Complex shock history in the eucrite Padvarninkai

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HEDs clan is regarded as the fragments launched from 4 Vesta because of i) the similarities in the reflectance spectra between HEDs clan and 4 Vesta, ii) the dynamic considerations. The Dawn mission has revealed that many craters exist on 4 Vesta (e.g., [1]). Several studies propose that impact events formed the craters and delivered HEDs clan to the Earth. However, the origin and deliver process of HEDs clan have been still under debate (e.g., [2]).

The Padvarninkai is one of the most heavily shocked eucrites because of pervasive shock-melt veins [3]. One of the representative clues for clarifying an impact event is a shock-melt vein and high-pressure polymorph therein. However, the high-pressure polymorphs in the shock-melt vein of the Padvarninkai have not been investigated in detail so far. Accordingly, we investigated the high-pressure polymorphs in and around the shock-melt veins of the Padvarninkai to clarify the recorded impact event and verify the prediction for HEDs clan delivery process using SEM, EMPA, Raman, and FIB-TEM analysis.

The host rock of the Padvarninkai had an ophitic texture and consisted of pyroxene, plagioclase, and minor amounts of ilmenite, chromite, troilite, silica minerals (tridymite, cristobalite, and quartz), and Ca-phosphate. Most plagioclase grains in the host rocks have become amorphous. Many crystallites occurred in the plagioclase grains next to the shock-melt veins. Some crystallites were aggregated in the shape of a spherule. Based on the chemical compositions and Raman shifts, the crystallite was Ca-pyroxene. Planar defects were observed in some quartz grains of the host rock. Parts of silica minerals in the host rock have become glass. Silica grains in the shock-melt veins have become coesite. Garnet-like minerals occurred in the matrix of shock-melt veins. The existence of coesite indicates that the shock pressure is ~2 GPa at least. In contrast, plagioclase glasses surrounded some Ca-pyroxene grains emerged from plagioclase. Quartz grains or silica glasses surrounded some coesite grains. These featuers are suggestive of dual impacts or back transformation. We have to consider the shock metamorphism carefully to uncover the impact history recorded in Padvarninkai.

References: [1] De Sanctis et al., 2012, Science 336, 697–700. [2] Yamaguchi et al., 2002, Science 296, 334–336. [3] Yamaguchi et al., 1993, Meteoritics 28, 462–463.