Origins of chromite found in chemical and clastic sedimentary rocks of the 3.2 Ga Moodies Group, South Afirica

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The timing of the emergence of oxygenic photoautotrophs (e.g. cyanobacteria) is critical for understanding the evolution of life and the earth's surface environments. Yet, no palaeontological or geochemical signature in sedimentary rocks has provided unequivocal evidence for the emergence of cyanobacteria in the Archean era. The objective of this study was to find mineralogical and geochemical signatures that mark the emergence of cyanobacteria in a shallow ocean environment from the the Moodies Group, South Africa (~3.2 Gyr), in which Javaux *et al.* (2010) [1] discovered large, well-preserved microfossils, possibly the remnants of eukaryotes. We were particularly focused on the origins of chromite ($FeCr_2O_4$) and magnetite (Fe_3O_4), which contain the redox-sensitive elements, iron (Fe) and chromium (Cr), found in the chemical and clastic sedimentary rocks.

Our samples collected from underground mines (e.g. Sheba gold mine) were divided into 3 groups, based on the dominant iron-bearing mineral: the Siderite ($FeCO_3$), Mgnetite, and Hematite (Fe_2O_3) groups. While fine-grained (<5 μm in diameter) hematite, or ferric hydroxide ($Fe(OH)_3$) as its precuror, was interpreted to have been directly precipitated from seawater, large-grained (>50 μm in diameter) magnetite and siderite were interpreted to have formed during early diagenesis. We identified two types of chromite: eudheral and unhedral chromite. All eudheral chromite, which was observed in the Magnetite group, was overgrown by magnetite. This suggests that both euhderal chromite and magnetite in the Magnetite group were formed during diagenesis. On the other hand, unhedral chromite in the Siderite group was often included in silicate minerals (e.g. chlorite and biotite), indicating that it is detrital in origin. A positive correaltion between the Cr/Ti ratio and the U/Th ratio in the bulk chemical composition of the Magnetite group may suggest that both Cr and U were transported to the ocean through oxidative chemical weathering, and therefore that cyanobacteria was emerged before 3.2Ga.

[1] Javaux *et al.* (2010) *Nature* **463**, 934–938.

Uranium speciation in opals from the Nopal I deposit (Mexico)

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The study of uranium migration and trapping in the environment is relevant to assess the safety of potential high-level nuclear waste repositories (HLNWR). The Nopal I uranium deposit (Sierra Peña Blanca, Mexico) is a natural analogue of HLNWR located in volcanic tuff. Secondary uranyl minerals such as uranophane and weeksite occur in the deposit and are coated by opal [1], [2].

The aim of this study is to determine the uranium speciation in these opals to reveal the low temperature conditions of trapping of this element, from the micrometer scale of electron microscopy to the molecular scale provided by fluorescence spectroscopy.

Uranium speciation was found to be various and complex. We evidenced by scanning electron microscopy (SEM) microparticles of ß-uranophane $Ca[(UO_2)(SiO_3OH)]_2(H_2O)_5$ and apatite $Ca_5(PO_4)_3(OH, Cl, F)$ containing small amounts of uranium. However the major part of uranium is concentrated in Ca-U-enriched zones with a Ca:U ratio of 1:1 and displaying spherical features (Fig. 1).

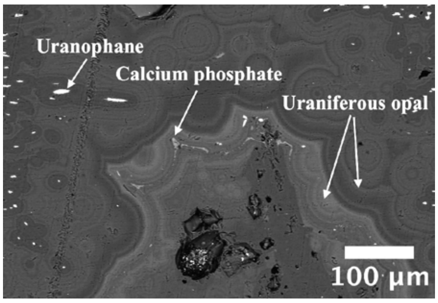

Figure 1: SEM back-scattered electron picture of a yellow opal cross-section from the Nopal I uranium deposit, Mexico.

The exact nature of Ca-U species in these zones was not determined but transmission electron microscopy (TEM), cathodoluminescence and time-resolved laser fluorescence spectrocopy (TRLFS) analyses suggest the presence of Ca_m-$(UO_2)_m$-$(O/OH/H_2O)_n$ complexes adsorbed or incorporated in opal. These results will be discussed in terms of chemical conditions that prevailed during U incorporation.

[1] Calas *et al.* (2008) *Terra Nova* **20**, 206–212. [2] Schindler & Fayek (2010) *Geochim. Cosmochim. Ac*, **74**, 187–202.