Unusually high Nb/Ta ratio of fluid-precipitated jadeites from New Idria serpentinite body, California: Implications for extreme fractionation in slab fluids

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Fractionation of Nb and Ta, which are conventionally thought as geochemical twins, is a key to understanding the evolution of the silicate Earth. The subchondritic Nb/Ta ratio of the continental crust (12-13; Barth et al., 2000), which is a long-standing problem, has been explained by Nb/Ta fractionation during subduction processes such as slab melting and/or dehydration. However, recent studies have revealed that extreme Nb/Ta fractionation of subduction-zone fluids from minerals in eclogite (up to 87; Xiao et al., 2006; Liang et al., 2009) and metagranite (up to 239; Chen and Zheng, 2015). In order to decipher Nb-Ta (and Zr-Hf) behavior of slab-derived fluids in shallower levels, we investigated a veined jadeitite from the New Idria serpentinite body, which is regarded as direct precipitates from slab-derived fluids at forearc depth. We applied *in-situ* measurements of trace element abundance of jadeites using a LA-ICP-QMS. The New Idria jadeites is characterized by remarkably high Nb concentration but depleted in Ta. Consequently Nb/Ta ratio varies from 10 to 115; Zr/Hf ratio also shows a wide range of 38–164. Nb–Ta and Zr–Hf correlations suggest coupling behaviors of those elemental pairs in fluids during the jadeitite vein formation. A simple Rayleigh fractional crystallization model for jadeite growth using partitioning coefficient D_{Nb} and D_{Ta} between clinopyroxene-aqueous fluid (Stalder et al., 1998) is also unlikely to explain the data. Although the extreme Nb/Ta and Zr/Hf fractionation can occur in seawater (Firdaus et al., 2011), oxygen isotope composition of New Idria jadeites ($\delta^{18}O$ = +8.4 to +9.9‰; Sorensen et al., 2006) eliminates a possibility that jadeitite-forming fluid source was originated from pore fluids derived from seawater. Alternatively, the Nb-Ta behavior might be explained by breakdown of hydrous minerals with high Nb/Ta ratio such as phengitic mica and/or consequences of high degree of fluid-rock interaction in a case of $D_{Nb}/D_{Ta} > \sim 10$ for fluid-rock system. New Idria jadeitite veins would provide an evidence for the presence of highly Nb/Ta fractionated fluids in serpentinized mantle wedge beneath forearc, supporting the idea that Nb and Ta are highly mobile and fractionate during the early stage of oceanic plate subduction before the appearance of rutile.

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