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Radiotracer Methods for Understanding Contaminant Dynamics in Aquatic Environments

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Radioactive tracers have a distinct advantage in tracing contaminant migration in natural systems and characterising contaminant mobility and uptake into living organisms in already-contaminated environments or at trace (environmental) levels. To use the contaminant itself in its non-radioactive form, concentrations significantly higher than the normal contaminated background level are commonly required which may be undesirable from a toxicological, chemical or regulatory perspective by impacting on the very processes under study. In contrast, radioactive forms of the contaminant can often be more easily measured (often in-situ or non-destructively) and imaged at trace levels (using autoradiography), and usually have the advantage of a short half-life to remove residual contaminant. As such radiotracers have a valuable role to play in contaminant dynamics studies from the lab scale to the field. In the lab, radiotracers are well established in studies of contaminant kinetics and bio-distribution in living organisms, in interactions with non-living natural environments e.g. sorption to soils and sediment, rocks and organics matter, and in tracing contaminant flow pathways and rates.

Radioisotopes of heavy metal contaminants (e.g. Cd, As, Se, Zn, Pb, Hg), nutrients (P, C) and the shorter-lived isotopes of longer lived radioactive contaminants such as Cs and Sr are commonly used in environmental contaminant studies. Recently, there is increasing interest and benefit in using radiotracer versions of emerging environmental contaminants such as persistent organic compounds or nano-particles.

While most radiotracer work is conducted in laboratories, this approach can be up-scaled to field environments. There are obvious scientific benefits of conducting studies in situ, where the tracer interacts with the complex natural environment rather than an artificially simplified laboratory representation. However there are few examples where this has been done. Since the first field scale uses of radiotracer in the mid-1950s, the majority of field scale radiotracer applications have been in the nexus between industry and environment – sediment transport in harbours and dams, effluent dispersion from outfalls and in mining and oil extraction. Exceptions include whole ecosystem studies in the Canadian Experimental Lakes in the 1970s, heavy metals downstream of a uranium mine in Kakadu NP in Australia, and studies demonstrating the retardation of metals and nutrients in studies in Sweden. Increasingly public and regulatory concern about the potential impact and perception of radiotracing in field environments has made these methods appear largely inaccessible to the research community. However, the introduction of new biota dose modelling tools and guidelines over the past two decades has provided improved evaluation of the environmental impact of radiotracer releases to the environment and ensure and demonstrate their safe use.

Country/Organization invited to participate

Australia

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