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Testing models for the formation of the Great Valley Basin using detrital zircon U/Pb dates: An Early Cretaceous forearc basin or a mid-Jurassic pull-apart basin?

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This ACS-PRF grant supports a field- and laboratory-based project focused on identifying the protoliths of metavolcanosedimentary pendents in the western Sierra Nevada batholith, and reconstructing their post-depositional tectonic histories. Specific goals of the study are to use detrital zircon “bar codes” to locate boundaries between metavolcanosedimentary pendents having unrelated protoliths, and to work towards reconstruction of Mesozoic depositional environments. The overarching goal of the study is to assess whether any of these hypothesized terrane boundaries may represent structures that participated in the formation of the Late Jurassic (?) to Cretaceous forearc basin, in which California’s oil-rich Great Valley Group was deposited.

During the first year, my students and I worked hard to move the field and lab-components of this grant forward. These enhanced efforts anticipated slower progression this second year, as I was asked to complete a fourth year as Department Chair. This year I took no new students, instead using my limited teaching time to focus on helping my existing students move forward and finish. With the help of an undergraduate lab assistant, students spent the fall and early spring in the mineral separation labs concentrating zircon. In April 2018, five students accompanied me to Tucson, AZ where we collected U-Pb data around the clock at the Arizona Laserchron Center. So far, one student (Magumcia) has completed his research thesis and graduated, while two more (Aviles, Concha) are on-track to finish by December 2018.

