Multivariate Statistical Analysis of the REE-mineralization of the Maw Zone, Athabasca Basin, Canada

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Abstract

To evaluate the relationship between the enrichment of rare earth elements (REEs) and U, we carried out a principal component analysis (PCA) of sandstones in the REE-rich Maw Zone in the Athabasca Basin, Canada. The Maw Zone, a breccia pipe with surface exposure of 300 x 200 m, consists of highly silicified, hematitized, tourmaline-rich rocks with high REEs (up to 8.1 wt. % as total REE oxides). It is ~ 4 km southwest from the south end of the Phoenix U deposits, however, rocks in the Maw Zone do not show high U (< 7.8 ppm in most rocks). We used RQ-mode PCA to compute variable and object loadings simultaneously, which allows the displays of observations and the variables at the same scale. PCA biplots of the Maw Zone data show that U is strongly correlated with V, Cr, Fe, Ni, Cu, Na, Li and Ba, but very weakly correlated with heavy rare earth elements (HREEs)+Y, and inversely with light rare earth elements (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 probable occurrence of monazite and/or

aluminum phosphate-sulphate (APS) minerals. A mineralogical study confirmed the common occurrence of xenotime and APS minerals. 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. The PC1 and PC2 may reflect the major element assemblages related to the REE mineralization. The comparison of the maps of PC scores and the concentrations of HREEs+Y and P shows that the scores of PCs are better indicating the hydrothermal REE mineralization. For prospecting HREEs, PC2 is more reliable than PC1 because PC2 has the largest variance of HREEs and the second largest variance of LREEs.

Keywords: data analysis; elemental assemblage; multivariate methods; mineralization prediction; uranium deposits