MINERALOGICAL STUDY OF COEXISTING SILICA POLYMORPHS IN SEVERAL CUMULATE AND NON-CUMULATE EUCRITES.

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Introduction: Silica minerals are major rock-forming minerals and have more than 23 polymorphs. It is known that their phase transition conditions are very complex [e.g., 1]. For example, hexagonal tridymite transforms to monoclinic via orthorhombic at low temperature below 400 ^{o}C [2]. Although silica minerals are minor components in meteorites, eucrites contain substantial amounts of silica compared to other meteorite groups. As reported in some previous studies, silica polymorph can be a good indicator of both secondary alteration and late-stage igneous events in eucrites [e.g., 3-5]. Therefore, in this study, we try to constrain thermal and metamorphic histories of the Vesta's crust by comparing silica polymorphs in several cumulate and non-cumulate eucrites, which originated from lower and upper regions of the crust, respectively.

Samples and Method: We studied six thin sections of cumulate (Moore County, Moama, and Y 980433) and non-cumulate (basaltic clasts and isolated grains in Y-75011, Pasamonte, and Stannern) eucrites. They were analyzed by SEM-EBSD (JEOL JSM-7100F) and micro-Raman spectrometer (JASCO NRS-1000) both at NIPR for the phase determination. Mineral compositions were acquired by EPMA (JEOL JXA-8530F) at Univ. of Tokyo.

Results and Discussion: Our observations are summarized in Table 1.

Cumulate eucrites: We found that tridymite is monoclinic in all samples, but orthorhombic tridymite lamellae exist in Moama [5]. It is considered that Moama experienced relatively rapid cooling below 400 ^{o}C compared to other cumulate eucrites because orthorhombic tridymite could not be preserved by slow cooling. Quartz was not found in cumulate eucrites except for Y 980433 (quartz is present adjacent to a glass vein) because tridymite rarely transforms to quartz once it crystallizes from magma [6]. Quartz in Y 980433 may have been crystallized from shock melt [5].

Non-cumulate eucrites: As our previous study reported, Y-75011 and Pasamonte contain 2 or 3 co-existing silica polymorphs whereas Stannern only contains quartz [7,8]. In Pasamonte, the presence of 3 different silica phases with subhedral shapes in basaltic clasts (shown in Table 1) may be explained by impurity such as water in the magma. Y-75011 contains monoclinic tridymite grains in matrices (outside of the basaltic clasts), similar to Moore County, which could be from deep crust of Vesta. Pasamonte also includes isolated tridymite fragments that are surrounded by ferrosilite and fayalite rims, showing a corona-like texture [8]. If these isolated tridymite fragments are derived from cumulate rocks, the corona-like texture may be formed by a secondary thermal event after brecciation such as the reburial and reheating event as suggested by [9].

Table 1: Silica polymorphs in cumulate and non-cumulate eucrites

	Cumulate			Non-cumulate		
				Polymict		Monomict
	Y980433	Moore County	Moama	Y-75011	Pasamonte	Stannern
Quartz	· adjacent to melt vein			· aggregate with cristobalite* · single crystal*	· subhedral*	· anhedral*
Cristobalite				· aggregate with quartz*	· subhedral with inclusions*	
Tridymite (Monoclinic)	· many cracks	· large sized	· host	· euhedral**	· corona texture***	
Tridymite (Orthorhombic)			· lamella		· subhedral*	

*: in basaltic clast, **: fragment or in cumulate clast, ***: fragment

Conclusions:

(1) The presence of orthorhombic tridymite indicates rapid cooling at low temperature blow 400 ^{o}C in Moama and Pasamonte.

(2) Pasamonte shows the most complicated silica occurrence with 3 existing subhedral silica polymorphs (quartz, cristobalite, and tridymite) in basaltic clasts.

(3) Water may be widely present in the Vesta's crust because its presence is suggested both from cumulate and non-cumulate eucrites (e.g., quartz adjacent to a glass vein, and co-existence of 3 silica polymorphs).

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