



Respectfully submitted,

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Dated: October 13, 2009

**UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION**

**Atomic Safety and Licensing Board**

<b>In the Matter of</b>	)	
	)	
<b>U.S. DEPARTMENT OF ENERGY</b>	)	<b>Docket No. 63-001-HLW</b>
	)	
<b>(High Level Waste Repository)</b>	)	<b>October 13, 2009</b>

**CERTIFICATE OF SERVICE**

I hereby certify that the foregoing State of Nevada's Initial Party Witness List for Phase I Discovery has been served upon the following persons by the Electronic Information Exchange:

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**Exhibit 1**  
**Nevada's Party Witness Designations**

## EXHIBIT 1

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	General subject matter that will be addressed	
	Specific list of contentions that will be addressed	
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	NEV-SAFETY-042-044, 055-059, 067, 070, 071, 078, 079 and 113-116	
	Dr. Bath's CV and list of publications is provided as Exhibit 2. Dr. Bath has not provided any testimony in the past 4 years.	
Dr. Adrian P. Butler	Department of Civil & Environmental Engineering Imperial College	Skempton Building London, SW7 2AZ, UK
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	NEV-SAFETY-035, 044-047, 049, 050, 052, 053 and 065	
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	NEV-SAFETY-014-018, 024, 028-030, 034, 035 and 037-040	
	Dr. Chandler's CV and list of publications is provided as Exhibit 4. Dr. Chandler has not provided any testimony in the past 4 years.	

Dr. Robert A. Cottis	Corrosion Science & Engineering Corrosion and Protection, Centre University of Manchester Manchester, UK	P.O. Box 88, Sackville Street Manchester, M60 1QD, UK
<p>Emplacement drift geochemistry, corrosion, waste dissolution, drip shields, and rock structure, geomechanics and engineered barrier systems</p> <p>NEV-SAFETY-073, 075, 076, 080-094, 097-110, 124-127, 129 and 142</p> <p>Dr. Cottis' CV and list of publications is provided as Exhibit 5. Dr. Cottis has not provided any testimony in the past 4 years.</p>		
Dr. Douglas F. Hambley	Agapito Associates, Inc.	2 East 22nd Street Suite 307 Lombard, IL 60148-6106
<p>Emplacement drift seepage, corrosion, drip shields, rock structure, geomechanics and engineered barrier systems, human reliability, retrievability, TAD inspection and verification, and emergency plan effect on post-closure</p> <p>NEV-SAFETY-061-064, 077, 090, 121-123, 128, 130-134, 136-141, 144, 147, 148, 162, 168 and 173</p> <p>Dr. Hambley's CV and list of publications is provided as Exhibit 6A. Dr. Hambley's prior testimony list is provided as Exhibit 6B.</p>		
Francis S. Kendorski	Agapito Associates, Inc.	2 East 22nd Street, Suite 307 Lombard, IL 60148-6106
<p>Emplacement drift seepage, rock structure, geomechanics and engineered barrier systems</p> <p>NEV-SAFETY-077, 121, 123, 131-134 and 136</p> <p>Mr. Kendorski's CV and list of publications is provided as Exhibit 7. Mr. Kendorski has not provided any testimony in the past 4 years.</p>		
Dr. Stephan K. Matthäi	Chair of Reservoir Engineering Department of Mineral Resources and Petroleum Engineering Montan University of Leoben Austria	Max Tandler Strasse 4 8700 Leoben, Austria
<p>Infiltration, unsaturated zone flow and transport, emplacement drift seepage, and corrosion</p> <p>NEV-SAFETY-041, 047, 048, 050-054, 061-064, 066, 095 and 096</p> <p>Dr. Matthäi's CV and list of publications is provided as Exhibit 8. Dr. Matthäi has not provided any testimony in the past 4 years.</p>		

James A. McMaster	MC Consulting	5483 Bluff Head Road Huletts Landing, NY 12841
	Corrosion and drip shields	
	NEV-SAFETY-080-085, 124-130, 142-145 and 162	
	Mr. McMaster's CV and list of publications is provided as Exhibit 9. Mr. McMaster has not provided any testimony in the past 4 years.	
Dr. Maurice E. Morgenstein	President Geosciences Management International, Ltd. Monmouth, Oregon	450 S. Walnut Drive Monmouth, OR 97361
	Unsaturated zone flow and transport, unsaturated zone geochemistry, emplacement drift seepage, emplacement drift geochemistry, corrosion, waste dissolution, and saturated zone geochemistry	
	NEV-SAFETY-055, 056, 060, 065, 067-073, 084, 086-100, 105-109, 111, 112, 114, 115 and 117	
	Dr. Morgenstein's CV and list of publications is provided as Exhibit 10. Dr. Morgenstein has not provided any testimony in the past 4 years.	
Dr. Jonathan T. Overpeck	Institute for Environment and Society (IES) University of Arizona Tucson, Arizona	715 N. Park Ave., 2nd Floor Tucson, AZ 85721
	Climate and precipitation	
	NEV-SAFETY-009-013, 018 and 019	
	Dr. Overpeck's CV and list of publications is provided as Exhibit 11. Dr. Overpeck has not provided any testimony in the past 4 years.	
Dr. Lawrence D. Phillips	Visiting Professor of Decision Sciences London School of Economics	1 Ladywell Court 22 East Heath Road London, NW3 1AH, UK
	Volcanism	
	NEV-SAFETY-164	
	Dr. Phillips' CV and list of publications is provided as Exhibit 12. Dr. Phillips has not provided any testimony in the past 4 years.	

Dr. Don L. Shettel	Consulting Geochemist GeoData Systems	1616 Broadmoor Court Boulder City, NV 89005
	Unsaturated zone flow and transport, unsaturated zone geochemistry, emplacement drift seepage, emplacement drift geochemistry, saturated zone geochemistry, corrosion, drip shields, and rock structure, geomechanics and engineered barrier systems	
	NEV-SAFETY-048, 049, 055-059, 061-064, 067, 077-079, 113, 116, 123, 130 and 162	
	Dr. Shettel's CV and list of publications is provided as Exhibit 13. Dr. Shettel has not provided any testimony in the past 4 years.	
Dr. Eugene I. Smith	Department of Geoscience University of Nevada	4505 S. Maryland Pkwy Las Vegas, NV 89154-4010
	Volcanism	
	NEV-SAFETY-150-158 (to be consolidated with CLK-SAFETY-003-011 and INY-SAFETY-003)	
	Dr. Smith's CV and list of publications is provided as Exhibit 14. Dr. Smith has not provided any testimony in the past 4 years.	
Dr. Michael C. Thorne	Mike Thorne and Associates, Ltd.	Abbotsleigh, Kebroyd Mount Ripponden, Halifax West Yorkshire HX6 3JA, UK
	Climate and precipitation, infiltration, saturated zone geochemistry, corrosion, drip shields, volcanism, rock structure, geomechanics and engineered barrier systems, biosphere factors, human reliability, and TSPA & PMA	
	NEV-SAFETY-009-011, 041, 074, 117-120, 122, 147, 148, 159-164 and 170, and NEV-NEPA-018	
	Dr. Thorne's CV and list of publications is provided as Exhibit 15A. Dr. Thorne's prior testimony list is provided as Exhibit 15B.	
Dr. Howard S. Wheeler	Imperial College of Science, Technology & Medicine	Skempton Building London, SW7 2AZ, UK
	Climate and precipitation, and infiltration	
	NEV-SAFETY-014-018, 020-038, 040 and 046	
	Dr. Wheeler's CV and list of publications is provided as Exhibit 16A. Dr. Wheeler's prior testimony list is provided as Exhibit 16B.	

**Exhibit 2**  
**Dr. Adrian A. Bath's Curriculum Vitae**

## **Dr Adrian Bath**

### *Capabilities, Qualifications and Experience*

<b>Capabilities</b>	Environmental geochemistry and contaminant chemistry in groundwaters, the surface environment and engineered systems. Services for clients in radioactive waste management, hazardous waste management, environmental remediation, water resources and environmental quality.
<b>Qualifications</b>	BA (Chemistry) and PhD (Isotope Geochemistry), Oxford University CGeol (Chartered Geologist)
<b>Affiliations</b>	Fellow of the Geological Society, UK; Member of the Geochemical Society, USA; Member of the International Association of Hydrogeologists Member of the International Association of Geochemistry
<b>Contact</b>	E: abath@intellisci.co.uk    T: +44-(0)1509-889229    M: +44-(0)7769-712233
<b>Employment</b>	2000 to present    Intellisci Ltd, Loughborough, UK Independent geoscientific consultant 1994 to 1999    Golder Associates (UK) Ltd, Nottingham, UK Principal geochemistry consultant 1974 to 1994    British Geological Survey, Keyworth, UK Group manager, environmental and waste management group

#### **SUMMARY OF EXPERIENCE**

- Environmental geochemistry and contaminant chemistry in groundwaters, the surface environment and engineered systems.
- Services for clients in radioactive waste management, hazardous waste management, environmental remediation, water resources and environmental quality.
- 33 years as research scientist in groundwater chemistry, hydrogeology, and environmental chemistry.
- 24 years in applying geochemistry in radioactive waste management, environmental behaviour of radionuclides, and safety assessment of waste repository sites.
- Providing scientific advice and services to European, American and Japanese radioactive waste management and nuclear regulatory organisations.
- Planning and interpretation of site investigations for repositories and underground laboratories in crystalline rock and clay rock.
- Geochemical modelling of radionuclides in engineered barriers, groundwater systems around repositories, and in contaminated construction materials.
- Specialist problem-solving inputs to projects concerning hazardous waste management, landfill disposal, groundwater contamination and geotechnics.
- Scientific management and review activities in projects on hydrogeochemistry, isotope hydrology, groundwater flow, solute transport, groundwater/soils contamination, and palaeohydrogeology.
- Lead author of many scientific publications and consultancy reports on the applications of geochemistry in radioactive waste management and other areas of groundwater and environmental science.
- Expert adviser/reviewer to national/international organisations, peer reviewer for scientific journals, conference organiser, external examiner for MSc and PhD at European universities.

#### **PROJECTS**

- **NDA–Radioactive Waste Management Directorate (2008-ongoing)**  
Member of high-level Geosphere Characterisation Advisory Panel (GeoCAP). Provide preview and review of activities being undertaken with the geosphere characterisation project, and provide ad hoc advice of geoscientific aspects of characterising sites for potential geological disposal facility. Additional framework contract to provide scientific consultancy services to support implementation of UK's geological disposal facility, specifically to represent NDA-RWMD on high-level specialist groups.
- **Low Level Waste Repository Ltd (LLWR) (2007-ongoing)**  
Member of Peer Review group, focusing on geochemistry and hydrogeology. Review documents prepared by LLWR and contractors for authorisation of repository at Drigg, including EA's schedule 9 requirements, radiological capacity, design of vault 9, R&D programme, other work leading to post-closure safety case in 2011.
- **NDA–Radioactive Waste Management Directorate (2006-2008)**



Responsible for geochemistry in GeoCORE project for developing strategy, capability and technical plans for characterising potential repository sites in the UK. Contribute to strategic plan, produce information requirements for geochemistry and hydrogeology. Specify technology requirements and research needs. Review and update Nirex geosphere characterisation project documentation.

- **STUK (Radiation and Nuclear Safety Authority), Helsinki, Finland (2007-ongoing)**

Member of ONKALO expert group (SONEX). Responsible for review of geochemistry and hydrogeology outputs from Posiva's underground rock characterisation excavation (ONKALO). Commentary on site investigation strategies with focus on the geochemical and hydrogeological data requirements for a deep repository performance assessment and on the general arguments for site suitability and safety.

- **Nagra Switzerland and University of Berne (for the Nuclear Energy Agency) (2007-2008)**

CLAYTRAC project for the NEA's 'Clay Club' special interest group on clay rock as repository hosts. Compilation and quality review of geochemical and isotopic data from clay rock investigations at potential repository sites and at underground laboratories worldwide. Assistance to modellers at University of Berne in setting up parameters and boundary conditions for diffusion-advection transport modelling of natural solute and isotope profiles. The aim of the project is to review natural tracer evidence for solute transport processes in clay rock repository hosts.

- **Golder Associates GmbH for Bundesamt für Strahlenschutz (BfS), Germany (2007-2008)**

Compilation of information on strategies for investigation of sites for deep repositories and underground laboratories. Data for borehole drilling, hydrogeological testing and hydrochemical sampling. Description of testing methods and outcomes with discussions of site-specific strategic and logistical issues. Advice to BfS on applicability and lessons learned for German site selection and investigations according to AkEnd recommendations and criteria.

- **DEFRA and Committee on Radioactive Waste Management, UK (2005-2007)**

Provision of expert advice and input at workshops of the UK government's Committee on Radioactive Waste Management (CoRWM, 2005-6). Production of methods for technical scoring of radioactive waste disposal options. Participation in options scoring sessions. Attendance as specialist panel member to assist CoRWM discussion on geological disposal options and safety. Member of Defra's Site Screening Criteria Proposals Group (2007). Drafting of technical annexe on geoscientific site screening for government consultation on a framework for implementing geological disposal in the 'Managing Radioactive Waste Safely' programme.

- **European Commission, Brussels (2005-2008)**

Expert peer reviewer for EC of annual progress in the ACTINET project (FP6 Network of Excellence for Actinide Sciences). Review progress reports and technical outputs from work packages on actinide chemistry and geochemistry. Attend annual review presentations and discussions with project management team, executive board and research leaders. Make recommendations to EC.

- **State of Nevada, USA via Egan, Fitzpatrick & Malsch PLLC (2004-ongoing)**

Assistance in assessing the proposed USDOE HLW and spent fuel repository at Yucca Mountain, Nevada. Review of geochemical, hydrogeological and engineered barrier chemistry designs, analytical and process model reports, and other documentation.

- **Golder Kft. and PURAM (Hungarian Radioactive Waste Authority), Hungary (2004-2006)**

Development of a reactive transport model using the PHREEQC geochemical model for radionuclide solubility and sorption in engineered barrier of repository concept in fractured rocks. Simulation of long-term evolution of repository system and provision of radionuclide transport parameters for safety analysis. Estimation of hydrogeological, geochemical and radionuclide transport parameters for a preliminary safety analysis of potential spent fuel repository in a clay rock.

- **SSM (Swedish Radiation Safety Authority, previously SKI), Stockholm, Sweden (2001-ongoing)**

Member of INSITE group advising on SSM's review of SKB investigations at proposed sites for a deep HLW repository. Advice to SSM on geochemical data requirements and evaluation of priorities in safety case of repository in crystalline rock. Review of repository implementer's strategic plans, scientific methods, designs, Site Descriptive Models and preliminary safety assessments SR-Can and SR-Site. Specifications for geochemical data requirements from site characterisation. Study of geochemical and isotopic methods of investigating groundwater stability.

- **UK Nirex Ltd (2000-2005)**

Provision of consultancy services for the planning of site characterisation at potential repository sites, focusing especially on sampling and testing for geochemistry and hydrogeology. Development of methods for interpretation of hydrochemical and isotopic data, geochemical modelling and regional groundwater modelling.

- **DEFRA, UK (2005)**

Review and evaluation of the 2001 UK Radioactive Waste Inventory including appendices for MoD and BNFL stocks.

- **Quintessa K.K. for NUMO, JAEA and RWMC, Japan (2004-2006)**

Evaluation of methods for measuring and interpreting in situ groundwater compositions from data obtained in boreholes during site investigations. Compilation of hydrochemical data and groundwater flow information for low-permeability, low-flow groundwater settings for potential repository sites. Review of a classification system using Evidence Support Logic for assessing the quality of hydrogeochemical data from the Tono/Mizunami area.

- **Brenk Systemplanung GmbH, Aachen, Germany (2002-2003)**

Study of radioactive contamination by concrete in nuclear facilities and of subsequent releases on reuse or disposal after decommissioning and dismantling. Theoretical study and literature review of locations of radionuclides in contaminated concrete. Development of numerical models for release of radionuclides in various scenarios, construction of source terms for radiological dose assessments and comparisons with clearance levels.

- **European Commission & UK Nirex Ltd (2002-2005)**

PADAMOT (Palaeohydrogeological Data Analysis and Model Testing) research project in the 5th Framework Programme of the EU with Nirex (UK), SKB (Sweden), ENRESA (Spain) RAWRA (Czech Republic) and BGS (UK). Investigation of methods for assessing stability of groundwater conditions for long-term safety of radioactive waste repositories. Development of geochemical models for water-rock reaction and secondary mineralisation in shallow and deep groundwaters.

- **Mont Terri Project International Consortium, Switzerland (2000-2002)**

Interpretation and reporting of isotopic, geochemical and hydrogeological data from borehole investigations in mudrocks at Mont Terri underground laboratory in Switzerland. Joint editor of a major synthesis of geochemical data and interpretations. Interpretation of isotopic and geochemical data for evolution of clay pore waters.

- **SKB (Swedish Radioactive Waste Company), Stockholm, Sweden (2000-2001)**

Scientific peer review of international research project on coupling of hydrochemical and hydrogeological models at Äspö underground laboratory, Sweden.

- **European Commission, Brussels, Belgium and UK Nirex Ltd, Harwell, UK (1997-2000)**

Co-ordination and management of EQUIP research project on geochemical and mineral indicators of groundwater history in low permeability terrain for repository siting for EC R&D Programme on Radioactive Waste Management. European partners: Posiva (Finland), SKB (Sweden), Andra (France), Enresa (Spain), UK Nirex, Environment Agency.

- **Enresa (Spanish Radioactive Waste Company), Madrid, Spain (1996-1998)**

Chemical modelling of bentonite backfill and of radionuclide solubilities for spent fuel disposal concepts in granite and clay rocks. Geochemical modelling of sorption and solubilities of radionuclides and providing parameters for safety analyses.

- **International Atomic Energy Agency, Vienna, Austria (1996)**

Expert consultancy in evaluating the use of natural analogue information to support geochemical and radionuclide transport models for geological repositories

- **UK Nirex Ltd, Harwell, UK (1991-1998)**

Lead investigator in geochemistry and hydrogeology tasks for safety assessment of deep radioactive waste repository at Sellafield, UK. Design and specification of data acquisition. Interpretation of geochemical data for site characterisation and safety assessment. Technical tasks include geochemical modelling, isotope hydrology, baseline data assessment, evaluation of uncertainties in geochemical data for safety analyses.

## SELECTED REPORTS AND PUBLICATIONS

- Apted, M., Arthur, R., Bath, A., Mazurek, M., Rutqvist, J., Saario, T., Saarnisto, M., Stephansson, O. and Tsang, C-F. (2008) Review of Posiva 2006-05: Expected evolution of a spent nuclear fuel repository at Olkiluoto. Report to STUK, Helsinki, Finland. April 2008.
- Styles, P., Wheeler, H. and others (2007) Sub-surface exclusion criteria for geological disposal: Joint report of the Criteria Proposals Group (CPG) and the Criteria Review Panel (CRP). Appendix in the Managing Radioactive Waste Safely (MRWS) consultation and 2008 White Paper. Defra.

