Geochemistry of Betul Mafic Layered Intrusion, Central India: Implications on Proterozoic Mantle Evolution and Ni-Cu-PGE Metallogeny

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Precambrian crust of Central India is divided into northern Bundelkhand craton and southern Bastar craton separated by Central Indian Tectonic Zone (CITZ). The Betul Layered Complex (BLC) emplaced into the Mesoproterozoic Betul supracrustal belt (1.5-0.85 Ga) occur in CITZ. In this study we present the geochemical characteristics of the mafic-ultramafic rocks with particular relevance to the nature of contemporaneous sub-continental lithospheric mantle and Ni-Cu-PGE mineralization. BLC is characterized by metamorphosed ultramafic-mafic rocks emplaced into Betul belt consisting of bimodal volcanics and metasediments hosting VMS ores formed under a continental arc setting. The BLC exhibits primary mantle mineralogy (ol, opx, cpx, amp, phl) with secondary metamorphic mineral assemblages. The BLC rocks are subalkaline tholeiites and record Fe enrichment and fractionation trends. High concentrations of Cr, Ni and Cu indicate the presence of accessory chromite and Ni-Cu sulphides. Compositional heterogeneity is noticed with enrichments of LILE and Pb, and depletion of Nb, Zr-Hf suggesting mantle wedge of these rocks has been metasomatically enriched with the fluids derived from subducting slab. SEM-EDS study on gabbros from BLC has revealed that they contain unusual native gold, Ni-Cu, Ni-Co, Fe-Cu sulphide and Fe-Ti-Si phase with platinum group mineral inclusions and are genetically related to the magmatic hydrothermal fluids. PGE geochemistry is characterized by a high total PGE content of 1.2-1.5 ppm and have fractionated patterns (PPGE>IPGE; high Pd/Ir = 11 to 147) resembling the interstitial variety of mantle sulphide type and also fractionated PGE patterns of basalt (Mondal, 2011). It is considered that the Mesoproterozoic period witnessed extensive ultramafic-mafic magmatism with orthomagmatic ores and existence of a long lived metasomatically enriched mantle source, VMS ores and convergent margin tectonic settings. The geochemical characteristics of the BLC rocks corroborates the above proposition.

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Assessing the dissolution of marine sediment with ^{230}Th, and the impact of dissolution on sedimentary ^{231}Pa/^{230}Th

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Dissolution of marine sediment at the seafloor takes place in all ocean basins and is an important process controlling the release of chemicals from sediment back into seawater, and in setting the composition of marine particulates buried in sediment. Assessing the rate and extent of this dissolution is therefore critical for understanding of internal cycling of many chemical species in the ocean. In this study, we test the use of ^{230}Th, whose flux to the seafloor is assumed constant and well known, to assess sediment dissolution.

Sediment samples were collected during UK-GEOTRACES Cruise GA10E (D357) from the slope of the Cape Basin in the SE Atlantic. Intact core-top sediments and three short cores were selected for this study from a range of water depths. Samples of shallow-margin and deep-sea sediments are bathed in different water masses and vary in particle flux and compositions. Our results show that ^{230}Th concentrations increase from low core-top values to a depth of~3cm and are constant below this depth. These observations can be best explained as a result of sediment dissolution in the upper centimetres of the sediment core. Core-top ^{230}Th measurements thus provide a tool to quantify the rate of sediment dissolution at the seafloor and assess the magnitude of this process in various ocean settings. Dissolution rates derived from ^{230}Th measurements have been used on these cores to assess the burial of organic biomarkers, and the fluxes of metals from upper centimetres of sediment back to overlying water column.

Meaurements of ^{231}Pa on the same sediment aliquots were also conducted to assess the impact of the observed sediment dissolution on ^{231}Pa/^{230}Th ratios (a proxy for past rates of ocean circulation, and particle flux). Results show that, despite the large dissolution indicated by ^{230}Th profiles, ^{231}Pa/^{230}Th ratios appear to be almost unaffected, indicating the robustness of sedimentary archives as records of the ^{231}Pa/^{230}Th as a paleoceaongraphic proxy.

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