Identification of sandstones associated with U mineralization using multielement statistical methods

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Denison Mine's Wheeler River property in the eastern Athabasca basin hosts both the Phoenix deposit, currently the largest undeveloped U deposit in the basin, and the newly discovered Gryphon deposit. The Phoenix deposit occurs along the basal unconformity at ~ 400 m depth. Multivariate statistical analysis differentiates sandstone compositions associated with U deposits from those in un-mineralized areas in Athabasca basin. R-Q mode principal component analysis (PCA) reveals that U is positively associated with Y, Cu, Zn, Na, W, Co, Ni, B, Mg, HREEs, Cr, Sc, Mo, V and LREEs, and inversely with Ba, Li, P, Sr, Sn, Al, Mn, Ti, Fe and K. The elemental assemblages in sandstones in Wheeler River property are essentially identical to those of sandstones overlying the Phoenix deposit, indicating cryptic yet extensive U-related hydrothermal activity in the Wheeler River property. The mapping of PC1, the most significant PC for U, for sandstones at shallow (<40 m) depth, shows a strong U-related geochemical signature overlying the Phoenix and Gryphon deposits. In contrast, PCA of sandstones in un-mineralized areas of Athabasca basin shows that U is positively associated with Th, Ti, Zr and Hf, suggesting that the U is occurring in detrital, heavy minerals. Linear discriminant analysis of U-related elements delineates three groups of sandstones with good accuracy (95.5%): sandstones in the property, regional background sandstones, and sandstones overlying the Phoenix deposit. This study proves the usefulness of multivariate statistical methods to identify sandstones that underwent uraniferous hydrothermal alteration. The multivariate statistical methods used in this study are applicable to other areas in exploration for concealed resources.