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Targeted Geoscience Initiative 4: Increasing Deep Exploration Effectiveness

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DENISON MINES

Geochemical anomalies in the surface media over the Phoenix Deposit, Athabasca Basin

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Geological Survey of Canada with Provincial and Territorial Collaboration

Introduction

The Wheeler River Property, host of Denison Mine's Phoenix uranium deposit, is situated near the southeastern rim of the Athabasca Basin in Northern Saskatchewan (Figure 1). The mineralization drilled to date is estimated to contain from 45 to 90 million pounds U_3O_8 making Phoenix, even at the lower figure, the sixth largest known individual deposit in the Athabasca Basin (Gamelin et al., 2010). This deposit has no surficial expression, and occurs near the unconformity between the crystalline basemen rocks and the overlying Athabasca sandstones approximately 400 meters below the surface.

In September 2011, we initiated a study to evaluate i) whether geochemical anomalies related to such a deeply seated deposit exist in surface media or the overlying sandstones, ii) in which type of surface media (soil, gas, water, till) displays anomalies, and iii) what is the most efficient analytical method to detect these anomalies.

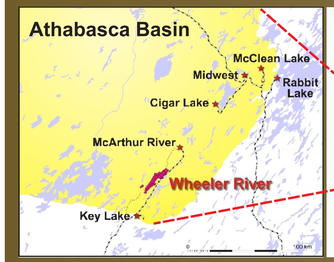


Figure 1: Denison Mine's Wheeler River property, hosting the Phoenix Deposit, in the Athabasca Basin (www.denisonmines.com)

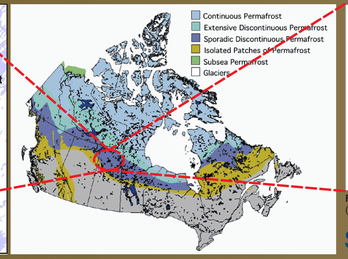


Figure 2: Permafrost Map of Canada. The Athabasca Basin is within the region of mainly sporadic discontinuous permafrost (Burgess, 1999).

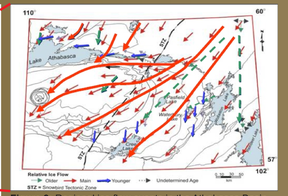


Figure 3: Regional ice flow events in the Athabasca Basin (Campbell, 2005).

Study Area

The Athabasca Basin experiences a sub-arctic climate (Figure 2) with long, dry and cold winters with warm, wet summers. The surface topography on the Wheeler River Property consists mainly of gently rolling hills of glacial moraines and till, and has experienced several ice flow episodes (Figures 3 and 4). The area is covered with ~3 m tall young black spruce trees (Figure 5) and caribou moss and minor shrubbery. Average thickness of overburden is approximately 25 m, but can be more than 100 m in place. The study area receives approximately 475 mm of annual rainfall.

Figure 4: Lease road at the Wheeler River Property. The small hills in the background indicate gentle topographical relief.

Figure 5: View through the forest, with abundant young black spruce and extensive mossy undergrowth.

Samples

In September 2011, a total of 226 soil samples (humus, B, E, and C horizon) from 59 sites along 3 transects over the "A" and "B" ore zones were collected approximately 10 meters apart in undisturbed forest (Figures 5 and 6). Humus samples were subjected to *aqua regia* digestion, whereas B horizon soil samples underwent both an *acetate* and *hydroxylamine* leach, with all being measured with ICP-MS analysis at Acme Labs in Vancouver. pH and conductivity were measured for soil-water *in-situ* shortly after sampling.

Figure 6: Soil horizon profile at Wheeler River, with a marker in the upper left for scale. It is characterized by a relatively thin humus layer with substantial "E" and "B" horizons at most sites.

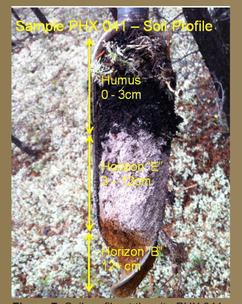


Figure 7: Soil profile at the site PHX 041, with the humus, "E" and top of "B" clearly visible.

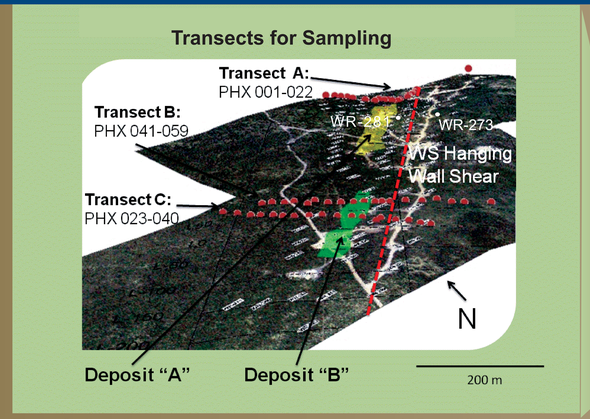


Figure 8: Sampling was conducted along three transects A, B, and C (red dots) that include the areas directly above the ore zones and the WS Hanging Wall Shear Zone. The surface projection of two ore zones (yellow and green areas) and the WS Hanging Wall Shear Zone (red dashed line) are shown in the above map.

