Examining the possibility of carbon as a light element in the core of Mercury

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Results from the MErcury Surface, Space ENvironment, GEochemistry and Ranging (MESSENGER) spacecraft have shown elevated abundances of C on the surface of Mercury [e.g.,1]. Peplowski et al. [1] used GRS data from MESSENGER to show an average northern hemisphere abundance of C on the planet of 0 to 4.1 wt% C at the three-sigma detection limit. Confirmation of C on the planet prompts many questions regarding the role of C during the differentiation and evolution of Mercury. The elevated abundances of both S and C on Mercury's surface, coupled with the low abundances of iron, suggest that the oxygen fugacity of the planet is several $\log_{10}$ units below the Iron-Wüstite buffer. These observations spark questions about the bulk composition of Mercury's core. This experimental study seeks to understand the impact of C as a light element on potential mercurian core compositions. In order to address this question, experiments were conducted at 1 GPa and a variety of temperatures (700 – 1500 °C) on metal compositions ranging from Si_5Fe_{95} to $Si_{22}Fe_{78}$, possibly representative of the mercurian core. All starting metals were completely enclosed in a graphite capsule to ensure C saturation at a given set of run conditions. All elements, including C, were analyzed using electron probe microanalysis. Precautions were taken to ensure accurate measurements of C with this technique including using the LDE2 crystal, the cold finger on the microprobe to minimize contamination and increase the vacuum, and an instrument with no oil based pumps. Based on the superliquidus experimental results in the present study, as Fe-rich cores become more Si-rich, the C content of that core composition will decrease. Futhermore, although C concentration at graphite saturation (CCGS) varies from a liquid to a solid, temperature does not seem to play a substantial role in CCGS, at least at 1 GPa. **References**:[1] Peplowski, P.N., et al., (2015) Planetary and Space Science.