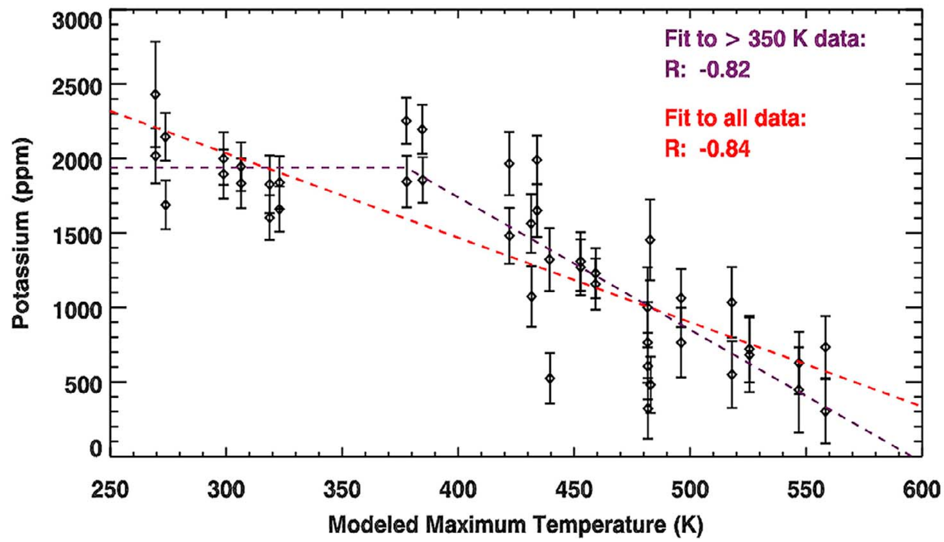

Figure 12. Measured K abundances versus the modeled maximum temperature at a depth of 7 cm (Figure 11) for each pixel in Figure 8. A linear fit of K abundance as a function of the maximum temperature was carried out over all temperature ranges (red), and the correlation coefficient (*R*) of −0.84 indicates a high likelihood that the two quantities are related. A separate fit (purple) was carried out under the assumption of no correlation between K abundance and maximum temperature for regions at low (<350 Kelvin) maximum temperature but a linear relationship at higher temperatures, consistent with the discussion of temperature-driven diffusion of K presented in section 6. For the latter scenario, the correlation coefficient at high temperatures is −0.82, again indicating a strong correlation between the two variables.

mechanisms. The hypothesis that K is preferentially mobilized to the surface and added to the exosphere at warm latitudes and longitudes would result in diminished abundances in the top ~30 cm of the regolith, which is of the order of the depth sensitivity of the GRS measurements. In such a scenario, equatorial regions and particularly areas near the hot poles gradually lose K relative to cooler longitudes and higher-latitude regions, consistent with the distribution of K on the surface (Figure 8).

[46] Once atoms are part of the exosphere, they become visible through resonant scattering emissions. Telescopic measurements by *Potter and Morgan* [1986] yielded estimates of the Na/K ratio in the exospheres of Mercury and the Moon to be ~14 and 5, respectively. Subsequent measurements indicated that the Na/K ratio in Mercury's exosphere varies from 20 to 190, with the minimum value corresponding to that near the sub-solar point. This pattern has been attributed to the fact that the photo-sputtering rate of K is twice that of Na and the lifetime against ionization is ~6.9 times longer. Observations also showed that at Mercury the Na abundance exceeds that at the Moon by a factor of ~250, whereas K at Mercury exceeds the lunar value by ~93. These inferences, along with the measurements by *Sprague et al.* [1990] indicating more than an order of magnitude enhancement of exospheric K at "warm longitudes" and equatorial and middle latitudes than at other locations, led *Sprague* [1990] to suggest a diffusion source for Na and K at Mercury and the Moon. Mercury's higher temperature and the strong temperature dependence of diffusion could account for the ratios of Na to K without requiring markedly different Na and K abundances in surface rocks and regoliths on the two bodies.

[47] The observations of *Potter and Morgan* [1997] showed that K in Mercury's exosphere is spatially and temporally variable, with indications that K might be sputtered from surface materials at high latitudes. *Doressoundiram et al.* [2010] measured Na and K simultaneously at Mercury over an extended time period in 2006 and found that the Na/K ratio varied with true anomaly. They also observed the dawn enhancement of K first noted by *Sprague* [1992], again indicating a strong mobilization of K by thermal processes. *Leblanc and Doressoundiram* [2011] assembled all available Mercury exospheric measurements of K and compared them with models that include temperature-driven diffusion and evaporation, photo- and electron desorption, and ion sputtering. Also included in the simulations were the effects of radiation pressure on atoms and the thermal effects of Mercury's eccentric orbit. Thermally driven flux rates are sufficiently high to contribute a major fraction of the observed K and Na exospheric components. Their results indicate that a substantial fraction of the surface reservoir for K is driven by diffusion from subsurface materials, consistent with the observed correlation between the maximum near-surface temperature and the GRS-measured K abundances.

7. Conclusions

[48] MESSENGER GRS measurements of the surface composition of Mercury demonstrate that the abundance of K varies from 300 to 2400 ppm over the surface in the northern hemisphere. There is no clear relation between K