Institution: Newcastle University

Unit of Assessment: 7 Earth Systems and Environmental Science

a. Context

There are three research groups submitted under UoA7: **Geochemistry**, **Biotechnology** and **Biodiversity**. In **Geochemistry** and **Biotechnology** we ensure our research has impact through extensive ***industrial collaboration*** and in **Biodiversity** impact is achieved via ***policy development.*** Newcastle research has introduced new exploration and production practices in the oil industry, resulted in successful spin-out companies, and in the development of policies and guidance for managing sensitive ecosystems. The beneficiaries and the nature of impact from the research are outlined below with details provided in sections (b), (c) and REF3b.

1. **Geochemistry**
   Beneficiaries. The ***energy and mineral resource industries***
   Type of Impact: New approaches for intelligent exploitation of heavy oil resources and oil shales, prediction of reservoir seal integrity, fluid flow prediction, source rock prediction, clay mineral processing and carbon capture strategies. These have been adopted by industry and led to substantial financial savings across the petroleum sector with substantial economic impact (ICS 1 and 2). A successful spin out company (Gushor Inc.) arose from this research and was recently acquired by Schlumberger (ICS 1).
2. **Biotechnology**
   Beneficiaries. *SMEs and large pharmaceutical companies, specialist coatings sector*.
   Type of Impact: Several novel bioactive compounds from organisms we have discovered are being developed with commercial partners. Two successful spin-out companies were founded by our researchers (Demuris Ltd. and Geneius Ltd.). Our research on biofouling and adhesion underpin the development of new nontoxic antifouling concepts, e.g. zwitterionic and amphiphilic surfaces and the use of carbon nanotubes in silicone coatings (e.g. BIOCYL™ marketed by Nanocyl SA).
3. **Biodiversity**
   Beneficiaries. *UK and international government agencies*, *NGOs, local conservation organizations worldwide, industry.* The ***UK Parliament*** has used our research in policy development for implementation of marine conservation zones, and new knowledge of factors affecting coral reef recovery and restoration highlighted by our research has benefited the ***insurance and shipping industries*** (ICS 3).
   Type of Impact: Development of international best practice guidelines used worldwide by conservation groups involved in restoration of coral reefs (ICS 3). Provision of objective scientific evidence to inform compensation claims following ship groundings (ICS 3). We also provided evidence to aid implementation of the Marine and Coastal Access Act (2009) and we wrote the guidelines used for pheasant re-introduction schemes worldwide. Our research has therefore had an impact on policy decisions, changes to legislation and environmental management guidelines.

b. Approach to impact

Achieving impact from our research relies on engaged ***collaborative research with industry partners,*** related ***consultancy activities*** and close ***engagement with policymakers***. Developing these relationships and securing impact of our research has relied on four main approaches:

1. Bespoke industrial liaison activities. We build on individual industrial research collaborations by hosting industrial liaison events, either with representatives of individual companies or with a range of companies from a single sector. This introduces organizations to research that is relevant to their business and is used to leverage industry-focussed, and funded, research programmes. Prominent examples of the success of such an approach are the Bacchus (*Head, Jones and Larter*) and Caprocks (*Aplin* – Durham since 2013 and *Larter*) projects (see ICS 1 and 2). These were initiated from meetings of an industrial liaison group and led to 10 years research investment totalling almost £6M from two consortia incorporating most of the major international oil companies (**Bacchus**: Shell, BP, ConocoPhillips, Total, ENI-Agip, ExxonMobil, ChevronTexaco, Petrobras, Woodside, Anadarko, Statoil, Norsk Hydro, Total, Saudi Aramco; **Caprocks**: Agip, Amerada Hess, Amoco, Arco, BP, Chevron, Conoco, Elf, Enterprise, JNOC, Mobil, Norsk Hydro, Phillips, Statoil, BG, DBIS, ExxonMobil, BHP Billiton, Shell, Total, ConocoPhillips, Anadarko, ENI). The outputs

from this research have included new tools for well placement, tools for assessing reservoir seal integrity, software that has been widely adopted in the oil industry and a spin-out company that was recently bought by Schlumberger for an undisclosed sum (see ICS 1 and 2 for full details). We regularly host annual visits from industry colleagues, which have generated industrially funded research and consultancy projects, as well as training workshops on petroleum source rocks in Jordan (Shell; *Jones and Wagner*) and Colombia (Ecopetrol; *Jones and Wagner*).

