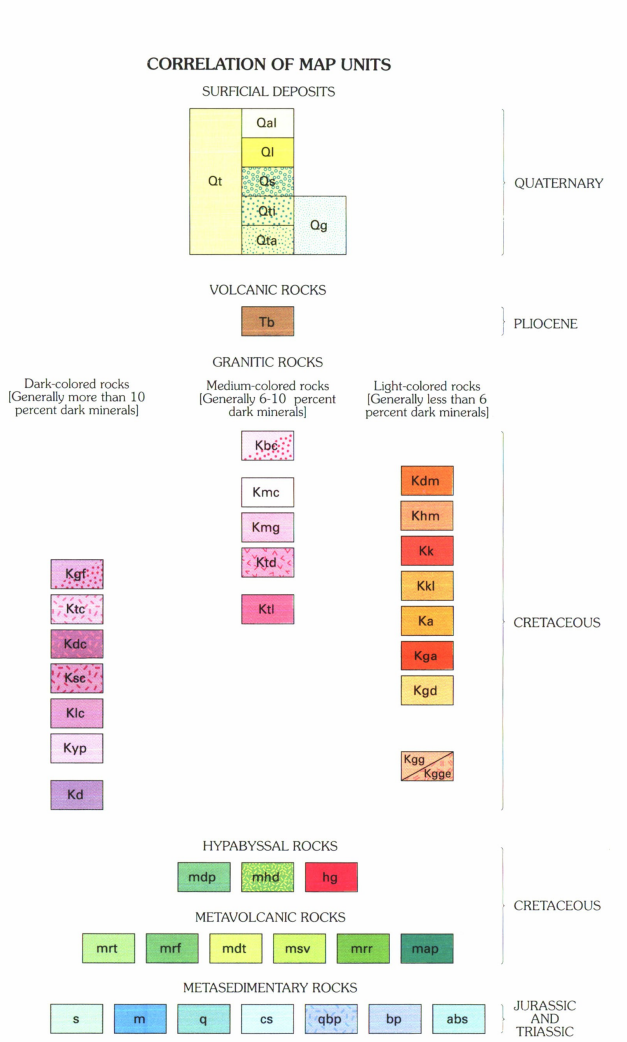
Tehipite Dome 15' Quadrangle

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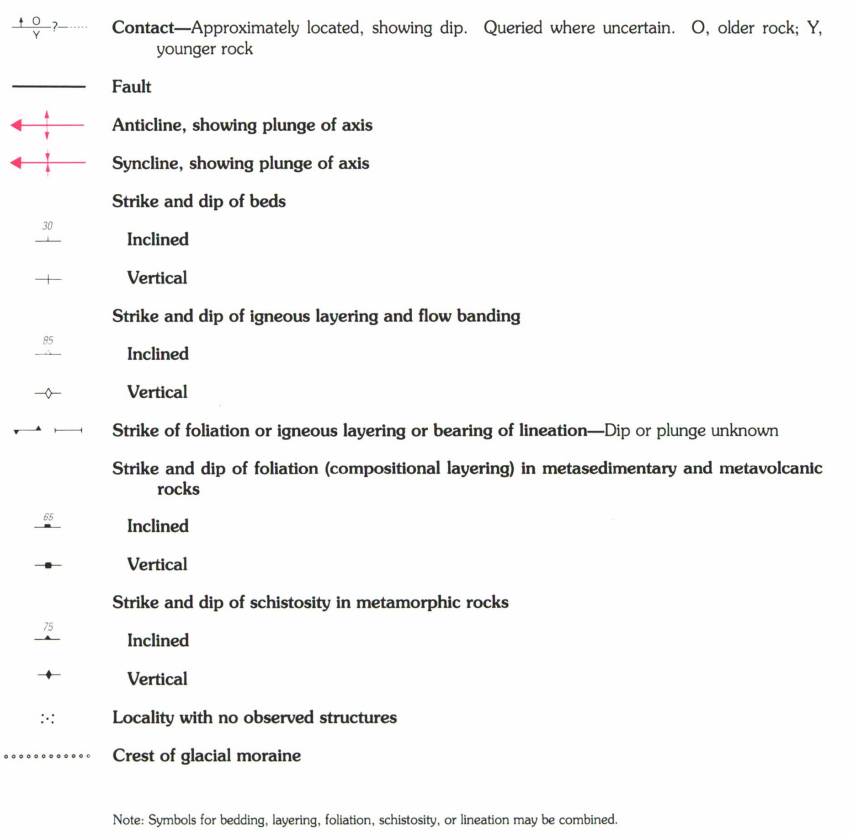
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Correlation of Units



