Transdisciplinary measurements and cross-analysis during scientific drilling

*Natsue Abe[1,2], Kohei Hatakeyama[3]

1. Mantle Drilling Promotion Office, MarE3, Japan Agency for Marine-Earth Science and Technology , 2. Graduate School of Natural Science& Technology, Kanazawa University, 3. Meisei University

In the International Ocean Drilling Program (IODP) and the International Continental Scientific Drilling Programs (ICDP), many multi-disciplinary experts participate in core describing the campaign in onboard laboratories and onshore core research facilities. They simultaneously conduct lithological description, chemical analysis, paleomagnetic measurements, and physical property measurements of core samples. Borehole measurements include wall imaging, electrical resistivity, elastic wave velocity, density, and chemical composition are also performed at the drill site. Those data are linked to the borehole depth in mm units for cross-analysis. As an example, we present the results of our research in the International Continental Science Drilling Program (ICDP) Oman Drilling Project (OmanDP).
During the OmanDP, which was conducted from 2016 to 2018, 300-400 m long drilling was carried out at nine sites in the crustal section, mantle section, and ophiolite basement in the southern Oman ophiolite region. One of them, Hole GT3A, is a 400 m long hole that penetrates near the upper and lower boundaries of the oceanic crust, where sheet-like vein assemblages and a small amount of gabbro were collected. The rock core samples were described and measured during Leg 1 of ChikyuOman 2017 by an international team of about 30 researchers using the D/V Chikyu shipboard laboratory. In the D/V Chikyu shipboard laboratory, physical properties of the whole-round core were measured by X-ray CT and Multi-sensor core logger (MSCL), followed by surface observation and description of the half-cut core samples, whole-rock chemical composition, and thin section observation of the individually cut discrete pieces, and physical properties measurement. After measuring the physical properties of the whole-round core, we observed and described the surface of half-cut core samples, observed the chemical composition and thin sections of individual discrete samples, and measured the physical properties.
Since the rock core samples were hydrothermally altered into various mineral combinations, they showed a wide range of physical properties. For example, the samples' P-wave velocity (Vp) ranges from 2.2 to 7.1 km/s. There is a clear negative correlation between P-wave velocity and porosity. It is noteworthy that there is a positive correlation between the densities and porosity in more than 1/4 of the samples. Highly altered samples from the GT3A cores show high porosity (up to 12%) and high densities (up to 3.4 g/cm^3). It is probably because of the larger volume of epidote with high density (3.39 –3.48 g/cm^3) in the more altered samples. The color spectrums, especially the yellowness of the core samples, clearly have correlations with the rock physics of the GT3A samples. The yellowness of the mafic rocks in the GT3A implies their degree of alteration reflected the mode of epidote. In other words, the epidote precipitation during the hydrothermal alteration reduces the volume of a part of the oceanic crust and probably causes higher porosity as previously proposed on a qualitative basis.

Keywords: IODP, ICDP, Oman Drilling Project, D/V Chikyu, X-ray CT, color spectrum

