

Discovery of stishovite in an Apollo 15 sample and impact record on the Moon

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Thick regolith layers and many craters on the Moon indicate that the Moon has been heavily bombarded after the lunar formation. Short time intervals of high-pressure and high-temperature occurred on the lunar surface during the collision of asteroids on the Moon, and the constituent minerals of the Moon and asteroids transformed into high-pressure polymorphs during the high-pressure and high-temperature conditions. Although many brecciated lunar rocks have been recovered by the Apollo missions, any high-pressure polymorph has not been observed in Apollo samples so far. Silica is one of constituent minerals of terrestrial planets and asteroid. We investigated a lunar regolith collected by the Apollo 15 mission with a special interest on silica, because high-pressure polymorphs of silica are recently reported from shocked lunar meteorites (Ohtani et al., 2011; Miyahara et al., 2013). Here, we show stark evidence for stishovite from a sample collected by the Apollo 15 mission. X-ray diffraction analysis and transmission electron microscopic observations clearly confirmed the existence of a high-pressure polymorph of silica, stishovite, in the Apollo sample, which suggests that the lunar regolith preserves records of early shock events. Considering radio-isotope ages, lithologies, and shock features, stishovite was formed by an impact event in the near side Moon ca. 3.8-4.1 Ga ago.

Keywords: Stishovite, Apollo mission, Impact, High pressure and temperature, Lunar sample