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Role of silica for the progress of serpentinization reactions: Constraints from successive changes in mineralogical textures of serpentinites from Iwanaidake ultramafic body, Japan

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Abstract

Serpentinization of peridotite in subduction zones and mid-ocean ridges is a key process that controls not only the geodynamic behavior of the mantle but also the activity of modern (and probably primordial) microbial systems on the seafloor. However, there is still controversy about what factors promote the mineralogical reactions of serpentinization in natural ultramafic rocks. Here we report textures, chemistry, and magnetic susceptibility of variably serpentinized harzburgite and dunite samples from Iwanaidake ultramafic body, Japan, which originated from the forearc mantle of the Northeast Japan arc. Successive changes in textures, mineral chemistry, and magnetic susceptibility during serpentinization of harzburgite involved two stages: replacement of olivine by serpentine and brucite, and subsequent formation of magnetite along with more-magnesian serpentine and brucite. The later reactions occurred concurrently with serpentinization of orthopyroxene, which supplied the silica component. In serpentinized dunite, which does not contain orthopyroxene, serpentinization involved replacement of olivine by serpentine and brucite, and the fraction of magnetite did not increase with the progress of serpentinization. These observations suggest that the silica supply from serpentinization of orthopyroxene is an essential factor for the formation of magnetite during serpentinization. Magnetite formation facilitated by addition of silica has often been reported for many serpentinite systems, suggesting that the magnetite formation triggered by silica addition is one of the key reactions for the progress of serpentinization in natural ultramafic rocks.

Keywords: Serpentine, magnetite, magnetic susceptibility, bulk H_2O content, mineralogical texture