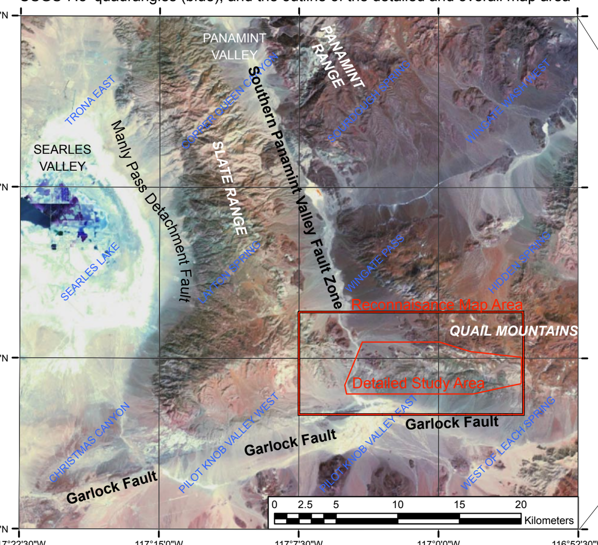
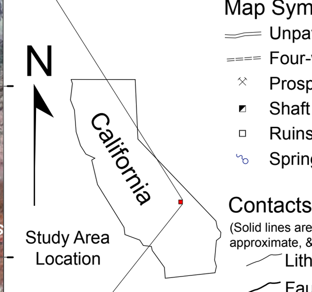
Location Map showing major topographic features, major fault zones, USGS 7.5' quadrangles (blue), and the outline of the detailed and overall map area



Western Quail Mountains Geologic Map

China Lake Naval Air Weapons Station, California

Geology by J. E. Andrew (2007)



Map Symbols

- Unpaved road
- Four-wheel drive road
- Prospect Pit
- Shaft
- Ruins
- Spring

Contacts

(Solid lines are known, dashed are approximate, & dotted are inferred)

- Lithologic Contacts
- Faults
- Detachment Faults
- Thrust faults

Structural Symbols

- 44 Bedding
- 45 Foliation
- 47 Mylonitic foliation
- 40 Fault
- 38 Shear Zone
- 63 Joint or Dike
- 65 Foldaxis
- 8 Elongation
- 26 2nd Elongation
- 27 Fault striae
- 21 2nd Fault striae
- 14.81 ☆ Geochronology Sample location and age in Ma

PROJECTION.....UTM, ZONE 11
DATUM ....NAD 1983
CONTOURS INTERVAL 40 FEET

1 0 1
kilometers

Neogene

Qa **ALLUVIUM** (Holocene)

Qp **ACTIVE PLAYA** (Holocene)

Qo **OLDER ALLUVIUM** (Holocene-Pleistocene(?))
Dissected, locally-derived, inactive alluvium (includes colluvium). These units probably represent a range of different age deposits and surfaces, but no attempt was made to differentiate them. No obvious shoreline features from Pleistocene playa lakes were observed so these deposits/surfaces may be mostly Holocene.

Qg **OLDER GRAVELS** (Pleistocene-Pliocene(?))
Dissected fanglomerates and gravel deposits younger than the Christmas Canyon Formation (Smith et al., 1968). Relative ages between this unit and older alluvium (Qo) are uncertain; deposits are labeled older gravels (Qg) based on the usage of Smith et al. (1968) because this mapping area is outside of the detailed study area on this map. This unit is strongly tilted and disrupted along the Garlock fault.

Qcc **CHRISTMAS CANYON FORMATION** (Pliocene)
Light-colored, lacustrine silts and sands (Smith et al., 1968). An ash bed in the upper part of this sequence correlates with the ~600 ka Yellowstone eruption (Smith et al., 2002). This young unit is strongly folded and disrupted along the Garlock fault.

Tg **FANGLOMERATE** (Pliocene-Miocene(?))
Fanglomerate, noted for abundance of coarse-sized (10 to 30 cm diameter), light gray to brown, well-rounded quartzite clasts.

Ts **MIDDLE SEDIMENTARY SEQUENCE** (Miocene(?))
Volcaniclastic, graywacke to pebble conglomerate. Occurs locally, thickness up to 51 meters (Muehlberger, 1954).

Tva **ANDESITIC VOLCANICS** (Miocene)
Andesite and basaltic-andesite flows, commonly with phenocrysts of augite and plagioclase. Basalt flows occur near the base of this sequence. One basal basalt has an Ar-Ar plateau age 14.27 Ma (Walker and Andrew, unpublished age data, 2003). Andesites from the southeasternmost Slate Range (within this mapping area) have Ar-Ar plateau ages of 14.62 and 14.81 Ma. This unit is 60 to 90 meters thick (Muehlberger, 1954) and possibly thickens northward toward Brown Mountain.

Tvx **BRECCIA OF ANDESITIC VOLCANICS** (Miocene)
Volcanic or tectonic origin, weathers to a bluish-gray color.

