Zinc isotopes in ferromanganese crusts as vectors to base metal deposits

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Ferromanganese (FM) crusts, coatings of Mn and Fe oxide minerals, occur on a range of surface materials in the subaerial environment. Manganese oxide minerals in particular, have very high adsorption capacities for heavy metals and trace elements. Thus in the scenario whereby metals from ore deposits are liberated and mobilized to the surface and interact with FM crusts, there is potential for such crusts to adsorb anomalous concentrations of target and pathfinder elements, thereby offering potential for geochemical exploration.

A case study on FM crusts from a known fault-hosted Zn deposit from the Capricorn Orogen, in semi-arid Western Australia, shows that Zn liberated from an ore deposit by meteoric fluids can be preferentially adsorbed onto Mn oxide minerals within FM crusts[1]. Concentrations of Zn in FM crusts are demonstrably high in close proximity to primary ore mineralization but decrease distance to mineralization. To further test a possible genetic link between the Zn in FM crusts to primary ore, non-traditional Zn isotopic analysis was performed.

Isotope tracing has emerged as a new technique applied to the petrogenesis and evolution of ore deposits from their formation to later alteration. Recently, non-traditional isotopic systems, e.g. Li, Fe, U, Tl, Mo, have been proposed to use as an exploration tool. Here we present low δ^{66}Zn values for orezone sphalerite, typical for hydrothermal Zn mineralization, and similarly low δ^{66}Zn values for FM crusts in close proximity to mineralization. However, δ^{66}Zn values for FM crusts become progressively higher with increasing distance from mineralization, more typical of slow Zn precipitation in low temperature surface environments. Our results show that the source of anomalous Zn concentrations in FM crusts can be linked to Zn mineralization using Zn isotopes. Thus analysis of Mn oxide minerals in FM crusts can be a useful tool for geochemical exploration, but combined with Zn isotopic analyses, FM crusts offer a robust capacity to vector to Zn mineralization.