

Assessment of metal contamination using Cu/Zn Ratio in offshore surficial sediment: A case study of Ulsan, South Korea

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To assess heavy metal contamination and its spatial distribution in offshore Ulsan, South Korea, where a large industrial complex is located, surface sediments were analyzed for major elements (Al, Fe, Ca, Mg, Ti, and Mn) and trace elements (Li, V, Cr, Co, Ni, Cu, Zn, Mo, Cd, Sn, Sb, Cs, and Pb). Factor analysis classified the elements into three groups, among which Cu, Zn, Mo, Cd, Sn, Sb, and Pb were identified as contamination-related elements. These elements were found to be highly enriched near the port areas. The Cu/Zn ratio was calculated to evaluate the spatial extent of contamination, revealing high Cu/Zn ratios in two distinct areas of Ulsan. However, considering the enrichment patterns of other elements, the pollution sources in these two areas appear to be different. In Ulsan Port, antifouling paints from shipyards were identified as the primary source, whereas in Nam Sin Port, a non-ferrous metal industrial complexes located in the hinterland was considered the main contributor. The Cu/Zn ratio was found to be high inside the breakwater and rapidly decreased outside, suggesting that the breakwater effectively prevents the outward dispersion of heavy metals.