Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SIT38-P01 Room:Poster Time:April 30 18:15-19:30

Relationship between Skempton's coefficient and diagenesis of the Quaternary Kazusa Group siltstones

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Skempton's coefficient B is one of fundamental properties of sediments and rocks. B is defined as the change in pore pressure per unit change in total stress applied under undrained conditions. To reveal the evolution of B of sediments and sedimentary rocks during diagenesis is critical for some processes relating to geophysics and geology, such as mechanisms of developing abnormal pore pressure in sedimentary basins (Tanikawa et al., 2008). However, how B depends on diagenesis is still not clear. To understand the dependency, we evaluated B based on porosity measurements under effective stress for siltstones collected from various formations in the Quaternary Kazusa Group. We also tried to measure B directly, and compared the results with B values obtained from measurements of porosity.

We used siltstones of Umegase, Otadai, Kiwada, Ohara and Katsuura Formations of the Kazusa Group as the samples for the experiments. The specimens from the samples were 30 mm in diameter and 40 mm in length. The laboratory experiments were performed using an intra-vessel deformation fluid-flow apparatus at Toho University, at room temperature and under confining pressures from 2 MPa to 35 MPa. Distilled water was used for pore fluid. From the results of the porosity measurements under effective pressure, we estimated the compressibilites of the rock on the assumption that volume change of the rock at effective stress change equals to the pore volume change, and calculated B from the results. In the direct measurements of B, we measured pore pressure changes when confining pressure were applied under undrained conditions.

The results of B estimations from porosity measurements indicated that B tends to decrease with increasing burial depth. But, B of Ohara siltstones was somewhat higher than other samples despite Ohara Formation is relatively lower in the Kazusa Group. This is probably because siltstones at Ohara Formation were not consolidated enough as compared with those at other formations due to some reasons such as developing abnormal pore pressure. Results indicated that the dependency of B on effective pressure is not simple. B was not simply decreased with effective pressure increases, but B was increased at some range of effective pressure, which mostly reflected that the compressibility was increased at the transition from overconsolidation to normal consolidation state. B depends on both compressibility and porosity, and in the case of the Kazusa Group siltstones, the behavior of compressibility has greater effect on B. Thus, B is decreased as a grade of diagenesis increases because compressibility is decreased. The values of B measured directly tended to be higher than B estimated from measurements of porosity. This is probably because a period between step changes of effective stress was not enough for the rocks to reach steady state.

Keywords: Skempton's coefficient, diagenesis, Kazusa Group, porosity, compressibility, laboratory rock experiment