Institution: University of Derby
Unit of Assessment: Earth Systems and Environmental Sciences (07)

a. Overview

Formed in late 2008, the Human and Physical Environments Research Group (HPERG) provides the intellectual home for research active staff drawn from the Department of Geographical, Earth and Environmental Sciences (GEES), while managing the structured co-ordination of research-related activities and distribution of university funding to targeted projects. The principal focus of the research group is that of climate change with a particular emphasis upon: **(1)** palaeoclimate change (dynamics, environmental and fluvial system responses over Plio-Quaternary timescales [**Johnson, Valentine, Jones, Banks, Fox** and **Pope**]); and **(2)** contemporary climate change in respect of: (i) the lived experience [**Abbott**]; (ii) glacial microbial activity and melt regimes [**Cook**] (iii) reworking of mine waste in dryland fluvial systems [**Pope**]; and (iv) impacts upon transport policies [**Stubbs**]) Expertise and interest therefore transcends both time (earlier Earth history through to present day) and space (from the poles down to low latitudes) and the University of Derby is therefore uniquely positioned to collaborate and contribute widely to cutting edge climate science. Furthermore, within the unit there is also a small group with a focus on the solid Earth with an interest in Crust and mantle dynamics (**Rollinson** and **Adetunji**). This coherent and sustainable pooling of research interests has stimulated the development of a strong research culture, which through supporting collaborative research and actively encouraging staff to disseminate research outputs via invited seminars, key notes and presentations at national and international conferences, and journal publications, has raised the external visibility of the HPERG.

b. Research Strategy

The HPERG's strategy is strongly aligned with the University Research Strategy which emphasizes the role that research plays in enriching the taught curriculum and stimulating new knowledge and understanding that brings economic, social, and cultural benefits to the region and beyond. The University did not submit Earth Systems Science to RAE2008, but supported by University research developments, the group put a strategy in place (2008-2013) to build research capacity and output for submission to REF 2014. The HPERG formed with the aim of developing a self-sustaining research culture based around small research groups developing national and international networks and engaging in collaborative research. The group's post-2008 approach has been to increase the visibility of research across the UoA through: **(1)** generating increased staff outputs and external activities; **(2)** increasing PGR student numbers; **(3)** securing external funding; and **(4)** developing an awareness of impact and support for staff looking to enhance this aspect of their research.

There is clear evidence of increased output and external activity within each research group. Within the ***Palaeoclimate change group*: Johnson, Valentine** and collaborators from other HEIs and PRISM have presented new data on the Pliocene climate of the north-east Atlantic and Antarctic at international conferences e.g. the 2008 & 2010 General Assemblies of the EGU, and 2nd & 3rd International Sclerochronology Conference, and published in six high-profile journals. The most significant finding is that isotopically determined winter temperatures in the Pliocene North Sea were little different from present winter temperatures, contrary to the warmer estimates derived from other proxies and climate modelling. The research of **Pope** and colleagues focuses upon the key question of how environmentally sensitive steep-land catchment systems have responded to late Quaternary climate change. New data generated by a robust methodology that combines **(i)** detailed geochemical and spectral analysis of soils with **(ii)** high resolution OSL dating and O and C isotope analysis of fluvial sediments highlights the complex relationships between the sedimentary dynamics of catchments and climate cycles, and more importantly demonstrates that sedimentation occurred during *both* glacial and interglacial stages. The results of this research have been widely disseminated via five high profile publications, three conference presentations,

and four invited seminars. Research being undertaken by **Jones** and **Banks** (British Geological Survey) combines interests in Quaternary science, karst hydrogeology and engineering geology to address the question of Quaternary landscape evolution within the Peak District. The outputs of this research form the basis of two journal publications and a book chapter. The latter has attracted an international readership with the chapter being downloaded in excess of 2000 times since publication. Additionally, the research has also directly informed local authorities on aspects of the classification and conservation of tufa as a building stone, and new BGS research in the areas of hydrogeology and radioactive waste disposal.

