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Proposal:

In ^{238}U and ^{232}Th disintegration chains, determination of disequilibrium by direct chemical analysis is difficult because contents of daughter products are very low. For instance, at secular equilibrium, mass ratio $^{226}Ra/^{238}U = \lambda_{238}/\lambda_{226} = 3{,}4\times10^{-7}$. Aiming to localize spatially radioactive disequilibrium of any geomaterial included in the U production chain (intact rock, residues, etc.), we propose a mapping approach based on the combination of homologous images (means images taken on the same zone and at the same scale):

- U and Th (mother elements) chemical content maps determined by Electron Probe Micro Analysis.
- Maps of alpha (and/or beta) radioactivity obtained by film autoradiography and polycarbonate film techniques.

The novelty of this scheme is that it is based on mapping methods, which are theoretically applicable at the field sample scale or thin section scale.

Main Principle

First, total U and Th elemental maps give the spatial distribution of mother elements (^{238}U and ^{232}Th) ; indeed, at equilibrium, other isotopes of U and Th which are present in ^{238}U and ^{232}Th disintegration chains are negligible in terms of content (^{234}U, ^{234}Th and ^{230}Th for ^{238}U chain, and ^{228}Th for ^{232}Th chain). At the scale of a point, or at the scale of a map, judicious/ reasonable combination of total (U + Th) is able to estimate a **theoretical alpha emission at EQUILIBRIUM**, this according to the total integration time, the disintegration constants, and the number of emitted alpha N in both considered chains (N= 8 for ^{238}U and N=6 for ^{232}Th). This combination will provide a foreseen surface density emission map (alpha / mm^2) if both chains would be at equilibrium. Thorium is included in this scheme, because it is a natural alpha emitter presumably dispersed in all studied materials. ^{235}U disintegration chain is here neglected.

Second, actual alpha autoradiograph by polycarbonate film technique (Cr-39) gives a hole density mapping (one hole = one emitted alpha particle), that is to say the **REAL alpha emission** of the material.

Alpha autoradiographs are performed in three steps: (1) exposure, (2) reveal alpha tracks by etching, and (3) digitization(optical microscope) and image processing to obtain hole density mapping.

Finally, difference between theoretical alpha density (equilibrium hypothesis) from U and Th content mapping, and real alpha density given by polycarbonate films will underline the disequilibrium. These differences will be interpreted in terms of absence or presence of chain elements in the considered disintegration chain.

Schedule :

We propose a two steps work schedule:

Step 1 : implementation of alpha polycarbonate film technique.

Reproductibility of alpha polycarbonate film technique? How to link holes map, holes density map? Is optical density map necessary ? How to optimize alpha emission density determination in terms of acquisition time and spatial definition?

Step 2 : On four ideal target samples : E1 sample : U-rich, Th-poor, secular equilibrium	D1 sample : U-rich, Th-poor, residue (after U leaching)
E2 sample : U- and Th-rich, secular equilibrium	D2 sample : U- and Th-rich, residue (after U leaching)