DIGITAL MAP AND CHART SERIES DMCH020
DOC 10.1130/2014.DMCH020

Published by
The Geological Society of America, Inc.
3300 Penrose Place • P.O. Box 9140
Boulder, Colorado 80301-9140

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GEOLOGIC MAP OF THE SOUTHERN SLATE RANGE AND A PORTION OF THE CENTRAL GARLOCK FAULT, CHINA LAKE NAVAL WEAPONS STATION, SAN BERNARDINO COUNTY, CALIFORNIA

By
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2014

SCALE 1:20000

CONTOUR INTERVAL 10 FEET FOR SEARLES LAKE 7.5' QUADRANGLE,
20 FEET FOR SEARLES VALLEY, LAYTON PASS, PILOT KNOB WEST, AND PILOT KNOB EAST 7.5' QUADRANGLES

NATIONAL GEODETIC VERTICAL DATUM OF 1983

CORRELATION OF MAP UNITS

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qa **ALLUVIAL DEPOSITS (Holocene)** – Unconsolidated silt, sand and gravel deposited in active stream channels.

Qe **EOLIAN DEPOSITS (Holocene)** – Well sorted, unconsolidated silt or sand in depositional dunes and dune fields.

Qp **PLAYA DEPOSITS (Holocene)** – Well sorted, unconsolidated silt and clay deposited in active playa lakes.

Qc **COLLUVIUM DEPOSITS (Holocene)** – Poorly sorted, unconsolidated angular debris of local derivation deposited on slopes.

Qy **YOUNG INACTIVE ALLUVIAL DEPOSITS (Holocene)** – Unconsolidated silt, sand and gravel deposited in now-abandoned stream channels. These deposits have poor soil and desert varnish development and are not incised.

Qi **INTERMEDIATE AGE ALLUVIAL DEPOSITS (Holocene)** – Unconsolidated silt, sand and gravel deposits with moderate desert pavement development and desert varnish. Commonly occur as slightly upraised terraces above active and young inactive alluvium. These deposits are younger than local Pinedale talus and so do not have lacustrine affects.

SEARLES LAKE LACUSTRINE DEPOSITS – Deposits that define the Searles Lake chronology for surface exposures and subsurface correlatives in Searles Lake drill cores. The age of this formation is estimated to be 150 to 2 ka (Smith, 2009).

Qzw **Washed surface (late Pleistocene)** – Older sediments along Searles Valley with surfaces modified by Pleistocene Searles Lake. These washed surfaces consist of numerous paleo-lake shoreline beaches and wave-cut terraces. The uppermost washed area is bound by the high-stand beach terrace at 695 meters (2280 feet) elevation. These washed surfaces correlate with members 4 to 8 of the Searles Lake Formation (Smith, 2009).

Qst **Tufa deposits (late Pleistocene)** – Deposits of calcium carbonate tufa with pea-sized vug spaces. These vuggy tufas correlate to the tufas of the basal unit of Smith's (2009) Searles Lake Formation.

Qo **OLDER ALLUVIUM (late Pleistocene)** – Dissected, locally-derived, inactive alluvial fans. These deposits are moderately incised, have well-developed desert pavement and are commonly preserved as terraces that are incised by younger alluvial systems. These deposits are older than the last time period of Pleistocene lakes in the area but they are exposed at higher elevations than the Pleistocene lakes levels and so do not show lacustrine affects. The oldest and highest-level terraces of the older alluvium deposits have minimal desert pavement development due to erosional removal of the upper layers of soil leaving a remnant layer of soil petrocalcite (caliche) exposed at the surface.

Ql **LAG GRAVELS (late Pleistocene)** – Deposits of gravel and sand developed on coarsely conglomeratic units of the formation of Pilot Knob Valley. These deposits consist mostly of recycled pebbles, cobbles and boulders that are reworked and redeposited.

CHRISTMAS CANYON FORMATION (late Pleistocene) – Lacustrine and fanglomerate deposits originally defined in the Lava Mountains, just southwest of the map area (Smith, 1964). Revised by Smith (2009) and revised herein. Smith (2009) estimated ages of the Christmas Canyon Formation to be 0.30 to 1.3 Ma.

Qcf **Fanglomerate member** – Cobble to boulder fanglomerate with a sandy matrix capping the lacustrine member. This unit is generally coarse-grained and poorly sorted with the coarser boulder conglomerate at the top. Rounded basalt boulders are distinctive clast types in this member.

