

SEDIMENTARY PHOSPHORUS CYCLING IN TOMALES BAY, CALIFORNIA

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

OCEANOGRAPHY

AUGUST 1994

By

Suzanna Vink

Dissertation Committee:

Stephen V. Smith, Chairperson

Fred T. Mackenzie

Marlin J. Atkinson

Francis J. Sansone

James T. Hollibaugh

Brian N. Popp

ABSTRACT

Cycling of phosphorus deposited in sediments and associated with suspended sediments delivered to Tomales Bay, California, was investigated in order to determine the mechanisms controlling exchange of phosphorus between these solid phases and the water column. Phosphorus exchanged from suspended sediments transported from Lagunitas Creek into the bay during a storm event in March 1991 did not result in a significant input of phosphate to the bay water column. Laboratory experiments, using suspended particles collected during this storm, showed that phosphate was not released from these particles in response to increased salinity. These particles did, however, have a high capacity to buffer the phosphate concentration of solutions in which they were suspended by both adsorbing and desorbing phosphate. The generally higher phosphate concentrations in "inner" Tomales Bay compared with Lagunitas Creek may in fact promote adsorption rather than desorption of phosphate from suspended sediments delivered to the bay from the creek.

The porewaters of cores collected from two sites in the bay were depleted in phosphate relative to ammonium and DIC released stoichiometrically from organic matter decomposition. Results from sequential extraction of these sediments showed that phosphate is removed from the porewaters by adsorption. Bioturbation and the relatively refractory nature of the organic matter deposited to these sediments promotes suboxic degradation reactions, in particular iron and manganese reduction.

While these reactions do not account for a high percentage of the organic matter remineralised in these sediments, these reactions are important in recycling iron and manganese oxides within the sediments, thereby providing fresh adsorption sites deep within the sediments. Burial of this adsorbed/exchangeable phosphorus phase was a sink for approximately 15 % of the phosphate released from organic matter decomposition. An additional sink of phosphate released to the porewaters from organic matter decomposition remains to be identified. This sink may be either authigenic precipitation of carbonate fluorapatite, or incorporation into metal oxides.

The net flux of phosphate from the sediments to the overlying water column is principally supported by organic matter decomposition occurring in the upper few centimeters of sediments. Additionally throughout most of the year, the rate of organic matter decomposition in the surface sediments is sufficient to overwhelm the capacity of the sediments to buffer porewater phosphate concentrations. Consequently, removal of porewater phosphate by adsorption does not greatly influence the net benthic phosphate flux.