

Distribution and partition of trace elements in the Amazon mainstream

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Since 1995 in the framework of the the UnB-ANELL-IRD joint project, the HiBAM program has carried out a systematic sampling survey of the Amazon River and its major tributaries. The aim of this program is to explain and quantify the actual geochemical processes controlling the input to the ocean of large tropical hydrosystems. For this purpose trace elements are assessed in order to characterize and quantify the weathering and transport mechanisms. This understanding may also provide a scientific basis for the anticipated development of the Amazon basin. The work reported here derives from a new set of data on both dissolved and solid load of trace metals (V, Cr, Mn, Co, Cu, Zn, As, Rb, Sr, Mo, Cd, Sb, Cs, Ba, U) of the Solimões-Amazon mainstream and its tributaries between Tabatinga, situated on the boundary between Colombia and Brazil and Santarem situated upstream the marine influence. Moreover, a monthly time series covering a whole hydrological cycle was obtained at the Óbidos gauging station during the 1997 year. Concerning the origin of the trace elements, the close correlation between V, Cu, As, Sr, Ba, U and major ions and pH suggest that these elements have a common carbonate and/or evaporite source. However, in waters with high DOC content as Negro and the Upper Solimões rivers, Cu could be strongly complexed by organic ligands. Cr, Mn, Co, Ni are well correlated and Cr and Co are rather well correlated with Dissolved organic carbon, reflecting probably their relative abundance in dolomitic formations occurring in the upper Madeira basin and in the ferricrete soils of the lower parts of the basins. The correlation between Zn and Pb reflect a control by source rocks, probably sulfide mineralization where Zn and Pb are commonly associated. Rb and Cs are well correlated together but the origin are more difficult to precise, since their concentrations are in the

same order of magnitude in the Amazon tributaries. The trace element concentrations in the particulate matter show a clear relationship with the location of the samples. For instance, V, Co Cr, Mn, Sr, Cs, Ba concentrations are higher in the Solimões left-bank tributaries than in its right-bank tributaries. Left bank tributaries come from the Andean Cordillera (Iça and Japura rivers), while right bank tributaries (Javari, Jurua, Purus) drain the soils and sediments of the subandean trough and of the central plain. The composition of suspended sediments in the Solimões mainstream reflects the mixing of both but is closer to the composition of its Andean tributaries. Concerning the transport of dissolved trace metals in the Amazon mainstream, the concentrations decrease downstream from Tabatinga to Óbidos, as previously observed for the major elements. The common concentration decrease is a consequence of the dilution of the high-concentration waters coming from the Andes by the low-concentration waters originating in drainage basins of the lowland and shield areas. Downstream the Negro and Solimões junction, the increase of Cs, Cr is due to the inputs of more concentrated waters coming from Rio Negro. In suspended matter, the trace elements concentrations are rather uniform for each sub-basin. All the trace elements are highly auto-correlated. Flat patterns are observed for the samples from the Solimões, Madeira and Amazon mainstream. By contrast, the Rio Negro is enriched in Fe and impoverished in Mn, Co and Ni. The Trombetas shows enrichment of Mn and to a lesser extent of Zn. In order to compare the dissolved and suspended trace elements loads of the different types of rivers of the Amazon basin, we computed the mass of each element in one liter of river water. - In the Rio Solimões, V, Cr, Mn, Co, Ni, Zn, Cs, and Pb are almost entirely carried by the river particulate matter; Cu, Rb, Sr, Ba and U are transported mainly by the suspended particles, but dissolved phase contribute to the transport. Only As is transported predominantly in a dissolved form. In the Rio Negro, the proportion of the elements transported by the dissolved phase is higher for the whole set of elements. The proportion of V, Cr, Mn, Rb, Sr, Ba and U associated with the dissolved phase accounts for more than a half of the total transport. In the Rio Amazon at Óbidos, the proportion between the dissolved and particulate transport clearly shows an intermediate pattern. The increase of the dissolved transport observed from the Solimões to the Rio Negro can be explained by the degree of mobility for a given element during the weathering. As already emphasized, and

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