Applications of radionuclide tracers to studies of mixing and accumulation in modern sediments

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The authors of the first paper on ^{210}Pb dating in marine sediments had the good sense to validate their method by performing their measurements in varved sediments in the Santa Barbara Basin, off California for which the time-stratigraphic horizons had been well established. Several years later, Robbins & Edgington (1975) pointed out that most sediment regimes in lake and marine environments undergo mixing or bioturbation in the upper 10-20 cm, mainly as the result of the feeding and physiological activities of benthic organisms. Mixing confounds the time-stratigraphic resolution of the sedimentary record and eliminates the possibility of determining 20th century, contaminant geochronologies in most marine and aquatic sediment regimes. The only recourse of the tracer geochemist is to formulate a model that simulates particle uptake and post-depositional mixing and apply it to the interpretation of radionuclide and contaminant sediment profiles. Geochemists accept this reality reluctantly, because of the enormous loss of chronological information resulting from even very low rates of sediment mixing. The interplay of sediment mixing and accumulation can be illustrated using examples from a variety of depositional regimes ranging from the slowly accumulating sediments of the Arctic Ocean basins to high sedimentation rate environments in the Saguenay Fjord, Quebec. The intention of this paper is to identify the pitfalls of ignoring the impact of mixing on the interpretation of geochemical features in marine sediments and to highlight the insights into animal-sediment interactions that can be gained from a more realistic approach to these types of studies.