Trace element geochemistry of hornblende from the Bonanza arc, Vancouver Island, Canada

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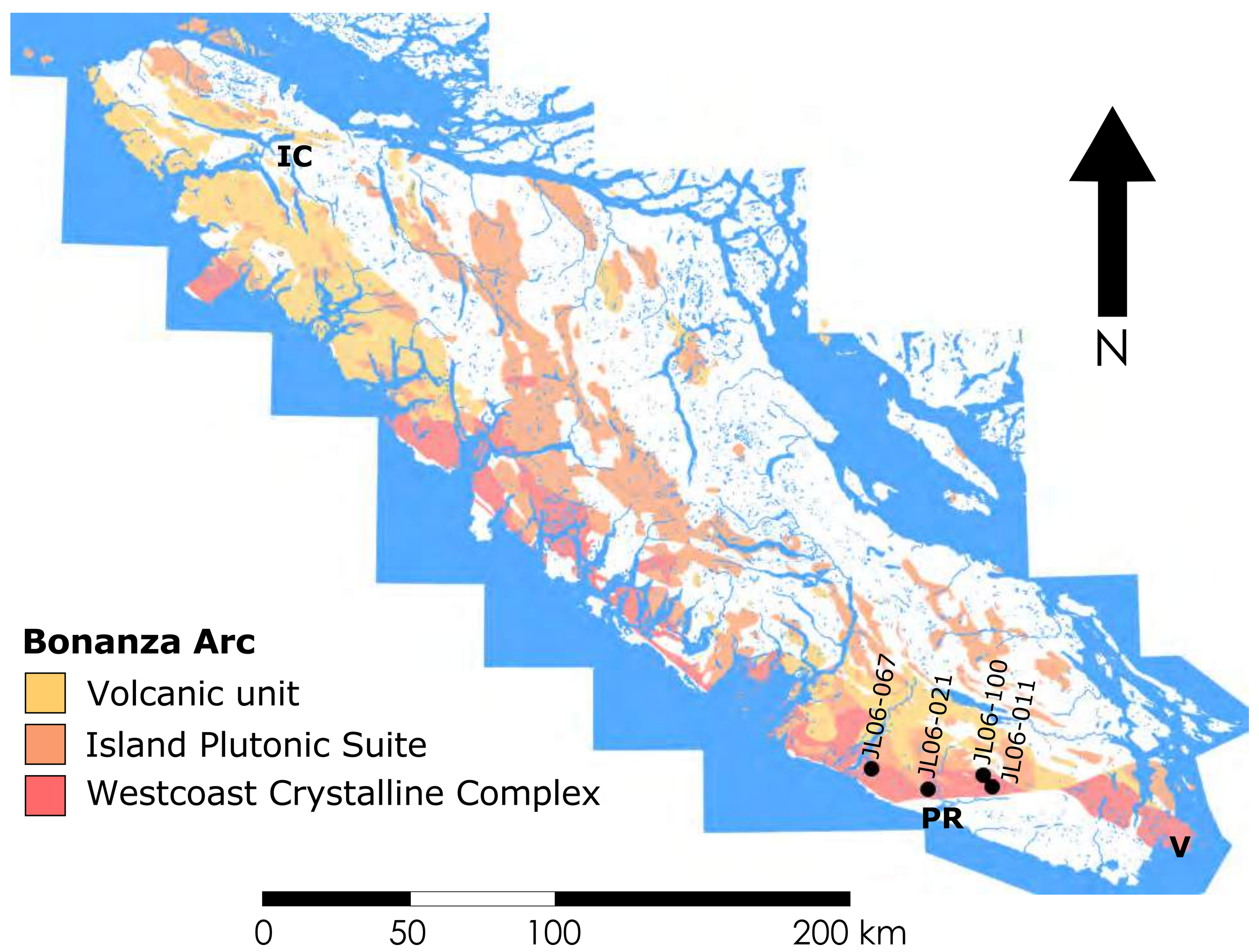
1. Introduction and objective

It has been suggested that porphyry Cu deposits, commonly associated with arc settings, may be formed by the melting of a sulfide-rich lower crust in which chalcophile elements have been concentrated during earlier arc building phases. During heating, water released byb amphibole in the lower crust can greatly increase the amount of melt produced. Although hornblende-bearing ultramafic cumulates have been described from many locations worldwide, it is debated whether the amphibole is a primary fractionating phase in arcs or secondary, melt-reaction product of clinopyroxene. Knowing whether amphibole is primary or secondary is important in determining the porphyry magma productivity of an arc.

