Ultramafic Occurrences in the Bonanza Arc, near Port Renfrew, Southwestern Vancouver Island

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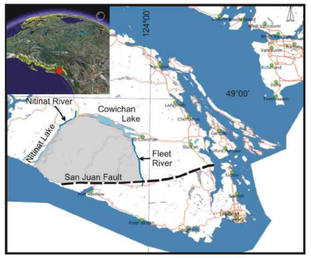
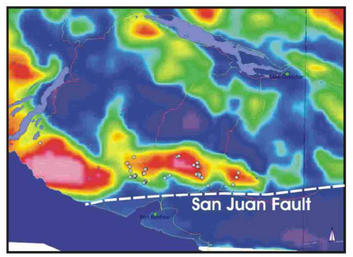
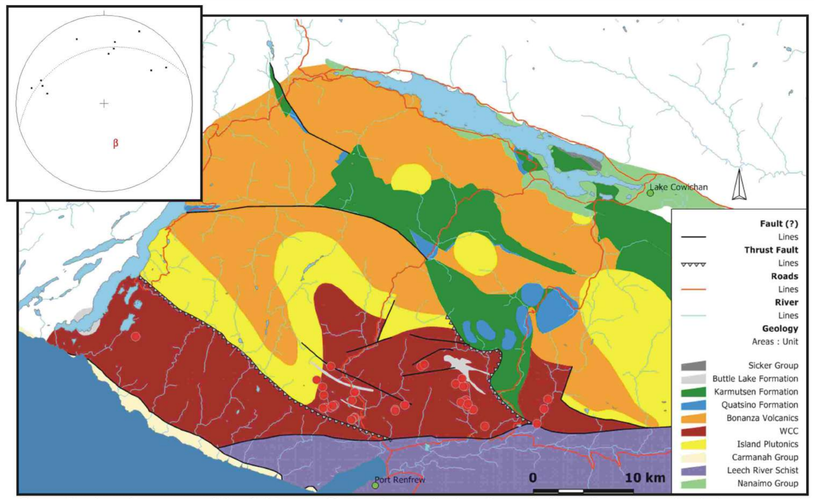
Overview and Geology

- Jurassic-aged igneous rocks on Vancouver Island represent an obliquely tilted section of island arc crust called the Bonanza arc.
- The Bonanza arc intrudes and overlies the Triassic Karmutsen basalts, which were themselves erupted into the Paleozoic Sicker Group, an island arc active from Devonian to Permian time.
- Recently discovered ultramafic rocks occurring within the mafic-intermediate plutons of the Bonanza arc generally correspond to anomalies in the regional aeromagnetic signal, as well as to soil anomalies for nickel and chromium in nearby streams.





Above left: geographic location of the field area (shaded region). Right: aeromagnetic anomaly map centered on the field area (courtesy of BC MapPlace). Circles denote the locations of ultramafic outcrop.



Generalized geology map of the field area. Circles denote the locations of ultramafic outcrop. Inset shows poles to foliations within the WCC. The data define a fold axis plunging steeply to the southeast.

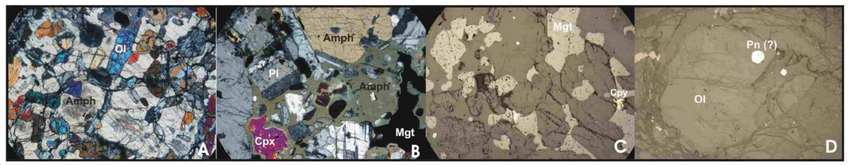
Field Relations

- From base to top, the Bonaza arc is comprised of the West Coast Crystalline Complex (WCC), the Island Plutonic Suite, and the Bonanza Group volcanics.
- The West Coast Crystalline Complex has been interpreted as the deepest preserved level of the arc, based on its intrusive relationship with Sicker Group country rock. The complex is dominated by plutons of gabbroic to dioritic composition.
- The Island Plutonic Suite is composed of plutonic rocks ranging from quartz diorite to alkali feldspar granite.
- Ultramafic rocks occur as discrete bodies within the WCC diorites, ranging in size from one metre to several tens of metres.
- Smaller bodies, which tend to be olivine-rich, have either abrupt contacts with their host, or are present as sheared pods.
- Larger bodies of cumulate gabbro grade into the diorites of the WCC.