Qcll **Lacustrine member** – Siltstone and sandstone with interbedded thin layers of pebbles. The beds are sub-horizontal and commonly weather to a slightly greenish color. An ash correlated with the Lava Creek B ash (640 ka) occurs near the top of this member near Christmas Canyon in the Lava Mountains, south of the Garlock fault (Smith, 2009).

SEDIMENTARY ROCKS

Qfg **METAMORPHIC CLAST-BEARING FANGLOMERATE (early Pleistocene)** – Poorly lithified and poorly bedded fanglomerate, with clasts derived from the southern flank of the Slate Range. The outcrop color is light green due the presence of the greenschist-grade metamorphosed clasts of metapsilomelane or metavolcanic rocks. Locally alaskite clasts are abundant giving the outcrop a light gray color.

Qfv **VOLCANIC CLAST-BEARING FANGLOMERATE (early Pleistocene)** – A poorly lithified and bedded fanglomerate containing clasts of only volcanic rocks. The clast sources are the dominantly intermediate composition volcanic rocks in the western Quail Mountains.

Qfq **QUARTZITE CLAST-BEARING FANGLOMERATE (early Pleistocene)** – Poorly lithified conglomerate to sandstone unit. The lower beds are poorly sorted and poorly stratified conglomerates containing pebbles, cobbles and boulders of quartzite, quartzite-cemented sandstone rocks and quartzite. The upper portion of this unit has well-bedded sandstone and cobble conglomerate. Distinctive quartzite clasts occur as cobbles to boulders up to 0.5 meters in diameter that are well-rounded and polished. The quartzite clasts are derived from the quartzite clast-bearing conglomerate unit below the Miocene volcanic rocks.

FORMATION OF PILOT KNOB VALLEY (early Pleistocene to early Pliocene) – Informally named unit separated out from rocks previously classified as Christmas Canyon Formation by Smith (1964 and 2009). This unit is significantly older than the Christmas Canyon Formation as shown by the much greater degree of deformation, including generally steeper bedding dips of 30–90° vs. the 0-5° dip of the Christmas Canyon Formation. The rocks are cut by numerous faults with slip-cleavage fin, and the formation of Pilot Knob Valley is an angular unconformity (Figure 2 of Smith (2009)). Tephrochronology samples for this unit correlate to ash deposits with early Pleistocene to middle Pliocene ages (see details under each member below). The exposures we reinterpret to be in the formation of Pilot Knob Valley were classified on the map by Smith (2009) as Christmas Canyon Formation, 'Tertiary siltstone and sandstone', or 'Tertiary or Quaternary sandstone and siltstone'.

Qp5 **Member 5 (early Pleistocene)**
Slate Range Fanglomerate – Fanglomerate containing metamorphic and plutonic clasts. This unit is well-indurated, but does not generally support cliffs. It is mostly matrix-supported but is locally clast-supported. Bedding is parallel and ranges in thickness from 10 cm to greater than 1 meter. Sorting and grading of clasts are poor. The clast size ranges from pebbles to boulders greater than 1 m in diameter. The clasts are subrounded to subangular. The plutonic monzodiorite, gneiss, schist, slate and meta-tuff, matching the rocks exposed along the southern flank of the Slate Range. The deposit has an overall greenish-gray color due to the presence of chlorite-bearing metamorphic clasts. The matrix is a light orange-red. These fanglomerates are incised and cut by flat-lying, younger alluvial units and are distinct from the older members of this unit because they are less deformed and have generally low dips between 5 and 10°.

Qp9b
Qhp3
Qp9
Np2t
Np2c
Np2e
Np1
Jmc7
Jmc6
Jmc5
Jmc4
Jmc3
Jmc2
Jmc1
Jmg
Jmz
Jma
Jm
Jk
Jd
Jt
Jr1
Jr11
Ja
Jv
Ts
Tg1
Qs
Qo
Ql
Qzw
Qst
Qcf
Qcll
Qfg
Qfv
Qfq
Qp5
Qp9b
Qhp3
Qhp2
Qhp1
Np2t
Np2c
Np2e
Np1
Nm
Np2t
Np2c
Np2e
Np1
Nvu
Nva
Nvt
Nvt
Nvk
Np2t
Np2e
Np1
Nvt
Nvk
Rfq
Np1

