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Evidence for a dynamic event recorded in HED meteorites

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It is expected that HED meteorites originate from one of the largest asteroids in the solar system, 4 Vesta. Recent Dawn mission operated by NASA also supports the prediction [1][2]. Dawn mission clearly revealed the existence of many craters on 4 Vesta, which are the records of heavy meteorite bombardments. The existence of a high-pressure polymorph in a shocked meteorite is a robust evidence for a dynamic event on its parent-body (e.g., [3][4]). A high-pressure polymorph can be used for estimating the magnitude of a dynamic event (e.g., [5][6]). Some previous studies propose that 4 Vesta might suffer from late heavy bombardment (LHB) as well as the moon [7]. However, a high-pressure polymorph has not been found in HED meteorite so far.

We got one of eucrite samples, Bereba to clarify a dynamic event occurred on 4 Vesta using a high-pressure polymorph. Present Bereba sample has several shock-melt veins, implying that it was heavily shocked. Accordingly, we investigated Bereba using Raman spectroscopy, FEG-SEM, synchrotron(s)-XRD and FIB-TEM techniques to clarify a record of a dynamic event occurred on 4 Vesta.

We focused our interest on silica phase in this study. Raman spectroscopy analyses show that the silica grains in the host-rock of Bereba are cristobalite, tridymite and quartz. Most quartz grains entrained in the shock-melt veins are partly replaced with coesite. BSE images show that silica grains entrained in or adjacent to the shock-melt veins have network-like and/or lamellae-like textures. Raman spectroscopy, s-XRD analyses and TEM images indicate that such silica grains include coesite, stishovite and silica glass along with quartz.

We found the high-pressure polymorphs of silica from HED meteorites for the first time. The existence of stishovite indicates that pressure condition recoded in Bereba should be ˜8 GPa at least based on a phase diagram obtained from static high-pressure and high-temperature synthetic experiments [8]. Two giant impact basins on 4 Vesta are depicted by Dawn mission. Crater chronology obtained by Dawn mission reveals that the giant impact basins were formed around 1.0 Ga ago [9]. Its fragments became Vesta family in asteroid belt, and a part of them fell into the Earth as HED meteorites. The existence of high-pressure polymorphs in Bereba may support the giant impact occurred on 4 Vesta

References:

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