Geophysical Research Abstracts
Vol. 21, EGU2019-3955, 2019
EGU General Assembly 2019

Applying cosmogenic Ne to evaluate sediment residence time in large rivers: The modern Colorado and the Lower Cretaceous Kurnub rivers

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Rivers are the most effective agent of erosion on earth, transporting massive amounts of detrital and dissolved matter into depositional basins. Therefore, the relationship between denudation of continents and the pathways of sediment transport by large rivers has been extensively examined (e.g., sediment flux gauging, basin-wide erosion rates, recognizing sediment source and mixing). However, due to the complex nature of sediment storage and transport dynamics in large-scale fluvial systems, our understanding of the seemingly simple relationship between erosion and deposition in large rivers is limited.

In large-scale fluvial systems, where sediment is stored for extended periods, stable cosmogenic nuclides are a useful tool for quantifying the time sediment spends exposed during fluvial transport. We examined changes in cosmogenic Ne concentrations along an ∼450 km section in the lower basin of the modern Colorado River. Sediments along the river show no clear trend between Ne concentration and distance down the river. Nevertheless, the variability in Ne concentrations can be translated to the maximal time the sediment was exposed during its transport down the lower Colorado River (∼120 kyr).

Applying these understandings to an ancient river, we collected Lower Cretaceous fluvial sediments from 5 locations along an ∼400 km transect in the general downstream direction of the Lower Cretaceous Kurnub River. This river flowed across the passive margin of northern Gondwana into the Tethys Sea. Both variability and maximum duration of exposure (up to ∼130 kyr) of sediments in the Kurnub River are similar to the Colorado River.

These results, combined with the residence time of sediments in large modern rivers deduced from U-series isotopes, demonstrate that throughout the geologic record large rivers show a similarity in sediment dynamics expressed by large variability in sediment residence time ranging up to several hundreds of thousands of years.