In-situ stress determination: An example from Taiwan Chelungpu-fault Drilling Project

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Determination of current in-situ stress is important and necessary in cases of active fault drilling programs. Based on the investigation of various existent stress measurement methods, unfortunately, it was preliminarily concluded that there is not a perfect method by which the magnitudes and orientations of the three-dimensional in-situ stress tensor can be reliably measured at large/great depth. I suggest that combinational applications of borehole methods and core-based methods, considered being possible and practical approach for ocean deep drilling projects, should be employed. As an example of stress determination by combinational applications of multi measurement methods in active-fault drilling project, I will show the stress determination results from Taiwan Chelungpu-fault Drilling Project (TCDP) which was aimed at investigating physical and chemical properties of the active Chelungpu-fault that slipped during the 1999 Chi-Chi, Taiwan earthquake (Nw 7.6).

Our research group employed two stress measurement techniques in TCDP. The firs method employed is a core-based, anelastic strain recovery (ASR) technique (Lin et al., 2007a). It was used to determine the orientations of current three-dimensional principal rock stresses using dill core samples retrieved from TCDP main hole (Hole-A). Acquired anelastic strains were of high quality and reached several hundred microstrains which is sufficiently high for the accuracy of measurement system used. Thus, the strain data could be used for a three-dimensional analysis resulting in the determination of orientations of the principal in-situ stresses. The results of stress measurement showed that the orientations of principal stresses changed between the shallower depth above the fault and the deeper depth beneath it, that is, the present stress distribution in the TCDP hole might be influenced by the Chelungpu-fault rupture.

Using the second approach, that included the analysis of both drilling-induced borehole compressive failures (borehole breakouts) and tensile fractures from electrical resistivity-based images, reliable orientations of in-situ horizontal principal stresses were determined in TCDP second hole (Hole-B) which is located just 40m away from the Hole-A (Lin et al., 2007b). Overall, the orientation of the maximum in-situ horizontal principal stress SHmax in the studied depth range of about 930-1330 m coincides with the downdip direction of the rock formations. However, the SHmax at the depths of around 1130 m where the first major fault zone locates oriented at right angle to the dip of the strata. This stress orientation change can be interpreted due to the fault rupture.

With respect on downhole experiment, hydraulic fracturing test or extended leak-off test (Lin et al., 2007c) may be a useful method and have advantages on determination of minimum stress magnitude in ocean deep drilling program.

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