Formation of Garnet Orthopyroxenites and Mobility of Siderophile and Chalcophile Elements in the Subcontinental Lithospheric Mantle during Metasomatism by Asthenospheric Mantle-derived melt below the Southern South America

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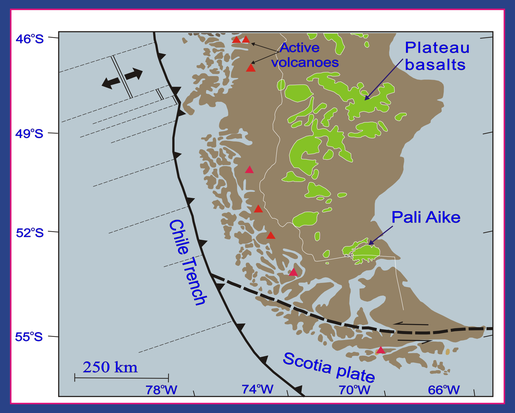
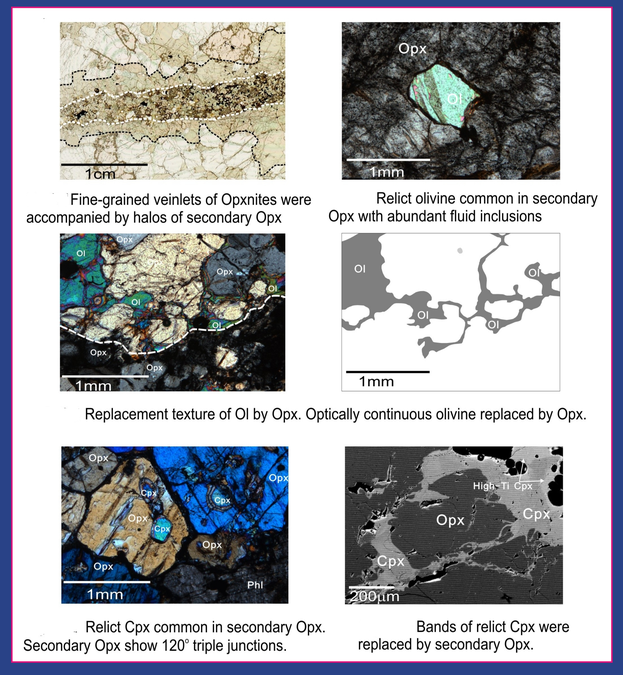
Introduction

The occurrence of secondary orthopyroxene has been reported in subarc mantle and it has been interpreted as Si enrichment by aqueous fluids and melt derived from slabs. High modal abundance of orthopyroxene in ancient SCLM is also explained by infiltration of Si-rich melt. An alkali-rich melt has a low activity of SiO_2 and is not expected to cause Si enrichment. However, a recent study of xenoliths in western Japan by Arai et al (2006) suggests that evolved alkali-rich melt is capable of producing Si enrichment in such peridotites.

Voluminous alkali basalts of Quaternary age in the southern South America contain abundant mantle xenoliths including garnet-bearing orthopyroxenites. They are distinct in color and texture from other mantle peridotites. This paper reports the mineralogy and petrology and origin of garnet orthopyroxenites.



The map shows the distribution of the Quaternary alkaline basalt fields (apple green) including the study



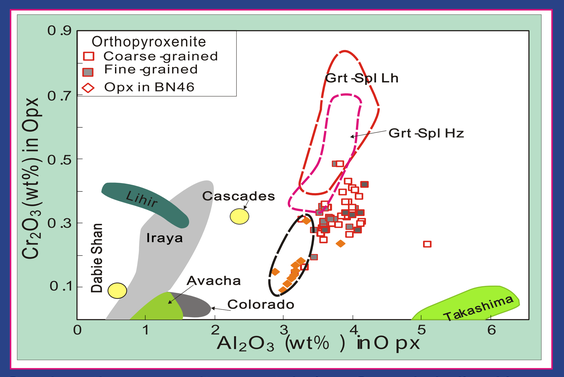
Fine-grained veinlets of Opxnites were accompanied by halos of secondary Opx