2. Spin-out companies. Forming spin-out companies is a very direct way of generating impact from research and we have done this successfully. Our research has led to spin-out companies serving the heavy oil sector (Gushor Inc, www.gushor.com, ICS 1), bioprospecting (Demuris Ltd, http://www.demuris.co.uk, *Goodfellow and Stach*) and molecular diagnostics (Geneius - http://www.geneiuslabs.co.uk, *Stach*).

3. Research consultancy. We build upon our consultancy activity to develop more collaborative research relationships, and ultimately impact, in the form of new products and processes. This approach has been successful with our biofouling research, which was initiated through consultancy for International Paint Ltd. (AkzoNobel). Collaboration in this area has diversified (e.g. Procter & Gamble, Unilever, Fujifilm Diosynth, the Office of Naval Research (ONR); *Burgess and Clare*). This has attracted research awards exceeding £2.4M from stakeholders in the last decade and led to the development and marketing of novel antifouling coatings (e.g. BIOCYL™, Nanocyl SA). This route has worked successfully for our biodiscovery research too. The therapeutic properties of the novel bioactive compounds from our unique collection of *Actinobacteria* from around the globe are being evaluated through key collaborations with the pharmaceutical industry (Dow, Cubist, Croda, Servier; *Goodfellow and Stach*) and with our spin-out company, Demuris, established specifically to exploit this resource.

4. Publicly funded schemes. Taking research to market can be challenging and is greatly facilitated by publicly funded schemes including Knowledge Transfer Partnerships (KTPs) and RCUK and Technology Strategy Board (TSB) schemes. For example, we worked with the TSB to develop two of our spin-out companies (Geneius and Demuris; *Goodfellow and Stach*). Geneius, which provides advanced molecular diagnostic services, was founded in 2010 and now has 28 FTE staff. TSB, EU and ONR funding will allow us to advance new antifouling solutions (*Clare*) and bring our algal biofuels research to end user groups (NERC/TSB Algal Bioenergy Special Interest Group and the UK Algal Industry Bioscience KTN; *Caldwell*). We have used KTPs to develop new technology with a waste processing company (Graphite resources; *Gray*) and Defra's Animal Health and Veterinary Laboratories Agency (AHVLA; *Mill*). We collaborate with non-academic partners on RCUK-funded research programmes with over 30 industry partners signed up to current RCUK projects or CASE studentships (e.g. Shell, Chevron, Rawwater Engineering Ltd., WH Partnership, Northumbrian Water Ltd., AkzoNobel). We have also made use of the EPSRC/DTI Technology Programme to facilitate research with the minerals industry (Imerys Minerals Ltd) developing approaches to remove coloured impurities from clays destined for the paper industry, by bioleaching of iron (*Manning and Gray*).

5. Engagement with government departments and NGOs. A cornerstone of our approach to impact is active involvement with government departments and NGOs (e.g. as panel and committee members). This ensures that we are exposed to the latest thinking on significant policy priorities relevant to our research, and in a position to influence the agenda (See REF5 section e for details). This approach enabled us to influence the implementation of the Marine and Coastal Access Act (2009) (*Polunin*), make a central contribution to international guidelines for coral reef management (ICS 3; *Edwards*) and avian reintroduction schemes (*McGowan*). Engagement with local government was also instrumental in securing the headquarters for the Marine Management Organisation in Newcastle upon Tyne (*Stead*). This 2010 development not only guaranteed our continuing influence in marine policy development and implementation, but also secured 321 Civil Service jobs.

c. Strategy and plans

Our strategy of achieving impact through ***collaborative research*** and ***engagement with policy makers*** at a high level is working increasingly well. We will enhance and strengthen these approaches rather than implement a radical change of direction. Nevertheless we continue to seek new ways to ensure increased relevance and impact. We therefore plan the following:

