Transition-matrix model of bioturbation and radionuclide diagenesis

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Limnol. Oceanogr., 46(4), 2001, 905-916 | DOI: 10.4319/lo.2001.46.4.0905

ABSTRACT: Bioturbation rates in muddy sediments are thought to be due primarily to the reworking activities of benthic deposit feeders. However, current mathematical models of bioturbation do not explicitly link rates of particle mixing with realistic biological reworking mechanisms. To address this problem, I present a transition-matrix model of bioturbation that quantitatively links the reworking activities of individual organisms and community-level particle-mixing rates. Solutions to the model are presented for two kinds of tracers; particle-reactive radionuclides with a constant input flux and conservative tracers added to the sediment as a pulse. The model was used to predict the vertical profiles of excess 234 Th and 210 Pb in the field. The model parameters were determined from benthic community-structure data. Model predictions were then compared to measured profiles of these tracers. On the basis of this comparison, I inferred that maldanid polychaetes at the study site were collecting sediment at the sediment-water interface and depositing it at depth. This transport mechanism had a large effect on the predicted tracer profiles. A sensitivity analysis of the model indicated that deposit feeding by the two most abundant species, *Mediomastus ambiseta* and *Nucula annulata*, was the most important process determining the burial rate of the tracers. The model results also indicated that the combined effects of deposit feeding and sedimentation were sufficient to determine the vertical distributions of excess 234 Th and 210 Pb at the study site.

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