Strength and mechanical behavior of the Nankai accretionary prism sediments from NanTroSEIZE Expedition 348

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Physical properties of rocks are generally examined by compression or extension experiments in laboratory (e.g., Paterson and Wong, 2005). For these laboratory experiments, cylindrical rock specimens with diameter and length >20 mm are commonly used. However, in ocean drilling, in particular deep riser drilling, core samples that can be used for the experiments are often collected from limited depth. Thus it is quite difficult to know continuous physical property along the drilling hole from geological materials. Hence, we have developed a potential method using an indentation test for the estimation of strength and Young's modulus of rocks from drilling cuttings recovered during riser drilling operation. In this study we conducted the spherical indentation tests as well as conventional uniaxial compression tests on four rocks types with different porosities under room temperature and pressure conditions. As a result, we found an exponential correlation between the Young's modulus obtained by uniaxial test and indentation test, and a linear correlation between strength obtained by those tests.

We adapted this method to investigate the depth profile of mechanical property along Holes C0002N and C0002P, the Nankai accretionary prism. We conducted spherical indentation experiments on the hand-picked intact cuttings retrieved from 870 to 3058 meters below seafloor (mbsf) at Site C0002. We used a spherical sapphire indenter with a diameter of 4 mm to deform the cuttings sample of >2mm thickness saturated with brine at room temperature and pressure conditions with a constant loading/unloading rate of 0.5 N/sec and maximum load of 100 N. Using the correlations mentioned above and assuming internal friction value that may be correlated with porosity, we estimated in-situ Young's modulus and strength of the sediments at Site C0002. The Young's modulus increases from ~0.5 GPa at 870 mbsf to ~2.2 GPa at 2000 mbsf, then it becomes nearly constant at ~2.2 GPa below 2000 mbsf. The failure strength under in-situ pressure condition increases with depth from a few MPa at 870 mbsf to ~70 MPa at 3000 mbsf. The results of the failure strength are consistent with that obtained by triaxial compression tests on discrete core samples collected from ~2200 mbsf under in-situ pressure and temperature conditions. The result indicates the possibility that strength of sediments which is commonly determined by triaxial experiment can be reasonably estimated from drill cuttings using a spherical indentation test.

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