Schematic Cross Section

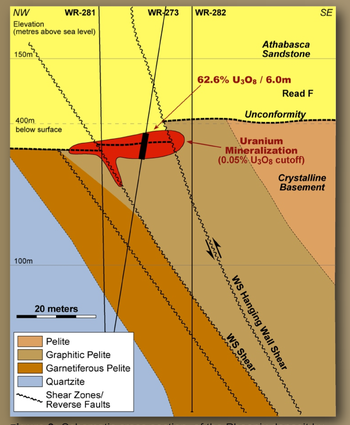
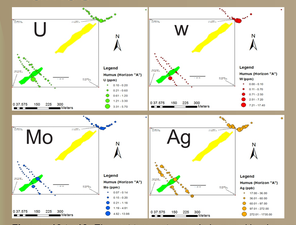


Figure 9: Schematic cross section of the Phoenix deposit by Gamelin et al. (2010). The deposit straddles the unconformity between the crystalline basement and the Athabasca Manitou Falls sandstone units. Note the presence of the WS Hanging Wall shear zone, which extends to the surface and may have acted as a conduit for fluid movement.

Results

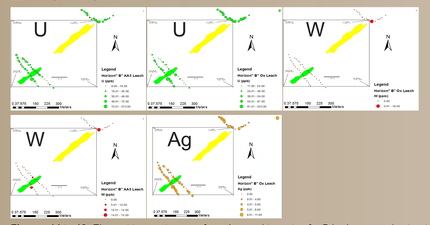
Results show strong anomalies of U, Mo, Ag and W in humus and B horizon soil not only overlying the A and B deposits, but also immediately southeast of the deposit where a northeast-trending WS Hanging Wall Shear Zone is located. The traverse sampling method provided the location of anomalies and background values in given environments.

Humus



Figures 10 to 13: Element transect maps in humus. Uranium anomalies were up to 20 times the background values, Mo more than 50 times, and Ag and W more than 250 and 70 times, respectively.

B horizon



Figures 14 to 18: Element transect maps of uranium and tungsten for B horizon samples treated with acetate leach and uranium, tungsten and silver maps for the samples leached with acetate and hydroxyalamine. Anomalies were not as pronounced with respect to the background as much as the humus samples.

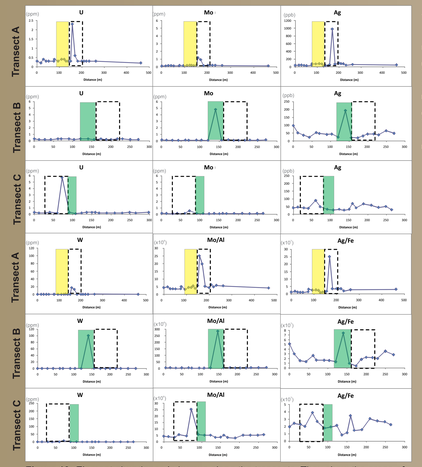


Figure 19: Element abundance in humus along the transects. They show the areas of the surface projection of ore zones (yellow and green) and the WS Hanging Wall Shear Zone.

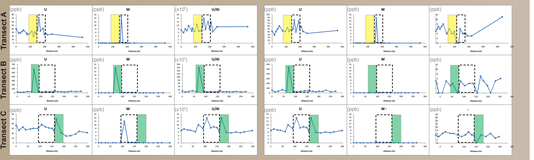


Figure 20: Element abundance in B horizon along the transects. They also show the areas of the surface projection of ore zones (yellow and green) and the WS Hanging Wall Shear Zone.

Summary

- Low background values suggest that there is no effect from potential sources of contamination, such as dust particles from the nearly Key Lake uranium milling facility.
- Distribution of geochemical anomalies in surface media is narrow, restricted to less than 10 meters away from either directly above the deposits or above the WS Hanging Wall shear zone.
- Anomalies over the WS Hanging Wall Shear zone suggest that it is acting as a conduit for the movement of fluids, uraniferous or otherwise.

Ongoing Work

- Geochemical analysis of tills and water samples.
- Noble gas isotope analysis of gas samples collected from selected holes.
- Lead isotope compositions will be determined with a TIMS for samples with high Pb values.
- Compare the results with those in other areas in Athabasca Basin.
- Evaluate the migration mechanism of elements from such deeply buried deposits to the surface.

Ore Zone "A"

Ore Zone "B"

WS Hanging Wall Shear Zone

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