Halogens and other volatiles in the UHP Tso Morari unit, NW Himalaya

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The Tso Morari eclogitic unit in E-Ladakh, NW Himalaya represents metamorphosed mafic rocks and sediments of the northern margin of the Indian continent that were subducted to 70+ km following closure of the Neo-Tethys and subsequent collision with Asia. Trace element abundances suggest a plume-related origin of these mafic rocks. The UHP unit was exhumed together with lenses of antigorite-bearing serpentinites that represent a deep (>120 km) portion of the hydrated mantle wedge. Eclogites contain garnet, omphacite, glaucophane, phengite, rutile, quartz, zoisite, paragonite and apatite.

Chlorine (<50 ppm), Br (<0.2 ppm) and I (<0.2 ppm) contents of the metapelites are low compared to typical incoming plate sediments, whereas F (up to 960 ppm), B (up to 90 ppm) and N (up to 400 ppm) are high. The heavy halogen/Nb ratios in the metapelites are an order of magnitude lower than those of incoming plate sediments, confirming Cl, Br and I are lost from sediments during subduction. Eclogites contain high F (up to 360 ppm), along with variable Cl (10-140 ppm), low Br (<0.3 ppm) and B (<2 ppm), and elevated I (up to 0.82 ppm). F/Nb ratios of the eclogites are similar to those typical of plume-related basalts, suggesting F may be partially inherited from its protolith, in addition to input from incoming plate sediments. Sediments are also the likely source of higher I contents in the eclogites. A positive correlation between bulk rock F and K_2O suggests F in metapelites is primarily hosted in K-rich phengite, but in eclogites both phengite and apatite host F.

The halogen contents of the mantle wedge serpentinites that overlay the subducting UHP unit are similar to those of the metapelites. Ratios of heavy halogen/Nb of the serpentinites are similar to typical incoming plate sediments, confirming hydration of the forearc mantle by fluids from dehydrating sediments during early subduction, and their high F/Cl contents suggest serpentinites are capable of transfering F into the deeper mantle.

This study supports our earlier work on lawsonite blueschists from Turkey that Cl and Br are expelled from subducting slabs at shallow depths, where as F and some I are retained even to UHP conditions.