

Impact template (REF3a)

Institution: Royal Holloway, University of London
Unit of Assessment: Earth Systems and Environmental Sciences
a. Context <p>Society faces enormous challenges in needing to exploit earth resources while safeguarding our environment. The Earth Sciences department is unusual in its strong focus on energy discovery while simultaneously addressing the environmental impacts of our economy.</p> <p>For the Earth Sciences department, impact is a natural outcome of research collaborations with both the industrial and manufacturing sectors as well as from our blue-skies research projects. Impacts are delivered from research projects across the breadth of the departmental expertise. The Department aims to conduct research of the highest quality whilst at the same time identifying, taking advantage of, and developing opportunities for impact that arise from our research. The main beneficiaries are the resource industries and analytical equipment manufacturers, whilst recent environmental research has provided a substantial financial bonus for the Treasury. Our research has provided (1) economic impacts through enhanced exploration and development of established and frontier basins and fields, the provision of consultancy, the training of industry personnel, and the development of new analytical equipment and methodologies with technology companies; (2) environmental health impacts through a wide range of geochemical analysis and advice including development of techniques for analysis of depleted uranium following the Gulf War and concerns that veterans were adversely affected, water quality, quantifying the Elgin gas leak, assessment of landfill leachates and pollution from old mines; and (3) influence on public policy with advice to policymakers at national and EU level regarding greenhouse gas emissions and depleted uranium.</p>
b. Approach to impact <p>Since the Department of Earth Sciences was established in 1985 a key part of our impact strategy has been to develop and nurture links with industry and commerce. Staff are strongly encouraged and supported in their pursuit of partnerships and the identification of mutually beneficial research programs.</p> <p>The Department has very close, long-standing partnerships with the international oil, gas and mining industries, resulting from our research profile and our role as one of Europe's leading graduate training centres for oil and gas discovery. Many major and junior companies turn to us for solutions, for example through the large commercially supported SE Asia and Structural Analogues for Reservoirs (STAR) Consortia. Projects, such as modelling in petroleum frontier areas, have brought many strong economic impacts for the UK and the international oil and gas sector. In parallel with research in the resource sector, the Department's environmental strengths include world-class leadership in geochemistry, palaeoclimate and greenhouse gas analysis which has led to significant impacts. Our analytical research strengths have led to close relationships with instrument manufacturers and the development of novel instrumentation and techniques with them.</p> <p>External non-academic collaborators and advisors play important roles in much of the research undertaken by the Earth Sciences Department. We make full use of external contacts (from multinationals, nationals and SMEs) to ensure we continue to pursue science of direct benefit and relevance to industry and commerce. Our Industry Advisory Board meets 3-4 times a year at Royal Holloway to provide advice on our research projects and developments and on our teaching deliverables. The efficacy of our approach is particularly apparent through our Petroleum MSc alumni body, now numbering over 500 and holding positions of influence throughout the international petroleum industry.</p> <p>Whenever appropriate, initial scoping projects from industry are offered as MSc projects as a test-bed of their viability. Those projects with the most research and/or impact potential can be developed fully within the research groups and PhD projects offered with industry. This template perfected over decades, has enhanced the impact of our research in both the natural resource and manufacturing sectors. In the case of petroleum companies it has spawned several Consortia which we have established and managed over two decades. The Fault Dynamics Research Group's Structural Analogues for Reservoirs (STAR) modelling consortia under McClay (one of our case studies) and the South East Asia Research Group under Hall have very wide international</p>

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recognition. Research and development partnerships with analytical equipment manufacturers have also been part of our impact portfolio since 1985 as is illustrated by the recent pioneering development of a new LA-ICPMS prototype under Müller (case study).

Staffing – Royal Holloway has impact formally embedded in the staffing policies, formally classifying the criteria for the appointment and promotion of academic staff under four headings: ‘*Research*’, ‘*Teaching*’, ‘*External Engagement & Impact*’ and ‘*Leadership & Enhancement*’. Impact from research is an important factor in the institutional and departmental expectations of our academic staff starting from first appointment. Our high-impact research has benefitted from strategic staff appointments made during the REF period (*Burgess, Gudmundsson, Hernandez-Molina, Le Heron, Morgan, Pérez-Gussinyé*).

Workload - Support for academic staff who are setting up new consortia/partnerships is provided by the Department through reduced teaching/administrative duties. Industrial sabbaticals are encouraged (e.g. Waltham’s sabbatical with Midland Valley Exploration Ltd. which led to turbidity-current commercial software, detailed in our third case study). To ensure the longevity of major industry consortia and to help spread the workload, we encourage collaborative research projects that involve several academic staff as co-supervisors. This helps maintain research productivity, delivery to sponsors and research momentum during staff sabbaticals thus maximising probability of societal impact.

Infrastructure – Royal Holloway facilitates and encourages greater industrial collaboration in the Department through the provision of posts for early career researchers to release senior staff for industrial and commercial collaboration (e.g. *Watkinson 2011 for McClay; Manning 2010 for Thirlwall*). Institutional support for launching research projects with industry/external agencies, for commercialising research findings, for Knowledge Transfer and for IP is provided through the Research and Enterprise (R&E) office. Specialist R&E Business and Development Managers provide legal and financial advice, negotiate agreements, contracts and partnerships, assist in knowledge transfer, and in securing funding for commercialization and licensing. Institutional policy on IP and consultancy encourages innovation by ensuring that the bulk of any income goes to the PI to support further research. Bringing our research to the attention of the public is facilitated by the Communications and External Relations Office and the Science Outreach Officer through the media and events such as the annual Science Festival which brings several thousand visitors each year.

