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Reconstructing the Geologic History of the House Mountain Metamorphic Complex (Southern Idaho) Through Zircon Age and Geochemical Analysis

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Introduction

The House Mountain Metamorphic Complex provides a unique view into the Mesozoic and older history of the northern U.S. Cordillera, through its exposures of a variety of metamorphosed igneous and sedimentary rocks (Jacob, Alexander, 2007). This study examined a quartzo-feldspathic orthogneiss intrusion within the Neoproterozoic layered paragneiss suite on the western flank of House Mountain, in order to refine the intrusive and metamorphic history of the complex.

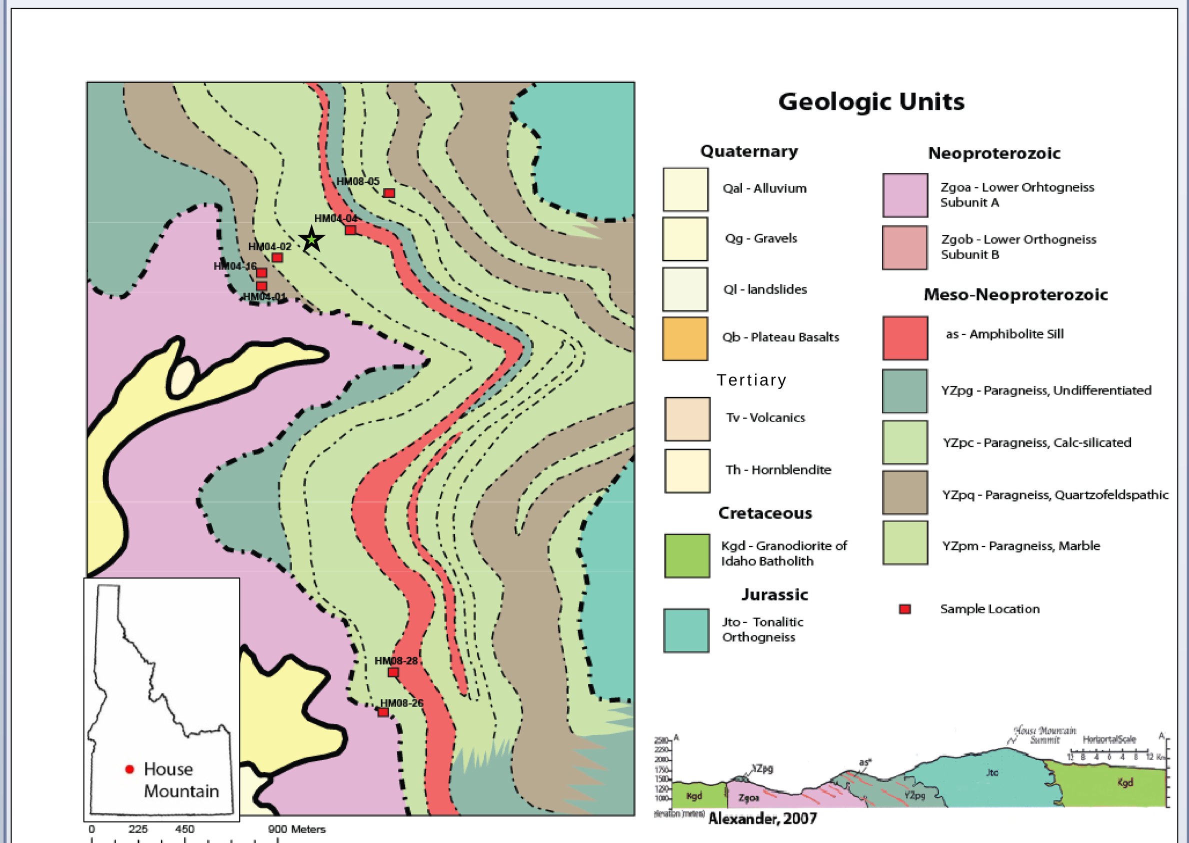

Figure 1. Geologic map of study area showing previous sampling sites (red squares) and the current study (green star). Lower left inset shows location within Idaho.

