

Application for a 2007 GSA Research Grant

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Master's in Geological Sciences
Structural history of western North America

Project Title: Using zircon U/Pb ages and geochemistry to understand the magmatic and tectonic transition to Laramide low angle subduction in the easternmost Peninsular Ranges batholith, southern California and northern Baja California

Project Supervisor: Kimbrough

Academic Info (Department Address): SDSU – Dept. of Geological Sciences

Clearly state the problem(s) to be addressed, the hypothesis or hypotheses to be tested, and the overall objectives of your proposed project. (1,000 character limit):

Recent work in the eastern Peninsular Ranges batholith (PRB) of northern Baja California has identified a previously unrecognized suite of Laramide-age granitic intrusives. This suite is sparsely exposed for at least 200 km along strike and comprises >300 km² in surface outcrop exposure. It intruded into La Posta-type plutonic rocks that comprise the main phase of the eastern Peninsular Ranges batholith. This suite records the tectonics and magmatism associated with a poorly understood transition in Cordilleran geology. The eastern Peninsular Ranges batholith has been described as a “migrating” arc representing the initial stage of inboard migration of Laramide Cordilleran magmatism. The new data now suggest that following the voluminous La Posta magmatic flare-up at 100-90 Ma, magmatism stalled but continued intermittently until ~70 mybp in the eastern PRB before inboard migration was initiated. Characterizing the age, chemistry, and structure of the newly recognized eastern PRB “Laramide” phase of magmatic activity is mandatory to better understand the crustal structure and tectonics of the region and is the focus of my study.

Discuss the previous work on your problem(s) that (1) places the project in a disciplinary and, if appropriate, regional context and (2) documents the importance of your project. (2,500 character limit):

Latest Cretaceous (ie., 85-70 Ma) plutons have been undocumented from the Peninsular Ranges batholith (PRB) before now and could dramatically improve our knowledge and understanding of the geologic history of southwestern North America. Work by Gastil et al. (1975), Silver & Chappell (1988), Walawender et al. (1990), Kimbrough et al. (2001) Grove et al., (2003) as well as many others have greatly expanded our knowledge of the PRB in

Southern and Baja California. Saleeby (2003) relates the Laramide orogeny and low-angle subduction to subduction of an aseismic ridge. In his model, the low-angle section of the slab occurred in the region between the Sierra Nevadas and the Peninsular Ranges representing a ~500 km long 'breached' segment in the arc. Magmatism supposedly ceased in the Peninsular Ranges and Sierra Nevada batholith at this time due to underthrusting and rapid cooling beneath the batholiths. Thrust assemblages of the amphibolite facies Rand-Orocopia-Pelona schists derived from the Franciscan subduction complex were emplaced beneath southern California at this time.

The "young" Laramide-aged PRB magmatism described here is close to the paleo-subduction zone may support the model of Saleeby (2003), which required only the ~500-km long section of the slab between the Sierras and the Peninsular Ranges to be shallow. The Laramide-aged plutons may be a continuation of the eastern PRB migrating arc.

The REE data presented by Gromet and Silver (1987) shows that the 100-90 Ma La Posta suite was derived from deep crustal sources, potentially from a crustal 'root' below the arc. Comparing the chemistry and petrology of the La Posta suite to the newly discovered Laramide suite is an important of this study. The western most transitional Laramide granitics may have some deep La Posta flavor or may be more closely related to the shallower formed and emplaced eastern Laramide units (McDowell et al., 2001; Valencia-Moreno et al., 2003). The presence or absence of a mantle signature may also help reveal the extent of a shallow slab as argued by Bird (1988) and Livaccari and Perry (1993). The answers to these questions will provide a key missing link between the widely known, but poorly understood initiation of Laramide low-angle subduction.

Concisely state how you plan to address your problem(s) and test your hypothesis or hypotheses (2,500 character limit):

Only a multidisciplinary field and laboratory investigation can fully constrain the petrology and tectonic history of the Laramide-age plutonic suite. Numerous samples must be collected and analyzed to identify any trends or similarities within the new transitional suite as well as between the new suite and the known La Posta and Laramide suites in Sonora and the Mojave Desert.

Extensive ~85-70 Ma plutonic bodies have already been identified from the Sierra Cucapahs and Sierra San Felipe in Baja California. Field mapping will determine the structure and extent of these bodies and contact relations with surrounding units. This will be expedited by the use of aerial photography including ASTER satellite imagery. Samples will be collected for petrologic investigation and zircon U-Pb dating.

Whole rock major and trace element analyses will be done at San Diego State University (SDSU) using the Philips Magix Pro XRF. To date, 30 samples have been collected in the Sierra Cucapas and the Sierra San Felipe. 13 have already been prepared for analysis. Thin sections will also be made for the petrographic microscope to characterize the mineralogy and texture of the Laramide-age units. Based on initial field and hand sample observations, the

Laramide-age plutons are generally fine-grained even-textured leucocratic biotite granodiorites and granites (?) that contain minor garnet and muscovite. These characteristics allow them to be clearly distinguished from typical rocks of the La Posta suite which are often hornblende-bearing and contain accessory allanite and titanite.

In SDSU laboratories, zircons from selected samples will be separated and prepared for laser ablation ICPMS analysis at the University of Arizona LA-ICP-MS LaserChron facility operated by George Gehrels. Zircon U-Pb ages will provide accurate crystallization ages of individual plutons. Six samples from previously undifferentiated bodies have been dated thus far at the University of Arizona, 2 giving La Posta ages (~96 Ma for both), 2 giving younger ages (76 and 84 Ma), and 2 weakly gneissic samples giving numerous ages, perhaps due to inheritance.

REE analysis will be run to better understand the depth of formation of the batholithic melts. This data can help to decipher whether the lithospheric mantle remained intact here, or if it was sheared off by the shallow slab. The extent of the shallow slab may be further refined with this information.

Duration of investigation (dates): late March - early April 2007

Budget: LIST IN ORDER OF PRIORITY AND JUSTIFY IN DETAIL, for example, funding of chemical and isotopic analysis, equipment, technicians and expendable laboratory supplies is necessary for consideration. Grants are made for one year only.

Category	Total amount budgeted	Amount Requested from GSA
1. Travel expenses	Mileage \$0.445x2000	\$800
2. Mexican insurance	15x 20days	\$890
3. food/incidentals	25x20days	\$500
4 Thin sections	40x\$10	\$400

***References cited in proposal (2,500 character limit):**

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- Grove, M., Jacobson, Carl E., Barth, Andrew P., Vucic, Ana, 2003a, Temporal and spatial trends of Late Cretaceous-early Tertiary underplating of Pelona and related schist beneath southern California and southwestern Arizona, GSA Special Paper 374, p. 1-26.
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