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Predictive geochemical mapping using environmental correlation

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Abstract

The distribution of chemical elements at the Earth's surface is complex and reflects the geochemistry and mineralogy of the original substrate modified by environmental factors that include physical, chemical and biological processes over time.

Geochemical data typically is illustrated in the form of horizontal maps or vertical cross-sections, where the composition of regolith, bedrock or any other material is represented. These are primarily point observations that frequently are interpolated to produce rasters of element distributions. Here we propose the application of environmental or covariate regression modelling to predict and better understand the controls on major and trace element geochemistry within the regolith. Available environmental covariate datasets (raster or vector) representing factors influencing regolith composition are intersected with the geochemical point data in a spatial statistical correlation model to develop a system of multiple linear correlations. The spatial resolution of the environmental covariates, which typically is much finer (e.g. ~90 m pixel) than that of geochemical surveys (e.g. 1 sample per 10 to 10,000 km^2), carries over to the predictions. Therefore the derived predictive models of element concentrations take the form of continuous geochemical landscape representations that are potentially much more informative than geostatistical interpolations.

Environmental correlation is applied to the Sir Samuel 1:250 000 scale map sheet in Western Australia to produce distribution models of individual elements describing the geochemical composition of the regolith and exposed bedrock. As an example we model the distribution of two elements – chromium and sodium. We show that the environmental correlation approach generates high resolution predictive maps that are statistically more accurate and effective than ordinary kriging and inverse