Depth dependent spatial variation of pore size distribution for sediments at Nankai accretionary prism

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Sediment porosity at accretionary prism varies with burial depth mainly due to mechanical compaction. Elastic wave velocity and thermal conductivity that are primary governed by porosity thus increase with depth. On the other hand, influence of depth and compaction on pore size distribution is not well known. Permeability is related with not only porosity but also pore size distribution. Therefore depth variation of permeability can be estimated from that of pore size distribution by understanding the fundamental physical process that causes the depth variation. In this study, porosity and pore size distribution were measured on cuttings and core samples obtained by NantroSEIZE project, IODP Expedition 348 (Site C0002).

Sediment at site C0002 is mainly composed by silty sediment. 44 cuttings and 7 core samples were used in this study. At the beginning, samples were washed by sea water, then dried using vacuum pump. Then, porosity and grain density were measured by using a gas pycnometer. Finally, porosity and pore size distribution of the same samples used for the gas pycnometer measurements were measured by a mercury intrusion porosimeter. 3D X-ray microscope was used to visualize internal microstructures of samples, and XRD analysis was performed to evaluate mineral composition.

Our results show a porosity ranges from 20 to 55 % for the gas pycnometer method, and 15 to 50 % at 878-2825mbsf, and 2 to 5 % at 2830-3200mbsf for the mercury injection method. Both porosities deceased gradually with depth. However, at depth around 2200 mbsf, porosity was fluctuated at around 15 to 34%, which were deviated from depth reduction curve. On the whole, porosity measured by the gas pycnometer is relatively higher than that measured by the mercury porosimeter. Pore size distribution at depth shallower than 2000 mbsf show clear single peak, which represents model of pore size, and mode gradually decreased with depth. On the contrary, at depth greater than 2000 mbsf, pore size distribution shows broad and it is difficult to determine the mode.
3D X-ray microscopic images for samples at around 2200 mbsf show variation of amount of coarse grain particles and the fractures developed parallel to preferred orientation of sediment particles. XRD data shows variation of clay mineral compositions among samples. Therefore, fluctuation of porosity and pore size distribution around at 2200 mbsf is explained by the lithological variation and fracture formations. The average pore size decreases with depth, therefore, the permeability probably decreases with depth at Site C0002.

Keywords: Nankai Trough, Porosity, Pore size distribution, IODP Expedition 348, Permeability

