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A predictive and invertible model of fluvial sediment geochemistry

Gareth Roberts[1], **Alex Lipp**[1], Alexander Whittaker[1], Charles Gowing[2], and Victoria Fernandes[1]
[1]Imperial College London, Department of Earth Science and Engineering, London, United Kingdom of Great Britain and Northern Ireland (gareth.roberts@imperial.ac.uk)
[2]British Geological Survey, Keyworth, UK

The composition of sediments in large rivers and the rocks they form in sedimentary basins record provenance, weathering and surface processes. We predict the geochemical evolution of the Earth's eroding surface from source regions through fluvial systems, and into the sedimentary record using a simple deterministic model. Using a stream power formulation of fluvial erosion we predict the incision rate at any point in an eroding landscape. Combining these predictions with information about the geochemistry of the eroding substrate we predict the composition of the eroded sediment as it is routed through the landscape. This simple approach is tested in a case study of Scottish rivers by comparing predictions with fine-grained sediment composition measurements. The high-density GBASE stream sediment geochemical survey was utilised to predict fine-grained sediment geochemistry along major regional rivers (Spey, Dee, Don, Tay, Deveron). Sediment samples were gathered from river heads to mouths and their bulk geochemical composition was determined by ICP-MS following mixed acid digestion. Predicted geochemistry of major rivers was tested using the new independent geochemical dataset. Using this data we discuss down-system trends in fluvial sediment geochemsitry, and evaluate the success of our model. Finally, we discuss how bulk geochemical data from river sediments can be formally inverted to reconstruct the geochemistry of their source regions.

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