Abnormal geothermal gradients and development of calcic brine in the Athabasca basin and their importance for unconformity-type uranium mineralization

RYAN SCOTT[1] AND GUOXIANG CHI[1]

[1]University of Regina, Canada, ryan.dj.scott@gmail.com

The Athabasca basin plays host to a number of high-grade unconformity-type uranium deposits, which were formed via the interaction of oxidizing basinal brines that transport uranium and a reducing fluid or lithology that precipitates uranium. These deposits are associated with a highly calcic brine, which is thought to have been formed from evaportated sea water travelling through basement faults and undergoing extensive fluid rock interactions. Large amounts of brine are required to pass near the unconformity in order to form such high grade deposits, although the fluid flow mechanism in the Athabasca basin is not completely understood at this time.

A detailed petrographic and geothermometric (fluid inclusion and illite geothermometry) study of the Rumpel Lake drill core, located in the central part of the Athabasca basin, was undertaken to constrain the composition and temperature of the basinal fluids with depth away from the site of any known mineralization. Homogenization temperatures of fluid inclusions located in early syntaxial quartz overgrowths indicate that the thermal profile does not conform to a linear increase of temperature with depth, but shows a wide range of temperatures that reach a maximum near the central part of the stratigraphy (approximately 350°C). In contrast, illite geothermometry (diagenetically late) shows a restricted linear range of temperatures from 200°C to 250°C. Ice-melting temperatures indicate the presence of three types of fluids: a low-salinity fluid (ice-melting temperatures of -2°C to -6°C), a sodium-rich brine (ice-melting temperatures of -16.5°C to -21°C), and a calcium-rich brine (ice-melting temperatures of -24°C to -50°C). Of all three fluid types, the calcium-rich brine is the most abundant and occurs throughout the stratigraphy.

The results of this study suggest that some calcium-rich brine may have been developed within the basin, probably through fluid-rock interactions between initially sodium-rich brine and calcium-bearing minerals in the sedimentary rocks. The abnormal fluid temperatures and thermal gradients may indicate that the basinal fluids underwent thermal convection, which may have been the driving force for fluid flow responsible for uranium mineralization.