

Estimates of internal friction in the MK-type solid-medium apparatus

Ichiko Shimizu[1]; Yuta Watanabe[2]; Katsuyoshi Michibayashi[3]; Toshiaki Masuda[4]

[1] Dept. Earth Planet. Sci., Univ. Tokyo; [2] Department of Bio. & Geo., Shizuoka Univ; [3] Inst. Geosciences, Shizuoka Univ; [4] Inst. of Geosciences, Shizuoka Univ.

The solid-medium apparatus has been used for creep tests in high-temperature and high-pressure conditions comparable to the lower crust and upper mantle, which cannot be reached by other types of triaxial apparatuses using pressure mediums of oil or gas. However, it has been pointed out that differential stress is not accurately measurable in the solid medium apparatus, because of internal friction between the piston and the solid pressure medium. To avoid undesirable stress during pressurization stages before heating, we investigated the change of the axial load during compression and decompression, and evaluated the effects of internal friction in room temperature.

We used the MK-type solid-medium apparatus (MK65S), which was developed in 1965 by M. Kumazawa at the Nagoya University and are now installed to the Shizuoka University. Deformation experiments at temperature over 1000 C and confining pressure over 1.0 GPa are possible in this machine. The basic design of MK65 is common to the world wide standard of the Griggs-type apparatus; The pressure vessel has two concentric pistons entering to it. The outer piston, driven by a hydraulic ram assembly connected to a hand pump, provides confining pressure. The inner piston, connected to a motor and a gear train through a ball screw and a thrust bearing, controls the axial deformation of the sample. A unique feature of MK65S is its pressure measurement systems. The load of outer and inner pistons are measured by pairs of load cells which are set above and below the pressure vessels, respectively. The total load is also measured on the press frame.

We used pyrophyllite for the pressure medium and cylindrical samples of agate with the diameter of 10 mm. We moved the hydraulic ram and the inner piston alternately so that the confining pressure and the axial stress increase or decrease step by step. When we increased the confining pressure by 50-100 MPa intervals, the apparent axial stress measured by the upper load cell was significantly decreased and that measured by the lower load cell was increased, though the inner piston was kept at the same position. Inversely, when we decreased the confining pressure, the apparent axial stress measured by the upper load cell was increased and that measured by the lower load cell was decreased. When we stop the movement of the hydraulic ram, the values of axial load were kept constant. These behavior in the step tests can be interpreted in terms of internal friction between the inner piston and the pressure medium. When internal friction is taken into account, the axial load at the center of the sample is given by the average of the upper and the lower load cells. The true axial stress is derived as the axial load divided by the the intersection area of the sample. The internal friction can be estimated from the difference in measured loads between the upper and lower load cells. The nominal frictional (or tangential) stress on the inner wall of the pressure medium was about 20 MPa at maximum. Response of frictional stress against the confining pressure involves both reversible and irreversible paths. The apparent frictional coefficient in the compression path was estimated about 0.025.