Till stratigraphy in the drumlinized terrain of the McArthur River Uranium Mine area in the Eastern Athabasca Basin

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The high-grade uranium deposit at McArthur River, in northern Saskatchewan, is located at a depth of approximately 550 m. Related alteration products have been dispersed along structures in the overlying sandstones up to the bedrock surface where the sandstone, and contained alteration products, was eroded and dispersed by glacial processes during the Quaternary glaciations. However, glacial sediments are relatively thick (ranging from 0 to 100 meters) and the surface is characterized by large drumlins, which can affect the surface expression of dispersal patterns of alteration products (e.g. clay minerals and related geochemical pathfinders). Boron is a pathfinder element that is hosted by an alkali-deficient dravitic tourmaline mineral ("dravite") that is part of the primary alteration halo, resulting in boron enrichment in the altered sandstone rocks relative to the regional sandstone signature. Here we show discontinuous boron patterns from 130 surficial till samples from around McArthur River. An analysis of till stratigraphy and overall till provenance shows that different till units are exposed at surface, possibly due to erosional processes during drumlin formation, that appears to control the surficial boron patterns. Specifically, two end member tills (one local and one distal) and a range of hybrid tills were identified based on pebble counts and geochemistry. Till composition at surface and a supervised classification of airborne radiometric data clearly show that most of these tills are exposed at surface across the study area. The transport distance controls the amount of distal (basement) debris in the till as well as the geographic origin for the sandstone. Boron anomalies in bedrock are locally associated with the P2 fault and increased hydrothermal alteration. Overlying glacial sediments with the more locally derived altered sandstone are elevated in boron relative to the other tills. This study shows that complex interplay of glacial erosion and till deposition can produce discontinuous surficial geochemical dispersal patterns which, through careful and detailed till mapping, can be understood. This approach enhances surficial exploration in thick till areas. NSERC-CMIC-Footprints Exploration Project Contribution #138