Water Content in Nominally Anhydrous Mineral of Crust/Mantle Boundary Recovered by International Oman Drilling Project

*Muhamad Asyraf Aminuddin[1], Tomoaki Morishita[1,2], Juan Miguel Ramirez Guotana[1,2], Keita Itano[1], Kenji Shimizu[3], Takayuki Ushikubo[3]

1. Kanazawa University Graduate School Natural Science and Technology, 2. Oman Science Party, 3. Kochi Institute for Core Sample Research,JAMSTEC

The presence of water in the Earth’ s mantle has been to have a prominent role in the volatile cycle of Earth’ s mantle but measuring water flux into the mantle proved to be difficult and not fully constraint. Nevertheless, measuring water content in the mantle have its importance. It is known that some portion of water can be stored in nominally anhydrous mineral (NAM) like olivine and pyroxene which support the presence of water in the deep mantle. The significance of water retained in such minerals are that it can cause deformation to the minerals such as olivine which is the most abundant mineral in the mantle. Measuring water content in the oceanic plate specifically in the crust-mantle section is the most practical as water retained in the oceanic plate should be nearly zero due to the upwelling of the asthenosphere causing partial melting to occur extracting water into the melt. Therefore, the objective of this study is to measure water content in the oceanic crust specifically in the crust-mantle boundary.

As direct sample from the crust-mantle section is unattainable, ophiolite is used for this water content analysis as samples with the idea of measuring water content in oceanic plate as ophiolite is tectonically originated from mid-ocean ridge. However, some studies showed ophiolite might be affected by a later subduction zone tectonic setting (Lippard *et al.,* 1986) where second stage magmatism occurred at the subduction zone during obduction process. Thus, a high-water content could prove that ophiolite might be affected by subduction metasomatism. Ophiolite samples were from core samples recovered by International Oman Drilling Project in Samail Ophiolite, Oman. The core recovered reached about 400m depth and consists of layered gabbro (160 m), dunite (150 m) and harzburgite (75 m) with a compositionally gradational zone of 15m between dunite and harzburgite. Samples from each sequence (gabbro, dunite and harzburgite) of the core were used for water content analysis.

Secondary Ion Mass Spectrometry (SIMS) is used for water content analyses (Shimizu et al., 2017). SIMS have its disadvantage like high hydrogen background in low-concentration phases, but improved technique and procedure established by Hauri (Hauri et al., 2002; Koga et al., 2003: Shimizu et al., 2017) contributing for more reliable quantifications of low-level volatiles. Improved sample preparation technique and analytical sensitivity (Koga, 2003) are done like use of indium metal as embedment material instead of epoxy to limit the hydrogen background (Koga et al., 2003: Shimizu et al., 2017). IMS-1280HR of SIMS instrument is used which are installed in the Kochi Institute for Core Sample Research, JAMSTEC with 20 keV of Cs^+ ion beam bombarded to the sample surface with diameter 10-15 micrometer. Negative secondary ions of $^{12}C^-$, $^{16}OH^-$, $^{19}F^-$, $^{30}Si^-$, $^{32}S^-$ and ^{35}Cl signals will be collected from the center of analysis spot. The internally corrected data using ^{30} Si signal intensity were calibrated by the analyses of glass and olivine standard materials with known H2O concentrations.

Based on the result, $^{16}OH/^{30}Si$ signal intensities value on the layered gabbro sample are consistent with no significant changes of value on the rims and core of olivine. In contrast, $^{16}OH/^{30}Si$ signal intensities value on the dunite and harzburgite showed uncertainties where high hydrogen background occurred due to the presence of serpentine in the sample that prevent water to be completely removed during

degassing process prior analysis. Despite that, we can certain that the water content measured in gabbro sample is 34 ppm on average and the water content measured in dunite and harzburgite are on the range of 30-50 ppm. When comparing the value to the previous study of water content of olivine in natural peridotites obtained by Secondary Ion Mass Spectrometry (Kurosawa et. al., 1997, Warren & Hauri, 2014), the water content in olivine are significantly high. The explanation of high-water content of olivine is related to hydrous melting. Hydrous melting is where the presence of water in the mantle lower the solidus temperature allowing melts to be formed. The hydrous melting occurred in ophiolite support that subduction metasomatism might happened in ophiolite.

Keywords: Ophiolite, Nominally anhydrous minerals, Oman, Olivine, Secondary Ion Mass Spectrometry (SIMS)

