Recycling of Archean sulfur from the Proterozoic Kiggavik uranium deposit, Nunavut, Canada

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The Thelon Basin is temporally- and spatially-related to the Athabasca Basin in Saskatchewan, Canada, which hosts the highest-grade unconformity-related uranium deposits in the world. Several uranium deposits occur within the Aberdeen sub-basin of the Thelon Basin, and it has been suggested that they may also be unconformity-related deposits. However, the genesis of the deposits is still debated and the age of the uranium mineralization event remains loosely constrained.

In this study, we use secondary ion mass spectrometry (SIMS) to measure three isotope S in pyrite from the Kiggavik deposit to constrain the sources of sulfur (S). We use this information to determine whether these sulfides, if dated by the Re-Os method, would provide a better constraint on the timing of uranium mineralization.

The Kiggavik deposit is comprised of three zones (Main, Center, and East) that formed from ~200 ºC fluids at ~1600 Ma. There are three potential sources of sulfur associated with the Kiggavik deposit; the metagraywacke of the Neoarchean WLg Pipedream assemblage, the Pukiq Lake epiclastic rocks and the Paleoproterozoic granitic rocks of the Schultz Lake Intrusive Complex (SLIC). Pyrites that sourced their sulfur from the WLg would likely have $\Delta^{33}S$ values $\neq 0$ ‰, whereas sulfur derived from the Pukiq Lake formation epiclastics and Paleoproterozoic granitic rocks should have $\Delta^{33}S$ values ≈ 0 ‰. Non-hydrothermal pyrite and galena from all three zones have a wide range of $\delta^{34}S$ values from -41.2 to +37.4 ‰. $\Delta^{33}S$ values (>0 ‰) of pyrite indicate recycling of mass independent fractionated (MIF) sulfur, suggesting that pyrite from the Kiggavik deposit derived S from the Neoarchean metagreywacke host-rock. The preservation of these anomalous $\Delta^{33}S$ values suggests that the pyrite formed from low-temperature processes rather than hydrothermal processes. Low-temperature, high-latitude fluids may have been involved in the formation of the pyrite because some of these sulfides are also associated with uranium minerals that are devoid of Pb, and contain corroded calcite. Therefore, based on these data Re-Os geochronology of these sulphides would not yield an age that would constrain the timing of hydrothermal uranium mineralization.