

**Institution: Cardiff University**

**Unit of Assessment: 7**

**a. Overview** The School of Earth and Ocean Sciences is ranked in the top-100 in its field (QS Worldwide University Rankings 2013). Key indicators of research quality and activity over the REF period include: 2 Fellows of the Royal Society; >£10M of research income; 21 papers in Science and Nature; 60 completed PhD theses; >500 peer-reviewed publications; >200 invited and keynote lectures; many examples of international leadership roles (particularly in marine geosciences); and an infrastructure that includes particularly well-equipped laboratories for 3D seismic imaging, geomicrobiology, palaeoclimatology, stable isotope and trace element analysis. Table 1 summarizes the research structure of the School and staff contributing to research output during the REF period. The three **Research Themes** are subdivided into **Research Groups**, which vary in number and focus according to staff expertise and interests. We encourage the development of **Interdisciplinary Projects** which, when large enough, are recognised separately. Research is overseen by the **Director of Research** and the **Research Development Committee**.

		Themes					
		Solid Earth		Climate and Life		Environmental Science and Policy	
Research Groups		1. Magmatism & Metallogenesis		3. Palaeoclimate & Climate Systems (PACS)		5. Earth Surface Processes (ESP)	
		<b>Pearce**</b> <b>MacLeod</b> <b>Kerr</b> <b>Lissenberg<sup>o</sup></b> <b>Prichard</b> <b>McDonald</b>	<b>Maier (+)</b> <b>Bevins</b> (NMW)	<b>Pearson**</b> <b>Hall, Barker</b> <b>Lear, Pike</b> <b>Ziegler<sup>o</sup>(+)</b> <b>Sosdian (+)</b> <b>Edgar (+)</b> <b>Nederbragt (+)</b>	Hendry <sup>o</sup> (+/-) Knorr (-), <b>Gong<sup>o</sup>(+)</b> Coxall (-) Sexton (+/-) <b>Jonkers<sup>o</sup>(+)</b> <b>Moffe-Sanchez<sup>o</sup>(+)</b>	<b>Hales*</b> <b>Jones</b> <b>Ballinger</b> <b>Constantine</b> <b>Lourenço</b> <b>Lazarus<sup>o</sup>(+)</b>	Rickard (-) Yang (+/-) Harris (-) Smith (-) Wooldridge (-) <b>(Perkins)</b>
		2. Geodynamics		4. Palaeobiology		6. Geomicrobiology	
		<b>Davies*</b> <b>Alves,</b> <b>Blenkinsop (+)</b> <b>Fagereng<sup>o</sup>(+)</b> <b>Buchs (+)</b>	Lisle (-) Wright (-) Walker <sup>o</sup> (+/-) O'Regan (+/-) Cartwright(-) Della Porta (-)	<b>Edwards*</b> <b>Cherns</b> <b>Berry</b>	<b>Channing (+)</b> <b>(Pearson)</b> <b>(Pike)</b>	<b>Parkes**</b> <b>Sass</b> <b>Cragg</b>	<b>Perkins</b>
<b>Interdisciplinary Projects</b>							
The Climate Change Consortium of Wales, C3W [ <a href="http://c3wales.org">http://c3wales.org</a> ]; (Leader: Hall) Severn Estuary ( <a href="http://www.severnestuary.net/sep/">http://www.severnestuary.net/sep/</a> ) (Leader: Parkes)							

Table 1. Research organisation and staffing. (o) = Early Career Researchers. (+) = arrivals and (-) = departures during the REF period; \* = Group leaders; \*\*Group and Theme leader. (NMW) = National Museum of Wales. **Staff in post 31/10/13 in bold**. Staff in brackets are primarily members of another group.

**b. Research strategy**

**b.1. Current.** In RAE 2008, the main aspect of our Research Strategy was to support and enhance key Research Groups by both investment and creating critical mass. This was achieved e.g.:

- The RAE08 'Geoenvironment' Group has been rejuvenated following retirements with three new staff (Constantine, Lazarus, Lourenço) being appointed. They, together with Hales, provide a dynamic grouping in quantitative geomorphology, which forms the core of the new **Earth Surface Processes (ESP) Group** (Table 1).
- The concept of a **Biogeochemistry Research Centre** headed by the Geomicrobiology Group has been taken further through strong interaction between Earth Sciences, Biosciences, Chemistry and Engineering (current joint grants >£1M) and, recently, at College level an interdisciplinary Chemical Biology and Water Initiative.
- The **PACS Group has fulfilled its planned upward trajectory**, becoming a major partner in C3W (Table 1), Cardiff's Sustainable Places Institute and the Tyndall Centre for Climate Change Research, a member of the FP7 Initial Training Network 'Gateways', and contributing to the leadership of international programmes such as IODP, IMAGES, and PAGES.

