INTEGRATING GLOBAL-SCALE MISSION DATASETS – UNDERSTANDING THE MARTIAN CRUST. B. C. Hahn[1], S. M. McLennan[1], G. J. Taylor[2], and W. V. Boynton[3], [1]Department of Geosciences, Stony Brook University, Stony Brook, NY 11794-2100; [2]Hawaii Institute of Geophysics and Planetology, 1680 East-West Rd., Honolulu, HI 96822, [3]Lunar and Planetary Lab, University of AZ, Tucson, AZ 85721 (bhahn@mantle.geo.sunysb.edu)

Introduction: Constraining the composition of the chemical reservoirs of the Martian crust and mantle is critical to understanding its evolution. Over more than a half-decade, a suite of instruments on multiple spacecraft have been mapping the surface of Mars, producing a variety of different global geochemical and geophysical datasets. However, individual chemical datasets, while revealing, need to be cross-correlated with other data, such as surface age, topography or crustal thickness, to fully describe the processes that shape the Martian surface and sub-surface over geologic time. In this study, we present our first results in attempting to correlate various global datasets.

We also attempt to constrain the rate of Martian crustal growth and crustal recycling. Past studies have estimated the surface crustal recycling regime for Earth using calculations based on a combination of surface age versus area, Nd and Hf isotope compositions of sedimentary rocks and the geochemical evolution of sedimentary rocks [1, 2]. The degree of crustal recycling is crucial for determining the long-term evolution of a planetary crust/mantle system. Using existing surface geology data, a similar preliminary estimate can be made for the Martian surface.

Mineralogy and Element Abundances: The primary sources of remote sensing chemical and mineralogical information that have been or will be used for this study are: the Thermal Emission Spectrometer (TES – surface mineralogy spectra) on the Mars Global Surveyor [3]; and the Gamma Ray Spectrometer (GRS – element abundances) on the 2001 Mars Odyssey [4] orbiters. Other chemical/mineralogical instruments are currently mapping the Martian surface on these or other orbiters, but the data are not yet available for comparison and inclusion in this study.

Note that each instrument's dataset has a different resolution ranging from a few kilometers (TES) to several map degrees (GRS – variant depending on the particular element). Comparisons across different datasets must be made at the scale of the lower resolution dataset. Therefore, higher resolution data have been averaged to the lower resolution before running pixel-by-pixel comparisons. Thus, when comparing to TES, geologic maps are the limiting resolution (1°x1°), whereas when comparing to GRS, the GRS "footprint" is the limiting resolution (5°x5°, at best).

Surface Age, Crustal Recycling and Dataset Correlations: A 1°x1° resolution surface age map was developed (**Figure 1**) using available USGS Astro-

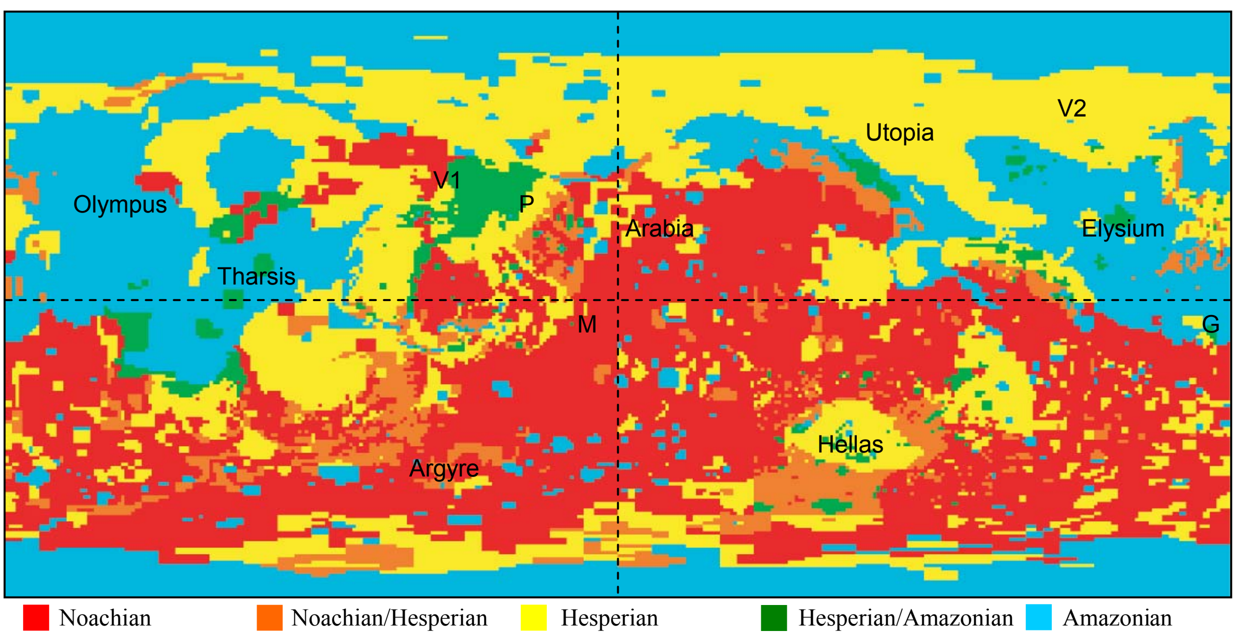

Figure 1 – Surface Age Map: Compiled from USGS Astrogeology geologic maps [6]. Age categories are broken into the three main geologic epochs and two intermediate age groups that cross geologic boundaries.

