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Diffusion creep experiments on polyctystalline anorthite

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It is very important to investigate the rheological properties of the lower crust because it plays a major role on the cause of inland earthquakes. In this study, we selected anorthite as a representative mineral of the lower crust and examined its flow properties.

Previous studies have proposed flow laws of polycrystalline anorthite with different amount of water. Based on these results, the polycrystalline anorthite will deform under diffusion creep on the conditions of the lower crust (temperature 400 to 1000C, grain size of $<$ 100 um, which is often observed in mylonites). The synthetic samples used in previous studies, however, contained a little water and glass phase which are difficult to eliminate with their technique for the sample synthesis .

We prepared polycrystalline anorthite using the technique that does not allow the contamination of water and glass phase. Creep tests were performed at temperatures ranging from 1150 to 1380C, stresses from 10 to 120 MPa, strain rates between 5x10^{-7} and 2x10^{-4} s^{-1}, and confining pressure of 0.1 MPa. We read strain rate from the rate becoming independent on time. Arithmetic mean grain size of the specimens was 1 um before and after the creep tests, which were found by the scanning electron microscopy. Log stress and log strain rate showed a linear relationship where its slope gave a stress exponent, n of 1, indicating that samples were deformed under diffusion creep. We obtain activation energy, Q of 490(30) kJ mol^{-1} and the preexponential factor, A of 10$^{10.7}$ MPa^{-1} um^{3} s^{-1}.Our samples exhibited two orders of magnitude stronger relative to the previous samples. There was no explicit difference in activation energy. The difference in the strength can be attributed to the presence of water and glass phase in the previously studied samples, which can reduce the sample strength.

We applied our obtained flow law to the temperature condition of the lower crust finding that the viscosity of polycrystalline anorthite with grain size of 10 um is harder than that of polycrystalline olivine deformed under dislocation creep at dry condition.

Keywords: polycrystalline anorthite, diffusion creep, the lower crust