Minor and trace element abundance of Cr-spinel from forearc mantle and abyssal peridotites

Fabio Stern[1], Keiko Hattori[1] and Simon Jackson[2]

1. University of Ottawa, Ottawa, Ontario, K1N 6N5, 2. Geological Survey of Canada, Ottawa.

uOttawa
L'Université canadienne
Canada's university

EARTH IN EVOLUTION
GOLDSCHMIDT MONTREAL JUNE 2012

Introduction

We studied chemical compositions of Cr-spinel in peridotites from several locations (fore arc mantle peridotites from the Marianas, Himalayas, Bay of Island Ophiolite Complex (BOIC) in Newfoundland and the northern ultramafic belt in Dominican Republic (DR). To characterize the spinel compositions from forearc mantle peridotites, spinel in abyssal peridotites from Dominican Republic was also examined.

The mineral Cr-spinel is a common accessory phase of mafic and ultramafic rocks. Since it is alteration resistant, it is useful in petrogenetic studies of host igneous rocks, but the major element composition of spinel is not sufficient to fingerprint types of host rocks. In this study minor and trace elements of Cr-spinel were examined.

Samples

Representative grains were selected for this study.

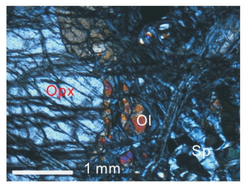


Fig 4: photomicrograph of partially hydrated harzburgite from Marianas (Sample: 609-01).

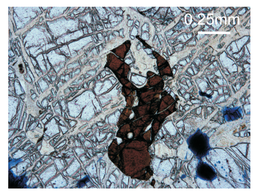


Fig 5: photomicrograph of Cr-spinel in dunite from BOIC (sample: BMD-19)

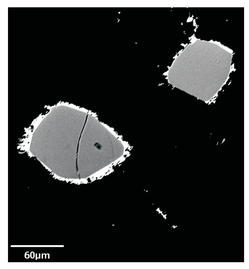


Fig 6: Back-scattered electron image of chromite (light gray) rimmed by magnetite (white) from Himalaya (sample TSL-20).

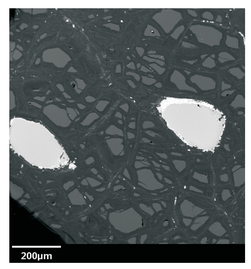
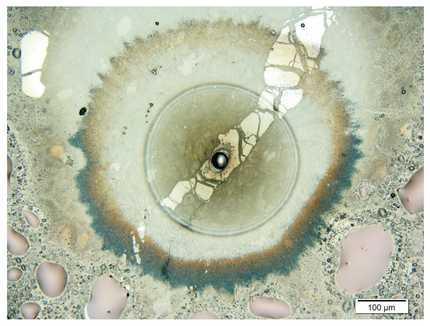
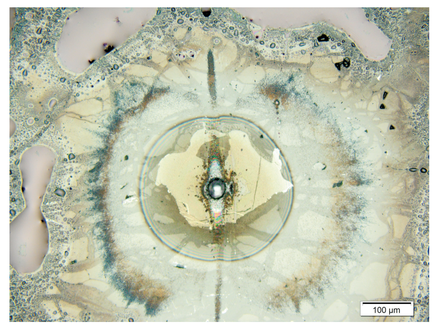


Fig 7: Back-scattered electron image of chromite (light gray) rimmed by magnetite (white) from BOIC (Sample: TBL-03).

Minor and Trace Element Abundance

By an Excimer laser-assisted ICP-MS

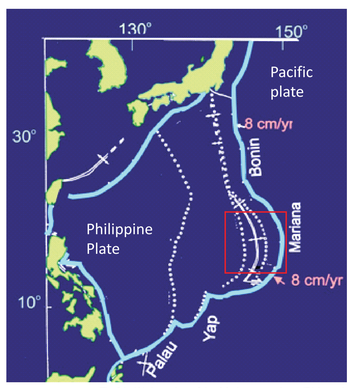




Cr-spinel grains in thick (50-100 mm) sections were first examined with an electron probe, and subjected to the analysis using a laser ICP-MS (Agilent 7500). Depending on the texture of spinel grains, we selected different focused beam sizes: 52 µm (left) and 69 µm (right) in diameter.

Geological Settings

In the Marianas, hydrated peridotites protrude as serpentinite diapirs from the base of the mantle wedge inthe outer 100 km of the forearc. Himalayan serpentinites have a similar origin and were exumed with Tso Morari UHP metasedimentary rocks along the subduction plane.



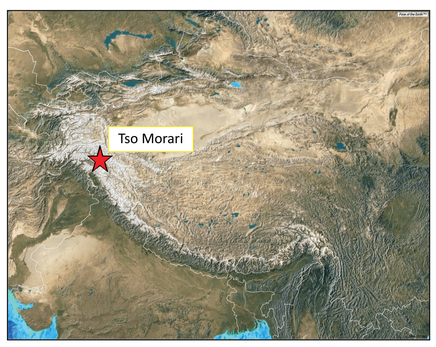


Fig 01: (A): Location of the Mariana trenches. (B) Location of the Tso Morani UHP rocks in the Himalayas.

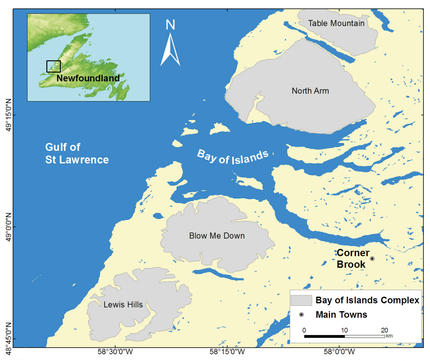


Fig 2: Location of the Bay of Islands Ophiolite Complex - Canada.