Hematite-stained Slate Range Fanglomerate – Hematite-cemented fanglomerate unit of meta-igneous and granitic clasts occurring locally below the Slate Range fanglomerate unit. This is more lithified than the overlying conglomerates and has dips that are slightly steeper. The clasts are commonly angular. This unit is very well indurated and commonly crops out as cliffs and ridges. The matrix is a coarse arkosic sand. Bedding is thick to massive. This unit has distinctive dark red to purple hematite and manganese staining. Locally it has thick concretions of hematite and manganese that completely incase the clasts. The base of this unit is disconformable, locally appearing conformable with member 4, but it has a scoured base on top of member 3 in places. The thickness of this unit is 0-100 meters thick. A similar unit is exposed in places along the nearly flat-lying boundary the southern edge of the Slate Range. This staining occurs across several contacts of metaplutonic bodies and the base of the hematite stain is roughly horizontal.

Member 4 Hatty Pleistocene) – Lacustrine mudstone, siltstone and sandstone grading upward into pebble fanglomerate. Lower portion has a distinctive brown mudstone. Upper fanglomerate is matrix-supported and contains clasts of meta-tuff, reddish monzogranite, white-gray granite, slate, schist, and also lesser amounts of vesicular basalt, plagioclase-rich basalt, gray dacite/andesite and dark reddish plagioclase-rich basaltic andesite. Generally this member erodes easily and forms large rounded mounds with only the interbedded white ash beds giving a sense of bedding orientation. The fanglomerate facies is more resistant to erosion, forming steeper slopes and protective caps on underlying beds. The fanglomerate facies is commonly cemented with evaporated rock in the Slate Range and the volcanic rocks correlative to rocks in the Eagle Crags to the south rock, but the color varies to yellow, purple and brown.

Member 3 (early Pliocene-late Pleistocene) – Well-bedded siltstone, sandstone and conglomerate with clasts of meta-igneous rocks sourced from the southern Slate Range. Lower portions are siltstone and sandstone. Upper half is conglomerate with clasts of meta-tuff, white granite, light-colored gneiss and mylonite, red granite, and bluish-green gneiss. Bedding thicknesses range from 2 to 10 cm at the bottom, to up to 0.5 m at the top. This unit is more resistant to erosion than underlying deposits. It is moderately thick to orange in color. It has normal sorting, patterns and planar bedding. The bottom of the member sits conformably on the Hatty Member. The bedding dips gradually decrease upwards section. This member pinches out to the west where member 3 sits unconformably on the lacustrine unit of member 2.

Member 2 (late to early Pliocene)
Lacustrine facies – Relatively thick (200 to 700 meters thick) sequence of light-colored and well-bedded gypsiferous siltstone, siltstone and mudstone. Generally well-indurated but the clay-rich beds are poorly exposed and often have a weathered popcorn-like surface texture. Karstification is common at ravine bottoms owing to dissolution of salts. The sandstone beds contain a few pebbles with apparent Slate Range provenance. To the east, these lacustrine beds are interbedded with alluvial facies of member 2. Numerous ash layers are exposed throughout the section, but most are flowtaly- reworked or clay-altered. Tephrochronologic samples from this member correlate with 3.3 to 3.6 Ma tephras.

Slate Range clast-rich alluvial facies – Poorly sorted and poorly graded fine-grained sandstone and siltstone interbedded with coarse-grained arkosic sandstone and pebble conglomerate and a rock avalanche deposit. This unit grades laterally into the lacustrine facies of member 2 to the west. The clasts are metaplutonic and plutonic rocks matching with a sediment source in the Slate Range. Locally these metaplutonic and plutonic clasts are mixed with 20% volcanic clasts. The volcanic clasts match with volcanic units exposed in the Eagle Crags, to the south of Pilot Knob Valley. A rock avalanche deposit occurs within this section of breccia of mostly pink-weathering coarse granite with ~5% dark green-black metamorphic rock. This rock avalanche deposit is a layer 1 to 5 m thick. The clasts types correlate with the coarse alaskite granite that intrudes metavolcanic rocks along the southeast flank of the Slate Range. The rock avalanche deposit is significant in the presence of smeared sediments at its base suggest a rock avalanche not into the lacustrine part of the basin from a source in the Slate Range.

