Geochemical fractionation in the regolith of western New South Wales

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Progressive weathering of rocks results in significant element fractionation in the Earth's regolith zone. This is most obvious and important in areas, including much of Australia, where weathering has been intense/prolonged and profiles well preserved. The principle chemical processes include replacement of more soluble ions by protons and oxidation of some elements. Major element changes reflect the path from the primary mineral assemblage to the typical end products of quartz, kaolinite and hematite/goethite (i.e. variable loss of mainly K^+, Na^+ Ca^{2+} Mg^{2+} and accumulation of Si^{3+}, Al^{3+} and Fe^{3+}). Minor and trace element fractionation reflects the relative retention or dispersion from the primary host minerals (depending on their stability) and sequestration of released elements by specific secondary host minerals.

Studies in the Cobar region of western NSW have established the main mineralogical controls on minor and trace element fractionation in regolith over a range of rock types and ore deposits. Four regolith components largely control the concentration of dispersed target and pathfinder elements typically used in mineral exploration. The sequence of iron mobility and precipitation of the major iron oxides/oxyhydroxides is critical to trace element distributions (goethite accumulates Cu, Zn ± Pb, As; hematite Pb, As, Sb, Ba, Bi ± Cu). Manganese oxides/oxyhydroxides, particularly lithiophorite developed in redox boundary accumulations, concentrate Co-Zn±Ni-Cu-Au. Regolith carbonate and sulfate accumulations in the upper regolith have associated Au-Ba-Sr enrichments and clay minerals, particularly kaolinite host elevated concentrations of trace elements such as Cu.

Deep in the weathering profile, element fractionation is controlled by chemical, biochemical and hydrologic processes, but on and near the surface mechanical processes also become important. Resistate components/products form a surface lag, which undergoes chemical and physical maturation while being mechanically dispersed. This results in a different pattern of element fractionation and trace element enrichments.

Weathered ore deposits show a progressive change in ore element mineral hosts from primary/supergene sulfides to specific metal-rich secondary minerals in the lower oxide zone to more generic Fe and Mn oxides/oxyhydroxides towards the top. Host mineral transformations result in element release and partial re-uptake to produce characteristic dispersion and retention patterns that are also influenced by the prevailing climatic-chemical regime/s. Reconstructing the weathering history and dispersion controls in the Cobar terrain has led to improved gechemical exploration models.