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U-Th disequilibria constraints on physical and chemical erosion processes and rates in soils from the Lake Natron-Lake Magadi (Gregory Rift Valley) drainage area vs hydrology/paleohydrology and bedrock lithology

Claude Hillaire-Marcel
GEOTOP, Université du Québec à Montréal, Canada (hillaire-marcel.claude@uqam.ca)

This presentation is a tribute to my former PhD student, the late Dr. Christian Goetz (1960-1991), who carried out intensive field and laboratory investigations on actinides in soils and sediments from lakes Manyara and Natron (Tanzania), and Magadi (Kenya) during his doctoral studies. Soils developed on granites from the Precambrian plateau, west of Gregory Rift, as well as those developed on the trachitic floor of the Rift yield nearly similar patterns, with U-leached (and Th-enriched) upper horizons vs source rocks. They differ from each other by i) the much higher [U]/[Th] mass ratio of soil over the granitic ($\sim$ 0.3) vs the trachitic ($\sim$ 0.1) basements (both near secular equilibrium), and ii) the greater decay of 230Th-excesses (230Thxs) in top soils over trachites, pointing to much older soils and/or lower leaching rates at the Rift floor. This difference seems related to the more arid conditions prevailing in the deeper part of the Rift. In contrast, soils developed on the basaltic walls of the Rift, characterized by abundant spring water from the basalt aquifer and a dense vegetation, depict a three-stage U-Th isotope evolution, with bedrock at near secular radioactive equilibrium and a [U]/[Th] ratio of $\sim$ 0.2. It is overlain by a U-depleted horizon (with up to 75% relative losses in U), then topped by a low Eh, organic-matter rich layer, with evidence for a secondary uptake of U. The high 230Thxs observed in the U-leached horizon point to relatively fast U-leaching rates and/or "young" soil pattern. The present-day clays deposited in Lake Natron point to a Precambrian granitic plateau origin (through major rivers flowing eastwards towards the lake), whereas clay supplies from the rift escarpment basalts are carried with hydrothermal seepages towards Lake Magadi. U-Th measurements in early diagenetic minerals (phosphates) and clays (smectites) deposited during late Pleistocene high-lake levels ($\geq$ 12 ka BP) provide robust constraints on source-rocks and source minerals, as well as on their paleodrainage patterns and depositional age.