ANCIENT SILICIFICATION ON ASTEROID 4 VESTA: EVIDENCE FROM A EUCRITE GROVE MOUNTAINS (GRV)13001 FROM ANTARCTIC

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Introduction: Eucrite meteorites are igneous rocks with basaltic or gabbroic in composition, which come from the crust of some Vestoids represented by asteroid 4-Vesta[1]. The eucrites have radiometric ages of ca.4.43-4.45 Ga, implying that they are the oddest igneous rocks in the solar system [2]. Thus, the study of the eucrites can help us understand the earliest asteroid differentiation, magmatism and later thermal metamorphism within the first 10 million years during the formation of the solar system. The eucrites have usually undergone extensive thermal metamorphism and possible fluid (or vapors) -rock interactions. The evidence includes as follows: (1) A few high-Fe pigeonite fragments and plagioclase grains were partially replaced by fine-grained troilite, Mg-rich augite and silica; (2) Fe-enrichment along the cracks that cross cut the pyroxene crystals; (3) Silica veinlets deposited from liquid water solutions are present in the eucrites [3-5]. Furthermore, some evidences suggest that its parent-body may have experienced complex thermal history. However, the heat and material source of the thermal metamorphism is unclear. GRV13001 is a new eucrite collected by CHINARE, which has complex silica metasomatism that may imply the thermal history of the eucrite parent-body. So the metasomatism of silica of GRV13001 with its implication is introduced.

Petrology and mineralogy: GRV13001 is a breccia of monomict eucrite. The clasts show a typical basalt texture consisting of pyroxene (49.3%), plagioclase (46.7%), silica (3.84%), along with minor ilmenite, troilite and chromite.The matrix is fine-grained and shares the same mineral assemblage as the clasts. The pyroxene varies from ferrohypersthene ($Fs_{58.6\text{-}59.7}Wo_{1.6\text{-}3.9}$), pigeonite ($Fs_{52.3\text{-}58.3}Wo_{7.7\text{-}13.9}$), augite ($Fs_{42.5\text{-}45.5}Wo_{29.5\text{-}34.9}$) to diopside ($Fs_{27.0\text{-}28.4}Wo_{58.3\text{-}60.6}$) in composition. And the plagioclase comprises anorthite and bytownite ($An_{75.6\text{-}97.4}$, $avg._{88.9}$). Based on the two-pyroxenes thermometers, there are two temperatures of 807℃ and 949℃ respectively, probably indicating its crystallization and equilibration. A few pyroxene fragments and plagioclase grains were partially replaced by porous silica and tiny troilite grains filled in the hole of silica. The phase of silica is quartz, cristobalite and glass identified by Raman spectrum analysis.

Discussion and conclusion: The metasomatic relict texture of the pyroxenes in the GRV13001 suggests an ancient silicification process by silica fluid. The silica fluid contained minor sulfur vapor reacted with the pyroxenes to form quartz, cristobalite, glass and troilite. Because the equilibrium temperature is higher than the crystallization temperature, the chemical equilibration may occur within the crust of the early basalts. The thermal equilibration is likely related to multi-stage magmatism that contributes both the heat and the source of silica fluid and sulfur vapor.

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Reference: [1]Harry Y.et al.(2011) Space Sci Rev, 163, 141–174.[2] Yamaguchi A et al.(2001) Geochimica et Cosmochimica Acta, 20,3577–3599.[3]Zhang A.(2013) Geochimica et Cosmochimica Acta,109,1-13. [4] Barrat J.et al.(2011). Geochimica et Cosmochimica Acta,75,3839–3852 [5]Allan H.et al. (2003) Earth and Planetary Science Letters ,219,189-199.