Throughout the REF period Royal Holloway has invested in our analytical infrastructure, in particular fully funding the new generation LA-ICPMS (£370k) and supporting the UCL-Royal Holloway joint venture purchase of a new thermal ionisation mass spectrometer TIMS (£300k). Other major investments in environmental/climate research include the sea-ice simulator laboratory (£140k) and atmospheric monitoring equipment (£171k) both at the heart of major NERC research programs active through 2014 and delivering impact. Very significant enhancement and refurbishment of the *analogue modelling labs* and the stable isotope labs was undertaken during the REF period and will secure and ensure the success of present and planned industry-funded projects.

In addition to our submitted case studies, the success of our impact approach can be gauged from the very large number of current projects with past, present or future societal impact potential:

1. The SE Asia Research Group has for 20 years provided geological field data, models and interpretation, all of which have been made available to sponsoring partners in the hydrocarbon industry, and have resulted in exploration of unexplored parts of SE Asia (*Hall*).
2. The atmospheric group in conjunction with NERC and TOTAL responded to the Elgin Platform gas leak in 2012 by sampling and analysing the gas plume leading to savings of ca. £1bn savings for the UK government/HMRC (*Nisbet, Lowry, Fisher*).
3. The geochemistry group in collaboration with the MoD and NERC Keyworth (*Parrish*) developed & standardised high precision technique for the measurement of depleted uranium (*DU*) in Gulf War Veterans. This illustrated our ability to react to new opportunities with clear societal relevance and impact (*Thirlwall*).
4. Our European greenhouse gas group has extended the measurement of methane (*CH₄*) in the London basin to the Atlantic Ocean and South China Sea (*Nisbet & Lowry*).

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5. Global climate records have benefitted from calibration of climate records in the Mediterranean from the analysis of speleothems (*Mattey*) and calibration of remote sensing platforms using data from Antarctica (*King*).

c. Strategy and plans

The core impact strategy in Earth Science involves:

- a) Growth of a “mixed-economy” funding base by encouraging and supporting both industrial collaborations and RCUK/government/charity/EU funding.
- b) Strategic staff recruitment with an emphasis on practical experience in both teaching and research in applied subjects.
- c) Nurturing of industrial partnerships (e.g. through our Industrial Advisory Panel) to provide feedback, advice and funding for high-impact research.
- d) Encouraging staff to expect impact to be a consequence of applied and blue-skies research.
- e) Our identification of potential impacts, with the appointment of a departmental impact officer who holds regular one-to-one meetings with all research active staff to discuss exploitation of current and recent research.

Much of our research has benefitted from several decades of industry funding and this will continue into the future. We have fully-funded research projects in the oil and gas sector on analogue modelling (*McClay*), south-east Asian geology (*Hall*), Precambrian petroleum (*Le Heron, Vining*), stratigraphic modelling (*Burgess, Waltham*), West-Asian geology (*Nichols, Burgess, Gudmundsson*), deepwater sedimentation/contourites (*Hernandez-Molina*), microbial carbonates (*Burgess, Bosence*) and geodynamics (*Pérez-Gussinyé, Adam, Burgess, Morgan*).

RCUK and EU funding also underpins research with potentially high societal relevance and impact. For example, in Global Environmental Change, with NERC funding, we have pioneered (a) long-term atmospheric monitoring/modelling (*Nisbet, King*); (b) calibration of climate records (*Mattey*); and (c) expansion of volcanic ash footprints using crypto-tephras (*Menzies*).

Our “mixed economy” of industrial, RCUK and EU funding allows pursuit of excellence in science across our discipline and our departmental and institutional policies and practices aim to facilitate and encourage the delivery of impact from our research.

d. Relationship to case studies

Our approach to research involves close liaison with industry and users thus maximising the potential to involve ourselves in high impact science. With the oil and gas industry we keep our “finger on the pulse” of new frontier requirements and how our research plans and skills can provide solutions. The Fault Dynamics Research Group has been funded from multi-million pound research consortia and in turn the oil and gas company partners have benefitted from targeted research programs that informed their exploration practises, reduced exploration costs and increased revenue. Research at the frontier of analytical geochemistry benefits both the Department’s research ambitions in environmental proxies and the aims of commercial partners. A viable product is “tried and tested” in an academic environment through peer-reviewed articles.

The chosen case studies demonstrate the success of our approach to impact:

- **Hydrocarbon Reservoirs** - “...pivotal to British Petroleum’s subsurface developments...” (*Humphries, bp, 2012*). McClay’s Fault Dynamics research resulted in a \$600M work program for bp illustrating our strong links to industry and our maintenance of long-term, commercially relevant research funded by large industrial consortia.
- **Laser-ablation system** - Müller arriving at Royal Holloway in 2006 initiated a novel R&D programme bringing together for the first time two global partners. Based on his in-house innovative design a new commercial product line was tested and validated and taken forward for manufacture.
- **Turbidity Currents** – Waltham’s software commercialization with Midland Valley Ltd. was greatly facilitated by the Department’s long-term association with the company and his sabbatical with them.