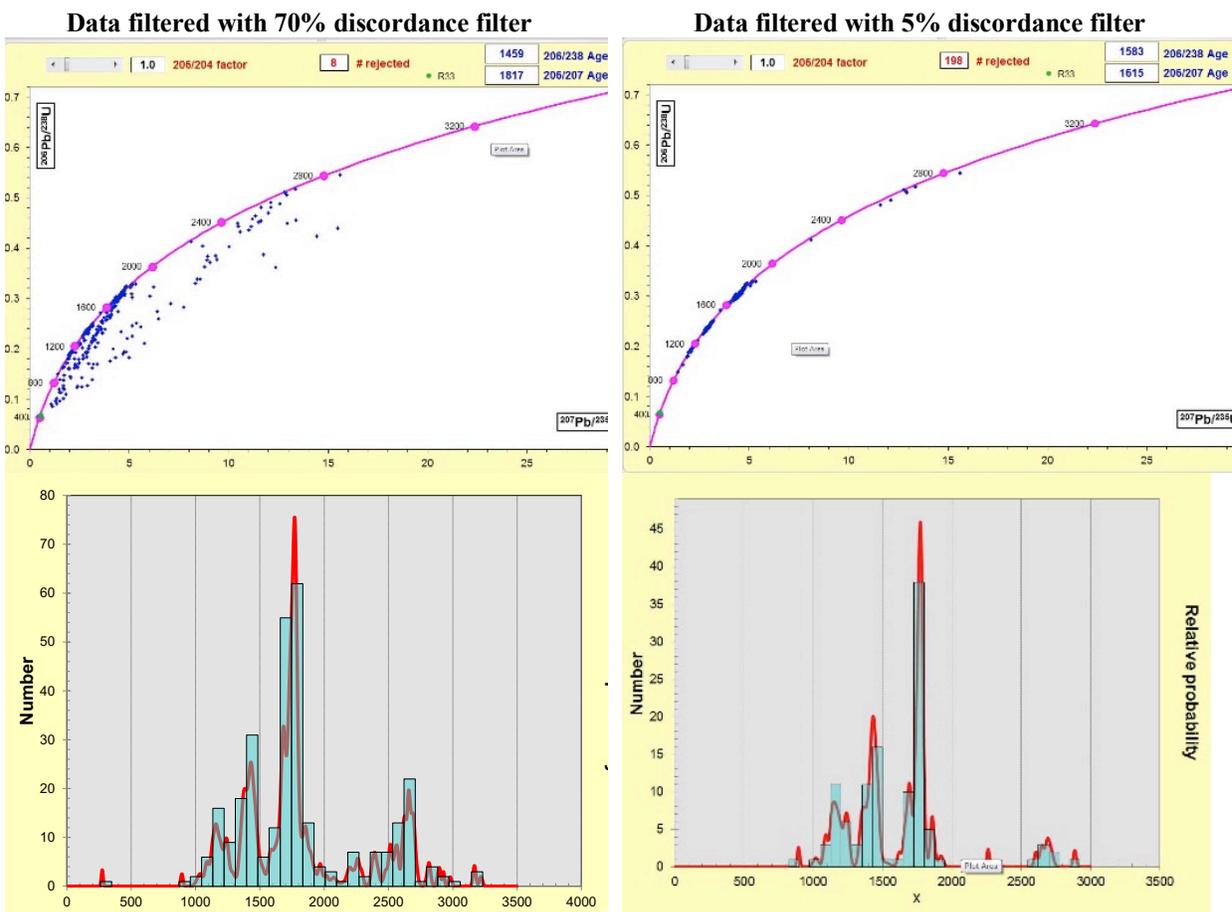


FIGURE 1: Typical protocol is to filter data for 20% or 30% discordance, which is an expression of the equivalence of calculated dates from the two, independent U-Pb systems. We’re evaluating a different protocol, wherein we first apply a 70% discordance filter (left-hand column) in order to identify linear trajectories of open-system disturbance. We’re interested in whether grains with Mesozoic dates crystallized in the Mesozoic arc or represent older detrital grains that half suffered near-complete resetting during Mesozoic hydrothermal alteration coeval with emplacement of the Sierra Nevada volcanic arc. We then apply a very strict 5% filter (right-hand column) before conducting statistical correlations with other samples to evaluate sediment provenance.

Because my schedule as Chair was significantly less flexible than previous years, I tackled some of the more logistically complex field work on my own. For the second time in 2018, I had my field plans thwarted by a large forest fire. Changing plans mid-trip, I explored part of the Great Western Divide that former students and I had sampled during my previous PRF grant. This detour proved particularly revealing, as one tall mountain had secrets ready to divulge regarding collisions between ancient tectonic plates, Jurassic paleogeography, and post-Jurassic tectonics. I returned twice more this last year to map and sample these curious rocks, along with pendants located to the east of the originally proposed field area on the Kern Plateau.

Meanwhile, I plan to make one final sampling expedition with my PRF-funded lab assistant this fall, hopefully to sample a remote pendant located in a recently burnt area of the Sierra foothills. I continue to mentor this undergraduate as she expands her laboratory skills, and plan to take her in the field this fall to introduce her to the strategies and logic underlying the collection of detrital zircon samples. I'm also working with two thesis students to refine our data processing strategy for the pre-Mesozoic pendants that experienced the entire 180 m.y. of arc hydrothermal metamorphism (see figure above).

Beyond being a more effective mentor, support from ACS-PRF has provided a vehicle for expansion of my abilities to new analytical techniques and expansion of my expertise in support of a more holistic understanding of the Sierra Nevada arc system, one that integrates sedimentology and tectonics with igneous and metamorphic petrology. I am repeatedly surprised by the interplay between seemingly disparate datasets, and look forward to being able to close the loop on a number of tectonic questions in the coming year.

To date, this grant has supported the required undergraduate research of four undergraduate (Aviles, Concha, Magumcia, Murrieta) and two graduate students (Chen, Duccini). Three more students (Titular, Kohler, Boeshart) have gained valuable laboratory experience while being gainfully employed as laboratory assistants. All nine of these students are members of groups that are underrepresented (six by gender; six by ethnicity) in the Earth sciences. ACS-PRF support has provided these students with rich field and laboratory research experiences, opportunities to work in labs at R1 universities, and the means to present at professional scientific conferences. I will take a student crew to Arizona Laserchron Center in January 2019 to complete data collection. Final data analysis and manuscript preparation/submission will follow.