ICDP DSeis 3: Spatial variation in stress state in the source region of Orkeny earthqauke (M5.5) based on analyses of the ICDP-DSeis borehole cores

*Yasuo Yabe[1], Akimasa Ishida[2], Kosuke Sugimura[2], Kanematsu Makoto[2], Mitsuya Higashi[2], Shunsuke YOSHIDA[2], Bennie Liebenberg[7], Takatoshi Ito[3], Akio Funato[5], Bryan Watson[6], Raymond Durrheim[4], Hiroshi Ogasawara[2]

1. Research Center for Prediction of Earthquakes and Volcanic Eruptions, Graduate School of Science, Tohoku University, 2. Faculty of Science and Engeneer, Ritsumeikan University, 3. Institute of Fluid Science, Tohoku University, 4. School of Geoscience, University of the Witwatersrand, 5. Fukada Geological Institute, 6. School of Mining Engeneering, University of the Witwatersrand, 7. Moab Khotsong mine

The Orkney earthquake (M5.5), South Africa, occurred on 5 August 2014 beneath a deep gold mine, of which the deepest mining horizon is ˜3 km depth from ground surface. Hypocenter of the Orkney earthquake and the shallowest aftershocks were located at ˜5 km and ˜3.5 km depths from ground surface. Therefore, the ICDP-DSeis project was devised to investigate the geological, geomechanical and geochemical environments in and around the source region of the Orkney earthquake. Two 800 m-long boreholes (Holes A and B) were drilled from a drilling site established on a tunnel at a depth of 2.8 km in the mine. While Hole A reached the seismogenic depth, it did not intersect the aftershock cluster. Hole B success fully penetrated to the aftershock cluster. Borehole cores were almost fully recovered from these holes, though they were not oriented during drilling. Therefore, the core orientation was determined by comparing in-hole optical images and unrolled core images in this study. Then, Diametrical Core Deformation Analysis (DCDA, Funato and Ito, 2017) and Deformation Rate Analysis (DRA, Yamamoto et al., 1990) were applied to borehole cores to evaluate a spatial variation in stress state in and around the aftershock cluster. Finally, a numerical elastic model in which the depth variations along Hole A and B were reproduced was developed to understand a spatial distribution of stress state in and around the aftershock cluster that extended along upper extension of the source fault of the Orkney earthquake.

Keywords: ICDP-DSeis, Stress measurement, DRA, DCDA, Deep mines in South Africa