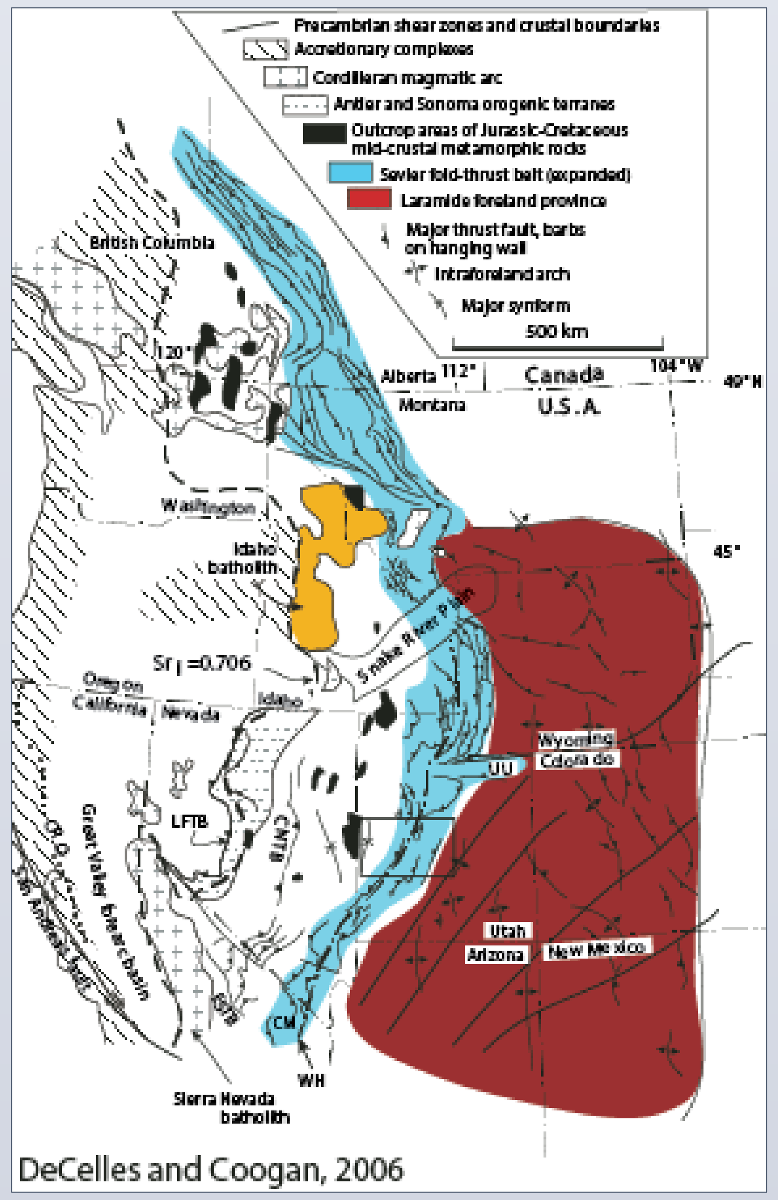

Figure 2. Map showing tectonomagmatic events related to orogenic history of the Cordillera. Color has been added to accent the orogenic events related to this study.

Geologic Setting

House Mountain is located north of the Snake River Plain and within the southernmost part of the Atlanta Lobe of the Idaho Batholith. House Mountain comprises a variety of tonalitic to granitic orthogneisss with a suite of paragneiss rocks between them. The paragneiss suite is intruded by a variety of sills and dikes including the quartzo-feldspathic gneiss from this study.

Objectives & Experiments

The objective of this investigation was to refine the intrusive and metamorphic history of the House Mountain Metamorphic Complex:

- Measure the age and geochemical signatures of zircons from the orthogneiss through laser ablation inductively coupled plasma mass spectrometry.
- Interpret the geochemical evolution of these zircons through comparison with thermodynamic mechanisms of element substitution and equilibration.
- Develop age correlations between the House Mountain orthogneiss evolution and various Cordilleran events.