In the ***Contemporary climate change group*: Abbott's** research with a consortium of EU universities has developed the concepts of "lived experiences" and "lay rationalities" with which the poor understand climate change which has been published in a special issue of the Journal of Innovation and Sustainable Development (*From Disciplinarity to Interdisciplinarity and Beyond in Higher Education on Climate Change*]) and distributed as a series of OERs *(Interdisciplinary methodologies for investigation into the 'lived experiences' of climate change).* **Cook's** cryosphere research has been disseminated via 4 high profile publications, conference presentations, and invited research seminars. Significant outputs have also resulted from staff not returned as part of this UoA submission. For example, **Stubbs**' applied climate change research has been disseminated in three publications that explore the management of transportation systems and their environmental impacts. **Fox** and **Moore's** research into the climate change impacts upon landfill restoration procedures forms the basis of two publications and a conference proceeding.

The ***Crust and mantle dynamics research*** group use geochemistry to solve large scale problems in the solid Earth. There are two themes. The first theme seeks to understand the mechanism by which the first continental crust was formed. This question embodies the fundamental question of when the process of plate tectonics began. **Rollinson's** strategy was to investigate late Archaean rocks for geochemical evidences of the operation of plate tectonic processes at this time and the presence of strong continents. Four examples illustrate the theme: **(i)** the link between Archaean continental crust and the associated subcontinental mantle is best explained in terms of a subduction model for the genesis of the crust; **(ii)** sanukoitoids in Karelia require an enriched subcontinental mantle source and slab break-off for their genesis; **(iii)** the presence of partially melted Archaean lower crust in the Lewisian of Scotland implies the formation of thick continents by 2.9 Ga; and **(iv)** the contrasting chemistry of Archaean and post Archaean crust implies a fundamental change in processes after about 2.5 Ga with the implication that 'average crustal compositions' long-used to establish the mechanism of crustal growth contain a confusing and mixed signal. The fruits of this strategy can be seen in 9 publications, 13 conference talks, and one external grant. The second theme seeks to enquire whether the Earth's mantle has become more oxidizing over geological time and if so when in the context of the Great Oxidation Event at 2.35Ga. The strategy adopted by Adetunji and Rollinson was to accurately measured $Fe^{3+}/\Sigma Fe$ ratios in chromitites in mafic and ultramafic rocks in order to quantify the oxidation state of the mantle source. The research is ongoing and has two strategic objectives. First, the establishment of a sound methodology. Initially Mossbauer spectroscopy was used, but now a coupled approach is being used incorporating single crystal X-Ray studies to provide robust $Fe^{3+}/\Sigma Fe$ ratios. Second, a number of case studies were undertaken of chromitites of different ages in order to establish oxidation ratios over geological time. A significant finding is the hydrous nature of mantle chromitites challenging the established ocean-ridge model for ophiolites. This work has resulted in five publications, two conference talks, and two internal grants.

The HPERG have drawn upon both University and Faculty funding to attend bid-writing courses and facilitate the partial buy-out of teaching in order for staff to attend conferences and initiate networking opportunities. This has led to increased applications for external funding with notable recent successes, including EU ERASMUS and National Geographic funding, and (payment in-kind) awards from the NERC Isotope Geosciences Laboratory. The number of research active staff within Earth and Environmental Sciences has risen from 5 in 2008 to 12 in 2013. Currently, the group comprises 3 Professors compared to 1 in 2008, 2 Readers (1 in 2008), and 2 Early Career Researchers (0 in 2008) who form the bulk of the staff being submitted by this UoA. Moving forward our strategy for the period 2014 to 2018 seeks to build upon the group's successful

outcomes through: **(1)** increasing the number of researchers by appointing new staff who have a track record of published research; **(2)** taking the lead in collaborative projects with colleagues in the UK, Europe and further afield (see Section 5e); and particularly for early career researchers **(3)** engaging in cross disciplinary research at Derby and working closely with Faculty Knowledge Transfer and Partnership managers to plan practicable pathways to research impact.

