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The occurrence, origin, and fate of water in chromitites in ophiolites

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Abstract

We present petrological investigations and mineral chemistry of several Tethyan ophiolites to reveal the occurrence, origin, and fate of water in podiform chromitites. The results show that clinopyroxene and olivine in chromitites have H_2O contents of 801–366 and 53–17 ppm, respectively. The highest water contents of olivine occur in massive chromitite and the lowest always in the clinopyroxene-bearing ores because much of the available hydrous fluids was taken up by the clinopyroxene during crystallization. The major and trace elemental and Li isotopic compositions of clinopyroxene associated with chromite and olivine in podiform chromitites indicate formation from a mixture of surface hydrous fluids on chromite grains and evolved melts from which olivine crystallized. The hydrous fluids initially originated from dehydration of a subducting slab as revealed by Li isotopic compositions of clinopyroxene and olivine in the chromitites. High fluid/rock ratios facilitated concentration of chromite to form chromitite, suppressing crystallization of olivine. The hydrous fluids that were collected on the chromite grain surface during crystallization allowed chromite grains to rise via decreasing density in the form of bubbles, thus promoting their gathering and concentration. The fate of these hydrous fluids depends on ambient physical and chemical conditions. Mostly they hydrate adjacent olivine grains in the chromitite or penetrate the surrounding dunite envelope. In some cases, the fluids dissolve into silicate melts to produce water-bearing clinopyroxene and/or hydrous minerals, such as amphibole, or infiltrate silicate and chromite grains to form inclusions, which may exsolve later in the form of mineral lamellae. Our investigations provide direct natural evidence for the presence and importance of water in the formation and evolution of chromite deposits, as inferred by earlier experimental studies.

Keywords: Podiform chromitite, clinopyroxene, olivine, ophiolite, water