

Elemental Assemblages in Sandstones Overlying the Phoenix U Deposits and REE-rich Maw Zone, Athabasca Basin, Saskatchewan

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Abstract

The Denison Mine's Phoenix deposits, with the current resources of 52.3 M lbs (indicated) and 7.6 M lbs (inferred) U₃O₈, occur both at the unconformity and along steeply dipping faults in the basement, at ~ 400 m depth. Sandstones above the deposits are variably altered to form kaolinite, illite/muscovite, clinochlore, sudoite and dravitic tourmaline. The Maw Zone, ~ 6 km SE from Phoenix Zone A, has a surface exposure of 200x200 m underlain by a breccia pipe from the unconformity. The Zone consists of highly silicified, hematitized, dravitic tourmaline-rich rocks. The Zone does not show high U (< 0.0031 %), but high REE (< 8.1% as oxides), Y (< 0.1%), and B (< 2.5%). In order to evaluate the elements associated with two different styles of mineralization, principal component analysis was carried out. For sandstones overlying the Phoenix deposits, U is associated with REE-Y-B-Na-Mg-Ni-Cr, but inversely correlated with K-Al-Fe-Ti-Th. Additionally, distinct elemental assemblages are found in different stratigraphic units. Relative enrichment of U-Pb-Y-HREE is apparent in MFa and MFd, whereas it is less so in MFb and MFc. MFa shows relative enrichment of U- Sr-LREE-P, suggesting the occurrence of monazite and possibly Sr-rich aluminum phosphate sulphate (APS). The unit also shows an inverse correlation of U with Fe, Mn and Ti. Since sandstones were extensively hematitized during the diagenesis, this inverse correlation of U and Fe suggests the enrichment of U is accompanied by the reduction of Fe to remove hematite. The principal component analysis of the Maw Zone shows different results. REE and Y are associated with P. Enrichment of HREE-Y-P occurs in the upper sandstone units (MFb, MFc, MFd), suggesting xenotime as the host of HREE. Hematization, reflected as the enrichment of Fe and V, is positively correlated with U, suggesting that the hydrothermal fluids were oxidizing and uraniferous, but no precipitation of significant U due to the lack of a reductant in the upper part of sandstones.