- Bath, A. and Metcalfe, R. (2008) NDA-RWMD Geosphere Characterisation Project: Data Acquisition Report: Groundwater Sampling and Analysis Techniques. Quintessa Report QRS-1421A-R2 v1.1, May 2008.
- Mazurek, M., Alt-Epping, P., Bath, A., Gimmi, T. and Waber, H.N. (2008) CLAYTRAC Project: Natural tracer profiles across argillaceous formations – review and synthesis. Report NEA No 6253, Radioactive Waste Management, Nuclear Energy Agency, OECD, Paris. 375 pp.
- Bath, A. and Hermansson, H-P. (2007) Impacts of Future Glaciations on Geochemical Conditions at Repository Depth: Review of SKB's Approach. Report by Intellisci Ltd and Studsvik AB for SKI Stockholm. 63 pp.
- Mazurek, M., Bath, A., Niemi, A., Stephansson, O. and Tirén, S. (2007) Consolidated review of Olkiluoto Site Description 2006, Posiva 2007-03. Review report by SONEX team for STUK, Helsinki, Finland.
- Mazurek, M., Alt-Epping, P., Gimmi, T., Waber, H.N., Bath, A., Buschaert, S. and Gautschi, A., (2007) Tracer profiles across argillaceous formations: a tool to constrain transport processes. Extended abstract, Procs 12th Intl Symp on Water-Rock Interaction, WRI-12, 13-18 Aug 2007, Kunming, China.
- Stephansson, O., Bath, A., Niemi, A. and Tirén, S. (2007) Review of Posiva's TKS-2006 programme. Review report by Site SONEX team for STUK, Helsinki, Finland.
- Mazurek, M., Alt-Epping, P., Bath, A., Buschaert, S., Gautschi, A., Gimmi, T. and Waber, H.N. (2007) CLAYTRAC project: evaluation of tracer profiles across argillaceous formations. Abstract, 3rd International Meeting on Clays in Natural and Engineered Barriers for Radioactive Waste Confinement, Lille, 17-20 Sept 2007. Andra, Châtenay-Malabry, France
- Bath, A. (2007) Interpreting the evolution and stability of groundwaters in fractured rocks. In: Groundwater in Fractured Rocks (J Krásný & JM Sharp, eds), IAH Selected Papers on Hydrogeology Volume 9, Intl Assoc of Hydrogeologists, pp 261-274. Taylor & Francis, London..
- Bath, A (2007) Geochemistry Strategy and Site Investigation Flow Diagrams for GeoCORE. Report 0607.17 by Intellisci Ltd for UK Nirex, March 2007. 47 pp.
- Chapman, N., Wilmot, R. and others (2007) Expert Evaluation of the Swedish Nuclear Fuel and Waste Management Company's Safety Assessment SR-Can Report of the Site Investigation Group. Report by INSITE/OVERSITE to SKI, Stockholm, June 2007. 41 pp.
- Bath, A. and Hermansson, H-P. (2007) Variability and Uncertainties of Key Hydrochemical Parameters for SKB Sites. SKI Report 2007:03, by Intellisci Ltd and Studsvik AB for SKI Stockholm. 56 pp.
- Metcalfe, R., Crawford, M.B., Bath, A.H., Littleboy, A.K., Degnan, P.J. and Richards, H.G. (2007) Characteristics of deep groundwater flow in a basin marginal setting at Sellafield, northwest England: 36Cl and halide evidence. Applied Geochemistry, 22, 128-151.
- England, G.L., Gillespie, M.R., Milodowski, A.E., Haszeldine, R.S., Degnan, P.J., Bath, A. and Macleod, G. (in press) Palaeo-redox conditions of groundwater during glaciation at Sellafield, UK revealed by SIMS analysis of REE in fracture-fill calcite. Accepted for publication in Chemical Geology.
- Bath, A. (2006) Contributions to Design and Performance Assessment of a Proposed LILW Repository at Bataapáti, Hungary. Final Report, Task 1: Geochemistry FEPs (Features, Events and Processes). Report prepared for Golder Associates (Hungary) Kft. 49 pp.
- Bath, A., Richards, H., Metcalfe, R., McCartney, R., Degnan, P. and Littleboy, A. (2006) Geochemical Indicators of Deep Groundwater Movements at Sellafield, UK. In: Special vol. 'Geochemical Aspects of Radioactive Waste Disposal' (guest eds. J-B Peyaud, T de Putter and I McKinley). Journal of Geochemical Exploration, 90, 24-44.
- Darling, W.G., Bath, A.H., Gibson, J.J. and Rozanski, K. (2006) Isotopes in Water. Chapter 1 in 'Isotopes in Palaeoenvironmental Research' (Leng, M.J., ed.), pp 1-66, Developments in Palaeoenvironmental Research, Vol. 10, Springer, Dordrecht, 307pp.
- Bath, A. (2006) Geochemical Investigations of Groundwater Stability. SKI Report 2006:12, by Intellisci Ltd for SKI Stockholm. 83 pp.
- Deissmann, G., Bath, A., Jefferis, S., Thierfeldt, S. and Wörten, S. (2006) Development and application of knowledge-based source-term models for radionuclide mobilisation from contaminated concrete. In: Van Iseghem, P. (ed.): Scientific Basis for Nuclear Waste Management XXIX. Mat. Res. Soc. Symp. Proc. 932: 259-266.
- Goldsworthy, M., Dankó, G., Kovacs, L., Bath, A. and Frigyesi, F. (2005) Initial performance assessment for a deep geological repository for HLW at Boda. Proceedings of ICEM'05: 11th International Conference on Radioactive Waste Management and Environmental Remediation, 5-8 Sept 2005, Glasgow, Scotland. 6pp. American Society of Mechanical Engineers, Tucson

- Degnan, P., Bath, A., Cortés, A., Delgado, J., Haszeldine, S., Milodowski, A., Puigdomenech, I., Šilar, J., Torres, T. and Tullborg, E.-L. (2005) PADAMOT: Project Overview Report. PADAMOT Project – EU FP5 Contract No FIKW-CT2001-20129. 85 pp. UK Nirex Ltd., Harwell.
- Bath, A. (2005) Technical Review of the 2001 United Kingdom Radioactive Waste Inventory: Main Report and Detailed Reports for BNFL Wastes and MoD Wastes (DEFRA Reports DEFRA/RAS/02.004, 02.005, 02.009 and Nirex Reports N/042, N/043, N/047). Report by Intellisci Ltd for DEFRA, London, 14pp. March 2005.
- Bath, A., Goldsworthy, M., Dankó, G. and Kovacs, L. (2005) Parameters for pre-investigation assessment of a fractured claystone as a repository host in Hungary. Abstract, Intl Meeting on Clays in Natural and Engineered Barriers for Radioactive Waste Confinement, Tours, France.
- Bath, A. and Jefferis, S. (2004) Performance of Concrete in the Source Term for Performance Assessment of the Proposed LILW Repository, Bataapáti, Hungary: Geochemical and Geotechnical Considerations. Report for Golder Associates (Hungary) Kft. May 2004, 92pp.
- Bath, A. (2004) Pre-investigation Estimates for Hydrogeological, Geochemical and Radionuclide Transport Parameters for the Boda Claystone (Host Formation for Proposed Spent Fuel Repository), Pécs, Hungary. Report for Golder Associates (Hungary) Kft. June 2004, 37pp.
- Bath, A. and C.P. Jackson (2004) Brines at the West Cumbrian Coast: Technical Note and Supplementary Memorandum on Comparison of Hydrodynamic and Geochemical Water Ages. Reports by Intellisci Ltd and Serco Assurance for Nirex, February 2004. 28 pp & 11pp.
- Bath, A., Deissmann, G. and Jefferis, S. (2003) Radioactive contamination of concrete: uptake and release of radionuclides. Proceedings of ICEM'03: 9th International Conference on Radioactive Waste Management and Environmental Remediation, 21-25 Sept 2003, Oxford, England. ICEM03-4814, 8pp. American Society of Mechanical Engineers, Tucson.
- Bath, A. and Strömberg, B. (2003) Geochemical Indicators of Groundwater Stability. Proceedings of MRS 2003, Kalmar, Sweden. Scientific Basis for Radioactive Waste Management XXVII, Volume 807, pp 773-778. Materials Research Society, Boston, USA.
- Bath, A. and Jefferis, S. (2003) Release of Radionuclides from Concrete and Building Rubble from the Dismantling of Nuclear Installations. Task 4: Release Behaviour of Radionuclides from Concrete Material. Final Report – February 2003. Report for Brenk Systemplanung GmbH, Aachen, Germany.
- Pearson, F.J., Arcos, D., Bath, A., Boisson, J.Y., Fernández, A. M<sup>a</sup>, Gäbler, H.-E., Gaucher, E., Gautschi, A., Griffault, L., Hernán P. and Waber H.N. (2003) Geochemistry of Water in the Opalinus Clay Formation at the Mont Terri Rock Laboratory. Mont Terri Project – Technical Report 2003-03. Reports of the Federal Office for Water and Geology, Geology Series, No. 5. 319pp., Bern-Ittigen, Switzerland
- Bath, A.H. and Jackson, C.P. (2003) Äspö Hard Rock Laboratory. Task Force on Modelling of Groundwater Flow and Transport of Solutes. Review of Task 5. International Progress Report IPR-03-10. SKB, Stockholm, Sweden.
- Bath, A. (2002) Geochemical Parameters Required from the SKB Site Characterisation Programme. Report by Intellisci Ltd for Swedish Nuclear Safety Inspectorate, Stockholm. SKI Report 02:13. 47pp. January 2002.
- Bath, A., Milodowski, A., Ruotsalainen, P., Tullborg, E.-L., Cortés Ruiz, A. and Aranyosy, J.-F. (2000) Evidence from Mineralogy and Geochemistry for the Evolution of Groundwater Systems During the Quaternary (EQUIP Project). Final Report, Contract No FI4W-CT96-0031. Euratom/EC DG Research Report EUR 19613EN. European Commission, Luxembourg. 157pp.
- Richards, H.G. and Bath, A.H. (1997) The Hydrochemistry of Sellafield: 1997 Update. Nirex Report SA/97/089. UK Nirex Ltd.
- Bath, A.H., McCartney, R.A., Richards, H.G., Metcalfe, R. and Crawford, M.B. (1996) Groundwater chemistry in the Sellafield area: a preliminary interpretation. In 'The Geology and Hydrogeology of the Sellafield Area', Quarterly J. Eng. Geol. 29 S39-S57.
- Reeder, S., Cave, M.R., Bath, A.H., Entwisle, D.C., Inglethorpe, S.J., Pearce, J.M., Trick, J.K., Blackwell, P.A., Green, K.A. (1993) A study of the Boom clay drillcore from Mol in Belgium. Chemical and isotopic characterization of porewater and clay mineralogy. BGS Technical Report WI/93/12C.



## **Adrian Bath**

### *Publications and Reports*

- Mazurek, M., Alt-Epping, P., Bath, A., Gimmi, T. and Waber, H.N. (2009) CLAYTRAC Project: Natural tracer profiles across argillaceous formations – review and synthesis. Report NEA No 6253, Radioactive Waste Management, Nuclear Energy Agency, OECD, Paris. 375 pp.
- Bath, A. and Hermansson, H-P. (2009) Biogeochemistry of Redox at Repository Depth and Implications for the EBS. Report by Intellisci Ltd and Studsvik AB for SSM Stockholm. 102 pp.
- Apted, M., Arthur, R., Bath, A., Mazurek, M., Rutqvist, J., Saario, T., Saarnisto, M., Stephansson, O. and Tsang, C-F. (2008) Review of Posiva 2006-05: Expected evolution of a spent nuclear fuel repository at Olkiluoto. Report to STUK, Helsinki, Finland. April 2008.
- Bath, A. and Metcalfe, R. (2008) Geosphere Characterisation Project: Data Acquisition Report: Groundwater Sampling and Analysis Techniques. Quintessa Report for NDA-RWMD QRS-1421A-R2 v1.1, May 2008.
- Styles, P., Wheeler, H. and others (2007) Sub-surface exclusion criteria for geological disposal: Joint report of the Criteria Proposals Group (CPG) and the Criteria Review Panel (CRP). Report to Defra and Appendix in the Managing Radioactive Waste Safely (MRWS) consultation and 2008 White Paper.
- Goldsworthy, M. et al. (in press) Anforderungen an Methoden und Umfang der über- und untertägigen Erkundung eines Standortes für ein Endlager unter Einbeziehung eines internationalen Vergleichs - Sachstandsdarstellung 2. Vorhaben SR-2555. Interim report by Golder Associates GmbH for Bundesamt für Strahlenschutz (BfS). Celle, Germany.
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**Exhibit 3A**  
**Dr. Adrian H. Butler's Curriculum Vitae**

## Curriculum Vitae

### DR ADRIAN BUTLER

<b>Name:</b>	Adrian Paul Butler	
<b>Date of birth:</b>	13 July 1960	
<b>Nationality:</b>	British	
<b>Present Appointment:</b>	Reader in Subsurface Hydrology Department of Civil & Environmental Engineering, Imperial College London	
<b>Degrees:</b>	B.Sc. (1st Class Honours) Physics University of London (Imperial College)	1981
	M.Sc. Engineering Hydrology University of London (Imperial College)	1985
	Ph.D. Groundwater Hydrology University of London (Imperial College)	1993
<b>Appointments:</b>	Reader in Subsurface Hydrology Imperial College of Science, Technology & Medicine	2005
	Senior lecturer Imperial College of Science, Technology & Medicine	2000
	Lecturer Imperial College of Science, Technology & Medicine	1992
	Research Assistant Imperial College of Science, Technology & Medicine	1988
	Scientific/Higher Scientific Officer Meteorological Office, Bracknell	1981 – 1984
<b>Memberships of learned societies:</b>	Fellow, Royal Meteorological Society	1984
	Member, British Hydrological Society	1988
	Member, American Geophysical Union	2004
	Member, Soil Science Society of America	2004
	International Association of Hydrogeologists	2005
	Fellow, The Geological Society	2009
<b>Teaching:</b>	Lecturer to Engineering Hydrology MSc/DIC Course	
	Lecturer to Environmental Engineering MSc/DIC Course	
	Lecturer to Environmental Technology MSc/DIC Course	
	Lecturer to Environmental Diagnosis MSc/DIC Course	
	Lecturer to Civil Engineering and Civil and Environmental Engineering, MEng	
<b>Recent research grants and contracts:</b>	Radionuclide transport in vegetated soils UK Nirex/NDA/ANDRA, £3.5 million	1988-2007
	Lowland Catchment Research (LOCAR): Investigation of groundwater flow heterogeneity in chalk aquifers using detailed borehole arrays and stochastic modelling techniques, NERC £290k Hydrogeochemical functioning of lowland permeable	2002-2006

	catchments: from process understanding to environmental management, NERC/Environment Agency, £500k	
	Decision support tool for innovative in-situ multi-contaminant groundwater remediation, DTI, £232k	2006-2009
	Modelling groundwater flood risk from extreme events NERC FREE thematic programme, approx £250k	2007-2011
	DIAMOND: Decommissioning, Immobilisation And Management Of Nuclear wastes for Disposal, EPSRC, £52	2008-2011
<b>Research training:</b>	17 PhD students, 60 MSc students (approx)	1993 – date
<b>College administration:</b>	Senior Tutor, Department of Civil and Environmental Engineering	2003 – 2009
<b>Professional and consultancy activities:</b>		
	Consultant British Nuclear Fuels Limited: Development of an experimental and modelling programme to investigate the hydrology at the low-level nuclear waste site, Drigg, Cumbria	1992 – 2000
	Committee member British Hydrological Society (BHS) South East Section	1995 – 2005
	Chairman of the local organising committee of BHS2004: International Conference in Hydrology (July 2004)	2003 – 2004
	National committee member British Hydrological Society	1995 – 2003
	Member of expert elicitation panel for the Food Standards Agency on modelling soil-plant transfer of radionuclides	2001
	Scientific Advisory Committee for ModelCARE 2005	2003 – 2005
	Consultant to Expedition Engineering: Development of Kempton Park racecourse	2004 – 2005
	Technical Expert for the State of Nevada: Review of DOE safety case of radioactive waste repository at Yucca Mountain	2004 –
	Consultant to Quintessa: Preliminary Safety Analysis Report for the Low-Level Radioactive Waste Repository Baita Bihor, Romania.	2005 – 2006
	Member of DEFRA review group on Sources and Impacts of Past, Current and Future Contamination of Soil	2005 – 2006
	UK Groundwater Modelling Forum Committee Member	2005 –
	Editorial Board Quarterly Journal of Engineering Geology and Hydrogeology, Geological Society	2008 –
	Expert witness for Environment Agency prosecution case against Magnox Limited.	2008 – 2009

**Research expertise:**

Published research is primarily associated with work on measuring, analysing and modelling subsurface flow and transport processes and their associated environmental impact. Particular areas within this context are:

- i) Migration of radionuclides through soil and uptake by vegetation
- ii) Application of stochastic contaminant transport modelling to groundwater protection
- iii) Development of new modelling techniques for environmental risk assessment
- iv) Development of analytical/modelling tools for flow and transport in fractured rock

Major contributions include:

- development of physically-based models of soil-to-plant transfer of radionuclides, which have provided the basis for new developments in safety assessment models for radioactive waste disposal;
- use of stochastic modelling techniques to represent the effects of uncertainty, arising from spatial heterogeneity, in groundwater protection;
- development of new methods for investigating and modelling flow and transport in permeable (fractured) catchments, in particular the Chalk of southern and eastern England.

**Publications:****Refereed Journals**

Butler, A.P., Mathias, S.A., Gallagher, A.J., Peach, D.W. and Williams, A.T. Analysis of flow processes in fractured chalk under pumped and 1 ambient conditions. *Hydrogeology Journal*, (2009), Published on-line 04 June 2009, DOI - 10.1007/s10040-009-0477-4.

Mathias, S.A., Butler, A.P., Atkinson, T.C., Kachi, S., and Ward, R.S. A parameter sensitivity analysis of two chalk tracer tests, *Quart. Journ. Eng. Geol. and Hydrogeol.*, *Quart. J. Eng. Geol. and Hydrogeol.* (2009), 42(2), 237-244.

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Buss, S.E., Butler, A.P., Johnston, P.M., Sollars, C.J. and R. Perry, Mechanisms of leakage through synthetic liner materials at waste containment sites, J. CIWEM, (1995), 9, 353-359.

Burne, S., Wheater, H.S., Butler, A.P., Johnston, P.M., Wadey, P., Shaw, G. and Bell, J.N.B., Radionuclide transport above a near-surface water table: I. An automated lysimeter facility for near-surface contaminant transport studies, J. Environmental Quality, (1994), 23, 1318-1329.

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Butler, A.P., Grundy, J.D. and May, B.R., An analysis of extreme rainfalls in Jersey, Meteorological Magazine, (1985), 114, 383-395.

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Ireson A.M., Wheater H.S., Butler A.P., Mathias S.A., Finch J., Movement of Water through the Chalk Unsaturated Zone: Development of a Depth-Dependent Model Parameterisation, Soil Physics and

Rural Water Management – Progress, Needs and Challenges (Proceedings of the International Symposium SOPHYWA September 28–29, 2006, Vienna, Austria).

Bakr, M.I., Butler, A.P., Guadagnini, A. & Riva, M. (2005), A state-space first-order method to estimate well catchment uncertainty. Proceedings volume Calibration and Reliability in Groundwater Modelling: From Uncertainty to Decision Making (Proceedings of ModelCARE'2005, The Hague, The Netherlands, June 2005).

Mathias, S.A., Butler, A.P., McIntyre, N. and Wheeler, H., Applicability of box models to dual porosity systems, Hydrology: Science and Practice for 21<sup>st</sup> Century (Vol I), (2004), 315-321.

Howden, N.J.K., Wheeler, H.S., Peach, D.W. & Butler, A.P., Hydrogeological controls on surface/groundwater interactions in a lowland catchment, Hydrology: Science and Practice for 21<sup>st</sup> Century (Vol II), (2004), 113-122.

Jackson, B.M., Wheeler, H.S., McIntyre, N., Butler, A.P., Whitehead, P. and Wade, A., Calibration and uncertainty issues arising from a process-based integrated nitrogen model (INCA) placed within a subjective probability framework, Hydrology: Science and Practice for 21<sup>st</sup> Century (Vol II), (2004), 123-129.

Zacharof, A.I. and Butler, A.P., Modelling landfill process incorporating data uncertainty – model assessment against experimental data using statistical techniques. Christensen, T.H., Cossu, R., Stegmann, R. ed. (CISA, Italy), 2003, (Proc. 9th Int. Waste Management and Landfill Symp., 2003).

Butler, A.P., Brook, C., Godley, A., Lewin, K. and Young, C.P., Attenuation of landfill leachate in unsaturated sandstone, Christensen, T.H., Cossu, R., Stegmann, R. ed. (CISA, Italy), 2003, (Proc. 9th Int. Waste Management and Landfill Symp., 2003).

Butler, A.P. and Jackson, B.M., Identification and representability of processes controlling unsaturated flow at differing temporal scales using a coupled soil-plant-water model, Kovar, K. and Hrkal, Z. ed. Calibration and Reliability in Groundwater Modelling, (2003). (Proc. ModelCARE 2002 Conf. Prague, Czech, 2002), IAHS Publication 277.

Butler, A.P., Shields, A., Wheeler, H.S., Bell, J.N.B., Mason, J.R., Smith, S. and Jones, A.D.G., Performance assessment of the phased remediation of a former gas manufacturing plant Groundwater Quality: Natural and Enhanced Restoration of Groundwater Pollution, Proc. Groundwater Quality 2001 Conf., Sheffield, IAHS Publication no. 275, 353-360, (2002).

Zacharof, A.I. and Butler, A.P., Application of a stochastic flow and transport model for leachate production to tracer test data, Christensen, T.H., Cossu, R., Stegmann, R. ed. (CISA, Italy), 2001, III 605-614, (Proc. 8th Int. Waste Management and Landfill Symp., 2001).

Zacharof, A.I. and Butler, A.P., Application of a stochastic leachate and biogas model to the Brogborough test cell experimental data incorporating data uncertainty, Christensen, T.H., Cossu, R., Stegmann, R. ed. (CISA, Italy), 2001, I 119-128, (Proc. 8th Int. Waste Management and Landfill Symp., 2001).

van Leeuwen, M., Butler, A.P., Tompkins, J.A. and te Stroot, C.B.M., Stochastic well capture zones in fully-, leaky and randomly confined heterogeneous aquifers, Proc. MODEL CARE 99 Calibration and reliability in Groundwater modelling, 1999.

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Zacharof, A. and Butler, A.P., Modelling biodegradation processes in heterogeneous landfill waste, Christensen, T.H., Cossu, R., Stegmann, R. ed. (CISA, Italy), 1999, I, 95-102, (Proc. 7th Int. Waste Management and Landfill Symp., 1999).

Jones, A.D.G., Mason, J., Smith, S., Wheeler, H.S., Butler, A.P., Gao, H., Shields, A., Hardisty, P.E and Wallace, S. Hydro-biological controls on transport and remediation of organic pollutants Leeson, A. and Alleman, B.C. ed (Battelle Press, San Diego), 1999, XIII 123-128. (Proc. 5<sup>th</sup> Int. In Situ and On-Site Bioremediation Symp. 1999).

Purcell, B., Sollars, C.J. and Butler, A.P., Enhanced moisture movement in simulated landfill environments, Christensen, T.H., Cossu, R., Stegmann, R. ed. (CISA, Italy), 1997, I, 409-418, (Proc. 6th Int. Waste Management and Landfill Symp., 1997).