Graphic from source map: Tehipite Dome 15' Quadrangle

Map Legend



Graphic from source map: Tehipite Dome 15' Quadrangle

Report

INTRODUCTION

The Tehipite Dome quadrangle covers about 240 mil on the west slope of the central Sierra Nevada within the Kings River drainage. The physiography of the region is dominated by the extremely rugged canyons of the Middle and South Forks of the Kings River, which meet about in the middle of the quadrangle and form one of the deepest canyons in the United States. Slightly downstream from this confluence, the elevation at river level is 2,160 ft, and 4.7 mi north at Spanish Mountain on the north canyon rim, the elevation is 7,891 ft higher at 10,051 ft. North of the canyon a glaciated upland rises to 10,800 ft on Kettle Ridge, the highest point within the quadrangle.

A small part of Kings Canyon National Park, including Tehipite Valley, is in the northeastern part of the quadrangle, and a part of the General Grant Grove Section of the park is in the southwestern part. Within the quadrangle and south of the canyon, 15 groves of Sequoia trees outside the park occur on Sequoia National Forest land on north-facing upland slopes from 6,000 to 7,600 ft elevation. California Highway 180 provides access to the southern part of the quadrangle, and a paved road from Dinkey Creek (northwest of map area) extends to Wishon Reservoir on the North Fork of the Kings River at the north boundary of the quadrangle. Most of the uplands north and south of the canyon can be reached by unimproved roads and trails, but the steep and brushy slopes of the Kings River canyon are generally trailless, and therefore helicopter transport was used to support geologic investigations both for this work and for related wilderness studies (Nokleberg and others, 1983; Chaffee and Nokleberg, 1988).

PREVIOUS WORK

The southern part of the map area was first explored in 1864 by the Geological Survey of California. The field party included William Brewer, party chief, Charles Hoffman, topographer, and geologists James Gardner and Clarence King. King became the first Director of the U.S. Geological Survey in 1879. The earliest systematic geologic mapping within the quadrangle was done as part of a study of tungsten deposits during World War II (Krauskopf, 1953).

Topical studies of metamorphic and granitic rocks in the quadrangle are subjects of reports by Moore and Dodge (1962), Jones and Moore (1973), Girty (1977a, b), and Chen and Moore (1982). Regional studies of Cenozoic volcanic rocks in the quadrangle have been made by Moore and Dodge (1980) and Dodge and Moore (1981), and of metasedimentary and metavolcanic rocks by Bateman and Clark (1974), Saleeby and others (1978), Nokleberg and Kistler (1980), and Nokleberg (1983). A geologic guide of the Kings Canyon Highway, which crosses the southern part of the quadrangle, is available (Moore and others, 1979), and the mineral deposits and resources in various parts of the quadrangle have been assessed in several studies (Moore and Marks, 1972; Nokleberg and others, 1983; and Chaffee and Nokleberg, 1988).

METAMORPHIC ROCKS

Granitic rock of the composite Sierra Nevada batholith is the most abundant bedrock of the quadrangle, but remnants of pregranitic metamorphosed sedimentary and volcanic rocks occur as isolated screens or roof pendants that separate individual masses of granitic rock. The largest area of metamorphic rock in the quadrangle is called the Boyden Cave roof pendant and occurs in the southeast part of the quadrangle. A continuation of the roof pendant extends northwest across both forks of the Kings River to Spanish Mountain and Rodgers Ridge on the north canyon rim.

The metamorphic rocks in the Boyden Cave roof pendant, as well as in the quadrangle as a whole, comprise two major terranes—the Kings terrane to the west composed mainly of metasedimentary rocks and the Goddard terrane to the east composed mainly of metavolcanic rocks (Nokleberg, 1983). The Kings terrane, first called the "Kings sequence" by Bateman and Clark (1974) and best exposed in the western part of the Boyden Cave roof pendant, consists of highly deformed and regionally metamorphosed quartzite, arkose, marl, mudstone, calcareous sandstone, and limestone transformed into metaquartzite, meta-arkose, biotite-quartz schist, biotite schist, calcschist, and marble. Exposures of the metasedimentary rocks of the Kings terrane are spectacular in the southern part of the Boyden Cave roof pendant along the South Fork of the Kings River. In this area, the major metasedimentary rock types are marble, phyllite, biotite schist, calcschist, and quartzite. Prominent ridges of marble make up Windy Cliffs and cross Monarch Divide, and metaquartzite and meta-arkose form the prominent ridge south of Horseshoe Bend. Sparse fossils, mainly crinoids and ammonites found near the mouth of Boulder Creek, indicate an Early Jurassic age (Moore and Dodge, 1962; Jones and Moore, 1973; Saleeby and others, 1978). Available paleontologic evidence from other areas indicates a Late Triassic to Early Jurassic age for the Kings terrane which is believed to have been a submarine-fan system containing craton-derived sands and, farther to the south, silicic volcanic tuffs and breccias (Saleeby and others, 1978). The base and top of the Kings terrane are either faulted or intruded by granitic plutons; minimum stratigraphic thickness is estimated at a few thousand feet.

