Contribution ID: **137** Type: **ORAL**

The Midwest Project, East Athabasca Basin, Northern Canada: Reviving old deposits to prepare for the future

Tuesday, 26 June 2018 09:20 (20 minutes)

INTRODUCTION

The Midwest property, which hosts the Midwest Main and Midwest A deposits, is located within the eastern part of the Athabasca Basin in northern Saskatchewan. The Midwest Project is a joint venture between Orano Canada Inc. (Orano; 69.16%), Denison Mines Corp. (25.17%), and OURD (Canada) Co., Ltd. (5.67%) with Orano as the active project operator.

The Midwest Main uranium deposit was initially discovered in 1977 by Esso Resources with the initial discovery of sandstone mineralization immediately above the sub-Athabasca unconformity drilled from the follow-up of initial airborne and ground geophysical surveys, ground geochemical sampling, and boulder surveys. The Midwest A uranium deposit was later discovered along trend in 2005 by Orano following up on historical mineralized intercepts from the Esso Resources'property wide drill program between 1977 and 1981 [1, 2].

DESCRIPTION

Located 840 km northeast of Saskatoon in northern Saskatchewan on the east margin of the prolific Athabasca Basin, the Midwest Project was recently updated with new mineral resource estimates as of November 2017. The project is estimated to comprise 1.060 Mt of Indicated mineralization at an average grade of 2.19% U3O8 (1.85% U) with a contained uranium metal content of 51.1 Mlbs U3O8 (19,650 tU) as well as 0.830 Mt of Inferred mineralization at an average grade of 0.99% U3O8 (0.84% U) with a contained uranium metal content of 18.2 Mlbs U3O8 (6,980 tU) [1, 2].
The Midwest Project contains two separate deposits, Midwest Main and Midwest A, which feature high grade uranium mineralization mainly situated along the regional unconformity between the Athabasca Group sandstones and basement rocks of the Wollaston-Mudjatik Transition Zone comprising Paleoproterozoic Wollaston Group metasediments and Archean orthogneisses [3]. Midwest Main is interpreted to consist of a large unconformity lens with a basement mineralized root and 19 perched sandstone lenses. Midwest A consists of a large unconformity low grade lens that encompasses an interior high grade lens with a small basement root.

PURPOSE OF THE WORK

In response to the envisaged forecast of increased growth in electricity demand, and in turn the growth of nuclear power worldwide, medium to long term uranium prices are expected to reflect this increase in uranium demand [4]. In an effort to prepare and better plan for the next phase of the uranium market, mineral resources will need to be brought up to modern resource estimation standards to be readily available when their need arises.

The Midwest Main and Midwest A deposits have seen several resource estimations since their discoveries, however none were considered readily available to be used for the next levels of assessment prior to mining. Over the course of 2017, intensive work was completed to bring the dataset and estimates up to a more modern and rigorous standard. This resulted in the completion of separate resource estimates for both deposits in accordance with CIM Definition Standards (2014) in National Instrument 43-101 –Standards of Disclosure for

Mineral Projects ("NI 43-101"), which not only represented an increase in contained resources, but also an upgrade in the confidence level.

METHODS AND RESULTS

To modernize the mineral resource estimates at both deposits a comprehensive review of project data was undertaken prior to resource estimation. Concerns were identified at both deposits that needed to be addressed to increase both the confidence and the accuracy of the final estimate.

Given the historic nature of the data at Midwest Main a limited amount of data was readily available digitally; downhole gamma probe ("probe") data existed only as paper logs making it previously unavailable to be used, no comprehensive 3D geological model was available, perched mineralization was not fully modeled, as well as further data QAQC was needed. Midwest A has a much more modern data set, however no dry bulk density measurements were available, the latest drilling was not taken into account in the previous estimate, and the High Grade Zone was assigned an average uranium grade rather than performing grade estimation. Additionally, both deposits required new probe to chemical uranium assay grade ("grade") correlations for the calculation of equivalent uranium (eU), combination of probe and grade data based on core recovery and probing/drilling parameters to be available for estimation, updated lithology and structural models (geological model), and updated resource model.

Work began with verifying the grade data against assay certificates and a historical nine track database from ESSO. Some discrepancies were noted in the sample locations as well as some of the grades due to typographical errors. After comparison to the original drill logs and probe logs, these were rectified.

The Midwest deposits often have core loss associated with the mineralization, due to the high amount of clay alteration and quartz dissolution which makes core recovery while drilling difficult. This results in gaps in the grade dataset that are typically addressed by using probe equivalent uranium (eU) data. Digital probe data was available for Midwest A, however for Midwest Main most of probe data was never digitized and remained only available on paper logs. The paper logs for 218 holes were digitized and added to the Midwest data set. This was followed up by ensuring the probe data was depth matched with grade data, as well as the creation of grade correlations for both deposits.
Midwest Main had a robust density to grade correlation however, Midwest A did not have any dry bulk density measurements taken. The only density data at Midwest A was in the form of specific gravity measurements which do not take into account porosity and therefore tend to overestimate the density. Due to the high density of uranium, density is a vital reference for the expected tonnage of high-grade uranium deposits which has a direct effect on the amount of uranium estimated. Given this uncertainty at Midwest A, previous resource estimations were forced to use a very conservative grade to density regression formula to avoid overestimation of resources. During a 2017 site visit 25 dry bulk density measurements were taken from the remaining Midwest A drill core and sent for dry bulk density and geochemical analyses. A new grade to density regression formula was established showing an increase to the correlation by approximately 10%. This corresponded to a similar increase in mineral resources.

