

Platinum group element (PGE) resources in ocean sediments

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Due to the high concentrations of base and precious metals, seafloor polymetallic sulphide deposits have recently attracted the attention of the international mining industry. Co-rich Fe-Mn crusts occur throughout the global ocean on seamounts, ridges and plateaus where currents have kept the rocks, swept clean of sediments for millions of years. Crusts precipitate from cold ambient seawater onto rock substrates, forming pavements up to 250 mm thick. Crusts are important as a potential resource primarily not only for Co, but also for Ti, Ce, Ni, Pt, Mn, Tl, Te, W, Bi, Zr and other metals [1]. Though considerable work has been done on the Fe-Mn crusts of the world oceans, the studies on Indian Ocean Fe-Mn crusts are limited. Studies have been initiated to understand the Co-Pt enrichment processes in the Fe-Mn crusts on the Afanasy-Nikitin Seamount (ANS) in the Eastern Equatorial Indian Ocean. Fe-Mn crusts are hydrogenous colloidal precipitates, which are known to record oceanographic conditions contemporaneous to their growth period. Fe-Mn crusts in the Indian Ocean were found to contain an average of >1% Co and can be designated as Co-rich. The Co-rich crusts accrete at shallow water depths (generally <2500 m) as slabs capping the seamounts. They are 3-6 times more enriched in Co than the abyssal polymetallic nodules and deep-water crusts. After Co, Ni, Cu, V, Pb, Zn, etc., the second group of elements that is enriched is the REE and followed by ultra-trace metals such as platinum group elements (PGE). Geochemical studies of Pt and Ir have indicated that both of these elements are relatively enriched in samples of Mn nodules and crusts [2, 3] as compared to the concentrations of these elements in Earth's upper continental crust (~4 ng/g). There is a growing recognition that Co-rich crusts are an important potential resource for platinum group elements. Accordingly, it is necessary to fill the information gap concerning various aspects of geochemical characterization and crust mining through research, exploration and technology development.

- [1] Banakar *et al.* (2007) *J. Earth Syst. Sci.* **116**, 3–13.
[2] Balaram *et al.* (2006) *Indian J. Marine Sc.* **35**, 7–16.
[3] Balaram (1999) *Marine Georesources & Geochronology* **17**, 17–26.

Identifying the link between climate and trace element concentrations in cave deposits using a daily-scale cave drip water dataset

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Trace elemental concentrations in stalagmite calcite are a powerful palaeoclimatic tool when used on their own or in conjunction with stable isotope records. Here we present daily-scale cave drip water trace and major element data for 13 months which clarify the timing of element transport to cave calcites. The drip waters were collected at Ballynamintra Cave in southern Ireland using a custom-built automatic water sampler, which collected a drip water sample daily. Alkali and alkali earth element (Mg, Na, Ca, Sr, and Ba) concentrations decreased with decreasing drip rate in the late summer, coincident with an increase in concentrations of P, Cu, Zn, Rb, Y, Cs, U, Th, and Pb. This suggests that the latter set of elements is controlled by the seasonal influx of colloidal material, perhaps related to autumnal vegetation dieback and decay. Because the 'autumnal flush' at Ballynamintra Cave potentially results from the transport of organic colloidal material, only trace elements associated with this phase (i.e. P, Cu, Zn, Rb, Y, Cs, U, Th, and Pb) increase in concentration at this time. The concentrations of alkali and alkali earth elements are instead moderated by dilution, interactions with the carbonate bedrock, and by prior calcite precipitation, which result in reduced concentrations in the late summer. The annual flux pattern of different elements to the stalagmite very closely matches the inferred annual distribution of trace elements observed in stalagmite calcite in previous studies. This current research therefore further clarifies what processes affect the distribution of trace elements in stalagmite calcite, and how these trace elements are linked to climate.