**b.2. Future.** Our **vision** is to be one of the **top 5 Schools in the UK** achieved by the School's **strategy of investing in excellent staff in key areas of Earth and Ocean Sciences. Target**

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**research areas** are decided after consultation with all academics and discussions at research-group, -theme and –committee level, and documented in the School's **research strategy**, which is updated on rolling timescales (1–5 years). The School also supports all staff with **focussed research equipment, facilities and technical support**; whilst being **responsive to new research opportunities**. These have included:

- University reorganisation has placed the School within the College of Physical Sciences and Engineering. This has led to new opportunities for **cross-disciplinary collaboration and equipment share**. In particular, we are using retirements etc. to obtain new staff in (bio)geochemistry to support the Chemical Biology and Water initiative, and in petroleum geology - a potential new area for cross-College collaboration.
- The new NERC Doctoral Training Partnership scheme (GW4+) has been used as an opportunity for discussions, beyond PhD students, with the other three university members of the "Great Western Four" (GW4: Cardiff, Bristol, Exeter and Bath), to include **shared equipment and collaborative research projects**. These include projects on proxy- and modelling-based palaeoclimatology (w. Bristol, Exeter and the Met. Office), magma chamber processes (w. Bristol and BGS), economic geology (w. Exeter, Camborne School of Mines), geodynamics and biomarkers (both w. Bristol).

Recent **new infrastructure support**, reflecting recently appointed staff, is a total allocation of ~£600k for a **LIDAR system** for the ESP Group (purchased) and an **analytical SEM** for all groups (under tender). The SEM will, in particular, facilitate new synergy between petrologists (Lissenberg, MacLeod) and economic geologists (Maier, McDonald, Prichard) working on layered igneous intrusions, linking theory and application. This should also help us achieve another main strategic goal of creating a larger Impact portfolio for the next REF. This impacts goal is further supported by our Impacts Panel of representative research 'users'.

### c. People, including:

**c.1.1. Staffing strategy.** Following the rapid increase in staff numbers during RAE 2008, research-active FTEs have remained at a sustainable level of 30-36 for the past 5 years (Table 1) with a balanced seniority profile. There was a healthy turnover of FTE staff, with 12 departures (incl. 5 retirements), and 11 new staff (6 of whom were ECRs) appointed over the REF period. New appointments enabled implementation of a major aspect of research strategy, namely the focus on research excellence and funding, development of research groups and Impacts potential. The **School aims to increase its FTE's** to further enhance research excellence and impact, and this is supported by the College. We occupy the prestigious Main Building of the University and our **physical space has expanded** during the REF period following a University reorganisation. This has allowed us to develop **laboratory space according to staff need** and to carry out refurbishment of several rooms for staff and PGRs.

**c.1.2. Career development support.** Within the School and the University's 'Investors in People':

- **Annual review and appraisal** for all staff
- **Additional probationary meetings and mentoring** for recent appointees.
- **Structured career development and progress review schemes** for all staff, with a strong emphasis on providing **ECR's** with the skills necessary for an academic career.
- A comprehensive range of courses and training provided by the University's **Career Development Skills programme, Research Development and Leadership and Management courses**.
- At least **5 days' appropriate personal development activity** per person per year on average, with courses supported by the School Staff Development Fund, and conferences, workshops, research visits etc. supported by FEC return and the University Travel Fund.
- Granting of **research leave and time for extended field activities** at all stages (e.g., since 1/1/2012: Barker, 9mth Oregon; Prichard, 6mth Australia; Pike, 6mth Cardiff/Australia; Lissenberg 1y Cardiff/Amsterdam; Lissenberg and Alves, 2mth on IODP cruises; Lourenço, 2mth Japan). Plus a 5 yr Research Professorship for Pearson.
- **Academic research staff** can **consolidate teaching duties**, where possible, into one semester to **allow fuller concentration on research** in the other semester.
- **Active guidance and support for promotion** which has led to 8 internal promotions to Senior

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Lecturer, 6 to Reader and 2 to Professor (Hall, MacLeod) during the REF period.

