A Synchrotron based study of lateritic, gold bearing, iron oxide nodules

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Understanding the formation of near surface geochemical anomalies and the metal dispersion processes that operate during deep weathering of gold/base metal deposits, will include specific mineral associations with key elements like Au, Cu, Pb, As and Zn. Iron oxide nodules occurring in residual laterite and transported sediments at the Moolart Well gold prospect in Western Australia are anomalous for these elements and provide a good example to study in-situ metal residence and speciation.

We have conducted a detailed investigation using a combination of synchrotron X-ray fluorescence (SXRF), X-ray absorption spectroscopy, and synchrotron based tomography. SXRF element maps collected with full spectral data and re-processed using geoPIXE software permit fully quantified analyses and identification of minor components (Au). SXRF identified the distribution of Cu and Zn in-situ, in samples that have low bulk concentrations. The arsenic distribution is closely related to iron and is highest in the more hematitic, residual core of the nodules. X-ray absorption near edge structure analyses (XANES) revealed the presence of both As III and As V in residual nodules and speciation mapping using the two XANES edges, as constrained by arsenic standards, demonstrates that As V dominantly occurs within high Fe hematititc veins, whereas As III has a more homogeneous distribution throughout the nodule. Isolated hotspots of Zn and Cu also occur in some nodules and closely relate to high concentrations of Fe and Ni, these occur within resistant chromite grains that are themselves weathering to magnetite. Synchrotron based tomography with micron spatial resolution reveals the distribution of these magnetites in 3D through the nodule, also making it possbile to see the differential density from a core and rim structure to the magnetites related to incomplete pseudomorphic replacement of chromite. It is these less dense cores that appear to be the main host of Zn in these nodules.

Such studies of metal siting and speciation show that bulk geochemical and mineralogical data are inadequate to determine the true mineralogical hosts for the pathfinder elements of interest. More detailed characterisation at increasingly smaller scales is imperative in this regard.