Effect of recurrent episodes of hypolimnetic oxygen depletion in Lake Erie on accumulation of manganese and ^{210}Pb in sediments

John A. Robbins
R. Rossmann
A. Mudroch
R. Rood
N. Morehead
David N. Edgington

The eastern depositional basin of Lake Erie (North America) would seem to be an ideal environment for ^{210}Pb dating. Sediment accumulation rates are high (~1 cm/year) and profiles of ^{137}Cs in four cores (collected in 1976, 1981, 1983 & 1991) have sharply defined peaks. However marked departures of ^{210}Pb profiles (0-20 cm depth) from ideal exponential shape, particularly by 1991, are not explained by mixing of surface sediments or by changing rates of sediment accumulation. In cores dated initially by ^{137}Cs, decay-corrected excess ^{210}Pb activities correlate well with Mn concentrations and with total phosphorus loading between 1800 and 1982. Evidently rate of supply of ^{210}Pb the eastern basin increased with human-caused eutrophication of the lake especially from the 1960s through early 1970s, and subsequently diminished in concert with reductions in phosphorus loads. Because of eutrophication, hypolimnetic waters over large areas of central lake were depleted in oxygen during the summer and early fall, causing Mn (and presumably ^{210}Pb) to dissolve from surface sediments. Subsequent mixing and re-oxygenation of the water column re-precipitated Mn that then was transported to the eastern basin and delivered to sediments. A quantitative model linearly coupling concentrations of excess ^{210}Pb and Mn produces excellent ^{210}Pb profile fits yielding accumulation rates consistent with those from ^{137}Cs. The Lake Erie case exemplifies the failure of mapping schemes, such as CRS, whose validity depends on a constant rate of supply of ^{210}Pb. Since mapping schemes do not yield model profiles for comparison with data, faults in derived age-depth relations may go unrecognized.