Radionuclide tracers of processes in uranium deposits

K. KYSER*[1], D. CHIPLEY[1], A. VOINOT[1]

[1]Department of Geological Sciences and Geological Engineering, Queen's University, Kingston, Canada

Uranium deposits are potentially ideal for evaluating how radionuclides can be applied to tracing processes related to deposit generation, deposit evolution and deposit dectection because of their high concentration of radionuclides [1]. The uranium decay systems offer a plethera of radionuclides for dating events from the inception of the deposit to its final form, as well as tracing the character of fluids that have affected the deposit and mobilized progeny into the enevironment, thereby enhancing the footprint of the deposit. However, uraninum minerals are "self destructive" because radionuclides produce defects that make the minerals reactive with later fluids and most progeny have distictly different geochemical characteristics relative to the parent radionuclide [2].

Classical U-Pb dating can be used to determine both the age of deposits and the timing of fluid events that have interacted with them, but the system is normally disturbed and highly discordant. The radiogenic Pb that is produced from the decay of U is often missing from old deposits, and has been dispersed into the environment of the deposit, The timing of younger events or ages of younger deposits (<0.2Ma) are better evaluated using U-Th-Pa systems, with U-Pa being a recent addition to the radionuclides in the study of uranium deposits. However, some environments are condusive to the mobility of Th and Pa relative to U, thereby greatly complicating the utility of these radionuclide systems because of the lost of the progeny isotopes. Similarly, the ^{238}U-^{234}U system, which can be used to evaluate recent fluid interactions (<2Ma), is often disturbed because the deposits are structurally hosted and are near the surface.

Because U deposits tend to be open rather than closed systems when it comes to radionuclides and their progeny, many intermediate radionuclides or radiogenic isotopes are dispersed into the environment of the deposit. Elements such as Pb, Ra, Rn and He, which are often dispersed far from U-rich areas, can be used to explore for the deposits and to understand the U cycle in natural systems.

[1] Cuney, M. and Kyser, K. (2016) *Mineralogical Association of Canada Vol. 46, 357pp.*