Stratigraphy, structure, and potassic alteration of Miocene volcanic rocks in the Sleeping Beauty area, central Mojave Desert, California

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by ALLEN F. GLAZNER

DESCRIPTIONS OF THE MAP UNITS

The Sleeping Beauty area was first studied by Durrell (1953), who mapped it as part of a study of the strontium deposits that occur along its southwestern margin. Dibblee and Bassett (1966) and Dibblee (1967) mapped the Cady Mountains and Broadwell Lake 15' quadrangles, which include the Sleeping Beauty area. Trask (1950) and Wright et al. (1953) described the geology around the ore deposits.

Formation of Sleeping Beauty ridge

The oldest unit exposed in the Sleeping Beauty area is the formation of Sleeping Beauty ridge, a heterogeneous assemblage of andesitic to dacitic flows and flow breccias, pyroclastic rocks, shallow intrusions, and volcaniclastic sediments. The formation is best exposed on the crest of the range (Sleeping Beauty Ridge) and makes up most of the high, rugged, varicolored peaks which are prominent when the area is viewed from the south. Maximum exposed thickness is nearly 3 km.

The distribution of facies within the unit defines a stratovolcano whose center was located near the southeast quarter of sec. 7, T8N R7E. The size and petrology of this volcano suggest that it was similar to present-day stratovolcanoes in the Cascade Range. Dikes, intrusive pods of featureless purple andesite, and intense hydrothermal (generally potassic) alteration are abundant near the inferred center of the volcano. Away from the center, flows are more common and the pyroclastic rocks change from bright
green, highly altered breccias to fresh air-fall and ash-flow tuffs. These lateral changes are best seen to the northeast of the center.

Lithology. The formation of Sleeping Beauty ridge is extremely heterogeneous and is often highly altered. Massive dark purple to red lava flows, dikes, sills, and podlike intrusions make up about half of the unit. In altered samples, plagioclase is the only recognizable primary mineral, but in relatively fresh samples, which are rare, augite and hornblende make up as much as 5% of the phenocryst assemblage. Stubby plagioclase phenocrysts up to 5 mm in length comprise 30-40% of most samples. The groundmass consists of plagioclase microlites, opaque granules, and hematite dust. Calcite pseudomorphs after mafic phenocrysts are common.

Ash-flow tuff, tuff breccia, and air-fall and ash-flow tuff make up most of the remainder of the unit. Ash-flow tuff consists of altered, clay-rich, angular green lapilli or blocks of andesite in a fine-grained greenish-purple matrix which was derived by comminution of andesite. Andesite fragments range up to several tens of cm across. Locally the color order is reversed and purplish andesite lapilli reside in a light green ashy matrix.

Air-fall and ash-flow tuffs interbedded with andesite flows are common away from the central facies of the Sleeping Beauty volcano. These tuffs consist of plagioclase phenocrysts (30%) in a matrix of fresh to devitrified glass and pumic lapilli. Crystals of hypersthene and augite up to 3 mm across make up a few percent of the tuffs.

Thin epiclastic beds, ranging in grain size from fine sandstone to coarse conglomerate, are common but volumetrically minor in the formation of Sleeping Beauty ridge. They usually occur as thin (about 1 m) bright-green sandstone beds interlayered with the distal facies of the volcano.

Formation of Argos Station

The formation of Argos Station comprises basalt to andesite flows and basalt scoria tuffs, silicic tuffs, and clastic sedimentary rocks. Resistance to weathering decreases with increasing silica content such that basalts are cliff formers and basaltic andesites are slope formers. Similar sequences of mafic
flows and silicic tuffs in the nearby Bullion, Bristol, Newberry, and central and northern Cady Mountains may be equivalent to this sequence.

The unit lies unconformably on the formation of Sleeping Beauty ridge. Silicic tuffs are common in the eastern half of the area, but they thin rapidly to the west and are absent in the western half. Total thickness of the formation of Argos Station decreases from about 500 m in the east to zero in the west. Vents for the mafic flows are common in the mapped area, but no source areas for the silicic tuffs were found. They may have been erupted from vent areas to the east in the northern Bristol Mountains (D. M. Miller, oral communication, 1983).

The base of the formation of Argos Station locally is defined as the lowest of the mafic flows, which are easily distinguishable from the underlying formation of Sleeping Beauty ridge because they are generally black to dark gray or greenish-gray, sparsely porphyritic, and scoriaceous. Silicic tuffs of the formation of Argos Station resemble biotite-hornblende tuffs of the formation of Sleeping Beauty ridge.

A representative section of the formation of Argos Station is the northern slope of hill 3012, sec. 16, T8N R7E. In this area both the upper and lower contacts of the unit are exposed with only minor fault complications. Other representative sections, which do not include exposures of both contacts, are: (1) the eastern slopes of hill 3012, in the northwest 1/4 of sec. 22, T8N R7E; and (2) the northeast slope of hill 2547, sec. 28, T8N R7E. These sections illustrate the extreme lateral variability of the unit, and were chosen to avoid areas that have suffered extreme potassic metasomatism.

Lithology. Flows of nonporphyritic olivine basalt and quartz-bearing basaltic andesite comprise the majority of the formation of Argos Station. These flows are generally black, gray, or greenish-gray, and are locally scoriaceous with vesicle fillings of calcite, zeolites, and glauconite. Deuteric alteration is pervasive and most olivine has been replaced by iddingsite.

