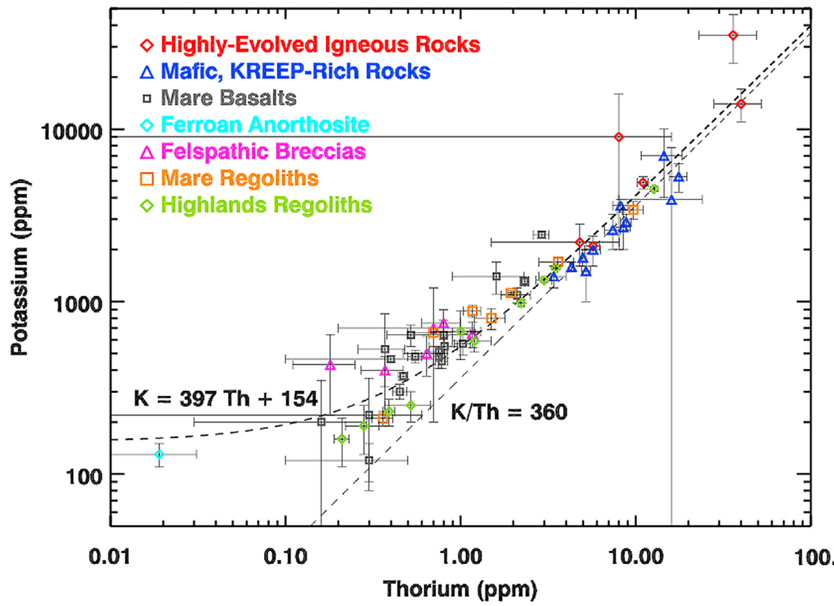

Figure 10. K abundance versus Th abundance for a wide range of lunar samples as compiled by *Korotev* [1998]. At high K and Th abundances, the data are consistent with a constant K/Th ratio similar to that (360) inferred from remote-sensing gamma-ray measurements. However, at the lowest Th abundances, similar to those observed on Mercury, the K/Th ratio values diverge from the ratio at higher abundances. The error bars represent the 95% confidence limits for each category and reflect both the number of measurements and variance of the average values (see *Korotev* [1998] for details).

elements. Examination of the K and Th abundances measured by Lunar Prospector for the pixels with the lowest K and Th values reveal considerable deviation from a line of constant K/Th. As the statistical uncertainty of these values is larger than for the regions with higher abundances, it is not readily apparent as to whether this spread is the result of the precision of the measurements or the properties of the surface.

[36] The extensive collection of lunar samples, whose elemental abundances are well known, can be used to examine the behavior of the K/Th ratio over a wide range of K and Th abundances with a higher precision than is possible for the orbital gamma-ray spectrometer measurements. The elemental abundances compiled by *Korotev* [1998] are used as the basis for this analysis, and the formalism utilized in that paper is also adopted here. This formalism includes grouping the lunar samples into seven categories; highly evolved igneous rocks (IR); mafic, KREEP-rich rocks (KR); mare basalts (MB); ferroan anorthosites (FA); feldspathic breccias (FB); mare regolith samples (MR); and highland regolith samples (HR). A plot of K versus Th abundances for these samples is shown in Figure 10.

[37] The highest K and Th abundances in the lunar samples are found in the IR and KR categories, which correspond to the most highly processed material on the lunar surface. The large K and Th abundances found in these materials are the result of interior melting, which concentrated these incompatible elements. The IR and KR abundances closely follow the Lunar-Prospector-derived K/Th ratio of 360 (Figure 10). The least processed materials are the FA and HR samples, which are more representative of the earliest lunar crust, albeit modified by subsequent impact processes. These samples exhibit considerable spread in their K and Th abundances and deviate systematically from the K/Th ratio derived from samples with higher K and Th abundances. *Korotev* [1998] found that the relationship between K and Th was best described as

$$K = 397\ \mathrm{Th} + 1547 \quad (7)$$

where K and Th are the elemental abundances in ppm. For large Th abundances, this relation reduces to a K/Th ratio of 397, close to the value of 360 adopted by *Taylor et al.* [2006] and utilized by *Peplowski et al.* [2011b].

[38] Of particular interest for comparison to Mercury is the behavior of K in the regime of low Th abundances. For a Th abundance of 0.2 ppm (close to Mercury's value), the K abundances of the lunar samples vary from 100 to 700 ppm (Figure 10), a dynamic range that is similar to the observed range on Mercury. To the extent that these data sets can be applied to Mercury, they suggest that in the limit of low Th the generality of constant K/Th may break down. Similarly, the Martian meteorites with the lowest Th abundances also appear to deviate from the average K/Th value (Figure 9), although this deviation occurs at Th abundances of <0.05 ppm, which is lower than those found on Mercury.

[39] The K and Th abundances on Mercury are in good agreement with those for terrestrial oceanic basalts and the Martian meteorites with the higher K and Th abundances (Figure 9), both of which represent partial melting products of mantle depleted in incompatible elements. That the Martian meteorites with similar K and Th abundances to Mercury follow the global K/Th ratio derived from Mars Odyssey GRS data [*Boynton et al.*, 2007] (Figure 9) despite low absolute abundances of K and Th relative to surface material suggest that measurements of mantle material