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Record of Heavy Metal Pollution on the Bilbao Estuary, Northern Spain

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Although the Bilbao estuary was originally the most extensive estuarine area of the Spanish Cantabrian coast, its natural features have been dramatically modified by human activities. The exploitation of local iron ores led to the industrial and urban development of the surrounding area, and land reclamation during the last 150 years turned it into a largely artificial tidal channel. Huge amounts of polluted effluents have been directly wasted into the estuary, and previous works have pointed out its extremely high level of environmental degradation (see Cearreta et al., 2000, and references cited therein). However, until now little work has been done about the sedimentary record of anthropogenic impact. The main aims of this study are to examine the history of heavy metal pollution in the Bilbao estuary and to provide a preliminary view of the magnitude of the contaminated deposits. The obtained data may be also useful to assess the success of recent effluent clean-up procedures and environmental remediation measures taken by local authorities. Six sediment cores (from 6 to 10 metres length) were collected in the unconsolidated intertidal materials from the Bilbao estuary on January 2000. All geochemical analysis were carried out by X-ray fluorescence (XRF) using an automated Philips PW1480 wavelength dispersive spectrometer. Sediments consisted mainly of dark silty muds and sands. Molluscan estuarine shells, fragments of wood, iron minerals and anthropogenic components such as foundry slags have been identified in some samples. No attempt has been made to normalise data with respect to a selected element, in order to compensate for granulometric variations (Ackermann, 1980), due to uncertainties in metal associations. Thickness of the mantle of contaminated sediments seem to be quite variable throughout the estuary. Three of the studied cores (10, 10 and 8 metres depth) exhibit elevated contents of Zn, Pb and Cu even in deep samples (maximum values: 3360 mg/kg Zn, 1595 mg/kg Pb, 740 mg/kg Cu and 713 mg/kg As). Despite enhanced concentrations of Ni (max. 133 mg/kg) and Cr (max. 298 mg/kg) have been found in uppercore sediments, in bottom sediments they fall into near constant values. Thus, the anthropogenic inputs of both metals appear to be more recent. Samples collected downstream local mines are enriched in iron (max. 31.4% Fe_2O_3), while those collected near a large TiO_2 processing plant are enriched in this element (max. 3.0%). The rest of the cores (7.5, 6 and 6 metres depth) exhibit the following pattern: high concentrations of heavy metals and As in the upper part (1-1.5 metres thick) and low contents in deeper sediments. Maximum concentrations are: 1880 mg/kg Zn, 793 mg/kg Pb, 655 mg/kg Cu, 950 mg/kg As, 617 mg/kg Cr and 106mg/kg Ni. The occurrence of these relatively small volumes of contaminated sediments is more likely related to the continuous dredging carried out to maintain a navigation channel. On the other hand, Sáiz-Salinas et al. (1996) suggested the precipitation of insoluble sulphides (favoured by the anoxic conditions prevailing even in surface sediments) as a suitable mechanism for the retention of metals in this estuary. However, no positive correlation has been found between S and heavy metals in the studied cores. Sediments from the Bilbao estuary reflect a long lasting history of pollution. During the last decades implementation of environmental policies, improvement of clean-up procedures and the industrial recession, have led to a decrease in the flux of contaminants to the estuary. In some cases heavily polluted materials are covered by "cleaner" sediments, which seem to "mask" to some extent the real magnitude of this environmental problem.

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