Geochemical Background: A Statistical Approach to Anomaly Detection

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The ability to identify geochemical anomalies is a fundamental aspect of geochemical exploration for mineral deposits. Identification of such anomalies and/or haloes associated with mineralization requires an understanding of the background geochemical variability of the area of interest, the scale of which can vary from just a few square kilometers to several thousand square kilometers. In general, a larger area provides a clearer assessment of the geochemical background; what may appear anomalous in a 10 km^2 area may not, in fact, be anomalous when a much larger area is considered. Furthermore, an in depth understanding of geochemical background can highlight other regional- or local-scale hydrothermal systems, which may or may not be related to mineralization, and must be accounted for during exploration.

The Prairie Downs base metal deposit is located in the northeast of the Capricorn region of Western Australia, approximately 60 km southwest of Newman. A number of subdeposits are hosted along a fault zone that cuts through mafic lavas of the Fortescue Group and younger sediments. Here we compare the geochemistry of the Fortescue Group lavas at Prairie Downs with that from the Fortescue Group found across the 100,000 km^2 Hamersley Basin to the northwest. The Fortescue Group lavas across the Hamersley Basin have been subjected to intense, regional-scale metasomatism, resulting in significant depletions in alkalis, Mg, Fe, Mn, and base metals (Ni, Cu, Zn, Pb). The chemical variability recorded in this regional data set from across the Hamersley Basin forms a 'background' set against which the geochemistry around the Prairie Downs deposits can be tested.

The Kolmogorov-Smirnov test is a non-parametric statistical null hypothesis test to compare two data distributions and calculate the likelihood that they come from the same population. As such, it is a useful tool in comparing geochemical data, which typically do not have parametric distributions (e.g., a normal distribution). A full 63 element geochemical suite from both data sets was tested. Certain elements, including K and Cd, show localized concentration highs immediately around the deposits (within a few hundred meters). However, when tested against the background data, these elements are all statistically higher up to 3.5 km away from the deposits, forming a significantly larger detectable halo. This larger halo could not be detected without access to the regional background data. Conversely, other elements, including Mn, V, and Se, are locally depleted immediately around the deposits. However, comparison with the background data shows that these depletions are in fact part of the regional metasomatic event in the Fortescue Group occurring along the fault systems, and are not related to the Prairie Downs mineralization. Instead, when ignoring these local depletions, these elements actually have statistically higher concentrations in the rocks around Prairie Downs than in the background data set. These examples highlight the importance of background studies in barren rocks and demonstrate the utility of a method to perform anomaly detection in a statistically robust way.