"CAGE": a new uranium province, Nunavik, Quebec

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The CAGE district was discovered during an exploration survey made in 2005 in Northern Québec, by Claude Caillat (AREVA) and Serge Genest (Omegalpha). The district is located in the northeastern Canadian Shield, at the eastern margin of Ungava Bay. The U showings are located in Paleoproterozoic metasedimentary rocks (Lake Harbour Group) that were deposited on a passive margin epicontinental platform setting. High-grade metamorphism with partial melting occurred during the Torngat collision (1.86–1.74 Ga). Several pegmatoid generations were injected into the metasedimentary rocks. The strongly differing structural, mineralogical and geochemical characteristics of each generation reflect derivation by partial melting from a variety of protoliths. The pegmatoid bodies are generally poorly mineralized in U, except for some located outside the CAGE district (e.g., Amaujaq). Two types of mineralization have been distinguished according to their geological setting, mineralogical, and geochemical characteristics, but both give the same age on uraninite (1790 ± 10 Ma).

The first type is hosted by impure dolomitic marble (with phlogopite – olivine – K-feldspar) and skarnoids (diopside – tremolite – phlogopite – K-feldspar – scapolite), resulting from nearly isochemical metamorphism of impure dolomitic limestone or marl. The ore mineral is pure uraninite with REE patterns characterized by a decreasing fractionation from the LREE to HREE, with neutral or a slightly positive Eu anomaly and a low total REE. The uraninite is consistently associated with enriched Ba (Ba-rich K-feldspar and phlogopite, celsiane, kampfite, baryte), V (coulsonite $Fe^{++}V^{+++}{}_2O_4$, V-pyroxene), Zn (sphalerite), Pb (non-radiogenic galena), S-Cu (pyrite, pyrrhotite, chalcopyrite, chalcosite), As (arsenopyrite), Sb (ullmanite NiSSb) and Mo (molybdenite). The scapolite composition ($40 < \text{marialite \%} < 60$) and kampfite [$Ba_{12}(Si_{11}Al_5)O_{31}(CO_3)_8Cl_5$] suggest the influence of evaporitic fluids. Graphite is locally observed in the marble. Organic matter and/or sulphide minerals may have represented the initial U traps. The uraninite could have been present in the marble prior to metamorphism or it may have been introduced during metamorphism.

The second type of U mineralization is hosted by calc-silicate rocks (skarnoids or primary skarns) located in the vicinity of pegmatoid injections in transtensional settings. The endoskarns are dominated by scapolite and the exoskarns by Fe-rich diopside. Newly formed tremolite, scapolite ($20 < \text{Marialite \%} < 70$), phlogopite, and calcite in veins and vugs are spatially associated. The ore minerals are Th-rich uraninite and uranothorianite, characterized by high REE contents, a weak global fractionation, and a marked Eu anomaly. These are typical of magmatic uraninite, in particular that of the Rössing alaskite. Both uranium enrichment and the late vein minerals are seemingly related to expulsion of magmatic fluid from the latest pegmatites. This event corresponds to transtension near the end of the tectonic-magmatic cycle, also typical of the Rössing setting.

U-enrichment in the CAGE province is interpreted to have started with the emplacement of U-rich high-K Archean granite in the basement. During the Paleoproterozoic, U was leached from the Archean granite and trapped in the reduced epicontinental platform sedimentary rocks. Partial melting of the metasedimentary rocks and possibly of the basement gneiss led to the formation of U-rich anatectic melts and fluids which were trapped in overlying marble, forming the second type of mineralization. The first type of mineralization may be of sedimentary or diagenetic origin with local remobilization by metamorphic fluids.

Atlantic Geology, 2009, Volume 45, Number 1