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### ***Published Peer Reviewed Reports***

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Ireson, A.M. and Butler, A.P. (2009) The effect of sorption on radionuclide uptake for different soil textures. Imperial College Report for the UK Nuclear Decommissioning Authority (NDA), Imperial/NRP 021, September 2009.

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Butler, A.P. (2001) A Review of Biogeochemical Modelling in Subsurface Environmental Systems. Imperial College Report for United Kingdom Nirex Limited, ICSTM/NRP\_001, January 2001.

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**Exhibit 3B**  
**Dr. Adrian H. Butler's Testimonies in the Last Four Years**

### **Testimony of Adrian Butler**

Environment Agency -v- Magnox Electric Ltd and T.20080321, respectively, evidence given over two days (23rd and 26th January 2009). Written evidence (i.e. deposition) was taken by Mr. Paul Taylor (Environmental Agency solicitor).

**Exhibit 4**  
**Dr. Richard E. Chandler's Curriculum Vitae**

## CURRICULUM VITAE – RICHARD CHANDLER

**Full Name:** Richard Eric Chandler      **Date of Birth:** 16th March 1969  
**Nationality:** British      **Marital status:** Single  
**Private address:** 36B Hainthorpe Road, West Norwood, London SE27 0PH  
**Telephone:** 020 8670 0642      **Email:** [richard@stats.ucl.ac.uk](mailto:richard@stats.ucl.ac.uk)

### ***Employment history***

**2004-date** Senior Lecturer in Statistics, Department of Statistical Science, University College London.  
**1997-2004** Lecturer in Statistics, Department of Statistical Science, University College London.  
**1997** Visiting Scientist, CSIRO Land and Water, Perth, Western Australia (July-August).  
**1994-1997** Research Associate, jointly at Department of Statistical Science, University College London; and at Department of Civil Engineering, Imperial College London.  
**1993** Visiting Lecturer, Optometry Department, UMIST (October-December).  
**1990-1993** Dental Health Unit, University of Manchester: Statistical and computing support for a unit involved in clinical trials.  
**1990-1993** Various Health Authorities in the Manchester area: statistical and computing support.  
**1987-1990** British Telecom, Liverpool District: Bursary Student.

### ***Education***

**1990-1993** UMIST: PhD (Mathematics), subject *The Application of Spectral Methods to the Analysis of Point Process Data*.  
**1987-1990** UMIST: B.Sc. in Mathematics, Statistics & Operational Research (1st Class Hon.).

### ***Main administrative responsibilities in current employment***

**2004-** Director of Studies and Chair of Departmental Teaching Committee  
**1999-** First aid qualified person.  
**2000-2004** Tutor to Economics and Statistics degree programme



## ***Professional service***

- 2009-** Member of steering committee for International Meetings on Statistical Climatology (<http://cccma.seos.uvic.ca/imsc/stcommittee.shtml>)
- 2007-** Member of steering committee for Water initiative of the UCL Environment Institute (see <http://www.ucl.ac.uk/environment-institute/Research/water.htm>).
- 2006-** Secretary, Royal Statistical Society Environmental Statistics Section (on committee since 2003)
- 2004-** Lecturer on several training courses *Statistics for Environmental Evaluation*, funded by NERC and organised by the Department of Statistics at University of Glasgow
- 2003-** Member of DEFRA Peer Review Panel
- 2004-2009** Statistical advisor to the EU Framework 6 programme *EUROLIMPACS* (see <http://www.eurolimpacs.ucl.ac.uk/>)
- 2005-2008** Associate Editor, JRSS Series C Applied Statistics.
- 2007-2008** Advice on collation and analysis of a national water temperature archive, for the Environment Agency (project co-ordinated by the Environmental Change Research Centre at UCL).
- 2003-2007** Committee member, Royal Statistical Society General Applications Section.
- 2007** Member of scientific organising committee, 10<sup>th</sup> International Meeting on Statistical Climatology, Beijing
- 2003-2005** Member of EPSRC Peer Review College.
- 2002** Delivered a three-day course *Advanced analytical methods for climate research* at the Institute of Atmospheric Physics, Beijing. Lecture notes available at <http://www.homepages.ucl.ac.uk/~ucakar/work/glmnotes/>.

**Refereeing:** for a wide range of journals in the environmental and physical sciences as well as in statistics

**PhD examining:** acted as internal examiner for six University of London PhD candidates, and as external for candidates in Glasgow, Newcastle, Beijing and Padova.

## ***Membership of professional bodies***

Fellow of the Royal Statistical Society

Member of the Bernoulli Society

Honorary member of the Institute of Atmospheric Physics, Beijing

## ***Consultancy work***

- 2007-** Advice on transfer function modelling with application to groundwater systems, for British Geological Survey.

<b>2006-</b>	Development of commercial version of GLIMCLIM software package (see publications), with Halcrow plc.
<b>2004-</b>	Provision of advice to State of Nevada on rainfall modelling and uncertainty analysis in safety assessment of Yucca Mountain nuclear waste storage facility.
<b>2007-8</b>	Advice on assembling and analysing national archive of surface water temperature data, for UK Environment Agency (with consortium led by S. des Clers, ENSIS, UCL)
<b>1997-2004</b>	Training lectures and workshops for UK insurance industry.
<b>2000</b>	Provision of investigation into rainfall data requirement and supporting raingauge network design (with H.S. Wheeler, V.S. Isham, C. Onof and W.S. Atkins Consultants Ltd.), for UK Meteorological Office.
<b>1999-2000</b>	<i>A rainfall disaggregation scheme for operational use</i> (with N.G. Mackay, C. Onof and H.S. Wheeler), for UK Meteorological Office.
<b>1998</b>	<i>Modelling of heating degree days for quantifying insurance risks</i> (for Tempest Re, Bermuda).
<b>1996-1998</b>	Report to MacDowells plc on the role of rainfall in flooding in the Gort region of Western Ireland (with H.S. Wheeler).

## ***Areas of expertise***

Time series, space-time modelling and associated inference techniques, hydrology, climatology and other environmental applications.

## ***Research funding***

<b>10/2003-9/2006</b>	DEFRA project FD2113 <i>Spatial-temporal rainfall modelling with climate change scenarios</i> (joint with H.S. Wheeler, V.S. Isham and C. Onof), value £154K.
<b>10/2002</b>	NERC Ph.D studentship <i>A Bayesian probability framework for assessing climate change simulations</i> .
<b>5/2002-4/2005</b>	DEFRA project FD2105 <i>Improved methods for national spatial-temporal rainfall and evaporation modelling for BSM</i> (joint with H.S. Wheeler, V.S. Isham and C. Onof).
<b>9/1999-8/2001</b>	Award from TSUNAMI <i>Investigation of the risk from climate variability and change over Northern Europe</i> (joint with H.S. Wheeler and V.S. Isham), value £55K.
<b>1/1998-12/1999</b>	Award from MAFF <i>Generation of spatially consistent rainfall data</i> (joint with H.S. Wheeler, V.S. Isham and C. Onof), value £149K.

## ***Research students***

<b>2008-</b>	Olalekan Obisesan ( <i>Multivariate time series modelling with application to water pollution and public health</i> )
<b>2008-</b>	Simon Harden ( <i>Inference with composite likelihoods</i> )

- 2007-** Chiara Ambrosino (*Water shortage and drought in South Africa*; co-supervised with the Geography Department at UCL)
- 2007-** Mohammud Shamsudduha (*Groundwater dynamics, water resources and arsenic mobilisation in Bangladesh: a national-scale study*, co-supervised with the Geography Department at UCL)
- 2007-** Joao Jesus (*Inference without the likelihood function*)
- 2003-2007** Nadja Leith (*Downscaling climate model outputs for hydrological applications*)
- 2000-2003** Steven Bate (*Generalized linear models for large dependent data sets*)

## ***Research in progress***

Current areas of research investigation include:

- An investigation into the drivers of the current drought in Western Australia (with collaborators at CSIRO), with a view to informing water resource management / adaptation strategies.
- Quantifying and handling uncertainty in climate model projections for the 21<sup>st</sup> century. This work involves the development of hierarchical models for multivariate time series, and poses some interesting theoretical and computational challenges.
- Work on the comparison of estimating equations (e.g. when one estimating equation is more efficient than another under more restrictive assumptions that are difficult to verify in practice).
- Work (with PhD student Joao Jesus) on inference for stochastic processes when a likelihood function is unavailable, either because of intractability or because the full distributional structure is deliberately left unspecified.
- Work (with PhD students Chiara Ambrosino and Mohammud Shamsudduha) on quantifying spatial structure of rainfall fields in tropical and subtropical areas, with particular application to the estimation of, and implications of climate change for, groundwater recharge.
- Work (with PhD student Simon Harden) on the use of composite likelihood functions for the computationally efficient analysis of high-dimensional data (particularly in a space-time context).

## ***Publications***

### **Journal papers, book chapters and technical reports:**

- Wang, Y., Yan, Z. and Chandler, R.E. (2009). An analysis of midsummer rainfall occurrence in eastern China and its relationship with large-scale warming using Generalized Linear Models. *Int. J. Climatol.*, to appear.
- Kenabatho, P., McIntyre, N., Chandler, R.E. and Wheeler, H.S. (2009). Stochastic simulation of rainfall in the semi-arid Limpopo basin, Botswana. *Int. J. Climatol.*, submitted.
- Shamsudduha, M., Chandler, R.E., Taylor, R.G. and Ahmed, K.M. (2009). Seasonality and long-term trends in shallow groundwater levels in Bangladesh.

- Hydrology and Earth System Sciences*, submitted.
- Chandler, R.E., Isham, V.S., Northrop, P.J., Wheeler, H.S., Onof, C.J. and Leith, N.A. (2009). Uncertainty in rainfall inputs. To appear in *Applied uncertainty analysis for flood risk management* (eds. K.J. Beven and J. Hall). World Scientific.
- Leith, N.A. and Chandler, R.E. (2009). A framework for interpreting climate model outputs. *Appl. Statist.*, to appear. Also available as Research Report No. 294, Department of Statistical Science, University College London (<http://www.ucl.ac.uk/Stats/research/Resrpts/abs08.html#294>).
- Chandler, R.E., Isham, V.S., Bellone, E., Yang, C. and Northrop, P.J. (2007). Space-time modelling of rainfall for continuous simulation. Chapter 5 in Finkenstadt, B., Held, L., Isham, V.S. (ed.) *Statistical methods for spatial-temporal systems*. Boca Raton: CRC Press.
- Chandler, R.E. and Bate, S. (2007). Inference for clustered data using the independence log-likelihood. *Biometrika* **94**: 167-183.
- Yan, Z., Bate, S., Chandler, R.E., Isham, V. and Wheeler, H. (2006): Changes in extreme wind speeds in NW Europe simulated by generalized linear models. *Theoretical and Applied Climatology* **83**: 121-137.
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- Wheeler, H.S., Chandler, R.E., Onof, C.J., Isham, V.S., Bellone, E., Yang, C., Lekkas, D., Lourmas, G. and Second, M-L. (2005) Spatial-temporal rainfall modelling for flood risk estimation. *Stochastic Environmental Research and Risk Assessment* **19**: 403-416.
- Yang, C., Chandler, R.E., Isham, V. and Wheeler, H.S. (2005). Spatial-temporal rainfall simulation using Generalized Linear Models. *Water Resources Research* **41**, doi:10.1029/2004WR003739.
- Chandler, R.E. (2005). On the use of generalized linear models for interpreting climate variability. *Environmetrics* **16(7)**: 699-715.
- Yang, C., Chandler, R.E., Isham, V.S., Annoni, C. and Wheeler, H.S. (2005). Simulation and downscaling models for potential evaporation. *Journal of Hydrology* **302**: 239-254.
- Chandler, R.E. and Wheeler, H.S. (2002). Analysis of rainfall variability using generalized linear models: a case study from the west of Ireland. *Water Resources Research* **38(10)**, 1192, doi:10.1029/2001WR000906.
- Chandler, R.E. (2002). *GLIMCLIM: Generalised linear modelling for daily climate time series (software and user guide)*. Research Report No. 227, Department of Statistical Science, University College London (<http://www.ucl.ac.uk/Stats/research/abs02.html#227>)
- Yan, Z., Bate, S., Chandler, R.E., Isham, V. and Wheeler, H. (2002). An analysis of daily maximum windspeed in northwestern Europe using generalized linear models. *J. Climate* **15(15)**: 2073-2088.
- Chandler, R.E., Wheeler, H.S., Isham, V.S., Onof, C., Bate, S., Northrop, P.J., Cox, D.R., and Koutsoyiannis, D. (2002). Generation of spatially consistent rainfall data. In *BHS Occasional Paper No. 13 Continuous river flow simulation: methods, applications and uncertainties* (IG. Littlewood, ed.), pp.59-65. British Hydrological Society.
- Mackay, N.G., Chandler, R.E., Onof, C. and Wheeler, H.S. (2001). Disaggregation of

- spatial rainfall fields for hydrological modelling. *Hydrological and Earth System Sciences* **5**: 165-173.
- Wheater, H.S., Isham, V.S., Cox, D.R., Chandler, R.E., Kakou, A., Northrop, P.J., Oh, L., Onof, C. & Rodriguez-Iturbe, I. (2000). Spatial-temporal rainfall fields: modelling and statistical aspects. *Hydrology and Earth System Sciences* **4**: 581-601.
- Onof, C., Chandler, R.E., Kakou, A., Northrop, P., Wheeler, H.S. and Isham, V. (2000). Rainfall modelling using Poisson cluster processes: a review of developments. *Stochastic Environmental Research and Risk Assessment* **14**: 384-411.
- Chandler, R.E., Mackay, N.G., Wheeler, H.S. & Onof, C. (2000). Bayesian image analysis and the disaggregation of rainfall. *J. Atmos. and Oceanic Technol.* **17**: 641-650.
- Saunders, M.A., Chandler, R.E., Merchant, C.J. & Roberts, F.P. (2000). Atlantic hurricanes and NW Pacific typhoons: ENSO spatial impacts on occurrence and landfall. *Geophysical Research Letters* **27(8)**: 1147-1150.
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- Wheater, H.S., Jolley, T.J., Onof, C., Mackay, N.G. and Chandler, R.E. (1999). Analysis of aggregation and disaggregation effects for grid-based hydrological models and the development of improved precipitation disaggregation procedures for GCMS. *Hydrology and Earth System Sciences* **3**: 95-108.
- Onof, C., Mackay, N., Chandler, R.E. & Wheeler, H.S. (1998). A rainfall disaggregation scheme for forecasting. In *Hydrology in a Changing Environment* (eds H.S. Wheeler and C. Kirby), pp.107-116. Wiley, Chichester.
- Armitage, P. & Colton, T. (eds) (1998) *Encyclopedia of Biostatistics* (Wiley). Articles on Model checking and Orthogonality.
- Chandler, R.E., Isham, V.S. Northrop, P.J. (1997). Spatial-temporal rainfall processes: stochastic models and data analysis. In *Statistical Computing and Graphics Newsletter*, vol. 8 No. 2/3.
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- Chandler, R.E. (1996) A note on analytical solutions to the Whittle likelihood equation. Research Report No. 173, Department of Statistical Science, University College London (<http://www.ucl.ac.uk/Stats/research/abs96.html#173>)
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- Clerehugh V., Lennon M.A., Worthington H.V. & Chandler R.E. (1995): Site analysis of progression of loss of attachment in a 5 year longitudinal study of adolescents. *Journal of Clinical Periodontology* **22**: 15-21.

## Book reviews

- H. von Storch and F.W. Zwiers (1999): *Statistical Analysis in Climate Research*. Reviewed in *The Statistician* **51**(4): 587-8.
- J. Møller and R.P. Waagepetersen (2004): *Statistical Inference and Simulation for Spatial Point Processes*. ISI Short Book Reviews, to appear (August 2004).
- A.C. Davison (2003): *Statistical Models*. ISI Short Book Reviews, to appear.
- W.N. Venables and B.D. Ripley (2002): *Modern Applied Statistics with S (4th edition)*. Reviewed in *J. Time Series Anal.*, **26**.

## In preparation

- R.E. Chandler and E.M. Scott (eds): *Statistical Methods for Trend Detection and Analysis in the Environmental Sciences*. Wiley, Chichester.

**Exhibit 5**  
**Dr. Robert A. Cottis' Curriculum Vitae**

## Curriculum Vitae - Robert Alan Cottis

### ***Personal Record***

Date of Birth		18th April 1946
Place of Birth		Epping, England
Nationality		British
Marital Status		Married, 3 children
Home address		42, Clement Road, Marple Bridge, Stockport SK6 5AG. Tel. 016-449-8593
Secondary education	1957-64	Forest School, Snaresbrook.
University education	1964-67	Gonville and Caius College, Cambridge. Natural Sciences Tripos Part I - First Nat. Sciences Tripos Pt. II (Metallurgy) - First
	1967-70	Gonville and Caius College, Cambridge and Department of Metallurgy and Materials Science (postgraduate research).
Degrees awarded	1967	BA (Hons), 1st class, University of Cambridge
	1970	MA, University of Cambridge.
	1973	PhD, University of Cambridge.
Scholarships	1963-67	Scholar, Gonville and Caius College.
	1967-70	Rhonda Studentship, Gonville and Caius College.
PhD thesis	1973	"Metal Deposition in the Fluidized Bed Electrode"
Present position	1978-	Lecturer then Senior Lecturer (1992-) Reader (2000-) and Professor (2007-) in Corrosion Science and Engineering, Corrosion and Protection Centre, UMIST (merged with the University of Manchester in 2004).
Previous employment	1970-78	Project Manager, then (1973) Research Manager, Fulmer Research Institute, Stoke Poges, Bucks.
Visiting Appointments	2002-	Visiting Professor, 1 <sup>st</sup> Class, University of Burgundy, Dijon.



## **B - Teaching and Learning**

### **B1 Current teaching duties:**

MSc Course in Corrosion Science and Engineering (20-30 students)  
Corrosion Chemistry and Electrochemistry (part, 18 hours)  
Localized and Mechanical Aspects of Corrosion (part, 2 hour)  
Corrosion Control by Materials Selection, Surface Engineering and Corrosion Testing (part, 12 hours)

### **B2 Other teaching**

Internal service teaching (none taught currently):

MSc Course in Terotechnology (later Maintenance Management and Engineering)  
Mechanical Metallurgy (10 hours)  
Principles of Corrosion (10 hours)

Chemical Engineering 3rd Year Materials Option  
Mechanical Metallurgy (9 hours)  
Corrosion (9 hours)

Civil and Structural Engineering 2nd/3rd Year (~60 students)  
Introduction to Corrosion (8 lectures)

MSc Course in Civil and Structural Engineering (5-15 students)  
Introduction to Corrosion (9 lectures)

Metallurgy Undergraduate Course, 3rd year  
Hydrogen Embrittlement and Corrosion Fatigue (3 lectures)

Continuing education:

Departmental Short Course Organizer (1982-86).

Regular contributions to 'Corrosion Control' short courses (5 days), both in Manchester (typically once per year) and overseas (including Philips Petroleum, Stavanger, Kuwait Petroleum Corporation, Kuwait, Kuala-Lumpur, Abu Dhabi and Bahrain).

Co-organizer and lecturer to 'Stress-Corrosion in Plant and Structures' (3 days, 1985).

### **B3 Publications related to teaching**

- (1) S.E. Faidi, M. Fay and R.A. Cottis    The Use of Multimedia in the Teaching of Corrosion, *Proc. 13<sup>th</sup> International Corrosion Congress*, Melbourne, November 1996.

- |     |                                                                                               |                                                                                                                                                                    |
|-----|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (2) | S.E. Faidi, M. Fay and R.A. Cottis                                                            | “A Computer Aided Learning Package for Teaching Corrosion to Engineering Students”, Corrosion/96, Paper No 377, NACE 1996.                                         |
| (3) | R.A. Cottis, A-M. McAllister and W. David                                                     | “Online delivery and tutor support of an introductory corrosion course”, Corrosion/2004, Paper 69, 2004.                                                           |
| (4) | W. Bogaerts, R.A. Cottis, S.B. Lyon, P. McIntyre, M. Piens, G. Pimenta, P. Poh and Thuy Vuthi | “Mentor-C – a Resource for Corrosion Education”, Paper 687, Eurocorr 2005, Lisbon, September 2005.                                                                 |
| (5) | R.A. Cottis                                                                                   | “A Low-Cost Computerised Electrochemistry System for Corrosion Teaching”, Eurocorr, Maastricht, September 2006                                                     |
| (6) | R.A. Cottis                                                                                   | “Low cost development methods for postgraduate courses in materials”, Symposium on Educational Methods in Materials, Shenyang, China, 31 August – 2 September 2009 |
| (7) | R.A. Cottis                                                                                   | “Interactive case studies for the support of corrosion education”, Symposium on Educational Methods in Materials, Shenyang, China, 31 August – 2 September 2009    |

#### ***B4 Innovative work and contributions to curriculum reform and development***

I have played a significant part in the introduction of case study teaching methods in the Centre, and have been responsible for a number of failure investigation and other exercises.

I have also been concerned with the introduction of several aspects of computer technology into teaching. This has included the introduction of computer-aided preparation of visual aids, and the provision of computing facilities for dissertation and doctoral research.

