Titanite and zircon petrochronology on two granites from the Western Idaho Shear Zone

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In areas where tectonic plates converge, a geologic feature called a shear zone forms, which is an area within Earth's crust under an immense amount of pressure. For this project, I examined two different rocks from the Western Idaho Shear Zone (WISZ), which have been exposed to the surface after 100 million years of erosion and uplift. I analyzed zircon and titanite minerals from these two deformed rocks, one from the outer margin of the WISZ (sample A) and one from the center of the WISZ (sample B). This study tests the hypothesis that these two granites formed at the same time and were split apart by a younger pluton. The mechanisms behind pluton emplacement within a shear zone are not yet fully understood but are crucial for advancing our understanding of shear zones, and more broadly, the tectonic activity that caused shear zones to form (Harrigan *et al.* 2024). This work also contributes to ongoing research on how minerals grow in response to the environment, so that we can accurately apply mineral dates to tectonic-scale processes.

Titanite and zircon grains were extracted from our two granite samples and grouped based on relative size. We sampled 10 – 50 grains from each size group and mounted them into epoxy pucks, which were polished down until we reached the largest diameter of the grain. These pucks were imaged under a scanning electron microscope with a backscatter electron probe. After reviewing the images, some of the grains were selected for additional analysis via laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS). LA-ICPMS is a two-part process conducted by two coupled machines that allows us to chemically analyze a mineral. The first part is to ablate, or remove and break apart, a tiny spot of material from the mineral. These spot sizes are typically around 50 microns large, which is 1/200th of a centimeter! The second part is to take this mineral material and give it an electric charge, which turns all of the constituents of the material into ions. These ions are separated by a magnet and counted by the machine, giving us an idea of the elements that make up the material.

We found that sample A zircon is not the same age as sample B zircon, suggesting that these two granites are not from the same pluton and were not split apart by a younger pluton. Additionally, sample A zircon is older than sample B zircon, suggesting that plutons did not form in the W – E direction, which contrasts previous research on the WISZ which proposes an age gradient going from old in the west to young in the east. Finally, sample A titanite is younger than sample A zircon, suggesting that this granite deformed immediately after forming and continued to stay under tectonic pressure for tens of millions of years. Our new model for the WISZ is more complex than previously hypothesized. The WISZ may be creating areas of localized higher pressure instead of exerting a high pressure on all rocks equally.

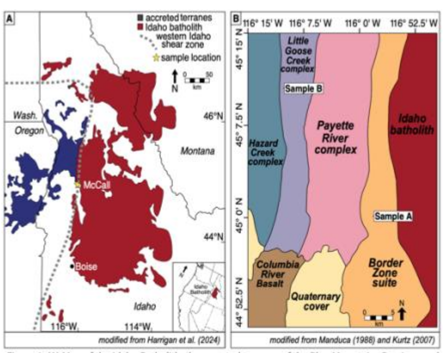

Figure 1: (A) Map of the Idaho Batholith, the accreted terranes of the Blue Mountains Province and the WISZ. (B) Map of the plutonic complexes sampled in our study.

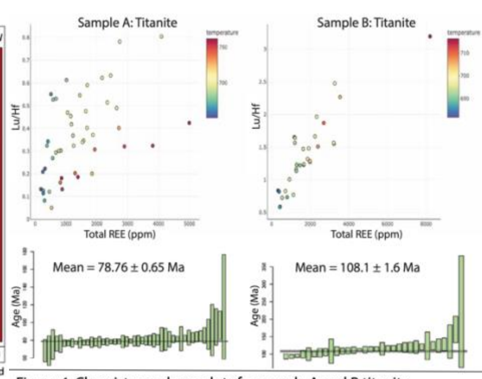

Figure 4: Chemistry and age plots for sample A and B titanite.

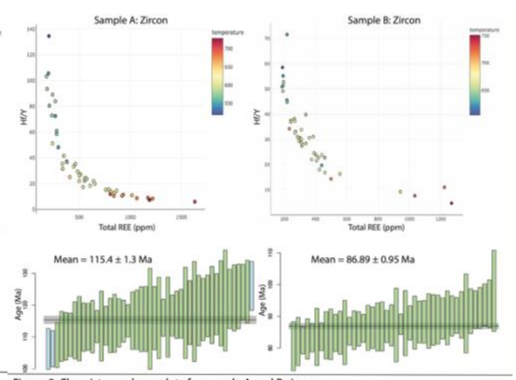

Figure 5: Chemistry and age plots for sample A and B zircon

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References:

Harrigan C. O., Trevino S. F., Schmitz M. D., Tikoff B. (2024) Determining the initiation of shear zone deformation using titanite petrochronology. Earth and Planetary Science Letters, v. 631