At Midwest Main, uncertainty of basement lithologies'foliation trends existed, which have a control on the basement and unconformity mineralization. More data is needed to improve the understanding of the structural setting, as few oriented structural measurements are available leaving some uncertainty on fault orientations. A geological model, which provided additional information on the controls and constraints on the mineralization, was created. For Midwest Main, this included digitization and generalization of drill log descriptions to make them available for cross-sectional 2D and 3D interpretation. To aid in this interpretation, the geophysical surveys (electromagnetic, magnetic, and resistivity) were re-interpreted to confirm orientation of some structures and basement lithologies.

Based on this work, a complex structural setting appears to control the mineralization location at Midwest Main. Several reactivation stages occurred within the north-northeast-trending belt of graphitic metasediments which was a key-element for Egress-style hydrothermal fluid circulation along the unconformity and into the Athabasca sandstone. These NNE faults are interpreted extending into the sandstone, off-setting certain lithological markers. A series of N80° "EW"small-scale structural features (probable faults) appear to cross-cut the unconformity mineralization, locally off-setting and extending the mineralization. Additionally, these "EW"structures appear to be limiting the extensions of certain perched mineralized lenses. North-south trending "Tabbernor"-style faults cross-cut the deposit and appear to control some extents of the high-grade mineralization at the unconformity. Additionally, the main mineralized basement root seems to follow this fault in the northern part of the deposit. High-grade mineralization at Midwest Main is interpreted to be located in certain triple-point zones where the reactivated northeast-trending graphitic belt is intersected by cross-cutting EW and NS trending fault systems. The dominant control for perched mineralization in the sandstone appears to be the stratigraphic bedding planes. Mineralizing fluids are believed to have circulated through localized fault zones precipitating uraninite/pitchblende along bedding planes.

The updated geological model at Midwest A showed that the uranium mineralization follows the northeast-southwest structures with some broader areas where interpreted north-south structures cross-cut the mineralization. These north-south structures also appear to limit the extent of the high-grade mineralization along strike, with the unconformity limiting its down-dip extents. Mineralization was also modelled to reflect the control by the basement graphitic lithologies, and the unconformity on the mineralization. The higher-grade material is generally interpreted to be associated with the graphitic packages and NE-SW structures. Some mineralization control is also provided by the unconformity. A relatively minor basement mineralized root was modelled and is interpreted to follow the steeply-dipping graphitic packages.

At Midwest Main the mineralization is interpreted to consist of a larger Unconformity Zone, a small Basement Zone, and 19 Perched Zones. The Unconformity Zone is relatively flat lying and approximately 920 metres long, 10 to 140 metres wide, and up to 33 metres in thickness, not including the basement roots which have been modeled to extend approximately an additional 90 metres into the basement. The bulk of the mineralization occurs in the Unconformity Zone at depths ranging between 170 and 205 metres below surface. Perched mineralization was interpreted to be flat-lying, occurring along stratigraphic bedding planes in the sandstone.

Midwest A mineralization is interpreted to consist of a larger Low Grade Zone encompassing an interior High Grade Zone. The deposit is approximately 450 metres long, 10 to 60 metres wide, and ranges up to 70 metres in thickness. It occurs at depths ranging between 150 and 235 metres below surface. Based on the geological model, the interior High Grade Zone was interpreted to reflect the orientation of the steeply dipping basement graphitic lithologies while being limited down dip by the unconformity and along strike by the cross-cutting north-south structures. The relatively minor basement mineralized root was modelled and is interpreted to follow the steeply-dipping graphitic packages.

Block models were created for both deposits, constrained by the re-interpreted mineralization models which utilized the geological models. A two to three-run ordinary kriging analysis was conducted for the unconformity mineralization at both deposits estimating DG (density x grade in %U) and density. The majority of the blocks were estimated with the first run. The remaining run(s) were used to fill in any un-estimated blocks. Hard boundaries were used to prevent the use of composites between the unconformity, perched, and basement zones. A single run inverse distance estimate was completed for the Basement and Perched lenses. In order to manage the influence of high grades within the unconformity zones, the influence of high grade samples were restricted to prevent smearing into lower grade areas. No restrictions were placed on the High Grade Zone at Midwest A, as it was able to be domained and estimated separate from the surrounding lower grade mineralization.

CONCLUSION

Data mining and QAQC as well as a detailed evaluation of lithology and structures that control the mineralization are vital to the construction of a robust resource model. Many of the previous outstanding issues were addressed, readying the Midwest Project deposits to become a new source of uranium supply to help meet global uranium market demands when the price recovers.

The authors would like to thank Orano Canada Inc., ORANO (formerly AREVA), Denison Mines Corporation, and OURD (Canada) Ltd. for giving permission to publish this abstract.

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Session Classification: Advances in Exploration

Track Classification: Track 4. Advances in exploration