I was Project Director for the Ecorr (Engineering Corrosion) TLTP project that developed a series of CAL modules to support the teaching of corrosion to engineering undergraduates.

I was responsible for the successful reorganization of the MSc Course into ‘short-fat’ modules, and the structuring of these modules to facilitate part-time attendance.

I was responsible (with Professor Thompson) for the preparation of the successful bid to EPSRC for the Masters Training Package in Corrosion Control Engineering. This provided £k for the development of the Course.

In 2001 I studied the application of computer-based formative assessment to Masters level teaching with the support of a Teaching Research Fellowship. This has been disseminated through a TaLSC Workshop.

I am currently responsible, as MSc Course Development Director, for the introduction of distance learning routes for this course.

In 2002-3 the initial delivery of the first distance learning module was supported by an award from the Curriculum Innovation Fund to support the development and trialling of a tutor training course, which is now a standard university course.

I was a member of the Management Board of GLOW (Graduate Learning on the Web).

#### ***B5 Examination responsibilities***

Responsible for preparation and marking of examination questions for all courses taught, and member of appropriate Boards of Examiners (formerly Chemical Engineering BSc, Civil and Structural Engineering BSc and MSc Courses and Corrosion Science and Engineering MSc, currently Corrosion Control Engineering MSc).

#### ***B6 Results of Assessment of Teaching***

One of my lectures was assessed during the QAA Teaching Assessment, and it was found to be at the highest level. Student teaching assessment scores have generally been in the region of 3-4 out of 5; however, the recent offering of the difficult and normally poorly rated Unit 2 (the first to build on the distance learning material) has received very positive comments from students, and, more significantly, an increase in average examination mark of the order of 10%. This has convinced me of the major benefits to be gained from the application of e-Learning techniques for both on-campus and distance students.

#### ***B7 Appointments held as Course Director or Tutor***

Development Director, MSc in Corrosion Control Engineering (2000-); responsible for the production of a distance learning version of the course.

I am chair of the School Working Party on e-Learning.

#### ***B8 Voluntary Activities with Students***

Pastoral tutor for MSc course students (around four per year).

I trialled a PASS scheme with the MSc in the period 1999-2002, using PhD students as mentors. This was eventually abandoned due to difficulties in accommodating it in a very busy timetable, and the lack of sufficient time in the taught component of the course to induce the students in the process. However, it convinced me of the benefits of the merits of student mentoring, and lead to the use of research students as tutors for the distance learning version of the course, which has proved very successful.

#### ***B9 Statement on Teaching***

I have been very active in the development of teaching and learning, particularly in recent years, when I have been leading the reorganization of the MSc Course into a modular format, and the development of a distance learning version of course modules, with EPSRC MTP funding. As well as providing a new route to the degree, the e-Learning techniques used have demonstrated very significant benefits for campus-based students; subject to the approval of the School's CTA bid, I would hope to help extend the application of e-Learning to other components of the Manchester Materials Masters programme and to undergraduate programmes.

Teachings loads in a research-oriented postgraduate centre are inevitably low by comparison to undergraduate departments; in the past I have usually had one of the highest teaching loads in the Corrosion and Protection Centre. However, in recent years this has reduced somewhat as I have concentrated on the development of the distance learning version of the course.

I have also taught a number of introductory corrosion courses to students in other departments, and I have been a regular contributor to short courses, both in Manchester and elsewhere.

In respect of the administration of teaching, I have been an active member of the Teaching and Learning Committee, member of the internal programme review committees for the Departments of Chemical Engineering and Textiles and Paper, and I prepared the Centre's documentation for its programme review.

## **C - Research and Academic/Professional Standing**

### **C1 Publications**

In my employment at Fulmer Research Institute I was engaged almost exclusively in work for the Ministry of Defence, which was subject to the Official Secrets Act, or for commercial sponsors who required confidentiality. Therefore I was not able to publish in the open literature during this period. However I was responsible for numerous technical reports in this period (I do not have a detailed record, but I would estimate that the total would be in the region of 150, with about 20% being reports on major research projects, the remainder being on smaller research projects or failure investigations).

In addition to the more conventional publications discussed below I am the founder, with Dr M.W. Kendig of the Rockwell International Science Centre, of CORROS-L, the first international electronic mailing list for corrosion and related subjects, currently hosted on the JISCMail List Server (<http://www.jiscmail.ac.uk>), and with list members around the world. I am also founding editor of the open access electronic Journal of Corrosion Science and Engineering, sponsored by the International Corrosion Council (<http://www.jcse.org>).

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- (10) R.A. Cottis "Guide to Good Practice in Corrosion Control : Stress-Corrosion Cracking", 11p, HMSO, 2000 (also available online at <http://www.npl.co.uk/materials/ncs/docs/stress.pdf>).

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- (126) R.A. Cottis "Sources of Electrochemical Noise in Corroding Systems", *Russian Journal of Electrochemistry*, **42**, 5, pp 497-505 May 2006.
- (127) A. Mihi, R. Benbouta, A. Abbassi and R. Cottis. "Simulated heat affected zone hardness limits of C-Mn steels used in offshore structures", *Materials and Corrosion - Werkstoffe und Korrosion*, **57**, 766-770, 2006.
- (128) B. Vuillemin, R. Oltra, D. Crusset and R.A. Cottis "Consideration of the formation of solids and gases in steady state modelling of crevice corrosion propagation", *Electrochimica Acta*, Volume 52, Issue 27, 10 October 2007, Pages 7570-7576.
- (129) R.A. Cottis "The Significance of Electrochemical Noise Measurements on Asymmetric Electrodes", *Electrochimica Acta*, Volume 52, Issue 27, 10 October 2007, Pages 7585-7589.

### Popular Journal Papers

- (130) R.A. Cottis "Reducing the Cost of Corrosion", *Maintenance Engineering*, Mar/Apr 1974.

- (131) R.A. Cottis, D. Howland and P. Crowe "E78 - The Europa Bus", *Personal Computer World*, **1**, 2 (1978).
- (132) R.A. Cottis and M. Blandford "A High Speed Cassette Interface", *Personal Computer World*, **1**, 8 (1978)
- (133) R.A. Cottis "Corrosion is not a Problem - but the Cost of Corrosion is", *Metallurgia*, **49**, 2, pp76-80, February 1982.
- (134) C.A. Loto and R.A. Cottis "Electrochemical Noise Generation during Stress Corrosion Cracking of High Strength Carbon Steel - II - Maximum Entropy Method", *The Nigerian Engineer*, Nigerian Society of Engineers, **23** 2, pp1-14, 1988.
- (135) R.A. Cottis "Listening in to Corrosion", *Materials World*, **7**, 8, pp482-483, July 1999.

### Review Articles

- (136) R.A. Cottis "The Interpretation of Electrochemical Noise Data", Invited Review with 78 references, *Corrosion*, **27**, 3, 265-285 (2001).

### Patents

- (137) L.C. Knight, D.A. Cash, D. Stewart, R.A. Cottis, W.H. Bowyer, R.C. Newnham, F.J. Williams, D.W. Pardon "Firing range", US Patent 4281241 (filed 22 June 1979, granted 28 July 1981).
- (138) L.C. Knight, D.A. Cash, D. Stewart, R.A. Cottis, W.H. Bowyer, R.C. Newnham, F.J. Williams, D.W. Pardon "Transducer apparatus for detecting airborne pressure pulse", US Patent 4282453 (filed 22 June 1979, granted 4 August 1981).
- (139) L.C. Knight, D.A. Cash, D. Stewart, R.A. Cottis, W.H. Bowyer, R.C. Newnham, F.J. Williams, D.W. Pardon "Firing range", US Patent 4425500 (filed 23 July 1981, granted 10 January 1984).
- (140) L.C. Knight and R.A. Cottis Target comprising a resilient material coated with thermoluminescent material", US Patent 4392652 (filed 16 September 1980, granted 12 July 1983)
- (141) R.A. Cottis "Method and apparatus for monitoring corrosion", GB2407169 (application filed 6 June 2003, granted 16 November 2005).

## **C2 Other Research Achievement**

I was awarded the T.J. Hull Award for 2005; this is one the five top awards of NACE International, awarded for contributions to NACE in the field of publications.  
I was elected a Fellow of NACE International in 2009.

## **C3 Creative or Innovative Work**

Design and construction of a computer-controlled potentiostat, together with controlling software. This has found wide use in the Centre laboratories and elsewhere.

Design of servo-hydraulic fatigue test machines, including control electronics with low cost digital waveform synthesis.

Design of electronics for Barkhausen noise measurements on fatigue specimens.

Design of hardware and software for a computer-controlled crack length measurement system.

Invention of system (subject to patent protection) for the detection of bullet trajectory in automated rifle-range system, and invention of a device for the low-cost simulation of battle-field conditions in a rifle range.

The ENAnalyse program for spectral and statistical analysis of electrochemical noise data.

## **C4 Supervision of Research**

Post-doctoral research assistants, 6 supervised as primary or sole supervisor, 2 supervised in collaboration with colleagues.

PhD and students, 37 supervised, 26 completed, 2 failed to submit, 2 interrupted studies, 2 transferred course, 6 in progress.

MSc (research)/MPhil students, 2 supervised, both completed.

MSc students, 58 supervised, 55 completed, 3 failed to submit.

## **C5 Organization and Promotion of research**

### **Major Research Contracts**

<b>Value (£k)</b>	<b>Period</b>	<b>Sponsor</b>	<b>Subject</b>
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<b>Value (£k)</b>	<b>Period</b>	<b>Sponsor</b>	<b>Subject</b>
28	1980-82	SERC (MTD)	The influence of marine fouling on the uptake of hydrogen by steel (PI with Dr R.A. King, CAPCIS and Dr E.D.G. Bellinger, University of Manchester).
73	1981-89	SERC (MTD) and Industry	The corrosion fatigue behaviour of steel wire rope in marine environments
96	1982-90	SERC	The influence of microstructure on the stress corrosion cracking of chain steels (PI with Dr R.P.M. Procter).
25	1983-86	SERC (MTD)	The application of hydrogen permeation measurements to the monitoring of hydrogen damage of steels.
14	1985-87	SERC and AEA Technology Ltd	CASE Studentship High temperature stress-corrosion cracking.
22	1985-87	SERC (MTD)	Instrumentation for corrosion research (CI with Dr R.C. Newman and Dr G.E. Thompson).
\$225 k	1985-88	National Bureau of Standards (USA)	The statistics of pitting corrosion (PI with Dr P.J. Laycock, Department of Mathematics).
14	1986-88	SERC	Studies in high temperature stress-corrosion cracking (CI with Dr R.P.M. Procter and Dr R.C. Newman).
72	1986-89	SERC (MTD)	Fundamentals of hydrogen embrittlement in offshore materials (PI with Dr R.C. Newman and Dr R.P.M. Procter).
52	1986-89	SERC (MTD)	Cathodic protection requirements for higher strength steels (PI with Dr R.P.M. Procter).
24	1986-89	British Gas (Engineering Research Award – studentship)	Stress-corrosion cracking in coal gasification condensates (CI with Dr R.C. Newman and Dr R.P.M. Procter).
21	1987-90	SERC and AEA Technology Ltd	CASE Studentship Oxide film properties and stress-corrosion cracking of steels in high temperature water.
12	1988-90	Alcan International	Computer simulation of alloy corrosion and activation (CI with Dr R.C. Newman).



<b>Value (£k)</b>	<b>Period</b>	<b>Sponsor</b>	<b>Subject</b>
54	1989-91	MTD Ltd and industrial sponsors	The influence of weld and heat-affected zone microstructure on the hydrogen embrittlement of micro-alloyed steels (PI with Dr R.P.M. Procter).
44	1989-91	SERC/MOD	Electromagnetic impedance spectroscopy for non-destructive evaluation (CI with Dr S.B. Lyon).
21	1989-92	SERC and National Power	Total Technology Studentship Pitting corrosion and corrosion fatigue of turbine rotor steels.
45	1990-92	SERC	Computer modelling of alloy corrosion (CI with Dr R.C. Newman).
100	1993-96	EPSRC	The Applications of Neural Networks in Corrosion Engineering (PI with Dr M. Turega, Computation)
130	1993-98	HEFCE	The Development of Computer Assisted Learning Material to support the teaching of corrosion to engineering students (TLTP Project 71)
48	1997-2000	Procter and Gamble	Corrosion Monitoring of Aerosol Cans
100	1998-2001	Ford Motor Corporation	Prediction of Corrosion Behaviour
100	1998-2001	EU	The OCEAN Thematic Network (Network Co-ordinator)
320	2000-2003	EPSRC/British Energy	Stress-Corrosion Cracking of Austenitic Stainless Steels in High Temperature Alkaline Environments (CI with Professor R.C. Newman)
90 k€	2005-2008	Electricité de France	Research Collaboration Agreement (PI with Professor A. Sherry)
33 k€	2005-2006	Electricité de France	Stress Corrosion Cracking of IN718 (PI with Dr T.J. Marrow and Professor A. Sherry)
345	2006-2008	Rolls-Royce	Construction of Imaging Autoclave (CI with Dr T.J. Marrow)
103	2006-2009	EPSRC	Enhancing the performance of pulsed current applied coatings for corrosion protection (PI with Dr S.B. Lyon and Professor J Lloyd)

<b>Value (£k)</b>	<b>Period</b>	<b>Sponsor</b>	<b>Subject</b>
145 k€	2006-2009	EDF	Modelling of Flow Assisted Corrosion of Stainless Steels in PWR Primary Water (CI with Dr N. Stevens)
168 k€	2006-2009	EDF	Effect of Strain History on the SCC of Alloy 600 in PWR Environments
750	2007-2012	EPSRC	Oxidation of zirconium alloys in high temperature water (CI with Dr M. Preuss and Dr S.B. Lyon)

### **Major Research Contracts in Previous Employment**

Determination of the corrosion fatigue initiation properties of marine gas turbine compressor blade materials and aircraft aluminium alloys (sponsored by Admiralty Research Establishment).

Examination of the effect of contaminant diffusion into imperfectly sealed cavities on the stress corrosion cracking of aluminium components (sponsored by MOD PE).

Determination of the corrosion fatigue crack propagation properties of quenched and tempered steels and aluminium bronzes (sponsored by Admiralty Research Establishment).

An investigation into the mechanism by which a corrosive environment accelerates fatigue crack growth (sponsored by Admiralty Research Establishment).

Testing a novel concept for the construction of the lead-acid battery (commercially sponsored).

A technical survey of the existing and potential uses of manganese in batteries (sponsored by the Manganese Centre).

The assessment of a novel method of removing sulphur oxides from flue gases (commercially sponsored).

The development of manganese alloys for use as sacrificial anodes in seawater (sponsored by the Manganese Centre).

The development of manganese-containing paints for corrosion protection (sponsored by the Manganese Centre).

The assessment of the hot corrosion and oxidation resistance of two cobalt alloys (sponsored by EEC).

An investigation of the diffusion of chloride into concrete as a result of exposure to hydrogen chloride-containing atmospheres (sponsored by Building Research Establishment).

The assessment of electrode potential fluctuation monitoring as a technique for the detection of corrosion fatigue crack growth (sponsored by Admiralty Research Establishment).

### **Research conferences organized**

Electrochemical methods in corrosion testing and research, Manchester, 4-6 Jan 1982. Around 90 participants from 12 countries. Co-sponsored by ICorrST, NACE and EFC. This meeting initiated a regular triennial series, with subsequent meetings in Toulouse (1985), Zurich (1988), Helsinki (1991), Sesimbra (1994), Trento (1997), Budapest (2000), Ysermonde (2003) and Dourdan (2006).

Electrochemical techniques in corrosion science, Manchester June 1990. A two-day national meeting organized on behalf of the Institution of Corrosion Science and Technology.

Corrosion Science Symposium, Manchester September 1991. This is four day research symposium which is held annually at Universities in the UK, sponsored by the Institute of Corrosion (formerly the Institution of Corrosion Science and Technology).

### **Membership of Organizing Committees of International Conferences**

Member of Technical and Organizing Committees for the international conference "Electrochemical Methods in Corrosion Research", held in Toulouse, July 1985, co-sponsored by ICorrST, NACE and the Electrochemical Society.

Member of Technical and Organizing Committees for the international meeting "Environmentally-Assisted Fatigue", held in Sheffield, April 1988.

Member of Technical Committee for the third international conference on "Electrochemical Methods in Corrosion Research", held in Zurich in July 1988, sponsored by Electrochemical Society, NACE, European Federation of Corrosion and ICorrST.

Member of International Conference Committee for the meeting "Creation and Growth of Surface Cracks", held in Sheffield, 1990, sponsored by the European Group for Fracture.

Member of Technical Committee, fourth international conference "Electrochemical Methods in Corrosion Research 1991" held in Helsinki, June 1991.

Member of Organising and Technical Committees for the international conference "Advances in Corrosion and Protection", held in Manchester, June 1993.

Member of Organising and Scientific Committees, fifth international conference on "Electrochemical Methods in Corrosion Research", held in Sesimbra, Portugal, September 1994.

Member of Organising Committee, "Corrosion Fatigue", held at Sheffield, May, 1997.

Member of Organising and Scientific Committees, sixth international conference on "Electrochemical Methods in Corrosion Research", Trento, Italy, August 1997.

Chairman of the NACE T3-U Symposium, at Corrosion 2000, Orlando, March 2000.

Member of International Scientific Committee, seventh international conference on "Electrochemical Methods in Corrosion Research", Budapest, May 2000.

Member of Local Organising Committee, EuroCorr 2000, London (September 2000).

Member of Organising Committee, Alt-C 2000, Manchester 2000.

Member of the Local Organizing Committee and Technical Committee of the International Conference on Engineering Education, Manchester, 2002.

Member of International Scientific Committee, eighth international conference on "Electrochemical Methods in Corrosion Research", Ysermonde, July 2003.

Member of the International Advisory Board of the Kurt Schwabe Corrosion Symposium, Helsinki, 2004.

Chairman, Symposium "Corrosion, Computers and the Web", Corrosion 2004, New Orleans

Chairman, Symposium "Field and Plant Applications of Electrochemical Noise", Corrosion 2005, Houston.

Member of International Scientific Committee, ninth international conference on "Electrochemical Methods in Corrosion Research", Dourdan, June 2006.

## **C6 Professional Advisory or Consultancy Work**

In my former employment I was involved with a wide range of failure investigation and consultancy activities, ranging from the stress-corrosion cracking and pitting corrosion of food processing equipment, to corrosion of chemical plant and a major problem of legal liability for widespread failures of central heating systems.

Following my appointment I have been engaged in a number of consultancies. With a few exceptions (noted below) these have resulted from direct personal approaches.

I visited the Mamara Research Institute, Gebze, Turkey in 1982 for one month as UNIDO consultant to assist in the development of a corrosion advisory group.

Prepared survey of hydrogen embrittlement in prestressing steel and advised on failure of a marine dry dock (approached through Professor F.M. Burdekin and CAPCIS).

Consultant on sulphur corrosion of a bulk carrier, including visiting S. Africa to examine the ship in dry dock.

Investigation of the pitting corrosion of aluminium beer kegs.

Advice on the liability for the perforation and leakage of an oil transmission pipeline.

Long-term consultancy on the development of cathodic protection methods for coated reinforcement in concrete.

Hydrogen embrittlement of prestressing steel in a Calgary office building.

Examination of the hypothetical performance of martensitic stainless steels for architectural fasteners.

UNESCO consultant, the Great Man Made River Project, Libya, 2000.

Several smaller consultancies for local and national organizations.

### **C7    *External Examining and Refereeing***

Examined PhD theses for:

University of Sheffield,  
Sheffield Hallam University,  
Cranfield University (3),  
University of Cambridge (3),  
University of Plymouth,  
University of Oxford,  
University of Cape Town (S. Africa),  
Monash University (Australia),  
Curtin University (Australia)

Examined MSc/MPhil theses for

University of Bath,  
University of Strathclyde,  
University of Newcastle,  
University of Nairobi (Kenya),  
University of Mauritius.

Regular referee for:

Corrosion Science,  
British Corrosion Journal (now Corrosion Engineering, Science and Technology),  
J. Electrochem. Soc.,  
Electrochimica Acta,  
Journal of Physics E,  
Materials Science and Technology,  
Fatigue and Fatigue of Engineering Materials and Structures.

Referee for many conference proceedings.

Regular reviewer of research proposals for Flanders Institute for the Promotion of Innovation by Science and Technology (IWT-Flanders), Belgium (all expenses and fee paid).

## **C8    *Offices in professional bodies***

- |           |                                                                                                                                                                                                                                                                                  |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1978-82   | Member of Institution of Corrosion Science and Technology (ICorrST), Corrosion Science Division Committee.                                                                                                                                                                       |
| 1980-82   | Hon. Treasurer, ICorrST, Corrosion Science Division.                                                                                                                                                                                                                             |
| 1989-91   | Chairman, ICorrST, Corrosion Science Division. In this position I was responsible for the initiation of a regular six-monthly series of meetings on the general theme of 'The Science of Corrosion'. At the time of my election there were no meetings planned for the Division. |
| 1989-92   | Member of ICorrST Council and Executive Committees.                                                                                                                                                                                                                              |
| 1989-91   | Chairman, U.R. Evans Award Panel of ICorrST (this is the premier British Award for corrosion scientists and engineers).                                                                                                                                                          |
| 1990-     | U.K. Representative, European Federation of Corrosion Working Party on Expert Systems and Databases for Corrosion.                                                                                                                                                               |
| 1997-2001 | Chairman of NACE T3U-8, Application of the Internet for Corrosion Control                                                                                                                                                                                                        |
| 2005-     | Chair, European Federation of Corrosion Working Party 7, Education and Computer Applications                                                                                                                                                                                     |
| 2004-     | Chair, Basic Technology Working Group, ECG-COMON (a closed European technical exchange activity concerned with the application of electrochemical monitoring techniques in nuclear and other applications)                                                                       |
| 2006-     | Chair, Accreditation Board, ICorrST and member of Council ICorrST                                                                                                                                                                                                                |

## **C9    *Other Public Service***

Member of the External Review Panel for Corrosion Monitoring at the Hanford (USA) Nuclear Waste Storage site (2001).

