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Geochemical Analysis of River Borne Sediments from Narmada Basin: Implications for Chemical Weathering and CO_2 Sequestration

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Weathering and erosion of crustal rocks significantly shape the Earth's landscape and moderate atmospheric CO_2 levels. In this process rivers are the major pathways to transport both particulate and dissolved weathered continental materials to the oceans which act as a long-term sink for CO_2. In this context detailed geochemical investigations were carried out on bed sediments from Narmada Basin (Narmada River and its tributaries) of peninsular India that flows over the Deccan Traps basalt. Our findings indicate that the Chemical Index of Alteration (CIA = 64 to 90), Chemical Index of Weathering (CIW= 74 to 96), Plagioclase Index of Alteration (PIA= 70 to 96), and Ruxton Ratio (R= 2.5 to 5.8) for the Narmada Basin suggest moderate to high chemical weathering. Elemental ratios like Th/U ranges from 4 to 8 with extreme value up to 10 also indicates higher weathering. Strong correlation between TiO_2 and Fe_2O_3 (r^2 = 0.85) shows their co-occurrence and scavenging of Ti by Fe oxy-hydroxides during weathering of basalts. V and Ni show significant correlation with Fe_2O_3 due to their association with iron minerals or their sequestration with iron oxy-hydroxides. Previous studies on the Narmada Basin identified evapotranspiration as a limitation while using dissolved phases for analysis. Our data corroborated this by showing a dispersed plot with no correlation between Na_2O and other immobile major oxides (e.g., Al_2O_3, SiO_2). The rare earth elements REE (REE) shows enriched light REE (LREE; La/Gd_N = 2 to 9) with flat heavy REE (HREE; Tb/Lu_N=1 to 2.5) pattern; indicating high LREE fractionation compared to the HREE during weathering and transportation. Negative Eu-anomaly (Eu/Eu* = 0.3 to 0.9) reveals significant contribution from source containing plagioclase phases. This significant chemical weathering due to silicate minerals, water, and CO_2 reaction in the source of Narmada Basin eventually sequestrates high level of CO_2 in the Arabian Sea. This comprehensive analysis enhances our understanding of the Indian peninsula's geological processes along with revising CO_2 consumption rates for the Deccan Traps region, thereby contributing valuable insights into Earth's climate system dynamics and long-term CO_2 sequestration trends.