PRF Grant Number: #57809-UNI8

Grant Title: *Reconstructing Neogene Paleogeography and Forearc Basin Evolution of Southern Cascadia using Detrital Mineral Geochronology*

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Describe briefly the progress of the research and the impact of the research on your career and that of the students who participated in the project during the reporting period.

Progress of the research:

The goals of this research are to quantify sediment source, paleotopography, and forearc basin evolution of Southern Cascadia (i.e., Northern Californian Klamath Mountains) during Neogene time. This problem is especially challenging because of the lack of the terrestrial sedimentary record in the forearc; while the Miocene sedimentary record is robust in most of Coastal California, much of the record in the Klamath Mountains is missing due to erosional removal during unroofing, or, conversely, a long period of non-deposition. To address these competing, end-member hypotheses, we focused on the early-mid-Miocene Weaverville formation, a terrestrial unit that records lacustrine to fluvial facies, and is preserved today in small (<10km^2), isolated basins in down-dropped grabens. During the reporting period, students D. Christensen and S. Allen and I isolated and identified freshwater diatoms in the lacustrine units, and detrital zircons for U-Pb geochronology to fingerprint their provenance.

S. Allen (BS thesis) found diatom species of the genera *Pinnularia, Hantzschia,* and *Luticola* in the lacustrine facies of the Weaverville that are consistent with current age estimates of late-Oligocene to mid-Miocene and a paleoenvironment consisting of warm, moist, low-lying marshland (Figure 1). D. Christensen (MS student) found U-Pb detrital zircon ages in the sandy matrix of the fluvial member of the Weaverville to be remarkably consistent with Klamath Mountain plutonic sources only; an age range of 125-165Ma (Figure 2). Both detrital samples shown below (Figures 2a and 2b) also show a minor ~400Ma signal, which is most likely derived from Devonian gabbros of the Trinity Ultramafic sheet in the Klamath Mountains, as 400Ma sources are rare in the western US. Morever, these age ranges support the idea that at the time of early Neogene Weaverville deposition, paleotopography of the Klamath Mountains exhibited enough relief to prevent more broad, regional sediment sources (such as Cascade volcanic arc, Sierra Nevada or Idaho/Challis batholith). Taken together, these new results imply that uplift of the Klamath Mountains had initiated by early Neogene time —perhaps earlier— and Weaverville deposition may have been constricted in isolated basins, in an environment that was marshy and transitioned to predominently fluvial, with primary paleocurrents from north to south/southwest. This environment transition recorded by facies change could be coincident with accelerating tectonic extension and localized basin formation.

In the upcoming academic year, we are expanding our detrital zircon data set within basins in the Weaverville (D. Christensen), as well as dating the Devonian gabbros (A. Troia), and including the Oligocene Montgomery Creek Formation (D. Kinser) for detrital U-Pb geochronologic work.

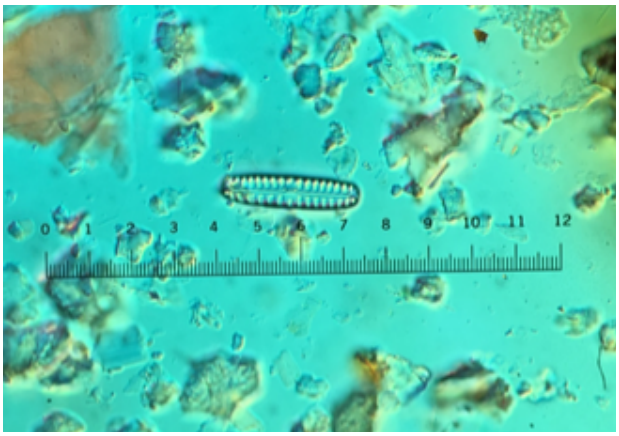

Figure 1. *Pinnularia borealis* photo in 100x magnification, scale in tens of microns. Identified by linear to linear-elliptic valves, broadly rounded apices, and lateral deflection of the proximal raphe (Ehrenberg 1843).