Olivine basalt consists of rare plagioclase (3 mm) and iddingsite (1 mm) phenocrysts in a holocristalline intergranular matrix of plagioclase and titanaugite. Basaltic andesite is light to dark gray with rare plagioclase phenocrysts (1 mm) and ubiquitous resorbed quartz xenocrysts with augite coronas
in a matrix of plagioclase laths and pale brown augite. Quartz xenocrysts are common in andesites of the Mojave Desert, and indicate assimilation or magma mixing (Glazner, 1985 and in press).

Lenticular beds of basalt scoria are a common feature of the formation of Argos Station, and a small cinder cone is exposed in cross section on the northern part of hill 2985, sec. 16, T8N R7E. Fusiform bombs in these deposits reach 2 m in length. Basalt feeder dikes are present in several places.

Silicic (generally rhyodacite) ash-flow and air-fall tuffs, ranging from white to buff to pale green in color, occur interbedded with thin basalt flows in the eastern part of the area. The tuffs are never strongly welded, and pumice fragments are generally uncollapsed. The tuffs are rich in lapilli, including accessory fragments of older tuffs and accidental fragments of basalt. Locally the tuffs are fine grained and exhibit excellent, continuous bedding which suggests deposition in water. Sanidine is conspicuously absent from the phenocryst assemblage.

Sedimentary layers within the formation of Argos Station are composed of detritus from underlying volcanic units and the granitic basement. Conglomerates are light green to dark brown and are calcite cemented. The most continuous of these deposits is a boulder conglomerate, 0-10 m thick, that is generally present immediately beneath the overlying dacite of Cady Mountains. Lenses of arkose, ranging from brick-red to salmon, are common between basalt flows. They are rarely thicker than 5 m and rarely persist along strike for more than 100 m. Bedding is prominent and persistent.

Dacite of Cady Mountains

The dacite of Cady Mountains is a homogeneous unit composed of several thin flows of platy low-silica, high-potassium dacite which cover the southeastern part of the mapped area. Like the formation of Sleeping Beauty ridge, the dacite of Cady Mountains straddles the chemical boundary between andesite and dacite. The unit was locally strongly affected by potassic metasomatism, and many of its field characteristics are determined by whether or not the outcrop is metasomatized. For example, fresh dacite is not resistant and forms rounded, flaggy, gray hills, whereas metasomatized dacite is highly resistant and forms craggy red outcrops. The dacite rests unconformably upon the formation of Argos Station,
and usually sits on a boulder conglomerate of basaltic detritus.

Lithology. The dacite is uniform in mineralogy and chemistry but varies greatly in field appearance. The freshest dacite is medium gray, nearly aphanitic, and well-laminated. A few flows are locally vitrophyric with a matrix of black devitrified glass which weathers to chalky pink. Sparse, small crystals of plagioclase and rare hypersthene (both <1 mm) comprise the only phenocrysts. Pale shreds of phlogopite are common in the groundmass.

Peach Springs Tuff

A welded rhyolite tuff which is correlated with the 18-19 Ma old Peach Springs Tuff of Young and Brennan (1974; see Glazner et al., 1986) crops out discontinuously above the dacite of Cady Mountains. Locally, a thin boulder conglomerate of volcanic detritus separates the two. This tuff was first described by Durrell (1953), and recent work in the Mojave Desert and Colorado River trough indicates that it is a western facies of the Peach Springs Tuff. Best exposures of the tuff in the Sleeping Beauty area are found in the westward-opening gulch located in the northeast quarter of sec. 14, T8N R6E.

The tuff is usually strongly welded in outcrop, although poorly welded and unwelded facies are locally present. The groundmass of the tuff is highly variable in color, ranging from tan to red to grayish blue. Locally, a black vitrophyre about 1 m thick is present. The vitrophyre is underlain by punky, poorly welded facies of the tuff. Petrographic descriptions of the tuff are given by Durrell (1953), Young and Brennan (1974), Buesch and Valentine (1986), and Glazner et al. (1986).

Hector Formation

After the Peach Springs Tuff blanketed the area, alluvial and lacustrine deposition began. These sediments are correlated with the Hector Formation of Woodburne et al. (1974), and are mainly exposed in strike ridges along the southern and western margins of the area. The sediments exhibit a facies change from limestone in the southeast to siltstone in the southwest to volcanic conglomerate in the west. About 200 m of sediments are exposed near the celestite mines in section 30, T8N R7E, but the top of the
section is not exposed. No diagnostic fossils have been found.

At the type locality of the Hector Formation, in the western Cady Mountains, Woodburne et al. (1974) obtained a K-Ar age of 21.6 Ma (recalculated to new decay constants; Dalrymple, 1979) on a tuff bed intercalated with the sediments. In the northern Cady Mountains, Miller (1980) obtained K-Ar ages ranging from 22.9 Ma to 17.9 Ma on tuff layers within the Hector Formation.

*Lithology.* The limestone facies consists of well-laminated light-gray limestone with abundant silty layers. The silts varnish to a very dark brown and are locally so abundant that the rock takes on the appearance of a basalt. Oncolites, oolites, and algal mats are common. Algal features are common in saline lakes such as the Great Salt Lake (Eardley, 1938) and indicate a shallow-water, near-shore environment.

The siltstone facies contains abundant layers of celestite interbedded with white, buff, or light-green siltstone, claystone, limestone, and tuff. Individual beds range from a few mm to several tens of cm thick. Silicification is common and has locally produced beds of bright green, red, orange, or yellow-brown chalcedony. Durrell (1953) described these sediments in detail.

The conglomerate facies of the Hector Formation comprises well-cemented volcanic boulder conglomerates and gravels which lie unconformably on the older volcanic units in the northwestern part of the area. Clasts of plutonic basement comprise less than 1% of the unit.
REFERENCES CITED


