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ELEMENTAL MASS-BALANCE OF MATERIAL CARRIED BY MAJOR WORLD RIVERS

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ABSTRACT

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An estimate of average river particulate matter (RPM) composition was based on analyses of more than 40 elements in the Amazon, Congo, Ganges, Magdalena, Mekong, Parana and Orinoco rivers, to which were added literature data for 13 other major world rivers, covering the whole spectrum of morphoclimatic features. Geographic variations of major elements in RPM are mostly linked to weathering types and to the balance between weathering rate and river transport. As a result of chemical erosion, Al, Fe and Ti are enriched in RPM with respect to the average parent rock, while Na, Ca, Mg and Sr are strongly depleted. These figures are directly related to the relative importance of dissolved and particulate transport in rivers; this has been computed for each of 40 elements. In order to study weathering on a global scale, the total observed elemental fluxes (dissolved + particulate) have been computed and compared to theoretical ones. The latter were derived from the elemental content in the average parent rock and the total quantity of weathered material, computed from the Al ratio in RPM and in parent rock. Observed and theoretical fluxes are balanced for the less mobilized elements (rare earths, Co, Cr, Cs, Fe, Mn, Rb, Si, Th, Ti, U and V) for which no enrichment relative to Al is noted in RPM, and for B, Ba, Ca, K, Mg, Na, Sr which are relatively depleted in RPM due to their high dissolved transport. Additional fluxes have been found for Br, Sb, Pb, Cu, Mo, Zn and are possible also for Ni and P. This is reflected by marked enrichments in RPM relative to Al for the poorly or moderately dissolved transports (Pb, Cu, Zn). Several hypotheses involving either the natural origin (volcanic dust, marine aerosols, geochemical fractionation) or the artificial origin (worldwide pollution) are discussed to explain these discrepancies, assuming river transport and weathering either to be in a steady state on a global scale or not. However, none of them can fully account for these additional fluxes. It is most likely that these excesses have multiple origins, anthropogenic or natural or both. The comparison between RPM and deep-sea clay compositions emphasizes the prime influence of river input on oceanic sedimentation of Si, Al, Fe, Ti, lanthanides, Sc, Rb, V, etc. A few elements such as Zn, Sb, occur in excess in RPM as compared to deep-sea clays; in order to balance this excess, a remobilization of these elements out of the sediment can be considered. Finally, the enrichment of Co, Cu, Mn and Ni in deep-sea clays compared to RPM is discussed and attributed to several sources and processes.