## **C10   *Invited Conference Presentations and Seminars.***

- (1) "The Influence of Crevice Conditions on the Uptake of Hydrogen by Steel", presented to International Conference on Corrosion Chemistry Within Pits, Crevices and Cracks, NPL, London, 1984.
- (2) Invited discussion leader, Corrosion Fatigue, international conference "Fundamental Questions and Critical Experiments in Fatigue", Dallas, October 1984.
- (3) "Crack Chemistry and Corrosion Fatigue", invited seminar, Lehigh University, 1983.
- (4) "The Corrosion Fatigue of Steels in Saline Environments : Short Cracks and Crack Initiation Aspects", presented to international conference Small Fatigue Cracks, Santa Barbara, 1986. (all expenses paid)
- (5) "Electrochemical Noise Generation during Stress Corrosion Cracking", presented to

2nd International Conference on Electrochemical Methods in Corrosion Research, Toulouse, 1986.

- (6) "The Role of Inclusions in Corrosion Fatigue Crack Initiation in Q1N", presented to Third International Conference on Fatigue and Fatigue Thresholds, Charlottesville (1987).
- (7) "The Role of Corrosion in the Initiation and Growth of Corrosion Fatigue Cracks", presented to international conference Environment-Assisted Fatigue, Sheffield, 1987.
- (8) "The Role of Crack Chemistry in Hydrogen Embrittlement", invited seminar, Battelle Pacific Northwest, Richland, USA, 1987.
- (9) "The Use of Slow Strain Rate Testing for the Study of Hydrogen Effects in Steels", presented to Slow Strain Rate Technique - Value, Application and a Standard, S.C.I., London, November 1987. (all expenses paid)
- (10) "A Low Cost Computer-Controlled Electrochemical Measurement System for Education and Research", presented to 3rd International Conference on Electrochemical Methods in Corrosion Research, Zurich 1988.
- (11) Invited Rapporteur for international conference Environment-Induced Cracking of Metals, Kohler, Wisconsin, 1988. (In the event I was unable to attend this meeting due to indisposition at the time).
- (12) "Pitting Effects in Marine Steels" invited presentation to Corrosion Pitting and its Practical Implications - Crack Initiation at Corrosion Pits, the Institute of Metals, March 1989 (all expenses paid)
- (13) "Initiation Aspects of Corrosion Fatigue" invited presentation to State of the Art in Understanding Environmentally-Assisted Cracking, Engineering Integrity Society, Wolverhampton, May 1989 (all expenses paid)
- (14) "Linear Electrochemical Methods", presented to NATO Advanced Study Institute, Electrochemical and Optical Techniques in Corrosion, Viana do Castelo, July 1989.
- (15) "The Application of Computer Modelling Techniques in Corrosion Science and Technology", presented to Corrosion Research Symposium, UK Corrosion 89, 1989.
- (16) "The Relationship between Polarization Resistance and Electrochemical Impedance Spectroscopy", invited seminar, University of Bahrain (1990) (all expenses paid).
- (17) "Linear Electrochemical Methods" introductory presentation to Electrochemical Techniques in Corrosion, Manchester, June 1990.
- (18) "Crack Initiation in Corrosion Fatigue", presented to Creation and Growth of Surface Cracks, Sheffield, 1990.

- (19) "Effect of Cathodic Protection on the Mechanical Properties of Steels", UK Corrosion '90, Sandown Park, November 1990. (all expenses paid).
- (20) "Extreme Value Statistics for the Analysis of Pitting Corrosion" invited presentation to Institute of Metals, London, 14 March 1990 (all expenses paid)
- (21) "Modelling of Corrosion Processes", invited course tutor (all expenses paid), Working Party on Computer Modelling in Materials Science, International Centre for Theoretical Physics, Trieste, 5-14 June 1991.
- (22) "Techniques for Analysis of Electrochemical Noise Data", presentation to "Electrochemical Noise : The Technique for the '90s", SCI Materials Preservation Group, London, 4 September 1991.
- (23) "Electrochemical Methods of Corrosion Monitoring", presentation to M6 Sensors Group, Risley, 13 May 1992.
- (24) "Fracture Mechanics of Stress-Corrosion Cracking", invited presentation to AEA Technology course "The Engineer's Guide to Corrosion Cracking", Warrington, May 1993. (all expenses and fee paid).
- (25) "Hydrogen Embrittlement", invited presentation to *Environment-Assisted Fracture*, Institute of Corrosion, Sheffield, 1993 (all expenses paid).
- (26) "Modelling of Electrochemical Noise due to Activation-Controlled Dissolution of Metals", presented to NATO Workshop, *Modelling of Corrosion Processes, (1993)* (all expenses paid)
- (27) "Environment Sensitive Fracture: an Overview", presented to *Environment-Assisted Fracture in Industry*, ICorr meeting, Sheffield, July 1995 (all expenses paid)
- (28) "OCEAN - A Collaborative Information Access Development for the Internet", Materials Informatics, Boston, June 1999.
- (29) "Electrochemical Noise Measurements for Corrosion Studies", EMCR 97, Trento, 1997.
- (30) "Techniques for the Interpretation of Electrochemical Noise", Electrochemical Society Fall Meeting, Montreal, 1997
- (31) "The Analysis of Electrochemical Noise Data", *Research Symposium*, Corrosion 1998, Denver (expenses paid).
- (32) "Measures for the Detection of Localized Corrosion with Electrochemical Noise", Electrochemical Methods in Corrosion Research 2000, Budapest, Keynote.
- (33) A Practical Evaluation of Electrochemical Noise Parameters as Indicators of Corrosion Type", presented to Electrochemical Methods in Corrosion Research 2003,



Ysermonde, Belgium, Keynote (all expenses paid).

- (34) "Electrochemical Noise as a Technique for Corrosion Monitoring", invited keynote lecture, CorCon 2005, Chennai, Tamil Nadu November 2005 (all expenses paid).

**C11 Other Conference Presentations**

- (1) "The Corrosion Fatigue Propagation Behaviour of Steels and Aluminium Alloys", presented to Metals Society Conf. "Corrosion Fatigue", Newcastle, 1977.
- (2) "Theoretical Models for Corrosion Fatigue Crack Propagation", presented to Metals Society Conf. "Corrosion Fatigue", Newcastle, 1977.
- (3) "pH and Potential Measurements in an Artificial Crevice", presented to "Electrochemical Methods in Corrosion Testing and Research", ICorrST, Manchester (1982).
- (4) "The Role of Inclusions in Corrosion Fatigue Initiation in a Maraging Steel", 8th Internat. Cong. on Metallic Corrosion, Mainz, 1981.
- (5) "Corrosion Fatigue Initiation Processes in a Maraging Steel", presented to Metals Society Conference "Defects and Crack Initiation in Environment Sensitive Fracture", University of Newcastle upon Tyne, (1981).
- (6) "The Measurement of pH and Chloride Concentration in a Simulated Crevice", presented to Symposium on Localized Crack Chemistry and Mechanics in Environment-Assisted Cracking, Philadelphia, 1983.
- (7) "Polarity Reversal and Protection of Crevice Mild Steel in Sodium Chloride Solutions", presented to International Conference on Corrosion Chemistry within Pits, Crevices and Cracks, NPL, London, 1984.
- (8) "The Effect of Trace Sulphur Compounds on the Pitting of Austenitic Stainless Steels in Potable Water", presented to 9th International Congress on Metallic Corrosion, Toronto (1984).
- (9) "Hydrogen Uptake by Steel Under Marine Fouling Growths", presented to 9th International Congress on Metallic Corrosion, Toronto (1984).
- (10) "The Influence of Seawater Corrosion and Mechanical Damage on the Fatigue Endurance of Wire Rope", presented to Endurance Research of Wire Rope and its Practical Applications, London, 1985.
- (11) "The Influence of Seawater Corrosion on the Fatigue Strength of Steel Wire Rope", presented to Fatigue of Engineering Materials and Structures, Sheffield, 1986.
- (12) "The Application of Hydrogen Permeation Measurements to the Study of Corrosion Fatigue Crack Growth in Steels", presented to 2nd International Conference on

Electrochemical Methods in Corrosion Research, Toulouse, 1986.

- (13) "The Influence of Crack Conditions on Hydrogen Uptake by Steel", presented to Third Int. Conf. on Fatigue and Fatigue Thresholds, Charlottesville (1987).
- (14) "The Statistics of Pitting Corrosion of Austenitic Stainless Steels in Chloride Solutions", 2nd U.R. Evans Conference on Localized Corrosion, Orlando, Florida, 1987.
- (15) "Chemical Conditions and Hydrogen Generation Within Crevices in Carbon-Manganese Steels", 2nd U.R. Evans Conference on Localized Corrosion, Orlando, Florida, 1987.
- (16) "Effect of Tempering Temperature on Stress Corrosion Cracking of Mining Chain Steels", presented to Electrochemical Society Fall Meeting, Honolulu, October 1987.
- (17) "The Effect of Marine Fouling on Hydrogen Uptake by Steel", 1st European Federation of Corrosion Symposium on Microbial Corrosion, Lisbon, 1988.
- (18) "Atomistic Computer Simulation of Alloy Corrosion", to be presented to *ASTM G01.03 Symposium, "Computer Modelling for Corrosion"*, San Antonio, November 1990.
- (19) "Modelling of Electrode Processes and Surface Chemistry in Carbon Dioxide-Containing Systems", to be presented to *ASTM G01.03 Symposium, "Computer Modelling for Corrosion"*, San Antonio, November 1990.
- (20) "The Estimation of Corrosion Rates from AC Impedance Measurements", presented to EMCR 91, Helsinki, July 1991.
- (21) "Life Prediction in Corrosion Fatigue", presented to *Corrosion Deformation Interactions*, Fountainblau, September 1991).
- (22) "The Visualization of Corrosion Processes on an Atomic Scale", presented to *Advances in Corrosion and Protection*, Manchester (1992).
- (23) "An Approach to Life Prediction in Corrosion Fatigue" presented to *Advances in Corrosion and Protection*, Manchester (1992).
- (24) "The Passivation of Steel in Neutral Sodium Fluoride Solutions" presented to *Advances in Corrosion and Protection*, Manchester (1992).
- (25) "The Effects of Solution Resistance on Electrochemical Noise Resistance Measurements : A Theoretical Analysis", presented to *ASTM Symposium on Electrochemical Noise*, Montreal, May 1994.
- (26) "The Corrosion Information Server – Experience of the First Year", presented to Corrosion/96, Denver, 1996.
- (27) "A Computer Aided Learning Package for Teaching Corrosion to Engineering

- Students”, presented to Corrosion/96, Denver, 1996.
- (28) “Monte Carlo Simulation of Electrochemical Noise Resistance Measurements”, presented to Corrosion/96, Denver, 1996.
  - (29) “Neural Networks for Corrosion Data Reduction”, presented to Corrosion/96, Denver, 1996.
  - (30) “The Use of Multimedia in the Teaching of Corrosion”, presented to 13th International Corrosion Congress, Melbourne, November 1996.
  - (31) “Long-Term Monitoring of Electrochemical Noise”, presented to 13th International Corrosion Congress, Melbourne, November 1996.
  - (32) “Crack Initiation Processes in the Corrosion Fatigue of Copper in Active Corrosion Conditions”, presented to 13th International Corrosion Congress, Melbourne, November 1996.
  - (33) “The Influence of Coating Disbondment on the Corrosion of Coated Reinforcement - a Numerical Model”, presented to Corrosion/98, San Diego, 1998.
  - (34) “Tuning the Internet for Corrosion”, presented to Corrosion/99, San Antonio, 1999.
  - (35) “Neural Network Methods for the Estimation of Pitting Corrosion Behaviour”, presented to Corrosion/99, San Antonio, 1999.
  - (36) “Higher Order Measures for EN Analysis”, presented to Corrosion/99, San Antonio, 1999.
  - (37) “Electrochemical Noise Signature Analysis Using Power and Cross-Spectral Densities”, presented to Corrosion/99, San Antonio, 1999.
  - (38) “Prediction of the Corrosion Rate of Steel in Seawater Using Neural Network Methods”, Paper 00489, Corrosion/2000, Orlando, NACE, March 2000.
  - (39) “Electrochemical Noise Analysis of Carbon Steel in Sodium Chloride Solution with Sodium Nitrite as an Inhibitor”, presented to Eurocorr 2000, London, 2000
  - (40) “Parameters for the Identification of Localized Corrosion: Theoretical Analysis”, presented to the 200th Meeting of the Electrochemical Society, San Francisco, 2001.
  - (41) “Measures for the Identification of Localized Corrosion from Electrochemical Noise Measurements”, presented to Corrosion/2002, Denver, 2002.
  - (42) “Electrochemical Noise Study of Stress Corrosion Cracking of Sensitized 304H in Thiosulfate”, presented to Corrosion/2003, San Diego, 2003.
  - (43) “Combined Measurement of Electrochemical Noise and Electrochemical Impedance”, presented to Corrosion/2003, San Diego, 2003
  - (44) “Laboratory Testing and Computer Modeling of the Performance of Sacrificial Anodes for use in Reinforced Concrete Structures”, presented to Corrosion/2003, San Diego, 2003
  - (45) “The Simultaneous Measurement of Electrochemical Impedance and Electrochemical Noise”, R.A. Cottis, M. Kumaraguru, M. Marti, L. Daněk and V. Matoušek, presented to EIS 2004, Cocoa Beach, May 2004.
  - (46) “The use of electrochemical noise to detect initiation of stress corrosion cracking”, A.A.M. Gebriel and R.A. Cottis, present to Corrosion/2005, Houston 2005.
  - (47) “Modeling of Image Formation and Image Enhancement for Scanning Electrochemical Methods”, R.A. Cottis and S.B. Lyon, presented to Corrosion/2005,

Houston 2005.

- (48) “Error Sources and Image Enhancement in Scanning Electrode and Related Techniques”, R.A. Cottis and S.B. Lyon, presented to Eurocorr 2005, Lisbon, September 2005.
- (49) “Mentor-C – a Resource for Corrosion Education”, W. Bogaerts, R.A. Cottis, S.B. Lyon, P. McIntyre, M. Piens, G. Pimenta, P. Poh and Thuy Vuthi, presented to Eurocorr 2005, Lisbon, September 2005.

### **C12 Major academic visits and collaborations**

Collaborative research with the University of Santiago de Compostela, Spain.

Collaborative research with Instituto Eduardo Torroja, Madrid, supported by British Council.

Collaborative research with the University of Bahrain (1990). (expenses paid).

Collaborative research with the University of Rome, Tor Vegata.

Collaboration on Corrosion Teaching with ITESM, Monterrey, Mexico (2000), supported by British Council.

Visiting professor, University of Burgundy, Dijon, 2002-.

Collaborative research with the Universities of Milan (2002), Cadiz (2003) and Brno (2004) supported by the EU through Marie-Curie Training Fellowships.

Collaborative research with the University of Nairobi (Kenya), supported by a Commonwealth Scholarship.

### **C13 Statement on Research**

My research has contributed to the international development of the subject in a number of areas. As is normal in university research, the day-to-day research has been undertaken primarily by post-doctoral research assistants, research students and dissertation students working with me (and identified as authors of the relevant papers), while the developments in interpretation, analysis and modelling have been a partnership to which I have generally been the major contributor, except for the collaboration with colleagues detailed below.

In summary, the main area of early research has been in the mechanistic aspects of corrosion fatigue, both in respect of crack initiation, which is significant primarily for smaller components and where my work has demonstrated the role of corrosion in assisting the initiation process, and crack growth, where my work has shown that larger cracks, such as those found in offshore structures, are relatively unaffected by corrosion and hydrogen entering the steel is a more important factor. In collaborative work I have been responsible for the clarification of the interpretation of the results of existing electrochemical techniques, and I have contributed to improvements in the statistical interpretation of pitting corrosion, both of which are of considerable industrial significance. On a more fundamental note, I have also developed very efficient algorithms for the modelling of alloy corrosion. Most recently, I have been one of the leaders in the development of a fundamental understanding of the theoretical basis of electrochemical noise measurements, and in the better

understanding of the capabilities and limitations of the use of artificial neural network methods for modelling corrosion processes.

The most significant developments in environmentally-assisted fracture have probably been made in the field of crack initiation in corrosion fatigue. These arose out of a recognition that the application of fracture mechanics to corrosion fatigue had diverted attention from the early stages of crack initiation and growth. By studying the growth of very short cracks (generally less than 1 mm) I have been able to develop very clear qualitative models of crack growth processes and the role of corrosion in this regime (see references 94, 95, 25, 28, 81, 29, 31, 34, 35, 115, 20). Additional mechanistic studies examined model systems (notably copper in  $\text{CuSO}_4/\text{H}_2\text{SO}_4$ ) to elucidate the role of corrosion (88).

I also commenced work on the chemical conditions within corrosion fatigue cracks soon after taking up my position. The results of this work, which remains the experimental standard by which theoretical models are judged, were able to confirm the theoretical predictions developed at about the same time by Turnbull and others at NPL. This experimental work provided two significant advances in the state of knowledge of the subject. Firstly, both as a result of over-simplified analogies with the crevice corrosion of stainless steels, and a number of apparently sound experiments, it was believed at the time my work commenced that the solution in a fatigue crack for a carbon steel in seawater was quite acid (about pH 2). My work, in agreement with the theoretical predictions of Turnbull, demonstrated that in fact the solution was very slightly alkaline, and the earlier experimental results were in error because of oxidation of the solution prior to the measurement of the pH (21, 22, 101, 102, 103, 79). A second observation of my experimental work, which was not predicted by early theoretical models, was that the hydrogen overpotential could be *increased* by anodic polarization, contrary to the expectations and assumptions of most workers in this field, who had frequently used anodic polarization as a test for the behaviour of a sample in conditions for which hydrogen embrittlement was not possible. This observation has since been confirmed by numerical models (128).

At the same time as the initial work on the chemical conditions within the corrosion fatigue crack, I started to use the electrochemical hydrogen permeation technique to measure the rate of hydrogen entry into the steel, initially to study the influence of marine fouling growths on hydrogen entry (105, 113, 75). This technique was then combined with the techniques for the study of conditions within cracks to study the influence of conditions within a simulated crack on the rate of hydrogen entry. This work demonstrated very clearly that hydrogen embrittlement could indeed occur under conditions where it had previously been assumed by most workers to be impossible (23, 97, 27, 79). This lead further to the use of the hydrogen permeation technique to study the details of hydrogen embrittlement processes in somewhat more detail, with a view to optimising welding procedures for higher strength steels for use in marine environments (37, 39). This also relates to earlier work in collaboration with Dr R.P.M. Procter on the effect of tempering temperature on the hydrogen embrittlement susceptibility of chain steels, where the link between hydrogen entry, heat treatment conditions and susceptibility to hydrogen embrittlement were clearly demonstrated (76).

Also in the field of corrosion fatigue I have been heavily involved with studies of the effects of corrosion on the fatigue of steel wire rope (24, 26). This largely phenomenological study was supported through a programme funded by SERC/MTD in collaboration with a number

of offshore operators.

In addition to the above research areas, which have primarily been conducted by myself in association with research students or research assistants, I have also been engaged in a wider range of research projects in collaboration with my colleagues in the 'Environmental Cracking Group', Dr R.P.M. Procter and Dr R.C. Newman. These include a range of studies of mechanistic aspects of stress-corrosion cracking and hydrogen embrittlement, together with the use of Monte-Carlo computer modelling to help understand the corrosion of alloys (108, 111, 32). The latter work provided new insights in the processes underlying the corrosion of alloys, and has given a very simple explanation of a range of phenomena, such as the sharp compositional thresholds for transitions in dealloying and passivation behaviour, which had previously been difficult to interpret. My contribution to this work has been largely concerned with the computing aspects of the study, and in particular the development of efficient algorithms for the modelling, where I have been able to reduce the 3-dimensional problem from order  $N^3$  to approximately  $N^2$ .

In the case of the development of the theory of electrochemical noise, I published one of the first descriptions of the currently-accepted analysis of the electrochemical noise resistance technique (38, 118, 40). Others have since published more complex analyses, but these have not significantly extended the basic theoretical treatment. The theories were subsequently tested with a simple Monte-Carlo model of a noise generation process (44). I have been invited to a number of international conferences to present this work, and have written a commissioned book that is the standard reference for the measurement and interpretation of electrochemical noise in corrosion (4). More recently, I have produced a major invited review of the theoretical aspects of electrochemical noise analysis (136), which is widely cited (45 citations as of the end of 2006). The theoretical analysis that has been developed in this work has recently led to the award of a patent for a novel measurement method that combines electrochemical impedance and electrochemical noise methods (141). With the assistance of two Marie-Curie students, this has been realised as a practical instrument, based on digital signal processor technology (presented to EIS 2004).

