Using multi-element comparisons to discriminate between natural and anthropogenic additions to estuarine sediments

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In many populated regions around the world, estuarine sediments are highly contaminated due to riverine transport of suspended sediments and associated contaminants, derived from upcatchment industrialised, populated or agricultural regions. In south-eastern Australia, where populations are spread out and industry along river systems is minimal, the estuaries are relatively pristine. Such an environment provides the basis for undertaking a study to compare baseline sedimentary end members (terrestrial river-borne clays and marine sands) with the estuarine sediments to distinguish between the source (anthropogenic or natural; terrestrial or marine) of post-depositional elemental additions to the estuarine sediments.

The REE La and Ce were identified as behaving as conservative elements within the estuarine system, with the ratios of these elements showing a pattern which remained unchanged between the freshwater and marine environment, irrespective of dilution, or perturbations from other inputs. The concentrations of La and Ce when plotted against each other show linear mixing trends between the end-member sediment types. Plotting other elements which may be indicative of authigenic, biogenic and anthropogenically derived additions against these conservative species allow anomalous concentrations to be identified. These trends distinguish between original material sourced from terrestrial and marine sediments, and the material added to the sediment post-deposition in the estuary.

The chemistry of estuarine sediments is therefore not simply a product of original source material, but also includes a number of post-depositional additions, transformations and significant geochemical changes. In many cases, it is possible to identify these perturbations, the process responsible, and the source through the use of multi-element ratios and relationships. The use of a baseline determined by local concentrations of a conservative element also allows for subtle anomalies to be identified and localised, making early identification of potential contamination issues possible.