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Determination of sedimentary transfer time from U-series nuclides:implications from the study of the Gandak river sediments

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In previous studies, it was proposed to constrain sediments transfer time in alluvial plains by analyzing the variations of the U-series disequilibria in river sediments along the stream. This approach was illustrated in the case of the Ganges-Brahmaputra basin and it allowed defining a sediment transfer scenario that includes significantly different transfer times within the alluvial plain. These studies suggest that the transfer times depend on the sediment grain size: short transfer times for fine-grained sediments (a few ky or less) and much longer ones for coarse-grained sediments (100 ky or more - [1-4]). However, those estimations can be questioned in the light of recent studies based on the analysis of cosmonuclides [5] and Sr et Nd isotopes [6] , that suggest shorter transfer times (respectively 1-2 ky and less for the second study) for coarse-grained sediments in Himalayan streams.
In order to better constrain the origin of the U-series disequilibria variations in river sediments, we performed a detailed study of the U-series nuclides in the sediments of the Gandak River, one of the main Ganges tributaries. This study involves the sampling during monsoon period of suspended sediments, collected at different depths of the water column in the downstream and upstream river sections. At the same time, a regular upstream-downstream sampling of riverbank sediments during non-monsoon period was conducted, with sediments collection on both riversides of a same sampling station.
U-Th data obtained on whole rock samples outline the occurrence of significant 238U-230Th-226Ra disequilibria in river sediments, with however no simple upstream-downstream variation. The correlations observed between (238U/232Th) activity ratios and Ti/Th ratios as well as between (230Th/238U) ratios and (Nd, Ce, La, Sm)/Th ratios suggest that minor mineral phases, such as Ti-bearing minerals, monazite, zircon or xenotime, are likely to control a significant part of the U-Th-Ra budget in the Gandak sediments. U-isotopes fractionation could therefore not only depend on the chemical evolution of the sediments during its transfer within the plain and on the time evolution, but also on the mechanical transformation of the sediments mineralogical composition. This last aspect can be significantly influenced by local hydraulic conditions, inducing important sorting effects in river sediments. These results illustrate the interest to investigate separated mineral phases of river sediments. Indeed, we need to clarify the role of the mineral composition in the control of U-Th-Ra isotopic fractionation in river sediments. This is a key point to achieve more reliable transfer times, avoiding problems linked to environmental bias.
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