American Mineralogist, Volume 100, pages 1308–1311, 2015

LETTER

Discovery of stishovite in Apollo 15299 sample

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ABSTRACT

High-pressure polymorphs recovered in terrestrial craters are evidence of meteoroid impact events on the Earth's surface. Despite countless impact craters on the Moon, high-pressure polymorphs have not been reported to date in returned Apollo samples. On the other hand, recent studies report that the high-pressure polymorphs of silica, coesite, and stishovite occur in shocked lunar meteorites. We investigated regolith breccia 15299, which was returned by the Apollo 15 mission, using the combined techniques of focused ion beam (FIB), synchrotron X-ray diffraction (XRD), and transmission electron microscopy (TEM). The regolith breccia 15299 studied here consists of a mafic impact melt breccia with millimeter-sized, coarse-grained, low-Ti basalt clasts. The mafic melt breccia consists of fragments of minerals (olivine, pyroxene, plagioclase, silica, and ilmenite) and glass. Several quartz, tridymite, and cristobalite grains of 10–100 μm across occur in the mafic impact melt breccia. Vesicular melt veins of less than ~200 μm wide cut across the mafic melt breccia matrix and mineral fragments. Some silica grains are entrained in the melt veins. One of the silica grains entrained in the melt veins consist of stishovite [$a = 4.190(1)$, $c = 2.674(1)$ Å, $V = 46.95$ Å^3, space group $P4_2/mnm$] along with tridymite and silica glass. This is the first report of high-pressure polymorphs from returned lunar samples. TEM images show that the stishovite is needle-like in habit, and up to ~400 nm in size. Considering the lithologies and shock features of 15299, it is inferred that the stishovite possibly formed by the Imbrium impact or subsequent local impact event(s) in the Procellarum KREEP Terrane (PKT) of the nearside of the Moon.

Keywords: Apollo, stishovite, Imbrium impact, Procellarum terrane