Estimation of in-situ stress by a new analysis method of Diametrical Core Deformation Analysis (DCDA)

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Determination both direction and magnitude of in-situ stress is very important for many geoscience and geoengineering problems. Diametrical Core Deformation Analysis (DCDA) was developed to determine the difference of maximum and minimum stress and the stress orientations on the plane perpendicular to borehole. In case of vertical borehole, they are maximum horizontal stress (SHmax) and minimum horizontal stress (Shmin). It is based on measurement of diametrical core deformation accompanied with stress release caused by drilling. This method has simple and clear principle, and is a non-destructive method. However, it cannot provide the individual SHmax and Shmin magnitudes. Therefore, we propose a new analysis method using the same core diameter data as the conventional method, the new method enables us to estimate SHmax and Shmin magnitudes and their orientations in both vertical and deviated borehole. To examine this new analysis method, we applied it for estimation in-situ stress using the DCDA data of core samples retrieved from the IODP Expedition 319.

The new analysis method is based on an assumption that principal stresses are in horizontal plane and a vertical direction. Then circumstance distribution of core diameter is given by a theoretic equation with SHmax, Shmin and vertical stress (Sv). We can get the optimum SHmax and Shmin values and the azimuth analytically by fitting to the observed core diameter by this equation. In this study, we adopted this new method to three cores from a vertical borehole at depths of ~1540 mbsf in site C0009 drilled during the IODP Expedition 319 and estimated the principal stress magnitudes and orientation. Moreover, we compared this result to other results measured by other methods at same depth.
As a result, azimuth of SHmax was N140°, SHmax and Shmin magnitudes were ~65MPa, 42MPa (average of three cores), respectively. The result of SHmax azimuth was consistent to that from breakout. In particular, the SHmax and Shmin magnitudes estimated by the new method were reasonable, and showed the same stress regime with the others. It suggests the new analysis method may be valid.

Keywords: DCDA, core sample, principal stress