1. **Strategy: *Improved coordination of our impact activities***
   Plan: The large and diverse constituency of stakeholders/partners with whom we engage

increasingly necessitates a co-ordinated approach. This will be implemented through the appointment of a new **Impact Officer** to coordinate Knowledge Exchange and Knowledge Transfer programmes; maintain web facilities for advertising and download of outputs; organize international, national and regional seminars and workshops to showcase our research to industry and policymakers; and maintain a database of partners and end-users. Through these activities the Impact Officer will increase opportunities for end-user engagement; increase effectiveness and efficiency of our current engagement activities; stimulate new synergies; and systematically record evidence of impact. The position will be part-funded through Pathways to Impact funding from our extensive portfolio of research grants.

2. **Strategy: *Focus research around societal challenges***
   Plan: Making our research outputs relevant to stakeholders is a fundamental requirement if we are to translate them to real impact. One way to achieve this is to identify societal challenges that can be tackled with the spread of expertise in our UoA. Sustainability is now a well-established grand challenge. The Newcastle Institute for Research on Sustainability (NIReS), our interdisciplinary institute, plays a key role in stakeholder engagement and has organized over 150 events to promote dialogue between academics, industry, government and policymakers relevant to UoA7 (e.g. visits from Fera Chief Scientist; DECC Assistant Director, Chair of the IUCN Species Survival Commission). We will extend this activity to maximize our collaborations across a wide range of public and private sector stakeholders. Several staff in the UoA are members of the newly formed Centre for Synthetic Biology and Bioexploitation (http://www.ncl.ac.uk/csbb/) which involves extensive stakeholder engagement for the development of user-focussed applications of the powerful tools that synthetic biology offers.
3. **Strategy: *Formalize relationships with stakeholders***
   Plan: Among other activities we are establishing The North Sea Strategic Partnership. A coalition between the universities of Newcastle, East Anglia, Hull, Cranfield, Durham and NaREC (National Renewable Energy Centre) and their network of industry partners. This will spearhead research, initially on the impact of offshore renewables and will forge joint research and development activities. It will use NERC's Marine Renewable Energy Knowledge Exchange Programme and target TSB Catapult funding to achieve end-user impact.
4. **Strategy: *Collaborate more effectively with regional and UK-wide SMEs***
   Plan: We have ambitious plans to catalyse more effective relationships between our researchers and end users. A flagship for this activity is ***Science Central***, a new urban quarter crucial to Newcastle's economic future and a hub for the scientific growth of the city. The University is investing £50M into its first facility on the Science Central site, housing key research alongside enterprise, business and the community. The facility will allow us to showcase our research, as well as interface face-to-face, with stakeholders. Our recently revamped Research and Enterprise Service (RES) is focused on facilitating research which meets the needs of commercial collaborators. RES operates an 'Innovation Fund' providing funding to pump prime collaboration between the University and UK SMEs.
5. **Strategy: *Embed impact in the development of the next generation of researchers***
   Plan: We are partners in the £5M IAPETUS NERC DTP in environmental and Earth science and in a bid for a NERC Oil and Gas CDT led by Heriot-Watt University. These involve > 30 industry, government department and NGO partners. We will work with them to develop the skills our students will require to translate research from the laboratory to application.

d. Relationship to case studies

ICS 1 Improved production from biodegraded heavy oil reservoirs: Exemplifies research funded by industrial research collaborators integrating fundamental and applied research strands in a single project to deliver both short term and long term game changing benefits to the industry.

ICS 2 Risk reduction in petroleum systems and pore pressure prediction: A second exemplar of industry-funded, integrated fundamental and applied research in a single project to deliver both short and long term benefits to industrial stakeholders.

ICS 3 Coral Reef restoration: Resulted from engagement with national and international bodies with leading roles in policy development via participation as panel members / chairs of such organizations. Further engagement with stakeholders undertaken to address specific needs. Led directly to the impact of our research through guidance on approaches to coral reef restoration.