c. People: Staffing strategy and staff development

The HPERG comprises Richard **Pope** (Reader in Climate Change and Head of research group), Hugh **Rollinson** (Professor of Earth Sciences and Head of Department), Dina **Abbott** (Professor of Development Geography), Andrew **Johnson** (Reader in Sclerochronology), Jacob **Adetunji**, Joseph **Cook**, Peter **Jones**, Vanessa **Banks,** and Annemarie **Valentine**. In addition, Aradhana Mehra (Professor of Environmental Geochemistry, is returned to UoA 5). Other staff contributing to the research environment, but who are not returned in this submission include Howard **Fox**, John **Stubbs,** Peter **Baker** (Emeritus Professor), Neil **Hudson** (Emeritus Professor [deceased November 2012]), Paul **Guion**, (visiting research fellow), Heather **Moore** (visiting research fellow), Sian **Vollum-Davies** (visiting research fellow in 2011). **Hudson**'s work in metamorphic petrology contributed to the solid Earth group and **Baker** (3 papers in Palaeonotology), **Guion** (2 papers) and **Vollum-Davies** (1 paper and 1 conference presentation with colleagues Satterfield and Suthren, whilst in Derby), form the basis of an embryonic sedimentary research cluster.

Recent staffing additions to the Department have been on the basis of their research experience and potential contribution to one or more research areas within the UoA. Once in post, new staff are mentored by an experienced researcher and offered support and training to develop a research profile. Research and scholarship is an expectation of all academic staff at Derby. This is managed through the setting of research objectives during the annual development and performance review for every member of academic staff. Since 2010 the University has focused upon developing the research skills of early career staff by offering an assessed credit based programme in Academic Practice in Research, which explores the practice of the researcher and provides training for staff supervising PGR students for the first time.

The University has supported staff development through three main funding sources: **(1)** The Research for Learning and Teaching fund (established in 2005) provides monies to develop links between pedagogic and discipline-based research. This fund has played a significant role in sustaining research within this UoA with staff having successfully bid for £55,000 since 2008; **(2)** The Promising Researcher fund has enabled inexperienced researchers to develop a research profile specialism (with £5245 awarded to this UoA since 2010 supporting new climate change research); and **(3)** The Strategic Research Investment fund that was established from University QR funds to support a range of research-related activities (with £4500 awarded to this UoA since 2010 to support attendance at international conferences and fieldwork activities).The University has also supported staff seeking to secure external funding for research activities. In 2012 the University organised: (1) two one-day conferences (*Changing UK & EU Funding Landscape*) that provided an overview of the changing UK environment in terms of access to funding following the 2010/2011 Comprehensive Spending Review; and (2) two proposal writing workshops held in collaboration with the UKRO. Following these conferences the University introduced a Peer Review Scheme (March 2012) which required applicants for external funding to obtain a detailed peer review critique of their draft application. It is clear that this policy has borne fruit with much improved research income for the UoA between 2010 and 2013.

c. People: Research students

The HPERG sustains a community of 2 F/T students and 2 P/T PhD students. Although numbers are small the research students are fully integrated into the larger and diverse PGR community within the Faculty of Education, Health, and Sciences, comprising 48 FT/PT students undertaking research in Biological Sciences, Psychology and Education. In 2009, two large fully equipped open-plan offices were created to accommodate PGR students and provide hot-desk facilities for PT students. To ensure that research is undertaken by high calibre PGR students the HPERG has

sought to recruit individuals who hold a 1st/upper second class UG degree and ideally a Master's degree. All PGRs within the HPERG are supported by a Director of Study. Through links with other institutions the HPERG has been able to support the development of specific analytical skills in its PGR students. For example, PGR students engaged in climate change research have received specialist training in optically stimulated luminescence (OSL) dating at Risø Luminescence laboratory (Denmark), U-series dating at Royal Holloway (UoL), and isotope analysis at the NERC's Isotope Geosciences Facility**.**

