Ph.D. Candidate

Shuai Ma

Graduate Academic Unit

Earth Sciences

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September 9, 2022

2:00 p.m. (Atlantic)

Virtual Defence

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Examining Board:
Dr. Jacob Hanley (Geology – Saint Mary's University)
Dr. Chris McFarlane (Earth Sciences)
Dr. Lin Wang (Math & Stats)
Dr. Cliff Shaw (Earth Sciences) Supervisor

External Examiner: Dr. Yana Fedortchouk
Department of Earth and Environmental Sciences
Dalhousie University

The Oral Examination will be chaired by:
Dr. Kevin Englehart, Associate Dean of Graduate Studies

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2015 – present	Ph.D. candidate, University of New Brunswick
2015	Master in Geological Engineering, China University of Geosciences
2013	Bachelor of Science, Geological Science, China University of Geosciences,

Publications:

Ma Shuai, Di Yongjun, Zhang Da, Vatuva Absai：Characteristics of Makeng Iron Deposit in Southwestern Fujian Province, Implications for the Skarn Deposit of Magmatic Oringin. Acta Geologica Sinica (English Edition), 2014, 88(supp.20); 576-577.

Shuai Ma, Cliff Shaw: Choose your model carefully: comparison of two versions of the MELTS algorithm with sub-liquidus phase relations in mineral – melt equilibration experiments at 1 GPa and 1250°C. Atlantic Geology, 2019, Volume 55.

Shuai Ma, Cliff Shaw: An Experimental Study of Trace Element Partitioning between Peridotite Minerals and Alkaline Basaltic Melts at 1250°C And 1 Gpa: Crystal and Melt Composition Impact on Partitioning Coefficients. Journal of Petrology, 2021, Volume 62, Issue 11, egab084

In Review for Journal of Petrology: **Shuai Ma**, Cliff Shaw: Modelling vein and wehrlite formation by magma – peridotite interaction with pMELTS: effects of pressure, temperature and peridotite:melt ratio.

Upon submission: Wehrlite Vein In Mantle Xenolith From West Eifel Germany: Evidence For Vein Formation By Carbonatite Metasomatism

A Thermodynamic and Experimental Study of Rock / Melt Reaction in A Basanite-Peridotite System: Trace Element Partitioning and Formation of Wehrlite Veins

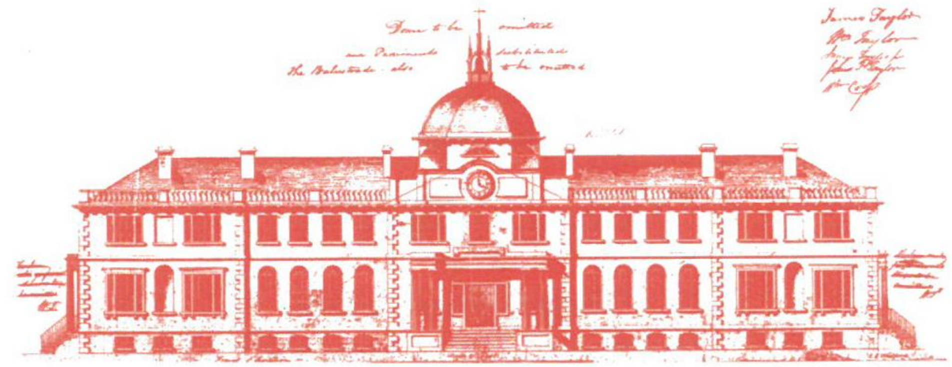
Abstract

Enrichment of mantle previously depleted by partial melting, termed mantle metasomatism, occurs by reaction of peridotite with fluids / melts derived from deeper in the mantle. Clues provided by mantle xenoliths about the nature of the metasomatic agent include 1) discordant veins of dunite, wehrlite and clinopyroxene; 2 disseminated occurrences of phlogopite, amphibole or apatite; 3) LREE-enriched but isotopically depleted mineral phases such as amphibole and clinopyroxene; 4) preserved reaction textures such as incongruent dissolution texture and sieve texture of peridotite minerals.

To understand the compositional effects of the transformations that occur during mantle metasomatism, a complete set of mineral / melt trace element partition coefficients (Kd) is an essential input into thermodynamic models. Up to now, the partition coefficients have been compiled from a variety of studies that used different melt compositions, pressure, temperature, and initial starting mineral assemblages. The first part of this study describes the development and testing of an internally consistent database of mineral / melt partition coefficients for a variety of peridotite compositions interacting with an alkaline mafic magma. The Kd values, determined at 1 GPa and 1250 °C for clinopyroxene, orthopyroxene and olivine were compared with predictions from the lattice strain model which indicates two site mixing and in some cases multivalence of single elements. Partitioning is controlled by both mineral and melt compositions. Of particular importance is the structure of the melt as indicated by viscosity and the ratio of non-bridging oxygen to tetrahedrally coordinated oxygen.

In the second part of the study the new set of partition coefficients were used to model magma – peridotite interaction and its relation to the origin of clinopyroxene- dominated veins that are found in the peridotite xenoliths from the West Eifel Volcanic Field, Germany. The pMELTS algorithm used for the model examines how alkaline mafic magma reacting with mantle can modify mineral assemblages, proportions, and compositions in a variety of peridotite assemblages. The models reproduce the observed mineral assemblages and compositions in the natural samples from the West Eifel and support the earlier interpretation that these veins represent migration pathways for rising asthenospheric magma and that interaction with this magma caused significant changes to the lithospheric mantle, depleting it in orthopyroxene and enriching it in clinopyroxene.

The final part of the study is an examination of an unusual type of amphibole-phlogopite-rich wehrlite vein also from the West Eifel Volcanic Field (termed a type II vein to distinguish it from the compositionally distinct magmatic veins described in the second part of the study). This vein contains clinopyroxene, phlogopite and amphibole that are identical in major and trace element composition to the same phases found as disseminations in metasomatized xenoliths in the West Eifel. Previous studies have linked the disseminated metasomatic assemblage to passage of fluids through the mantle. The vein mineralogy cannot be linked to any of the primitive silicate melts thus far identified in the Eifel region. Instead, the low Ti, Zr and high LREE abundance as well as the fractionated LREE/HREE ratio suggests a carbonatitic source for both vein and disseminated minerals. Although carbonatites are known from the Eifel region, those already studied have been interpreted to be related to extreme fractionation of mafic magmas in the upper crust. The carbonate signature in the peridotite xenolith described here is the first unequivocal evidence that such melts were an active metasomatizing agent in the sub-Eifel lithospheric mantle.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

The University of New Brunswick recognizes that the university sits on traditional Wolastoqey territory. The river that runs right by our university – the St. John River – is also known as Wolastoq, along which live the Wolastoqiyik -- the people of the beautiful and bountiful river.

University of New Brunswick
School of Graduate Studies

Oral Examination

Shuai Ma

in Partial Fulfilment of the Requirements for the Degree of

Doctor of Philosophy