VARIOUS SILICA POLYMORPHS IN THE YAMATO-75011 NON-CUMULATE EUCRITE.

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Introduction: Yamato- (Y-) 75011 is a rare non-cumulate eucrite that contains a clast classified into type 1 thermal metamorphic degree [1]. This clast is a mesostasis-rich basalt whose pyroxenes are extensively zoned and has clearly experienced rapid cooling. We studied silica minerals in this basaltic clast and found aggregates of quartz and cristobalite in the mesostasis [2]. We interpreted that these silica aggregates formed by partial transformation from cristobalite to quartz either by secondary alterations (including hydrothermal alterations) or upon cooling at high temperature (cooling slower than 1 °C/hr from 1300 to 850 °C as suggested by our crystallization experiment [3]). Takeda and Graham [1] considered that the clast was partly equilibrated by sub-solidus annealing after brecciation. However, the temperature was too low to homogenize pyroxene Mg-Fe contents and the mesostasis was not influenced by the annealing [1,4]. In this abstract we report mineralogy of silica minerals in basaltic clasts and matrix in Y-75011 to verify that this eucrite was minimally affected by thermal metamorphism after brecciation in terms of silica mineralogy.

Samples and Methods: We observed a polished thin section of Y-75011 using FE-SEM (JEOL JSM-7100F at NIPR). Identification of silica phases was performed by a micro Raman spectrometer (JASCO NRS-1000 at NIPR).

Results: In our previous study, we have analyzed the largest basaltic clast (~1.8 mm in size) in this thin section [2]. We additionally studied 3 different basaltic clasts. They have various silica mineral combinations. One is a clast including monoclinic tridymite and anhedral quartz. In this clast, tridymite (~690 µm) is much larger than quartz (~10 µm) and quartz includes tiny sulfide and pore spaces. This combination is the same as silica minerals in the Millbillillie eucrite [5], but the texture is different. The second clast contains cristobalite and monoclinic tridymite. These two silica phases have almost the same size (30~90 µm in size) and the shape. The third clast has only quartz which includes tiny sulfides same as quartz in Millbillillie and Stannern. Additionally, many isolated silica fragments are found. They are cristobalite, monoclinic tridymite, orthorhombic tridymite and an aggregate of monoclinic tridymite and quartz. Fragments of monoclinic tridymite are the most abundant silica polymorph. Their form is characteristic, for example, one is present as a large grain (~320 µm in size) with ilmenite and another forms a corona-like texture which is similar to isolated monoclinic tridymite fragments in the Pasamonte matrix [6]. Cristobalite grains are similar to one in the run produnct of crystallization experiment [4] and the clast in Pasamonte [6] because they have similar characteristic cracks. Orthorhombic tridymite grains are ~30 µm in size. The aggregate of monoclinic tridymite and quartz is the same combination as one found in Millbillillie [5], but their textures are not similar. Quartz exists in a part of the aggregate and contains tiny sulfides and vesicles.

Discussion and Conclusion: In this study, we found variable combinations of silica polymorphs in the basaltic clasts in Y-75011: (1) monoclinic tridymite and quartz, (2) monoclinic tridymite and cristobalite and (3) quartz. We also found different kinds of isolated silica minerals in the matrix: cristobalite, monoclinic tridymite, orthorhombic tridymite and aggregate of monoclinic tridymite and quartz. In our previous study, we pointed out that the presence of monoclinic tridymite suggested slower cooling than orthorhombic tridymite below 400 °C [7]. In this sample, we found two kinds of tridymite, indicating that they have experienced different low-temperature cooling processes. Additionally, there are many kinds of silica mineral combinations in this sample. Because these various silica minerals have been found in the same meteorite, it is consistent with previous studies that the degree of thermal metamorpshim of Y-75011 after brecciation was minimal at low temperature [1,4].

We also found a monoclinic tridymite fragment which forms a corona texture in Y-75011. This texture is remarkably similar to isolated monoclinic tridymite fragments in Pasamonte [6]. Both Y-75011 and Pasamonte are classified as polymict eucrite. Because the same fragments exist in different polymict eucrites, it indicates that they have been formed at the same region in their parent body. Although Pasamonte has a slightly distinct oxygen isotope ratios compared to normal HEDs [e.g., 8], this study suggests that Pasamonte came from the same parent body with Y-75011 (asteroid 4Vesta). Additionally, it was reported that similar metasomatic veins were found in both of Pasamonte and Y-75011 [8]. Therefore, we favor the idea that the anomaly of oxygen isotopic compositions of Pasamonte was caused by trapping of a heterogeneous oxygen isotope reservoir on Vesta [9].

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