Eagle Crag clast-rich alluvial facies – Fine-grained sequence of gypsiferous sandstone, siltstone and mudstone. It is more easily erodible than member 1. This unit weathers similar to the lacustrine facies of member 2, but is of a slightly darker color and less hummocky. Pebbles occur locally in the sandstone beds that are identifiable as mafic and intermediate volcanic rocks belonging to the Eagle Crags uplands (Sabin, 1994; Monastero et al., 1997) to the south of Pilot Knob Valley. This unit occurs along the southern exposure of the lacustrine facies and is stratigraphically below most of the lacustrine unit of member 2, but they are locally interbedded. The contact is gradational into pure lacustrine sediments and conformable with them. To the west, this is interpreted to be a distal alluvial fan facies.

Member 1 (early Pliocene) – Fanglomerate and coarse sandstone with mixed mafic and intermediate volcanic clasts that are commonly rounded. Bedding is typically crude in the eastern exposures where the deposit contains a higher percentage of coarse sand, but the western exposures have coarser conglomerate and show better apparent bedding. Beds are up to 10 cm thick and the deposit is locally clast-supported. Clasts are up to 20 cm in diameter, but commonly 2-10 cm across. In outcrop, this unit forms low rolled hills that are mantled by weathered-out clasts. The weathered surface has a distinctive gray-blue hue from the numerous dacitic volcanic clasts. Fresh exposures along cut banks appear more dark gray colored. The sediment source is unquestionably the Eagle Crags area, south of Pilot Knob Valley, as there are no similar rock types present in the southern Slate Range. Clast lithologies are dominantly dacite porphyry (~80%) with about 15% of the clasts are of gray monzonite, possibly from Robbers Mountain (Carr and Poole, 1984, on the north flank of Eagle Crags.

Nm **METASEDIMENTARY CLAST-BEARING ROCKS (late to early Pliocene(?))** – Clastic rock sequence of beds of siltstone, fine arkosic sandstone with lenses of pebble sandstone and pebble conglomerate. This unit is similar to some of the units in the formation of Pilot Knob Valley, but with a distinctly different source area for clasts. It only occurs south of the Garlock fault in the southwestern corner of the map area. The clasts are a mix of basalt, intermediate volcanic rocks, tectonite of hornblende diorite with a lineated and foliated fabric and metasedimentary rocks including meta-limestone, argillite and quartzite. This clast assemblage matches the rocks south of Pilot Knob Valley where metasedimentary rocks are rare but are a part of the Eagle Crags uplands and the Eagle Crags volcanics (Sabin, 1994; Monastero et al., 1997). A tephrochronology sample from just west of the map area correlates with 3.14 Ma tuffs. These conglomerate beds were previously included within the Christmas Canyon Formation (Smith, 1964) and were separated out as older units by Smith (2009). This unit is deformed a similar amount to the beds in the formation of Pilot Knob Valley.

Nc **BRECCIA DEPOSIT (Pliocene or late Miocene(?))** – Massive-textured, well-cemented breccia deposit of alaskite clasts. The alaskite is very light colored and medium to fine-grained with very rare and fine-grained mafics. The clasts range from several meters across to fine gouge. The breccia occurs with a faulted basal contact over a lens of hematite mineralized, blue-colored fine breccia. The bedrock below this fault is strongly sheared and intensely fractured. The alaskite of the clasts correlates with rocks exposed in the Slate Range, alaskite bodies within the mixed complex 3 to 5 km east of the breccia exposure.

VOLCANIC AND SEDIMENTARY ROCKS

VOLCANIC-SEDIMENTARY ROCK SEQUENCE OF SOUTHERN PANAMINT VALLEY (middle Miocene) – A sequence of Miocene sedimentary and volcanic rocks occurs in the southern Panamint Valley region included in this map. This sequence is 60 to 90 meters thick in the western Quail Mountains (Andrew, 2007) and thickens northward. Correlative volcanic rocks occur farther north in the 12-14.5 Ma volcanic rocks exposed in the northern Slate Range, southeastern Panamint Range (Andrew and Walker, 2009) and Overhead Mountains (Luckow et al., 2005). The lowermost member is a 1-2 meter thick, well-indurated, fine-grained, replaced wetrewed from and very similar sedimentary-volcanic sequence rocks along the east side of the Slate Range by the Slate Range derived member (Dickerson, 2005; Andrew and Walker, 2009). The Miocene rocks at Layton Pass have anomalously steep dips and have been diametrically aligned along the exposed Slate Range detachment. The maximum apparent displacement of these Miocene rocks from the rocks in Panamint Valley is 4 km. The sedimentary-volcanic sequence rocks farther south in the southeastern Slate Range and Quail Mountains are similar and different from the Layton Pass sequence with more volcanic debris flows, a major dacite lava dome and no lacustrine or arkosic beds.

