THE IRON CONTENT OF MERCURY'S SURFACE FROM MESSENGER X-RAY SPECTROMETRY.

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Introduction: Early orbital measurements of Mercury by the X-Ray Spectrometer (XRS) on the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft indicated a low Fe content, with reported Fe/Si ratios (~0.03 to 0.15) giving an upper limit of ~4 wt% Fe [1]. These values are consistent with a bulk estimate provided by the Gamma-Ray Spectrometer (Fe/Si: ~0.12) and the upper limit of ~6 wt% FeO (in silicate minerals) constrained by the absence of a 1 μm absorption band in reflectance spectra of Mercury's surface [2,3]. Given that Mercury's surface displays heterogeneities, *e.g.,* in Mg, Al, S, Ca, and K [4,5], it should be expected that the Fe abundance also varies across the planet.

XRS Fe estimates: Obtaining accurate estimates for Mercury's surface Fe abundance from XRS data is difficult for a number of reasons, including: (i) strong solar flares are needed to induce measureable Fe K_α X-ray fluorescence; (ii) many of the XRS spectra obtained during the strongest flares contain enhanced high-energy background, caused by interactions between energetic particles and the instrument, which especially affects the spectral modeling for Fe; and (iii) spectra from shorter XRS integrations (required for high spatial resolution) generally have insufficient signal-to-noise for reliable Fe abundance modeling.

We have used two methods to derive surface Fe abundances for substantial areas of Mercury through XRS modeling [1]: (i) analysis of a single summed spectrum, with sufficient Fe signal-to-noise, based on co-adding several short integrations with small spatial footprints (the forward modeling of such spectra introduces a small additional error due to the use of an average solar spectrum, and can include spectra from chemically distinct lithologies); and (ii) averaging the derived Fe abundance values for several, long integration spectra from a single solar flare period. Analysis so far indicates that some of the reported range in XRS-derived Fe/Si ratios may be attributable to systematic errors related to solar flare temperature and, especially, viewing geometry. Work to characterize and correct for these effects is ongoing.

Implications: Early orbital XRS data suggest that Mercury formed from highly reduced materials, perhaps similar to enstatite chondrites (EC) [1]. However, even the few % Fe indicated by XRS and GRS is higher than that in partial melts of EC material [6] and may require invoking more oxidizing conditions [7], incorporation of an FeS immiscible melt, or possible exogenous delivery by meteoroid impact. Refinement of the Fe abundance and its spatial variability should provide better constraints on the nature of the major Fe-bearing phase(s) at the surface (*i.e.,* metal, sulfide, and/or silicate) and hence a more complete view of the planet's mantle and geological evolution.

References: [1] Nittler L. R. et al. 2011. *Science* 333:1847–1850. [2] Vilas F. 1988. In: *Mercury*, Univ. Arizona Press, pp. 59–76. [3] Blewett D. T. et al. 2002. *Meteorit. Planet. Sci.* 37:5123–5131. [4] Weider S. Z. et al. 2012. Lunar Planet. Sci. 43:1472. [5] Peplowski P. N. et al. 2012. Lunar Planet. Sci. 43, 1541. [6] McCoy T. J. et al. 1999. *Meteorit. Planet. Sci.* 34:735–746. [7] McCubbin F. M. et al. 2012. *Geophys. Res. Lett.* 39, L09202.