Understanding the formation mechanism of uraninite on sulphide minerals at the nanometer scale

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The Camie River uranium prospect is one of several prospects hosted in the western portion of the Paleoproterozoic Otish basin located in Central Québec. The most recent exploration in the Camie River area has been conducted by Areva (Camie River Zone) and Cameco (Otish South). It is the only uranium prospect in the Otish basin that represents unconformity type mineralisation, similar to the high grade U deposits of the Athabasca basin in Saskatchewan. Fluvial sandstone and conglomerate of the Indicator formation unconformably overlay Archean metasedimentary basement rocks containing zones of massive sulphides and graphitic schists. Uranium mineralisation, extending 20-50 m above and below the unconformity, occurs where there is contact between the unconformity and the massive sulphide and graphitic schists. Pyrite and galena from the massive sulphide zone have a close spatial relationship with uranium mineralisation and likely play a significant role in the reduction of U^{6+} to U^{4+}. The relationship between the redox pairs of S^{2-}, S^{6+} and Fe^{2+}, Fe^{3+} in the reduction of uranium requires further study in order to better understand redox sensitive mineralisation mechanisms and the formation of uraninite. The chemical and mineralogical processes that occur between the surface of sulphides and uraninite have been studied in detail using morphological, chemical, and mineralogical features between interfaces of both pyrite and uraninite and galena and uraninite. Four samples have been collected using drill core from the Otish South zone (OTS07-04) which intersected the ore body with an average grade of 1% U_3O_8 over 15 m. Polished thin sections are pre-examined with optical microscopy and Scanning Electron Microscopy in order to identify interfaces between the sulphide phases and uraninite. One area of interest is subsequently chosen and lifted out with Focused Ion Beam technology, milled with Ga- ions to electron transparency and examined with Transmission Electron Microscopy. A long term autoclave experiment was simultaneously conducted in an attempt to simulate the interaction of uranium rich fluids and pyrite. Preliminary findings suggest the presence of anglesite as well as ferrous and ferric iron species along uraninite-sulphide interfaces that may represent step-wise redox processes related to uraninite mineralisation.