Sandstone-Hosted Uranium in Southern Alberta

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Summary

Alberta Geological Survey has been investigating uranium potential of Southern Alberta since 2006. A sandstone-hosted uranium deposit model is being used by mineral exploration companies to direct uranium exploration in southern Alberta. Alberta Geological Survey's fieldwork studies, detailed sample analyses, and oil and gas well logs studies suggest that the geological evidence does not support direct application of this model. Nonetheless, known and newly discovered uranium anomalies warrant further studies of the uranium potential of the area.

Introduction

A number of junior mineral exploration companies are exploring southern Alberta for sandstone-hosted uranium. In 2006 Alberta Geological Survey initiated evaluation of the regional uranium potential of the area. Important conclusions were derived from fieldwork, detailed rock-sample studies, and oil and gas well logs.

Theory and/or Method

Sandstone-hosted uranium deposits produce 28% of the world's uranium. In 2009, Kazakhstan overtook Canada as the top world producer, with almost all of the production coming from sandstone-hosted deposits. In the U.S., Wyoming and Colorado have been producing sandstone-hosted uranium deposits for decades.

Sandstone-hosted uranium deposits are formed by uranium first leached from felsic volcanics and/or granite-derived (mainly arkosic) sandstones, then transported in oxidizing groundwaters through confined aquifers and finally deposited along regional redox fronts in fluvial sediments. A reducing agent within the productive package controls the location of individual ore bodies. Deposits are typically low grade (0.05%-0.4% U3O8) and small in size (often up to 50,000 t U3O8) (Dahlkamp, 1993), but are economically attractive because they occur in clusters and can be mined using a low-impact, economical, in situ leach method.

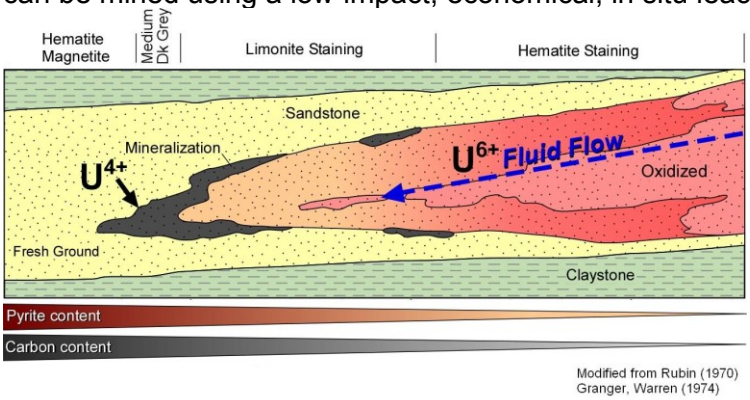

Figure 1. Roll-front deposit model.

Uranium occurrences were known in Alberta since the uranium exploration boom of the early 1980s. With the renewed interest in uranium in the past decade, exploration companies are back in southern Alberta conducting drilling campaigns, ground- and airborne-radiometric surveys, geochemical and ground-geophysical surveys.

Upper Cretaceous and Tertiary fluvial sedimentary sequences of southern Alberta have some common features with Wyoming and Colorado – world-class uranium provinces. Alberta Geological Survey investigated the uranium potential in southern Alberta from both from a deposit model perspective (looking for uranium source rocks, regional redox fronts and hydrogeological parameters) and a practical exploration approach (looking for radioactive anomalies on the ground and in the tens of thousands of digital gamma-ray logs from oil and gas wells).

We described outcrops of Upper Cretaceous and Tertiary formations in the field, took radioactivity measurements on-site and collected 237 rock samples for geochemical analysis. Outcrop sampling and thin-section studies showed low background-uranium values. Mineral composition and the texture of sandstones are significantly different from those of sandstones in Wyoming, Kazakhstan and other world-class, sandstone-hosted uranium provinces. We made 25 representative thin sections and detailed petrographic descriptions, including point counts. The thin sections showed that input of volcanic or granite material is minimal, and we saw evidence of sandstone provenance from sedimentary Paleozoic formations in the Rocky Mountains west of our study area (Stepic and Matveeva, 2010).

Figure 2. Oldman uranium occurrence.

We discovered a new radioactive occurrence, with anomalous uranium content (158 ppm), in the siltstones of the Willow Creek Formation along the banks of the Oldman River (Matveeva and Kafle, 2010). The electron microprobe studies of thin sections revealed an unexpected mode of uranium occurrence. In four thin sections studied, uranium occurs as inclusions in quartz and plagioclase grains. This was an unexpected result because, in the sandstone-hosted uranium model, the mineralization occurs in the matrix, either as uranium oxides or silicates. This has important implications for in situ leach mining technology, which uses weak solutions to remobilize and extract uranium from the ore body. We hope that future investigation into the origin of these grains will help us understand their provenance and relationship to the uranium potential of the area.

