Simulations of fluid migration and excess pore pressure distribution in the Ursa Basin

Yasutaka Aizawa[1]; Toshihiko Shimamoto[1]; (Peter Flemings) IODP Expedition 308 Shipboard Scientific Party[2]

[1] Dept. of Geol. & Mineral., Graduate School of Science, Kyoto Univ.; [2] -

Integrated Ocean Drilling Program (IODP) Expedition 308 drilled multiple holes in the northern Gulf of Mexico (The Brazos-Trinity Basin #4 and Ursa Basin), to clarify mechanisms of producing excess pore poressure and fluid migration. The most notable point in this region is that sedimentation rate is relatively high (at least 1 cm/year), and numerous mud sediments accumulate on permeable aquifer (Winker and Booth, 2000). These phenomena caused the pore fluid to transfer laterally along the aquifer to regions of low overburden before they are expelled into the overlying sediment. This flow migration creates characteristic distributions of rock properties, fluid pressure, effective stress, temperature, and fluid chemistry in the aquifers and bouding mud. During the expedition verious petrophysical properties associated with fluid migration were collected on board.

After the expedition, we carried out gas and water permeability measurements using an intravessel deformation and fluid-flow apparatus at Kyoto University (Shimamoto, 2003; Shimamoto, 2006; Sone et al., 2006). The permeability of the cores from Site U1322B and U1324B in Ursa Basin were measured as a function of confining pressure up to 120 MPa. Two methods were used, the constant-pressure flow method (Katz et al., 1959) and the pulse transient method (Brace et al., 1968). In the case of using distilled water as pore fluid, the latter was only used to prevent water from collapsing sample. While the constant-pressure flow method was employed when pore medium was nitorgen gas. Cylindrical samples were first dried at room temperature for a week, and placed in a thermo chamber at 90-100 degrees C for more than 3 days to evaporate pore water. With regard to samples for the pulse transient method, they were not dried forcibly to keep original condition.

As a result of the measurements, the gas permeabilies of samples from both Sites generally decreased with pressure. Those of Site U1322B and U1324B respectively ranged from $2.0*10^{-17}$ to $6.9*10^{-17}$ m^2 and from $2.9*10^{-16}$ to $2.9*10^{-17}$ m^2.

The simulation of fluid flow was performed using SIGMA-2D/W produced by Mizuho Information & Research Institute, JAPAN. The results illustrated that the fluid flow apparently excelled not vertical direction but horizontal. It was extremely similar to model of Expedition 308 preliminary report.

[References]
Brace, W. F., Walsh, J. B. and Frangos, W. T., 1968, Permeability of granite under high pressure. *Jour. Geophys. Res.*, **73**, 2225-2236.
Katz, D. L., Cornell. D., Kobayashi R., Poettmann. F. H., Vary. J. A., Elenbaas. J. R. and Weinaug. C. F., 1959, *Handbook of Natural Gas Engineering.* McGraw-Hill, New York, 802p.
Shimamoto, T., 2003, Development of an intravessel deformation and fluid-flow apparatus, 'Yoko'. *The 110th Annual Meeting of the Geological Society of Japan, Abstr.*, 115 (in Japanese).
Shimamoto, T., Tsutsumi, A., Hirose, T., Aizawa, Y., Sone, H., Uehara, S., Tanikawa, W., Noda, H. and Mizoguchi, K., 2006, Friction, deformation and fluid-flow appratuses at Kyoto University. *Japan. Jour. Struct., Geol.*, **49**, 49-71 (in Japanese with English abstract).
Sone, H., Hirose T., Uehara, S., Noda, H., Aizawa, Y., Mizoguchi, K., Tanikawa, W., Tsutsumi, A. and Shimamoto, T., 2006, Rock deformation apparatuses at Kyoto University. Japan. *Jour. Struct., Geol.*, **49**, v-viii.
Winker, C. D. and Booth, J. R., 2000, Sedimentary dynamics of the salt-dominated continental slope, Gulf of Mexico:

integration of observations from the seafloor, near-surface, and deep subsurface. *Deep-Water Reservoirs of the World: Proc, GCSSEPM 20th Annu. Res. Conf.*, 1059-1086.