Tt **LOWER SEDIMENTARY SEQUENCE** (Miocene(?))
Light-colored (white to yellow) rhyolitic tuffs and tufaceous sandstones which occur in the lowest exposures of Tertiary volcanics. Locally there is basal, granitic-clast conglomerate (Muehlberger, 1954) or basal chert and silicic breccia possibly representing a rhyolite flow.

Mesozoic Intrusives

Jmyl **GRANITIC MYLONITE** (Late Jurassic)
Map-scale body of mylonite derived from granitic gneiss (Jgn). Lineation fabrics are very strong within this unit (see also Burks, 1987). Centimeter-scale folds of the mylonitic foliation show top-eastward asymmetry, and some folds (only on the west-side of the domal structures) have top-west asymmetry (Andrew, 2002). The mylonitic fabric is commonly cut by brittle shears probably related to deformation along splays of the Garlock fault.

Jgn **GRANITIC GNEISS** (Late Jurassic)
Light-gray, coarse-grained granite, with variable strain textures: undeformed igneous, gneiss, augen gneiss, mylonite and ultramylonite. Mylonitic fabrics commonly cut gneissic fabrics at moderate to high incidence angles. The mylonitic and gneissic foliation and the fault structurally above them are folded about north-northeast and also west-northwest trending fold axes creating dome and basin structure (Andrew, 2002). The folding about west-northwest trending axes correlates (Andrew, 2002) to Garlock fault-related defomation while the other correlates to the Jurassic East Sierran Thrust System contractile deformation observed in the region (Moore, 1976; Dunne and Walker, 2004). The fault boundary of this unit with the overlying "mixed complex" rocks (Jm) is a detachment fault, which shows top-west and downward shear. This sense of shear agrees with the second stage of deformation of the mylonite (see above, Jmyl), which may correlate with regional Late Cretceous extension (Andrew, 2002). A relatively undeformed sample of this unit yielded a U-Pb zircon age of 151+/-3 Ma (sample Q-3, Andrew (2002)).

Jg **UNDEFORMED GRANITE** (Late Jurassic)
Yellow-weathering medium grained granite with coarse potassium-feldspar. No ductile deformation fabrics were observed within this unit. This granite has a U-Pb zircon age of 153.2+-3.7 Ma (sample Q-1, Andrew (2002)).

Jpd **PORPHYRITIC DIORITE** (Late Jurassic(?))
Porphyritic dikes with coarse plagioclase phenocrysts within green-colored fine-grained matrix in a large intrusive body and smaller, unmapped dikes. The dikes trend west-northwest and may correlate with the regional ~148 Ma Independence Dike swarm (Moore and Hopson, 1961; Chen and Moore, 1979; Carl and Glazner, 2002).

Jp **PORPHYRITIC DACITIC** (Late Jurassic(?))
Intrusive of plagioclase phenocrysts in dark, pinkish-gray silicic matrix.

Jm **MIXED COMPLEX** (Middle to Late Jurassic(?))
Mixed complex of voluminous light-pink colored granite, with lesser, but abundant diorite and amphibolite dikes. A sample of porphyritic potassium-feldspar granite analyzed by U-Pb zircon method gave an age of 174.3 +/- 2.3 Ma (sample Q-2, Andrew (2002)). A granodiorite dike intruding mylonitic fabrics of the voluminous granite has a U-Pb zircon age of 162.7 +/-1 Ma (sample Q-4, Andrew (2002)).

Mesozoic meta-volcanic and meta-sedimentary

Jvgn **GNEISSIC META-VOLCANICS**
Light gray to dark purple colored gneiss and mylonite. Older fabrics are overprinted by strong brittle crushing and brecciation. The generally fine grain of relict textures supports a meta-volcanic protolith.

WESTERN SEQUENCE (Late Jurassic(?))
This succession of rocks is similar to rocks exposed in the southern portion of the Slate Range (Smith et al., 1968; Dunne et al., 1994; Walker et al., 1994) which have ages of ~152 Ma (Dunne and Walker, 2004).

Jv **UNDIFFERENTIATED META-VOLCANICS**
These units are correlative to the meta-volcanic-sedimentary sequence exposed in the western succession of the Quail Mountains. These are included on the map in the southern Slate Range but were not mapped in this study. The foliation data are from Smith et al. (1968).

Jva **MASSIVE META-ANDESITE**
Dominantly dark green but also dark purple, thick meta-andesite lava flows with fine (< 1 mm) relict plagioclase laths and local volcanic breccia. Similar rocks are found in the southern Slate Range (Smith et al., 1968; Dunne et al., 1994; Dunne and Walker, 1996; Dunne and Walker, 2004).

Jvr **META-RHYOLITE**
A thin layer of very light-gray colored siliceous matrix with minor quartz and feldspar phenocrysts, which may represent an ash-flow tuff or a rhyolite lava flow.

