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カンラン石の転位移動度の温度圧力依存性の評価
Estimation of dislocation mobility in different slip systems in olivine as a function of pressure and temperature

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It is considered that the seismic anisotropy in the upper mantle will be caused by crystallographic preferred orientation of olivine. The seismic anisotropy rapidly decreases below 200 km depth, which is attributed to a transition from A-type to B-type fabric with pressure indicated by deformation experiments. However, stress and strain-rate conditions in deformation experiments are by orders of magnitude higher than in the upper mantle, which may mislead our understandings.

A- and B-type fabrics are produced by the dominant slip systems of (010)[100] and (010)[001], respectively. Hence, the fabric transition implies that the dislocation mobility in (010)[100] will decrease with increasing depth more than in (010)[001]. In order to examine this hypothesis, we determined the dislocation mobility of (010)[100] edge (a-dislocation) and (010)[001] screw (c-dislocation) dislocations at pressures of 0 to 12 GPa and temperatures of 1470 to 1770 K by means of the dislocation recovery technique, in which the dislocation mobility is determined under quasi-hydrostatic conditions. The a- and c-dislocations were produced in (010)[100] and (010)[001] simple shear geometries by 45-degree-edge alumina pistons at a pressure of 3 GPa and a temperature of 1600 K for one hour. TEM observations indicated that 90 % of dislocations produced in (010)[100] and (010)[001] simple shear geometries are a- and c-dislocations, respectively.

The experimental results show: (1) The mobility of a-dislocation is almost identical to or up to 0.5 orders of magnitude lower than that of c-dislocation at ambient pressure. (2) The activation energies of both dislocations are comparable, about 400 kJ/mol. (3) The activation volumes of both dislocations are also comparable, about 2.6 cm3/mol.

The comparable activation energies and volumes suggest that the transition of A-type to B-type fabric by pressure and/or temperature is unlikely. The rapid decrease in seismic anisotropy below 200 km will be due to decrease in flow rate in this depth.

キーワード: カンラン石, 転位, 移動度, 圧力, 温度
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