Transport and accumulation of stable metals and radionuclides in Loch Etive and Anglesey

H. AL-QASMI[1*], G. T. W. LAW[1], L. K. FIFIELD[2], N. D. BRYAN[3] AND F. R. LIVENS[1]

[1]Centre for Radiochemistry Research, School of Chemistry, The University of Manchester, Manchester, UK (*correspondence: hamza.al-qasmi@manchester.ac.uk)

[2]Department of Nuclear Physics, Research School of Physics and Engineering, The Australian National University, Canberra, Australia

[3]National Nuclear Laboratory, Warrington, UK

The Sellafield nuclear fuel reprocessing plant in northwest England is the dominant source of anthropogenic radioactivity to the Irish Sea. Permitted discharges of a complex mixture of radionuclides from Sellafield to the Irish Sea in low level effluents have occurred since 1951. These discharges have changed considerably from 1951 until present, with a maximum in the mid-1970s and a significant decline thereafter. A proportion of the historical discharges has been retained in offshore sediments which act as a long-term secondary source of soluble and particle associated artificial radionuclides. Natural uranium is, in general, soluble in seawater and any uranium released from Sellafield to the environment is diluted with the natural uranium background and historical, non-nuclear discharges. However, ^{236}U ($t_{1/2}$ 2.3 x 10^7 years) is a unique marker for irradiated, and hence Sellafield-derived, uranium and could be used as a tracer to study its transport and accumulation.

This study investigates the transport and accumulation of radionuclides and stable metals and any connections between them in two sites: Loch Etive and Anglesey, north and south of Sellafield respectively. Particle-reactive radionuclide profiles (Pu and Am) were approximately uniform in the Loch Etive sediment cores suggesting a homogeneous secondary source of Sellafield-derived radionuclides, whereas Cs, less particle-reactive, shows a peak reflecting the Sellafield historical maximum discharges and hence solution input. By contrast, Pu and Am in the Afon Goch core in Anglesey show peaks responding to the historical maximum discharges from Sellafield with a lag time of about 10 years with a similar behaviour of Cs and that may suggests more important particulate input of Cs in this core. The anthropogenic ^{236}U shows a clear response to the redox chemistry at both sites. The ^{236}U data in Anglesey also show how ^{236}U could be used as a signature of Sellafield releases of uranium.