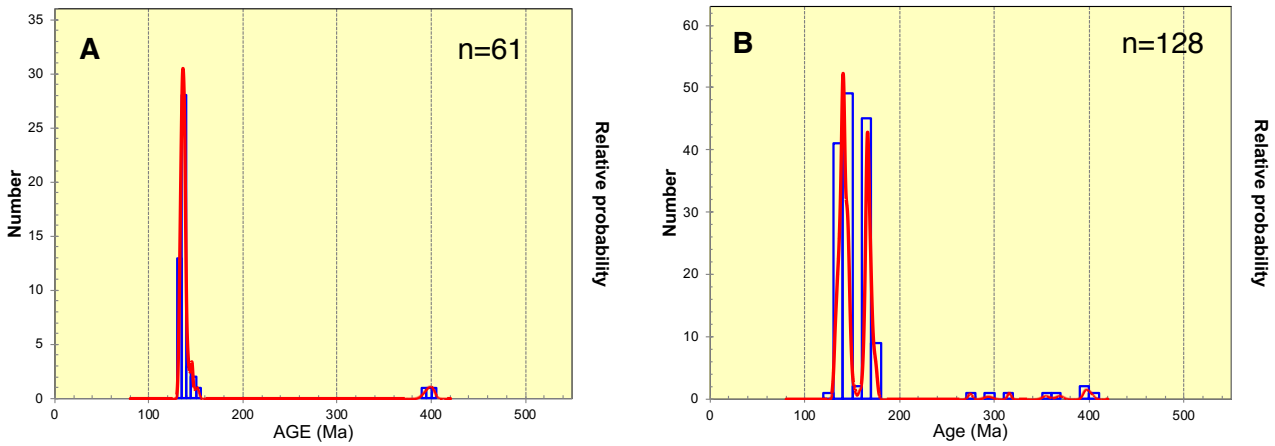

Figure 2. Probability distribution plots of Weaverville sands from Louden Ranch (A) and Hyampom (B) localities. Blue shows binned histograms of ages, and red is the probability distribution curve. Both show dominant age ranges of 125-165Ma, which is likely derived solely from plutons of the Klamath Mountains. Noticeably absent are any grains <125Ma; no Cascade volcanic or Sierra/Idaho/Challis aged grains are observed. The presence of ~400Ma grains likely points to a local source from gabbros within the Trinity Ultramafic sheet of the Klamath Mountains.

Impact of research on PI career:

This research has had several primary impacts on the PI's career. First, it has supported field work, analyses, and conference travel to collect and disseminate preliminary findings, which we are compiling to publish at least one manuscript in an international journal that will be of broad interest to scientists working in onshore and offshore regions of the southern Cascadia forearc. Second, the work has fostered a connection with the University of Arizona to use the LaserChron facility. In the reporting period, one student has used this facility, and two more are scheduled to complete analyses in January 2020, which allows me to expand my teaching impact outside what is available or offered within HSU (a small, rural unversity). Third, the research questions posed by this work have allowed PI Michalak to recruit students and support them with hourly wages, and involve every student in my upper division geochronology course (offered every Fall semester) in some aspect of this research, such as sample preparation. Finally, this research has encouraged me to form new collaborations with other institutions, such as a new project working on the Montgomery Creek Formation with Drs. Rebecca Dorsey (University of Oregon) and Francis Souza (Oregon State), with whom I am co-convening a conference session at the 2020 GSA Cordilleran Section meeting.

Impact of research on students:

In the reporting period, three students have received salary or stipend (D. Christensen, S. Allen, A. Troia) and one student (D. Kinser) has joined our team for the 2019-20 academic year. In August 2019, students and I traveled for field work on a three day sample collection field trip in Northern California to show students the field area and collect samples for their senior thesis work (two students) and MS work (one student). Additionally, in the reporting period, D. Christensen was supported with conference travel (part from this grant, part from HSU Geology Deparmental funds) to attend and present at the 2019 Spring Cordilleran Section GSA meeting. One student (D. Christensen) and myself travelled to the University of Arizona LaserChron laboratory facilty in May 2019 to learn hands-on instrumental and collect publishable data. D. Christensen also attended the Fall GSA 2019 meeting specifically to attend a one day geochronology workshop taught by UofA personnel geared toward students and postdocs to learn data reduction software and best practices in the field. In the upcoming semester, D. Christensen and S. Allen are co-authoring a Fall AGU abstract to present their work. In the reporting period, one student, S. Allen has received a BS degree from HSU and is now employed by the River Institute in Humboldt County.