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A petrochronological comparison of Neoarchean-Paleoproterozoic monazite from southwestern Montana

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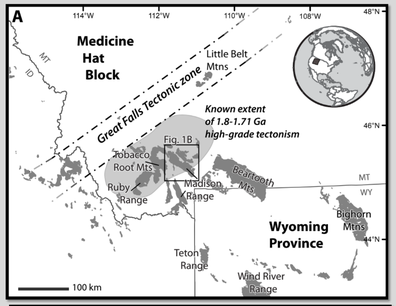
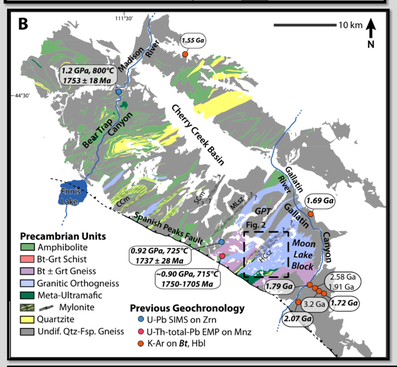
Motivation

Develop a timeline of metamorphism and deformation within the Hell Roaring Creek shear zone using U-Th-Total Pb dating and high-resolution geochemical maps of monazite.

Regional Context





Hell Roaring Creek shear zone

- Dextral transpressive ductile shear zone
- Strikes NE-SW
- Mean orientation: 228°, 79°
- Amphibolite facies
- Suspected activation during Big Sky orogeny (ca. 1800-1700 Ma)

Moon Lake block

- Low-strain folding believed to connect to shear zone activation
- Superior preservation of events pre-dating shear zone formation
- First formal analysis of Moon Lake block

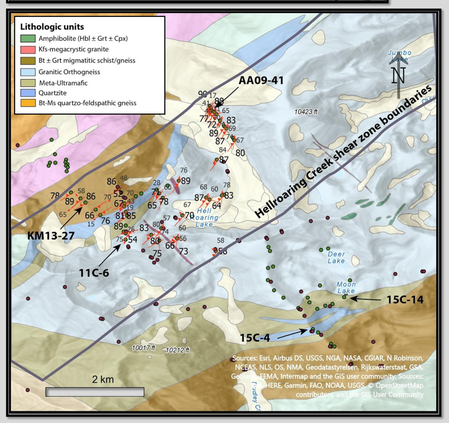


Figure 1A. Map showing Hell Roaring Creek shear zone's location near the NW margin of the Wyoming Province in SW Montana.

Figure 1B. Map showing the shear zone is located in the Precambrian rocks of the Northern Madison Range.

Figure 2. Lithologic map of the ~2 km wide shear zone. Sample sites are noted within the shear zone and the Moon Lake block ~2 km to the SE.

Why Monazite?

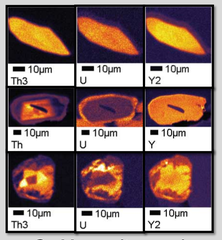


Figure 3. Monazite grains with varying domain complexity.

Availability: Common metamorphic accessory mineral found in igneous and sedimentary sources

Resiliency: Pb closure temperature >800°C

Efficiency: Single grain may record timing of multiple events in geochemically distinct domains

Results: Moon Lake Block

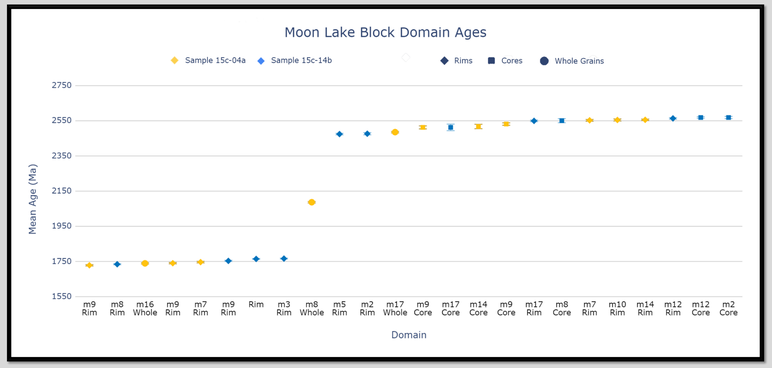


Figure 4. A sum of 14 monazite grains from 2 samples were split into 25 domains for analysis. Dates fell into 2 main clusters. Most grains were "old."

Results: Shear Zone

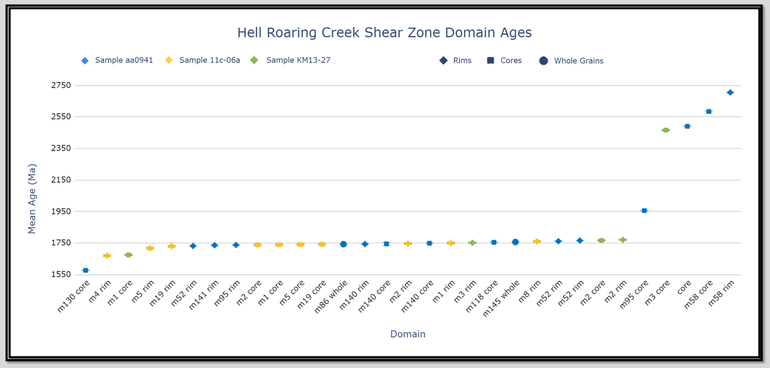


Figure 5. From 3 samples, 18 grains were divided into 31 domains for dating. Clustering was akin to Moon Lake block samples. Most grains were "young."

Conclusions

1. Monazite growth occurred during two main time frames: 2580-2470 Ma and 1770-1730 Ma.
2. Conditions within the shear zone from 1770-1730 Ma were more suitable for monazite growth than along the Moon Lake block. This may be attributed to shear zone activation.
3. Moon Lake block monazite underwent multiple phases of growth from 2580-2470 Ma. Possible sign of variable localized conditions at the time.
4. Shear zone monazite experienced similar growth pulses from 1770-1730 Ma. Supports hypothesis that the Big Sky orogeny and shear zone formation occurred during this time.
5. Old population of monazite in Moon Lake block is almost entirely absent from samples dated in Bear Basin ~2 km NW of the shear zone. May indicate the shear zone played a significant role in regional tectonic evolution.

References

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Acknowledgments

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