

TRACE METALS: INPUTS, SEDIMENTATION AND ACCUMULATION IN SAN VICENTE BAY, CHILE

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Abstract. The present study deals with sediment dynamics affecting sediment-associated metal distributions in an embayment system experiencing pollution from coastal industries. Sedimentary metal content may originate from diagenetic processes of foundation rock on the bottom, allochthonous minerals from natural sources, and metals from industrial effluents along the coast. The study presents experimental estimations of quantities of metals entering the bay in industrial wastewater, measurements of metal content in particulate material captured in sediment traps, and metals distribution in surface sediments. Quantitative estimations of metals entering the system in industrial effluent showed the relation $Pb \geq Zn > Cu > Cr \geq Ni > Cd$. That of metals associated with particulate material from traps was $Zn > Cr \approx Cu \geq Pb > Ni > Cd$ and the abundance of metals in sediments was $Zn > Cr > Cu > Pb > Ni > Cd$. Finally, rates of bottom sediment accumulation are estimated in relation to the time of residence of water in the bay. The experimental data on sedimentation and sediment abundance were consistent with field observations on distribution and accumulation at sites of major sedimentation in this bay.

Keywords: coastal zone, embayments, pollution, sediment traps, trace metals

1. Introduction

Metal distribution patterns in sediments are often related to the sedimentation of particulate matter in coastal embayments. Dissolved metals may arrive in rivers or in industrial effluents, and may adsorb on particulate organic materials or form inorganic complexes at the fresh/salt water interface (Förstner *et al.*, 1978). The coastal zone receives large quantities of metals produced by natural leaching processes on continents, as well as metals from industrial residues produced by human activity. The concentration of this fraction depends on the reactivities of the metals, chemical characteristics of the matrix, and presence of reactive substrates in receiving waters. A complex set of chemical equilibria govern the presence of metals in the water column, as well as physical-chemical processes of adsorption of metals to inorganic and organic materials, which may become sedimented in certain regions of a bay. The dynamics and behavior of metals in water and their transfer to other matrixes need to be studied in order to understand the fate of these elements in

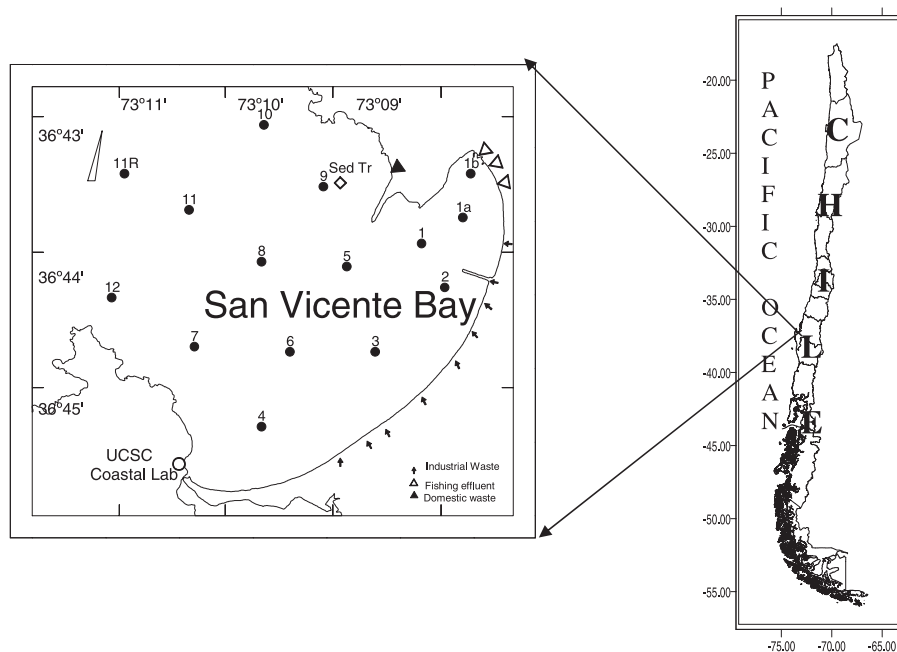


Figure 1. Map of San Vicente Bay, showing approximate locations of waste outfalls (arrows) hydrographic stations and placement location of the sediment trap.

the ocean, and produce some understanding of local metal-enrichment of bottom sediments. Movement of metals from a dissolved state to a particulate state occurs when the metals interact with organic and inorganic particulates (Salomon and Förstner, 1984; Emerson *et al.*, 1983; Krungal, 1989). This transformation is important in the distribution and routes of metals in the coastal zone. Metals normally enter seawater as cations, and may react with elements or compounds present to form inorganic complexes. The chlorides, carbonates and sulfates are the more important anions in this respect, and depending on the metal, may produce insoluble compounds or complexes (Buffle, 1988).

These reactions require a combination of the metal having a coordination number greater than unity, and a multidentate ligand, which may be an organic compound with numerous functional reactive groups. In order for the reaction to occur, the concentration of free ligands (chelating agents) must be much higher than that of the trace metals (Stumm and Morgan, 1981; Morel, 1983).

This paper presents experimental data on rates of sedimentation of metals in San Vicente Bay, Chile, in order to determine the relation between amounts and types of metals entering the system from industrial sources and the rate and distribution of their deposition into the bottom sediments.