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Tracing Heavy Metal Pollution Sources in Coastal Sediments Using Pb Isotopes: Onsan port and Oewhang River

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In order to trace pollution sources in the Oewhang River estuary sediments, which are known to be contaminated with heavy metals, we employed metal concentration mapping, contamination assessment, statistical analysis, and heavy metal isotope analysis. Total 50 surface and 1 core sediments were collected in 2024 and analyzed for TOC, grain size, metal concentrations, and Pb isotope ratios.

The contamination assessment using SQG in MOF indicated that Cu, Zn, Pb, and Cd exceeded the PELs as much as 20%, 76%, 26%, and 8% of the sediments, respectively. These metals exhibited a strong positive correlation with Pb.

PMF model clearly distinguished two groups of metals (natural & polluted) and of regions (Onsan Port and the Oewhang River estuary). Onsan Port sediments exhibited highly enriched metal concentrations (Cu, Zn, Cd, Pb), indicating that Onsan Port is a major pollution source.

Pb isotope analysis revealed distinct mixing patterns between Onsan Port and the Oewhang River estuary; Onsan Port sediments showed a mixing relationship between an anthropogenic endmember with 0.8704~8792 for $^{207}Pb/^{206}Pb$ ratio and offshore sediments ($^{207}Pb/^{206}Pb$ 0.8806), on the meanwhile, the Oewhang River estuary sediments showed a mixing relationship between offshore and background sediments ($^{207}Pb/^{206}Pb$ 0.8441).

The Pb isotope ratios in anthropogenic endmember in the Oewhang River estuary was changed significantly between 2011 ($^{207}Pb/^{206}Pb$ 0.8958) and 2024 ($^{207}Pb/^{206}Pb$ 0.8798), suggesting a shift in pollution sources over time reflecting the change of import country from Australia in the past (2006–2010), but from Peru (2018–2022). Therefore, it might be suggested that Pb was released during cargo treatment as well as smelting processes, accumulating in the sediments within Onsan Port as well as estuarine sediments, respectively.