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Isotopic traces of REE, Pb and U migrated from the Bangombé natural reactor, Gabon

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Natural fission reactors at Oklo and Bangombé in the Republic of Gabon provide geochemical information on long-term predictions of migration and retardation processes of radionuclides for radioactive waste repository. Fission products from the natural reactors can be used as isotopic tracers to estimate the distribution behavior of radioisotopes in a geological media.

The samples used in this study were taken from a sandstone layer at 40-100 cm beneath the reactor. Micro-uraninite, coffinite, françoisite and goethite were observed as U- and REE bearing minerals. In-situ isotopic analyses of REE, Pb and U in individual mineral grains were performed by the Sensitive High Resolution Ion Micro-Probe (SHRIMP II) at Hiroshima University.

Coffinite and françoisite include depleted ^{235}U ($^{235}U/^{238}U$=0.00609~0.00638) and large amount of fissiogenic light REE, while micro-uraninite and goethite have normal U isotopic values ($^{235}U/^{238}U$= 0.00725) and small amount of fissiogenic REE. Relative abundances of fissiogenic REE components in the samples vary with the distance from the reactor, which suggests the mixing of two components between fissiogenic isotopes from the reactor and non-fissiogenic isotopes of pristine minerals in the sandstone. Significant chemical fractionation was observed between Ce and the other REE in the secondary minerals, which shows evidence of oxidizing atmosphere during the formation of secondary minerals.

U-Pb data from each mineral do not provide chronological information because of large chemical differentiation between U and Pb. However, systematic Pb isotopic data from all of the minerals suggest that a large mobilization of fissiogenic isotopes, Pb and U from the reactor ocurred in association with dolerite dyke intrusion at 0.798 Ga ago and the secondary minerals was formed by mixing event due to recent alteration. The result is consistent with previous chronological works on the Oklo uranium deposit [1,2].

References

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Interaction of U(VI) with bacterial strains isolated form uranium mining piles: Spectroscopic and microscopic studies

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Bacteria, ubiquitous in all aquatic and soil systems, can interact in many ways with actinides. They can mobilize or immobilize actinides in the environment, leading to their dissolution or precipitation. Knowledge of bacteria-actinide interactions is important for understanding the migration behaviour of the latter in the biogeosphere. In this work, a combination of Extended X-ray Absorption Fine Structure (EXAFS) spectroscopy, Infrared (IR) spectroscopy, Transmission Electron Microscopy (TEM) and Energy Dispersive X-ray Spectroscopy (EDS) was used to conduct a molecular and atomic analysis of the uranium complexes formed by different bacterial strains isolated from uranium mining waste piles. EXAFS analysis showed that the cells of *Stenotrophomonas maltophilia* JG-2, *Pseudomonas rhodesiae* R5 and *Myxococcus xanthus* precipitate U(VI) as autunite-like phase at pH 4.5, probably due to the release of the inorganic phosphate from the cells. However, in the case of *B. sphaericus* JG-A12 the uranium bonding was consistent with the formation of a ternary complex with phosphate and carboxylate. These results are in agreement with those found by Infrared measurements. TEM and EDS analysis showed strain-specific extracellularl and/or intracellularl uranium accumulation to varying degrees. In *B. sphaericus* JG-A12 the uranium is located at the cell wall, while the cells of *S. maltophilia* JG-2 and *P. rhodesiea* R5 accumulate uranium both extracellularly on the cell surface and intracellularly as electron-dense granules.