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Quantifying heavy metal concentrations throughout drainage basins from river sediment mixing

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The concentration of elements in river sediments play a fundamental role in determining the 'health' of rivers. They also contain important information about provenance and geomorphic processes (e.g. mixing). For instance, concentrated heavy metals, such as lead, copper and chromium, can identify foci of polluting industry and stressed ecosystems. Attempts to monitor pollution in river sediments and to generate geological baselines are thwarted by the lack of available measurements of sediment geochemistry in higher-order, downstream, river channels. We address that issue by developing forward and inverse methodologies to predict the composition of river sediments throughout drainage basins from small inventories of geochemical measurements (tens of samples). A case study, centered on the River Clyde near Glasgow, Scotland, shows that conservative downstream mixing generates robust and continuous estimates of element concentrations in river sediments. Predicted geochemistry and independent observations match well for elements that have diverse concentrations in source regions (e.g. magnesium). Anthropogenic enrichment of heavy metals along large rivers, compared to geologic baselines generated by mixing 'clean' source regions, correspond to the Glasgow city area and old mining regions. Continuous predictions of river chemistry are used to identify river reaches where heavy metal concentrations exceed toxic threshold levels.