ABUNDANCES OF RADIOACTIVE ELEMENTS ON THE SURFACE OF MERCURY: FIRST RESULTS FROM THE MESSENGER GAMMA-RAY SPECTROMETER.

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Introduction: On 18 March 2011, MESSENGER became the first spacecraft to enter orbit around Mercury, inaugurating a one-year campaign of orbital operations [1]. This investigation includes mapping the surface composition from orbit using the MESSENGER Gamma-Ray Spectrometer (GRS) [2]. Data from the GRS can be used to determine the surface composition to depths of tens of centimeters by measuring gamma rays originating from both radioactive elements (K, Th, and U) and excitation of stable elements (e.g. Si, Fe, Ti, O) by interactions with incident galactic cosmic rays. This work details the measurement of K and Th abundances on the surface, the results of which have important implications for our understanding of the formation and thermal history of Mercury [3].

Preliminary results: GRS data acquired during the first month of orbital operations have been used to determine the average abundances of K (1078 ± 49 ppm) and Th (0.173 ± 0.088 ppm) in the northern hemisphere of Mercury. The K/Th ratio in this region is 6230 ± 3180, which is within the range of values for the other terrestrial planets but is significantly higher than the average lunar value of 360 [4].

Discussion: Ratios of the volatile incompatible K to the refractory incompatible Th provide insights into volatile element depletions in planetary bodies. The K/Th ratio for the surface of Mercury is similar to that for Mars (4000-7000 over 95% of the surface [5]). The K/Th ratio for Mercury is also similar to that for martian meteorites. Absolute surface abundances for Mercury are a factor of 3-4 lower than for Mars, however, probably reflecting the enhancement of K and Th abundances at the martian surface by aqueous processes. The K/Th ratio of Mercury, particularly when coupled with the high S abundance of Mercury [6], suggests that evaporation or refractory condensation models [3] for the formation of Mercury are not viable. These models should produce volatile-poor compositions, counter to the observations presented here. Other models are less constrained by these data, although chondritic melting models appear to predict higher Th abundances (~1 ppm) [4] than observed. Future determination of U abundances from GRS observations should provide additional constraints on these models.

References: [1] Solomon S.C. et al. 2007. *Space Sci. Rev.* 131:3-39. [2] Goldsten, J.O. et al 2007. *Space Sci. Rev.* 131:339-391. [3] Taylor, G.J., and Scott, E.R.D. (2003), *Treatise on Geochemistry*, Vol. 1, pp. 477-485. [4] Taylor G.J. et al. (2006) *J. Geophys. Res.* 111, E03S06. E03S10. [5] Taylor G.J. et al. (2006) *J. Geophys. Res.* 111, E03S06. [6] Weider S.Z. et al., this volume.