Geomathematical analysis of composition data combined with a mineralogical study of the sandstones overlying Phoenix U deposits and REE-rich Maw Zone, Athabasca Basin, Saskatchewan

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Uranium deposits are commonly associated with the enrichment of REE. To evaluate the relationship between the two, we examine sandstones above the Phoenix U deposits and REE-rich Maw Zone, both of which are in the Denison Mines' Wheeler River Property. The Phoenix deposits, with indicated resources of 70.2 M lbs U_3O_8, occur along the unconformity and a steeply dipping fault in the basement, at ~ 400 m depth. The Maw Zone, a breccia pipe with surface exposure of 300 x 200 m, consists of highly silicified, hematitized, dravitic tourmaline-rich rocks with high REE (<8.1 wt% as total REE oxides). The Maw Zone is ~ 4 km southwest from the south end of Phoenix deposits, however, rocks in the Maw Zone do not show high U (< 7.8 ppm in most rocks). Elemental plots suggest that major alteration minerals in sandstones above the Phoenix and in Maw Zone are illite, sudoite, tourmaline and kaolin. The ratios of Mg/Fe above the Phoenix deposits are generally higher than those in the Maw Zone. At the Phoenix site, the ratios of Mg/Fe are higher in deeper sandstones closer to the deposits. Principal Component Analysis (PCA) of sandstones above the Phoenix deposit shows that U is associated with Heavy REEs (HREE)+Y, Light REEs (LREE) and Pb, and inversely correlated with Ti, Zr, Al, and Th. The Maw Zone displays different element groupings in PCA: U is strongly correlated with V, Cr, Fe, Ni, Cu, Cd, Na, Li and Ba, but very weakly correlated with HREEs+Y, and inversely with LREEs and P. Relative enrichment of HREEs, Y, and P suggests xenotime as the predominant host of the HREEs. The grouping of LREEs+Sr+Th+P suggests the occurrence of monazite and/or aluminum phosphate-sulphate (APS) minerals. A mineralogical study confirmed xenotime and APS minerals as the major host of HREEs and LREEs, respectively. Xenotime rims zircon grains and forms fine dissemination with magnesiofoitite. These REE-bearing minerals precipitated from hydrothermal fluids during the brecciation of hematitized sandstones. The positive association between U and Fe in the PCA plot in the Maw Zone suggests that U was transported by oxidized fluids. The absence of U mineralization in the Maw Zone is explained by low U in the oxidizing fluids, or a lack reducing fluids to precipitate U.