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Geologic map of the San Emigdio Mountains, southern California

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ABSTRACT

New and existing geologic mapping and geochronology of the San Emigdio Mountains are compiled in a 1:40,000 scale map, establishing the framework for recently published and ongoing studies of Cretaceous assemblages belonging to the Sierra Nevada batholith and the Late Cretaceous San Emigdio Schist. Basement exposures of the San Emigdio Mountains are subdivided into four principal fault-bounded assemblages: (1) mid- to Late- Cretaceous shallow-level granitoids and Paleozoic to Mesozoic metamorphic pendant rocks of the Pastoria plate; (2) Early- to mid-Cretaceous deep-level intrusives of the Tehachapi–San Emigdio complex; (3) mid- to Late-Jurassic gabbro, tonalite, ultramafic rocks, and framework basalts of the Western San Emigdio mafic complex; and (4) the Late Cretaceous San Emigdio Schist. The field relations summarized here, when viewed in a regional context, constrain the lateral extent of major Laramide detachment systems (the Pastoria and Rand faults) that were active during Late Cretaceous extensional collapse of the southern Sierra Nevada batholith and adjacent Mojave Desert area and document a highly dismembered and deeply exhumed ancient flat slab system.

INTRODUCTION

The San Emigdio and related Pelona, Orocopia, Rand, and Sierra de Salinas schists of southern California were underplated beneath the southern Sierra Nevada batholith along a shallow segment of the subducting Farallon plate in Late Cretaceous to early Tertiary time (e.g., Saleeby, 2003; Chapman et al., 2010, 2011, in press; Jacobson et al., 2011). Basement exposures in the San Emigdio Mountains represent a regional, deeply exhumed, shallowly dipping domain from this ancient slab segmentation system and record the complete life cycle of the segmentation process from initial flattening and compression to final extensional collapse. For this study, we remapped (1:40,000 scale) the basement rocks in the San Emigdio Mountains, focusing on the structural relations between the San Emigdio Schist and adjacent Cretaceous plutonic and associated framework metamorphic rocks. In addition to the geologic map, three cross sections, modified after Davis (1983), showing basement relations based on our new mapping are provided.

FIELD SETTING

In terms of physiography, the San Emigdio Mountains are part of the Transverse Ranges and include units south of the San Andreas fault. However, the San Emigdio Mountains are distinct from the Transverse Ranges in terms of geology and are better categorized as part of the Sierra Nevada and, in conjunction with the Tehachapi Range to the east, define the "Sierran tail." By this

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definition, the San Emigdio Mountains extend from Grapevine Canyon (Interstate 5) in the east to highway 33 and 166 on the west and are bounded by the San Andreas fault to the south and the Pleito thrust to the north, residing within Kern, Los Angeles, and Ventura counties of southern California. The elevation of the San Emigdio Mountains ranges from 7492 (San Emigdio Mountain) to ~1600 ft (2284 to ~500 m), with ridge to valley relief ranging from ~1000 to 3000 ft (~300 to 900 m). The San Emigdio Mountains lie at the intersection of five geologic provinces: the Sierra Nevada, the Mojave Desert, the Transverse Ranges, the Coast Ranges, and the Great Valley. As a result, the climatecontains elements of each province, including Mediterranean, xeric, and subalpine zones. Cool, moisture-retaining north-facing slopes are mixed evergreen forest and grasslands, while warmer and drier south-facing slopes are chaparral and woodlands. The combination of high topographic relief and locally thick vegetation render fieldwork in the San Emigdio Mountains difficult, although many areas within the range are accessible year round.

PREVIOUS FIELD AND ANALYTICAL WORK

Reconnaissance geologic mapping focusing on Eocene to Quaternary sedimentary and volcanic deposits by Dibblee (1973) and Dibblee and Nilsen (1973) and crystalline basement rocks by Ross (1989) represent the bulk of previous work at the regional scale of this investigation. Geologic mapping of sedimentary, volcanic, and crystalline basement rocks adjacent to the San Andreas fault zone has been done by Crowell (1952), Duebendorfer (1979), Davis (1983), Davis and Duebendorfer (1987), Kellogg and Miggins (2002), and Kellogg (2003).