Nvu **Undifferentiated sedimentary-volcanic sequence (middle Miocene)** – Undifferentiated Miocene sedimentary and volcanic rocks in the Quail Mountains. This unit is 60 to 90 meters thick in the Quail Mountains.

Nva **Andesite lava flows (middle Miocene)** – Andesite and basaltic andesite flows and flow breccias, and volcanic debris flows/lahar deposits. Lower portions tend to be andesite lava flows and intermediate composition lava in a fine volcanic debris or tuffaceous matrix. At least one exposure of volcanic debris flow also contained exotic clasts of meta-sandstone, metavolcanic rocks, medium-grained monzogranite, hornblende diorite and vitrophyre. Lava flows of basaltic andesite are dark purple-gray to greenish-gray and often contain coarse (up to 5 mm long) phenocrysts of plagioclase and hornblende. The westernmost exposures of these lavas at Layton Pass, in the hanging wall of the Slate Range detachment, has celadonite alteration and bright green amygdules. The andesitic lava flows have reddish-purple color and may contain fine to coarse phenocrysts of hornblende, biotite and/or plagioclase. The andesite lava often has weak flow banding. These lavas are often poorly exposed. Correlative lava flows are exposed in the northern Slate Range and Slate Range Fans At a plateau ages of 14.62 and 14.81 Ma (Andrew and Walker, unpublished data). Very coarse-grained lithic tuffs in the western Quail Mountains with clasts of porphyritic-flow-banded dacite up 3 meters across are mapped with these andesitic lava flow units.

Nvd **Dacitic lava (middle Miocene)** – A large exposure of very flow-banded and flow-foliation-contorted dacitic lava in the western Quail Mountains. Fine-grained phenocrysts of biotite or hornblende are commonly present. This rock weathers to bluish-gray to light purple. Strong fracturing and brecciation occurs in the upper levels. This unit is interpreted to be a dacite lava dome. The lava dome is overlain by light gray-blue colored volcanic debris flows with a tuffaceous matrix and in turn overlain by andesitic lava flows.

Nvt **Tuffaceous sedimentary rocks** – Light-colored (white to yellow) felsic tuffs and tuffaceous sediments that occur below the intermediate composition lava flows. Much of this deposit is felsic ash tuff, but layers of pumice lapilli tuff and lithic lapilli tuff do occur locally. Some of the tuffs contain opaline silica mineralization. The thickness of this unit varies with a maximum thickness of ~50 meters.

Lacustrine deposits (middle Miocene) – Light-gray, massive textured lacustrine limestone beds generally 10-20 cm thick. These are interbedded with arkosic sandstone, with the limestone beds more abundant up section. The arkosic sandstone and pyroclastic units at Layton Pass grade eastward into the dominantly lacustrine facies. The interbedded units with the limestone typically show lacustrine affects, such as silicification of felsic tuffaceous beds and carbonate-cemented arkosic sandstone beds.

Nvk **Arkosic sandstone (middle Miocene)** – Gray to white colored, medium-grained arkosic sandstone. Bedding is indistinct due to lack of contrasting grain size between layers. Many of the arkose beds have a light green color due to alteration of the clay matrix. Commonly the sandstone beds contain pebbles and cobbles of plutonic rocks. This clastic material is derived from intermediate to felsic plutonic and is stratigraphically below most of the lacustrine unit of member 2, but they are locally interbedded. The contact is gradational into pure lacustrine sediments and conformable with them. To the west, this is interpreted to be a distal alluvial fan facies.

