Multivariate statistical analysis to identify pathfinders in sandstones for deeply seated uranium deposits in Wheeler River Property, Athabasca Basin, Canada

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The Athabasca Basin is a large Paleo- to Mesoproterozoic sandstone basin in the northern Saskatchewan, Canada. It hosts the world's largest high-grade U resources along the unconformity between the sandstones and underlying crystalline basement rocks. Uranium deposits are accompanied by hydrothermal alteration halos, which overprint the diagenetic minerals of the sandstones and the metamorphic minerals of the basement rocks. Our research area, Denison Mines' Wheeler River Property, is in the southeast part of the basin and where Phoenix and Gryphon U deposits occur. Enrichment Factor (EF), Pearson's r, RQ-mode principal component analysis after centred log-ratio transformation are conducted on the sandstone compositions from the Wheeler River Property and compared to those from background sandstones from the entire Athabasca. The EFs show that B, Mg, Ni, Cu, Pb, W, Nb, Th, Ti, Ga, Zn, Zr, U, Er and P are relatively enriched in the Wheeler River Property compared to background sandstones from the entire Athabasca Basin. The Pearson's r and PCA results show that U is positively associated with B, Cu, REEs, Y, W, Pb and inversely with Th, Fe, Ti in sandstones over Phoenix and Gryphon deposits, indicating strong hydrothermal imprints. The uppermost sandstone unit overlying the two U deposits, Dunlop Member of Manitou Fall Fm. (MFd), U is postively correlated with B, HREEs, W, Pb, Cu, representing the U-related hydrothermal imprints in shallow sandstones. Elevated values of important principal components and elemental ratios (Mg/Fe, Mg/Li, U/Th, Y/Th, B/K) in the MFd and the lowermost sandstone unit, Read Fm., also indicate that shallow sandstones show geochemical signature of uraniferous hydrothermal activity. The information is useful in geochemical exploration for buried U deposits.