STRATIGRAPHY OF THE ATHABASCA GROUP SANDSTONE USING NUCLEAR WELL LOGGING: ITS APPLICATION TO URANIUM EXPLORATION IN SASKATCHEWAN

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ABSTRACT

The Athabasca sandstone on the eastern part of the basin belongs to the Manitou Falls Formation of continental origin. The sandstones are monotonous and lack good stratigraphic markers that would allow stratigraphic correlations from hole to hole. In 1986, P. Ramaekers in a special study for the Cigar Lake Joint Venture, indicated that detailed lithofacies analysis allows us to identify at least 3 stratigraphic markers within the Manitou Falls Formation, corresponding to contacts between stratigraphic units of regional extent. However, detailed lithofacies analysis is time consuming and inevitably varies between geologists.

Probing data give objective and unbiased information. It can be shown from diamond drilling data on the Cigar Lake and Close Lake properties that neutron-neutron, gamma-gamma and resistivity logs allow a clear and precise identification of the main stratigraphic markers of the Manitou Falls Formation. The best results are obtained from reduced scale (1:2000) and filtered logs where the contrasted signature of each unit is enhanced. Stratigraphic markers can be easily recognized from resistivity logs but, unfortunately, these may only be obtained in open holes, and heavy fracturing and alteration prevent in most cases logging of the hole down to the unconformity. In practice, the neutron-neutron logs which give comparable information have been used because the data is available for all holes. The stratigraphic markers are identified by a qualitative analysis of the response: background value, curve shape, peak amplitude, peak density and curves matching with well documented holes. Several cross sections are presented through the Close Lake and Cigar Lake properties to illustrate the usefulness of stratigraphic correlations at regional and local scales.

Exploration for Key Lake-Cigar Lake type uranium deposits in areas of thick sandstone cover (350-700m) is very expensive and the information of each drill hole has to be maximized. Recent progress in ground geophysics and a better understanding of geochemical alteration haloes have modified substantially our drilling strategy, the regional approach being favoured. In recent years, exploration for blind Athabasca uranium deposits has been frequently carried out through widely spaced drilling of pluri-kilometric electromagnetic basement conductors. Stratigraphic correlations between holes provide information on post-Athabasca and syn-sedimentary faulting, both of which are important controls for fluid circulation and uranium deposition. Furthermore, the neutron log provides information on fracturing and clay alteration haloes. Alteration haloes around Athabasca uranium deposits are usually large and clearly identified from lithogeochemical analysis (U, K, Al and, in some cases, trace elements). However, uranium, trace element content and clay composition as indicated by the K/Al ratio vary with the stratigraphy of the Manitou Falls Formation. The MFd member is generally low in uranium with illite-rich clay. On the other hand, the MFb member at the base of the formation has higher uranium content and low K/Al ratio indicative of a kaolinite-rich clay. Sandtone stratigraphy is therefore essential to the definition of proper threshold values for tracers of mineralization and alteration haloes.

Long term applications of well multi-parameter logging in the Athabasca Basin is foreseen when non-coring drilling techniques will be used in exploration (top 300 to 500m of sandstone) and/or for the delineation of mineralized zones.