Relict olivine common in secondary Opx with abundant fluid inclusions

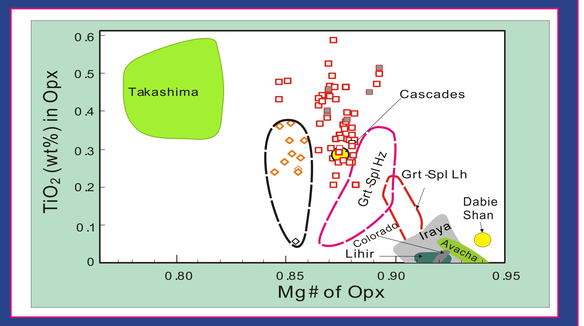
Replacement texture of Ol by Opx. Optically continuous olivine replaced by Opx.

Relict Cpx common in secondary Opx. Secondary Opx show 120° triple junctions.

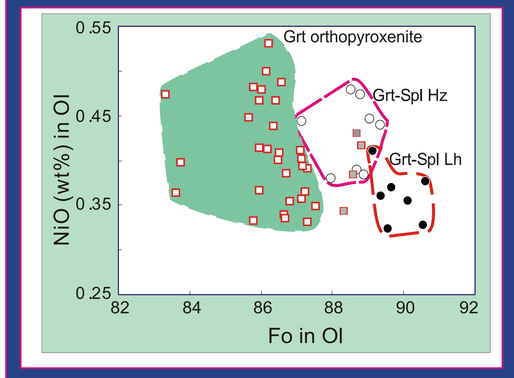
Bands of relict Cpx were replaced by secondary Opx.



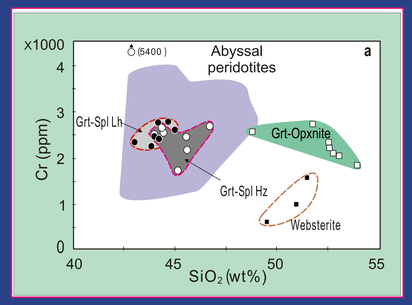
Opx in orthopyroxenites contain low Cr and similar Al compared with Grt-bearing peridotites in the study area. Aluminum contents are higher than those of the secondary Opx in subarc mantle



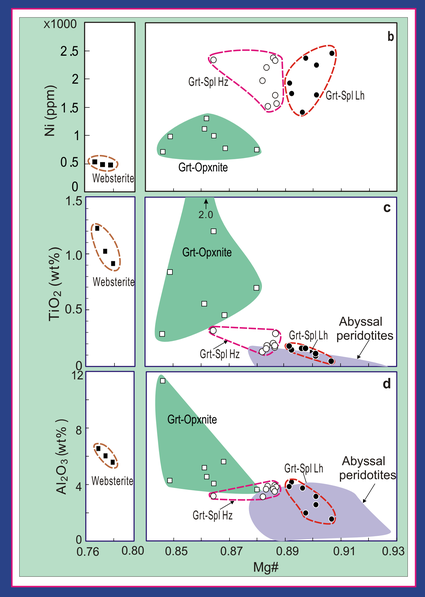
The secondary Opx contains high Ti and low Mg# compared with Opx in peridotites in the study area and other subarc mantle. The evidence suggests that the metasomatizing agent is most likely evolved (low Mg) high Ti melt because Ti is usually not mobile in fluids.



The contents of Ni in relict Ol in Grt orthopyroxenites are similar to slightly higher than those in peridotites. Higher contents of NiO in the secondary Ol are explained by preferential uptake of Ni by Ol compared to Opx.



