

## Galena S Isotopes in and Around the Natural Fission Reactors at Oklo and Bangombé, Gabon

Lena Zetterström (lena.zetterstrom@nrm.se) & Torbjörn Sunde (torbjorn.sunde@nrm.se)

Lab. for Isotope Geology, Swedish Museum of Natural History, Box 50007, SE-104 05 Stockholm, Sweden

The uranium deposits at Oklo and Bangombé, Gabon, contained over a dozen small zones that showed evidence that nuclear chain reactions had taken place in situ. The reactor zones were found in the Francevillian sedimentary basin. This 2 Ga sedimentary basin is unmetamorphosed and is often stated to have had a simple geologic history since the formation of the reactor zones at 1950 Ma. The details of the time-temperature-fluid flow history convey a more complex picture, involving elevation of temperature and fluid flow between 1000 Ma and 750 Ma. During that time, regional extension and intrusion of a dolerite dyke swarm heated the basin and triggered fluid circulations. One of the dolerite dykes intruded the Oklo uranium ore. It has been argued that this event caused alteration of uraninite, which was accompanied by episodic and thermally activated Pb loss. Ion microprobe studies of U and Pb isotopes in uraninite and galena (presented elsewhere) indicate the initiation of this Pb loss at ca. 900 Ma. This was either followed by a prolonged period of elevated temperature, or there has been another episodic Pb loss around 500 Ma. Isotopic composition of S in galena could confirm the involvement of S from the dolerite dyke intrusions.

S isotope analyses were made using a Cameca IMS1270 ION microprobe at the NORDSIM facility in Stockholm, Sweden. S analyses were performed mainly on relatively large galena crystals (1-3 mm in diameter), due to the necessary primary beam size during analyses, but also on two smaller galena crystals (ca. 50  $\mu\text{m}$ ). Also, galena from a ca. 50 cm thick altered dyke, parallel to the main dyke at Oklo, has been analysed. The results are given as  $\delta^{34}\text{S}$  in‰ relative to Canon Diablo Troilite.

The  $\delta^{34}\text{S}$  data plots within a range of 40‰, which indicates the influence of sedimentary or biogenic S. However, many data points also lie within the range of expected values of volcanic sulphides (+15 to -10 (Jäger & Hunziker, 1979)) and the influence of magmatic S emitted from dolerite dyke intrusions cannot be excluded. Data appears to form two groups, one with an average around +2 and one around -20. There is a wide scatter of values between crystals only a few mm's apart. There seem to be variation even within single crystals. This kind of scatter could be due to the presence of biogenic S. A wide range of sulphur isotope compositions on a very small scale can occur when bacterial microenvironments have developed around particles of organic matter (Hoefs, 1997). There is a lot of organic matter in the Francevillian sediments, especially around the uranium deposit. The host rock is therefore a possible and likely source of S. When comparing crystal by crystal, we see that both crystals of ca 50  $\mu\text{m}$  size plot within the range compatible with volcanic S. One of the crystals from the altered dyke plots outside of this range, indicating that the alteration introduced S into the dyke. Large galena crystals are found both within and outside of the volcanic range. A preliminary conclusion from these studies would be that S in galena crystals at Oklo and Bangombé mainly originates from the surrounding sediment, rich in organic matter, possibly mixing with S originating from the basaltic magma that crystallised nearby ca 900 Ma ago. There are also indications of non-magmatic S introduced into a small dolerite dyke, possibly during alteration.

Hoefs J, *Stable Isotope Geochemistry*, Springer, 201, (1997).

Jäger E & Hunziker JC, *Lectures in Isotope Geology*, Springer-Verlag, 283-312, (1979).