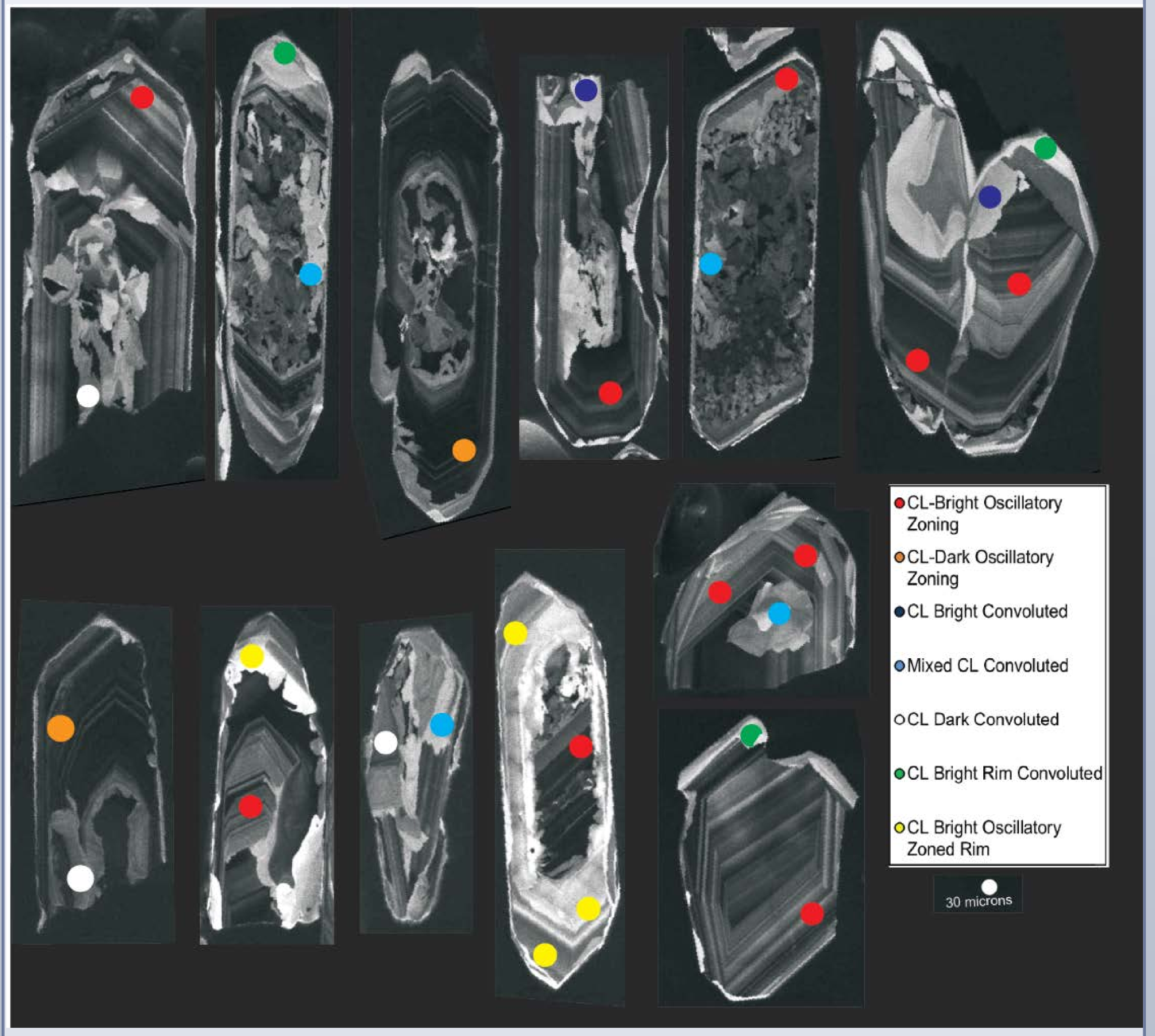

Figure 3. CL images of a selection of the zircons from this study. Spots represent LA-ICPMS sampling locations color coded by developmental stage.

Stage	Morphology	Age (m.y.)	Geochemical (U-ppm:ΣREE:T (°C):Th/U)	Mechanism
1	CL-Bright Oscillatory Zoning	139-123	2772:853:633:0.12	Primary magmatic crystallization; high retention of Pb
2	CL-Dark Oscillatory Zoning	105-99	5297:964:685:0.08	Primary magmatic crystallization overprinted by partial transgressive recrystallization; low retention of Pb
3	CL Bright Convoluted	135-120	745:315:618:0.08	
4	Mixed CL Convoluted	130-104	1386:374:614:0.05	Spectrum of recrystallized oscillatory zoning
5	CL Dark Convoluted	121-105	2029:455:624:0.04	
6	CL Bright Rim Convoluted	96-92, 65	415:127*:614:0.09	Transgressive Recrystallization
7	CL Bright Oscillatory Zoned Rim	86-82	974:754:675:0.15	Overgrowth

Table 1. A summary of the metamorphic stages with defining characteristics.

