STRENGTH CONTRAST BETWEEN PLAGIOCLASE AND OLIVINE: IMPLICATION FOR RHEOLOGICAL LAYERING IN THE TERRESTRIAL PLANETS.

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Introduction: It is thought that plate tectonics is a product of the localized brittle failure in the lithosphere and viscous flow in the asthenosphere, and strength profile is a key to understand tectonics of terrestrial planet [1] . Physical properties, such as temperature and pressure and stress, and the chemical compositional layering between crust and mantle result in a strong rheological layering in the planet interior. It has been estimated by previous experiments that the brittle-ductile transition occurs in the planet interior and deformation mechanisms can be changed with increasing depth. In the present study, we evaluate rheological variation in the crust-mantle transition based on new series of deformation experiments, and discuss why plate tectonics doesn't exist in the other terrestrial planets except the Earth.

In case of the earth, two different models on the strength profile in the continental crust have been proposed. The first is the "jelly sandwich" model that had been embraced for the past two decades. This model is that a weak middle and lower crust are sandwiched between strong upper crust and strong mantle lithosphere just like a jelly sandwich e.g., [2]. The second one is the "creme brullee" model, in which the upper mantle is significantly weak, and consequently region for viscous deformation continues into the mantle depth [3] . These two models of strength profile are given by extrapolating frictional strength and viscous flow law of each material to temperature and pressure corresponding to the Earth's interior.

Deformation Experiment: In this study, we performed experiment to directly determine the relative strength between plagioclase and olivine without any extrapolating of flow law; the crustal materials consist predominantly of plagioclase that largely control deformation of the crust, whereas deformation of the upper mantle is largely controlled by olivine. These samples are together sandwiched between alumina pistons in a simple shear geometry and we used the hot-pressed samples and performed deformation experiments using solid-medium deformation apparatus. The experimental conditions were ranging 1GPa and 400- 800 °C, corresponding conditions approximately to Moho of the Earth under water-rich conditions. The experimental results show that plagioclase is expected to be a little bit weaker than olivine or show almost no difference in strength at temperatures of the continental Moho of the Earth, ca. 500- 600 °C. Moreover, we found the change of relative strength contrast between plagioclase and olivine at low temperature; plagioclase becomes stronger than olivine at 400 °C. Plagioclase is generally believed to be weaker than olivine [4],which is also endicated by extrapolation from power-law relations. However, our experimental results indicate that olivine can be weaker than plagioclase [5]. In materials with a relatively strong chemical bonding such as silicates, Peierls mechanism becomes dominant at low temperatures [6]. Based on deformation mechanism map, deformation of olivine could be controlled by this type of flow mechanism under our low temperature experiments. Thereby, the strength contrast between plagioclase and olivine are reversed at low temperatures. Some natural observations, such as boudin structure of plagioclase in olivine matrix from the Oman ophiolite, suggest that the strength contrast between plagioclase and olivine might be reversed under different geological conditions. This observation agrees with our results. Consequently, our result of this experiments surppoted "creme brullee" model, in which the upper mantle below the Moho is expected to be comparable or less viscous than crustal materials e.g.,[3], as continental strength profile and showed us that flow law can not be applied for low temperature conditions.

In the future, we are going to conduct experiments under dry condition to evaluate strength profile of terrestrial planets like dry Venus. Venus has been thought as a similar planet to the Earth because of closet to the Earth in mass, density, size and in distance from Sun [7] . However, Venus has extraordinary crustal features and plate tectonics doesn't seem to work in this planet. This can be a result of dfferent rheological property on the Venus. In previous study, behavior of Venusian lithosphere have been inferred by deforomation experiments of dry diabase e.g. [8]. We are going to report our new result of deformation experiments under dry conditions, and present their tectonic difference.

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