

An approach to interpreting contaminant deposition fluxes from dated sediment cores

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Background

Detailed interpretation of trends in particle-associated contaminant fluxes to sediment often requires modeling to resolve the effects of drainage basin holdup and post-depositional mixing. Modeling is especially necessary for constraining flux estimates for atmospherically deposited contaminants. We apply simple models of drainage basin holdup and post-depositional mixing to the interpretation of ¹³⁷Cs and other tracer profiles in dated cores collected from lakes and reservoirs in New York State.

Discussion of results

Dated cores collected from two New York City drinking water reservoirs are well described by a 3–4 year half-time of delayed delivery followed by simple, complete mixing of sediments to a fixed depth. Model results for the reservoir cores are consistent with delayed delivery of atmospheric ¹³⁷Cs indicated by historical measurements in reservoir-derived tapwater.

Modeling of a core collected from Central Park Lake, Manhattan, suggests that a substantial portion (ca. 40–85%) of recent contaminant flux is due to indirect inputs from the drainage basin, and cannot be attributed to direct atmospheric input.

Conclusions

A small set of simple models constrained by geochemical tracers can comprise a workable approach to the interpretation of local and regional atmospheric contaminant depositional fluxes from well-dated sediment cores. This is in contrast to recent efforts to model less-ideal cores using models which are markedly more complex and less constrained by geochemical evidence.

Reference

Chaky, D. A. (2003) PhD dissertation, Rensselaer Polytechnic Institute.

Factors controlling tufa deposition at waterfall sites

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Study on calcite precipitation has major implications for both the hydrochemical evolution of river systems and the global carbon cycle. The precipitation of calcite generally requires the water to be 5 to 10 times supersaturation with respect to calcite, which is usually achieved by the removal of CO₂. Formation of waterfall tufa has been often simply described as the result of water turbulence in fast-flowing water. In this paper, the formation mechanisms of waterfall tufa are discussed and a series of laboratory experiments are designed to simulate the hydrological conditions at waterfall sites. The influences of the air-water interface, the water flow velocity and the solid-water interface on CO₂ outgassing and calcite precipitation are compared and evaluated quantitatively. The results show that the principal cause of waterfall tufa formation is the enhanced inorganic carbon dioxide outgassing resulted from the sudden hydrological changes occurring at waterfall sites, rather than organisms, evaporation or the solid-water interface. The air-water interface area and the water flow velocity are greatly increased at waterfall sites as a result of the “aeration effect”, “low pressure effect” and “jet-flow effect”, which greatly accelerate CO₂ outgassing. Inorganic CO₂ outgassing drives the waters to become highly supersaturated with respect to calcite, and consequently results in much calcite deposition. The solid-water interface is less important as the air-water interface in affecting calcite precipitation at waterfall sites. Field measurements showed that conductivity, Ca²⁺ and HCO₃⁻ concentrations along Tianhe Creek and Hot Creek decrease downstream while pH rises. Field observations also showed that tufa deposition occurred mainly at waterfall sites.