Methods

Zircons and garnets were separated using standard physical, magnetic, and heavy liquid techniques, mounted in epoxy, polished to expose the center of grains, and imaged with cathodoluminescence (CL) on a scanning electron microscope. CL images were used to interpret the history preserved by internal morphology, and select locations for analysis with laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS).

Observations & Interpretations

CL imaging revealed a variety of internal features in the zircons. LA-ICPMS data helped to further divide these features into distinct growth or recrystallization zones. They revealed seven stages of evolution linked to different events in the geologic history of House Mountain. The oldest zircons have primary oscillatory zoning and an igneous crystallization age of ~135 Ma. Cross-cutting zones show varying levels of convoluted structure accompanied by decreased uranium and rare earth element (REE) concentrations attributed to progress recrystallization of the primary zircon during metamorphism. The youngest ages are from zoned overgrowths with increased U and REEs requiring a fresh injection of melt into the grain boundaries of the orthogneiss. Multiple distinct metamorphic events are centered near 120, 95, 84, and 65 Ma.

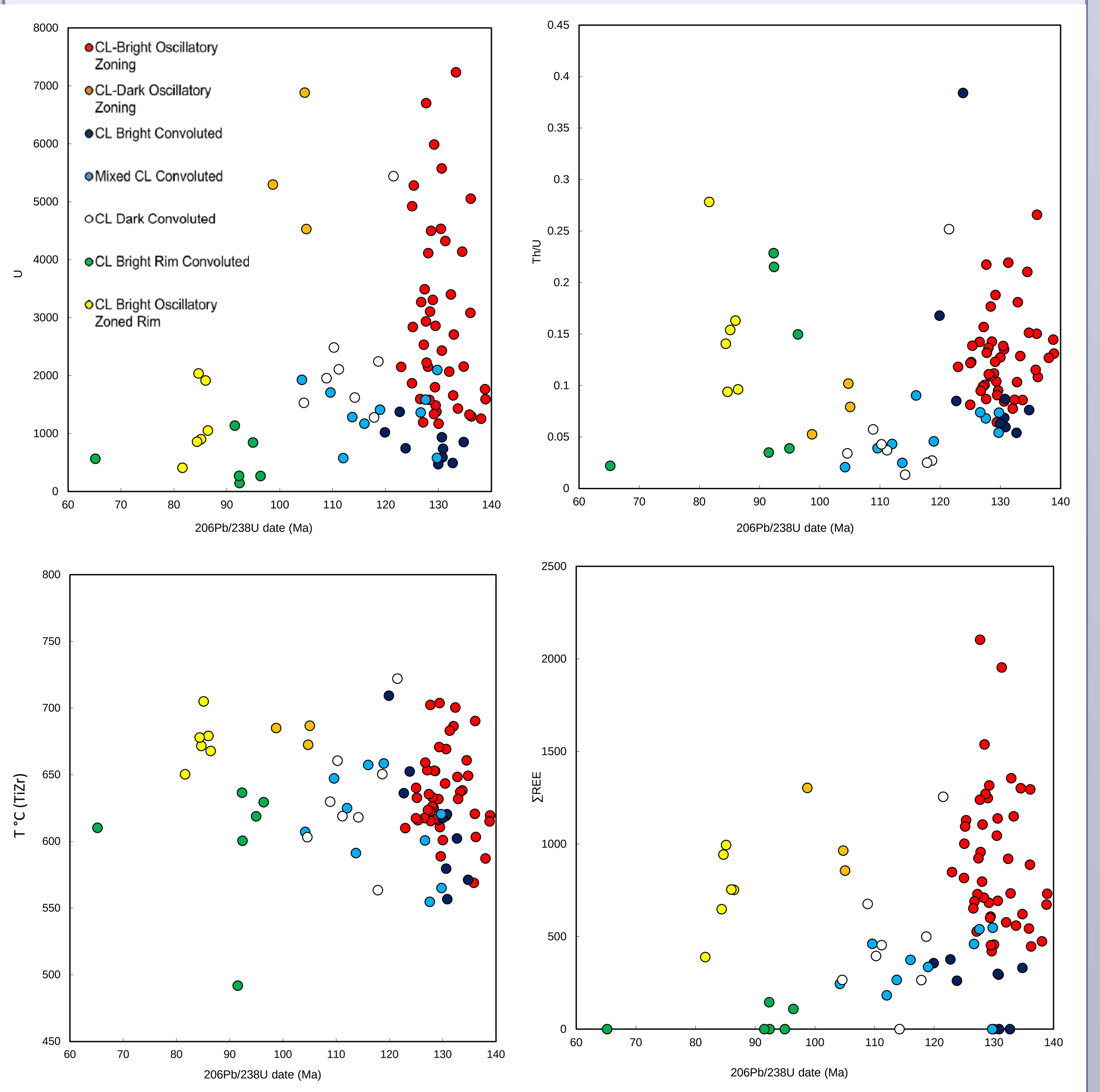

Figure 4. Age plots of zircon LA-ICPMS data showing geochemical trends over time through successive metamorphic events.

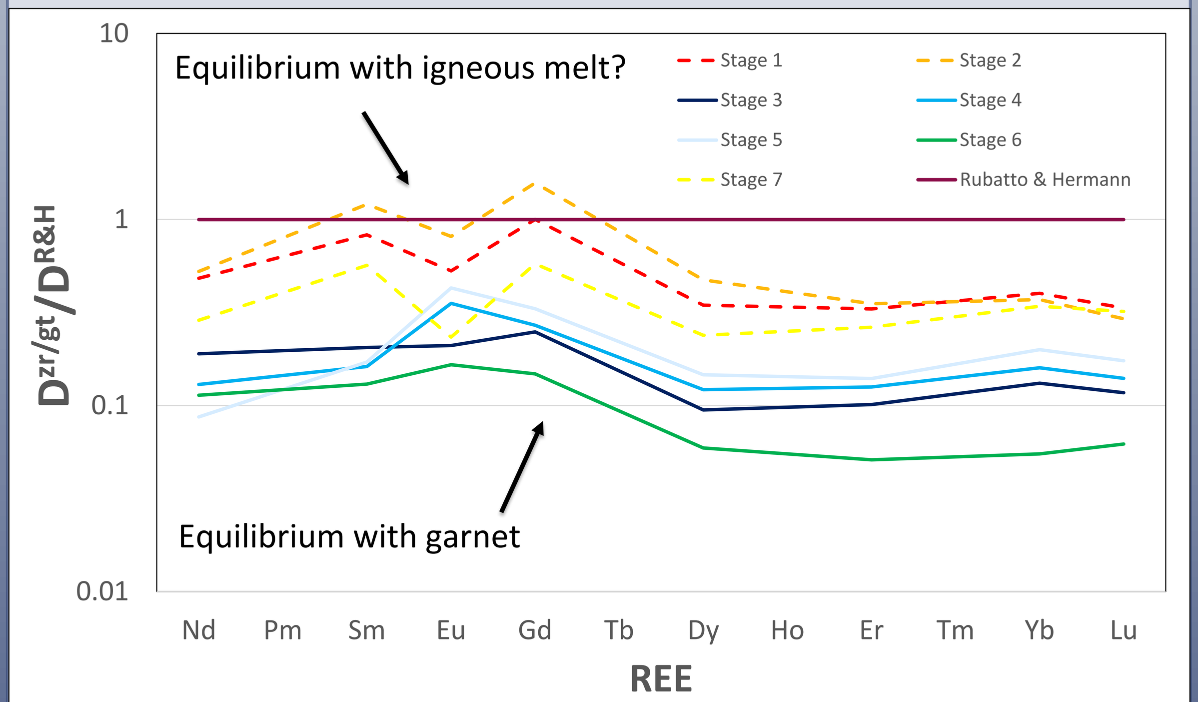

Figure 5. Zircon/Garnet partitioning data from this study compared to Rubatto & Hermann (2007) 800°C data. All data is normalized to the Rubatto & Hermann data.

Analysis of REE partitioning between these groups of zircons and garnets from the same unit shows that zircons were in equilibrium with garnet throughout metamorphic recrystallization (Stage 3 - 6). The REE partitioning data does not support equilibrium between garnet and the oscillatory zoned zircon domains (Stage 1, 2, 7), which are rather interpreted as crystallizing from an igneous melt.

