Discovery of heavily shocked type 3 ordinary chondrites

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Based on the onion cell model, a parent-body of an ordinary chondrite consists of petrographic type 6, 5, 4 and 3 from inward to outward. A high-pressure polymorph occurring in a shocked ordinary chondrite gives shock pressure, temperature, impact velocity and impactor size, which become clues for understanding a destruction process of an ordinary chondrite parent-body. We have to clarify the inventories of a high-pressure polymorph included in all petrologic types to elucidate the destruction process of an ordinary chondrite parent-body. Accordingly, we will describe the petrologic and mineralogical features of the shock-induced textures and high-pressure polymorphs therein in heavily shocked type 3 ordinary chondrites.

We observed about three hundreds Antarctica type 3 ordinary chondrite (H-, L- and LL-type) petrographic thin sections stored in the NIPR under an optical microscope. We found eight type 3 ordinary chondrites with a distinct melting texture; Y-981139 (H3), A-87170 (L3), A-87220 (L3), Y-000886 (L3), Y-86706 (L3), Y-981327 (L3) A-881199 (LL3.4) and A-881981 (LL3). We also selected thirty three type 3 ordinary chondrite petrographic thin sections without a melting texture as a reference. All these samples were scanned with a field-emission scanning electron microscope (FE-SEM) to observe the fine-textures of melt-pockets and the morphologies of chondrules. Mineralogy was determined by a laser micro-Raman spectroscopy.

FE-SEM observations revealed that the melting textures (melt-pocket) in type 3 always occur around a boundary between a chondrule and matrix. Fine-grained quench silicate crystals and the spherules of metallic iron-nickel + iron sulfide with a eutectic texture filled the melt-pockets. Several interstitial glass fragments were entrained in the melt-pockets of A-881199 (LL3). Their bulk-chemical compositions are similar to that of plagioclase. Based on a Raman spectroscopy analysis, most of them are amorphous. On the other hand, back-scattered electron (BSE) image depicted that one of the interstitial glasses had a granular texture. A strong Raman shifts appeared at 372, 693 and 1032 cm-1 from the interstitial glass with a granular texture, which appear to be those of jadeite (Considering its chemical composition, probably, jadeite-diopside solid-solution) or tissintite. This is a first discovery of a high-pressure polymorph from type 3 ordinary chondrite. The ellipticity of chondrules (1 −(short axis/long axis)) in type 3 chondrites with and without a melting texture was measured. The ellipticity of chondrules in chondrites with a melting texture is ˜0.31, which appears to be a bit bigger than those of chondrules in chondrites without a melting texture. The orientation of the long axis of chondrules was also measured. The long axis of chondrules in chondrites with a melting texture appears to be oriented along a specific orientation. The ellipticity and orientation degree of chondrules besides a high-pressure polymorph would be available for estimating shock pressure condition recorded in an ordinary chondrite.

Keywords: ordinary chondrite, shock, high-pressure polymorph

