Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33162

The roles of serpentine in earth processes

KEIKO HATTORI

University of Ottawa

Serpentinites exert a major influence on geochemical and geological processes of Earth and beyond, as highlighted in the description of this session. Serpentine is the group name that includes lizardite, chrysotile, and antigorite. All are 1:1 layered silicates containing up to 13 wt% H_2O, formed by hydration of olivine or orthopyroxene. Serpentine is common in places where olivine-bearing rocks are exposed to H_2O, such as on and near the sea floor and in subduction zones. Serpentine has also been identified on other planets, plus asteroids from the outer solar system, providing evidence for the past presence of liquid water in these places. The importance of serpentine stems from its physical and chemical properties and its wide stability field, from surface to the mantle. Serpentine is rheologically weak, allowing focused deformation, and its low density (2.6 g/cm^3) contributes to the exhumation of ultrahigh pressure rocks.

This presentation summarizes our group's work over 25 years. Chemically, serpentine accommodates fluid-mobile elements (e.g., LILE, As^{5+}, Sb^{5+}), volatiles (F, Cl, Br, I, B, N) and high-field strength elements (Sc, Ti, Y) which are incorporated from fluids during hydration (serpentinization). Serpentinization converts Fe2+ in olivine to magnetite, thus leading to the release of H_2 and CH_4 gases. The resulting reduced conditions allow anoxic bacteria to thrive near Mg-rich rocks, with serpentinization thus likely related to the abiotic synthesis of organic compounds. In the reverse process, serpentine dehydrates to secondary olivine during subduction, accompanied by release of H_2O and oxidized components to the mantle wedge, thus influencing the redox state. Such newly formed olivine inherits some H_2O (≤0.7 wt %) and other elements (≤0.45 wt% Ti, ≤130 ppm F, <100 ppm B) from serpentine, transferring them in olivine to as deep as ~ 400 km in the mantle. In cold subduction zones, dense hydrous Mg silicates may form from serpentine, allowing volatiles and HFSE to be transferred even deeper, to the lower mantle. Serpentine is thus the critical mineral that allows elements to be recycled from the surface to the deep mantle