A suite of presumably cogenetic mid- to Late-Jurassic layered to isotropic gabbroids, ultramafic rock, and tonalitic assemblages have received detailed study by Reitz (1986) and James (1986) (the "Northern San Emigdio plutonic complex"), Ross (1989) (the "Eagle Rest Peak" area), and Chapman et al. (2010; in press; this study) (the "Western San Emigdio mafic complex"). Basaltic sheeted dikes and pillows, contact metamorphosed to hornblende-hornfels facies by plutonic rocks of the Western San Emigdio mafic complex, constitute the intruded framework of the mafic complex, and are referred to by Hammond (1958) as the "Schoolhouse Canyon metamorphic complex." A tentative correlation has been drawn between this unit and Paleozoic assemblages of the Kings-Kaweah ophiolite on the basis of whole rock geochemistry and Sr and Nd isotopes (Saleeby, 2011; Chapman et al., in press).

A semi-continuous belt of schist constitutes the base of the tectonic section in the San Emigdio and Tehachapi Mountains and is referred to as Pelona Schist by Sharry (1981); Rand Schist by Ross (1989), Grove et al. (2003), Saleeby et al. (2007), and Chapman et al. (2010); and San Emigdio Schist by Jacobson et al. (2011) and Chapman et al. (2011). Geologic mapping of the San Emigdio Schist and adjacent assemblages of the Sierra Nevada batholith has been done in reconnaissance mode by Ross (1989) and at 1:10,000 scale (compiled here at 1:40,000 scale) by Chapman et al. (2010, 2011). Continuation of units east of Grapevine Canyon is based on work by Saleeby et al. (1987, 2007) and Pickett and Saleeby (1993, 1994). U/Pb zircon igneous emplacement ages (Saleeby et al., 1987, 2007; Pickett and Saleeby, 1994; Chapman et al., in press) are also shown on the map.

GEOLOGIC SETTING AND SUMMARY OF KEY BASEMENT FIELD RELATIONS

Uplift of basement and sedimentary cover strata in the San Emigdio Mountains is controlled by Pliocene-Quaternary north-south compression between the big bend in the San Andreas fault and the Pleito fault zone (Davis, 1983; Dibblee, 1986). Mesozoic to Paleozoic plutonic and associated framework metamorphic rocks comprise the bulk of the basement complex in the San Emigdio Mountains (Ross, 1989). These rocks are overlain by a thick (locally >7000 m) Cenozoic sequence of largely marine sedimentary and volcanic rocks. A detailed synthesis of sedimentary and volcanic basement cover rocks is provided by Dibblee (1986) and is beyond the scope of this effort. However, in the course of our mapping of basement rocks in the San Emigdio Mountains, we have recognized that Late Pleistocene to Holocene gravels in San Emigdio Canyon (e.g., Keller et al., 2000) contain detritus derived exclusively from the Abel Mountain–Frazier Mountain–Mount Pinos area south of the San Andreas fault. This suggests that uplift and exposure of basement rocks north of the San Andreas fault occurred after Late Pleistocene time and that San Emigdio Canyon is an antecedent drainage of the Abel Mountain–Frazier Mountain–Mount Pinos area.

Basement exposures of the San Emigdio Mountains are subdivided into four principal assemblages. First is a collection of shallow-level (3–4 kbar) eastern Sierra Nevada batholith affinity granitoids and metamorphic pendant rocks referred to as the Pastoria plate (Crowell, 1952; Ross, 1989). The Pastoria fault, a member of the Late Cretaceous–Paleocene southern Sierra detachment system (Wood and Saleeby, 1997; Chapman et al., in press), folded and cut in Pliocene-Quaternary time by south-dipping thrust faults, lies at the base of the Pastoria plate. Early- to mid-Cretaceous deep-level (7–9 kbar) Sierra Nevada batholith rocks of the Tehachapi–San Emigdio complex (Pickett and Saleeby, 1993; Chapman et al., 2011, in press) lie in the footwall of the Pastoria fault. Contact relations between these units and a third basement assemblage, the Western San Emigdio mafic complex, are obscured by Tertiary sediments. The Tehachapi–San Emigdio complex sits tectonically above the San Emigdio Schist along the Rand fault, a locally ductile to brittle low-angle detachment fault system (Ross, 1989; Chapman et al., 2010, 2011). During Pliocene–Quaternary compression, the Rand fault in the San Emigdio Mountains was largely folded with a major south-dipping thrust fault cutting across the folded structural section with the San Emigdio Schist in the hanging wall and the Tehachapi–San Emigdio complex in the footwall. The reader is referred to Chapman et al. (2010, 2011, in press) for additional details regarding these relations and their tectonic significance. In short, our field studies, when viewed in the context of schist windows in the Tehachapi and Rand Mountains, constrain the lateral extent of a major Laramide detachment system that was active during a phase of extensional collapse above the underplated schists and document a highly dismembered and deeply exhumed ancient flat slab system.

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