Mass Transport and Rock Properties of Diatomaceous Mudstone Caused by Phase Change of Silica Minerals

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To investigate mass transport and rock properties of diatomaceous mudstone, pore size distribution, chemical composition and air permeability are analyzed on specimens of Koetoi and Wakkanai formation sampled from boreholes HDB-1, HDB-2 and HDB-5 drilled by Japan Atomic Energy Agency at Horonobe area in Hokkaido, Japan.

Koetoi Formation defined as a formation which includes diatom fossils belonging Opal-A phase in this study. Fossils remain original shapes of diatom in Koetoi Formation. In Koetoi Formation, Pore throat radius concentrate around 1000 angstrom and the shape of cumulative curve of pore size distribution has single mode. As burial depth increasing, cumulative curve shift gradually narrower side and decrease total volume of pore throats. In contrast, specific surface area is gradually increasing. Porosity and permeability of Koetoi Formation seems to be decrease due to compaction of particles of mudstone with increasing burial depth.

On the other hand, in Wakkanai formation, diagenetic facies of diatomaceous fossil is changes into Opal-CT. The feature of cumulative curves of pore throat radius shows bimodal concentration of pore throat. The one has a diameter around several hundred angstrom which formed by ordinary compaction due to overburden of sediment and the other has pore throat ranges 20 to 40 angstroms in radius should be formed by phase change of silica minerals from Opal-A to Opal-CT. In Wakkanai Formation., beneath the phase boundary, porosity is abruptly deflated and specific surface area is extended than Koetoi Formation.

Yamamoto et al., (2003) reported that microscopic crystals of Opal-CT, such as cristobalite, are crystallized within the pore of hardshale in Wakkanai formation. Low permeability of Wakkanai formation seems to be caused by crystallization of these minerals with forming pore throats ranged 20 to 40 angstrom in radius. 30 to 50 % of pore throats ware shared by pore throat ranged 20 to 40 angstrom in radius in Wakkanai Formation. From the result of chemical analysis, the sample which have higher SiO2 content are highly shared by these narrow pore throats and air permeability tend to be low. These phenomena suggest that pore throats which have radius 20 to 40 angstrom are not contributed transport of ground water.

Pore throat radius concentration ranged from 20 to 40 angstrom is not observed in the core specimen sampled about 600m below the formation boundary. The feature of cumulative curves of pore throat radius distribution changes into single-modal and pore throats which have a radius about 100 angstrom are dominated in the core specimens. Porosity and permeability of these samples are higher than the core samples sampled around 200 to 300m below the formation boundary of Koetoi and Wakkanai formation. The feature of the cumulative curve of pore throat radius distribution of these core specimens is some resemble to Masuhoro formation which under raying Wakkanai formation. The lowest permeability is observed in Wakkani formation at 200 to 300m depth from the formation boundary of Koetoi and Wakkanai formation. Abnormal high-pressures have been reported at the boreholes HDB-2 and Kita-kawaguchi SK-1. (Yamamoto et al.,; 2002 and Kanekiyo; 1999) Both abnormal high-pressures are detected more than 200 to 300m beneath the facies boundary of Opal-A and Opal-CT.

Rock properties of Wakkanai formation below 200 to 300m depth from Opal-A and Opal-CT boundary have a potential as seal rock which can keep the high pressure and disturb ground water flow and faculty to delay mass transportation.

References

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