Arrangement of transient pulse method for the quick measurement on permeability

Masumi Sakaguchi[1]; Wataru Tanikawa[2]

[1] MWJ; [2] JAMSTEC

Introduction

Permeability is one of the important physical properties that influences on the pore pressure change within fault zones during geological time scale and dynamic slip motion. Transient pulse method, pore pressure oscillation method and flow pump method commonly used as methods of measurement on low-permeability in the impermeable rocks, such as clay rich fault gouges. Transient pulse method is the easiest method though it takes very long time before evaluating the permeability. In this presentation, we will report the improvement of measurement system and its utility in the transient pulse method for the purpose of the quick permeability measurement. In addition, we will report the permeability of core sample obtained in Taiwan Chelungpu Drilling Project (TCDP).

Measurement system

The confining pressure and pore pressure of this system can be increased up to 200 MPa and about 2MPa, respectively. Both water and gas can be used as pore fluid medium at room temperature. The pore water can be pressurized by using a hydro-pump system and a commercial water regulator, and we can also use the N_2 gas as to pressurize water. We minimized the downstream storage volume to about 4 cc so as to increase the sensitivity of pore pressure change during the tests, which can shorten the time for the permeability measurement. Simplified fitting curves introduced by Zoback and Byerlee (1975) and Walls et al. (1982) are used for our permeability evaluation.

Results

The permeabilities of 3 rocks (Inada-granite, quartzose sandstone and limestone) were measured up to 100 MPa of confining pressure by transient pulse method. The permeability of each rock decreased with increasing the confining pressure. Under the confining pressure of 100 MPa, the permeability decreased about 1 order of magnitude in comparison to initial permeability at 20MPa (e.g. limestone: $1.6*10^{-16}$ to $3.0*10^{-17}m^2$). A result of measurement of Inada-granite indicates mach the same values with the permeability reported in the previous study and the result measured by a steady state flow method. In the other rocks, permeabilities measured by transient pulse method indicated same values with that measured by steady state flow method at the same confining pressure. The measurement time is shorter in about 1/10 than the previous study. When the differential pore pressure is fixed, the permeability increases with increasing pore pressure. If we pressurize the water by using gas bottle, it might cause the dissolution to pore water of N_2 gas and this may reduce the permeability. However, permeability measured by using gas bottle as pore pressure generation is not much different from that using hydro-pump. Above the results, when our system is applied for permeability measurements, even very low permeability can be evaluated very quickly. But, it is necessary to analyze by a fitting curve using a stricter formula to obtain an accurate permeability.