In addition, we use a formula based on grant capture, applications and other factors to redistribute up to 33% of FEC grant income to research staff to support their research/initiatives. All new academics have start-up research funds and ECR's have research and teaching mentors.

**Research Fellows** are supported in research applications and **treated as permanent academics**.

**c.1.3. Support for Career Development of Researchers.** Evidence for implementation of the seven principles of the Concordat is itemised below:

- **Employment is based on excellence** evidenced by recent success with NERC New Investigator (Lissenberg, Hendry) and FP7 Career Integration Grants (Hendry, Buchs, pending).
- **ECRs are members of all relevant School committees** and invited to attend all staff meetings.
- The University has **regular interdisciplinary events** for Early Career Researchers and runs **career development courses**.
- The School has a **Staff Development Fund**.
- A University monthly **Research Newsletter** lists funding opportunities and the School helps in the writing/ targeting of **grant proposals and manuscripts**.
- **Equality and diversity** is a statutory part of the recruitment and career development process.
- **Review of progress** is conducted by mentors, annual appraisals and regular line management.

This support led to some fixed term academic-staff (Lecturers and Fellows) obtaining **open-ended lectureships** here (Barker) and elsewhere (Hendry, O'Regan, Coxall, Sexton) and some PDRAs **progressing to Fellowships and lectureships** (e.g. Lissenberg, Hastie, Ziegler, Aze) as well as to posts in a range of industrial, commercial and industrial sectors.

Name	From
Blenkinsop	Townsville
Maier	Oulu
Fagereng	Cape Town
Lazarus	Maine
Buchs	GEOMAR
Lissenberg	Paris
Constantine	UCSB
O'Regan	Rhode Is.
Ziegler	Utrecht
Sosdian	Rutgers
Jonkers	Barcelona
Nederbragt	Amsterdam

Table 2: International staff appointments since RAE08

**c.1.4. Personal Research Fellows. 39 Research Fellows, Associates and Assistants** were employed during the REF period. These with independent remits were Coxall (RS Research Fellow), Edgar (NERC Research Fellow), Sexton (Marie Curie International Fellow, then Leverhulme Fellow), Ziegler (Marie Curie ITN Established Researcher), Jonkers and Moffa-Sanchez (C3W Fellows).

**c.1.5. International recruitment.** Of incoming staff, 80% were **international appointments** (Table 2), (Lourenço and Walker, both from Durham being the exceptions). Some departing staff took international posts, notably O'Regan and Coxall at Stockholm University and Knorr at the AWI, Bremerhaven. Scholars have visited from virtually all parts of the world, usually

giving seminars or public lectures during their visits funded by the University. Others were directly School funded, or from FEC support to research groups. Particularly high-profile geoscientists in their fields are Gensel (North Carolina), Jørgensen (Aarhus), Summons and Solomon (FRS, FFRS at MIT). Some international scientists have been awarded **honorary fellowships or professorships**, the best known perhaps being Wallace (Wally) Broecker (Lamont).

**c.1.6. Equality and diversity consideration on all School committees ensures that all staff are recognised equally within the School.** All staff undertake mandatory training in E&D whilst initiatives and activities to support E&D are embedded in our structures, such as College level networks for female researchers and ECRs. Flexible working is encouraged in the School, being arranged through line-management. The School has a **comprehensive Work Load Model**. Consideration is given to the timing of events to ensure that staff with caring duties can participate. The School has representation on the committee of the *Cardiff Women in Science* network. Cardiff University holds an Athena SWAN Bronze Award and ranks in Stonewall's "Top 100 Employers".

## c.2. Research Students

The School is a member of two new **NERC Doctoral Training Partnerships: GW4+ DTP** and an

**Oil & Gas DTP** (Heriot-Watt University Lead).

**c.2.1. PGR recruitment.** Recruitment (>14 p.a. average over the 07/08 academic year) involves submission of a costed proposal, then selection, national and international advertisement, and candidate interview. The process is managed by a Director of PG Research and a rolling recruitment panel. The top students are offered the most prestigious studentships they are eligible for, typically the NERC awards (presently ~2 p.a. via algorithm and 1 p.a. CASE awards) and the University 'President's Scholarships' (average 2 p.a. obtained competitively). Plus **the School provides ~£200k/year for School studentships**, each ideally provided with 50% supervisor-matched funding, while some studentships are self-funded or funded by industrial, or other, grants.

