Tectonic Evolution of the Northern Appalachian Mountains recorded in the Bay of Island Ophiolite Complex, Canada.

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Introduction

The Bay of Islands Ophiolitic Complex (BOIC) in the northern Appalachians is one of most well exposed ophiolites in the world. Proposed opinions for the origins of the BOIC include the oceanic lithosphere of the Iapetus Ocean and arc lithosphere following the closure of the Ocean. We studied ultramafic rocks in the BOIC to evaluate their origins and tectonic evolution of the area.

Geological Settings

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

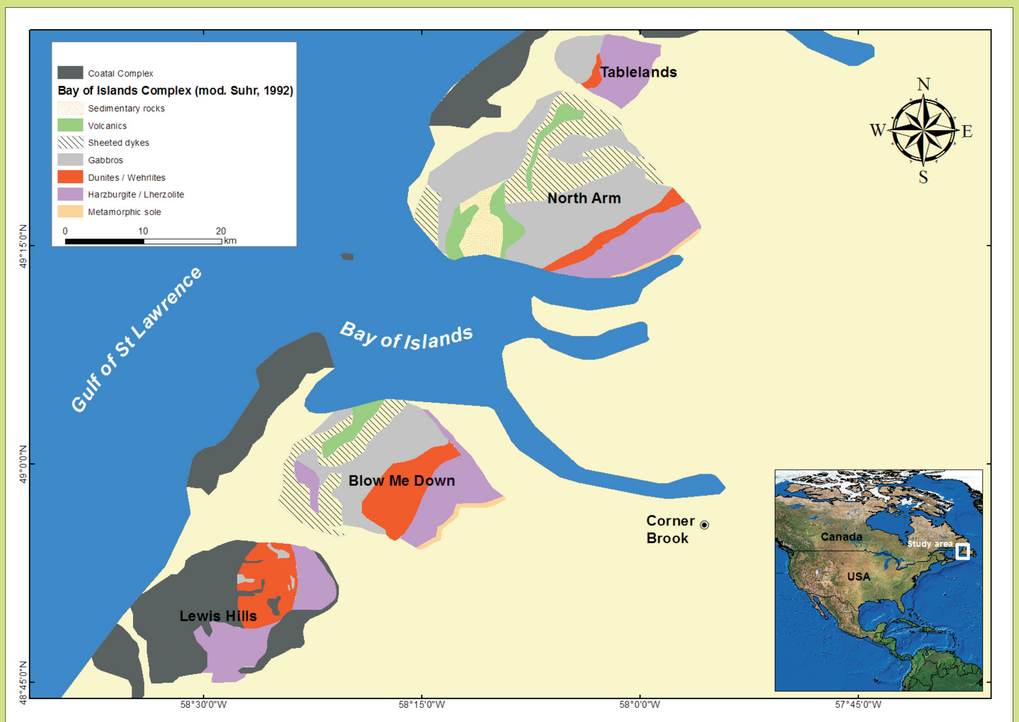


Fig 1: Geological Map of Bay of Islands. (Modified from Suhr, 1992)

Rock Types

Representative harzburgite and dunite samples were selected for this study. Harzburgites are composed of olivine, orthopyroxene and chromite. They may contain veinlets of dunites. Dunite is composed of olivine with minor chromite. Minor orthopyroxene and clinopyroxene occur in several samples. It contains lenses and veins of chromite.

Fig 2: Slightly foliated harzburgite from Table Mountain.

Fig 3: Harzburgite with dunite veins from Table Mountain.

Fig 4: Dunite with chromite lenses from the Blow-Me-Down Massif.

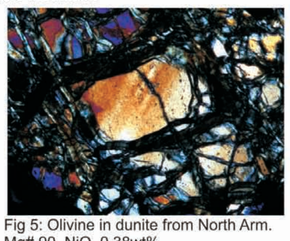


Fig 5: Olivine in dunite from North Arm. Mg# 90, NiO 0.38wt%.

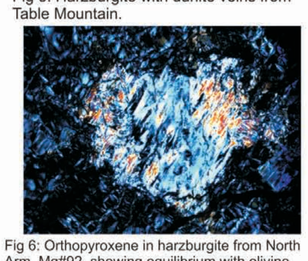


Fig 6: Orthopyroxene in harzburgite from North Arm. Mg#92, showing equilibrium with olivine.

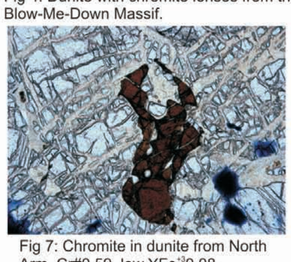


Fig 7: Chromite in dunite from North Arm. Cr#0.59, low YFe^{+3}0.08.

