

---

# Isothermal Diffusion of Eu and Th in Deep-Sea Sediments: Experimental Results and a Numerical Model

Gerald B. Epstein and G. Ross Heath

Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02882  
College of Ocean and Fishery Sciences HA-40, University of Washington, Seattle, Washington 98195

**Abstract:** Batch data for the sorption of Eu and Th on pelagic sediments may be represented by equations of the form:  $\ln M = A \ln C_s + B/T + D$ , where  $M$  = concentration of sorbate on sediment,  $C_s$  = concentration of sorbate in solution,  $T$  = absolute temperature, and  $A$ ,  $B$ , and  $D$  = constants. Thermodynamic interpretation of this equation leads to an expression for the true thermodynamic equilibrium constant of  $K = m/C_s^A$  and for the enthalpy change,  $\Delta H$ , of  $d \ln(M/C_s^A)/d(1/T) = -\Delta H/R$ , where  $R$  = universal gas constant.

Experimentally, the sorption of Eu onto clay-rich sediments was very rapid in the first few seconds and slowed over an interval of minutes to hours. Rate curves were similar in shape to those of  $\alpha$ -iron hydroxide, rather than of the oxalate-extracted residual sediment, indicating the importance of oxyhydroxide-like phases in the uptake of Eu onto red-clay sediments. For clay-rich sediments, numerical modeling reproduced the general features of a series of diffusion experiments. To a first approximation, the penetration of Eu into a sediment proceeded by saturation of the sediment to the depth of penetration and produced a sharp drop-off in sorbed + dissolved Eu concentration at the diffusion front. Higher partition coefficients ( $K_p$ ) resulted in greater sorbed + dissolved concentrations, but reduced penetration. For calcareous sediments, however, Eu concentrations at the surface were much higher than at depth, presumably due to the formation of an insoluble carbonate.

**Key Words:** Deep-sea sediments • Diffusion • Europium • Partition coefficient • Sorption • Thorium

*Clays and Clay Minerals*; June 1986 v. 34; no. 3; p. 295-306; DOI: [10.1346/CCMN.1986.0340310](https://doi.org/10.1346/CCMN.1986.0340310)

© 1986, The Clay Minerals Society

Clay Minerals Society ([www.clays.org](http://www.clays.org))

---