The Bay of Islands Ophiolite Complex (BOIC) is an Early Ordovician ophiolite located on the western ultramafic belt of the northern Appalachians in Newfoundland. The BOIC consists of four massifs; Tablelands, North Arm, Blow Me Down, and Lewis Hills massifs from the north to south.

Peridotites from a Tertiary subduction complex were collected in the northern Dominican Republic. Hydrated abyssal peridotites occur in ophiolite complexes in the northern terranes and in serpentinite mélanges. Hydrated forearc mantle peridotites occur along major strike-slip fault zones.

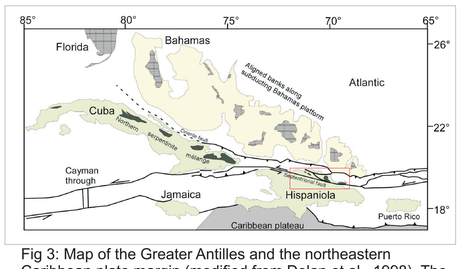


Fig 3: Map of the Greater Antilles and the northeastern Caribbean plate margin (modified from Dolan et al., 1998). The box indicates the study area

Results

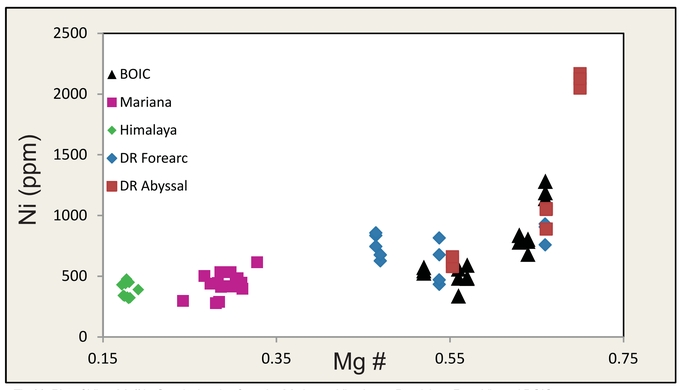


Fig 08: Plot of Ni vs Mg# in Cr-spinel grains from the Marianas, Himalayas, Dominican Republic and BOIC.

Nickel concentration in Cr-spinel from all locations range from 276 to 2166 ppm; showing a broad positive correlation with Mg#, confirming their coherent behaviour in the mantle. High Ni contents (887–2166 ppm) are found in spinel in abyssal peridotites from Dominican Republic and low contents (317-470 ppm) are found in forearc mantle peridotites from the Himalayas.

Cobalt has a strong inverse correlation with Mg# and a positive correlation with Cr#. Co contents are low (295-367 ppm) in abyssal peridotites from Dominican Republic and high (574-777 ppm) in forearc mantle peridotites from the Himalayas.

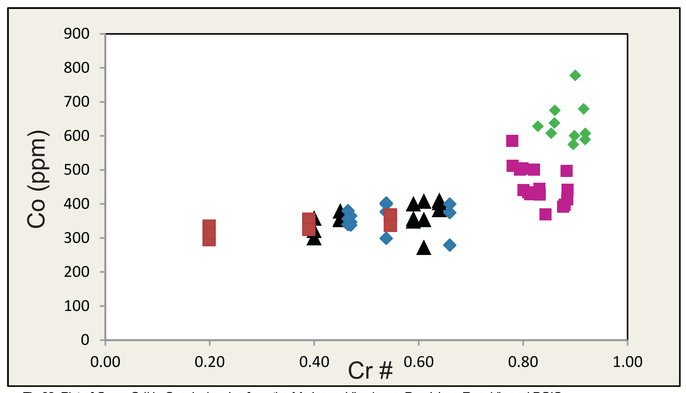


Fig 09: Plot of Co vs Cr# in Cr-spinel grains from the Marianas, Himalayas, Dominican Republic and BOIC.

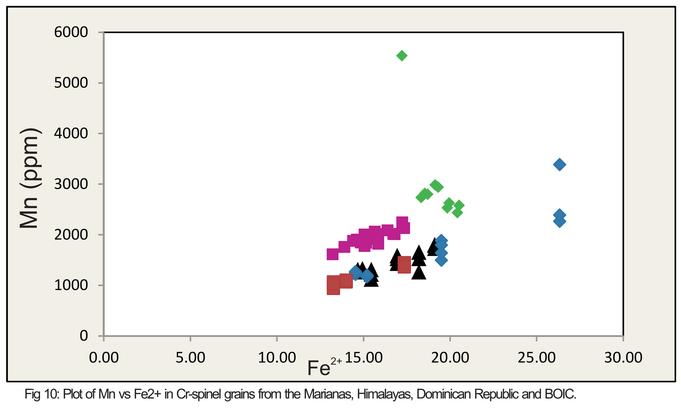


Fig 10: Plot of Mn vs Fe2+ in Cr-spinel grains from the Marianas, Himalayas, Dominican Republic and BOIC.

Manganese has the widest range of concentration among the minor elements from 938 to 5535 ppm. It shows a positive correlation with Fe2+ suggesting Mn also resides in the octahedral site. Cr-spinel in abyssal peridotites from Dominican Republic shows low Mn contents (938–1446 ppm) whereas the Himalayan Cr-spinel shows high contents (2432-5535 ppm).

Conclusions

- We observed very large variations in minor and trace element abundances in spinel compared to major elements;

- Some elements, such as Ti and Ni, show variations greater than one order of magnitude;

- Trace and minor element abundances provide distinct geochemical signatures reflecting tectonic settings of the host rocks.