Jvt **META-RHYOLITIC TUFFS**
This unit occurs below a massive meta-rhyolite Light green-gray colored breccia of rhyolite or pumice clasts so it may represent a basal flow breccia of a lava flow or a basal pumice deposit as part of a large ash flow tuff.

Jvp **META-SEDIMENTARY ROCKS**
Dominantly light-gray colored phyllite and lesser fine-grained sandstone beds.

CENTRAL META-VOLCANIC & META-SEDIMENTARY SEQUENCE (Middle to Late Jurassic(?))
This succession of meta-volcanic and meta-sedimentary rocks occurs in a thrust imbricate structurally above Neoproterozoic rocks. These rock are similar to rocks exposed in the central Slate Range (Smith et al., 1968; Walker and Andrew, unpublished data, 2002). These may be Late Jurassic as are Jurassic volcanics in the southern Slate Range (Dunne and Walker, 2004) and eastern Panamint Range (Andrew, 2002) or Middle Jurassic as in the Argus and Inyo Ranges (Dunne et al., 1998).

Jvx **META-ANDESITE AGGLOMERATE AND BRECCIA**
Dominantly dark green but also dark purple thin meta-andesite. Agglomerates and flow breccias are more common than massive lavas.

Jvr **META-RHYOLITE**
This unit is locally present as a thin layer of very light-gray colored siliceous matrix with minor quartz and feldspar phenocrysts, which may represent an ash-flow tuff or a rhyolite lava flow.

Jvs **META-SEDIMENTARY ROCKS**
This weakly metamorphosed sedimentary rock succession occurs in the central portion of the study area. The lowest exposed rocks are banded purple argillite and sandstone; above this is a layer of white to light-green silicic rock; then a pebble conglomerate to fine-grained sandstone with purple-pink clasts (< 6 cm) of andesite and of a silicic plagioclase porphyritic rock; then upward into a brown dolomite; and then very fine-grained gray rock (chert, or argillite?).

NORTHEASTERN META-VOLCANIC SEQUENCE (Middle to Late Jurassic(?))
This succession of meta-volcanics was deposited uncomformably onto Neoproterozoic rocks making this the lowest stratigraphic section exposed. The outcrop pattern of repeating Jurassic meta-volcanics and Neoproterozoic rocks support hypotheses of thrusting imbrication of these rocks during contractile deformation of the Jurassic-Cretaceous(?) Eastern Sierran thrust system (see regional summary and geochronology in Dunne and Walker, 2004). This northeastern unit is the lowest structural unit, below several imbrications.

Jvi **INTERMEDIATE AND FELSIC META-VOLCANICS**
Intercalated medium-gray andesite and flow-banded rhyolite (or tuff?). This probably is a deformed and metamorphosed equivalent to the massive meta-andesite (Jva) and meta-rhyolite (Jvw). This unit was intruded by the protolith of the granitic gneiss (Jgn) and subsequently deformed with the granitic gneiss.

Jva **MASSIVE META-ANDESITE**
Dominantly dark green but also dark purple, thick meta-andesite lava flows with fine (< 1 mm) relict plagioclase laths and local volcanic breccia. Similar rocks are found in the southern Slate Range (Smith et al., 1968; Dunne et al., 1994; Walker et al., 1994; Dunne and Walker, 2004).

Jvw **META-RHYOLITIC WELDED TUFF**
A thick massive unit of very light-gray colored siliceous matrix with minor quartz and feldspar phenocrysts. A flattening strain occurs in the stratigraphically lowest exposures: fiammé or shear zone?

Neoproterozoic

KINGSTON PEAK FORMATION
Stratigraphically and texturally these units correlate with the Kingston Peak Formation in the Panamint Range (Johnson, 1957; Miller, 1983; Cichanski, 1995; Prave, 2000; Andrew, 2002). These have lower greenschist grade metamorphism.

SOUTH PARK MEMBER

Zkwd **WILDROSE DIAMICTITE SUBMEMBER**
Locally exposed very dark, brown-weathering fine matrix with abundant clasts of limestone, quartzite, granitic, and gneiss pebbles. Clasts range in size from < 1 to 10 cm. A glacial interpretation is supported by the voluminous matrix material, the isolated clasts and by dropstone textures observed rocks in the Quail Mountains (Andrew, 2002). The top of this unit is an erosional unconformity overlain by Jurassic volcanic rocks.

Zkmp **MIDDLE PARK SUBMEMBER**
A banded, medium to dark grayish-colored siltstone with several light-gray, laminated limestone beds. These limestone beds may correlate with the Thorndike Limestone Submember (Prave, 2000).

Zksd **SOURDOUGH LIMESTONE MEMBER**
Thin (>3 meters thick) light bluish-gray limestone with thin, dark-colored argillaceous laminaeof dark-gray micaceous limestone. This unit is deformed into tight isoclinal folds and it is locally duplicated by thrust imbrication.

(Zks) **SURPRISE MEMBER**
Massive, bimodal to unsorted argillite, pebbly argillite and diamictite. Clast types are dominantly quartzite and generally small (< 1 cm).

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