

### MAJOR-ELEMENT ABUNDANCES OF SURFACE MATERIALS ON MERCURY: FIRST RESULTS FROM THE MESSENGER X-RAY SPECTROMETER

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**Introduction:** MESSENGER became the first spacecraft to orbit Mercury on 18 March 2011. One of the mission's major scientific objectives is to characterize the chemical composition of Mercury's surface in order to address key questions on the formation and geologic history of the least-explored, innermost planet [1]. The X-Ray Spectrometer (XRS) on MESSENGER [2] employs the technique of planetary X-ray fluorescence (XRF) to estimate quantitatively the abundances of major rock-forming elements (e.g., Mg, Al, Si, S, Ca, Ti, and Fe) on Mercury's surface. The instrument measures characteristic X-rays that are excited by the incident (and variable) flux of solar X-rays from within the top ~100  $\mu\text{m}$  of the regolith.

**Preliminary results:** Preliminary analysis of XRS data acquired during solar flare events indicates that Mercury's crust is substantially richer in Mg and poorer in Al and Ca than both lunar crustal rocks and terrestrial basalts. The derived Mg/Si, Al/Si, and Ca/Si ratios lie within the range of terrestrial ultramafic rocks. Analysis of "quiet Sun" data gives Mg, Al, and Si abundances consistent with the flare data. The flare spectra also indicate low total concentrations of Ti (<1 wt. %) and Fe (<~5 wt. %) and a surprisingly high S abundance (S/Si ~ 0.1) in surface materials on Mercury.

**Discussion:** In order to explain Mercury's high density and metal/silicate ratio [3], it has been suggested that a primary crust and much of the original mantle may have been stripped away, e.g., by a giant impact event [4,5]. The Mg/Si, Al/Si, and Ca/Si data reported here indicate a relatively low abundance of plagioclase feldspar, perhaps consistent with this model. However, models [e.g., 6] whereby Mercury originally formed from highly reduced (e.g., enstatite chondrite) material may also explain our elemental data. Melting of such precursory material produces basaltic and metal-rich (Fe, Ni-FeS) melts, leaving an ultramafic (mainly enstatite) residuum. Melting experiments [6] on material from the EH-chondrite Indarch have been used to suggest a "synthetic Mercurian basalt" composition whose Mg/Si, Al/Si, Ca/Si, and S/Si ratios lie within the range seen by MESSENGER, although even the relatively small amount of Fe seen is higher than predicted by the melting experiments. The relatively low apparent Fe and Ti abundances reported here indicate that these elements are not responsible for the thermal neutron absorption observed during MESSENGER's Mercury flybys [7].

**References:** [1] Solomon S.C. et al. 2001. *Planetary & Space Science* 49:1445-1465. [2] Schlemm C.E. et al. 2007. *Space Science Reviews* 131:393-415. [3] Lewis J.S. 1972. *Earth & Planetary Science Letters* 15:286-290. [4] Wetherill G.W. 1988. In: *Mercury*, Univ. Arizona Press, pp. 670-691. [5] Benz W. et al. 1988. *Icarus* 74:516-528. [6] Burbine T.H. et al. 2002. *Meteoritics & Planetary Science* 37:1233-1244. [7] Lawrence, D.J. et al. 2010. *Icarus* 209:195-209.