A range of experimental projects have added to the understanding of the electrochemical noise technique, including very long-term measurements that provide an estimate of the electrochemical impedance at frequencies down to  $10^{-6}$  Hz (56). Working with Dr S. Turgoose (who provided support on the corrosion inhibition aspects) I have also studied electrochemical noise generation during inhibitor depletion (123,124,89,55). This has been particularly fruitful; as well as clarifying the way in which breakdown of inhibition occurs, it provided a high quality data set that has provided considerable insight into electrochemical noise theory. In particular it provided support for an analysis based on shot noise theory (54,61) that is gradually gaining support as a simple, yet theoretically sound, indicator of the extent of localized corrosion.

My work on electrochemical techniques was initially concerned with the development of methods appropriate for the study of environmentally-induced fracture, such as the measurement of chemical conditions in cracks and crevices (101, 102), and the study of electrochemical noise generated during stress-corrosion crack growth (96, 78, 99, 104, 107, 109, 134). In the latter field I was responsible for the first measurements of electrochemical noise associated with environmentally-induced fracture. Recently, in collaboration with Dr

S. Turgoose, computer models have been used to examine the fundamental aspects of existing electrochemical techniques. These have helped to clarify the relationship between apparently different techniques, and to demonstrate some of the fundamental limitations of the techniques (30, 33, 114, 36). This has been an equal collaboration; I initiated the studies of the relationship between transient and impedance techniques and undertook the transformations from the time to the frequency domain, Dr Turgoose developed the detailed mass transport model, and has further developed the model in his field of interest in CO<sub>2</sub> corrosion. I also used a similar approach to analyse the expected performance of sacrificial anodes embedded in concrete (58). As well as clarifying the expected performance of such anodes, the work identified some potential problems associated with the influence of the compositional gradients induced by the application of current to the concrete. More recently work has been commenced, using finite element methods, on the re-evaluation of the theoretical basis of cathodic protection, where it is becoming clear that current ideas of the mechanism of cathodic protection are over simplistic. In parallel with this work, I have been collaborating with Dr Roland Oltra at the University of Burgundy, Dijon, on the modelling of crevice chemistry, using the same finite element tools (60).

In practical electrochemistry I have been responsible for the development of a range of low-cost electrochemical instrumentation for use in the research laboratories (106). This work is currently being extended to take advantage of low-cost commercial data acquisition systems (5).

In a project on the effect of nitrogen introduced during welding of duplex stainless steels (116,84,85,86,119,42,46) new welding procedures were developed, and several aspects of the pitting corrosion process clarified. In particular, the role of surface oxidation was identified.

My work on the statistical aspects of pitting corrosion arose out of my teaching activities in corrosion testing, which introduced me to the application of extreme-value statistics to the extrapolation of expected pit depths, and initiated a project that examined the statistics of pitting corrosion (98). This work also provided some of the early evidence that traces of reduced sulphur species in solution can have a dramatic effect on the pitting corrosion of stainless steels (74). In collaboration with Dr P.J. Laycock of the Department of Mathematics this has been extended to a practical and theoretical study of the long term statistics of pitting corrosion, with a particular eye to the disposal of nuclear waste (110, 80, 112). This work has demonstrated that most prior workers have used inappropriate models for the extrapolation of pitting data, with the result that extrapolated maximum pit depths have been considerably over-estimated. This has been a reasonably equal partnership; while the development of the theoretical and algorithmic aspects of the problem has clearly been the responsibility of Dr Laycock and his colleagues, I was responsible for the initiation of the project, and for the production of very large quantities of experimental data on which to test the mathematical models. The collaboration with Dr Laycock also resulted in the first application of bispectral methods to the analysis of electrochemical noise data (120, 51).

In collaboration with Dr M. Turega, Department of Computation, I have been engaged in the application of neural network techniques to corrosion studies. The variability and poor quality of corrosion data has lead to the development of new techniques. These allow, for example, the description of predicted corrosion rate in terms of three parameters; the mean rate, the expected variance (the variance being derived from the training data, and varying

over the problem space), and the 'confidence' (representing the estimated reliability of the prediction, based, among other things, on the 'closeness' of training data to the prediction point) (41, 45). Other work has been concerned with the reliability of input parameter reduction methods, notably the use of the pitting resistance equivalent to represent compositional effects in the pitting of stainless steels (45, 121, 50, 53), and the modelling of atmospheric corrosion data (122). Current developments are concerned with the wider application of the techniques that have been developed, together with studies of the ways in which human expertise can be merged with neural network techniques. More recently, neural network techniques have been used to model the electrochemistry of iron in solutions of varying chloride content and pH (59).

I have been engaged in a number of projects involving aqueous corrosion at elevated temperature and pressure, including studies of stress corrosion cracking in environments associated with the PWR (56). Recently this has led to the long-term collaboration agreement with EDF that I am leading. In this field I have been active in the development of research within the Materials performance Centre.

I am also becoming increasingly involved in the application of IT to corrosion technology. One of the most significant projects has been the OCEAN (Open Corrosion Expertise Access Network) Thematic Network, of which I was Network Co-ordinator. This has developed a metadata description for corrosion information, based on the Dublin Core (49). This format has recently been used to provide a standard method of reporting electrochemical noise data (92).

## **D - Administration**

### **Departmental**

Editor of departmental Research in Progress Brochure from 1980 to 1994, together with other departmental literature (MSc prospectus, advertising posters, promotional leaflets etc.). Word processing and desk-top publishing methods were introduced to reduce production costs and increase accuracy. Illustrations were also introduced into the brochure to improve the attractiveness, and the brochure has been used by several groups (both in Manchester and elsewhere) as a model.

Developed and managed an ERASMUS ICP with the University of Burgundy, Dijon, Instituto Superior Tecnico, Lisbon, and the Danish Technical University, Lyngby. The ICP ran from 1991 to 1997, when it was incorporated into the UMIST Socrates programme.

Preparation of timetables, including the development of a computer program for the optimization of timetables for the option modules scheme (1990-1994).

Specification, introduction and support of word-processing and computer systems in the department. These were initially based on Apricot PCs and Vuwriter. They were upgraded in 1990 to Word Perfect on IBM PC compatible computers, and in 1996 to Microsoft Word. While we have used the training courses at the Staff Teaching Workshop, the provision of day-to-day support during the introductory and transitional periods has taken a lot of my time



(1985-2001), especially with the introduction of the computer network, which I managed within the department.

Maintenance of Research in Progress mailing list. This has been transformed from a card-index-based list of about two hundred entries, to a computer-based list which has reached 1600 entries, with regular annual updating to target the mailing (1980-).

Departmental MSc course and research advertising organiser (1984-1994).

Departmental library representative (1982-2004) and organiser of departmental library (prior to incorporation into Joule library) and preparation of MSc course reading list (1982-).

Departmental computer representative (1979-2000)  
Careers service and employment liaison (1984-).

Chairman, Departmental Academic Board (1988-2004).

### **UMIST/University of Manchester**

Member, Graduate School Council (1998-2001)

Member, Board of Graduate Studies (1999-2001)

Chairman, Working Party to enhance Web-based Careers information for MSc students (1999-2000).

Chairman, Distance Learning Interest Group (1999-2004).

Invited Member, UMIST Academic Board (1988-2004).

Member, Library Users Subcommittee (1988-2001), Chair (2001).

Departmental representative on Group 9 Library Subject Panel for all of its existence (1988-90).

Member UMIST Library Committee (1996-99) and Library Services Committee (1999-2001).

Member Teaching and Learning Committee (1998-2004).

Member, UMIST Continuing Professional Development Committee (1996-1999).

Member, UMIST CAL Working Party/Teaching Technology Sub-Committee (1994-1999).

Member of Periodic Programme Review Panels (Textiles, 2003, and Chemical Engineering, 2004).

Member, UMIST (computer) Users Subcommittee (1979-99).

Member UMIST Academic Information Systems Committee (1996-99).

Departmental representative on Chemical Engineering Departmental Academic Board (1982-1993).

Member, AFR Sub-Group 3, Project Unity

Member Faculty PGT Panel (2005-).

### **D4 Statement on Administration**

I have been heavily involved in administrative activities within the Corrosion and Protection Centre and the University. In particular I was Chairman of the Departmental Academic Board

from 1988-2004, and I have also chaired a number of University Committees.

I am a regular referee for all major corrosion and many related journals, and for several conference proceedings

I have been active in the Institute of Corrosion, NACE, and the European Federation of Corrosion, where I am Chairman of Working Party 7, Education and Computer Applications.

On a more practical note I have lead (my colleagues might say forced) the introduction of IT to the Corrosion and Protection Centre since “pre-IBM PC” times.

**Exhibit 6A**  
**Dr. Douglas F. Hambley's Curriculum Vitae**

**DOUGLAS F. HAMBLEY, Ph.D., P.E., P.Eng., P.G.**  
**Mining Engineer and Geologist**  
**Associate**

**Education**

Ph.D. (Earth Sciences) University of Waterloo, Ontario, Canada, 1991  
M.B.A. Lewis University, Romeoville, Illinois, 1986  
B.Sc./Honours (Mining Engineering) Queen's University at Kingston, Ontario, Canada, 1972

**Professional Registrations and Memberships**

Professional Engineer: States of Illinois (by examination), Maryland, Pennsylvania, Virginia, Wisconsin, and Colorado (in progress) and Provinces of Ontario and Saskatchewan, Canada  
Professional Geologist: States of Illinois, Indiana (by examination), Pennsylvania and Wisconsin.  
Member, Illinois Board of Registration for Professional Geologists, 1996-2000  
Member, Past (Founding) Chicago Section Chairman, Society for Mining, Metallurgy, and Exploration of AIME  
Member, Canadian Institute of Mining, Metallurgy and Petroleum  
Member, American Society of Mining and Reclamation  
Member, Past Rock Mechanics Committee Chairman, Association of Engineering and Environmental Geologists

**Experience**

2007-Present	Associate, Agapito Associates, Inc., Golden, Colorado (formerly Lombard, Illinois). Dr. Hambley participates in projects related to mine and tunnel design, underground nuclear waste disposal, mine ventilation, blasting, and groundwater prediction. Recent projects have included: review of the License Application for the Yucca Mountain Repository for the State of Nevada, design and cost development for new underground stone mines in Illinois and Ohio, ground control consulting to an industrial facility in a stone mine in Pennsylvania, evaluation of room and pillar stability at industrial mineral and limestone mines in Indiana, Illinois, Virginia, West Virginia and Wisconsin, and preparation of NI 43-101 technical reports for a uranium prospect in Arizona, potash deposits in Brazil and Canada and a sulfur deposit in Alberta.
2005-2007	Mining and Geo-Environmental Engineering Consultant, Wheaton, Illinois. Designed systems for remote backfilling mine voids in Oklahoma and Kentucky;
2000-2005	Senior Consultant, Practical Environmental Consultants, Inc., Schaumburg, Illinois. Consultant to Potawatomi Tribe on Crandon Mine in Wisconsin.
1992-2000	Senior Project Manager, Graef, Anhalt, Schloemer and Associates, Inc, Chicago, Illinois. Managed the Environmental Department in the Chicago Office. Program Manager on two successive three-year contracts with Illinois EPA as Statewide Consultant on State-Lead Brownfields investigations.
1991	Geo-Environmental Group Manager, Nova Environmental Services, Inc., Des Plaines, Illinois.
1989-1991	Special Term Appointee, Energy Systems Division, Argonne National Laboratory, Illinois. Reviewed references in documents developed by subcontractors on the Nevada Nuclear Waste Storage Isolation (NNWSI) project for accuracy for USDOE Office of Civilian Radioactive Waste Management (OCRWM); performed shielding calculations for proposed Hadron Injector tunnels at Fermilab for ANL High Energy Physics Division; Co-Principal Investigator on contract with Baltimore District, US

- 1989 Army Corps of Engineers for Technical Assistance on Superfund and Defense Environmental Restoration Project sites.  
Senior Consultant, Dunn Geoscience Corporation, West Chicago, Illinois. Performed reserve analysis for a stone quarry; blast vibration analysis for construction sites; due diligence for acquisition of salt mines in Louisiana and Canada.
- 1988 Research Assistant; Department of Earth Sciences, Univ. of Waterloo, Ont., Canada.
- 1984-1988 Mining Engineer, Energy & Environmental Systems Div., Argonne National Laboratory, Illinois. Responsible for mining engineering and facilities design on Peer Review of the Salt High-Level Nuclear Waste Program and served as Lead Reviewer on four of seven major document reviews conducted and reviewer of drafts of the Environmental Assessments for seven salt repository sites. Consultant to Fermilab on geology, tunneling and ventilation aspects of the Superconducting Supercollider (SSC) Accelerator.
- 1980-1984 Senior Mining Engineer, Engineers International, Inc., Westmont, Illinois. Project Engineer on USNRC contracts regarding retrievability of high-level nuclear waste and technical assistance for repository design reviews; Project Engineer for design and construction of tunnel and shaft for a hydroelectric project, and design of highway tunnels on I-70.
- 1977-1980 Long Range Planning Rock Mechanics Engineer, Denison Mines Ltd., Elliot Lake, Ontario. Responsible for ground control, pillar design, and special studies at the mine; performed ventilation studies for pillar mining in association with radioactive backfill placement.
- 1975-1976 Mining Engineer, Harrison Bradford and Associates, Ltd., St. Catharines, Ontario. Performed shaft and tunnel design studies for Strait of Belle Isle Cable Crossing in Newfoundland. Evaluated soft-ground tunnel bid specifications for Contractor.
- 1974-1975 Mining Engineer Trainee, Falconbridge Nickel Mines, Ltd., Falconbridge, Ontario. Long-range planning and mine research studies; underground miner at East Mine.
- 1972-1973 Junior Engineer, Iron Ore Co. of Canada Ltd., Schefferville, Quebec. Pit Engineer and Geologist at Redmond Mine.
- Summer 1971 Junior Engineer – Mines, International Nickel Co. of Canada, Ltd., Copper Cliff, Ontario. Performed surveying at Crean Hill Mine and Ellen Pit.
- Summer 1970 Underground Miner, Falconbridge Nickel Mines, Ltd., Falconbridge, Ontario.
- Summer 1969 Underground Miner, Kam-Kotia Mines Ltd., Timmins, Ontario.

**Selected Publications**

Author of over 35 publications on mine opening and pillar design, mine ventilation and cooling, shaft design, hazardous waste site remediation, and nuclear waste disposal including:

Hambley, D. F., in press. "Backfill Systems," Chapter 18.2 in *SME Mining Engineering Handbook*, Third Edition, SME, Littleton, CO. Also Technical Editor/Reviewer of chapters on Block Caving, Cut and Fill Mining, Explosives, Mine Communication Systems, Compressed Air, and Mechanical Excavation.

- Hambley, D. F. and F. S. Kendorski, 2008. *Reducing the Impact on Underground Stone Mines of Some Geologic Features*, presented at NIOSH Underground Stone Seminar, Louisville, KY, December 9-10, 2008 (abstract only).
- Kendorski, F. S., and D. F. Hambley, 1992. "Other Applications of Geomechanics," Chapter 10.7 in *SME Mining Engineering Handbook*, Second Edition, SME, Littleton, CO, 975-991.
- Hambley, D. F. and J. R. Morris, 1988. "Designing Shafts for Handling High-Level Radioactive Wastes in Mined Geologic Repositories," *Nuclear Technology*, 80(3): 476-482.
- Hambley, D. F. et al., 1987. *Radioactive Waste Isolation in Salt: Peer Review of the Fluor Technology, Inc., Report and Position Paper Concerning Waste Emplacement Mode and Its Effect on Repository Conceptual Design*, ANL/EES-TM-322, Argonne National Laboratory, Argonne, IL.
- Hambley, D. F. et al., 1987. *Radioactive Waste Isolation in Salt: Peer Review of the Golder Associates Draft Test Plan for In Situ Testing in an Exploratory Shaft in Salt*, ANL/EES-TM-320, Argonne National Laboratory, Argonne, IL.
- Hambley, D. F., 1985. "Effects of Retrieval on Ventilation and Cooling Requirements for a Nuclear Waste Repository," in Mine Ventilation (Pierre Mousset-Jones, ed.), A. A. Balkema, Rotterdam, 311-316.
- Harrison, W. et al., 1985. *Radioactive Waste Isolation in Salt: Memorandum to Peer Review Panelists on the Rationale and Methodology for Argonne-Conducted Reviews of Site Characterization Programs*, ANL/ES-147, Argonne National Laboratory, Argonne, IL.
- Rote, D. M. et al., 1985. *Radioactive Waste Isolation in Salt: Peer Review of Westinghouse Electric Corporation's Report on Reference Conceptual Designs for a Repository Waste Package*, ANL/EES-TM-292, Argonne National Laboratory, Argonne, IL.
- Hambley, D. F. et al., 1984. *Radioactive Waste Isolation in Salt: Peer Review of the D'Appolonia Report on Schematic Designs for Penetration Seals for a Repository in the Permian Basin, Texas*, ANL/EES-TM-262, Argonne National Laboratory, Argonne, IL.
- Hambley, D. F. et al., 1984. *Radioactive Waste Isolation in Salt: Peer Review of the Office of Nuclear Waste Isolation's Report on Functional Design Criteria for a Repository for High-Level Radioactive Waste*, ANL/EES-TM-261, Argonne National Laboratory, Argonne, IL.
- McPheeters, C. C. et al., 1984. *Radioactive Waste Isolation in Salt: Peer Review of the Office of Nuclear Waste Isolation's Reports on Multi-factor Life Testing of Waste Package Materials*, ANL/EES-TM-263, Argonne National Laboratory, Argonne, IL.

- Kendorski, F. S., D. F. Hambley, and P. L. Wilkey, 1984. *Assessment of Retrieval Alternatives for the Geologic Disposal of Nuclear Waste*, NUREG/CR-3489, U.S. Nuclear Regulatory Commission, Washington, DC.
- Hambley, D. F., D. G. F. Hedley, and G. M. Morgan, 1980. "Use of the Analog and Computer Models in the Elliot Lake Uranium Mines," in *Underground Rock Engineering*, Special Vol. 22, Canadian Institute of Mining and Metallurgy, Montreal, 151-161.

**Exhibit 6B**

**Dr. Douglas F. Hambley's Testimonies in the Last Four Years**



**Testimony of Dr. Douglas F. Hambley:**

Board of Zoning Appeals, Anderson Township, Hamilton County, State of Ohio:

Case 08-2008, Martin Marietta: October 2, 2008, testified under examination by Dick Braam, Esq., attorney for Martin Marietta, with cross-examination by Tim Mara, Esq. and Doug Miller, Esq., attorneys for parties with standing at the hearing

Case 08-2008, Martin Marietta: October 15, 2008, testified under examination by Dick Braam, Esq. regarding previous testimony.

Transcripts are available on the Anderson Township website:

<http://www.andersontownship.org/index.asp?page=BoardZoning>

**Exhibit 7**  
**Francis S. Kendorski's Curriculum Vitae**

**FRANCIS S. KENDORSKI, P.E.**  
**Mining and Geological Engineer**  
**Senior Consultant**

**Education**

B.S./Honors (Mining Engineering) South Dakota School of Mines and Technology, Rapid City, SD, 1969  
M.S. (Geological Engineering) University of Arizona, Tucson, AZ, 1971  
U.S. Army Captain, Combat Engineers, United States Army, completed Engineer Officer Basic Course, U. S. Army Combat Engineer School, Fort Belvoir, VA, 1972

**Professional Memberships**

Registered Professional Engineer: States of California (Civil, by examination), Alabama, Colorado, Illinois, Indiana, Missouri, New York, Ohio, Pennsylvania, and Wisconsin  
Licensed Blaster: States of Illinois (1980-1998) and Wyoming (1984-1998)  
Member, Past Vice-President Heartland Region, Past Director, Past Executive Committee  
Member, Past Chicago Section Chairman, Society for Mining, Metallurgy, and Exploration of AIME  
Founding Member and Director, American Rock Mechanics Association  
Member, American Underground Construction Association  
Member, International Society of Explosives Engineers  
Member, Association of Engineering and Environmental Geologists

**Awards**

Rock Mechanics Award, 2006, Society for Mining, Metallurgy, and Exploration, Inc.  
Named *Centennial 100 Alumni*, 1985, as one of 100 outstanding surviving alumni at the Centennial of the South Dakota School of Mines and Technology, Rapid City, SD.  
Received *Award of Merit* for Technical Writing from Society of Technical Communications, March 2000, for article "Mining in Chicagoland," *Midwest Engineer*, May/June 1999.

**Honors**

Invited lecturer, publication reviewer, and federally-funded research reviewer. Invited and funded to serve on the 2004 National Science Foundation Panel to select a site for the Deep Underground Science and Engineering Laboratory, invited and funded in 2003 to address the Pennsylvania Governor's Commission on Mine Voids and Flooding following the Quecreek No. 1 Mine incident, invited and funded to address the federal Mine Safety and Health Research Advisory Commission in 2004, invited and funded to serve on the 2006-2007 Committee to Review the NIOSH/CDC Mining Health and Safety Research Program, invited and funded to represent the United States at the 1999 Indian National Symposium on Rock Mechanics in Bangalore, invited to present a 25<sup>th</sup> anniversary retrospective paper on coal mine subsidence and water issues at the 25<sup>th</sup> Annual International Conference on Ground Control at West Virginia University in 2006, invited and funded to address Meeting of the Federal Nuclear Waste Advisory Board at Las Vegas, Nevada, November 2005.

