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Detecting anomalous metal concentrations in the regolith using cross–compositional detrending

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Deciphering element associations and affinities in the regolith is important for understanding mineral hosts and geological processes, such as sorting and pedogenesis. This has implications in environmental sciences in terms of distinguishing natural vs. anthropogenic element distributions and establishing realistic remediation targets. In mineral exploration, the strongest elements associations often drive distribution patterns in geochemical maps, yet these are not always the most useful ones to consider.

In this contribution, we use National Geochemical Survey of Australia (NGSA) data to (1) identify the strongest controls of mineralogy (using major element total concentrations as a proxy) on trace metal distribution (using aqua regia Cu as an exemplar), and (2) remove the trend driven by the strongest major–trace element association to calculate and map standardised residuals of the metals. In the coarse fraction (<2 mm) of NGSA top outlet sediments (0–10 cm depth), which are similar to floodplain sediments, aqua regia Cu is most strongly correlated with total Fe of all the major total elements ($r = 0.76$ based on log–transformed concentrations). Thus the aqua regia Cu map mostly shows regions where Fe–oxyhydroxides in the regolith are abundant (or not) and naturally adsorb dissolved cationic metals from surrounding solutions. The predicted Cu map based purely on the total Fe concentrations and on the Fe–Cu correlation is visually similar to the raw map. Only when calculating the standardised residuals between actual and predicted aqua regia Cu does additional information become apparent in the form of completely different geochemical patterns. These highlight areas where Cu that is *not* related to Fe (and therefore not in the form of Cu adsorbed onto Fe–oxyhydroxides) is abundant (or not). For instance this Cu could be associated with silicate, carbonate or sulfate minerals. Thus this approach allows both environmental management and exploration strategies targeting different types of metal associations to be more effectively implemented, thereby reducing risk and cost.