

---

 [JJ] Evening Poster | S (Solid Earth Sciences) | S-CG Complex & General

## [S-CG63] Rheology, fracture and friction in Earth and planetary sciences

convener: Osamu Kuwano (Japan Agency for Marine-Earth Science and Technology), Ichiko Shimizu (Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo), Hidemi Ishibashi (静岡大学理学部地球科学専攻, 共同), Miki Tasaka (Shimane University)

Sun. May 20, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)

The aim of this session is to join people from various research area in the earth and planetary sciences and to stimulate discussion beyond the boundaries of each research area. Our goal is to deepen our understanding of dynamics in geosciences by looking over whole areas in the earth and planetary sciences from the viewpoint of PHYSICS OF DEFORMATION, FLOW, AND FRACTURE. We welcome any field (e.g., earthquake, volcano, earth surface, crust, mantle and the core, and other planets and satellites) and any approach (e.g., laboratory experiments, numerical simulations, field observations, and theories).

---

## [SCG63-P02] Grain-size effect on the hardness of olivine

\*Sanae Koizumi<sup>1</sup>, Thoru S S<sup>2</sup>, Takehiko Hiraga<sup>1</sup> (1. Earthquake Research Institute, The University of Tokyo, 2. National Institute for Materials Science)

Keywords: Olivine, Grain size, hardness

The yield strength of oceanic lithosphere, which controls lithospheric flexure [Zhong and Watts, 2013] and formation of the plate boundaries [Tackley, 2000], is often corresponded to the strength of olivine, the dominant mineral in the upper mantle [e.g., Mei et al., 2010]. Yield stress of the mineral can be obtained from the hardness of the mineral measured by conventional indentation tests [Evans and Goetze, 1979], while corresponding such measured yield stress to that of the lithosphere has been a matter of debate [Iddrissi et al., 2016; Kumamoto et al., 2017]. The experimentally obtained yield stress (~1 GPa) is much larger to account the lithospheric deformation, which seems to require only a few hundreds of MPa [Zhong and Watts, 2013].

In this study, we examine the relationship of the strength of olivine with grain sizes. We carried out Vicker's indentation test to measure the microhardness (Hv).

Load of 0.49 - 1.96 N was applied for the indentation test with a holding time 15 s. The test were performed for five Fe-free olivine and two Fe-bearing olivine samples with grain size ranging from 0.17 to 0.89  $\mu\text{m}$ . We also tested single crystals of olivine: synthetic Fe-free olivine single crystal, natural Fe-free olivine single crystal from Mogok, Myanmar (Fe content >0.1 wt%) and Fe-bearing olivine ( $\text{Mg}_{1.8}\text{Fe}_{0.2}\text{SiO}_4$ ) Kohistan, Pakistan [Bouilhol et al. 2009]. Indented surfaces were observed by field emission scanning microscope (FESEM). Dimensions of the indents and fracture lengths were measured in SEM images. We successfully indented to obtain reliable  $H_v$  from all the polycrystalline samples. Essentially the same  $H_v$  were obtained by changing loads. The largest  $H_v$  was 13  $\mu\text{m}$ ; 0.4 GPa from 170 nm grain-size sample, while the  $H_v$  decreases with increasing grain size to 11  $\mu\text{m}$ ; 0.3 GPa for 890 nm grain size sample. Fe-free and Fe-bearing samples exhibited essentially the same  $H_v$  at the similar grain sizes. All the  $H_v$  from the polycrystalline samples are larger than the  $H_v$  of the single crystals, whose values are comparable to those reported in Evans and Goetze [1979]. The  $H_v$  from the polycrystalline samples show linear relationship with  $d^2$ , well following Hall-Petch relation. Further, the  $H_v$  from single crystals are plotted at  $d$  of  $+\infty$ ; in the relationship obtained from the polycrystalline samples indicating our Hall-Petch relation captures all the size effect in olivine.