

Origin and oxidation processes of the Oklo uranium ore, Gabon.: Reactive transport modelling.

Joaquin Salas¹, Carlos Ayora², Jesus Carreras²

¹AmphosXXI Consulting S.L., Passeig de Rubí 29-31, E08197 Vallldoreix, Barcelona (Spain), e-mail: Joaquin.Salas@amphos21.com

²Institute of Earth Sciences “Jaume Almera” (CSIC), Lluís Solé i Sabarís s/n. E08028 Barcelona, (Spain).

In 1972, a series of isotopic anomalies was discovered in uranium samples originating in the Oklo mine district, Gabon. The only explanation was the natural fission of the isotope ²³⁵U during the Paleoproterozoic, about 2·10⁹ years ago. This hypothesis has been corroborated with geochemical and petrographical evidences. As a consequence of the fissionogenic products preservation, the deposits have been intensely studied as a natural analogue of a nuclear waste disposal site.

Previous studies have described the geological environment and some mineralogical and geochemical aspects of the Oklo site. However, the genetic processes have not been strictly treated; topics as the uranium source or the hydrologic mechanisms have not been numerically studied. In this way, the objective of this work is to verify the feasibility of the conceptual mechanisms proposed by different authors and to propose our own theory by means of a 3D-model (Fig. 1). The overall goal of this study has been to advance our understanding of the uranium ore formation through numerical modelling of coupled groundwater flow, heat transport and reactive solute transport. Other specific research questions have been evaluated, as the factors lead to the observed location of the uranium deposits and other mineral paragenesis.

The Okélobondo uranium deposit is part of the Oklo district. Actually, it is located at a depth of about 300 m, and is affected by oxidation and dissolution of uraninite. The presence of oxidising conditions at depth is unusual and, if repeated elsewhere, may affect the stability of uranium oxide under repository conditions. Therefore, it is important to determine whether the processes leading to this situation are specific of Okélobondo or they might represent a common phenomenon. In order to identify the geochemical processes which control the water composition, reactive transport modelling has been applied. The high Mn/Fe ratio and the high pH-Eh values of the water sampled in the lower part of the Okélobondo system are attributed to the interaction of the recharge with rhodochrosite and manganite deposits. Three key factors have been identified to obtain the chemistry of this water: a fast dissolution of a Mn-phase, a slower dissolution of a Fe-phase and a continuous source of alkalinity. However, in spite of the presence of Mn-carbonate deposits is uncommon in the Earth surface, it is necessary evaluate its abundance and distribution in the recharge area of hydrological systems, when evaluating the location of a nuclear waste repository.

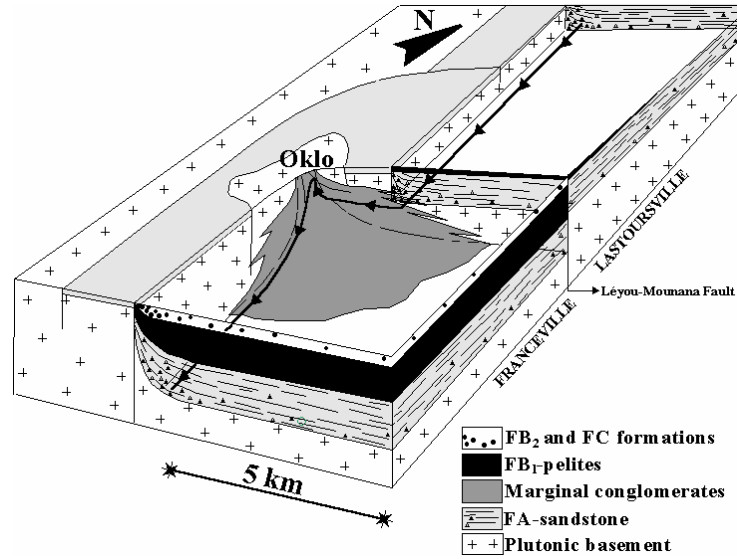


Figure 1: Geological schema of the basal Francivilian formations in the Oklo area. With a black line, the trace of the modelled streamline has been rebounded.

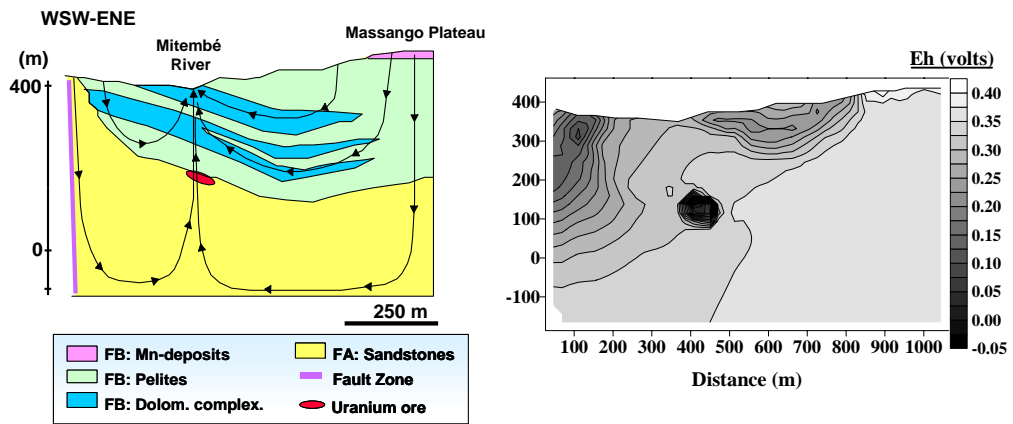


Figure 2: Geological schema and local groundwater flow system around of the Okélobondo area. Calculated redox distribution affecting the uranium ore, at a depth of 300 m.