The Uranium Mineralization Potential of the North-eastern Part of the Paleoproterozoic Thelon Basin

Yulia Uvarova*
Department of Geological Sciences and Geological Engineering, Queen's University, Kingston ON Canada K7L 3N6
uvarova@geol.queensu.ca

and

T. Kurt Kyser
Department of Geological Sciences and Geological Engineering, Queen's University, Kingston ON Canada K7L 3N6

Larry Lahusen
Uravan Minerals Inc., Calgary AB Canada T3E 7J4

Summary

The Paleoproterozic Thelon Basin is located in the Churchill Province of the Canadian Shield, Nunavut, Canada and is host to economic unconformity-type uranium mineralization (the Kiggavik deposit) and has the potential to host other deposits. The Thelon Formation sandstones and conglomerates and the Pitz Formation sandstones from the Garry Lake area in the northern part of the basin contain phosphates, illite, minor chlorite and quartz as cements. The matrix phosphates are fluorapatite with U concentrations up to 235 ppm. Lead isotope ratios and associated trace element concentrations extracted from sandstones, conglomerates and shales by partial-leaching with 2% nitric acid show that rocks with phosphates in the matrix have radiogenic $^{206}Pb/^{204}Pb$ ratios as well as high U, Pb, Th, Ca and P concentrations. Some radiogenic Pb is interpreted to be produced *in situ* by breakdown of fluorapatites. However, in some samples there is an excess of ^{206}Pb that could not have been produced by the amount of U in the sample and must have been derived from an extraneous U-rich source and then introduced into the rock by later fluids. The $^{207}Pb/^{206}Pb$ isochron for leachates gives an age of ca. 1500 Ma, which is younger than the age of the detrital and early diagenetic phosphates (1667±6 Ma, Davis *et al*. 2008) and is the same age as the U1 mineralization event in the Thelon Basin.

Introduction

The Thelon Basin is a coarse clastic sedimentary rock-dominated intracratonic basin that lies within the Rae Domain of the Western Churchill Province. The Thelon Formation is the dominant basin-filling unit, which has a maximum thickness of 2 km, and consists of quartz-dominated sandstones and conglomerates (Hiatt *et al*. 2009). Basement rock beneath the Thelon Basin in the study area include a series of Archean metapelites and gneisses of the Woodburn Lake Group, Aphebian metapsammites to metapelites of the Amer Group, and Late Aphebian sediments and volcanic (including the Pitz Formation volcanics) of the Wharton Group (Hiatt *et al*. 2003).

Representative core samples of the lithologies from drill-holes SL-1, SL-2, SL-3 and DPR-8 were collected by the Uravan Minerals Inc. team in July 2008 at the Kidd Creek historical core storage. The drill-holes are located in the eastern part of the Thelon Basin.

The Thelon Basin located in the Western Churchill province (Nunavut and Northwest Territories) is spatially and temporally related to the Athabasca Basin (Kyser *et al*. 2000) and has the potential to host economic uranium deposits. The maximum age of the basin is constrained by the age of emplacement of fluorite-bearing granites in the Amer Group metapelites at ca. 1753 Ma (Miller 1995). The minimum age is estimated to be 1720±6 Ma, the U-Pb age of fluorapatite cement from the basal sandstone and conglomerate of the Thelon Formation (Miller *et al*. 1989).

The Thelon Basin is host to two areas of uranium mineralization, the Kiggavik deposit in the eastern part of the basin and the Boomerang Lake showing in the north-western part of the basin.

Method

The similarities between the Thelon and the Athabasca Basins and discovered uranium showings are positive indicators of the potential for the Thelon Basin to host unconformity-related uranium mineralization. The present study concentrates on the north-eastern part of the Thelon Basin and is to determine if there is potential in this part of the basin to host uranium deposits. In 1981 Kidd Creek Mines discovered 19 uraniferous boulders in a train 3 km long and 0.5 km wide, extending along the north shore of Garry Lake, north-eastern part of the Thelon Basin. These boulders are of meta-arkose, fine-grained, up to 10 cm in diameter and grey in color with variable intensity of red due to hematite associated with mineralization which is fracture-controlled (www.nunavutgeoscience.ca under Showing 066FNE0001).
Samples from four drill-holes were petrographically examined and analyzed by electron-microprobe, LA-ICP-MS and 2% nitric acid leaching technique. Drill-hole SL-2 is representative of the Thelon Formation, with dominant lithologies being coarse-grained sandstones and conglomerates. Drill-holes SL-1 and SL-3 are representative of the Amer Group with dominant lithologies being grey and black shales and mudstones, and the DPR-8 drill-hole is representative of the Pitz Formation basement rocks.

