

Frictional property of rocks in the Izu-Bonin-Mariana Forearc under high temperature and pressure conditions

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The Kanto region lies atop of three tectonic plates: the North American Plate, the Pacific Plate, and the Philippine Sea Plate. In addition, the collision and subduction of the Izu-Bonin-Mariana (IBM) arc into the Kanto region results in a characteristic tectonic setting as compared with other convergent margins. Due to such complicated plate configuration, the different type of earthquakes including seismic slip (e.g., the Kanto earthquake) and aseismic creep (i.e., slow earthquake of Boso peninsula) occurs at the intra-plate and plate boundaries beneath the Kanto region. Moreover, the different type of events seems to take place side by side at almost same depth (probably nearly same P-T conditions). Although many factors including pore fluid pressure and fault topography can control earthquake generation, this study focus on frictional property of incoming materials to be subducted into the Kanto region in order to examine a hypothesis that the different types of slips arise from different input materials. Thus, we have performed friction experiments on rocks that constitute the IBM forearc using a high P-T gas medium apparatus at AIST.

We sampled five rocks (marl, boninite, andesite, sheared serpentinite and serpentinitized dunite) recovered from the IBM forearc by Leg 125, Ocean Drilling Program (ODP Site 784, 786). The rocks were crushed and sieved into 10~50 μm in grain size. Then, the rock powders were sandwiched between saw-cut alumina cylinders and sheared at temperature of 300°C, confining pressure of 156MPa, pore pressure of 60MPa and axial displacement rates of 0.1 and 1 $\mu\text{m/s}$. The sheared serpentinite and serpentinitized dunite exhibit steady-state friction of 0.55 and 0.35-0.41, respectively and their velocity dependence of friction is positive (velocity strengthening behavior). On the other hand, for marl, boninite and andesite, a periodic stick-slip behavior appears at 1 $\mu\text{m/s}$. However, contrary to a stick-slip behavior at room temperature in general, rise time of the stick-slip behaviors are quite long (3.9, 9.3 and 10.8 sec, respectively), that could be called as a “ slow stick-slip ” . Similar slow stick-behavior were observed in halite and serpentinite slipped at high temperatures (Noda and Shimamoto, 2010; Okazaki, 2013), but this is first time to recognize this unique slip behavior in sedimentary and igneous rocks. Although it is difficult to discuss the diverse slip behaviors observed at the Kanto region based on our limited experimental results, we will examine the conditions where the transition between stable and unstable sliding appears using the input materials and explore the generation mechanisms of earthquakes at the Kanto region.

Keywords: Friction, Izu-Bonin-Mariana Forearc (IBM), slow earthquake, stick-slip, earthquake