GEOLOGY OF GARNER VALLEY AND VICINITY

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SETTING

Garner Valley is a broad alluviated upland valley bordered by dissected alluvial fans and ringed by high ranges underlain by crystalline basement (Fig. 1). The valley floor at 1300 - 1400 m (4250 - 4600 ft) is paralleled to the north by the jagged spine of the Desert Divide of the southern San Jacinto Mountains at altitudes of 1800 - 2400 m (5900 - 7900 ft), and to the south by the gentler bulk of Thomas Mountain, at 1500 - 2076 m (4900 - 6811 ft). All three physiographic units are elongate northwest - southeast, paralleling both some of the old igneous structure and the Cenozoic San Jacinto fault system.

The valley is drained westward through the fault-controlled steep-sided canyon of the South Fork of the San Jacinto River. Hemet Dam was constructed across the upper reaches of this canyon in the 1890's to provide water for irrigation in the San Jacinto Valley; Lake Hemet has been developed into a popular recreational facility since then.

PRE-CENOZOIC ROCKS

The crystalline basement consists of metasedimentary rocks of probable Triassic or Jurassic age intruded by igneous rocks of the Cretaceous Peninsular Ranges Batholith.

Metasedimentary Rocks

Within the map area (Fig. 2) the metasedimentary rocks outcrop as small screens between, and pendants within, plutons. All of the areas mapped as metasedimentary rock contain considerable proportions (to perhaps 50% in places) of igneous material. This consists of small dikes and sills of tonalite and granodiorite, as well as aplite and pegmatite. The igneous materials all relate to the emplacement of the voluminous surrounding batholithic rocks.

The predominant metasedimentary rock-types are mica-schist and quartz - biotite gneiss; coarse-grained marble, calc-silicate material and garnet - sillimanite
Location of Carrizo Valley

Fig. 1.
GEOLOGY OF GARNER VALLEY

Legend

CAINOZOIC

Qal
Alluvium in active stream channels

Qco
Continental sediments. Conglomerates, conglomerates, sands, and muds.

CRETACEOUS

Ksj
Unit II, Intrusive Complex of San Jacinto Mountain
Sphene - hornblende - tonalite

Ksj (p)
Poikilitic - sphene facies

Kgr
K-feldspar megacrystic granodiorite

Kf
Idiomorphic - biotite sphene hornblende tonalite

Klad
Leucocratic quartz - diorite

Kgb
Gabbro and quartz - diorite

Kf
Undifferentiated intrusives

PRE-CRETACEOUS

Pkm
Metamorphic rocks.

Fig 2
Fig 2 (cont.)
gneiss are minor constituents. The metamorphic mineralogy of a particular rock is dependent on the composition of its protolith; all these rocks are now almandine - amphibolite facies metamorphics.

Brown (1968) has made a detailed study of the metamorphic rocks immediately to the southeast of the map area. Here a wide range of protoliths, including carbonates, shales, and almost pure quartz sands have been subjected to regional metamorphism. Assemblages in all rock types are compatible with the almandine - amphibolite facies of regional metamorphism (Brown, 1968). Temperatures of equilibration of 600 – 700°C and pressures of 3 – 4 kilobars (depth of 10 – 15 kilobars) are implied by these data and by electron microprobe analysis of selected samples (Hill, 1981, this volume).

Igneous Rocks

The igneous rocks of this small area cover a wide compositional spectrum, from hornblende - gabbro to true granite and alkali-rich pegmatite. By far the dominant igneous rock type, however, is sphene - hornblende tonalite. The following section describes the igneous rocks in compositional sequence, which is not necessarily their age sequence. These descriptions give some sense of the variety of the igneous materials that go to make up the batholith.

Gabbros and diorites (Kgb)

Four discrete bodies of gabbroic rock have been mapped. The largest, about 5 km (3 miles) due east of Herkey Creek campground, covers perhaps 0.3 km² (0.1 sq. mile). The other bodies are much smaller and are dike-like. Two are along tonalite - tonalite intrusive contacts. The two bodies north of Garner Valley appear intrusive into older felsic igneous rocks. All of these bodies are highly variable, both in grain-size and in mineralogy.

Coarse-grained hornblende - biotite tonalite (included in Ki)

This is a common rocktype toward the southern end of Thomas Mountain. It is invariably exposed as highly weathered boulders, is often strongly foliated and altered, and consists of hornblende and biotite aggregates to a maximum of 2 cm (possibly recrystallized from large original grains) in a matrix of quartz and feldspar of similar grain-size. It is intruded by many episodes of finer-grained more felsic igneous rocks, so that its original extent is unknown. It is not differentiated on the map.

