Effects of dislocations on rock anelasticity: *In-situ* forced oscillation experiments during the dislocation creep using analogue polycrystals

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Rock anelasticity causes seismic dispersion and attenuation and hence plays an important role in the interpretation of seismological structures. Effects of dislocations on the rock anelasticity, however, have been poorly understood, because only a few experimental studies have been performed [1, 2] due to the difficulty of high temperature and high pressure experiments. We therefore investigate the dislocation-induced anelasticity by using borneol (organic polycrystal, [3]) as a rock analogue. Flow law of this sample shows a transition from diffusion to dislocation creep around $\sigma = 1$ MPa (at 40–50°C). After the dislocation creep, the microstructure shows the occurrence of dislocation-induced grain-boundary migration. So far, we have captured a significant (≧ 10%) reduction of Young's modulus E at $f \leqq 100$ Hz. Although a slight increase in attenuation Q^{-1} was also captured at $f \leqq 100$ Hz, the major part of the dislocation-induced anelastic relaxation exists at $100 \leqq f \leqq 10^6$ Hz. This frequency range cannot be tested directly by the forced oscillation test nor by the ultrasonic test. Additionally, a recovery of E during the anelasticity measurements was captured, probably due to dislocation annihilation [4, 5]. In our previous experiments, dislocation creep test and anelasticity measurement were performed in the different apparatuses, and hence unloading and cooling of the sample were necessary. Therefore, dislocation density during the anelasticity measurement can be much smaller than that under the dislocation creep. In this study, we developed a new experimental system with which anelasticity of the sample can be measured under the dislocation creep.

A careful analysis of the previous creep curves has revealed a temporal evolution of the dislocation density during the dislocation creep. We calculated the dislocation density from the measured strain rate by using the Orowan's relation, where the dislocation velocity was assumed to be proportional to the differential stress σ. The result shows that after the loading, the dislocation density first increases for several hours and then decreases due to the decrease in σ caused by the relatively fast collapse of the samples. If we can perform an *in-situ* measurement of anelasticity and capture any change corresponding to this temporal evolution of dislocation density, we can study the effects of dislocations on anelasticity more quantitatively. In addition, dislocation annihilation by unloading can be avoided. We therefore developed a new experimental system. We attached a piezo-electric actuator which can add a small cyclic load to a large constant load. We also attached a load cell and two laser displacement meters to measure the small cyclic load and displacement accurately. We performed a blank test and confirmed that the new system works well. For ongoing work, anelasticity of analogue samples is to be measured *in situ* during the dislocation creep.

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