SEAES Molecular Environmental Science Research
Summary Report 2009 -2012

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Developments. The “Molecular Environmental Science” research group hosted in the Williamson Research Centre for Molecular Environmental Science (WRC) is the combination of the Mineral Physics and Geochemistry/Geomicrobiology research groups, highly rated in RAE2008, The new grouping now includes 9 academics, although 3 of the 9 are recent appointments in Nuclear Environmental Science (Prof Kath Morris, 2010) and Environmental Mineralogy (Dr Sam Shaw, 2012 and Dr Vicky Coker, 2013). The Research Centre for Radwaste and Decommissioning, supported by 1.4M BNFL endowment funding, and sharing many of the WRC’s facilities, was launched in 2011 providing focus and leadership in addressing the UK’s multi-billion pound nuclear waste disposal issues. New Radionuclide Biogeochemistry laboratories were commissioned in 2011 and new laboratory space for molecular ecology and geomicrobiology scale-up facilities have been opened. This suite of facilities is unique in the UK. Molecular Environmental Science Group members are at the cutting edge of developments at the Diamond Light Source with involvement in XAS, STXM, SANS-WAXS, nanoprobe beamline working groups. Since 2010 members of the group have been in active dialog with DIAMOND scientists to ensure analysis of radioactive materials at DIAMOND. There is an increasing use of environmental genomic, post-genomic and synthetic biology tools with FLS and Manchester’s Institute of Biotechnology, while bionanotechnology research has moved to the scale-up phase with several industrial partners.

Publication of over 150 peer reviewed Journal papers which record:

- Major advances in bionanotechnology with the controlled microbial synthesis of doped nanoscale magnets, catalysts and quantum dots (Highlights ALS, DLS (x2) and BBSRC Business).
- The highly acclaimed breakthrough in our understanding of the form and functionality of some key ‘evolutionary’ fossils such as Archaeopteryx, using synchrotron radiation and chemical proxies (published in Science and Nature Communications; La Recherche top 10 scientific discoveries 2012).
- Pioneering work on the microbial redox cycling of radionuclides including U, Pu, Tc and the first studies on the full redox cycling of Np (studied using XAS). New studies of highly radioactive environments e.g. Sellafield nuclear storage ponds and contaminated land, and also geodisposal scenarios (NERC Planet Earth, NDA Insight highlights
- World-leading geomicrobiological studies elucidating the mechanisms and impact of intracellular and extracellular electron transfer in freshwater and marine anaerobic metal-reducing bacteria using a unique combination of synchrotron, molecular ecology and post-genomic tools.
- Pioneering research, on the climate warming induced release of ‘old’ carbon across the Siberian Arctic; the first study on the fate of carbon in permafrost deposits in the Arctic region (Nature).
- World leading advances in characterising and determining the role of organics in controlling arsenic mobility in major aquifers in Asia and contribution and establishing rice as a major exposure route for arsenic in both Asia and the EU (Nature Geoscience, Pour La Science).
**Funding:** Over **£12M** worth of Research funding has been acquired/deployed in the past 3 years (£14M inclusive of internal funding) and the Research staff/PGR population has expanded from 20 to 45. Major funding streams include:

- The £3.5M NERC BIGRAD and part of the £1.1M AMASS consortia focussing on Radwaste disposal.
- The £1M+ EPSRC/BBSRC/EU funding on bioengineered nanomaterials
- Involvement in major EU networks including ERC’s FIMIN, BIOTRACS (2.2M euros), NanoRem (12M Euros) and leading the 3.5M euro Marie Curie ES&T “Aquatrain” programme and 0.7M EURO EU ASIA-LINK CALIBRE programmes
- £2M recent NERC funding including (2012) success in Nano-scale imaging; NIMMI (£540K), predicting arsenic groundwater contamination (£630K) and preserving fossil pigmentation (£630k)

![NERC](image1.png) ![EPSRC](image2.png) ![Europe](image3.png)

**Synchrotron Radiation Science:** The group’s members continue to undertake pioneering work using light sources worldwide and over 895 shifts of peer reviewed beamtime since 2009 (equivalent value of **£2.95M**) has been won at the ALS, APS, CLS, SLS, SSRL, Max Lab., INL- ANKA, ESRF and the Diamond Light Source. They have applied and developed magnetic spectroscopy to study novel nanomaterials, XAS/XRF mapping to determine metal distribution ‘world class’ fossils, XAS to determine radionuclide speciation across a range of environmental systems and to explore toxic metal behaviour including pioneering work on As biogeochemical speciation.

**Impact and influence:** In the last 3 years, Group members have held or currently hold the following awards/posts: A Royal Society Industrial Fellowship with National Nuclear Labs, Blaustein Professorship (Stanford), President of the Mineralogical Society of GB and Ireland, Royal Society L’Oreal Women in Science Fellowship, Diamond Science Advisory Committee, Diamond Beamline WGs (x5 - 2x Chair), ESRF peer review, CLS Peer review (x2), NERC-Peer review college (x3), NERC post genomics steering Group, NERC Life Sciences Mass Spectrometry Facility SG, NERC Arctic Round WG, NERC Environmental Radioactivity SG, Nuclear Decommissioning Authority Radioactive Waste Management Directorate Advisory Positions(x3), Member of Government Committee on Radioactive Waste Management and Nuclear Research and Development Advisory Board (FRL). The group undertake a number of outreach activities including at the Royal Society Summer Exhibition 2012, the molecular palaeontological research was presented in the display “Palimpsests, Palaeontology, and Particle Physics”. The interface of the group with industry is via the Nuclear Industry, involvement in increasingly important roles in nuclear waste management, by a number of KT grants, and funding for scale up in biotechnology. Emeritus Professor David Vaughan is the 2014 president of the American Mineralogical Society (the most prestigious in the World – only the second non-North American)

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