Climatic dependence of Hf-Nd isotope decoupling in clays

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The Lu-Hf and Sm-Nd isotopic systems behave differently during Earth surface processes. A large proportion of the Hf inventory in rocks remains locked in zircons during weathering, an unradiogenic (low e_{Hf}) highly resistant mineral, which tends to be sorted into silt/sand fractions during sediment transport. In addition to this 'zircon effect', silicate weathering also leads to preferential dissolution of radiogenic (high e_{Hf}) minerals. The Hf-Nd isotope decoupling during weathering and sedimentary processes is illustrated in the e_{Hf} vs. e_{Nd} diagram, where four distinct arrays can be identified: 1) the 'igneous rock array', corresponding to unweathered silicate rocks; 2) the 'seawater array'; 3) the 'zircon-bearing sediment array', formed by most coarse-grained sedimentary rocks; and 4) a 'zircon-free' (or zircon-poor) sediment array, defined by clays and mudrocks. To date, however, it remains unclear whether this latter array simply reflects zircon depletion in fine-grained sediment fractions, or whether it may be generated by chemical weathering processes.

We aimed at better understanding the factors controlling the distribution of Hf-Nd isotopes in fine-grained sediments. We analysed an important set of sediments deposited worldwide near the mouth of rivers. The rivers selected for this study included some of the world's largest rivers, plus rivers draining basins characterized by various geological and climatic contexts. Sediments were leached for removal of any non-terrigenous components, and only the ($<2\mu$m) clay fractions were retained for mineralogical, major/trace element and Hf-Nd isotopic analyses. These new Hf-Nd isotope data plot on the array defined previously for fine-grained sediments. The extent to which each e_{Hf} value deviates from this 'clay array' (the $\Delta e_{Hf\text{-}CLAY}$ index) appears not to be related to Zr contents. Instead, it correlates remarkably well with the climatic parameters of the studied drainage basins (average annual temperature and rainfall). This suggests that Hf-Nd isotope decoupling in fine-grained sediments is controlled to a large extent by the degree of chemical weathering on continents. This finding may have interesting implications for the use of Hf-Nd isotopes in paleoenvironmental studies.