Np1 **Member 1 (early Pliocene)** – Fanglomerate and coarse sandstone with mixed mafic and intermediate volcanic clasts that are commonly rounded. Bedding is typically crude in the eastern exposures where the deposit contains a higher percentage of coarse sand, but the western exposures have coarser conglomerate and show better apparent bedding. Beds are up to 10 cm thick and the deposit is locally clast-supported. Clasts are up to 20 cm in diameter, but commonly 2-10 cm across. In outcrop, this unit forms low rolled hills that are mantled by weathered-out clasts. The weathered surface has a distinctive gray-blue hue from the numerous dacitic volcanic clasts. Fresh exposures along cut banks appear more dark gray colored. The sediment source is unquestionably the Eagle Crags area, south of Pilot Knob Valley, as there are no similar rock types present in the southern Slate Range. Clast lithologies are dominantly dacite porphyry (~80%) with about 15% of the clasts are of gray monzonite, possibly from Robbers Mountain (Carr and Poole, 1984, on the north flank of Eagle Crags.

Rfq **QUARTZITE CLAST-BEARING ROCKS (Paleozoic(?))** – Cobble to boulder conglomerate dominated by rounded and polished quartzite clasts. The clasts are generally 10 to 30 cm in diameter but can reach 50 cm across. Quartzite clasts are light gray to light brown colored and commonly have crossbedding textures. Other clasts include light gray porphyritic hypabyssal rock and rare quartz monzonite. The source of the quartzite clasts is unknown, possibly in older than 14.27 Ma basalts (Duncan, 2003). Similar and very similar quartzite clasts and boulders occur at the base of the Miocene section farther north in Panamint Valley (Andrew and Walker, 2009) and to the southwest in the Lava Mountains (Smith, 1964). The rounded and polished quartzite clasts are similar to those present in the Paleozoic portion of the Goler Formation in the El Paso Mountains (Cox, 1982), ~35km west of the map area. The Chiquone Tiss Canyon Formation in northern Death Valley also contains well-rounded quartzite cobbles and boulder clasts (Snow and Lux, 1999). The quartzite clasts in the Slate Range area may be reworked and redeposited from one or both of these earlier units and this unit could be as young as middle Miocene.

LAYTON WELLS THRUST SYN-DEFORMATION PLUTONS

Jaf **FOLIATED ALASKITE (Late Jurassic)** – Light-colored tan, pink or gray mylonitic to granitic rock. Along the Layton Well thrust zone this fine-scale foliation is sometimes difficult to view except where there are porphyroclasts of K-feldspar. This unit has a U-Pb zircon age of 161.0 ±0.8 Ma (Dunne and Walker, 2004). The protolith for this unit is the medium to coarse-grained alaskite in the footwall of the Layton Wells thrust.

Ja **ALASKITE (Late Jurassic)** – Medium to coarse-grained alaskite (leucocratic alkali feldspar granite) exposed in the immediate footwall of the Layton Well thrust. This has distinctive rounded 2 mm crystals of quartz with abundant pressure fabrique phenocrysts up to 5 mm long in a very light pink-tan crystalline matrix. Fine-grained mafic minerals are very rare. This unit grades into foliated alaskite near the Layton Well thrust. A sample from this unit has a SHRIMP U-Pb zircon age of 151.5 ±1.8 Ma (Dunne and Walker, 2004). Dunne and Walker (2004) interpret this pluton to be synkinematic to the deformation along the Layton Wells thrust.

Jf **FELSITE INTRUSION (Late Jurassic)** – Light tan to light gray, massive, silicic dikes with fine-grained phenocrysts of quartz and feldspar with or without muscovite. Foliation is present in the footwall near the Layton Wells thrust, but a weak foliation can be seen in some other exposures. The western mapped exposure of this unit is porphyritic with quartz and feldspar in a fine-grained sheared light tan silicic matrix. Chlorite occurs locally as a product of ferromagnesian phenocrysts. Strong sericitization and iron (and manganese?) mineralization occurs at many of the exposures of this rock. Hematite is the dominant iron oxide. The potassium feldspar phenocrysts are generally 7 mm long. The matrix is relatively fine-grained. Near the Layton Wells thrust this unit grades into feldspar-aquam mylonite. No dikes were observed in this unit.

Jmh **Hornblende diorite (Early-Middle Jurassic)** – Dark green medium to coarse-grained hornblende diorite. Most of these exposures appear to be intermediate composition but some are quartz monzonite.

Jma **Andesite mylonite (Early-Middle Jurassic)** – Light gray to light green mylonite with coarse-grained augen of pink potassium feldspar and gray quartz. Textures range from mylonitic to gneissic. The foliation in this rock unit is dominantly steeply west-dipping. A zone of locally overprinting ductile deformation deforms this foliation into steeply-plunging asymmetric folds with axial planar cleavage and east-side to the south sense of shear (dextral).

