Serpentinites, a transient reservoir of fluid-mobile elements in the mantle: Clue to creation of metal-fertile belts

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Metal concentration, principally in porphyry and related hydrothermal deposits, is associated with felsic rocks at shallow depths of a few km in subduction/collision zones. However, processes at much greater depths are critical for the formation of large metal deposits. The S isotopic compositions of sulfides are skewed towards 0 ‰ for large deposits [1], confirming that S is not from a local crustal source. The transfer of large amounts of S with ~ 0 ‰ requires an oxidized mafic melt since felsic magmas have a low solubility of S. Oxidized mafic melt forms in the oxidized mantle in present (as well as past) subduction zones by incorporating an oxidized flux from slabs, whereas the mantle is depleted in S and metals through partial melting, requiring the mantle to be replenished with metals and S. Subducting slabs release fluids to the mantle, forming forearc mantle serpentinites and their eventual dehydration leads to partial melting to produce arc magmas [2]. Thus, forearc serpentinites record materials transferred from slabs to the mantle and then to magmas. Studies of such serpentinites show a general enrichment of fluid-mobile elements (FME), but the elements and their degrees of enrichment differ according to location. For example, Himalayan serpentinites, formed during the subduction of evaporites and shelf sediments on the margin of India, contain oxidized As(+5) in the Si site [3], and high As, Sb and Pb. Appalachian serpentinites contain reduced As(+3), reflecting the subduction of organic-rich shale on the margin of the Ipetus Sea. Studies of subducted shales in (U)HP belts suggest that metals are retained in slabs. Marianan serpentinites are overall low in FME compared to other sites due to the lack of a continental input. Serpentinites in Hispaniola are high in Cu that may have been incorporated from subducted Protocarribean oceanic lithosphere. These data suggest that a necessary factor to form a metal-fertile belt is the subduction of sediments + slabs that release oxidized fluxes, metals and also S. This can explain the lack of large porphyry deposits in New Zealand and Japan, where only monotonous oceanic lithosphere has been subducted.

[1] Hattori & Keith, 2001. *Min. Dep* **36:**799-806 [2] Hattori & Guillot, 2003.*Geology* **31**:525-528 [3] Hattori *et al* 2005 *GCA* **69**: 5585-5596.