**Experience**

2000-Present Senior Consultant, Agapito Associates, Inc., Downers Grove. Illinois  
Recent projects have included analyses of performance of underground storage space for domestic water supply treatment sludge, including limestone fracture characteristics; coal mine water barrier pillars in Utah, investigation of mine water intrusion in Pennsylvania, litigation assistance in alleged coal

	mine subsidence caused by blasting, inspection and rehabilitation designs of the NIOSH Lake Lynn Laboratory in a stone mine in Pennsylvania, ground control design and later performance inspection of underground stone mine commercial storage and freezer facility in Illinois, inspection, and closure design of shafts for a commercial underground stone mine large optics finishing facility in Pennsylvania, investigation of causes of ground failure and remediation for an underground rock crushing plant in West Virginia, design and cost development for two new underground stone mines in Illinois and one in Ohio, design of access and underground layout a multiple-level underground stone mine in Illinois, re-design of expansion of a new stone mine in Illinois, re-design of existing stone mines in Indiana, due diligence in the acquisition of a sand and gravel property in Illinois with extensive underground-mining stone resources, investigation of ground control problems in stone mines in Iowa, Indiana, West Virginia, and Illinois. Assistance to the State of Nevada in High-Level Nuclear Waste Storage licensing issues at Yucca Mountain proposed Facility in Nevada: In particular drift degradation, seepage in rock fractures and drilled holes, performance of ground control elements, and others.
1992-2000	Vice President, Weir International Mining Consultants, Des Plaines, Illinois Investigated coal mine subsidence under a reservoir in Alabama, coal mine water intrusions in Alabama, tunnel construction performance including TBM productivity, belt haulage, and belt haulage in shaft for City Water Tunnel No. 3, Queens, NY. Consultant on mineral valuations for limestone, dolomite, mica, for acquisitions, loan collateral, takings; reserve evaluations for sand and gravel, limestone, gold, coal, and copper. Projects include valuations of numerous industrial mineral properties; underground stone mine designs; subsidence for a landfill; audit of a feasibility study for a gold mine in Nicaragua; inspection of bauxite reserves in India; and geologic exploration and mine planning in Trinidad and Tobago.
Summer 1992	Consulting Engineer and Geologist, Downers Grove, Illinois Consulted on developing a novel combined surface and underground mining technique; cost estimates for moving a major primary crushing facility and associated conveyor belt installations in a very large quarry.
1987-1992	Division Manager, Dunn Geoscience Corporation, Downers Grove, Illinois Responsible for studies of longwall coal mine subsidence under rivers and prime farm land, converting a quarry into a waste water reservoir; a new cement stone quarry; designing underground stone mines; lining distress of the Eisenhower Memorial Tunnel; rehabilitation for a museum tunnel.
1984-1987	President, Terraform Engineers, Inc., Naperville, Illinois Retained as a Consultant by the High-Level Nuclear Waste Programs all states. Completed projects on instrumentation of a portion of the Washington Metro; engineering of a new level of a mine in Chile.
1977-1984	Division Manager, Engineers International, Inc., Westmont, Illinois Responsible for the production of a manual for mining with water hazards, design of the tunnel and shaft for a hydroelectric project, highway tunnels; and wastewater tunnel construction details and claims.
1973-1977	Senior Staff Engineer, Leeds, Hill and Jewett, Inc., San Francisco, California

	Project Engineer for the design and construction engineering of the second bore of the Eisenhower Memorial Tunnel in Colorado; the repair of a hydroelectric tunnel and a streetcar tunnel; and study of dam sites in Papua New Guinea.
1971-1973	Geological Engineer, Climax Mine, Climax Molybdenum Company, Climax, Colorado Responsible for the design of the slopes for the new open pit mine, redesigns of mine supports, and engineering for the of the cave on the 600 Level.
1970-1971	Mining Engineer, U.S. Bureau of Mines, Tucson, Arizona, and Denver, Colorado Completed rock mapping and testing at the San Manuel Mine in Arizona.
Summer 1969	Assistant Mine Engineer, Belle Isle Salt Mine, Cargill, Inc., Patterson, Louisiana Completed geologic mapping and volume survey of underground rock salt mine.

## **Publications**

### **Subsidence**

- “Design and Performance of a Longwall Coal Mine water-Barrier Pillar,” (with M. D. Bunnell), *Proc. 26<sup>th</sup> Int’l Conf. on Ground Control in Mining*, West Virginia University, Morgantown, 2007.
- “Effect of Full-Extraction Underground Mining on Ground and Surface Waters: A 25-year Retrospective,” *Proc. 25<sup>th</sup> Int’l Conf. on Ground Control in Mining*, West Virginia University, Morgantown, 2006, pp. 425-430.
- “A Study of Potential Fault Reactivation at a Longwall Coal Mine in Appalachia,” *Proc. 22nd Int’l Conf. on Ground Control in Mining*, West Virginia University, Morgantown, 2003, pp. 326-329.
- “Application of Mechanical and Groundwater-Flow Models to Predict the Hydrogeologic Effects of Longwall Subsidence - A Case Study,” (with D. J. Van Rosendaal and J. T. Padgett), *Proc. of the 14<sup>th</sup> Int’l Conf. on Ground Control in Mining*, West Virginia University, Morgantown, pp. 252-260, 1995.
- “Chinese and North American High-Extraction Underground Coal Mining Strata Behavior and Water Protection Experience and Guidelines,” (with M. Bai and D. J. Van Rosendaal), *Proc. of the 14<sup>th</sup> Int’l Conf. on Ground Control in Mining*, West Virginia University, Morgantown, pp. 209-217, 1996.
- “Room and Pillar Coal Mine Subsidence Evaluations for Design of a Lined Sanitary Landfill,” *Conf. on Mine Subsidence in Urban and Developed Areas*, Wyoming Department of Environmental Quality and City of Rock Springs, Rock Springs, WY, 1993 (presentation only).
- “Subsidence and Water Intrusion for Shallow Longwall Mine Planning in the Illinois Coal Basin - A Case Study,” *Longwall U.S.A.*, Maclean Hunter Mining and Construction Group, Littleton, CO, pp. 160-174, 1993.
- “Effect of Full-Extraction Mining on Ground and Surface Waters,” *Proc. of the 12<sup>th</sup> Int’l Conf. on Ground Control in Mining*, West Virginia University, Morgantown, pp. 412-425,

1993.

- “Intensive Subsidence Investigations and Predictions for a Lined Sanitary Landfill,” (with K.J. Smith, V. Mandros, P. Scheller), *1990 Annual Meeting of the Association of Engineering Geologists*, 1990 (abstract only).
- “Strata Disturbance Prediction for Mining Beneath Surface Water and Waste Impoundments,” (with M.M. Singh), *Proc. of the 1<sup>st</sup> Conf. on Ground Control in Mining*, West Virginia University, Morgantown, pp. 76-89, 1981.
- “Criteria for Determining When a Body of Surface Water Constitutes a Hazard to Mining,” (with I. Khosla and M.M. Singh), *Report on U.S. Bureau of Mines Contract J0285011*, 364 p., August 1979.

## Blasting

- “Forensic Rock Engineering,” *4<sup>th</sup> North American Rock Mechanics Symposium*, American Association for Rock Mechanics, Seattle, WA, July 2000. *In press*. (Invited Keynote Address)
- “Some Modes of Deformation and Failure of Lined Tunnels,” *Proc. of the 34<sup>th</sup> U.S. Symp. on Rock Mechanics, International Journal of Rock Mechanics and Mining Sciences*, University of Wisconsin, Madison, 30(7): 1497-1501, December 1993.
- “BLASTERR - Customized Personal Computer Applications for the Blaster at Smaller Operations,” *16<sup>th</sup> Annual Kentucky Blasting Conf.*, Lexington, KY, 1989.
- “Rock in the Box - Blasting Productivity,” *Mining Engineering*, 36(5), 1984.
- “Response of Rock Pinnacles to Blasting Vibrations and Air Blasts,” (with R.A. Cummings and C.H. Dowding), *Bulletin of the Association of Engineering Geologists*, 20(3): 271-281, 1983.
- “Field Study of the Blasting Vibration Stability of Large Natural Rock Pinnacles,” (with R.A. Cummings and C.H. Dowding), *Proc. of the 1982 Conf. on Explosives and Blasting Techniques*, Society of Explosives Engineers, Montville, OH, pp. 1-35, 1982.
- “Blasting Practices for Improved Coal Strip Mine Highwall Safety and Cost,” (with M.F. Dunn), *Proc. of the 3<sup>rd</sup> Int’l Conf. on Stability in Surface Mining*, Vancouver, BC, Canada, pp. 515-548, 1981.
- “Safety and Cost Benefits from Improved Highwall Blasting Practice,” (with M.F. Dunn), *Report on U.S. Bureau of Mines Contract H0282011*, 167 p., February 1981.
- “Safety and Cost Benefits from Improved Highwall Blasting Practice,” (with M.F. Dunn), *110<sup>th</sup> AIME Annual Meeting*, Chicago, IL, February 1981.
- “Blasting Procedures for Improved Highwall Safety and Cost,” (with M.F. Dunn), *7<sup>th</sup> Kentucky Blasting Conf.*, Lexington, KY, December 1980.
- “Effect of Blasting on Shotcrete Drift Linings,” (with C.V. Jude and W.M. Duncan), *Mining Engineering*, 25(12): 38-41, 1973.
- “Boulder Handling and Blasting for Greater Safety and Efficiency in Crushers,” (with M.F. Dunn and S. Bhattacharya), *Report on U.S. Bureau of Mines Contract J0100007*, 120 p., November 1981.

## Tunneling

- “Rock Reinforcement and Shotcrete for Temporary or Permanent Support,” *Short Course on Rock Mechanics for Underground Construction, 3<sup>rd</sup> National Conf. of the Geo-Institute*

- of ASCE, University of Illinois, June 1999 (notes and slides only).
- “Achieving Quality Cast-in-Place Concrete Tunnel Linings,” *Conf. on Structural Performance of Pipes*, Center for Geotechnical and Groundwater Research, Ohio University, Columbus, 1993, (abstract only).
- “The Design and Construction of the Excavation for the Underground Works at the Rocky Mountain Pumped Storage Project,” (with R.D. Prager and C.M. Lundhill), *Proc. of the 27<sup>th</sup> U.S. Symp. on Rock Mechanics*, University of Alabama, pp. 968-974, 1986.
- “The Rock Mass Characteristics of the Rocky Mountain Pumped Storage Project Hydroelectric Tunnel and Shaft,” (with G.S. Grainger, R.L. Butts, and R.A. Cummings), *Proc. of the 27<sup>th</sup> U.S. Symp. on Rock Mechanics*, University of Alabama, pp. 961-967, 1986.
- “Site Investigation and Underground Mapping,” *Short Course in Shafts for Underground Construction*, University of Wisconsin-Milwaukee, February 1986.
- “Effect of Geological Conditions on Shaft Support Systems,” (with M.M. Singh and D.F. Hambley), *Shaft Sinking and Boring Technology Symp.*, Socorro, NM, 22 p., May 1982.
- “Design of Rock Reinforcement Systems for Underground Openings Based on Critical Assessment of Geological Conditions,” (with D.F. Hambley), *14<sup>th</sup> Canadian Rock Mechanics Symp.*, Vancouver, BC, Canada, 1982.
- “Shotcrete Mine Applications: Uses, Techniques, Materials Handling, Design,” Short course on Tunnels ‘85: Design, Construction, and Instrumentation, University of Colorado, April 1985.
- “Shotcrete Mine Applications: Use, Techniques, Materials Handling, Design,” *Short Course in Shotcrete for Support of Underground Openings*, University of Wisconsin-Milwaukee, 40 p., November 1982.
- “Geomechanical Assessment of a TBM Excavated Tunnel in Carbonate Rock,” (with D.R. Bassarab and B.L. McCormick), *23<sup>rd</sup> Annual Meeting of the Association of Engineering-Geologists*, Dallas, TX, October 1980.
- “Field and Laboratory Assessment of Rock Mass Strength for Tunnel Design with Allowance for Dilation,” *Proc. of the 13<sup>th</sup> Canadian Rock Mechanics Symp.*, University of Toronto, 22: 162-167, 1980.
- “Effect of Rapid Water Pressure Fluctuations on Unlined Water Tunnel Stability,” (with T.A. Lang and K.S. Chawla), *Proc. of the 1976 North American Rapid Excavation and Tunneling Conf.*, Las Vegas, pp. 417-429, 1976.
- “Engineering Inspection and Appraisal of Rock Tunnels,” (with J.A. Bischoff), *Proc. of the 1976 North American Rapid Excavation and Tunneling Conf.*, Las Vegas, pp. 81-99, 1976.
- “Some Design and Construction Considerations for Large Permanent Underground Openings at Shallow Depths,” (with T.L. Brekke and T.A. Lang), *Proc. of the 3<sup>rd</sup> Congress of the Int’l Society for Rock Mechanics*, National Academy of Sciences, Washington, IB: 1507-1517, 1974.
- “Tunnel Advance Rate Prediction Based on Geologic and Engineering Observations,” (with W.D. Gentry and J.F. Abel, Jr.), *Int’l Journal of Rock Mechanics and Mining Sciences*, 8: 451-475, 1971.

## Ground Control

- “Structural and Stratigraphic Features within the Galena-Platteville Groups (Middle Ordovician): Impacts on Underground Stone Mine Development in Northeastern Illinois” (with J. E. Crawford) *presented at* Forum on Industrial Minerals, Oklahoma City, 2008.



- “Reducing the Impact on Underground Stone Mines of Some Geologic Features” (with D. F. Hambley) *presented at* NIOSH Seminar on Safety in Underground Stone Mines, Louisville, 2008.
- “Rock City Business Complex,” (with T. Boutaugh), *presented at* monthly combined meeting of Chicago Chapter of ASCE, Chicago Chapter of SME, Great Lakes Section of AEG, January 2009.
- “Towards an Improved Stone Mine Pillar Design Methodology – Observations from a Mistake,” *Proc. 26th Int’l. Conf. on Ground Control in Mining*, West Virginia Univ., Morgantown, 2007.
- “Workshop on Practical Geology for Roof Control,” (with A. T. Iannacchione and K. F. Unrug) *Safety Seminar for Underground Stone Mines*, National Institute for Occupational Safety and Health, Pittsburgh, Abstract Only, December 2002.
- “The Importance of Underground Stone Mine Roof Geology,” *Proc. 21st Int’l. Conf. on Ground Control in Mining*, West Virginia University, Morgantown, 2002, p. 208-213.
- “Understanding and Solving Roof Control Problems in Underground Stone Mines, Preprint 02-113” *Annual Meeting of the Society for Mining, Metallurgy, and Exploration Inc.*, Phoenix, AZ, February 2002.
- “Understanding and Solving Roof Control Problems in Underground Stone Mines,” *Safety Seminar for Underground Stone Mines*, National Institute for Occupational Safety and Health, Pittsburgh, Abstract Only, December 2001.
- “Rock Reinforcement Longevity,” *Proc. of the 19<sup>th</sup> Int’l Conf. On Ground Control in Mining*, West Virginia University, Morgantown, 2000, p. 266-271.
- “Rock Reinforcement Longevity,” *Geo-Strata*, Fall 2003.
- “Site Characterization for Planning Underground Stone Mines,” *Proc. of the 19<sup>th</sup> Int’l Conf. On Ground Control in Mining*, West Virginia University, Morgantown, 2000, p. 192-198.
- “The Evolution of Rock Reinforcement Design,” *Proc. of the 37<sup>th</sup> U.S. Symp. on Rock Mechanics*, American Rock Mechanics Association, pp. 643-649, 1999.
- “Ground Control in Underground Stone Mines,” *Aggregates Manager*, 3(2): 30-33, February 1988.
- “Ground Control in Underground Stone Mines,” *Safety Seminar for Underground Stone Mines*, National Institute for Occupational Safety and Health, Pittsburgh, pp. 20-25, December 10, 1997.
- “Rock Reinforcement - What Is It and What Does It Do?,” *Newsletter of the North Central Section of the Association of Engineering Geologists*, Chicago, 2 p. insert, October 1995.
- “Contractual Considerations in Rock Reinforcement Design and Installation,” (with R.D. Prager), *Annual Meeting of Society of Mining Engineers of AIME*, Atlanta, Preprint 83-183, 1983.
- “Ground Control, 1981 Annual Review,” (with V. Rajaram), *Mining Engineering*, 34(5): 518-520, 1982.
- “A Rock Mass Classification Scheme for the Planning of Caving Mine Drift Support,” (with R.A. Cummings, Z.T. Bieniawski, and E.H. Skinner), *Proc. of the 1983 Rapid Excavation and Tunneling Conf.*, Chicago, IL, pp. 191-223, 1983.
- “Rock Mass Classification for Block Caving Mine Drift Support,” (with R.A. Cummings, Z.T. Bieniawski, E.H. Skinner), *Proc. of the 5<sup>th</sup> Congress of the Int’l Society for Rock Mechanics*, Melbourne, pp. 851-863, 1983.
- “Prediction of Caving Mine Drift Deformations,” (with R.A. Cummings), *Proc. of the 1<sup>st</sup> Int’l Conf. on Stability in Underground Mining*, Vancouver, BC, Canada, pp. 653-673, August



1982.

- “Development and Testing of Self-Drilling Roof Bolts,” (with S.D. Singh and M.M. Singh), *Report on U.S. Bureau of Mines Contract H0272022*, 225 p., August 1979.
- “Development and Testing of Self-Drilling Roof Bolts,” (with M.M. Singh and R.P. Curtin), *Proc. of the 1979 North American Rapid Excavation and Tunneling Conf.*, Atlanta, p. 635-655. Synopsis in *Tunnels and Tunnelling*, 11(8): 39, October 1979.
- “Caving Operations Drift Support Design,” *Design Methods in Rock Mechanics, Proc. of the 16<sup>th</sup> Symp. on Rock Mechanics*, University of Minnesota, pp. 277-286, 1977. Reprinted in *Underground Mining Methods Handbook*, SME/AIME, New York, pp. 1568-1573.
- “Performance of Shotcrete Linings at the Climax Mine,” (with R.K. Towner), *Proc. of the 2<sup>nd</sup> North American Rapid Excavation and Tunneling Conf.*, San Francisco, pp. 1013-1026, 1974.

## Rock Mechanics

- “Forensic Rock Engineering,” *4th North American Rock Mechanics Symposium*, Seattle, WA, 2000 (Invited Keynote Address, Abstract Only)
- “Methodology for Characterizing Very Large Rock Masses,” (with B. Chirioti, A. Mahtab, and S. Xu), *Proc. of the 37<sup>th</sup> U.S. Symp. on Rock Mechanics, American Rock Mechanics Association*, pp. 263-270, 1999.
- “Dealing with Uncertainty in Geotechnical Design in Rock,” *Workshop on Geotechnical Design Methodology, 33<sup>rd</sup> U.S. Symp. on Rock Mechanics*, Sandia National Laboratory, Santa Fe, NM (slides only).
- “Use of Alternative Distributions for Characterizing Joint Extent and Spacing,” (with A. Mahtab, S. Xu, and P. Grasso), *Proc. of the 1992 Conf. on Rock Joints*, Lake Tahoe, NV.
- “Other Applications of Geomechanics,” (with D.F. Hambley), *SME Mining Engineering Handbook, 2nd Edition*, Chap. 10.7, pp. 975-991, 1992.
- “A Combined Soil Mass Sliding and Rock Toppling Slope Failure,” (with A.C. Pincomb), *Proc. of the 1991 Annual Meeting of the Association of Engineering Geologists*, St. Charles, IL, pp. 603-611, 1991.
- “Rock Mass Characterization and Engineering in Very Low-Stress Environments,” *Proc. of ‘Jamming in the Rockies’ - a Workshop on Scale Effects in Rock Mechanics*, 31<sup>st</sup> U.S. Symp. on Rock Mechanics, Colorado School of Mines, 1990.
- “Mixed Material Slope Design - A Case History,” with D.A. Myers and C.H. Grenot, Jr., *Proc. of the 31<sup>st</sup> U.S. Symp. on Rock Mechanics*, Colorado School of Mines, pp. 729-736, 1990.
- “How to Select a Strike and Dip in Fractured Rock for Engineering Design,” *1987 Annual Meeting of the Association of Engineering Geologists*, Atlanta, 1987 (abstract only).
- “Fracture Geometry Characterization for Use in Rock Mechanics Design,” (with A. Bindokas), *Proc. of the 28<sup>th</sup> U.S. Symp. on Rock Mechanics*, University of Arizona, pp. 89-97, 1987.
- “The Determination of Structural Domains,” (with A. Bindokas and M.F. Dunn), *Short Course in Rock Tunnels*, University of Wisconsin-Milwaukee, November 1986.
- “Resolved: The Risk of Failure of an Excavation in or on Rock is Acceptable for Public Safety, Second for the Question,” (with G.B. Baecher, R.E. Goodman, W.A. Hustrulid, R. McGarland, and D.A. Pentz), *26<sup>th</sup> U.S. Symp. on Rock Mechanics*, South Dakota School of Mines and Technology, Rapid City, SD, June 1985 (debate).
- Annual Review of U.S. Progress in Rock Mechanics: Rock Mass Characterization*, Contributor, U.S. National Committee for Rock Mechanics, National Research Council, 11 p., 1983.

