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Use of Geochemical Indices in Environmental Assessment of Soil; the Predictable and the Predictably Unpredictable

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Geochemical correlations between common contaminants (Pb, Ni, As, Cr, Co and Zn) and earth metals, Fe and Mn, have been recommended as empirical tools to estimate "background" concentrations of metals in soil. A limited number of studies indicate that geochemical ratios between Pb, Ni, As, Cr, Co, V and Zn with scavenger metals Fe or Mn, are consistent between soils collected from different regions (Hamon et al. 2004, Myers and Thorbjornsen 2004). These studies have resulted in the incorporation of geochemical indices into Australian guidance, for derivation of ecological investigation levels for Ni, Cr, Cu and Zn. However, little research has been undertaken to assess the variation of geochemical patterns between soils derived from different parent materials or different weathering environments.

A survey of background soils derived from four different parent materials, across Victoria, Australia, was undertaken, comprising collection of samples (n=640) from the surface (0 to 0.1 m) and sub-surface (0.3 to 0.6 m). Soil samples were collected from urban and rural areas of low disturbance, away from point sources of contamination. Samples were analysed for metals/metalloids and soil physical and chemical properties. Statistical review of results included regression and multivariate analysis. The results of the soil survey were compared against geochemical relationships reported within Australia and internationally.

Compilation of results from this study and international data sets, indicates that geochemical relationships for metals Cr and V (in the format of log[Cr] = alog[Fe] +c) are predictable, not only between soils derived from different parent materials, but also between soils of different continents. Conversely, relationships between Zn and Fe, Pb and Fe, Cu and Fe, Co and Mn are variable, particularly within soils derived from alluvial sediments, which may have undergone periods of reducing conditions, resulting in dissociation from metal oxides.

Broad application of geochemical indices without an understanding of site specific conditions could result in significant underestimation of anthropogenic impacts to soil and potential risks to the environment.

The reliability and application of geochemical indices for estimation of background concentrations will be discussed, including comment on statistical limitations, (such as management of censored results and the behaviour of composition data) and miss-use/miss-interpretation of geochemical indices within the environmental assessment industry, including inferences of causation based on empirical relationships.

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