Fission products as isotopic tracers for weathering processes at the natural reactor site at Bangombé, Gabon

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The unique natural fisson process which happened 2 Ga ago at Bangombé, Gabon, allows study of migration due to weathering by using the isotope composition of fisson products as tracers. The weathering effects are expected to be detectable since this is the only reactor core which is located close to the surface at 10 m depth (Gauthier-Lafaye, 1995).

Two main processes of a fission reaction lead to change in isotope ratios of natural elements:

a) accumulation of nonradioactive isotopes which are endmembers of a decay chain,

b) depletion of isotopes due to neutron capture depending on different cross section and subsequent decay

The isotope compositon of light *REE* are greatly affected by the fission reaction and therefore suitable as tracers for weathering effects.

It is well known that migration of elements occurs in fractures of the host rock preferently. A fracture located in the FA formation (sandstones) 4 m under the reactor core of the Bangombé site has been chosen for a closer investigation. One sample of the fracture itself and three samples of host rock beneath of it have been investigated by ICP-MS after a chromatographic clean up. A schematic scetch is given in Fig. 1.

The isotope ratios $^{143}Nd/^{146}Nd$ and the $^{147}Sm/^{149}Sm$ have been chosen for a first evaluation and are shown in Table 1.

The $^{149}Sm/^{147}Sm$ ratio is depleted close to 0 in the reactor core whereas the natural ratio is 0,92. All investigated samples are slightly depleted concerning this ratio.

The $^{143}Nd/^{146}Nd$ ratio is enriched in the reactor core whereas the natural ratio is 0,707. Surprisingly one sample investigated is slightly depleted concerning this ratio.

With some respect to the error of measurement (estimated to be 1 % after correction for mass discrimination) these results do not prove a migration of rare earth elements in or perpendicular to this fracture 4 m below the reactor core due to weathering.

In contrary a small depletion of $^{143}Nd/^{146}Nd$ and $^{147}Sm/^{149}Sm$ could be a result of a neutron flux. The cross section of ^{143}Nd (336 barns) is 300 times larger than ^{146}Nd (1,3 barns) and the cross section of ^{149}Sm (41000 barns) is larger than ^{147}Sm (52 barns). This would be sufficient to explain the relative depletion of the isotopes ^{143}Nd and ^{149}Sm.

TABLE 1. Isotope ratios detected in the fracture and perpendicular by ICP-MS

Sample	$^{149}Sm/^{147}Sm$*	$^{143}Nd/^{146}Nd$**
Natural	0.924	0.707
reactor (Hidaka, 1988)	0.020	1.615
1 (fracture)	0.895	0.703
2	0.906	0.697
3	0.906	0.707
4	0.883	0.716

*corrected for mass discrimination with 0.97, **corrected for mass discrimination with 1.037.

References

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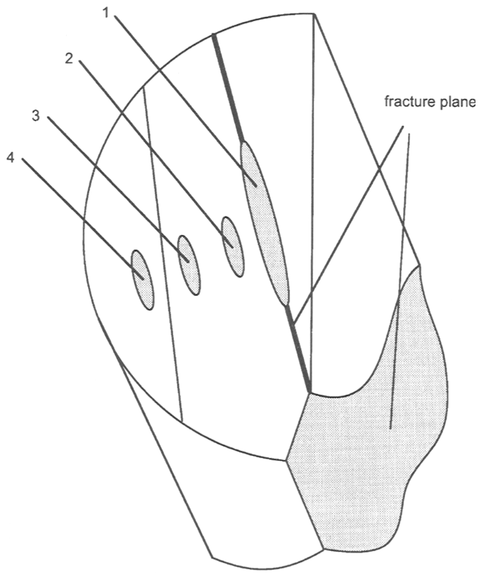

FIG. 1. Drill core BAX 08 at 13.95–14.00 m, sample locations along fracture in sandstone (FA).