K, Th, U patterns in Paleoproterozoic formations from airborne radiometric and ground-based measurements - Insights into superficial processes

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K, Th, and U are incompatible elements, with various degrees of mobility with respect to aqueous alteration and are considered as good tracers for magmatic and fluid-rock interactions. Endogenic and superficial processes are responsible for the distribution of these elements at the surface. Endogenic (partial melting, fractional crystallization, hydrothermal alteration…) and superficial processes (erosion, in-situ alteration, transport and mixing) do not operate at the same scales and are expected to produce different spatial patterns. These elements may be mapped at various scales from airborne or hand-held radiometric (gamma ray) techniques, and multi-scale statistical analyses may provide new insights into processes at work. Following earlier work focusing on K, Th, U distributions in Paleoproterozoic formations in Eastern Senegal (Fall et al., 2018), we focus here on the analysis of variograms, which reflect the spatial correlation of concentrations as a function of distance and direction.

Variograms are calculated from regional radiometric data (in the south part of the Kedougou-Kenieba inlier and the two parts of the Saraya granite, 250 m line spacing), from higher-resolution airborne radiometric data acquired with a helicopter in the mineralized zone of the Petowal deposit (Toro Gold) and using a hand-held spectroradiometer (FPGRS) for the acquisition of ground-based radiometric data with a resolution of 5 m, over typically surface areas of 150x150 m^2). Calculation of variograms for large data sets (in the case of radiometric data) are achieved in Fourier space (Marcotte, 1996).

Systematic behaviors are noted for all variograms: the variance of Th generally increases more rapidly (with distance) than the variance of U, and K (relatively to the absolute concentration). The behavior reflects the higher mobility of K and low mobility of Th. One exception to this behavior has been noted for the Saraya granite, where the variance of U shows a sharp increase at the small scale. Significant observations are also noted when orientation is taken into account. The variance is shown to increase more rapidly for K, Th, and U, within the Saraya granite in a direction perpendicular to the major structural orientations of the inlier. This anisotropic behavior is lost, especially for K, and to some extent for U, in the southern part of the granite, which is covered by alluvial material and transported or in-situ regolith. These preliminary results suggest that spatial K, Th, U pattern may be useful, in conjunction of other geophysical data sets, to decipher surficial geological processes.

Keywords: Paleoproterozoic, granite, variogram

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References

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