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Oxygen isotopic composition of nano-scale uraninite at the Oklo-Okélobondo natural fission reactors, Gabon

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ABSTRACT

High spatial resolution (10–30 μm), in situ oxygen isotopic analyses by secondary ion mass spectrometry (SIMS), coupled with high-resolution transmission electron microscopy (HRTEM), were used to show that uraninite from the Oklo-Okélobondo natural fission reactors that occur in near surface environments, have low $\delta^{18}O$ values and nanotextures that are consistent with interaction with ground water. These low $\delta^{18}O$ values (–14.4 to –8.5‰) suggest that the minerals exchanged with meteoric groundwater. In contrast, reactor zones that occur at depth have largely retained their original O isotopic composition (–10.2 to –5.6‰) and uraninites are well-crystallized and essentially defect-free. These observations clearly demonstrate that by combining both HRTEM and in situ O isotopic analyses by SIMS, it is possible to characterize the nano-scale porosity and post-depositional alteration of U-bearing phases.