The University attaches special importance to the development of research skills and research methods expertise in those undertaking research training and in 2008 introduced four year FT New Route PhD alongside the Traditional three year route. The new route is designed to provide the most comprehensive research training for graduate students without a master's degree through the study of level 7 research skills modules and an independent research project (leading to the interim award of M.Res), and the continuation and completion of the independent research for submission as a doctoral thesis. In an attempt to better support and improve the PGR experience on the new and traditional routes, the HPERG devised a two stage strategy comprising regular supervisory meetings and a production of progress reports to allow more effective annual monitoring of student progress. Other improvements (since 2009) include the establishment of the PGR Network to develop a stronger sense of community through organising a series of events to help PGR students mix across the different disciplines. These events provided the foundations for the Annual New Horizons PGR Conference in 2010. Sponsored by the University, but entirely organised by PGR students the conference has enabled students to present their research to an audience comprising c.80 PGR students and research staff. Additionally, PGR students at Derby have presented research talks following competitive application by submitted abstract and chaired sessions at the annual East Midlands PGR Conference. Other recent innovations to develop and sustain a PGR research culture have been a series of Communications workshops to help students enhance delivery skills and prepare them for future careers in academia and elsewhere. As a result of these initiatives and the parallel integration of PGR students within the UoA, the annual satisfaction questionnaire has shown a marked improvement. In 2011 85% rated their experience as excellent or good compared to 75% in 2007.

d. Income, infrastructure and facilities

The HPERG have won several small to moderate grants since 2008. As a partner in the European Union ERASMUS 'Lived Experience of Climate Change' project (total award of €387K over 2.5 years) **Abbott** received €29K in funding in 2009. **Rollinson** received *a* National Geographic award of £13K for geochemical analysis of crust in Oman (August 2013). As part of the BGS University Funding Initiative, **Johnson** received a £45K studentship to support the research of A. Valentine for the period 2008 to 2011. In addition, **Johnson** was also awarded €4.4K to resume a Research Fellowship funded by Alexander von Humboldt Foundation (University of Mainz) in 2009. A total of £10K has been awarded from various sources, including MAARA to support research into analysis of dust particles (**Rollinson** and **Adetunji**), the BSG to partially fund the dating of sediments to elucidate river system responses to climate change (**Pope**), and the BGS to date Quaternary carbonates to inform landscape development (**Banks**). Successful applications to the NERC Isotope Geosciences Facility generated grants in kind to the value of £28K for **Johnson** (2009 to 2012) and £8K for **Pope** (June 2013). Income generated by consultancy work (including flood risk assessments and water quality monitoring) conducted via the Centre for Land Evaluation and Management (CLEM). During the period 2008-2013, the research group generated an income in excess of £48K from external contracts.

Provision and operation of specialist infrastructure and facilities:

The HPERG has benefitted from ongoing investment in research infrastructure by the University and funding from the Derby and Derbyshire Enterprise Partnership (DDEP). Researchers have access to specialist research laboratories located at the main University site to undertake mineral separation and Mossbauer analysis, mineral magnetic work, and cathode luminescence analysis. Rollinson and Adetunji work with a MS-1 ^{57}Fe Mossbauer spectrometer with a cryostat operable at

liquid nitrogen temperature. This is the key tool in their work on mantle chromites and in the precise measurement of their $Fe^{3+}/\Sigma Fe$ ratio and hence the degree of oxidation (oxygen fugacity) of the parent melt. Pope and PGR researchers use a Bartington MS2 susceptibility meter, MS2B dual frequency susceptibility sensor and MS2F field probe to characterize the mineral magnetic properties of soils and sediments in order to test regional-scale fluvial system responses to climate change. Johnson and Valentine use a Citl cathodluminescence detector attached to Philips scanning electron microscope to investigate the preservation state of fossil shells. Staff also have full access to specialist laboratory facilities including AAS. Both staff and PGR researchers within the palaeoclimate and crust and mantle dynamics sub-groups are supported by a Geotechnics laboratory, and to rock cutting and thin/polished section laboratories with their specialist technical staff. Additionally, all staff and PGR students have access to an extensive map collection (and a Geosciences-trained map technician).

