Garnet stability during dehydration melting of MORB-composition amphibolites revisited

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Garnet growth during dehydration melting of metabasaltic rocks plays a key role in petrologic and geodynamic processes. In a geodynamic context, the high density of garnet-rich assemblages is thought to produce Rayleigh-Taylor instabilities that may lead to lower crustal delamination [1]. Considerable uncertainty exists about the low-temperature stability limit of garnet in dehydration melting as a result of difficulties associated with nucleating garnet in experimental studies [2].

Here we report on garnet stability during dehydration melting of two natural amphibolite powders of MORB-type compositions. The starting material contained trace amounts of garnet (<2 vol.%), which we believe would have avoided nucleation difficulties in the stability field of garnet. Experiments were conducted using an end-loaded piston cylinder apparatus from 7-22.5 kbar and between 775-1050°C with experimental run times varying from 720 hrs at 775°C to 48 hours at 1050°C. The majority of experiments below 900°C exceeded 300 hours.

Garnet growth required pressures of ≥10 kbar and temperatures of >800°C as constrained by experimental brackets for garnet appearance between 10 and 15 kbar and two successful phase reversal brackets at 10 and 12.5 kbar. Below 825°C none of the original garnet seeds persisted in the run products. We argue that a temperature >800°C is required for garnet formation by dehydration melting in MORB-type bulk compositions. The proportion of garnet in the residue coexisting with a felsic melt increases with pressure (10-22.5 kbar). Calculations of restite density indicate that the high densities required for initiating the crustal delamination process may only be attained at pressures >17.5 kbar, when garnet constitutes >20 vol. % of the residue and when plagioclase abundance is significantly reduced (<5-10 vol. %). This places constraints on the minimum crustal thickness (>55 km) required for delamination to occur.

[1] Zegers & van Keken (2001) Geol. 29:1083-1086. [2] Wolf & Wyllie (1994) CMP 44:151-179.

Geochemical and mineralogical evidences of melt-rock interaction in diopsidic harzburgites of Sorkhband ultramafic complex, Southern Iran

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The Ordovician Sorkhband ultramafic complex in Southern Iran comprises of a lower part of dunite, largest podiform chromitite deposits in Iran, olivine clinopyroxenite, wehrlite; and an upper part of foliated porphyroblastic diopsidic harzburgite with subordinate dunite and olivine clinopyroxenite dykes. Modally diopsidic harzburgite consist mainly of olivine (70-83%, Fo_{90-91}), orthopyroxene (10-30%, $En_{90}Fs_9Wo_1$), clinopyroxene (1-5%) and chromite (~1%). Mineralogic, petrographic and geological evidences which represent impregnation and melt-rock interaction in diopsidic harzburgites are:

1) Turbulence in PGE and REE patterns of peridotites resulted from melt-rock interaction. 2) enrichment in LREE and incompatible elements (e.g., Cs, Rb, Nb and Ta) relative to primitive mantle denotes the later interaction of harzburgites with a migrating melt rich in LREEs. 3) High orthopyroxene and low clinopyroxene content. 4) Melting of orthopyroxenes and substitution of diopside and tremolite may be the result of melt-rock interaction. 5) Chain and patches of smaller olivine crystals in the matrix, corroding orthopyroxene porphyroclasts, can be interpreted as second generations formed from melt percolating through diopsidic harzburgite. 6) Corrosion embayment of some orthopyroxenes and its replacement by tiny olivine grains may have been resulted from incongruent melting of orthopyroxene (orthopyroxene + low-Si melt → olivine + high-Si melt). 7) Anhedral grains of chromite which showing atoll like and embayed textures, which may result of corrosion and recrystallization of chromite in contact with percolating melts of exotic origin.

As a result, mineral and whole rock chemistry show that the Sorkhband ultramafic complex invaded by an exotic percolating melt with transitional boninitic composition.