Results

Sandstones and conglomerates of the Thelon Formation and the Pitz Formation from the SL-2 and DPR-8 drill-holes have phosphates, illite, minor chlorite and quartz as cements. The matrix phosphates are fluorapatite with low U contents (maximum of 28 ppm), although high U concentrations up to 235 ppm were observed in one sample. These contents are much lower than previously reported (Hiatt *et al*. 2009). For the first time in Thelon Basin rocks, high $^{206}Pb/^{204}Pb$ ratios were observed in drill-holes SL-2 and DPR-8. There is a positive correlation between U and P leachable concentrations in SL-1, SL-2, SL-3 and DPR-8 rocks. This correlation indicates that high leachable U concentrations are due to the partial dissolution of phosphate minerals, which, in turn, means that much of the radiogenic Pb was produced *in situ* from the breakdown of these minerals. However, on a $^{238}U/^{206}Pb$ *vs*. $^{206}Pb/^{204}Pb$ diagram, which shows the evolution of Pb isotopic ratios from uranium from 1750 to 250 Ma, a few samples plot in the area to the left of the 1750 Ma U-Pb evolution curve and have ^{206}Pb contents in excess of the amount that could have been produced by the leachable uranium in the sample since deposition of the sandstone (Fig. 1). Thus, radiogenic Pb in samples of the Pitz Formation sandstones is not supported by the amount of U in these rocks, and is therefore mobile Pb introduced from an extraneous U-rich source. That U mineralization was discovered in boulders of Amer Group metapelites indicates that there was U as vein-type mineralization in the Amer Formation, which might be a possible external source of radiogenic Pb and U in the samples. The $^{207}Pb/^{206}Pb$ isochron for leachates of the samples gives an age of ca. 1500 Ma, which is younger than the age of the detrital and early diagenetic phosphates (1667±6 Ma, Davis *et al*. 2008) and is the same age as the U1 mineralization event in the Thelon Basin. This suggests that there was later remobilization and migration of uranium-bearing fluids.

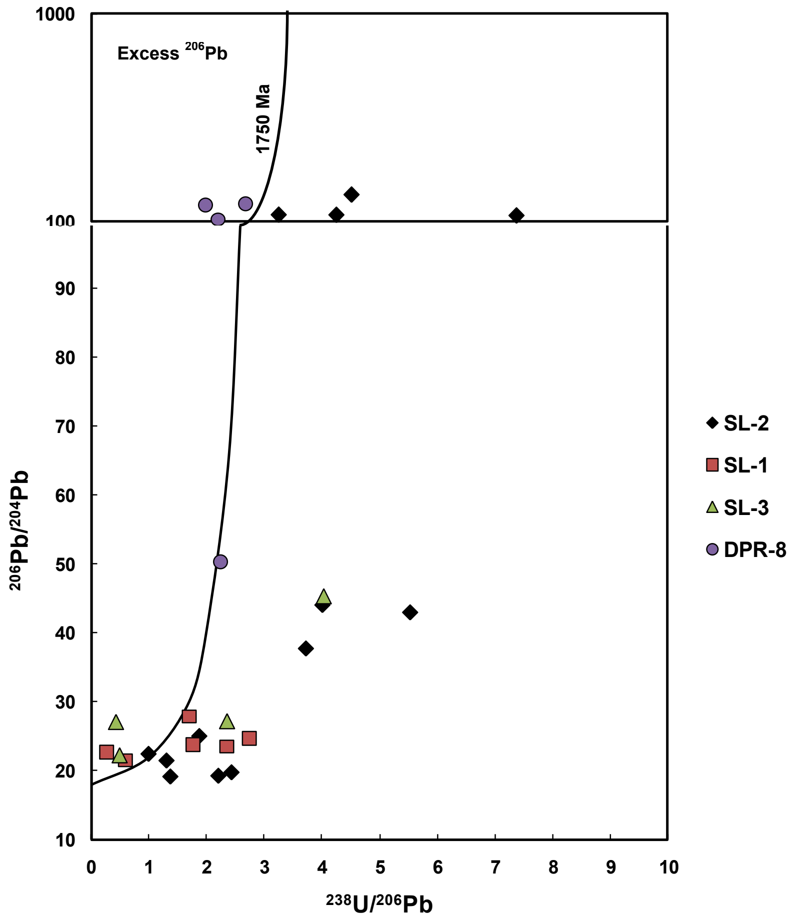

Figure 1: Plot of $^{206}Pb/$ c acid from four drill-holes. The curve is the 1750 Ma U-Pb evolution curve. All samples fall into the area on the left from the curve are interpreted to have ^{206}Pb contents in excess of the amount of leachable uranium in the sample (Holk *et al*. 2003).

Conclusions

For the first time in Thelon Basin rocks, high $^{206}Pb/^{204}Pb$ ratios in leachable Pb were observed in the drill-holes SL-2 and DPR-8. These high Pb isotopic ratios and metal concentrations are the result of breakdown of fluorapatite from cements as well as a minor addition of U and Pb from an external source. The external source of the U and radiogenic Pb could be numerous granitoids and ultrapotassic igneous rocks with U content up to 16 ppm that are common in the eastern part of the Thelon Basin, Archean basement or U mineralization. The U contribution from detrital grains within the Thelon Basin was estimated to be ca. 19 billion kilograms (Hiatt *et al*. 2009), and to date, a total of 51.6 million kilograms are estimated for the Kiggavik deposits (AREVA 2008). Therefore, there still is a potential for the presence of undiscovered deposits in the north-eastern part of the Thelon Basin.

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