P154-024 **Room: 201B** **Time: May 16 15:55-16:08**

Mechanical strength and flow properties of ice-glass beads mixture depending on the beads contents and the beads sizes

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The geological structures on the surfaces of icy satellites have been revealed by planetary explorations. They tell us intrinsic tectonic processes of the icy satellites at the past time. The icy crust and mantle of the satellite is composed of the mixture of ice and silicates supposed by the mean density and the observation of reflection spectrum on the surface. The ice sheets on mars are also observed, and the stripe patterns showing the layered structures with the different sand contents are discovered. Therefore, the rheological properties of ice-silicate mixtures are important to study the tectonics of icy satellites and the flow dynamics of ice sheets on mars.

We have made deformation experiments of ice-glass beads mixtures by using uniaxial testing machine in order to study the effects of glass beads (abbr. g.b.) on the ice strength. The sample was prepared by mixing ice particles (1mm in the diameter) with glass beads (1micron or 1mm in the diameter), which contents were from 0 to 50 wt.%. In order to exclude pores among particles, water at 0 deg. was put in the prepared mixtures. The cylindrical sample with the diameter of 30mm and the height of 60mm was deformed in the uniaxial compression at the strain rate from 3x10ˆ-3 to 3x10ˆ-6 sˆ-1. All of the experiments were conducted in the cold room regulating the temperature of -10 deg.

The maximum stress on the stress-strain curve in each experiment was plot against the strain rate. When the glass beads contents were a constant of 30 wt.% for the mixture samples, the relationships between the maximum stress (S) and the strain rate (de/dt) in the both sample, 1micron and 1mm particle size, can be expressed as the power law equation, de/dt = a Sˆn. The power law index, n, is calculated to be 5.6 and 6.5 for the 1micron-m g.b. sample and the 1mm g.b. sample, respectively. The difference of the strength between them is not so large, but it is clearly recognizable: the 1mm g.b. sample is weaker than the 1micron-m g.b. sample. It is also noticed that both mixed samples are weaker than polycrystalline pure ice obtained previously.