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THE CHALLENGE OF URANIUM EXPLORATION

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Mr. Chairman, Ladies and Gentlemen:

In the previous paper, Les Beck has outlined the Geological Promise for Uranium reserves in Western Canada and in particular in the Athabasca Basin. Based upon projections of present geological theories and data the potential for future orebodies is exciting.

Later, papers on Cluff Lake and Key Lake will deal with the problems of the development of these ore bodies once they are discovered.

In my brief presentation I will try and bridge the gap between the geological promise and the production problems by outlining the evolution of exploration techniques thus illustrating the challenges faced in exploration for uranium.

Because of the radioactive nature of uranium and the extensive exposures of rock outcrops in the Canadian Shield, most of the early discoveries in Canada were the result of surficial radiometric prospecting of rock outcrops. Uranium is somewhat unique as a commodity in that the mineralization is directly detectable by radiometric methods. However, this response is masked by a few metres of overburden, water or rock cover.

The following slides illustrate the typical approach which led to the Beaverlodge area discoveries in the late 1940's and early 1950's. An area of favourable geology is prospected with hand held geiger counters or more recently, more sensitive scintillometers and spectrometers.

A radiometric anomaly is located and detailed.

Moss and light overburden are stripped away to reveal the showing which is subsequently investigated by trenching and drilling.

This all seems so straightforward and simple. What is the big challenge? Why so many geologists, geophysicists and geochemists?

A brief review of exploration in the Athabasca Basin and the evolution of exploration techniques will perhaps illustrate some of the difficulties encountered. Prior to the late 1960's exploration for uranium in the Athabasca sandstone had been limited to a small amount of work in the Middle Lake Area near Stony Rapids and at Stewart Island south of Beaverlodge. In the summer of 1967 New Continental Oil of Calgary developed a programme to explore the Basin. Their first step was to fly fixed wing scintillometer surveys and to follow up radiometric anomalies with detailed ground prospecting.

As we all remember, this programme led to the discovery by Gulf Minerals of the Rabbit Lake Mine in 1968. This discovery revised the thinking on the Athabasca Basin as a uranium province and instigated an unprecedented exploration boom with the entire Basin in both Saskatchewan and Alberta being solidly covered with mineral dispositions.

At about the same time, Amok Ltée, a consortium of French companies, was carrying out a programme of helicopter radiometric surveying. This work led to the discovery of the Cluff Lake deposits and the mineralized boulder train leading to the Fond du Lac deposit.

The success of these programmes led to the development of an exploration approach based upon airborne prospecting utilizing helicopters. Use of helicopter-mounted radiometric systems allowed rapid and extensive coverage while maintaining the ability to land and immediately carry out further investigations on the ground. The spectrometer console and recording systems are mounted in the helicopter.

The detector crystals are commonly mounted externally on the skids of the helicopter in various configurations or in a special pod beneath the helicopter.

The helicopter-located anomalies are checked out on the ground employing a spectrometer capable of differentiating the response due to potassium, uranium and thorium.

This basic approach of radiometric surveying resulted, either directly or through the location of mineralized boulder trains, in the following discoveries during the late 1960's and early 1970's.

Rabbit Lake
Collins Bay A
Cluff Lake
Fond du Lac

Midwest Lake - boulder train
Key Lake - boulder train

Mention should be made here of the development of techniques for the tracing of radioactive glacial boulders or erratics back to their source area.

A programme of airborne radiometrics and boulder prospecting successfully led to the small Fond du Lac deposit on the north edge of the Athabasca Basin. As illustrated in this cross section of the orebody, the mineralization is almost exclusively within the Athabasca sandstone and is entirely overlain by approximately 10 metres of unconsolidated glacial overburden.

The mineralized boulder train or fan produced by glacial erosion of the mineralized zone, extends down-ice to the southwest from the deposit and has a length in excess of 10 kilometres.

This train was discovered by a reconnaissance helicopter total count radiometric survey with results shown here in plan. You will note that directly over the ore zone there is no significant radiometric response. However, the anomalous response becomes very distinct to the southwest down the axis of the boulder train where the boulders come to surface.

The nature of the glacial drift, and especially the size of some of the boulders is illustrated here.

Each mineralized sandstone boulder is marked with orange paint and its size, shape and location are recorded.

The boulder train was traced back up the glacial ice direction and subsequent diamond drilling led to the discovery of the deposit.

Following the Rabbit Lake/Cluff Lake exploration boom and coincident with the depressed price for uranium, exploration activity in Canada fell off drastically in the early 1970's.

The next exploration upswing in the Athabasca started with the uranium price increases in 1974-1975, but really took off with the discovery of the Key Lake Deposits. The Gaertner orebody was discovered in 1975 by following up mineralized Athabasca sandstone boulders to their source area and the drilling of geophysical electromagnetic anomalies related to conductive graphite. The discovery of the Deilmann orebody followed in 1976. This aerial photo taken at Key Lake in September 1976 indicates the location of the two ore zones by the cleared areas for drilling.

