ICDP DSeis project: compilation of borehole logging and recovered core information at the seismogenic zone of the M5.5 Orkney earthquake with lower crustal intrusives

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The ICDP DSeis project (ICDP, 2019, The Thrill to Drill) has accomplished a full core recovery with a total of 1.6 km length drilled from 2.9 km underground, probing the upper margin of the aftershock zone of the M5.5 Orkney sinistral earthquake (Ogasawara et al. Deep Mining 2019). It was known before drilling that the host rocks of this seismogenic zone were Archean metamorphosed sedimentary rocks (2.9 billion years old; West Rand group, including quartzite and etc.).

This presentation will report the results of the compilation of down-hole logging (gamma-rays, density, elastic wave velocity, magnetic susceptibility, water temperature and conductivity) performed in 2017-2018 and non-destructive analysis (e.g., MSCL) of a hundred-plus meter-long core imported to the Kochi Core Center in 2019.

Drilling and logging in 2017-2018 revealed not only that the densities and Vp of the metamorphosed sedimentary rocks of the West Rand group (Roodepoort, Crown, Babrosco formations) are comparable to the upper crust, but also that dolerite sills with densities and seismic velocities were comparable to the lower crust.

Lamprophyre dyke and fault gouge and breccia were recovered from the intersection with the aftershock zone of the M5.5 sinistral earthquake (Ogasawara et al. Deep Mining 2019), and talc was also detected (Yokoyama 2020 MSc thesis, Osaka University). Because the borehole collapsed and blocked at the intersection with the aftershock zone, it was not possible to conduct borehole logging at the intersection and beyond it. This section was imported to the Kochi Core Center for MSCL and X-ray CT in FY 2019.

In FY2020, these were compiled. As a result, the density of the intact part of the lamprophyre dyke intersected at the aftershock zone is significantly larger than that of the dolerite sill, and the magnetic susceptibility increases rapidly and Vp decreases sharply when approaching the fault zone.

At the other intersection of the dolerite sill and another mafic dyke, Wiersberg et al. (2019 EGU), Rusley et al. (2018 AGU), Nisson et al. (2019 AGU), Warr et al. (2020 AGU) also found hypersaline brine fissure and gases (similar to those near hydrothermal vents on oceanic ridges?) rich in dissolved organic hydrocarbons of non-meteoric or non-biogenic origins. Aftershock activity consists of several streaks, with direction in line with the intersection line between the aftershock plane and the dolerite sills (Tadokoro MSc thesis Ritsumeikan). Since it is well known that mafic intrusives affect the subsurface fluid flow, an integrated analysis of all of these will kick off discussions on the relationship between material, water, and rupture at a seismogenic zone.

The ICDP team consists of researchers from Japan, South Africa, USA, Germany, Switzerland, India, Israel, Australia, and practitioners from the mining industry in South Africa. The core members include Y. Yabe and T. Ito (Tohoku Univ.), J. Mori (Kyoto Univ.), T. Hirono (Osaka Univ.), Y. Yamamoto (Kochi Univ.), B. Liebenberg (Moab Khotsong mine), T.C. Onsott (Princeton Univ.), T.L. Kieft (New Mexico Tech), T. Wiersberg (GFZ), R.J. Durrheim (Wits Univ.). Durrheim (Wits Univ.), J. Castillo (Free State Univ.), M. Ziegler (ETH, Zurich), and their students.

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