MARTIAN SURFACE HEAT PRODUCTION AND CRUSTAL HEAT FLOW FROM MARS ODYSSEY GAMMA-RAY SPECTROMETRY. B. C. Hahn[1] and S. M. McLennan[1], [1]Department of Geosciences, Stony Brook University, Stony Brook, NY 11794-2100 (bhahn@mantle.geo.sunysb.edu; scott.mclennan@sunysb.edu).

Introduction: The Mars Odyssey Gamma-Ray Spectrometer (GRS) has mapped the Martian surface for a suite of elements. Of particular interest are the heat-producing, incompatible elements K and Th, which provide important information about the formation and evolution of the Martian crust-mantle system [1]. They (with U) are also the primary source of radiogenic heating for the planet. Here we use these GRS results of calculate crustal heat production on global and regional scales and model the crustal component of heat flow through Martian history.

Methods: Using smoothed re-binned GRS global K and Th maps [2], we determined the radiogenic ^{40}K and ^{232}Th surface abundances for each GRS 5°x5° pixel based on well-determined isotopic fractions. Uranium abundances (^{235}U and ^{238}U) were calculated using an assumed Th/U ratio of 3.8; a canonical cosmochemical value that also agrees with most SNC analyses. The GRS instrument measures elemental abundances in the top-most tens of centimeters of the Martian surface, and, as such, K and Th values must be renormalized to a H_2O-, S-, and Cl-free basis to better reflect bulk crustal values. H_2O and Cl surface abundances are obtained by using smoothed re-binned 5°x5° GRS maps [2]. While the GRS instrument cannot, at this time, map surface S abundances, we use preliminary estimates of a global S/Cl weight ratio of 5 to calculate the S content of each individual pixel.

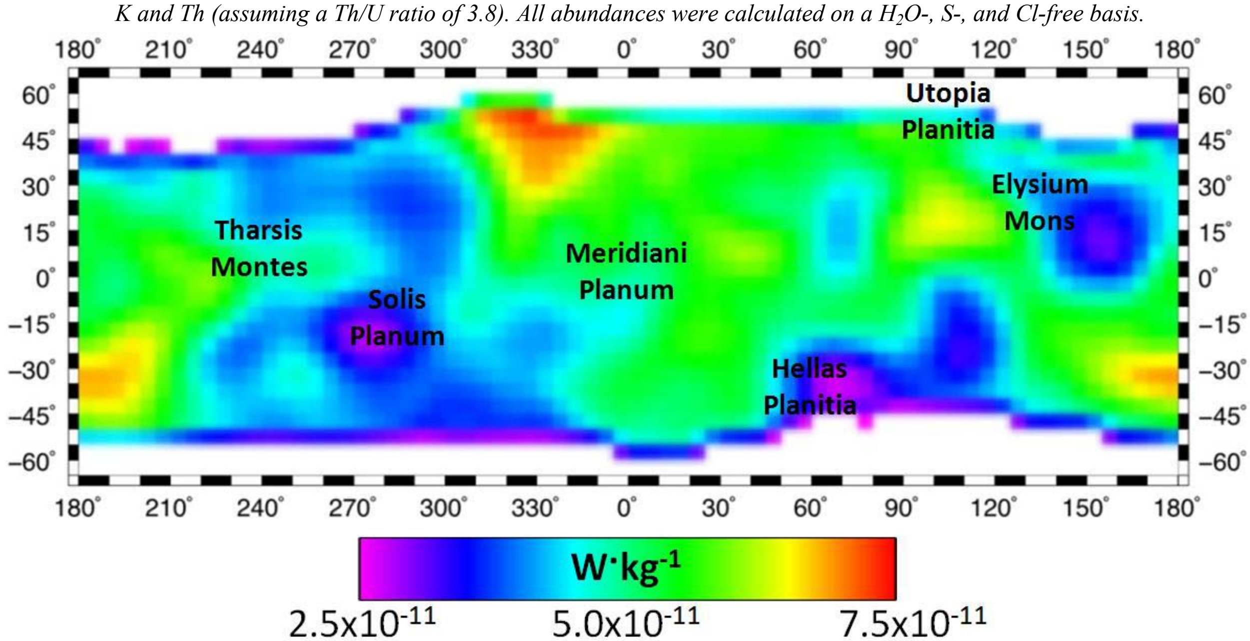
While the GRS instrument can determine K and Th abundances at high latitudes, extremely high concentrations of water ice (e.g., very near the poles) dilute these elemental signatures. Also, H concentrations have a strong influence on the correction techniques used for determining Fe, Si and Cl (and thus S) abundances. To compensate, we have excluded data poleward of ~45º-60º latitude in both hemispheres using a cut-off based upon water equivalent hydrogen concentration – the H-mask described in *Boynton et al., 2007* [2], which does not significantly affect our results. **Table 1** (above) provides the relevant calculated average abundances for the heat-producing radiogenic isotopes after renormalization.