The deposits occur at the unconformity between the overlying Athabasca sandstone and the underlying, steeply dipping basement rocks. Most of the reserves are within altered graphitic basement rocks with lesser amounts in the overlying sandstone. The upper diagram is a cross section while the lower one is a longitudinal section along the strike of the ore zones. These sections clearly illustrate the narrow, elongated geometry of the ore bodies. Note the thick section of glacial overburden overlying both the sandstone and the orebodies which would effectively mask any radiometric response. There were no significant surficial radiometric anomalies associated with the ore zones so that airborne radiometric surveying could not have directly located either deposit.

It is apparent the two ore zones were once a single deposit and that glacial erosion removed the central portion. This fortuitous glacial scouring between the two deposits eroded the original sandstone cover exposing the ore zone. During the last glacial ice advance, erosion of this exposed ore resulted in a train of mineralized boulders in glacial till, which comes to surface beneath Seahorse Lake. This accumulation of mineralized cobbles forms an economic deposit which will be mined.

During the retreat of glacial ice, an esker eroded a portion of this cobble ore, and transported it 6 kilometres where much of it was dispersed in an esker delta. A chain of post-glacial lakes and kettle holes associated with the esker, were found to carry sediment geochemical anomalies of over 700 ppm U_3O_8.

A five-year programme of lake geochemistry and boulder prospecting led to the discovery in 1975.

The next development in boulder prospecting involved a look at the third dimension. Trenching, manual or mechanized, is carried out to expose boulders masked by recent lacustrine deposits and, therefore, not exposed on surface. The glacial section is then mapped and prospected. Hopefully, buried mineralized boulders are discovered, which when fitted into the overall pattern of information, can lead to the source in outcrop.

An alternative to trenching is overburden mapping employing specially adapted drills which allow the overburden section to be sampled and analysed.

Sampling of soil gas to detect anomalous radon assists in locating buried mineralized boulders or shallow sub-outcropping mineralization.

All exploration techniques described so far have involved the detection of radiometric anomalies. However, in the case of truly blind orebodies which do not sub-outcrop and are therefore not exposed to glacial action, indirect detection methods are required.

From an exploration standpoint one of the most significant aspects of the Key Lake discovery was the recognition of the association of graphite with the uranium mineralization. Graphite is a good conductor and easily detected by the proven geophysical methods developed for the search for massive sulphides.

Subsequent to the Key Lake discovery, airborne electromagnetic surveys were flown over the basin. Systems employed included the Tridem system mounted in a Canso aircraft and the Input system mounted here in a Trilander aircraft.

Airborne anomalies interpreted as graphitic zones are more accurately located on the ground using various types of ground electromagnetic systems prior to drilling.

This type of approach has resulted in the discoveries at McClean Lake and Dawn Lake under up to 150 metres of cover. These deposits had no significant radiometric surface expression or boulder train. Recently SERU is rumoured to have made a significant discovery at a depth of greater than 400 metres by drilling ground electromagnetic anomalies as follow-up to an airborne survey.

This has been a rather brief and simple description of the evolution of exploration techniques in the Athabasca.

I do not wish to imply that every graphite zone hosts a uranium ore body. Extensive geologic and geochemical work has been carried out to identify favourable basement geology and structures underlying the sandstone that are most likely to host ore deposits. Extensive work has also been carried out to determine alteration parameters and other geologic data which would indicate favourable haloes around ore bodies and thus aid in the selection of drill targets.

A question to ponder is: How many additional Key Lake or Rabbit Lake orebodies remain undiscovered in the Basin because our present exploration techniques can not detect them?

a) They may lie under sandstone or overburden cover greater than the detection limits of present surface geophysical or geochemical methods.

b) They may not be directly associated with a detectable geophysical feature such as a graphite conductor.

c) They may not have a sub outcropping mineralized halo to produce an anomalous boulder train.

Will future uranium price and demand be high enough to provide the incentive (dollars) to develop the geologic theories and exploration techniques to find these deposits?

There is no question that the present evolution to more sophisticated exploration techniques has resulted in higher cost exploration.

In present day dollars, a simple fixed wing or helicopter total count radiometric survey might cost $15 per line km, and a two-man prospecting crew equipped with scintillometers could operate for less than $1000 per day. However, the more sophisticated combined airborne EM, magnetometer or gradiometer surveys with complete data reduction, cost $50 - $60 per line km, and more elaborate ground geophysical surveys can cost between $2,000 and $10,000 a day. Testing for deposits at depths of over 400 metres will cost in excess of $60,000 per drill hole.

These represent the real cost increases due to more sophisticated exploration techniques. However, when inflation is taken into consideration, the actual increase in all exploration costs is quite dramatic. This slide illustrates the percentage increases in the major components of exploration costs for the period 1976 to 1981. Unfortunately, as we all know, the trend of the price of uranium has been the inverse of these trends for the same period.

The point I have been attempting to make is that notwithstanding the excellent geologic potential for more discoveries in the Athabasca and similar environments, the step from potential to orebody will not be easy, technically or financially.

I would like to close on an optimistic note and for those of us with a little Irish blood in our veins the next Key Lake is out there at the end of the rainbow waiting for $50 a pound uranium and the diamond drill.