Platinum Group Element (PGE) mineralization in Madawara ultramafic complex, Bundelkhand Craton, Central India

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The Madawara mafic-ultramafic complex (~ 40 km in length 2 to 4 km in wide) in southern part of Bundelkhand craton in central India, has a well preserved peridotites, pyroxenites, talc-chlorite schists, coarse to medium grained diorite, quartz veins, pegmatites and dolerite dykes. The platinum group elements (PGE) mineralized zone containing highly altered, serpentinised and chloritised ultramafic body, trending in E – W direction, has a sheared relationship with rocks of BnGC (Bundelkhand Gneissic Complex) on their both ends. The petrographic studies suggests the presence of cumulates of olivine in these ultramafic rocks. The platinum group minerals are present in disseminated form especially present in the matrix of olivine cumulates. The altered peridotites and pyroxenites have Pd/Ir ratios ranging from 0.5 to 5.1, similar to Komatiites showing a distinct subduction zone influence. The Pd/Ir ratio indicates that these rocks were formed from evolved magmas after early crystal fractionation, which presumably resulted in positive Pt anomalies. They have a moderately high PGE (ΣPGE varies from 138 to 657 ng/g) abundances and show enrichment of PPGE relative to IPGE, reflecting fractionation of the two groups. The high Ni, Cr, Mg#s (83-88) and moderately high Ni/Cu ratios indicate that they were derived from relatively juvenile melts that experienced significant crystal fractionation, suggesting that this process may have played a role in the PGE fractionation. The PGE contents are explained by the formation of S-undersaturated melt produced by relatively high degrees of partial melting of the primitive mantle. The separation of IPGE- and Pd-containing alloys is considered to be the major cause of the relatively low Pd/Ir ratios and positive Pt anomalies. The PGE bearing ultramafic rocks probably formed from melts derived from MORB mantle that had been modified in a subduction zone environment with source enrichment by incorporation of subducted sediments.

Forward models of geomorphic processes used to interpret complex cosmogenic-nuclide data sets

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Cosmogenic-nuclide concentrations in a rock or sediment sample reflect the exposure history experienced by that sample. A simple exposure history (for example, a single period of erosion-free exposure) has only a single unknown parameter (the exposure duration) that is uniquely related to the nuclide concentration. A complex exposure history involving erosion, multiple exposure periods, or periods of deep burial, may have many unknown process rates or durations. A logical strategy for this situation is to collect many samples from a given landform, so that the number of measurements exceeds that of unknowns. Successfully applying this idea requires: i) a set of samples whose exposure histories are different, but linked in such a way that each unknown aspect of the exposure history can be separately resolved, and ii) a forward model of the geologic processes that control the exposure history of the sample, whose input parameters are the unknown rates or durations, and that predicts the measured nuclide concentrations. One must use geologic evidence to determine what happened (to formulate an exposure model with a minimum number of unknown parameters) and then use the cosmogenic-nuclide measurements to determine when, or how fast, it happened (by fitting model to measurements). We will show successful and unsuccessful applications of this approach to: i) infer both exposure age and erosion rate from depth-nuclide concentration profiles, and ii) relate large and seemingly inconsistent sets of cosmogenic-nuclide measurements from various elements of the same landform through a single forward model. We will focus on the important result that the most seductive potential application of this approach — to uniquely resolve both the age and surface erosion rate of a landform — is not always feasible and requires careful design of the sampling program.