Mineral Chemistry and PGE

The cores of Cr-spinel in harzburgite have similar compositions in individual samples, but different samples show a variation in Cr# from 0.20 to 0.78. Spinel and olivine compositions plot in the olivine-spinel mantle array of Arai (1994). Abundance of platinum group elements (PGE) show a flat to slightly negatively sloped normalized pattern, supporting the residual mantle origin. Dunite contains Cr-spinel with Cr# ranging from 0.19 to 0.71. Dunite also shows slightly positively sloped primitive-mantle normalized PGE pattern with low Os and Ir, confirming that dunite is a cumulate of a mafic melt. In Cr# vs. Mg# diagram spinel plots in the fields of abyssal and fore arc peridotites.

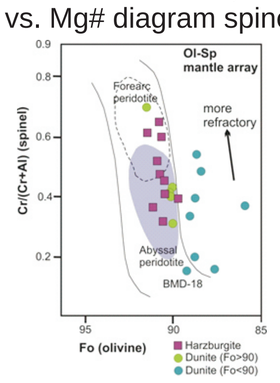


Fig 8: Forsterite component of olivine vs. Cr# of spinel. Abyssal and forearc mantle peridotites from Hattori *et al.* (2010).

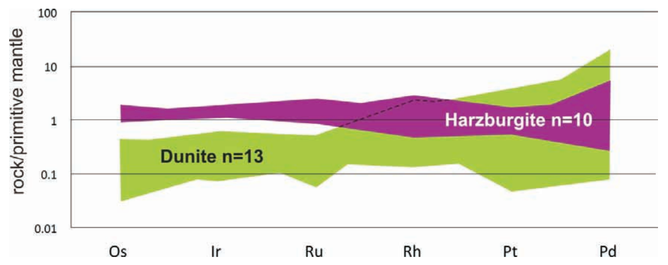


Fig 9: Abundance of PGE in bulk rock normalized to primitive-mantle values. Primitive mantle values are from McDonough and Sun (1995).

Mineral Chemistry

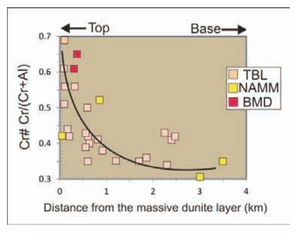
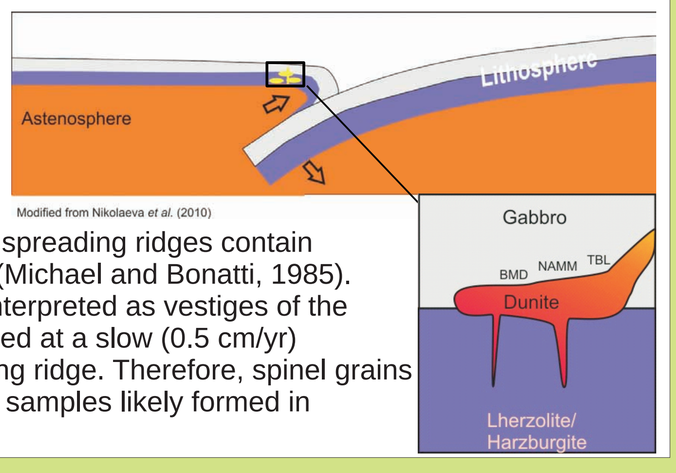


Fig 10: Cr# in the harzburgite samples from BOIC versus the distance from the massive dunite layer contact. Data from TBL include those obtained in this study and from Suhr (1992).

For harzburgite, the Cr# vs. Mg# diagram spinel plots in the fields of abyssal and fore arc peridotites. Cr-spinel with Cr# ranging between 0.4 and 0.55 may have either refractory abyssal peridotite or relatively fertile fore arc peridotite origin.



Modified from Nikolaeva *et al.* (2010)

Refractory abyssal peridotites form at ridges with fast spreading rates. On the other hand, peridotites formed at slow spreading ridges contain spinel with low Cr#, < 0.4 (Michael and Bonatti, 1985). The BOIC ophiolites are interpreted as vestiges of the Iapetus Ocean which formed at a slow (0.5 cm/yr) (Nicholson, 1992) spreading ridge. Therefore, spinel grains with high Cr# (>0.4) in our samples likely formed in subduction setting.

Conclusions

- Dunite is a cumulate of a mafic melt formed in a subduction zone.

- The values of Cr# of spinel in harzburgite closer to dunite show higher Cr#, suggesting the genetic link of the two.

- The parent melt for the dunite most likely formed in the harzburgite

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