Lessons learned from multi-scale studies of crustal K-Th distribution

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We examine here the distributions of K/Th abundances at various scales in exposed crustal material of the southern West African Craton (SWAC). The WAXI geochemical database contains about 3000 analyses of volcanic, intrusive and sedimentary rocks distributed over the SWAC. The K distribution from these data is exponential with frequent K_2O concentrations < 0.2 wt%. A similar behavior is observed from concentrations measured with a portable spectro-radiometer in the Sefwi, Bole Nangodi and Bui Belts (Ghana). In contrast, a unimodal and skewed right K distribution is obtained from airborne surveys at 100 m/pixel. The Th distribution is also unimodal but more symmetric than the K distribution. In order to explore K/Th distributions at much lower resolution, data from the Gamma-Ray Spectrometer on Mars (400 km/pixel) were compared to the SWAC craton. K/Th distributions are found to be unimodal and symmetric, with a notable lack of K_2O values below 0.2 wt%. Despite the non-uniform spatial sampling scheme for the geochemical database, we postutale that the unimodal, more or less right skewed distributions from remote sensing data may be explained by exponential distributions of concentrations at sub-pixel scales. This would imply that pixel values are generally not representative of typical K concentrations of the rocks within that pixel, but result from spatially dominant K-poor rocks (or regolith) combined with spatially minor exposures of K-rich material. Documenting the spatial K/Th distribution at scale < 100 m for various lithologies is important for the interpretation of airborne radiometric data. This proposition sheds new light on the apparent discrepancy between K concentrations from GRS data and bulk-rock analyses of Martian meteorites [1] which could result from the natural sampling of spatially dominant K-poor rocks, whereas GRS values are influenced by minor occurrences of K-rich compositions such as those recently identified at Gale crater [2].

[1] Taylor et al. 2007 *JGR* doi:10.1029/2006JE002676. [2] Sautter et al. [2013] doi : doi:10.1002/2013JE004472.