e. Collaboration and contribution to the discipline or research base

Collaborative Research Projects:

Johnson and Valentine's research into Pliocene climate of the North Atlantic region (from 2008) involves active collaboration with staff at NIGL (Prof. Leng), University of Leicester (Prof. Williams), University of Northumbria (Dr Salzmann) and US Geological Survey (Dr Dowsett). **Pope's** research into the impacts of high level glaciation on late Quaternary fluvial system dynamics in the southern Greece (from 2010 onwards) involves colleagues from Manchester University (Dr Hughes), and Athens University (Dr Skourtsos). Additional collaborators include Dr Rowe (UEA) who is undertaking isotope analysis of cave speleothems in order to derive a high resolution climate change record for the project, Dr Noble (NIGL) and Prof. Murray (Risø luminescence laboratory) who are generating robust chronologies of glacial melting and fluvial sedimentation phases using U-Th series and OSL dating. Pope is also leading a project that is elucidating the responses of small catchment/coastal fan systems to post-MIS6 climate change in the Balearics (from 2012 onwards) with colleagues from University of Balearics (Prof. Fornós), and Risø luminescence laboratory (Murray).

Jones and **Banks** are working with colleagues from BGS to elucidate the impact of Quaternary palaeoenvironmental change on the Peak District (from 2010). Additionally, both are collaborating with **Fox,** BGS, and the Environment Agency to gauge the effectiveness of desk studies as a cost effective investigation of historic closed landfills (from 2010). **Fox** is also working with the Institut Agronomique et Veterinaire Hassan II (IAV) Agadir. **Abbott** is collaborating with colleagues at the OU in both the UK and the Netherlands where as part of her visiting professor role (for the latter) she is undertaking policy-related research on "lived experience" transboundary competences with practitioners and academics. **Cook** is collaborating with Dr Hodson, Dr Langford and Dr Koziol (Sheffield) to investigate links between hydrological processes and supraglacial microbial activity, and Dr Sattler (Innsbruck) to characterise the radiative environment on glacier surfaces and its implications for microbial life.

Rollinson and **Adetunji** are collaborating with Prof. Yousif, Dr Gimelsmeed (Mossbauer Group Sultan) at Qaboos University, Oman and Dr Lenaz (University of Trieste, Italy. **Rollinson** is also collaborating with Prof. Nasir, sultan Qaboos University Oman on the petrology of the subcontinental mantle beneath the Arabian plate and Dr Fowler (Portsmouth University) on the geochemistry of Archaean sanukitoids. Other collaborative projects include research into Lewisian petrology with Dr Gravestock (University of Gloucester) and Prof Wheeler (University of Liverpool), and investigations of the Fiskenaesset petrology (W. Greenland) with Prof. Windley (University of Leicester), the Zimbabwe geochronology with Prof. Whitehouse, (Natural History Museum, Stockholm), and the Geochemistry of Archaean Sanuikitoids with Prof S Loback-Zhuchenko (Russian Academy of Sciences, St Petersburg).

International Conference organisation:

Johnson was co-organiser of session 1.6 (Climate and seasonality in a Pliocene warm world), European Geosciences Union, General Assembly, Vienna (May 2010) and the UK coordinator for

the 2nd International Sclerochronology Conference, Mainz (July 2010). **Rollinson** co-organised the Geology of the Arabian Plate conference in Muscat, Oman (January 2012).