**c.2.2. Training and support mechanisms.** Each PGR student has two academic supervisors and a personal mentor, all from within the University. Training and development are at three levels:

- The **School** covers subject-specific needs and new students must attend an induction and training programme, including an overview of School equipment and health and safety. School analytical facilities are free of charge for PGR students, and the supervisors provide all other research requirements. The School promotes interaction between graduate students from different research groups through generic skills development sessions, poster sessions, seminars and social events, so ensuring a vibrant PGR community.
- The **University Graduate College** - short-listed for the **2010 Times Higher Education Award for "Outstanding Support for Early Career Researchers"**- provides over 200 training courses, conferences, careers events, speaker events, and online research skills modules. It ensures that all PGRs in the University complete ~10 School + College training days p.a. in core research skills and that graduate students from the School are part of the wider University research community.
- The **Graduate Centre** is an additional hub for the PGR community and complements the School provision by providing year-round, centrally-located social and study facilities in the Student Union.

PGR students are expected to present their results at conferences, with financial support if required, and they have won ~15 prizes and awards for their presentations over the REF period. They benefit from frequent research seminars organised at the School and Research Group levels. An additional themed public lecture series provides a valuable breadth of knowledge: themes over the REF period have been 'Darwin', 'Scott', 'Our Changing Climate', 'Geohazards' and 'Wallace' (e.g. Sir David Attenborough's September 2013 Wallace Lecture). Interactions are enhanced by our regular "Friday Club" and "Research Coffee Mornings" within the School, where PGRs and staff can meet informally.

**c.2.3. Monitoring of progress.** Cardiff's **Code of Practice for Research Degrees** covers responsibilities, admissions procedures, induction, research planning, skills development, personal development planning, supervision, mentoring of progress, consultation and feedback, examination, complaints and appeals - as laid out in its own Research Degrees Handbook. **Annual 'quality progress reviews'**, via written reports and interviews, evaluate students' progress and disseminate best practice. **Student seminars, poster sessions and review meetings** at the end of the student's first and second years are attended by the PGR Director, academic supervisors, personal tutors and other researchers. The University provides skills development for supervisors, including information sessions focussing on the University's regulatory and quality frameworks, training sessions within broad discipline groups, and topic-focussed workshops. Support is provided through **School-based mentoring and appraisal schemes**. As evidence of success, our students had **61 co-authorships** on Cardiff publications since the start of the 07/08 academic year, and completion rates (85%) are above the Russell Group average

#### **d. Income, infrastructure and facilities**

**d.1. Provision and operation of specialist infrastructure and facilities.** Table 3 lists our principal in-house Facilities. Each Facility has sample preparation laboratories and a manager who

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reports to an Analytical Facilities Committee. We were extremely successful in building up our equipment base during RAE 2008 through success in competitive HEFCE, JREI and SRIF equipment bids. In this REF period, we have upgraded and expanded these facilities through a mixture of commercial and grant income and competitive University, Royal Society and HEFCW equipment bids, plus School funds, to ensure that they remain state-of-the-art. Distinctive aspects are: 1) the **Element Fingerprinting Facility** which permits analysis of liquids and solids for almost all elements in the Periodic Table; 2) the **3D Seismic, Palaeoclimate and Geomicrobiology Laboratories** which are particularly well-equipped in their fields; and 3) the **coastal research vessel** (RV Guiding Light) with its inbuilt sonar and new multi-coring capabilities which places us at the forefront for, for example, evaluating the environmental and engineering implications of tidal energy recovery schemes. Within reason, there is free access to analytical facilities for academics without research grants for pump-priming of research projects.

