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Integrated Protocols for Monitoring the Impacts of Landfill-Derived Leachates in Intertidal Environments

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We present the results of an interdisciplinary study that aims to elucidate the fluxes and impacts of metal leachates from a landfill site (scrap metal) into a small estuary in Northern Ireland, with a view to developing protocols that will have applicability in other regions, and will inform landfill design and location. We employ a novel methodology that combines ICP-MS (Inductively Coupled Plasma Mass Spectrometry) analysis of intertidal sediments, ITRAX-based sediment core analysis and the examination of an important group of shelled protozoans (foraminifera) that occur widely in estuarine environments and are highly sensitive to metal contamination.

Surface sediment samples (n=90) were collected at varying distances from the contaminated site in different morpho-sedimentary settings and subject to ICP-MS, particle size, loss-on-ignition and foraminiferal analysis. The impact of 28 measured variables on the foraminiferal faunas was considered, including 20 metals, pH, conductivity, elevation and other sediment-related variables. Channel sediments in close proximity to the contaminated site with the highest levels of Fe, Cu, Zn, Mg and As, yielded the sparsest faunas, whilst the highest prevalence of foraminiferids showing chamber deformities (*Figure 1*) were observed in channel edge and levée sites. Kernal density plots showing metal loading and foraminiferal concentrations with distance from the site aided in determining spatial trends. Sediment core data further revealed that deformed foraminiferal specimens can extend >15 cm below the surface to horizons that pre-date the historical onset of the contamination, indicating vertical mobilisation of leachates. Etching of the foraminiferal tests, probably in association with reduced pH conditions, was also observed.

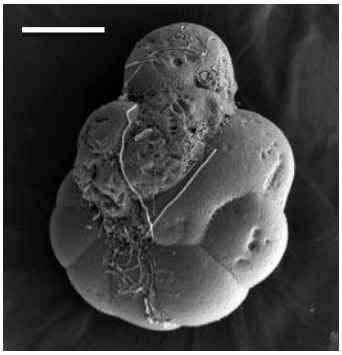

Figure 1. Deformed foraminiferid showing chamber abnormalities – a response to metal contamination (scale bar = 100 μm).

The results of this study indicate that the adoption of integrated methodologies that combine established geochemical techniques (e.g. ICP-MS) with the ecophenotypic response of key indicator groups such as foraminifera can provide invaluable insights into habitat responses to leachates and also

shed light on the stability of landfill sites in supratidal environments. Such habitat evaluation data are invaluable for prioritising management and remediation efforts.