PARADOXAL REFRACTORY AND VOLATILE ELEMENT RICH GLASS INCLUSIONS IN THE METAL GLOBULES OF THE SIERRA GORDA 013 CBa-LIKE CHONDRITE.

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Introduction: The CBa chondrites are the metal-rich meteorites composed of Fe,Ni- globules and silicate chondrules and similar by composition to CH chondrites (e. g. [1]). The CBa chondrites are coarse-grained type of the CB group [2, 3]. Formation of CB chondrites could be explained by collisions of planetesimals producing an impact plume [4-9]. Physico-chemical conditions of the plume were not studied well. Here we present results on an investigation of very rare glassy inclusions trapped in the Fe,Ni-metal globules of the Sierra Gorda 013 CBa-like chondrite [10] and discuss their origin in the light of heterogeneity of the plume formed during collision of planetesimals.

Results: We discovered that some of metal globules in SG 013 contain two types (T1 and T2) of siliceous Na, K-bearing inclusions, often associated with sulfides. The T1 inclusions are up to 10x20 μm and compose of Nb-bearing Ca,Al,Mg-poor glass, systematically associated with unknown Na-bearing Cr-sulfide with the best fit formula $NaCr_3S_7$ or $NaCr_4S_8$. The largest of them have a homogenous texture while the smaller inclusions demonstrate sharp zoning or segregation texture, both formed by SiO_2-rich globules in the SiO_2-less matrix. The T2 inclusions are mostly μm-sized and composed of Nb-poor Al-bearing glass associated with daubreelite. Both types have similar average contents of SiO_2 (75.6 and 78.0 wt. %) and Na_2O (7.0 and 8.3 wt.%) and are poor in FeO. The Nb-bearing glasses contain 2.3 – 8.4 wt.% of Nb_2O_5 (average 3.5 wt. %) and 0.07 wt.% Ta_2O_5. They are notably enriched in Ti, Mn and Cr and negligible concentrations of Ca, Al and Mg in comparison to the Nb-poor Al-bearing glasses some of them are enriched in Mg and Ca and depleted in Cr, Ti and Mn in comparison with the Nb-bearing glasses.

Discussion: Siliceous alkali-rich glass inclusions found at first in the metal globules of SG 013 are only known carriers of alkalis in CBa chondrites which are essentially poor in volatile elements [2, 3, 10]. Both glass populations are similarly enriched in Na and K relatively to the CI chondrites (~11 and 15xCI respectively). The forsterite chondrules of SG 013 have anorthitic mesostasis resulted in complete evaporation of Na and K and should be formed in reduced dust-poor region of the plume [11]. Based on compositional differences we suggest that the T1 and T2 inclusions could be formed from the middle- and high- temperature condensates in different regions of the plume reacted with a low-temperature silica- and alkali-rich vapor complementary to the forsterite chondrules that resulted in subchondritic Na/K ratio [13, 14]. The condensates were moved from different plume regions as it was modelled by [12] and passed through S-rich and alkali-rich plume regions before they were captured by metal in high-T S-poor region of the plume. Extreme Nb enrichment and superchondritic Nb/Ta ratio (31) of the Nb-bearing glasses are enigmatic assuming their chondrite source and relatively low-temperature condensate origin. Only traces of partial differentiation concerned with one of collided bodies were found in CBa chondrites [9, 10] and most of the known differentiated meteorites have nearly chondritic Nb/Ta ratios [15]. Thus, fractionation of Nb and Ta possibly occurred in a high temperature vapor due to their slightly different volatility [15] and siderophile behavior at low fO_2 [16] possibly due to condensation of Ti niobate. Refractory Nb-bearing condensates could be formed in the reduced plume as the sub-micron dust particles, were removed from their parent region as predicted by the model [12] and transported by a gas flow to the low-temperature region of the glass formation where the high pressure of Na, K and Si gas occurred and enter to the condensing melts. However, why the Ca-Nb condensates were not formed, and mechanism of early removal of refractory condensates from the plume before chondrules formation remain unclear.

Conclusion: We show as the glass inclusions could record information about geochemical heterogeneity of CBa-forming plume. Fine dust of collisional cloud observed in the system of HD172555 star [17] consists of amorphous SiO_2 and could be a condensate similar to the SG 013 siliceous glasses.

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