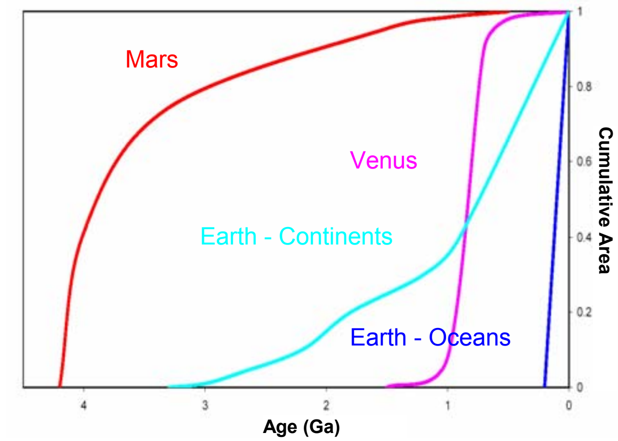

Figure 2 – Area vs. Age: Plots of surface age versus cumulative area. The Mars curve is calculated from this study. Earth continental age/area data is estimated from Veizer and Jansen, 1979 [2]. The Earth continental curve is representative of a system dominated by crustal recycling while the Mars curve indicates early crustal growth with limited recycling. Venus data is from Basilevsky et al., 2003 [7].

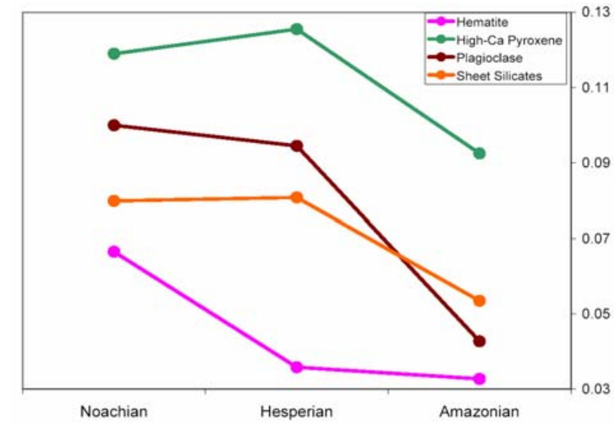

Figure 3 – TES Average Surface Abundance vs. Age: Correlations between ages and averaged surface abundance for several mineralogies. Selected regions have low dust coverage. Overall, younger regions show a higher areal dust coverage, which may explain the relative reduction in mineral abundances in Amazonian terrains.

geology relative age data calculated from surface cratering counts [5, 6]. Area vs. age summations confirm previous studies indicating a Martian crust that was largely in place early in the planet's history with some new resurfacing in the following epochs [8]. The areal breakdown of surface age is approximately: ~42% Noachian (primarily the southern highlands); ~31% Hesperian; and ~27% Amazonian (including polar regions). Unlike the Earth, the Martian surface is dominated by an early growth signature with limited crustal recycling (**Figure 2**). Also plotted is the area/age curve for Venus to illustrate a system completely dominated by total periodic resurfacing.

As an example of cross-correlations across datasets, consider initial comparisons between mineralogy derived from TES spectra and surface ages. These suggest a general negative correlation with some mineralogies decreasing in surface abundance for younger terrains (**Figure 3**). Data for other mineralogies are available, but averages lie too close to the TES detection limit to be considered reliable. There is a strong positive correlation between surface age and regions of high TES-inferred dust coverage. Younger regions have significantly higher areal dust coverage than older Noachian terrains.

TES has identified two primary surface compositions on Mars: Type 1 ("basaltic') – associated with the southern highlands; and Type 2 ("andesitic") – associated with the northern lowlands. Previous studies have suggested an age relationship between the two surfaces with younger Type 2 material overlying older Type 1 surfaces [9]. By cross-correlating the TES data with surface age on a pixel-by-pixel basis, we can test this hypothesis.

Additionally, it has been suggested that the "andesitic" surface Type 2 can result from the partial weathering of a Type 1 surface – instead of forming through igneous processes [10, 11]. TES cross-correlations with age and GRS element abundances can help constrain the degree of weathering and the weathering regime.

References: [1] Taylor, S. R. and S. M. McLennan (1985) *The Continental Crust: its Composition and Evolution*. [2] Veizer, J. and S. L. Jansen (1985) *Journal of Geology, 93,* 625-643. [3] Christensen, P. R. et al. (2004) *Space Science Reviews, 110,* 85-130. [4] Boynton, W. V. et al. (2004) *Space Science Reviews, 110,* 37-83. [5] Neukum, G., B. A. Ivanov and W. K. Hartmann (2001) *Space Science Reviews, 96,* 55-86. [6] Greeley, R., J. E. Guest, D. H. Scott and K. L. Tanaka (1986-1987) *USGS Atlas of Mars Geologic Series I-1802(ABC)*. [7] Basilevsky, A. T., J. W. Head and I. V. Setyaeva (2003) *GRL, 30,* doi:10.1029 /2003GL017504. [8] Taylor, G. J. et al. (2005) *JGR-Planets (in press)* [9] Rogers, D. and P. R. Christensen (2003) *JGR-Planets, 108,* doi:10.1029/2002JE001913. [10] McSween, H. Y., T. L. Grove and M. B. Wyatt (2003) *JGR-Planets, 108,* doi:10.1029/2003JE002175. [11] Wyatt, M. B. and H. Y. McSween (2002) *Nature, 417,* 263-266.