The Kings terrane is intensely deformed. Moderately appressed to isoclinal folds and axial-plane schistosities are common. Margins of the Boyden Cave roof pendant have been recrystallized to hornfels by the heat of adjacent granitic plutons. Bedding has generally been transposed to a series of parallel tectonic lenses or foliations by penetrative deformation. Structural analyses show that most of the Kings terrane was twice penetratively deformed and regionally metamorphosed (Girty, 1977a, b; Nokleberg and Kistler, 1980). Multiple deformations are indicated by two generations of superposed minor and major structures, mainly refolded folds with axial-plane schistosity, and by local younger shear and mylonite zones.

The older set of structures, termed "first-generation structures", strikes east-northeast and dips moderately to steeply north. These structures are well exposed in the phyllite unit along the north side of the paved road east of Boyden Cave. Amphibolite facies minerals occur along the axial-plane

schistosity of first-generation structures (Girty, 1977a, b). The younger set, termed "second-generation structures", strikes north-northwest and dips steeply to vertically. These structures are common in the metasedimentary rocks of the Kings terrane, and in the metavolcanic rocks of the Goddard terrane to the east. The second-generation structures are superposed on the first-generation structures (Girty, 1977a, b; Nokleberg and Kistler, 1980). Amphibolite to upper greenschist facies minerals occur within the axial-plane schistosity and along the lineation of the second-generation structures. Second-generation structures include a pronounced and widely distributed mylonitic schistosity that in places is concentrated in mylonite zones as wide as a few centimeters. Such zones occur in mid-Cretaceous metavolcanic rocks and the mid-Cretaceous granitic rocks bordering the Boyden Cave roof pendant, such as the granite of Grand Dike, indicating that granitic intrusion may have occurred during regional deformation and metamorphism. Local and regional comparisons of major and minor structures indicate that the first-generation structures formed in a regional deformation during the Early or Middle Jurassic, and that the second-generation structures formed during the Late Jurassic through the mid-Cretaceous.

The Kings and Goddard terranes are separated by a major pregranitic fault named the "Kings River suture" (Nokleberg, 1983). The evidence for faulting consists of narrow slivers of fault-bounded and deformed metasedimentary and metavolcanic rocks that strike obliquely into one another on the east-central side of the Boyden Cave roof pendant, east of upper Boulder Creek. Intense shears and mylonite zones, part of the second generation structures, also occur in the eastern part of the pelitic and calcphyllite of the Boyden Cave roof pendant near the fault. The parallelism of the Kings River suture to the second-generation structures indicates that the suture probably formed along with these structures. The occurrence of second-generation structures in the mid-Cretaceous metavolcanic rocks of the Goddard terrane, and in adjacent mid-Cretaceous granitic rocks indicates that second-generation structures, along with major movement on the Kings River suture, probably formed in the mid-Cretaceous during or just after granitic intrusion, regional deformation, and faulting.

The metavolcanic and metamorphosed shallow intrusive rocks of the Goddard terrane form the east half of the Boyden Cave roof pendant. These rocks consist mainly of metarhyolite and metadacite tuffs and flows, and include a distinctive shallow intrusion of metamorphosed hypersthene dacite. New Rb-Sr whole rock and U-Pb zircon isotopic dating of the metavolcanic rocks indicates a mid-Cretaceous age (J. B. Saleeby and R. W. Kistler, written commun., 1988). The Goddard terrane is interpreted as a fault-bounded fragment of the upper part of an Andean-type arc that formed on the Jurassic to mid-Cretaceous margin of western North America (Nokleberg, 1983).

Intense deformation and formation of second-generation structures are indicated by a well developed schistosity striking north-northwest and dipping steeply parallel to second-generation structures in the metasedimentary rocks. Absence of first-generation structures in the metamorphosed volcanic and shallow intrusive rocks of the Goddard terrane indicates these rocks formed after the deformation that produced the first-generation structures in the Kings terrane to the west, or else the terrane was tectonically transported to its present position after formation of first-generation structures in the Kings terrane.