Research Group. In-house Facility	REF Spend (and Funding Source)
<b>Magmatism &amp; Metallogenesis.</b> Geochemical Fingerprinting Facility: 2xICP-MS, ICP-OES, Laser, Microdrill, Atomic Fluorescence	2 x new ICP-MS (commercial: £111k); Analytical SEM (School: £480k*)
<b>Geodynamics.</b> : 3D Seismic and Visualization/HP Computing Labs.	3D lab. upgrade (RS/HEFCW/Uni.: £465k)
<b>PACS.</b> Stable Isotope Laboratory: 3xIR-MS + with Carbonate and Flash EA peripherals), HR-ICPMS, Advanced GSA Facility, Palaeoclimate Lab.	2 x new IR-MS; HR-ICPMS (Uni. £750k); Palaeoclimate. lab. (Uni. £300k)
<b>Palaeobiology.</b> SEM (analytical- & FE-SEMs; XRD) & microscopy	Analytical SEM (see above)
<b>Geomicrobiology.</b> Culture Facility inc. HT&P, HPLC, epi-fluorescent microscope, radio-IC, GC's Scintillation Counter etc.	New IC (Uni: £72k + School £20k); HPLC (NERC: £21k; School: £16k)
<b>Earth Surface Processes.</b> Coastal Research Vessel; Mobile Airborne Particulates and Fluvial Geomorphology Laboratories	Fluvial lab. (Uni. £50k); LIDAR [3D Laser] (School: £98k)
Table 3: Principal School equipment highlighting major capital spends in the REF period and their main source of funding. *approved spend.	<b>Total: £2.38M</b>

**d.2. Evidence of investments in infrastructure and facilities.** Estimated total expenditure in the REF period on major equipment alone is **£2.38M**, (Table 3), and we plan to purchase a second laser ablation system for the Fingerprinting Facility (**£200k**) in 2014. The School provides 5 technical posts and laboratory space, and contributes some **£60k p.a.** to support student use, but otherwise the Facilities are self-supporting through grants and commercial income. A future aim is for an Environmental Isotope Laboratory in the School and we have just submitted an equipment bid to NERC for a **MC-ICP-MS (c£450k)**. The School has the University science library on-site plus access to >23000 electronic journals (above the Russell Group average). The School has its **own parallel computing cluster** for running simulations such as whole-planet mantle convection models, plus direct access to Advanced Research Computing in Cardiff (**ARCCA**, one of the largest and efficient UK academic facilities, **~£3.9M investment** over the REF period) and to **HPC Wales (~£40M investment)**. The University is providing **future investment of £200-250M within 5 years**, from which the School will benefit significantly.

**d.3. Information on the research funding portfolio.** Our direct external research funding over the REF period has been **~£9M**, 54% from research councils, 13% from the EU and 33% from other sources. In **2010/11 we obtained over £2M of funding from NERC and were the top performing Earth Science School in the UK** in terms of combined total awarded and success rate (~50%). Indirect NERC funding is worth >£2M. Of this, NERC Facilities applications have 'brought in' £483k (for Ar-Ar dating, S isotopes, radiogenic isotopes, zircon dating, Si isotopes, O isotopes, radiocarbon dating, BOSCORF= sediment core usage). In addition, Davies received 81M AU of supercomputing time through HECToR valued at **£914k plus £200k** through HPC Wales, and MacLeod used the ISIS ROV for a cruise with an in-kind value of **£238k**. The latter used 36d of RRS James Cook time (@£25k/d = **£900k**). Other high-cost, in-kind funding includes use of beam facilities at Zurich and Lawrence-Berkeley (Edwards: **~ £100k**) and use of the US Research Ship Nathaniel B. Palmer (Pearce: **~£500k**). Future plans are to increase RCUK funding (e.g., £3.6M of applications made to RCUK in July 2013) while expanding other funding sources. Most recently,

we held an “away day” in September 2013 specifically to discuss funding strategies.

**d.4. Consultancies and professional services.** Commercial Facility use is c£1M over the REF period which primarily maintains our equipment (see above). A significant number of consultancies were provided by academics with the funding obtained used to enhance their research.

**e. Collaboration or contribution to the discipline or research base**

**e.1. Research collaborations.** We have identified >100 examples of major collaborations involving the School during the REF period. Collaborators include staff from **research institutes** (e.g. IFREMER, GEOMAR, CAGS, AWI, MPI, CSIRO, BAS, NOC), **national surveys** (e.g. USGS, GSC, GSWA, BGS), **international companies** (e.g. Shell, BP, Petrobras, Statoil, Anglo-American, SRK), and **top-ranked Universities** abroad (e.g. MIT, UCLA, Columbia, ETH Zurich and UT Austin) and in the UK (particularly our nearest neighbour, Bristol). The most obvious evidence for international collaboration is through our publications, where a significant majority of co-authors are from outside the UK. Many collaborations are through multi-national field programmes, including **research cruises** (4 in the REF period: W. Indian Ocean, East Pacific, Scotia Sea, Bay of Cadiz), **IODP** (3 Expeditions: Nankai Trough; Baltic Sea, Hess Deep), **continental drilling** (2 Projects: Tanzania Drilling Project; Chinese Deep Borehole), as well as through **IMAGES, PAGES, IMCORE and COREPOINT**. We are also proud of our support for Welsh science as shown through collaborations that include joint publications with other Welsh Universities (as in **C3W**), the **National Museum of Wales** (some of whom are honorary members of the School) and with Welsh companies and bodies (such as the **Severn Estuary Partnership** (SEP) and the Cardiff-based mineral exploration company **SRK**). Key examples of collaborations (1 per Research Group) are:

- *Magmatism and Metallogenesis*: a new **timescale** and **reactive flow model** for the formation of lower oceanic crust (Lissenberg & MacLeod: UK/France/US/Canada collaboration).
- *Geodynamics*: development of a **3D, whole-Earth dynamic model** (Davies: UK/EU/Shell).
- *PACS*: the role of **oceanic circulation in abrupt climate change** (Barker & Hall: UK/US/EU).
- *Palaeobiology*: the discovery of **early landplant lineages and new Devonian forests** as part of a larger focus on phytoterrestrialization (Edwards & Berry: UK/China/US/Switzerland).
- *ESP*: new policies for **integrated coastal zone management** (Ballinger & Smith: UK/EU/SEP).
- *Geomicrobiology*: Experimental demonstration of conditions for **hydrogen generation in the deep, sub-seafloor biosphere** (Parkes: Cardiff Earth/ Cardiff Biosciences/ Bristol/Germany)

**e.2. Interdisciplinary research.** Many of our major projects (e.g., research cruises, IODP Expeditions) involve collaborations with different disciplines. The Geomicrobiology Group is predominantly interdisciplinary, and many of its 30+ papers post-2008 have been published in non-geoscience journals, including *Science*, *FEMS Microbio.*, *Int. J. Syst. Evol. Microbio.*, and *Org. Geochem*. Hall is an executive board member of the University's **Sustainable Places Research Institute**, a £2M project which aims to find 'innovative solutions to the problems of climate change and resource depletion, which take into account the unique relationships between economic, ecological and social processes at local levels'. Also, the School has **two interdisciplinary projects formally within its research structure** (Table 1):

- **C3W** is a £4 million initiative (£1M to Cardiff) financed by the Welsh Assembly Government through HEFCW, together with additional support from the Countryside Council for Wales and substantial investment from the four largest Welsh universities. A distinctive feature is that its goal is to evaluate not just the impact of climate change on the Earth but also its **social consequences**: e.g. work with the School of Psychology on understanding risk perception and communication.
- **The Severn Estuary Project** is linked to the Severn Estuary Partnership an independent initiative set up in 1995 and based in the School. It works with all involved in the management of the estuary, from planners to port authorities and fishermen to farmers. The School has long collaborated on marine policy, but is now also conducting scientific projects, for example in environmental microbiology and (with Engineering) in geotechnical surveys in the Bristol Channel.

**e.3. How research collaborations have informed research activities and strategy.** Impact of the inter-university collaborations is evidenced by publications. Also important are commercial

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collaborations, which can provide access to new data, facilities and ideas. Examples include:

- The **petroleum industry**, including the CapRocks Consortium of 8 multi-national companies, provides the 3D seismic data for academic studies (Alves, Cartwright) of continental margins.
- **Mining company collaborations** (Prichard, McDonald, Maier, Blenkinsop: with SRK in Cardiff and others) provide field and core access for studies of ore genesis.
- Collaboration with **BGS** on their commercial mapping of the UAE ophiolite in Fujairah (MacLeod, Pearce) provided field support and equipment share, and even closer relationships with **BGS (Wales)** are being planned.

**e.4. Exemplars of leadership in the academic community.** Staff in the School are active at all academic levels with over the REF period: >500 peer-reviewed papers published, 21 of which are in *Nature* or *Science*; 35 journal editorships; 231 invited lectures, of which 48 were Keynotes; 86 conferences organised (5 of which were in Cardiff); 56 programme chairs; and 112 committee and advisory board memberships. Some examples are listed in Table 4.

