Speciation and sulfur solubility in basalts on Mercury

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Mercury's surface composition is characterized by very high sulfur concentrations (~1-4 wt.% S; [1]). This is unique in terrestrial planets and understanding the sulfur solubility and speciations in Mercury's silicate melts will help deciphering global differentiation processes of the planet. In this project, available XRS data for surface composition of Mercury's Northern Volcanic Plains (NVP) and older intercrater plains and heavily cratered terrains (IcP-HCT; [1-2]) are used as starting compositions for crystallization experiments at pressure ranging from 1 atm to 20 kbar and oxygen fugacity conditions from IW to IW-8.

Near-liquidus low- to medium-pressure experiments are made up of silicate melt, few forsterite crystals and several immiscible metal melts: (1) a FeSi-rich melt; (2) a FeS-rich melt and (3) a CaMgS-rich melt. In Na- and S-free systems, similar lavas are saturated in orthopyroxene instead of forsterite [3]. The concentration of sulfur in the silicate melt shows a correlation with the oxygen fugacity conditions and is relatively low (~ 0.5 wt.%) at IW, increasing significantly at more reduced conditions (2-4 wt.% at IW-4 - IW-6), in agreement with other studies [4]. High-pressure experiments are relatively similar and phase equilibria are used to identify multiple saturation points (melt-forsterite-hypersthene) for the NVP and IcP-HCT compositions and to constrain the source, melting P-T conditions and fO_2 that produced the different types of lavas erupted at the surface [5]. The effect of pressure and oxygen fugacity on the liquid metal-liquid silicate partitioning is also used to better constrain the global composition of the core and bulk silicate mantle of the planet [6].

Comparison between experimental data and XRS data from MESSENGER allows us to suggest that the basalts at the surface of Mercury may have not reached sulfide-saturation at the liquidus temperature and that the sulfur at the surface of the planet may be comprised of suldide minerals having crystallized from immiscible melts exsolved during cooling and crystallization. The depth of the source to these lavas is probably around 1 GPa and melting must have occurred at conditions betwen IW-4 and IW-8 [5].

[1] Nittler *et al* (2011). *Science* **333**, 1847; [2] Denevi *et al* (2009). *Science* **324**, 613; [3] Vander Kaaden & McCubbin (2014), LPSC. [4] Vander Kaaden *et al* (2014), LPSC. [5] Parman *et al* (2014), LPSC. [6] Hillgren & Fei (2014), LPSC.