GRANITIC ROCKS

Most of the quadrangle is underlain by granitic rocks of the Sierra Nevada batholith, and about two dozen separate intrusive masses have been identified and mapped. Available radiometric dating indicates all are Cretaceous and were emplaced as magmas (largely molten rock) that cooled 86-128 Ma. The plutonic rocks range in composition from dark-colored diorite and gabbro to lighter colored quartz diorite, granodiorite, and granite. Different color hues are employed on the geologic map to divide the granitic rocks into three compositional groups.

The southern parts of two large granitic masses, the Mount Givens Granodiorite, and the Dinkey Creek Granodiorite occur in the northern part of the quadrangle. The Mount Givens Granodiorite extends nearly 44 mi and the Dinkey Creek Granodiorite about 25 mi northwest of the quadrangle (Bateman, in press).

The youngest major granitic pluton is the porphyritic granite of Brush Canyon emplaced 86 Ma (Chen and Moore, 1982). It is exposed from the summit of Spanish Mountain to the floor of the Kings River

canyon and shows no marked compositional change through nearly 8,000 ft of elevation change. The pluton appears to be roofed on the north by metasedimentary rocks and partly floored on the west by the older granodiorite of Yucca Point, which crops out deep in Kings River canyon.

Extending into the quadrangle from the south is the large pluton composed of the Giant Forest Granodiorite (Moore and Sisson, 1987) emplaced 97-102 Ma. The granodiorite is dark, rich in hornblende, and contains abundant mafic inclusions, but south of the quadrangle, the pluton is markedly zoned and is intruded by progressively younger and more silicic masses toward its central part.

PLIOCENE BASALT
Numerous remnants of late Tertiary basaltic lava flows are scattered over the upland parts of the quadrangle. These flows, which belong to the San Joaquin-Kings volcanic field, were fed from scattered vents that produced small flows of varied composition--all alkalic and some extremely potassic (Moore and Dodge, 1980; Dodge and Moore, 1981). The basalts commonly contain phenocrysts of olivine and clinopyroxene, less commonly plagioclase and biotite. The large flow in the northwest part of the quadrangle, as well as flow remnants on Crown Ridge and Volcanic Cone are rich in potassium and contain small crystals of leucite in the groundmass.

Source vents for the various lava flow remnants are rarely seen. However, a basalt dike 0.5-2.5 ft thick on the north wall of the Kings Rive' canyon west of Deer Ridge may have conducted some of the lava to the surface. Most of the basalt flow remnants in the San Joaquin-Kings volcanic field were erupted 3-4.5 Ma (Moore and Dodge, 1980). A potassic basalt near Rancheria Creek in the northwest part of the quadrangle yielded a whole rock K-Ar age of 3.2 Ma (Huber, 1981).

QUATERNARY DEPOSITS
Periodically during the Pleistocene, icefields covered much of the upland region north of the Kings River canyon and the highest parts of the Monarch Divide between the Middle and South Forks of the Kings River. Valley glaciers shaped numerous lake basins and deposited extensive moraines, particularly in the northern part of the quadrangle. Major valley glaciers flowed down both forks of the Kings River. The Middle Fork glacier carved Tehipite Valley and terminated at about 4.000 ft elevation, and the South Fork glacier terminated a mile east of the quadrangle at an elevation of about 4,200 ft.

Report from source map: Tehipite Dome 15' Quadrangle

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Reference from source map: Tehipite Dome 15' Quadrangle

