コスタリカ沖未固結堆積物の差応力下の物性と異方性の分布
Distributions of physical property and anisotropy of unconsolidated sediments off Costa Rica under differential stress

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Static moduli of rock are used in borehole stability to evaluate elevated pore pressure and tectonic stress distribution. The static and dynamic moduli of the same rock may significantly differ from each other. The main reason is likely to be the difference in the size of strain between the dynamic and static tests. In the dynamic properties the strain is about 10^{-7}, while static strain may be about 10^{-2}.

The purpose of this study is to reveal the relationship between static and dynamic moduli of unconsolidated sediments obtained from off Costa Rica, and to evaluate anisotropy of static moduli using shear strain. To achieve this purpose, we obtained (1) static Vp/Vs using volumetric strain and shear strain from experiments in differential stress, and (2) dynamic Vp/Vs from dynamic wave propagation experiments. Then Poisson’s ratio was calculated using Vp/Vs. Using Poisson’s ratio, static and dynamic Young’s moduli were transformed.

Used materials are unconsolidated sediments obtained by IODP expedition 344. We focused on reference site U1414, frontal prism U1412, mid-slope U1380. Materials were remodeled into cylinder shape for the experiments.

Equipment of laboratory experiment consists of pressure vessel, three syringe pumps, computer, transducer, oscilloscope, displacement gauge. In laboratory experiment, pore fluid pressure was kept 1MPa. Effective pressure was controlled by changing axial pressure and confining pressure. We calculated in-situ effective pressure using sample depth, bulk density and assumption of hydrostatic pressure of pore pressure. We conducted 4-5 steps of experiment with isotropic pressure up to in-situ effective pressure. Between each isotropic condition, differential stress experiments were conducted. In differential stress experiments, axial pressure was increased and radial pressure was kept in constant; increment of differential stress is three times as large as increment of effective pressure. Axial strain was calculated from a value of axial displacement gauge. Volumetric strain and porosity were calculated from remaining volume of pore fluid pressure in a pump. When strain reached at equilibrium condition, waveform, a value of axial displacement gauge and remaining volume of pore fluid pressure were recorded.

In the results, static Vp/Vs ranges 1.5-1.6, and dynamic Vp/Vs covers 2.0-2.1. Using each Vp/Vs, Poisson’s ratio, static and dynamic Young’s moduli were calculated. The ratio of dynamic to static Young’s moduli (K) was about 0.6. Dynamic physical properties can transform into static physical properties using K value. Dynamic S-wave velocity was about 25% slower than static S-wave velocity systematically in all samples.

Shear strain of samples from U1414 was larger than that of samples from sites U1412 and U1380. Shear strain is described by the difference between axial strain and radial strain, suggesting anisotropy in reference site is larger than that in wedge.

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