Jmq **Quartz monzonite and granodiorite (Early-Middle Jurassic)** – Generally light gray orthogneiss of medium to coarse-grained biotite quartz monzonite and granodiorite with smaller zones of dark greenish-black dioritic orthogneiss. Locally these have gneissic textures with white feldspar laths up to 1.2 cm long and quartz phenocrysts to 1 cm. One phase of this unit is a coarse-grained biotite quartz monzonite with phenocrysts of pink potassium feldspar along with abundant quartz, plagioclase, and biotite. The dioritic rocks are fine-grained and dark green zones occur within this unit that were probably mafic dikes prior to ductile deformation. This unit grades into mylonite near the Layton Wells thrust, where it is a gray-green, augen-mylonite to mylonitic schist. The more felsic units near the Layton Wells thrust have ultramylonite textures. A sample of mylonitic rock from this unit has a U-Pb zircon age of 184 ±1 Ma (Dunne and Walker, 2004).

Ts **METASEDIMENTARY ROCKS (Triassic)** – Dark-green-gray, medium to fine-grained feldspar-quartz-biotite-chlorite schist to gneiss inferred to be derived from siltstones. This zones of carbonate-rich schist and gneiss inferred to be derived from calcareous sedimentary rocks and thin layers of white talc schist occur locally.

HANGING WALL OF LAYTON WELLS THRUST

Jmc **MIXED-COMPLEX METAPLUTONIC SUITE (Early-Late Jurassic)** – Complexly intermingled and intensely deformed mixture of metaplutonic rocks. Scale of mixing varies, but is commonly too fine or too complex to be represented individually at the map scale. Foliation is commonly observed in these units, with most having gneissic textures, although near the Layton Wells thrust the rocks have mylonitic to ultramylonitic textures. The dominant mafic unit is dark green meta-gabbro. Most of the intermediate to mafic rocks have a greenish color due to greenschist metamorphism. The dominant felsic unit is pinkish-orange, coarse-grained potassium feldspar porphyritic monzogranite with abundant quartz and minor mafics. Orthogneisses have both lineation and foliation fabrics, with the top-to-the-northeast sense of shear of the Layton Wells thrust. A few plutonic bodies were too large or important enough to map separately and are described below. A sample of weakly deformed pluton in the immediate hanging wall of the Layton Wells thrust has a U-Pb zircon minimum age of 177 Ma (Dunne and Walker, 2004).

Jmg **Monzogranite (Late Jurassic)** – Medium-grained biotite-of-unfoliated fine to coarse-grained porphyritic quartz-alkali feldspar granite. Biotite may be present as an accessory phase. The phase of this pluton intrude very sheared rocks but do not show noticeable foliation fabrics. A sample of biotite bearing monzogranite yielded a U-Pb zircon age of 151 ±1 Ma (Dunne and Walker, 2004).

