Major mineral mode of listvenite from ICDP Oman Drilling Project Hole BT1B inferred from X-ray CT core images

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To understand the global cycle of fluid flow from the surface to the deep of the Earth, it is important to constrain how and how much fluid is captured and released by metamorphic reactions following hydration/dehydration and carbonation/decarbonation. In the Oman Ophiolite, a fossil of an oceanic plate is widely exposed. Continuous drilling from the bottom of the ophiolite through the basal thrust to the footwall metamorphic sole was conducted in Hole BT1B by the ICDP Oman Drilling Project. Listvenite, completely carbonated former peridotite, is the main lithology in Hole BT1B also found in other ophiolite bodies. Listvenite is mainly composed of magnesite, quartz, dolomite and Fe-hydroxide with minor chromian spinel and chromian mica (fuchsite). Two serpentinite and ophicarbonate intervals were also found above the basal thrust. Below the basal thrust, the metamorphic sole composed by the greenschist/greenstone is the main lithology.

We evaluated the mineral mode of listvenite in BT1B from the X-ray Computed Tomography (XCT) images. XCT images was continuously obtained with a spacing of 0.625 mm along the Z-axis on all 401 whole-round core sections recovered from Hole BT1B. The X-Y resolution of XCT image is 0.125mm and an intensity of X-ray attenuation, “XCT number”, are computed for each voxel. The XCT number of a material depends on several factors such as density, element (e.g., atomic number), porosity, sample shape and sample volume. All listvenite and serpentinite core sections are nearly the same dimensions (~63.5 mm in diameter) and thus same volume, therefore, the XCT number provides information of physical and chemical properties of the core samples.

Each XCT number in XCT images and chemical mapping data of Mg, Si, Ca and Fe from the XRF core scanner in the same location as XCT images are compared for 27 sections including 9289 data points for each element. Multiple linear regression for XCT number and XRF quantified that XCT numbers of pure magnesite ($MgCO_3$), quartz (SiO_2), and dolomite ($CaMg(CO_3)_2$) grains in the cores are 3037+/−143 , 2999+/−140 and 3514+/−102, respectively. Using these values, histograms of XCT number of each slice in each section is fitted assuming that the CT histogram (CT number >2500) of a slice is composed of three peaks with Gaussian distribution.

In most core sections, XCT data indicates that the matrix of listvenite is mainly composed of magnesite and quartz, and minor dolomite, consistent with discrete XRD and XRF data. Veins usually show high CT number (~3400), while the CT number in veins is fitted well with dolomite. Dolomite abundance in each core section is highly dependent on the intensity of veins. Dolomite abundance in most core sections within 15 m from the basal thrust is higher than 50%. This is consistent with higher vein intensity close to the basal thrust and could indicate that significant amounts of Ca were supplied from Ca- and CO_2-rich fluids along the basal thrust. Total MgO/SiO_2 ratio in BT1B is ~1.2. This value is smaller than that

estimated from the geochemical analysis of the Oman peridotite and XRF data from the BT1B. This suggest that Si enrichment or Mg loss during carbonation and/or following serpentinization of the ophiolite. Fe contents may also have significant effect on evaluating the modal abundance of minerals in listvenite and further investigation of compositional effects, especially Fe solid solutions in carbonate and hematite on the XCT number would be needed for an accurate assessment of the mineralogy in listvenite.

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