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Methane inclusions in olivine in titanoclinohumite-bearing meta-dunite from the Sanbagawa high-P metamorphic belt, Japan

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Fluid inclusion studies of mantle-derived material, especially of subduction-zone related ones, are important to know fluid circulation itself and related element transportation. In general, aqueous fluids easily solve large-ion lithophile elements (LILE), and high-filed strength elements (HFSE) are insoluble in them. Some serpentinized ultramafic bodies from high-pressure metamorphic belt, e.g., Malenco (Trommsdorff and Evans, 1980) and Almirez (Trommsdorff et al., 1998; Scambelluri et al., 2001), contain titanoclinohumite of which TiO2 content is up to 5 wt%. High-pressure experiments by Iizuka and Nakamura (1995) produced titanoclinohumite resulted from interaction between metabasite and a mixture of olivine and orthopyroxene. They indicate Ti, the representative HFSE, could be mobile under high-pressure conditions.
Fujiwara meta-dunite is one of the examples of titanoclinohumite-bearing ultramafics from Sanbagawa high-P metamorphic belt, southwest Japan, and we found almost pure methane as micro-inclusions in olivine in it. The Fujiwara dunite is composed of serpentinized dunitic clasts with a matrix of olivine (Fo88-95) and titanoclinhumite with < 8 wt % TiO2. Titanoclinohumite also forms veinlets with brucite and carbonate with minor amount of magnetite, ilmenite, and perovskite. Petrographical and mineral chemical characteristics suggest a derserpentinization origin especially for the olivine-rich matrix, within a subduction zone complex. The protolith was brecciated dunite that contained an appreciable amount (4 volume % on average) of Ti-rich chromian spinel with 2 to 3 wt % TiO2. The source of Ti of titanoclinohumites was the chromian spinel, which could release Ti on alteration to magnetite via ferritchromite. Ti had most typically moved from the dunitic clasts to surrounding matrix. There have been some reports about the effect of hydrocarbon on the Ti mobility via aqueous fluid (e.g., Parnell, 2004). Ti was mobile probably within a range of several meters (on outcrop scale) via hydrocarbon-rich aqueous fluids at low-P conditions. The hydrocarbon-rich matrix has been converted to titanoclinohumites, carbonates and methane together with Mg-rich olivine on deserpentinization during subduction.