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Armalcolite and rutile-bearing mantle peridotites, Vitim volcanic field, South Russia: petrography and mineralogy

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One of the major problems in upper mantle geochemistry is the residence sites for high-field strength elements (HFSE, i.e. Nb, Ta, Ti, Zr, Hf). These elements show pronounced affinities for both Fe-Ti oxides and titanate structures but some (e.g. Ti) may also occur in clinopyroxene, amphibole and phlogopite. Ilmenite and rutile have been previously described as products of "Fe-Ti" metasomatism in mantle xenoliths entrained in alkali basalts (Menzies et al., 1987; Wass, 1979; O'Reilly, 1987; Ionov et al., 1999; Gregoire et al., 2000) and in orogenic lherzolite massifs (Lorand et al., 1990). Ionov et al. (1999) and Gregoire et al. (2000) found an unusual metasomatic vein mineral association in basalts of the Kerguelen Island and of the South Siberia consisting of feldspar, olivine II, chromite II and Ti-oxides (rutile, ilmenite and armalcolite).

Abundant mantle xenoliths in Pliocene basanites from the Dzhilinda river, Vitim volcanic field, are divided into three groups: (1) coarse-grained protogranular spinel and garnet-spinel lherzolites (BK 2px temperatures 1100-1250^{o}C; BK opx-gar pressure 18-23 kbar); (2) spinel lherzolites and harzburgites of protogranular (2a) to tabular equigranular (2b) microstructures (T = 800-900^{o}C; P = 10-15 kbar); (3) mosaic equigranular lherzolites (T = 710-750^{o}C) (Malkovets, 1994; Litasov et al., 2000a and b). Peridotites of group 3 are enriched in modal pyroxene and spinel. Minerals of these peridotites have contrasting petrological characteristics. On the one hand all the

minerals and the whole-rock analyses have the highest *mg* among the lherzolite suite and thus represent the refractory residue after partial melting. On the other hand these lherzolites have high modal pyroxene and spinel and analyses of clinopyroxene, orthopyroxene, spinel, and whole-rock samples show high Ti contents. Clinopyroxenes contain 2-2.2 % TiO_2, olivines 0.7 % NiO, and spinel 0.6-0.7 % NiO and 0.9-1.0 % ZnO. These features clearly indicate a late episode of metasomatic enrichment.

In 3 of 12 spinel lherzolites from group 3 Ti-rich oxide minerals, rutile, armalcolite, Ca-Cr armalcolite and ilmenite, have been identified by EMP analysis. The Ti-oxides in this sample are in microstructural equilibrium with the primary peridotite mineralogy. All previous occurrences of armalcolite in spinel peridotites (Ionov et al., 1999; Gregoire et al., 2000) describe the Ti-oxides in secondary veins obviously not in equilibrium with the primary host peridotite mineralogy. The Ti-rich oxides in lherzolites from Dzhilinda are compositionally very similar in major elements to ones from Sikhote-Alin, Hamar-Daban and Kerguelen (Ionov et al., 1999; Gregoire et al., 2000).

We suggest that Group 3 Ti-rich lherzolites characterize a unique type of mantle-melt interaction resulting from the infiltration of high-*mg*, high-HFSE melt into extremely depleted peridotites.