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Doping effect on high-temperature creep of polycrystalline anorthite

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Rheological properties of lower crust are considered to play important roles on the cause of inland earthquakes. Previous studies on creep properties of polycrystalline anorthite indicate that the polycrystalline anorthite will deform under diffusion creep at temperature condition of 400 to 1000C and grain size of $<$100 um where such conditions are identified in mylonites which are of lower crust origin. Therefore, it is important to know a precise strength of polycrystalline anorthite during diffusion creep.

Previous studies have shown the influence of grain size, temperature, stress, and water content on the strength of polycrystalline anorthite. It is well known that a small amount of impurities segregated at grain boundaries has a significant effect on the strength of polycrystalline oxides. We have shown that our pure anorthite aggregate, which was synthesized using the technique that could minimize the contamination of impurities, had two orders of magnitude larger strength than anorthite aggregates used in previous studies. In this study, we examine the effect of doping a small amount of MgO on high-temperature creep of anorthite aggregates.

MgO-doped anorthite aggregates were fabricated from nano-sized powders of $CaCO_3$, Al_2O_3, SiO_2 ,and $Mg(OH)_2$, all of which have $<$50 nm in diameter, and vacuum sintering of the powders. We controlled the amount of $Mg(OH)_2$ powders to obtain anorthite doped with 1wt% of MgO. Constant load tests were performed at temperatures ranging from 1150 to 1380C, stresses from 10 to 120 MPa, and confining pressure of 0.1 MPa. We measured Arithmetic mean grain size of specimens by microstructural observations using scanning electron microscopy (SEM) before and after creep tests.

Grain sizes of the specimens were 1~2um before and after the creep test. Log stress versus 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. MgO-doped anorhite aggregates exhibited more than one order of magnitude weaker than pure anorthite. We obtained activation energy, Q of 702 kJ/mol which was higher than that of our pure anorthite. The difference in strength between pure and MgO-doped anorthite was attributed to the presence of a small amount of MgO which was probably segregated at grain boundaries.

Keywords: polycrystalline anorthite, diffusion creep, effect of doping