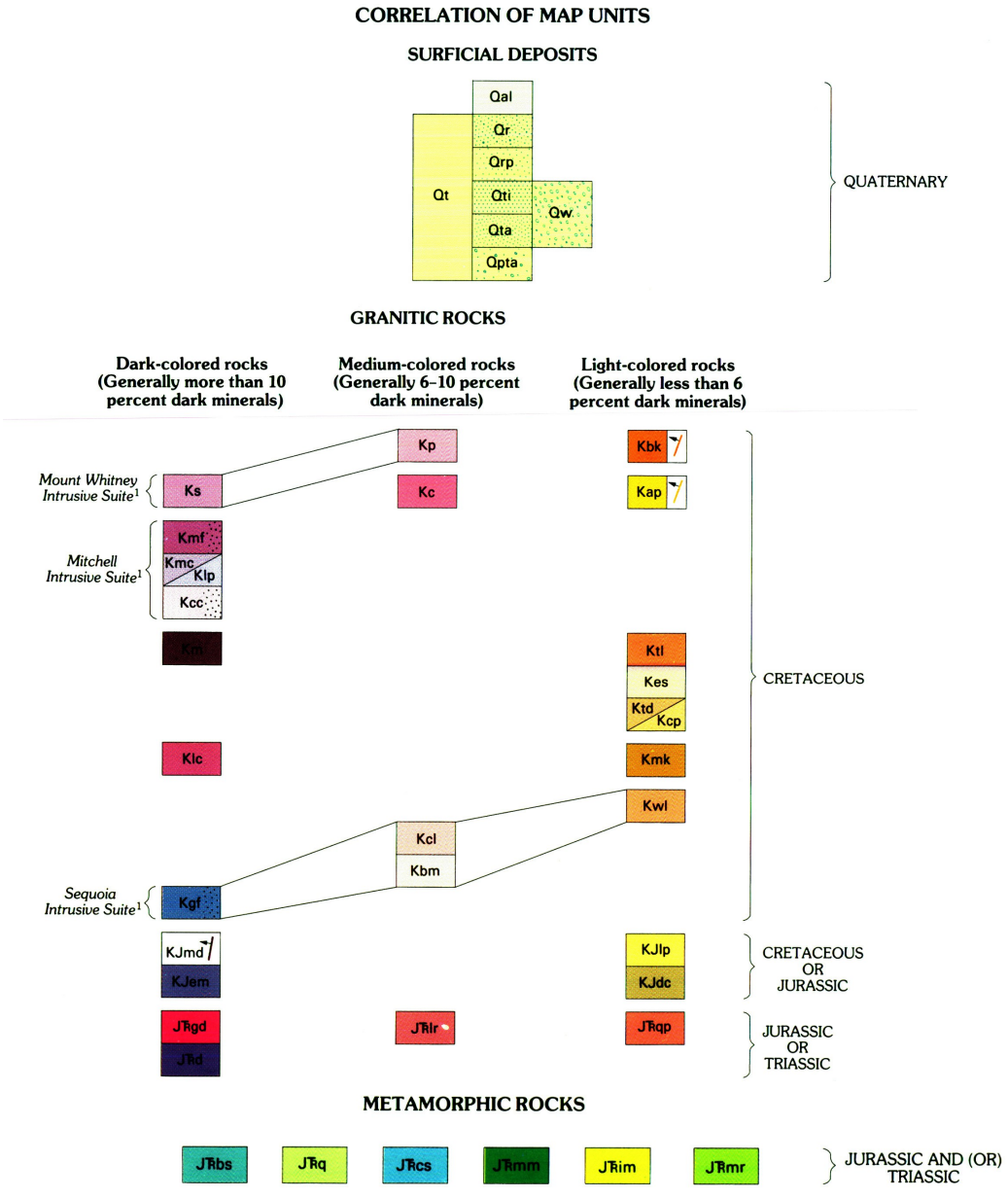
Triple Divide Peak 15' Quadrangle

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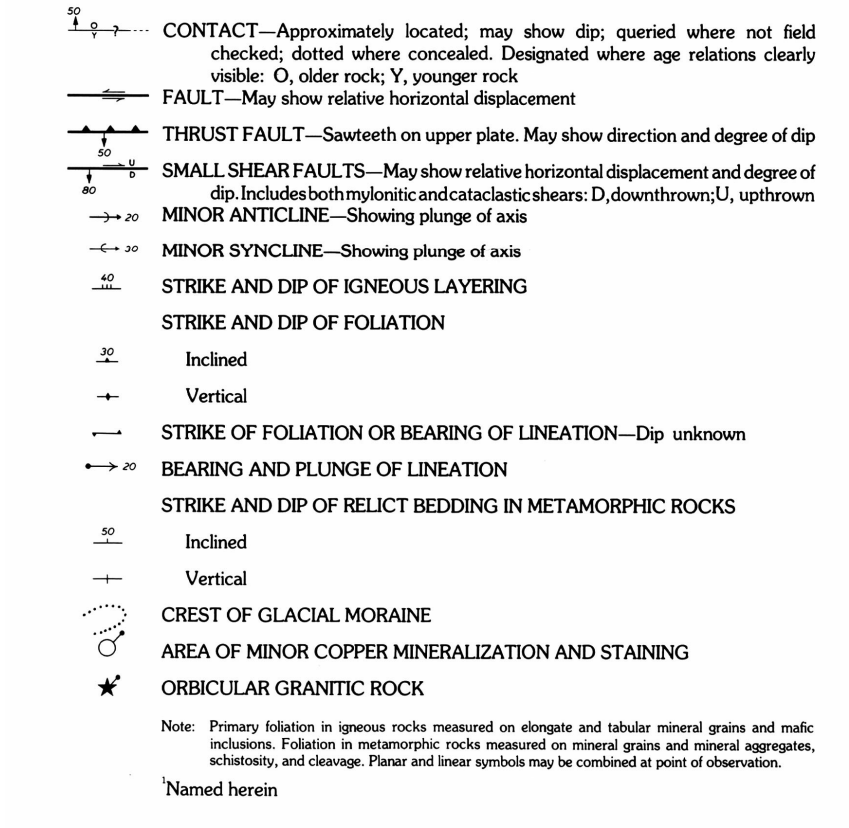
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Correlation of Units