Table 1: *Average abundances for the heat producing elements and specific radiogenic isotopes. Abundances are determined using H-masked GRS K and Th results, an assumed Th/U ratio of 3.8, and have been renormalized to be H_2O-, S-, and Cl-free.*

Element	Elemental Average Abundance	Isotope	Isotopic Average Abundance
K	3650 ppm	^{40}**K**	0.44 ppm
Th	0.69 ppm	^{232}**Th**	0.69 ppm
U	0.18 ppm	^{235}**U**	0.001 ppm
		^{238}**U**	0.18 ppm

In **Fig. 1**, we calculate crustal heat production (W·kg^{-1}) per pixel to produce a present-day, Martian crustal heat production map. Using the crustal thick-

Fig 1: *Crustal heat production of the Martian surface calculated from GRS 5°x5° H-masked elemental abundance maps for K and Th (assuming a Th/U ratio of 3.8). All abundances were calculated on a H_2O-, S-, and Cl-free basis.*



ness model of *Neumann et al., 2004* [3], smoothed to agree with the GRS 5°x5° pixel resolution, we also generate both a present day crustal-component heat flow model and, regressing the radiogenic isotope concentrations with their relevant half-lives, the crustal heat flow component at 1 Ga intervals backward through time (**Fig. 2**, right). These calculations assume no vertical change in the concentrations of K, Th and U with crustal depth.

Results: We calculate a present day average crustal heat production (**Fig. 1**) of 4.87x10^{-11} W·kg^{-1}. Heat production varies significantly across the Martian surface, ranging from 2.52 x10^{-11} W·kg^{-1} to 7.52 x10^{-11} W·kg^{-1}. The present day average radiogenic crustal heat flow component (**Fig. 2**, right) is 6 mW·m^{-2}. Also, using the respective half-lives of ^{40}K, ^{232}Th, ^{235}U, and ^{238}U, we calculate crustal heat production for the past 4 Ga (**Fig. 4**, below). Note, that these heat production and heat flow regression calculations assume that the K and Th abundances in the Martian crust have not been significantly modified due to past igneous processes. Although not an entirely realistic assumption (e.g., the formation of Tharsis), *Hahn et al., 2007* showed that K and Th vary only subtly with apparent surface age [5] indicating that past crustal resurfacing and the formation of past geologic provinces, did not form with dramatically different K and Th and, therefore, heat production values.

References: [1] Taylor G. J. et al (2006) *JGR, 111*, doi:10.1029/2006JE002676. [2] Boynton W. V. et al (2007) *JGR, 112*, doi:10.1029/2007JE002887. [3] Neumann G. A. et al (2004) *JGR, 109*, doi:10.1029/2004JE002262. [4] Taylor, et al. (2006b) *JGR, 112*, doi:10.1029/2005JE002645. [5] Hahn B. C. et al (2007) *JGR, 112*, doi:10.1029/2006JE002821.

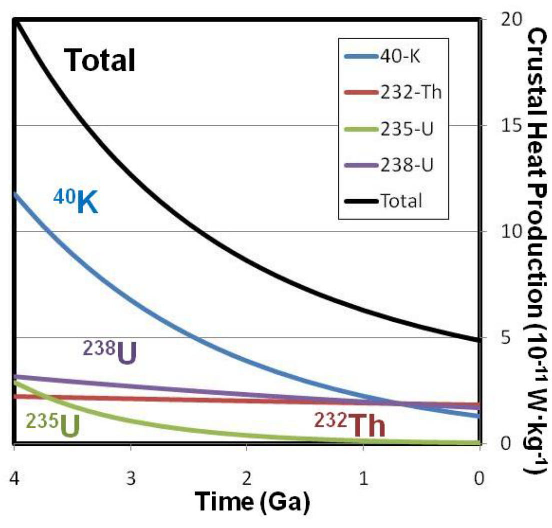


Fig 3: *Average crustal heat production as a function of time based on current surface observations from GRS. The present day average is 4.87x10^{-11} W·kg^{-1}.*

Fig 2: *The GRS-derived radiogenic crustal component of Martian heat flow for the present and regressed through time at 1 Ga intervals (using the crustal thickness models of* Neumann et al., 2004 *[3]). The radiogenic elements K, Th and U are highly incompatible and are concentrated in a planetary crust during differentiation. Assuming GRS-determined surface abundances are crustal averages, up to 50% of the Martian heat producing element budget could be sequestered in the Martian crust [1, 4], with the remaining 50% of radiogenic heating taking place in the mantle.*