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Zircon Chemistry in a Gabbro Pluton at House Mountain, Idaho

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Abstract

An Eocene (*ca* 45 million year old) gabbro pluton near House Mountain in southwest Idaho provides an opportunity to explore how the conditions of crystallization are recorded in zircon chemistry. Zircon is a zirconium silicate mineral present in trace amounts in magmas, which is capable of incorporating large, highly charged elements (e.g. transition metals, actinides, lanthanides) that do not easily substitute into other minerals. Variations in these elements can be used to track magma evolution. For example, the titanium concentration is related to the temperature at which zircon crystallizes from the magma; rare earth elements (REE) and the relative proportion of europium (Eu-anomaly) can be used to track the degree of crystallization of the magma.

Trace elements (TE) were measured in situ on 25 micron spots in zoned zircon crystals using laser ablation inductively coupled plasma mass spectrometry. Two samples from the pluton, an equigranular gabbro and a felsic granophyre, were analyzed. The zircons from the gabbro record cooling temperatures, and evolution from a primitive, mafic magma to one enriched in TE with a stronger Eu-anomaly. Residual felsic melt segregated from crystallized minerals and concentrated in the granophyre records evolved compositions in the final stage of crystallization.

Keywords

zircon crystals, magma composition, crystallization

Disciplines

Earth Sciences

ZIRCON CHEMISTRY IN A GABBRO PLUTON AT HOUSE MOUNTAIN, ID

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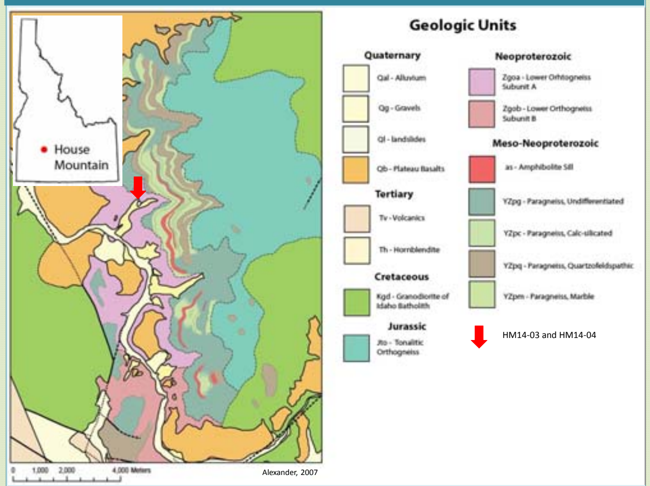
WHAT WE LEARNED

How can we reconstruct the evolution of a magma as it cools and crystallizes minerals?

Zircon crystals form over a range of magma conditions and their chemical signatures record changes in melt composition through cooling and crystallization.

Zircon geochemistry records comprehensive details of magma composition and evolution.

BACKGROUND

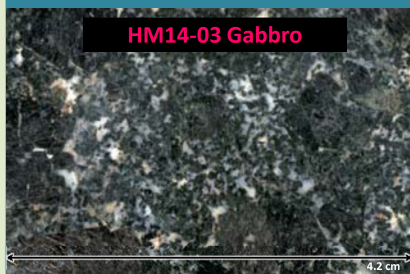


An igneous pluton at the base of House Mountain, Idaho is composed of a gabbro body with cross-cutting granophyre veins (Alexander, 2007). From field relationships and mineralogy, I hypothesize that the granophyre evolved from the gabbro, and have tested the ability of zircon geochemistry to record this relationship.

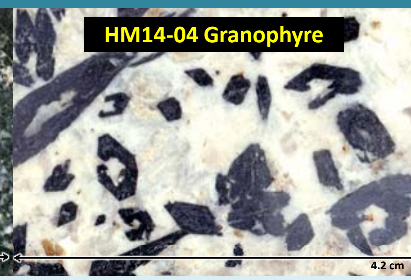
Key Concepts

- House Mountain HM14-04 granophyre is the residual melt that segregated from HM14-03 gabbro and represents a late stage of magma evolution.
- Magma composition changes through time due to cooling and crystallization (White, 2013).
- Zircon compositions are related to the composition and temperature of the host magma, as well as the degree of crystallization of the magma.

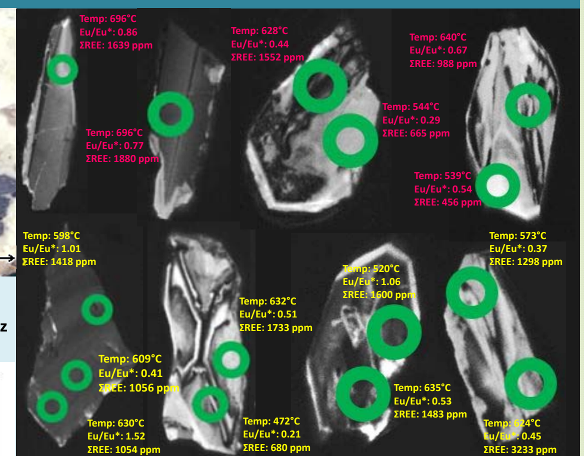
RESULTS

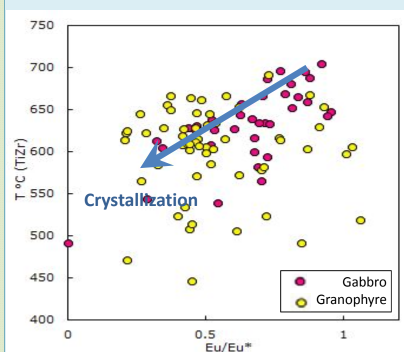


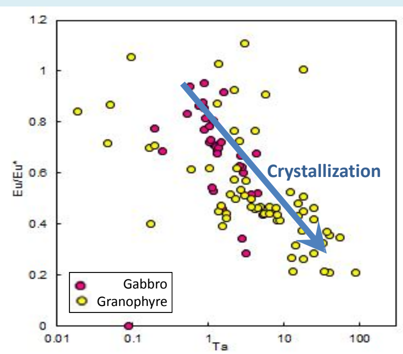
HM14-03 is a gabbro (a mafic igneous intrusive rock) with quartz & feldspar segregations around prismatic hornblende phenocrysts.



HM14-04 is a granophyre (a felsic igneous intrusive rock) with elongate skeletal hornblende phenocrysts surrounded by a quartz + feldspar-rich matrix.







- **Ti-in-zircon temperatures are relatively low in both samples, near the solidus.**
  Although the gabbro zircons are slightly higher T on average, both rocks record a similar range of temperatures, suggesting that zircon is a very late crystallizing phase in felsic segregations.
- **The granophyre records larger Eu anomalies (lower Eu/Eu*) related to increased feldspar crystallization relative to the gabbro.**
  Eu/Eu is a measure of degree of feldspar crystallization; the observed anomalies are consistent with the petrography of the samples.*
- **The granophyre zircons are enriched in trace elements (ΣREE, Ta, Nb, Hf) compared to the gabbro zircons, consistent with greater degree of crystallization.**
  As minerals crystallize and are removed from the bulk melt, trace elements concentrate in melt fraction; zircon incorporates these trace elements.

Methods

- Zircons were separated from the rocks by density and magnetic methods, mounted in epoxy, polished to their centers and imaged using cathodoluminescence.
- Chemical compositions were measured on 25 µm diameter spot analyses with laser ablation inductively coupled mass spectrometry (LA-ICPMS).
- Trace elements including U, Th, Nb, Ta, Hf, and rare earth elements (REE) were compared on bivariate diagrams with Ti-in-zircon thermometry (Ferry and Watson, 2007).

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