Graphic from source map: Triple Divide Peak 15' Quadrangle

Map Legend



Graphic from source map: Triple Divide Peak 15' Quadrangle

Report

INTRODUCTION

The Triple Divide Peak quadrangle encompasses about 620 km2 west of the southern Sierra Nevada crest almost entirely within Kings Canyon and Sequoia National Parks. The quadrangle includes the main drainage divide between the South Fork of the Kings River on the north and the Marble and Middle Forks of the Kaweah River on the south. This divide also marks the boundary between Kings Canyon and Sequoia National Parks. Triple Divide Peak is in the east-central part of the quadrangle where this divide is joined by the Great Western Divide, the boundary between the Kaweah and Kern River drainages. The Generals Highway, an all-weather paved road, enters the quadrangle at the west-central margin and extends 3 km to the summer settlement of Lodgepole where the National Park Service visitor's center, a store, and public campground are located. The northern part of the quadrangle is served by trails from a roadhead at Horse Corral Meadows at the extreme northwest corner. The southern part is served by the High Sierra Trail, which heads at the road at Giant Forest and Crescent Meadow on the west quadrangle margin south of Lodgepole. This trail extends eastward, crossing the Great Western Divide at Kaweah Gap 4 km south of Triple Divide Peak, and leaves the quadrangle on its southeast margin at Big Arroyo.

METAMORPHIC ROCKS

Metamorphic rocks are found chiefly in the southwestern and southeastern parts of the quadrangle and are older than the granitic rocks of the Sierra Nevada batholith. Metamorphic rocks in the southwest corner are mostly metamorphosed shale and sandstone, now recrystallized to schist and quartzite. Rocks in the southeastern region are primarily metamorphosed siliceous volcanic rocks

including tuffs and associated sediments. They are cut by shallow intrusions of similar composition and are associated with calcareous metasedimentary rocks that crop out in Big Arroyo. All the metamorphic rocks were recrystallized to the hornblende hornfels grade of metamorphism. No fossils have been found in the quadrangle; however, the metavolcanic screen at the south-central margin of the quadrangle is the northern extension of the Mineral King roof pendant in which fossils found 4-6 km south of the quadrangle indicate a Late Triassic and Early Jurassic age (Saleeby and others, 1978).

MESOZOIC GRANITIC ROCKS

More than 95 percent of the quadrangle is underlain by intrusive Mesozoic granitic rocks of the Sierra Nevada batholithic complex. The granitic masses or plutons were intruded beneath the Earth's surface as magma (largely hot molten rock) from about 160 to 85 million years (Ma) ago (Chen and Moore, 1982). Twenty-five individual plutons have been identified and mapped.

Several of the granitic plutons within the quadrangle belong to three intrusive suites that collectively include much of the area underlain by granitic rocks. Each intrusive suite is a group of two or more masses of intrusive rock that are related in space and time and are hence believed to be cogenetic. Each suite probably formed during a single melting event at depth; the resulting magma was chemically modified and physically separated during upward intrusion, thus producing the separate masses of plutonic rock. From west to east these newly named intrusive suites are the Sequoia Intrusive Suite (about 99 Ma), the Mitchell Intrusive Suite (about 91 Ma), and the Mount Whitney Intrusive Suite (about 85 Ma). The suites in general appear to have been emplaced from west to east over a time span of about 14 m.y. Some of the intrusive age relations are conflicting, perhaps because some granitic rocks were not wholly solidified when adjacent ones were emplaced.

The Sequoia Intrusive Suite, here named for Sequoia National Park, consists of the Giant Forest Granodiorite (oldest) and three somewhat younger and smaller plutons—granite of Big Meadows, granodiorite of Clover Creek, and granite of Weaver Lake (youngest). The type area of the suite is in the Shell Mountain-Little Baldy area in the adjacent Giant Forest quadrangle. The Giant Forest Granodiorite crops out over a broad area in the western part of the quadrangle and in much of the eastern part of the neighboring Giant Forest quadrangle. The unit takes its name from Giant Forest which lies both in the Triple Divide Peak and Giant Forest quadrangles; the type locality is at Moro Rock just south of Giant Forest in the Giant Forest quadrangle. The rock is a and the granite of Lodgepole to the east. The Giant Forest Granodiorite, the granite of Big Meadows, and the granite of Weaver Lake were successively emplaced and are progressively more felsic. They are interpreted as being the products of fractional crystallization of a common parent magma. The granodiorite of Clover Creek is, however, more mafic than the slightly older granite of Big Meadows and the younger granite of Weaver Lake. This reversal in trend, as well as the intrusion of minor synchronous diorite dikes and stocks, could have resulted from the introduction of a small batch of mafic magma into the crystallizing pluton.

