Continuous depth profile of mechanical properties in the Nankai accretionary prism based on drilling performance parameters

*Yohei Hamada[1], Manami Kitamura[3], Yasuhiro Yamada[2], Yoshinori Sanada[2], KYAW MOE[2], Takehiro Hirose[2]

1. Japan Agency for Marine-Earth Science and Technology Kochi Institute for Core Sample Research, 2. Japan Agency for Marine-Earth Science and Technology, 3. National Institute of Advanced Industrial Science and Technology

In-situ rock properties in/around seismogenic zone in an accretionary prism are key parameters to understand the development mechanisms of an accretionary prism, spatio-temporal variation of stress state, and so on. For the purpose of acquiring continuous-depth-profile of in-situ formation strength in an accretionary prism, here we propose the new method to evaluate the in-situ rock strength using drilling performance property, such as weight on bit (WOB), drillstring rotational torque (Tr), rate of penetration (ROP), and drillstring rotational per one minute (RPM). Drilling parameters are inevitably obtained by any drilling operation even in the non-coring intervals or at challenging environment where core recovery may be poor. The relationship between the rock properties and drilling parameters has been proposed by previous researches [e.g. Teale 1964]. We introduced the relationship theory proposed by Teale [1964] and Karasawa et al. [2002], and developed a converting method to estimate in-situ rock strength without using uncertain parameters such as WOB. Specifically, we first calculated equivalent specific toughness (EST) which represents gradient of the relationship between Torque energy and volume of penetration at arbitrary interval (in this study, five meters). Then the calculated EST values were converted into strength using the drilling parameters –rock strengths correlation obtained by Karasawa et al. [2002]. This method was applied to eight drilling holes in the Site C0002 of IODP NanTroSEIZE in order to evaluate in-situ rock strength in shallow to deep accretionary prism. In the shallower part (0 –300 mbsf), the calculated strength shows sharp increase up to 20 MPa. Then the strength has approximate constant value to 1500 mbsf without significant change even at unconformity around 1000 mbsf (boundary between forearc basin and accretionary prism). Below that depth, value of the strength gradually increases with depth up to 60 MPa at 3000 mbsf with variation between 10 and 80 MPa. Because the calculated strength is across approximately the same lithology, the increase trend can responds to the rock strength. This strength-depth curve correspond reasonably well with the strength data of core and cutting samples collected from hole C0002N and C0002P [Kitamura et al., 2016 AGU]. These results show the validity of the method evaluating in-situ strength from the drilling parameters.

Keywords: drilling parameter, formation strength, equivalent specific toughness

