Lithogeochemical Alteration Around the Century and Elura Zn-Pb-Ag Deposits: Detecting Alteration Expressions in Deep and Near Surface Environments.

Michael Andrew Ian Whitbread B.Sc. (Hons) (University of Queensland)

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Abstract

Exploration companies commonly rely on geochemistry to identify alteration of distinctive geochemical and mineralogical character, surrounding metal sulphide deposits that were precipitated from hydrothermal fluids. However, examination of raw analytical data is prone to error due to closure effects and the difficulty in removing the effects of background variation in unaltered rocks from the variations imposed by later hydrothermal alteration. Closure can be avoided by using ratios, or by utilising mass balance approaches based on fixing volume, mass or concentration changes between samples of parent and daughter lithologies. Using a parent-daughter approach is limiting, because only pairs of samples can be compared at any one time and because an unaltered equivalent must be produced for each sample examined in this way. Pearce Element Ratio analysis and General Element Ratio analysis (PER and GER) are not restricted in this fashion, and are more amenable to interrogation of large data sets. PER and GER are also capable of decoupling background variation from that variation due to hydrothermal alteration. Furthermore, these ratio methods are readily applied to commercially derived lithogeochemical assays.

In this study, various analytical methods and interpretive techniques (including PER and GER) have been applied to identify alteration in rocks around the Century and Elura Zn-Pb-Ag deposits, and to assess whether primary ore-related alteration effects can still be identified once altered rocks have been subjected to weathering.

Ratios of trace elements over a conserved element have been used to generate a suite of pathfinder elements for each deposit. Elements enriched in host rocks around both deposits include the economic metals Zn, Pb and Ag, along with Rb and Tl. Sodium is ubiquitously depleted in altered rocks. Other elements in the pathfinder suites are distinctive to each deposit type, and include a number of major and trace elements that are added or removed from the rocks around the mineralised zones. For example, Sb and As are enriched in rocks around Elura mineralisation while Ge and Cd are enriched in samples around Century deposit.

Iron carbonate development accompanied by potassic alteration, the destruction of albite and the absence of chlorite are the dominant mineral alteration effects at both deposits. PER and GER diagrams have been used to quantify the intensity of this alteration and allow lithogeochemistry to be used to vector towards high intensity alteration, which is adjacent to Century and Elura mineralisation. These ratio methods are applied to both visibly and cryptically altered rocks at both deposits, and have a very high degree of success in classifying alteration in unweathered rocks.

The following simple PER ratios indicate proximity to Elura mineralisation:
Ca/C, K/Al for shales, K/(Al-Na) for siltstones/sandstones.

The following simple PER ratios indicate proximity to Century mineralisation:
Mn/Ti, Mg/Ti and Fe/Ti vs C/Ti, K/Ti vs Al/Ti, K/Ti vs (Al-Na)/Ti.

Pathfinder elements can be overlain onto PER and GER diagrams to aid in ranking the prospectivity of samples, and to assess mineral hosts for individual pathfinder elements.

Weathering destroys most indicators of alteration in the Elura area, while alteration signatures are better preserved in host rocks around the Century deposit.

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