The Mitchell Intrusive Suite, here named for Mitchell Peak, occupies much of the central part of the quadrangle. The type area is the Tableland area on the divide between the Kings and Kaweah Rivers. The suite consists of the granodiorite of Castle Creek (oldest), granodiorite of Lookout Peak, and Mitchell Peak Granodiorite (youngest). The Mitchell Peak Granodiorite is the most extensive unit (32 km long and as much as 13 km wide) in the suite; it is well exposed on the summit of Mitchell Peak, its type locality, in the northwest corner of the Triple Divide Peak quadrangle where it was formerly called the granodiorite of Mitchell Peak by Moore (1978). The granodiorite of Lookout Peak (which barely extends into the north margin of the quadrangle) is tentatively correlated with the coarse-grained facies of the Mitchell Peak Granodiorite. In addition, the granodiorite of Castle Creek, which surrounds the southern part of the Mitchell Peak Granodiorite, is tentatively assigned to the suite.

The Mitchell Peak Granodiorite consists of a fine-grained facies and a coarse-grained facies; the fine-grained facies has a uranium-lead age of about 91 Ma. The dominant fine-grained facies is porphyritic and generally much finer grained than most Sierran granitic rocks. Groundmass minerals include most of the mafic minerals (biotite and hornblende) and are 1 to 2 mm in length. Potassium feldspar and quartz are found in the groundmass, whereas plagioclase is found as phenocrysts 2-4 cm in

length. Because of the fine grain size of the matrix, large scattered hornblende, biotite, and potassium feldspar crystals can also be considered phenocrysts. The coarse-grained facies, also porphyritic, contains phenocrysts of potassium feldspar 3-4 cm in length. It surrounds and is older than the fine-grained facies. Abundant angular blocks of the coarse porphyritic facies, as much as 1 km across, are scattered within the fine-grained facies and are clearly older than the fine-grained facies. These blocks have been mapped separately where possible in the higher, glaciated areas. The rather pronounced, generally near-vertical foliation of the enclosing fine-grained granodiorite is paralleled by a less pronounced parallel foliation within the blocks. The fine-grained facies is underlain by continuous exposures of the coarse-grained porphyritic facies near Deadman Canyon. This and other large exposures of the coarse-grained porphyritic facies at low elevations suggests that the fine-grained facies forms a thin intrusive mass floored by the coarse porphyritic granodiorite. The blocks were isolated by the injection and inflation of dikes of the fine-grained granodiorite. To the south, the marginal coarse-grained granodiorite facies has intruded into and is largely surrounded by the granodiorite of Castle Creek, suggesting that this granodiorite is a genetically related member. A few small stocks of fine-grained diorite intruded the coarse-grained unit before the coarse unit was separated into blocks.

The fine-grained facies of the Mitchell Peak Granodiorite contains pipes and dikes containing orbicular granodiorite generally at the outer margins of some of the larger coarse-grained blocks. Sixteen localities of orbicular granitic rocks have been mapped in association with the Mitchell Peak Granodiorite making this rather rare rock type (Moore and Lockwood, 1973) surprisingly abundant in this region. The pluton apparently underwent some form of abrupt change that affected its normal cooling and crystallization history after emplacement and crystallization of the coarse-grained marginal (and block) facies. The unsolidified interior of the intrusion then was reinjected into a cooler and lower pressure environment, crystallized rapidly, and exsolved volatiles that concentrated at sites favorable to the formation of the orbicular granite. Possible causes of the reinjection of the pluton to a higher level include: the intrusion of a neighboring granitic mass that forcibly remobilized the Mitchell Peak magma; surface eruptions that partly drained the chamber causing roof collapse and reinjection to a higher level; or fresh introductions of mafic magma that reheated the older magma making it less viscous and more buoyant.

The Mount Whitney Intrusive Suite, here named for Mount Whitney in the adjoining Mount Whitney quadrangle to the east (Moore, 1981), consists of the granodiorite of Sugarloaf (oldest), the Paradise Granodiorite, and the Whitney Granodiorite (youngest). The suite extends about 83 km southeastward from the central part of the Marion Peak quadrangle on the northwest to the southeastern part of the Olancha quadrangle on the southeast. The type area of the suite is along the Sierra Nevada crest near Mount Whitney. The Paradise Granodiorite crops out in the northeastern part of the map and surrounds the Whitney Granodiorite (exposed in the neighbor¬ing quadrangle to the east). The granodiorite of Sugarloaf is tentatively assigned to the Mount Whitney Intrusive Suite and probably represents an outer, older shell of this concentric suite, which is one of the largest and youngest composite granitic intrusions in the Sierra Nevada.