Field pictures showing ultramafic rocks in outcrop. Top: stongly altered peridotite grading in contact with pegmatite diorite. Centre: Peridotite outcrop against a background of strongly chemically weathered ultramafic rock. Bottom: abrupt contact between peridotite and diorite.

Petrography

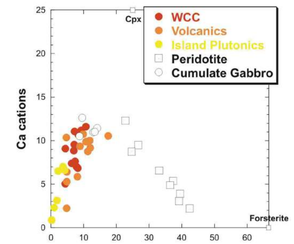
- Peridotites in thin section consist of variably serpentinized cumulus olivine with inclusions of euhedral spinel, poikilitically enclosed by either orthopyroxene, amphibole, or more rarely clinopyroxene. The presence of orthopyroxene in the Bonanza arc peridotites rules out an association with Alaskan-type intrusions.
- Weakly to strongly altered plagioclase is present as an intercumulus phase in some peridotite samples.
- Amphibole is of igneous origin as a deuteric alteration of anhydrous minerals during advanced crystallization of hydrous magma.
- Cumulate gabbro and gabbronorite display cumulus plagioclase +/- orthopyroxene and clinopyroxene.
- Magnetite with minor ilmenite exsolution is the dominant opaque phase in ultramafic rocks.
- Minor amounts of chalcopyrite are noted in most samples.
- Rare inclusions of white, high-reflectivity inclusions in olivine are noted, possibly pentlandite.

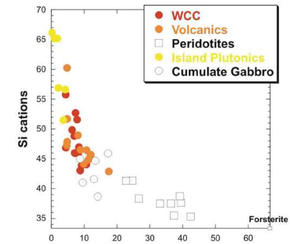


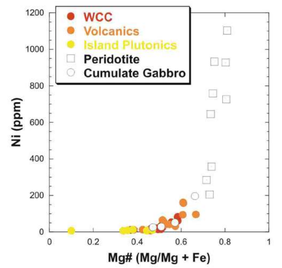
Photomicrographs of Bonanza arc ultramafic rocks. A) cumulus olivine enclosed by amphibole. B) Cumulus plagioclase with relict clinopyroxene enclosed by amphibole. C) Magnetite grains in cumulate gabbro with minor chalcopyrite. D) Possible pentlandite inclusion in cumulus olivine.

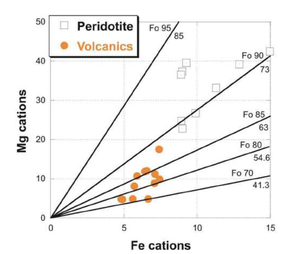
Geochemistry

- Ultramafic rocks of the Bonanza arc provide us with an opportunity to address the question of andesite genesis.
- While the dominant magma composition extruded in island arc settings is basalt, the continental crust, believed to have grown by accretion of island are terranes, has an andesitic bulk composition.
- Removal of mafic components from arc basalt may be an important mechanism in andesite genesis, as well as in the stabilization of continental crust.
- The ultramafic rocks within the Bonanza arc appear to represent an accumulation of these mafic components.









- The geochemistry of the Bonanza arc peridotites is controlled primarily by olivine fractionantion.
- The most primitive arc basalts found are in equilibrium with an olivine of composition ~Fo_{86}, and are therefore not primary.

Future Work

- Future work will include mineral chemistry analysis by electron microprobe, as well as trace and rare earth element analysis of select samples.
- Additional field work will be conducted in the summer of 2007 in order to improve the geological interpretation of the field area.

Acknowledgments

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