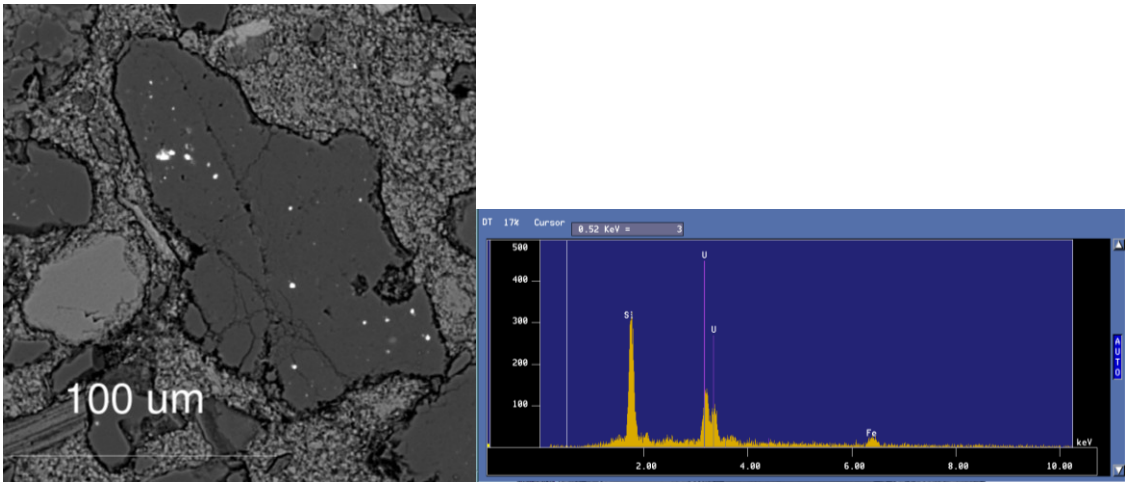

Figure 3: a) Microprobe back-scattered image of uranium-bearing quartz grain from Willow Creek Formation siltstones; b) Representative EDX spectrum confirming presence of U in inclusions

We conducted a radiometric survey along the St. Mary, Waterton and Oldman rivers. A small survey of radon in groundwater revealed an anomalously radon-rich water well (Olson and Anderson, 2007), which was followed-up by drilling by one of the exploration companies. Pollen studies of core samples from the Willow Creek and St. Mary River formations helped to pinpoint the formation boundary, which some geologists regard as an important locus for uranium mineralization.

At the Alberta Geological Survey, we have the unique ability to access digital logs from oil and gas wells. We queried more than 48 000 digital logs for anomalously high values in gamma logs, and subsequently did detail analysis of 1800 logs. Anomalous gamma intervals in the upper 500 m were selected for determination of rock type and formation. Eighty per cent of the high-gamma intervals occur within shaly units with a high organic content. Clusters of wells with high gamma readings in sandstone occur in four districts of Alberta. In the Claresholm area, multiple wells with high gamma readings in sandstones of the Willow Creek and St. Mary River formations occur within the upper 500 m (Matveeva and Kafle, 2010).

Exploration efforts by junior exploration companies have yielded new follow-up targets, but since the world financial crisis, the efforts have slowed down significantly. At this time, the results of extensive airborne and ground surveys have not been followed up. In 2008, only one company has done limited drilling in southern Alberta. No economic mineralization has been discovered so far. However, it is important to note that the bedrock exposure is very poor, and exploration efforts are in their infancy.

Conclusions

The geology of southern Alberta is different from other known sandstone-hosted uranium provinces. A sandstone-hosted uranium deposit model requires the existence of uranium source rocks (felsic volcanics or granites), highly permeable, arkosic sandstones, existence of a redox front in the area, and, of course, preservation of the ore bodies. In our studies, we could not identify significant sources of uranium. We saw no evidence of intense oxidation in exposed sandstones. Texture, composition and origin of sandstones in southern Alberta are significantly different than those in sandstone-hosted uranium provinces. This leads us to believe that the sandstone-hosted deposit model does not fit well for southern Alberta. However, each uranium region has unique features. Furthermore, the level of uranium exploration of southern Alberta is insufficient to reject the sandstone-hosted model, as it can help direct exploration efforts.

Currently, exploration efforts focus on following up on direct exploration criteria: radioactive anomalies and uranium occurrences.

The existence of uranium occurrences in the outcrops and shallow drillholes, as well as the unexplained radioactive anomalies in geophysical logs from oil and gas wells, continues to encourage exploration companies to pursue the uranium potential in southern Alberta.

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