

Electron microscope study of the reaction olivine + H₂O + TiO₂ → titanian clinohumite + Titanian chondrodite synthesized at 8 GPa, 1300 K

RICHARD WIRTH,¹ LARISSA F. DOBRZHINETSKAYA,^{2,*} AND HARRY W. GREEN II²

¹GeoForschungsZentrum, Potsdam Telegrafenberg, C-120, D-14473 Potsdam, Germany

²Department of Earth Sciences and Institute of Geophysics and Planetary Physics, University of California, Riverside, California 92521, U.S.A

ABSTRACT

The nucleation and growth processes of titanian clinohumite (Ti-Cl) and titanian chondrodite (Ti-Ch) during hydrous alteration of olivine at 8 GPa, 1300 K are described in detail. We observed two different nucleation sites and orientation relationships for Ti-Cl: (1) heterogeneous nucleation at olivine grain or phase boundaries, yielding semicoherent (001) lamellae with (001)_{ol}//(001)_{Ti-Cl} and (010)_{ol}//(010)_{Ti-Cl}; (2) formation of coherent nanometer-sized nuclei inside olivine with the orientation relationship (100)_{ol}//(001)_{Ti-Cl} and (011)_{ol}//(020)_{Ti-Cl}. Only the former, for which the interface with olivine facilitates the transport of OH⁻ and Ti necessary for the formation of the humite-group minerals, survives to large sizes. These results suggest that Ti-Cl should form readily in a Ti- and H-rich environment at mantle temperatures, independent of F content, from shallow environments to those at depths exceeding 250 km, and could play a role in recycling water back into the deep mantle.