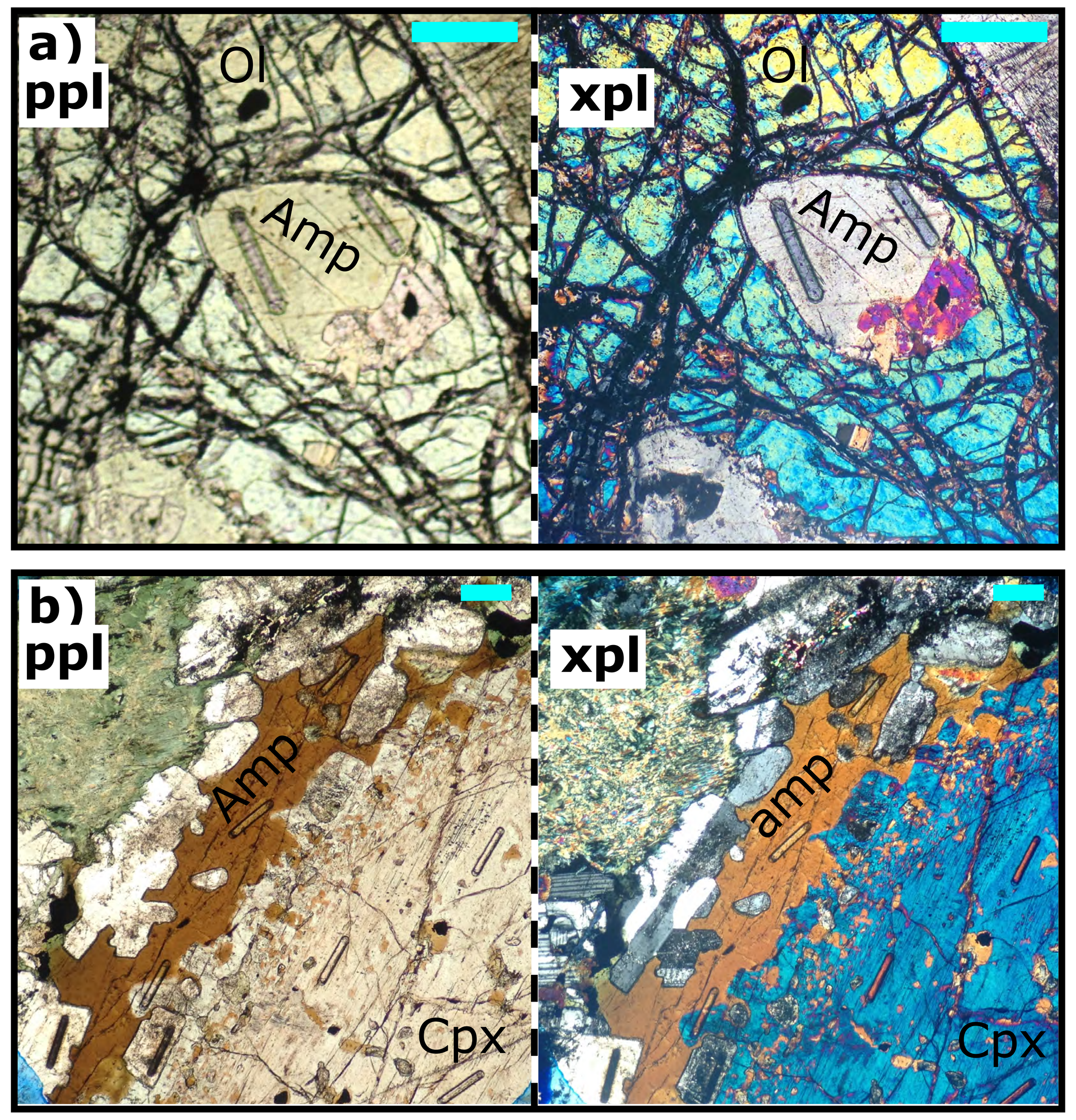
The Jurassic Bonanza arc, on Vancouver Island, is an ideal natural laboratory to study questions regarding the origin of amphibole in ultramafic assemblages as hornblende-bearing ultramafic cumulates have been reported. Furthermore, the Bonanza arc is known to be locally enriched in Cu, having hosted the world-class Island Copper porphyry mine.



↑ *Simplified geological map of the Bonanza arc on Vancouver Island. Dots indicate positions of samples used in this study;* ***V****, Victoria;* ***PR****, Port Renfrew;* ***IC****, Island Copper mine.*

In the present study we seek to test whether amphibole in the Bonanza arc cumulates is primary or secondary by examining their trace elment chemistry. We examine the trace element composition of the silicate phases present in four hornblende bearing cumulates The only olivine cumulate is JL06-021, whereas the remaining samples are plagioclase cumulates.