Plutonic complexes formed of light-colored silicic granite and dark-colored, mafic hornblende-rich rock, are present in the southeastern and eastern parts of the quadrangle and include the granites of Coyote Pass, Triple Divide Peak, and Tamarack Lake. They differ markedly from the more common compositionally zoned granodiorite plutons and zoned intrusive suites because of the rarity of rocks of intermediate composition, and the general absence of compositional zoning within the light-colored granites.

STRUCTURE

The older metamorphic rocks and some intrusive rocks were intensely deformed, but the ages of deformation are poorly known. In the Big Arroyo area, metamorphic calcareous sediments with weakly developed planar mineral fabric parallel to compositional layering are commonly cut by mafic dikes that are probably correlative with the Independence dike swami (148 Ma; Chen and Moore, 1982). The mafic dikes have subsequently been folded and possess a weakly developed schistosity parallel to that in the surrounding rocks. The fold hinges are unrecognizable in the host metamorphic rocks a short distance away from the mafic dikes, perhaps owing to the discontinuity of compositional bands

in the metamorphic rocks. Similar attenuated and locally folded mafic dikes are present in schistose intrustive rocks near Triple Divide Peak. The moderately developed schistosity is absent in rocks younger than about 100 Ma. Hence the youngest schist-producing event occurred between 148 Ma and roughly 100 Ma in this area.

Granitic rocks younger than the dike swarm commonly show planar fabrics defined by alignment of flattened mafic inclusions and linear and planar dark minerals. Microscopic examination of the youngest granites with this foliation reveals that the late-crystallizing minerals, quartz and potassium feldspar, are undeformed, indicating that the foliation formed before individual plutons had completely crystallized. These foliations are roughly parallel to pluton margins suggesting that the structures formed while magma filled and inflated the pluton chambers. Forcible emplacement of the Mitchell Peak Granodiorite may have warped the metavolcanic and mafic dike rocks in the vicinity of Elizabeth Pass from their regional northwest trend. Perhaps the minor thrust fault on Triple Divide Peak resulted from southward crowding of wall rocks during emplacement of the large Mitchell and Mount Whitney Intrusive Suites.

Two north-trending, right-lateral strike-slip faults, characterized by a zone of fractured rocks 20 m wide, are present near Big Arroyo and show apparent offsets as much as 1/2 km. These faults are probably related to the Kern Canyon fault 11 km to the east, which has a similar sense of offset.

Small-scale strike- and oblique-slip faults cut many of the granitic units. They commonly show a few centimeters to meters of offset and display either recrystallized cataclasite (a few millimeters thick and formed by brittle deformation) or mylonite (as much as 4 cm thick and formed by ductile deformation). The small brittle faults are part of the regional micro-fault sets documented by Lockwood and Moore (1979). These small faults locally combine to form larger faults similar to those in Big Arroyo, and the two groups may be related. The small ductile faults consistently predate the brittle faults.

GLACIATION

During parts of the Pleistocene Epoch (sometimes called the "Ice Age"), ice fields covered much of the higher parts of the quadrangle, including the Tableland region, and fed glaciers down the major canyons. Extensively glaciated canyons on the north side of the Kings-Kaweah divide include those of Sugarloaf Creek, Ferguson Creek, Deadman Canyon, and Cloud Canyon that contains well-preserved moraines near Scaffold Meadows.

South of the divide, glaciers filled the upper drainage of the Marble Fork of the Kaweah River and carved the U-shaped Tokopah Valley. The two Wisconsin glacial advances deposited Tahoe and Tioga moraines that are well preserved along the sides of the valley. During Tahoe time the ice depth at Lodgepole campground was about 270 m and the glacier terminated about 3 km west at an elevation of 1830 m. Glaciers also occupied the upper part of the Middle Fork of the Kaweah River canyon, and the main glacier descended to near the mouth of Granite Creek at about 1770 m.

The youngest glacial deposits include rock glaciers, which are tongues of rock debris with cores of ice, found above 3600 m in north- to northeast-facing cirques. Small, prominent Recess Peak moraines are found below the rock glacier in high cirques. They represent a slightly earlier neoglacial advance. All of the lake basins in the quadrangle were carved from bedrock by ice or were dammed by glacial moraines.

Report from source map: Triple Divide Peak 15' Quadrangle

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