Leadership in the academic community:
Rollinson is currently involved in the IGCP Project 599 (The Changing Early Earth) and is leader for work within Europe. Start date of project May 2011. **Abbott** is a board member of the Department for International Development (DFID) and ESRC for *Agriculture growth in developing countries.*

Visiting positions:
Abbott a visiting professor at the Open University (Netherlands) where she is developing policy-related research on "lived experience" transboundary competences.

Keynote lectures, invited talks, plenary and research seminars:
Rollinson presented keynote lectures at the Mineralogical Society of Berlin, Frei University of Berlin (May 2010) and the European Geoscience Union (Vienna Austria) Symposium on the early Earth (April 2011). **Johnson** gave an invited talk at the United States Geological Survey, Reston, Virginia (August 2011). Examples of invited research seminars include **Abbott's** *'Expanding Citizen and Practitioner Engagement with the Climate Change Challenge Through Collaborative Masters Curriculum, Open Educational Resources, E-learning Communities and Virtual Mobility',* presented at the European Association of Distance Teaching Universities (EDTU), Zermatt, Switzerland (September, 2010). **Cook** presented '*Climate change and the Cryosphere*' at Sheffield University (January, 2010) **Johnson** presented '*Sclerochronology and climate change: insights into the future from the Pliocene of the southern North Sea Basin*' at Royal Holloway (October 2009), and '*Past and future climate of the north-east Atlantic region from sclerochronology*' at the UK Alexander von Humboldt Foundation (German Embassy, London [October 2010]), and '*Cold winters in a warmer world*' at the East Midlands Regional Group, Geological Society of London (British Geological Survey, Keyworth [July 2013]). **Pope** presented '*Unravelling piedmont fan responses to climate change: new evidence from OSL and U-series dating*' (Manchester University [November 2008]), and '*Linking late Pleistocene fan alluvial with the melting of high altitude glaciers: a cautionary tale from Sparta*' (University of East Anglia [May 2011]) **Rollinson** presented '*A new model for the coupled evolution of Archaean continental crust and sub-continental lithospheric mantle*' at the Janet Watson meeting of the Geological Society of London (September, 2009) and '*Coupled Archaean crust-mantle evolution*' at the Meeting on Crustal Evolution and Tectonics, Northwestern University, Xian (China [January 2010]).

Editorial boards, Editorships and Guest editors:
Rollinson is Associate Editor for the Journal of the Geological Society (2008-) and on the editorial board of the Journal of African Earth Sciences (1999-), Precambrian Research (1999), and Geology Today (2009-). Rollinson is also lead editor for special publication of the geological society of London 'The tectonic of the Oman Mountains' (forthcoming 2014). **Abbott** is a member of editorial board on the International refereed on-line African Journal of Environmental Sciences and Technology.

Peer reviewer for journals:
Rollinson is a peer reviewer for Precamb. Res; Geochimica; Nature; Can. Mineral; Lithos; EPSL; JGSoc. Lond; GSoc. Lond. Spec. Pubs.; J. Petrol.; Geop. Res. Lett.; Geology; Terra Nova; Contributions to Mineralogy and Petrology; Prc. Nat. Acad .Science (USA); Gondwana Research. **Johnson** is a peer reviewer Paläontologische Zeitschrift; Palaeogeography, Palaeoclimatology, Palaeoecology; Palaios; Lethaia; Geological Journal; Journal of Molluscan Studies; Pliocene climate; Limnology and Oceanography. **Pope** is a peer reviewed articles for Geol. Soc. Lond. Spec. Pubs, J.Geodynamics, Geomorphology, ESPL, Geoarchaeology, The Holocene, QSR, and Sedimentology. **Banks** is a peer reviewer for Environmental Sciences: processes and impacts; and Mathematical Geosciences.

Reviewing grant applications:
The group have been involved in reviewing and grading grant applications for the NERC

(**Johnson, Pope,** and **Rollinson**)**,** NSF (**Rollinson**), the German DFG (**Rollinson**), and the ESRC (**Abbott**).

External Examining:
Rollinson was an invited PhD examiner at the University of Copenhagen (2012).