Leuco - quartz-diorite (Klqd)

South of Lake Hemet is a small mass of an unusual igneous rock, a leucocratic quartz diorite. This rock consists of about 70% plagioclase tablets, 25–30% mafic minerals (biotite and hornblende in approximately equal proportions) and minor quartz and sphene. Dikes of similar material outcrop in the area mapped as 'undifferentiated igneous' (Ki) north of Herkey Creek campground. Given
the calcic nature of the batholith as a whole, it is perhaps not unreasonable to expect such small plagioclase-rich masses as this.

Biotite and biotite - hornblende tonalite (included in K1)

This lithology occurs in small plutons and abundant dikes and sills within the 'undifferentiated igneous' material, and is most common on the lower slopes of Thomas Mountain adjacent to the Thomas Mountain fault. It is a white-gray, medium-grained rock with biotite and minor hornblende in a quartzo-feldspathic matrix. Much of the mica appears recrystallized. Euhedral sphene is uncommon.

Sphene - hornblende tonalite of the intrusive complex of San Jacinto Mountain (Ksj1 and Ksj2)

This rock-type is described in considerably more detail in a separate article (Hill, 1981, this volume). Three distinct units have been mapped; all vary from mafic tonalite with up to 15% biotite and 7% hornblende, and less than 2% K-feldspar, to granodiorite with 5% biotite, 10% K-feldspar and only trace amounts of hornblende. Sphene is a prominent minor constituent, and it occurs as either large euhedral grains to 5 mm or as poikilitic cores in plagioclase aggregates.

The three mappable units are called, in age sequence from oldest to youngest Unit I, Unit II, and Unit III. Unit I is subdivided further into a euhedral-sphene facies (Ksj1) and a poikolitic-sphene facies (Ksj1(p)). Only Unit I (Ksj1 and Ksj1(p)) and Unit II (Ksj2) occur in the map area (Fig. 2).

The rock exposed in the road-cuts south of the Hot Springs fault near Herkey Creek campground is typical of the poikolitic-sphene facies of Unit I (Ksj1(p)). Within the mapped intrusive units, particularly within Unit I, the two facies appear gradational, with the poikolitic-sphene facies more common towards the outer margin of the body.

This complex was intruded within a short time interval at 97 m.y., in the earliest Late Cretaceous (Hill and Silver, 1979).

Idiomorphic-biotite - sphene - hornblende tonalite (Kt)

About 2 km (1.2 miles) northeast of Herkey Creek campground is a small mass of medium-grained, salt-and-pepper textured tonalite, with biotite books and euhedral hornblende and sphene in a white quartz - plagioclase matrix.

K-feldspar-megacrystic granodiorite (Kgr)

North of the above mass is a body of K-feldspar megacryst bearing granodiorite with a crescentic outcrop pattern. Dikes of this lithology are found as far north as Tahquitz Peak. Aligned flesh-pink K-feldspar megacrysts to 4 cm long are set in a matrix of quartz, plagioclase and biotite.
These three lithologies (sphene - hornblende tonalite, idiomorphic-biotite - sphene - hornblende tonalite, and K-feldspar-megacrystic granodiorite) recur along the eastern (axial) portion of the batholith over distances of many hundreds of kilometres (L.T. Silver, pers. comm.; see Hill, 1981, this volume for more discussion).

This demonstrates that dissimilar rock types could be produced anywhere within a narrow linear belt several hundreds of kilometers long parallel to the long axis of the batholith, and presumably also parallel to the Cretaceous trench. Although the rocks from different areas are petrographically similar, they occur in discrete masses which need not be of the same age; accordingly, they should not be correlated with one another.

Adamellites and granites (included in Ki)

Abundant dike-like and sill-like bodies of felsic igneous rocks underlie much of the Desert Divide of the southern San Jacinto Mountains north of Garner Valley. They are also present south of the valley, particularly toward the southern end of Thomas Mountain. Iron-rich garnet in many of these rocks appears to be the result of reaction with the enclosing metasedimentary material, now present as small screens.

The spectacular bouldery outcrops on Butterfly Peak are composed of a medium-grained, often foliated garnet - biotite adamellite (the Penrod Quartz Monzonite of Brown, 1968). This is an unusual rocktype for the batholith, and is the host for the Au-containing quartz veins of the small mining district north of Kenworthy. Alteration along fractures, combined with the radiating pattern of quartz-veins centred on this small pluton (Unruh and Huff, 1981, this volume) may indicate that the gold was deposited by a small meteoric-hydrothermal system set up by the intrusion.

Pegmatites and aplites (not differentiated on the map)

These occur as small dikes, sills and pods, usually only a few cm wide but occasionally as much as a few meters across. The first gem tourmaline found in California was reportedly discovered by Henry Hamilton in a pegmatite on Thomas Mountain in 1872. Common black tourmaline (schorl), quartz (rarely rose-coloured), alkali feldspar and micas are by far the major minerals of the pegmatites; garnet is common in the aplites.

