

Electrical conductivity of micas

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Seismic velocity and electrical conductivity give us clues to infer constituent materials and their physical states in the Earth. Electrical conductivity is used to infer the distribution of water in the crust, since it is especially sensitive to the existence of fluids. Dry rocks are generally considered to be electrically insulating under the crustal temperature condition. However, Fuji-ta et al. (2006) recently pointed out that the interconnection of biotite grains might be the cause of the observed high conductivity. Although room-temperature properties of biotite are well known, high-temperature properties are poorly understood. We thus have investigated electrical properties of biotite single crystals up to 700 C. In order to get a good understanding of conduction mechanisms, electrical properties of phlogopite and muscovite have been also studied.

Thin plates (3 mm x 3mm x 0.15 mm) were prepared from single crystals of biotite, phlogopite and muscovite. Plates were parallel to cleavages. By 2-electrode method, the electrical impedance in the direction normal to cleavages was measured with an LCR meter (NF, ZM2353). The applied voltage was 1 V, and measurements were made at 27 frequencies between 40 Hz and 200 kHz. The specimen was kept in the nitrogen atmosphere.

The conductivity of biotite is higher than those of phlogopite and muscovite by 2-3 orders of magnitude. At 500 C, the conductivity of biotite is of the order of 10^{-4} (S/m). A preliminary experiment showed that the conductivity in the direction parallel to cleavages is higher than that in the direction normal to cleavages by around 3 orders of magnitude. This suggests that biotite explain the high conductivity observed by Fuji-ta et al. (2006).