DISCOVERY OF COESITE, STISHOVITE AND SEIFERTITE IN SHOCKED METEORITES AND ITS IMPLICATION

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The existence of a high-pressure polymorph in a meteorite is one of clear evidences for an impact event occurred on its parent-body. Recently, we have focused on the high-pressure polymorphs of silica (coesite, stishovite and seifertite) in shocked meteorites. Natural coesite and stishovite were discovered from impact craters on the Earth for the first time. We expected that lunar meteorites and Apollo return samples should include the high-pressure polymorphs of silica, because the lunar surface rocks contain a small amount of silica and there are many craters on the Moon. Several melt-pockets were identified in lunar gabbro Asuka 881757, implying that it was heavily shocked. A small amount of silica grain was entrained in the melt-pockets. A laser micro-Raman spectroscopy and EBSD analyses indicate that coesite and stishovite (accompanying silica glass) occur in the silica grains [1]. This is the first discovery of coesite and stishovite from a lunar surface rock. Considering the $^{39}Ar/^{40}Ar$ chronology of Asuka 881757, it is expected that the impact event formed the coesite and stishovite occurred about 3.8 Ga, which would support the late heavy bombardment (LHB) scenario. Lunar basalt NWA 4734 with shock-melt veins was also investigated. FIB-assisted synchrotron XRD and TEM analyses prove that α-PbO_2 type silica, seifertite along coesite and stishovite occur in and around the shock-melt veins of NWA 4734[2]. NWA 4734 shows one of the youngest radio-isotope ages (about 2.7 Ga). The existences of seifertite, coesite and stishovite allow us to infer that intense planetary collisions (like LHB scenario) occurred on the moon until at least about 2.7 Ga ago. After lunar meteorite investigations, we worked on Apollo return samples. Finally, stishovite was identified from Apollo 15299 breccia [3]. Considering the radio-isotope chronology of Apollo 15299, the existence of stishovite is closely related with the LHB and subsequent meteoroid impacts occurred on the Moon. Miyahara et al. (2014) [4] also worked on silica grains in eucrite, and identified coesite and stishovite for the first time, which raised an objection about howardite-eucrite-diogenite delivery model to the Earth. Most martian meteorites were heavily shocked, and several shergottites include seifertite, stishovite and ZrO_2 type silica [5][6][7]. Weisberg et al. (2010) [8] and Kimura et al. (2014) [9] reported that coesite and stishovite occur in enstatite and carbonaceous chondrites although their parent-bodies are expected to be less shocked. Now the high-pressure polymorphs of silica are becoming a new clue for clarifying a dynamic event occurred in the solar system. However, their formation processes, phase transformation mechanisms and required pressure conditions for formation have been still enigmatic (e.g., [10]). These matters should be addressed for the meaningful estimations of shock pressure conditions.

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