CENOZOIC AND QUATERNARY DEPOSITS

Fanglomerates correlated with the Pleistocene Bautista Beds by Sharp (1967), Brown (1968) and Dibblee (1971; 1981, this volume) are prominent features of both sides of the valley. The sediments of these fans were deposited in broad U-shaped valleys separated by more rugged ridges of basement rocks. The original form of the fan northeast of Herkey Creek campground is particularly well
preserved, and is seen beautifully from small hills south of the Pines-to-Palms highway (S.R. 74).

The sediments of these fans range from uncommon muds through silts and sands to abundant boulder conglomerates with meter-size clasts in a silt to sand matrix. Each fan has a clast population that is consistent with derivation from an area extending back into the the ranges from the current position of the head of the fan. The degree of rounding of the clasts increases markedly down-slope towards Garner Valley. Garner Valley at present is the site of extensive deposition of fine materials derived from both the crystalline rocks and from dissection of the older alluvial deposits.

QUATERNARY FAULTING

The map area (Fig. 2) is cut by faults of the San Jacinto fault system. Sharp (1967) demonstrated 23 km (14 miles) of right lateral displacement on the San Jacinto fault and 0.8 km (0.5 mile) with a similar sense of movement on the Thomas Mountain fault. He recognised that the Hot Springs fault of Fraser (1931) was part of the same system, but was unable to determine an estimate of the displacement on this structure. Sharp (1967; p. 726) concluded "the total horizontal displacement across the northern part of the fault zone is about 14 1/2 miles, assuming that possible lateral movement on the Hot Springs fault is not significantly greater than that observed on the Thomas Mountain fault."

Mapping for this project has shown that the region from the San Jacinto fault north to Mountain Center is cut by numerous small faults; only those with substantial mapped displacement or extensive zones of shearing are shown on the accompanying map.

The most important of these is the Hot Springs fault, originally mapped by Fraser (1931), and discussed in detail by Sharp (1967) and Dibblee (1981, this volume). These authors point out that the subdued physiographic features along this structure are suggestive of a fault that has not been active for some time. Where the fault-plane is exposed in a road cutting near Herkey Creek campground it dips at about 60° to the southwest; here tonalite is thrust over fanglomerates. Elsewhere the dip of this structure is to the northeast, and the sense of the vertical component of displacement is opposite to that found at its southern end (Sharp, 1967; Dibblee, 1981). East of Garner Valley contrasting basement rocks are juxtaposed along the extrapolation of the fault trace. The fault trace itself has not yet been found, however. Brown (1968) has mapped a fault with a small amount of demonstrable right-lateral offset that is on trend with the Hot Springs Fault and is some 10 km (6 miles) southeast of the easternmost exposure of this structure near Herkey Creek campground.

A south-dipping fault plane exposed in the spillway of Lake Hemet was mapped by Sharp (1967). The canyon of the South Fork of the San Jacinto River has been cut in the extensive crush zone of this structure, which I have traced east for several kilometers. The fault trace then curves towards the southwest, and where it is crossed by the Rouse Hill road it juxtaposes old alluvium and tonalite.
Similar relations (old alluvium in fault contact with tonalite) can be seen in the bed of the river east of Lake Hemet.

South of the junction of the Thomas Mountain road and S.R. 74, near the east end of Lake Hemet, is a fault-line scarp where younger fanglomerate onlaps onto a steep slope cut in older fanglomerate. This feature is on the trend of the Thomas Mountain fault, which is thus inferred to curve to the west and merge with the fault mapped south and west of Lake Hemet. The amount of offset on the fault exposed in the canyon of the San Jacinto River (very approximately 0.5 km (0.3 miles)) is similar to that determined for the Thomas Mountain fault (0.8 km (0.5 miles)) by Sharp (1967).

The intrusive contacts of the tonalitic Unit II (Ksj2) of the intrusive complex of San Jacinto Mountain, believed to be steep to vertical, can be used to estimate offset on the more important of these faults. Total right-lateral displacement amounts to about 4 km (2.5 miles) on the Hot Springs fault, with an extra 1 km (0.6 miles) on sub-parallel faults to the north and south. This adds about 5 km to the estimate of displacement on the whole San Jacinto fault system, giving a total of 29 km of right-lateral displacement since Cretaceous time.

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REFERENCES CITED

Brown, A.R., 1968, Geology of a Portion of the Southeastern San Jacinto Mountains, Riverside County, California: University of California, Riverside, California, unpublished Master's thesis

Dibblee, T.W., Jr., 1971, Regional geologic map of San Andreas and related faults in Eastern San Gabriel Mountains, San Bernadino Mountains, Western San Jacinto Mountains and vicinity, Los Angeles, San Bernadino and Riverside Counties, California: U.S. Geological Survey Open-File Map (Available at U.S.G.S., Los Angeles and San Francisco; C.D.M.C., Sacramento)