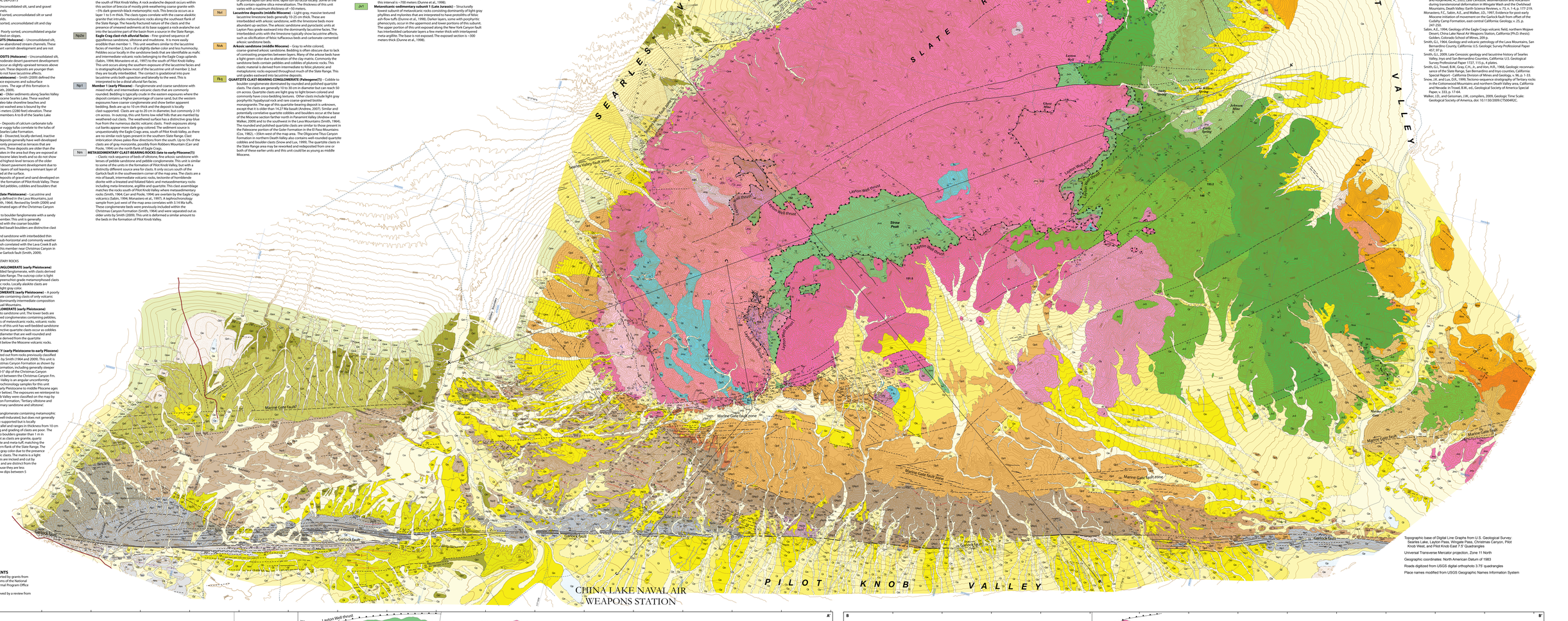
Jmz **Porphyritic monzogranite (Late Jurassic)** – Monzogranite with abundant porphyritic phenocrysts of pink potassium feldspar with smaller phenocrysts of quartz, plagioclase and biotite. The potassium feldspar phenocrysts are generally 7 mm long. The matrix is relatively fine-grained. Near the Layton Wells thrust this unit grades into feldspar-augen mylonite. No dikes were observed in this unit.

Jmh **Hornblende diorite (Early-Middle Jurassic)** – Dark green medium to coarse-grained hornblende diorite. Most of these exposures appear to be intermediate composition but some are quartz monzonite.

Jma **Andesite mylonite (Early-Middle Jurassic)** – Light gray to light green mylonite with coarse-grained augen of pink potassium feldspar and gray quartz. Textures range from mylonitic to gneissic. The foliation in this rock unit is dominantly steeply west-dipping. A zone of locally overprinting ductile deformation deforms this foliation into steeply-plunging asymmetric folds with axial planar cleavage and east-side to the south sense of shear (dextral).

Jmq **Quartz monzonite and granodiorite (Early-Middle Jurassic)** – Generally light gray orthogneiss of medium to coarse-grained biotite quartz monzonite and granodiorite with smaller zones of dark greenish-black dioritic orthogneiss. Locally these have gneissic textures with white feldspar laths up to 1.2 cm long and quartz phenocrysts to 1 cm. One phase of this unit is a coarse-grained biotite quartz monzonite with phenocrysts of pink potassium feldspar along with abundant quartz, plagioclase, and biotite. The dioritic rocks are fine-grained and dark green zones occur within this unit that were probably mafic dikes prior to ductile deformation. This unit grades into mylonite near the Layton Wells thrust, where it is a gray-green, augen-mylonite to mylonitic schist. The more felsic units near the Layton Wells thrust have ultramylonite textures. A sample of mylonitic rock from this unit has a U-Pb zircon age of 184 ±1 Ma (Dunne and Walker, 2004).

Ts **METASEDIMENTARY ROCKS (Triassic)** – Dark-green-gray, medium to fine-grained feldspar-quartz-biotite-chlorite schist to gneiss inferred to be derived from siltstones. This zones of carbonate-rich schist and gneiss inferred to be derived from calcareous sedimentary rocks and thin layers of white talc schist occur locally.



ACKNOWLEDGMENTS
This geologic mapping was supported by grants from the Tectonics and EarthScope Programs of the National Science Foundation and the Geothermal Program Office of the U.S. Navy.
This publication was greatly improved by a review from Sandra Wyld.