MINERALOGY OF SILICA POLYMORPHS IN BASALTIC CLASTS IN EUCRITES.

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Introduction: Silica minerals are known to have 23 or more polymorphs [1] and considered to provide useful information about thermal history of both igneous and secondary metamorphic activities. Silica minerals are rare in meteorites, but there is a report that silica polymorphs have primary information at magmatic temperature in enstatite chondrites [2]. There are relatively more abundant silica minerals in eucrites compared to other differentiated meteorites, and quartz, tridymite, and various polymorphs have been identified. For example, quartz of possible hydrothermal origin has been found in Sera de Magé cumulate eucrite [3]. However, in many cases they are simply mentioned as “silica”. In our previous study we suggested the presence of hydrothermal activity estimated from silica minerals in the Yamato-75011 (Y-75011) eucrite [4] and similar report has been done by [5]. In this study, we investigated silica minerals in other eucrites, and discuss the wide presence of hydrothermal activity in the Vesta crust. Thus, we focus on two brecciated eucrites having basaltic clasts in addition to Y-75011.

Samples and Method: We studied thin sections of Pasamonte and Stannern, and analyzed EBSD patterns of silica minerals using SEM (JEOL JSM-7100F) at National Institute for Polar Research (NIPR). Quantitative chemical analyses and elemental mapping were performed using the JEOL JXA-8530F electron microprobe at University of Tokyo. Raman spectra of these silica phases were obtained by the JASCO NRS-1000 at NIPR.

Result: Because both Pasamonte and Stannern are brecciated meteorites, we focus on basaltic clasts which contain pyroxene with chemical zoning and plagioclase laths in order to assess their formation conditions probably at near the surface of Vesta.

Aggregates of fine-grained quartz and cristobalite are found in Y-75011 basaltic clasts. These silica minerals exist at grain boundary of pyroxene and plagioclase, and aggregate sizes are about 300 μm. Cristobalite has tiny opaque inclusions less than 1 μm in diameter and quartz has sulfide inclusions and cavity less than 5 μm. We found some quartz grains between pyroxene and plagioclase which show a resorption texture. Such quartz penetrates into pyroxene and there are no exsolution lamellae of pyroxene around them. In Pasamonte, many subhedral cristobalite grains are present in basaltic clasts although they are not found in Y-75011. Sulfide particles fill cracks of cristobalite and there are small opaque particles (less than 1 μm in size) in domains divided by the cracks with sulfide. Additionally, quartz and tridymite are also found in the same clast with a similar texture to cristobalite. Irregularly-shaped silica-rich glass with vesicles resorb pyroxene and plagioclase in some areas. Basaltic clasts in Stannern include only quartz with irregular shapes, probably replacing pyroxene and plagioclase. Although its occurrence is similar to that of quartz-cristobalite aggregates in Y-75011 because of the presence of sulfide particles (~10 μm in size) and cavities (~5 μm) in quartz, cristobalite was not found.

In Y-75011 and Pasamonte, euhedral coarse-grained tridymite grains also occur in matrices as isolated mineral grains. Tridymite in Pasamonte is uniquely surrounded by ferrosilite and fayalite rims, showing a corona-like texture found in metamorphic rocks.

Discussion and Conclusion: Basaltic clasts in Pasamonte contain subhedral grains of cristobalite, quartz and tridymite interstitial to pyroxene and plagioclase, suggestive of magmatic origin. The presence of interstitial cristobalite is unusual because of its stability at high temperature. On the other hand, basaltic clasts in Y-75011 and Stannern did not contain such subhedral silica minerals. Therefore, basaltic clasts in Pasamonte and the others are derived from different parent magmas or experienced different crystallization history. In basaltic clasts of all samples studied, silica minerals showing secondary growth by resorbing pyroxene or plagioclase are commonly present. However, they contain different combinations of silica polymorphs (cristobalite and quartz in Y-75011, only quartz in Stannern and only silica-rich glass in Pasamonte). It is known that amorphous silica is transformed into cristobalite and then quartz by heating in alkaline solutions [6]. Therefore, coexistence of these silica polymorphs indicates hydrothermal origin with different conditions. Because basaltic clasts showing evidence for hydrothermal alteration would have originated from variable sources, this study and previous report of hydrothermal quartz in the Sera de Magé cumulate eucrite [3] indicate wide occurrence of hydrothermal activity throughout the crust of Vesta. In this way, silica polymorphs are good indicators for estimating environment in meteorite parent bodies.

References: [1] Sosman R. B 1965. *Rutgers University Press*, 388 pp. [2] Kimura M. et al. 2005. *Meteoritics & Planet. Science* 40:855-868. [3] Treiman A. et al. 2004. *Earth and Planetary Science Letters* 219:189-199. [4] Ono H. et al. 2016. Abstract #3844. 26th Goldschmidt Conference. [5] Kanemaru R. et al. 2016. Abstract #1424. 26th Goldschmidt Conference. [6] Zhu *et al*. 2005. *Journal of Materials Science* 40:3829-3831.