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Chloride and sulfide stabilities in crystal-melt-gas systems under the reduced conditions of Mercury: implications for hollows formation

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Measurements of moderately volatile element abundances at the surface of Mercury by MESSENGER provide important constraints on endogenic and exogenic processes that shaped Mercury's surface and interior [1]. Sulfur and chlorine are not depleted on the surface of Mercury with concentrations up to ~3 and ~0.4 wt%, respectively [1]. These elements may thus play a major role in volcanic, magmatic and surface processes, such as the formation of hollows. These landforms are characterized by shallow flat-floored depressions that are commonly associated with low reflectance material [2]. Hollows are young active features that may form by a "sublimation-like" process for which chloride and sulfide species are serious candidates [2-4], due to their peculiar thermo-physical properties (e.g low condensation temperatures). Thus the nature of the Cl-bearing or S-bearing phases that could explain hollow's formation remains unclear. We conducted an experimental study to characterize chloride and sulfide stability at the surface of Mercury. Experiments were performed under reducing conditions (~IW-6 to IW-2) in evacuated silica tube to study crystal-gas-melt interaction over a wide range of temperatures (1400°C-600°C) between two anhydrous Mercurian starting compositions (Low and High-Mg NVP : 10.1%wt and 26.5%wt MgO) in equilibrium with an atmosphere dominated by Na, CO, H_2, S and/or Cl-bearing species. Our results indicate that chlorides (NaCl), sulfides (MgS), graphite and silicate phases are associated at low temperatures - low pressure conditions. The presence of chlorides and sulfides could thus explain the previously proposed sublimation-like processes [4]. Our data are consistent with thermodynamic calculations that predict NaCl stability from the condensation of a Mercurian volcanic gas [1,5]. This study shed light on the importance of the behaviour of moderately volatile elements on Mercury, which could have important implications on the composition, formation and evolution of the planet.

[1] Evans et al. (2015), *Icarus* 257, 417–427. [2] Thomas et al. (2016), *Icarus* 277, 455–465. [3] Lucchetti et al. (2021), *Icarus* 370, 114694. [4] Blewett et al. (2013), *Journal of Geophysical Research: Planets* 118, 1013–1032. [5] Zolotov et al. (2011), *Icarus* 212, 24–41.