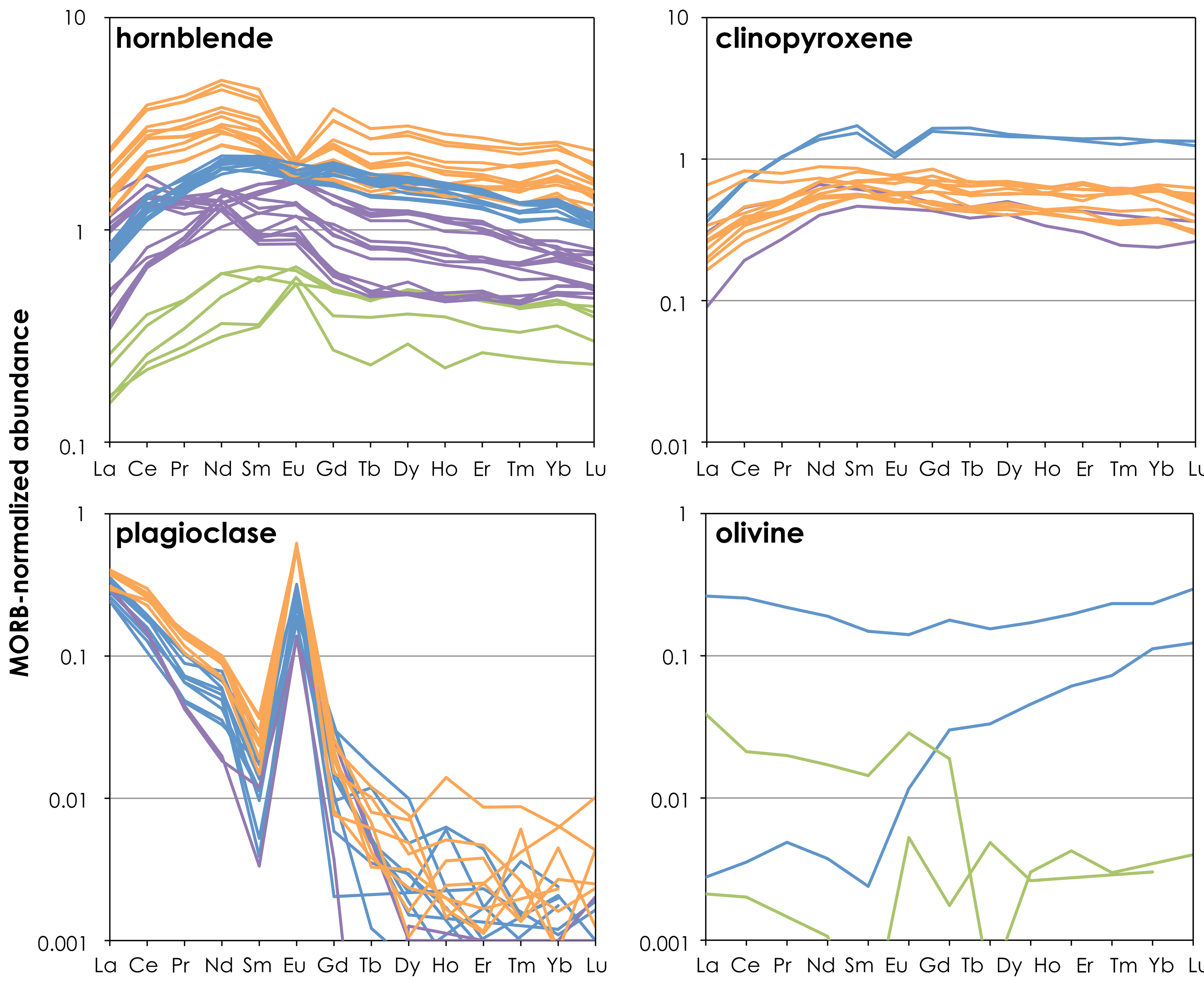
2. Method



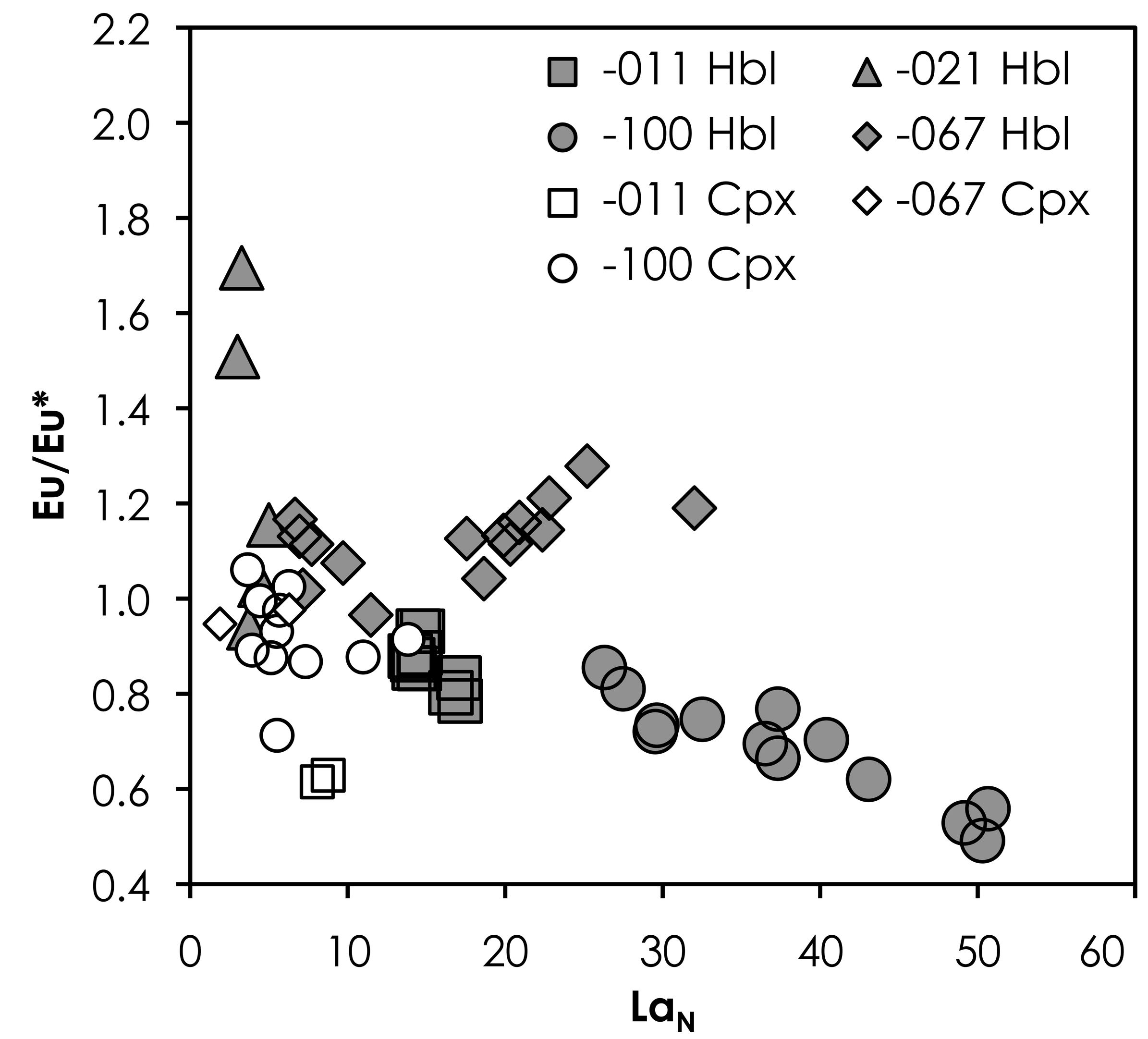
- TAnalysis of hornblende, pyroxene, plagioclase and olivine was done by Laser Ablation-Inductively Coupled Plasma-Mass Spectroscopy.
- Only fresh crystals with no visible inclusions were analyzed.
- We optimized analysis of low-concentration elements (e.g. heavy REE) by using a 40 micron wide laser beam rastered over a line 200 microns long.

← *Photomicrographs of a) a hornblende chadacryst within an olivine oikocryst, JL06-021; b) gradational boundary between a.mphibole and pyroxene, JL06-100. Scale bar (upper right) is 200 microns.*

3. Results



4. Discussion



↑ *A positive Eu anomaly has Eu/Eu* > 1; a negative anomaly has Eu/Eu* < 1. The higher the normalized La abundance, the more evolved a sample.*

- Similarities in hornblende and pyroxene REE profiles is due to their similar REE partition coefficients (Kd).
- Extremely high Eu Kd in plagioclase causes negative Eu-anomalies in minerals that crystallize after plagioclase (no Eu-anomaly is produced in minerals that crystallize before plagioclase).
- Comparison of Eu-anomalies can indicate crystallization sequence:
  - JL06-011: hornblende → plagioclase → pyroxene.
  - JL06-100: pyroxene → plagioclase → hornblende.

- Amphibole formed from melt-reaction of clinopyroxene will inherit the latter's Eu-anomaly.
- A first order interpretation is that the amphibole (slight negative Eu anomaly) in JL06-011 is not the product of clinopyroxene (very negative Eu anomaly) reacting with melt and is a primary fractionating phase.
- Alternately, there may have been two phases of clinopyroxene formation, one before plagioclase saturation and one after, and only the early formed clinopyroxene reacted with melt to form amphibole.

5. Further work

- Using trace element data from all the silicate minerals (whereas only hornblende and pyroxene are discussed in this presentation)to model the liquid in equilibrium with these rocks and compare this with the chemistry of primitive Bonanza arc volcanics.
- Comparing the major element chemistry of the minerals in thse cumulates to those produced in similar equilibruim assembalges from experimental studies.

6. Acknowledgements

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