<b>Publishing:</b> 10 papers in the top 1% of citations (Scopus) in their discipline for their year, with 2 already at >200 citations. Editorships include co-chief editor; <i>Kerr</i> <i>Lithos</i> (5y IF = 4.25); <i>Rickard</i> <i>Chemical Geology</i> (5y IF = 4.05).
<b>Conferences Organised:</b> <i>Hall</i> : Chapman (RSA, 2012). <i>Alves</i> : Geol. Soc. Continental Margins (London, 2012). <i>Kerr</i> : Circum-Caribbean Workshop (Cardiff, 2009). McDonald ERMG Conference (Cardiff, 2013). <i>Davies</i> : EGU Geodynamics Division Programs 2009-2013; <i>Pike</i> : 4 <sup>th</sup> Polar Marine Diatom Workshop (Cardiff, 2013).
<b>Advisory Boards/Assessors:</b> <i>Pearce</i> : GEOMAR, Germany; Macquarie Uni., Australia. <i>Hall</i> : DFG, Germany; Climate Change Commission for Wales. <i>Parkes</i> : Geobiology, Bergen; ISSM Methane Balance Team. <i>Edwards</i> : Trustee, Natural History Museum, Leverhulme Trust Advisory Panel.
<b>Society Chairs.</b> <i>Davies</i> : President Geodynamics Division EGU. <i>Edwards</i> : President Linnean Society; Vice-President Learned Society of Wales. <i>MacLeod</i> : Vice-President ESSAC. <i>Lisle</i> : Chair TSG (Geol.Soc.)
<b>Science Programme Leadership.</b> <i>Hall</i> C3W Institutional Director; <i>Pearce</i> : Co-chief scientist IODP Exp 352; <i>Pearson</i> : Co-chief scientist Tanzania Drilling Project; <i>MacLeod</i> , <i>Pearson</i> , <i>Pearce</i> all chief scientists of international research cruises.
<b>Awards.</b> <i>Parkes</i> : FRS, Fellow of the American Academy for Microbiology; <i>Rickard</i> : FRCS. <i>Edwards</i> , <i>Parkes</i> , <i>Rickard</i> and <i>Cartwright</i> : Fellows of the Learned Society of Wales (FLSW). <i>Edwards</i> : FRSE and Linnean Medal.
<b>Working Group Chairs:</b> <i>Kerr</i> : Solid Earth Chemistry and Evolution WG (IMA). <i>Parkes</i> : Co-chair Deep Biosphere WG of EU DS3 Project. <i>Hall</i> : Co-leader of the PAGES WG 'Synthesis of Transient Climate Evolution of the last 21-kyr (SynTraCE-21). <i>MacLeod</i> : IODP INVEST Chair: Variability in Oceanic Crust Composition and Structure.
<b>UK Representatives.</b> <i>MacLeod</i> : ECORD Technology Panel. <i>Lissenberg</i> : Magellan Steering Committee, ICDP. <i>Hall</i> : International Past Global Change Study (IMAGES II).
Table 4: Some Examples of Leadership in UK and International Science

Much of our most visible science leadership is in marine geoscience. Cardiff geoscientists ran the European IODP Science (ESSAC) Office during the RAE 2008 period and continued to contribute to its leadership, with MacLeod still Vice-Chair of ESSAC, in 2008. Parkes has similarly continued his leadership of research on the deep, sub-oceanic biosphere, and developed a unique HP core sampling and handling system for microbiology, and received an FRS for his work during this REF period. In addition, Hall, MacLeod, Lissenberg, Pearce and Pearson have been co-PIs or co-proponents on 8 IODP expedition proposals during the REF period, and one of these (Exp. 352 to the Bonin Forearc) has been scheduled with Pearce as co-chief scientist.

The PACS group also has a strong oceanic emphasis, contributing to the leadership of numerous international programmes such as PAGES and IMAGES and to SCOR/WCRP/IAPSO Working Groups (e.g. WG123 and 136, see also Table 4). Several staff contributed to the EU Marine Research initiative DS<sup>3</sup>F White Paper and Parkes co-Chairs their Deep Biosphere WG. ESP members have led working groups in European coastal research projects such as COREPOINT, SPICOSA and IMCORE. Finally, Cardiff's location in the capital city of a small nation gives a particular opportunity to influence national policy, facilitated by staff in key posts, e.g. Edwards as VP of the Learned Society of Wales, and Hall as Deputy Commissioner (HEI Sector) to the Climate Change Commission for Wales.