VOLATILE-RICH PHASES IN AUBRITES: CLUES TO UNDERSTANDING THE MINERALOGY OF MERCURY?

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Introduction: Formed under highly-reducing conditions, aubrites provide one of the best analogs for the geochemical processes that occurred during differentiation of Mercury. The combination of essentially FeO-free silicates, silicon incorporated into the metallic phases, and abundant Ca,Mg-sulfides is a common feature of both aubrites and Mercury [1]. Far more surprisingly, Mercury is enriched in volatile elements (e.g., Na, K., S, Cl) [1]. While not noted for being volatile-rich, a range of mineral phases host volatiles within aubrites. We have studied these phases in the Peña Blanca Spring aubrite to potentially elucidate the formation of similar phases on Mercury.

Peña Blanca Spring aubrite: In Peña Blanca Spring, roedderite grains of 1-2 mm in maximum dimension are rimmed by, and partially resorbed by, diopside, albite, and enstatite. Roedderite ($(Na,K)_2(Mg,Fe)_5Si_{12}O_{30}$), which appears to be the earliest crystallizing volatile phase in aubrites, requires a peralkaline melt for crystallization [2]. Although aubrites are metaluminous [3], EH chondrites are slightly peralkaline [4], consistent with formation of aubrites from an enstatite chondrite-like protolith. Modest co-crystallization of roedderite and enstatite at cotectic temperature of ~1150°C [2] would decrease the volatile abundance of the melt, evolving to a metaluminous composition. At this point, diopside and albite are the stable phases, resorbing roedderite and incorporating the Na into feldspar. Potassium from roedderite is likely liberated into the melt, with subsequent sulfidization producing djerfisherite ($K_6Na(Fe,Cu,Ni)_{25}S_{26}Cl$) [5]. Formation of Ca,Mg sulfides might have also occurred as a result of sulfidization of the melt.

Implications for Mercury: Many of the phases observed in Peña Blanca Spring have been inferred for the surface of Mercury, including albite, diopside, oldhamite, niningerite [6], and djerfisherite [7]. The inference of djerfisherite is particularly intriguing. If djerfisherite forms from sulfidization of roedderite [5], this might point to the presence of peralkaline magmas on Mercury. Resolvable geochemical provinces on Mercury are all distinctly metaluminous, with Al_2O_3 concentrations from ~9-15 wt.% [8]. It remains unclear, however, whether these geochemical units are compositionally homogeneous spatially or temporally. In particular, if late-stage pyroclastic melts delivered significant volatiles to the surface of the planet [9], those melts could have been peralkaline. Such melts may have crystallized minor phases not easily recognized from the bulk composition alone. The MERTIS thermal infrared spectrometer aboard Bepi Colombo might provide insights into the presence of phases indicative of peralkaline melts.

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