Conclusions

This rock unit is an orthogneiss originally crystallizing as an intrusvie sill around 135 Ma. The sill has undergone several metamorphic recrystallization and overgrowth events that record the geologic history of the House Mountain Metamorphic Complex:

- 120-110 Ma – Prograde metamorphism recorded in surrounding rock units.
- 95 Ma – Peak amphibolite grade metamorphism recorded in surrounding rock units.
- 82 Ma – Intrusion of foliation concordant pegmatite (Idaho Batholith intrusion)
- 66 Ma – Intrusion of post kinematic pegmatite dikes (Exhumation)

These observations link House Mountain to the orogenic history of the western North American Cordillera:

- The first occurrence of metamorphism near ~120 Ma via thickening of the crust during the Nevadan and early Sevier orogenies.
- A second episode of deformation and recrystallization at ~95 Ma related to continued crustal thickening during the latter stages of Sevier orogenesis.
- The third event at ~82 Ma was postulated by Alexander (2007) as being related to the local intrusion of the Idaho Batholith. I believe that the intrusion of the batholith may be responsible for introducing the fresh material necessary for the more U and REE rich overgrowths seen at this time. This time would also be consistent with compressional events related to the Laramide Orogeny.
- The final event is most likely related to regional pegmatite intrusions associated with exhumation of the volcanic arc during extension.

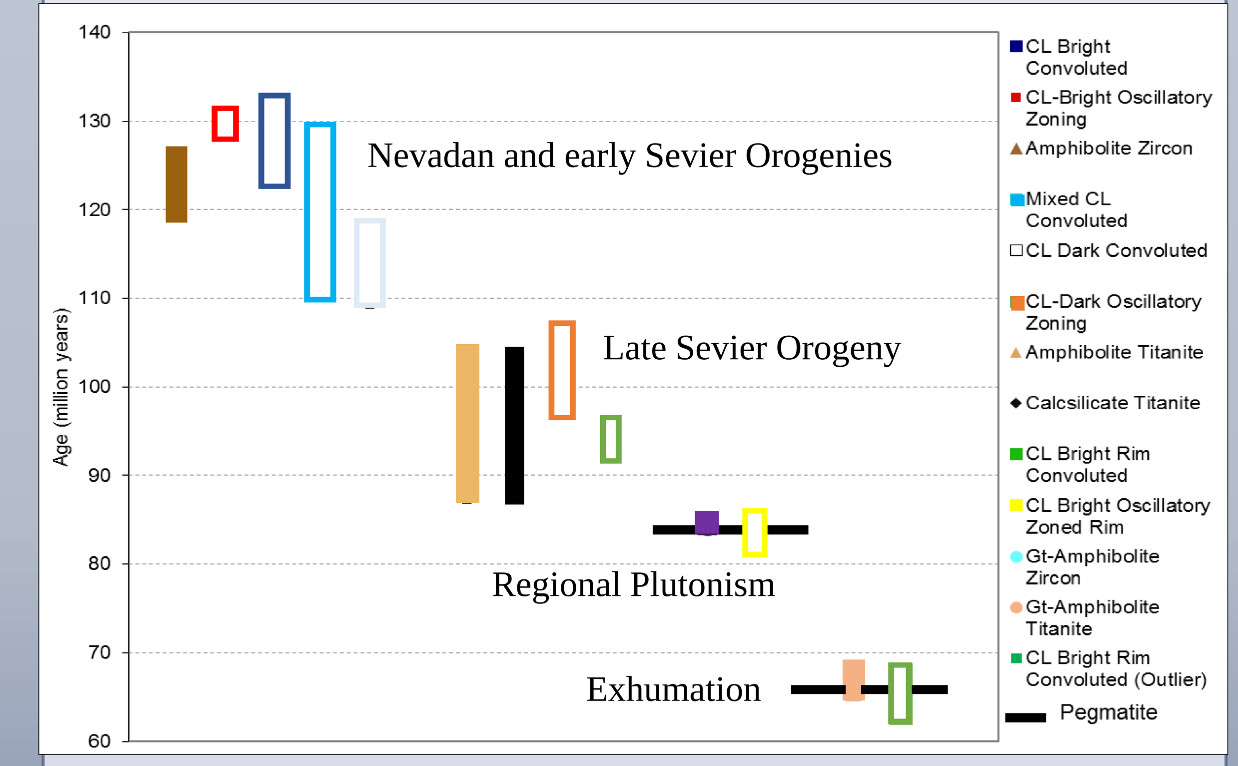

Figure 6. The zircon LA-ICPMS age data of this study (hollow) as compared to literature on rocks from the surrounding units (solid). (Alexander, 2007; Dye, unpublished)

References

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