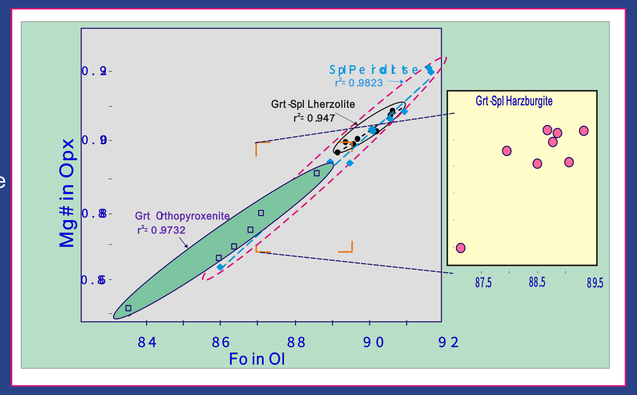
Silica is enriched during the metasomatism, but there is no change in the concentrations of Cr



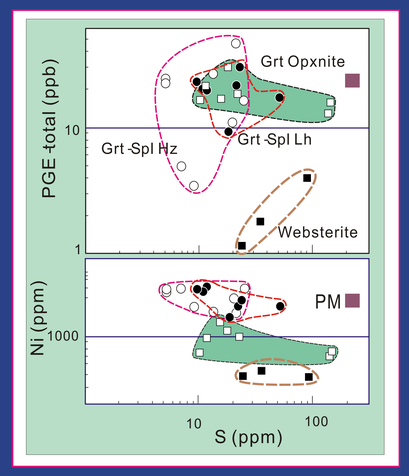
Nickel and Mg are depleted during the metasomatism

Titanium is enriched and Mg depleted during the metasomatism

Aluminum is enriched and Mg depleted during the metasomatism

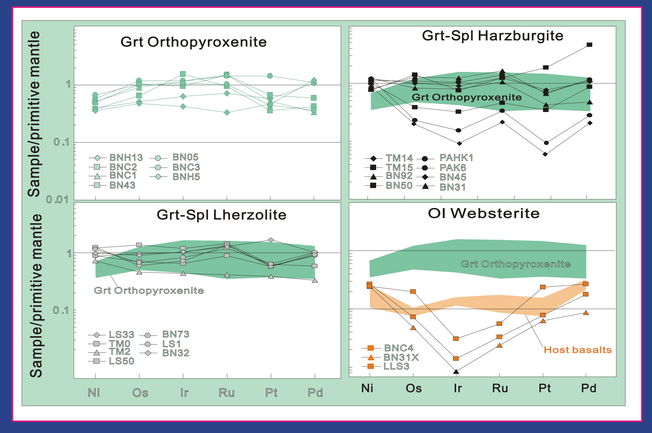


Grt-orthopyroxenite, Grt-lherzolite and Spl peridotites show good correlation of Mg# in Opx vs. Fo, and Mg# in Opx are always >Fo, suggesting equilibration attained. However, Grt-harzburgites show no good correlation, suggesting Opx and Ol were not equilibrated.



PGE are not controlled by S, suggesting that sulphides are not their host.

Ni are depleted and not correlated with S, suggesting that Ni is mostly hosted by silicates.



PGE abundances and patterns for Grt orthopyroxenites are similar to those of Grt-bearing peridotites, suggesting that PGE were not mobile during the metasomatism and that there was no introduction of PGE.

Cumulates show very different patterns and concentrations of

Conclusions

1. Grt orthopyroxenite xenoliths contain Ti-rich Amp and phlogopite, and abundant relict Ol in Opx. They are metasomatic products of Grt peridotites.

2. The Opx contains high TiO_2 (0.20-0.59 wt%), moderate Al_2O_3 (3.27-5.10 wt%) and Cr_2O_3 (0.15-0.48 wt%), and low MgO (Mg# 0.85-0.88) compared to Grt-bearing peridotites. The compositions are different from secondary Opx in subarc mantle.

3. The metasomatizing agent is likely an evolved alkali melt that was derived from the underlying asthenospheric mantle.

4. Cr, Ni, and PGE were essentially immobile during the metasomatism.