Ophiolites as archieves of recycled crustal material residing in the deep mantle

JINGSUI YANG[1], PAUL ROBINSON[1], YILDIRIM DILEK[2, 1], RICHARD WIRTH[3]

[1] CARMA, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China. Email: yangjsui@163.com;

[2] Department of Geology & Env. Earth Science Miami University, Oxford, OH 45056, USA.

[3] Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Germany

Our CARMA research team has investigated over the last 10 years ultrahigh-pressure and super-reducing mineral groups discovered in peridotites and/or chromitites of ophiolites around the world, including the Luobusa (Tibet), Ray-Iz (Polar Urals-Russia), and 12 other ophiolites from 8 orogenic belts in 5 different countries (Albania, China, Myanmar, Russia, and Turkey). High-pressure minerals include diamond, coesite, pseudomorphic stishovite, qingsongite (BN) and Ca-Si perovskite, and the most important native and highly reduced minerals recovered to date include moissanite (SiC), Ni-Mn-Co alloys, Fe-Si and Fe-C phases. These mineral groups collectively confirm extremely high pressures (300 km to ≥660 km) and super-reducing conditions in their environment of formation in the mantle. The carbon isotopes and other features of the high-pressure and super-reduced mineral groups point to previously subducted surface material as their source of origin.

Recycling of subducted crust in the deep mantle may proceed in three stages: Stage 1 – Carbon-bearing fluids and melts may have been formed in the MTZ, in the lower mantle or even near the CMB. Stage 2 – Fluids or melts may rise along with deep plumes through the lower mantle and reach the MTZ. Some minerals, such as diamond, stishovite, qingsongite and Ca-silicate perovskite can precipitate from these fluids or melts in the lower mantle during their ascent. Material transported to the MTZ would be mixed with highly reduced and UHP phases, presumably derived from zones with extremely low fO_2, as required for the formation of moissanite and other native elements. Stage 3 – Continued ascent above the transition of peridotites containing chromite and ultrahigh-pressure minerals transports them to shallow mantle depths, where they participate in decompressional partial melting and oceanic lithosphere formation.

The widespread occurrence of ophiolite-hosted diamonds and associated UHP mineral groups suggests that they may be a common feature of in-situ oceanic mantle and open a new window for probing the nature of deeply recycled crustal material residing in the deep mantle.