- “Underground Mines, Mining, and Instrumentation,” (with M.M. Singh), *Short Course lecture notes, Selected Geotechnical Design Principles for Practicing Engineering Geologists*, Annual Meeting of the Association of Engineering Geologists, Chicago, IL, pp. 6-1-6-85, October 1979.
- “The Cavability of Ore Deposits,” *Mining Engineering*, 30(6): 628-631, June 1978. Reprinted in *Underground Mining Methods Handbook*, SME/AIME, New York, pp. 1466-1471.
- “Applied Rock Mechanics at Climax,” *Applications of Rock Mechanics, Proc. of the 15<sup>th</sup> Symp. on Rock Mechanics*, South Dakota School of Mines and Technology, pp. 639-647, 1975.
- “Outline of Fracture Geology of the Climax Area,” 9<sup>th</sup> Annual Intermountain Minerals Conf., Vail, CO, August 1973.
- “Analysis of the Geometry of Fractures in San Manuel Copper Mine, Arizona,” (with M.A. Mahtab and D.D. Bolstad), *U.S. Bureau of Mines Report of Investigations 7715*, 24 p., 1973.
- “Influence of Jointing on Engineering Properties of San Manuel Mine Rock,” *Unpublished M.S. Thesis*, University of Arizona, 126 p., 1971.

## Ventilation

- “Auxiliary Jet Fans,” (with M.F. Dunn, M.O. Rahim, and J.C. Volkwein), *Engineering and Mining Journal*, 184(19), December 1983.
- “Reverse Performance Characteristics of Main Mine Fans,” (with M.F. Dunn, S. Bhattacharya, and V. Rajaram), *Mining Science and Technology*, 1(1): 59-68, October 1983.
- “Using Auxiliary ‘Jet Fans’ in Large Underground Metal/Nonmetal Mines: A Handbook,” (with M.F. Dunn, A. Mukherjee, and M.O. Rahim), *Report on U.S. Bureau of Mines Contract J0318015*, 20 p., July 1983.
- “Testing Jet Fans in Metal/Nonmetal Mines with Large Cross-Sectional Airways,” (with M.F. Dunn, A. Mukherjee, and M.O. Rahim), *Report on U.S. Bureau of Mines Contract J0318015*, 132 p., July 1983.
- “Main Mine Fan Reserve Performance Characteristics,” (with M.F. Dunn, R.D. Schilz, and E.D. Thimons), *Proc. of the 1<sup>st</sup> Ventilation Symp.*, New York, pp. 23-28, 1982.

## High-Level Nuclear Waste

- “Review and Critique of Drip Shield Concept and Retrieval Concept Planned for the Yucca Mountain Project, Nevada,” presented at meeting of U. S. Nuclear Waste Technical Review Board, November 8-9, 2005, Las Vegas, Nevada.
- “A Geologic High Level Nuclear Waste Repository Considered as an Underground Facility Design Problem,” *Proc. of the 25<sup>th</sup> U.S. Symp. on Rock Mechanics*, Northwestern University, pp. 1214-1218, 1984.
- “Assessment of Retrieval Alternatives for the Geologic Disposal of Nuclear Waste,” (with D.F. Hambley and P.L. Wilkey), *Report on U.S. Nuclear Regulatory Commission Contract NRC-02-82-031*, NUREG/CR-3489, 635 p., August 1983.
- “A Phased Design Approach to a Nuclear Waste Repository in Hard Rock During Regulatory Review,” (with V. Rajaram, M.S. Nataraja, and R.A. Cummings), *Proc. of the 24<sup>th</sup> U.S. Symp. on Rock Mechanics*, Texas A&M University and Association of Engineering Geologists, College Station, TX, pp. 829-835, 1983.
- “Rock in the Box: Box in the Rock,” Editorial on Radioactive Waste Disposal, *Mining*

*Engineering*, 35(3): 269, 1983.

### **Mineral Economics**

“Financial Valuation of Construction Materials Properties, Operations, and Plants,” (with D.D. Haas), *Annual Meeting of the Society for Mining, Metallurgy, and Exploration Inc.*, Cincinnati, OH, February 2003.

“Financial Valuations of Industrial Minerals Projects,” (with D.D. Haas), *Proc. 14<sup>th</sup> Industrial Minerals International Congress 2000*, Denver, pp. 91-95, 2000.

“Mining in Chicagoland,” *Midwest Engineer*, 51(5), pp. 2-5, May/June 1999. (Received Award of Merit for Technical Writing from Society of Technical Communications, March 2000)

**Exhibit 8**  
**Dr. Stephan K. Matthäi's Curriculum Vitae**

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Date of Birth: May 6<sup>th</sup>, 1963  
Place of Birth: Mosbach, Germany  
Sex/Marital Status: male / married, one child  
Nationality: German  
Languages: English, German, French, Italian

**10/2008- present: Professor (Ordinarius)** of Reservoir Engineering, Montan University of Leoben, Austria.

**1/2001-9/2008: Governor's Lecturer**, (formal title: Senior Lecturer) Department of Earth Sciences & Engineering, Imperial College London, South Kensington.

**3/2005: Concours National de la Recherche, habilitation**, (qualification) France.

**10/96-12/2000: Research Associate (Wissenschaftlicher Mitarbeiter)**, Institut für Isotopengeologie und Mineralische Rohstoffe, Swiss Federal Institute of Technology, Zürich, Switzerland.

**6/95-10/96: Postdoctoral Research Fellow**, Rock Fracture Project (RFP), Department of Geological and Environmental Sciences, Stanford University, Stanford, California, USA.

**4/94-6/95: Postdoctoral Research Fellow**, Department of Geological Sciences, Snee Hall, Cornell University, Ithaca, New York, USA.

**5/90-2/94: Ph.D.**, Research School of Earth Sciences, Australian National University, Canberra, Australia. Supervisors: Dr. Mike A. Etheridge and Dr. Stephen Cox. Advisor: Dr. Richard W. Henley.

PhD Thesis: **The Genesis of Intrusive-Related Hydrothermal Gold Deposits.**

**10/83-2/90: Diplom**, Master of Science, Eberhardt Karls University of Tübingen, Germany. Supervisor: Dr. Wolfgang Frisch.

Diplom Thesis: **Deformation and Mineralization History of Emplaced Backarc Basin Crust on the Argolis Peninsula (Greece).**

## Academic Activities

### Memberships

11/04-present, The Geological Society of London (GeolSoc)  
9/04-present, Society of Petroleum Engineers (SPE)  
11/85-present, American Geophysical Union (AGU)  
4/98-present, European Geophysical Society (EGS)  
11/03-present, Swiss Association of Petroleum Geologists & Engineers (ASP/VSP).

### Reviewing for journals

Advances in Water Resources  
American Association of Petroleum Geologists Bulletin  
Economic Geology  
Geofluids  
Geophysical Research Letters  
Journal of Geochemical Exploration  
Journal of Geophysical Research  
Journal of Structural Geology  
Mineralium Depositae  
SPE Journals  
SGE Bulletin  
Water Resources Research

## For granting agencies

DOE (USA)  
NERC (UK)  
EPSRC (UK)  
ARC (Australia)

## Editorial boards

2000-present Associate editor: Geofluids, Blackwell Science Publications

## Publications

### International Journals

2009

Paluszny, A., and S. K. Matthai, "Impact of fracture development on the effective permeability of porous rocks as determined by 2D discrete fracture growth modeling." *Journal of Geophysical Research*, doi:10.1029/2008JB006236 (2009).

Matthäi, S. K. and Maghami-Nick, H., "Upscaling two-phase flow in naturally fractured reservoirs." *AAPG Bulletin* 93:11, 1-12 (2009).

Belayneh, M., S. K. Matthäi, M. J. Blunt, and S. Rogers, "Comparison between deterministic with stochastic fracture models in water-flooding numerical simulations." *AAPG Bulletin*, v. 93 (2009).

Adriana Paluszny and Stephan K. Matthäi, "Impact of fracture development on the effective permeability of porous rocks as determined by 2D discrete fracture growth modeling" *Journal of Geophysical Research - Solid Earth*, in press 2009 (reference 2008JB006236RR).

Xavier Garcia, Lateef T. Akanji, Martin J. Blunt, Stephan K. Matthäi, and John Paul Latham, "Numerical study of the effects of particle shape and polydispersity on permeability." *Phys. Rev. E* 80, 021304 (2009).

Adriana Paluszny and Stephan K. Matthäi, Numerical modeling of discrete multi-crack growth applied to pattern formation in geological brittle media. *International Journal of Solids and Structures*, Vol. 46, No. 18-19. (September 2009), pp. 3383-3397.

Geiger, S., Matthäi, S., Niessner, J., and Helmig, R., "Black-Oil simulations for three-component, three-phase flow in fractured porous media." *SPE107485, SPE Journal*, 6, 338-354, June (2009).

Stephan K. Matthäi · Hamidreza M. Nick · Christopher Pain · Insa Neuweiler, "Simulation of Solute Transport Through Fractured Rock: A Higher-Order Accurate Finite-Element Finite-Volume Method Permitting Large Time Steps." *Transport in Porous Media*, DOI 10.1007/s11242-009-9440-z (2009).

Lateef T. Akanji · Stephan K. Matthai, "Finite Element-Based Characterization of Pore-Scale Geometry and Its Impact on Fluid Flow." *Transport in Porous Media*. 19 p., doi:10.1007/s11242-009-9400-7 (2009).

K. Stüwe, J. Robl and S. Matthäi, "Erosional decay of the Yucca Mountain crest, Nevada." *Geomorphology*, 108:3-4, 200-208, doi:10.1016/j.geomorph.2009.01.008.

### Other

1. Coumou, D., Matthai, S. K., Geiger, S., and Driesner, T., A parallel FE-FV scheme to solve fluid flow in complex geologic media, *Computers & Geosciences* 34:12, 1697-1707, doi:10.1016/j.cageo.2007.11.010 (2008).
2. Matthäi, S.K., Mezentsev, A., and Belayneh, M., "Finite-Element Node-Centered Finite-Volume experiments with fractured rock represented by unstructured hybrid element meshes," *SPE Reservoir Evaluation & Engineering*, 10:6, 740-756 (2007).
3. Linde, N., Jougnot, D., Revil, A., Matthai, S.K., Arora, T., Renard, D., and Doussan, C., "Streaming current generation in two-phase flow conditions." *Geophysical Research Letters* 34, L03306, doi:10.1029/2006GL028878 (2007).
4. Revil, A., Linde, N., Cerepi, A., Matthai, S.K., and Finsterle, S., "Electrokinetic coupling in unsaturated porous media," *Journal of Colloid and Interface Science* 313, 315 - 327, ISSN: 0021-9797 (2007).

5. Paluszny, A., Matthäi, S.K., and Hohmeyer, M., "Hybrid Finite Element Finite Volume Discretisation of complex geologic structures and a new simulation workflow demonstrated on fractured rocks." *Geofluids* 7, 186-208 doi: 10.1111/j.1468-8123.2007.00180.x (2007).
6. Belayneh, M., Geiger, S., Matthai, S. K., "Numerical simulation of water injection into layered fractured carbonate reservoir analogues." *American Association of Petroleum Geologists Bulletin* 90, 1-21 (Oct 2006).
7. Geiger, S., Driesner, T., Heinrich, C. A., Matthai, S. K., "Multiphase thermohaline convection in the earth's crust: I. A new finite element - finite volume solution technique combined with a new equation of state for NaCl-H<sub>2</sub>O." *Transport in Porous Media* 63, 399 – 434 (2006).
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9. Coumou, D., Driesner, T., Geiger, S., Heinrich, C. A. and Matthäi, S. K., "The dynamics of mid-ocean ridge hydrothermal systems: Splitting plumes and fluctuating vent temperatures." *Earth and Planetary Science Letters* 245:1-2, 218-231 (May 2006).
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15. Matthäi, S. K. and Belayneh, M., "Fluid flow partitioning between fractures and a permeable rock matrix" *Geophysical Research Letters*, 31:7, L07602, doi:10.1029/2003GL019027 (paper includes the magazine cover and was presented as an AGU publication highlight) (2004).
16. Matthäi, S. K., Heinrich, C. A., Driesner, T., "Is the Mount Isa copper deposit the product of forced brine convection in the footwall of a major reverse fault ?" *Geology* 32:4, 357-360 (2004). Also published reply to comment in Octobre 2004.
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18. Geiger, S., Roberts, S., Matthäi, S.K., and Zoppou, C., "Combining finite volume and finite element methods to simulate fluid flow in geologic media." *ANZIAM Journal* 44(E), C180-201 (2003).
19. Geiger, S., Haggerty, R., Dilles, J. H., Reed, M. H., Matthäi, S. K., "New insights from reactive transport modelling: the formation of the sericitic vein envelopes during early hydrothermal alteration at Butte, Montana," *Geofluids* 2:3, 185-193 (2002).
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26. Matthäi, S. K., and Henley, R. W., "Geochemistry and depositional environment of the gold-mineralized Proterozoic Koolpin Formation, Pine Creek Inlier, Northern Australia: A Comparison with Modern Shale Sequences" *Precambrian Research* 78, (1996), 211-235.
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28. Matthäi, S. K., Binns, R. A., Henley, R. W., Andrew, A. S., Carr, G. H., Bacigalupo-Rose, S., French, D. H., and McAndrew, J., "Intrusion-related, high-temperature gold-quartz veining at the Cosmopolitan Howley metasedimentary rock-hosted gold deposit, Northern Territory, Australia" *Econ. Geol.*, 90:5, (1995), 1012-1045.
29. Henley, R. W., Matthäi, S. K., and Kavanagh, M. E., "Hypothermal vein mineralisation at the Cosmopolitan Howley gold deposit, Northern Territory" *The Aus. IMM Bull.* 5, Sept. 1994, (1994).

30. v. Engelhardt, W., Matthäi, S. K., Walzebeck, J., "Araguinha impact crater, Brazil. I. The interior part of the uplift" *Meteoritics* 27, (1992), 442-457.

### Contributions to Books Edited by Others

1. Matthäi, S. K., Geiger, S., Roberts, S. G., Paluszny, A., Belayneh, M., Burri, A., Mezentsev, A., Lu, H., Coumou, D., Driesner, T., and Heinrich, C. A., "Numerical simulation of multi-phase fluid flow in structurally complex reservoirs, In: Jolley, S. J., Barr, D., Walsh, J. J., & Knipe, R. J., editor, *Structurally Complex Reservoirs*, Geological Society London Spec. Publ., 292, 405 – 429 (2007).
2. Belayneh, M., Matthäi, S. K., Cosgrove, J., "The implications of fracture swarms in the Chalk of SE England on the tectonic history of the basin and their impact on fluid flow in high-porosity, low-permeability rocks," In: Ries, A. C., Butler, R. W. H. & Graham, R. H., editor, *Deformation of the Continental Crust*: Geological Society London Spec. Publ., 291, 499 – 517 (2007),
3. Matthäi, S. K., Roberts, S. G., Aydin, A., and Pollard, D. D., "Numerical simulation of departures from radial drawdown in a faulted sandstone reservoir with joints and deformation bands" *Geological Society of London, Spec. Publ.* 147 (1998), 157-191.
4. Matthäi, S. K. and Roberts, S., "Transient versus continuous fluid flow in seismically-active faults: An investigation by electric analog and numerical modelling" in "Fluid Flow and Transport in Rocks: Mechanisms and Effects" (Chapmann & Hall), (1996), 263-295.

### Proceedings

0. Huangfu, Q., Reid, F., Matthäi, S., Coumou, D., Geiger, S., Belayneh, M., Fricke, C., and Schmid, K., "Massively parallel sector-scale discrete fracture and matrix simulations." SPE Reservoir Simulation Symposium, 2-4 February 2009, The Woodlands, Texas, USA (2009).
1. Geiger, S., Matthäi, S. K., Niessner, J., and Helmig, R., "Black-oil simulations for three component - three phase flow in fractured porous media," SPE Europe/EAGE Annual Conference and Exhibition, Richardson, Texas, USA, Society of Petroleum Engineering, 1 – 14 (2007),
2. Matthäi, S. K., Mezentsev, A., and Belayneh, M., "Control-Volume Finite-Element two-phase flow experiments with fractured rock represented by unstructured 3D hybrid meshes", SPE93341, Proc. SPE Reservoir Simulation Symposium, Houston Texas, 31 January – 2 February, (2005).
3. Matthäi, S. K., "Understanding the Influence of Faults and Fractures on Sub-Surface Fluid Flow: What can be achieved by Numerical Simulations Today ?" in "Fault Zone Characterization for Tectonic Numerical Modelling" Connolly, P. ed (Proc. Int. Workshop, 9-12th November, Frankfurt, Germany, 2001).
4. Matthäi, S. K. and Garofalo, "Three-dimensional shear zone and joint geometry and permeability in the Sigma Gold Mine, Canada" in Stanley, C. J. et al. ed (Proc. Fifth Biennial SGA Meeting and the Tenth Quadrennial IAGOD Symposium, London, Aug. 22-24th, London, 2, 1411-1414, 1999).
5. Matthäi, S. K., "Irregular alteration envelopes of mineralized fractures as a product of directed fluid flow and/or chemical dispersion ?" in "Mineral Deposits: Research and Exploration - Where do they meet ?", Papunen, H. ed (Proc. SEG Symposium, August 1997, Turku, Finland, 237-239, Balkema Rotterdam, 1997).
6. Roberts, S.G., and Matthäi, S.K., "High-resolution potential flow methods in oil exploration" in "Computational Techniques and Applications Conference" World Scientific Publications (Proc. Int. Conf. Melbourne, Australia, July 1995).

### Technical Reports

1. Matthäi, S. K., "The State-of-the-Art in Upscaling of Two Phase Flow in Fractured Rock," NDA (formerly NIREX), UK, 72 p. (2007),
2. Geiger, S., Roberts, S., Matthäi, S. K., and Zoppou, C., "Modelling Multi-Phase Flow in the Earth's Crust using Node-Centered Finite Volumes on Unstructured Finite Element Grids" Math. Res. Rep. MRR01-023, The Australian National University, School of Mathematical Sciences, 16 p. (2001),
3. Roberts, S. G., and Matthäi, S. K., "High-resolution potential flow methods in oil exploration" Math. Res. Rep. MRR 003-96, Centre for Mathematics and its applications, School of Mathematical Sciences, Australian National University, Canberra, Australia, 9 p., (1996).

### Non Refereed Publications

1. Matthäi, S. K., Geiger, S. and Roberts, S. G., "The Complex Systems Platform CSP5.0: User's Guide", 5th ed., ETH Research Reports, 150 p. (2004).

### Selected Keynote Lectures

(selected international presentations from the last 5 years)

1. "Insights from numerical modeling of reactive fluid flow in fractured porous carbonate," Bilbao HDT workshop, September 17-20, Bilbao, Spain (2007),
2. "Upscaling multiphase flow in fractured reservoirs," SSGM Skill Area Symposium, ExxonMobile, Houston, TX, USA, October (2006),



3. "Fracture to field simulation of flow and transport," Gordon Research Conference on Flow and Transport in Permeable Media, Proctor Academy, NH, USA, July 30– August 4 (2006),
4. "Control-Volume Finite-Element two-phase flow experiments with fractured rock represented by unstructured 3D hybrid meshes", SPE Reservoir Simulation Symposium (RSS), Houston Texas, January 31– February 2, 2005,
5. "Modeling multiphase flow in fractured porous rock," Workshop on Modelling Coupled Processes in Porous Media, Utrecht University & TNO-NITG, September 19-20 (2005),
6. "Two-phase flow properties for numerical simulations with discrete fractures," Fractured Reservoirs Conference, The Geological Society, Burlington House, London, November 16-17 (2004),
7. "Discrete Fracture Simulation," SPE ATW Workshop, Society of Petroleum Engineers, Millenium Hotel, London, November (2003),
8. "Numerical simulation of multiphase flow in fractured reservoirs," Statoil Research Summit, Trondheim, September (2003),
9. "Fluid flow and transport in fractured and faulted rock," Geofluids IV conference, May 12-16 2003, Utrecht, The Netherlands (2003),
10. "Understanding the influence of faults and fractures on sub-surface fluid flow: what can today be achieved by numerical simulations?" Workshop on Fault Zone Characterization for Tectonic Numerical Modeling, Seeheim (Frankfurt), Germany, November 9-12 (2001).

## **Presentations**

*(selected international conferences during last 10 years, excluding 2008-2009)*

1. "Numerical upscaling of relative permeability in fractured porous media," AGU Fall Meeting, San Francisco, EOS Trans. AGU, 88(52), Fall Meet. Suppl., Abstr. H12A-05 (2007),
2. "Characteristics of two-phase flow in complex fractured reservoirs: indications from Discrete-Fracture XFEM-FVM numerical experiments," Complexity in the Oil Industry (COI2007), Natal, Brasil, August 5-9 (2007),
3. "Stress and fluid pressure sensitivity of the effective permeability of fractured hydrocarbon reservoirs," DFG International Conference on Multifield Problems, Technical University of Stuttgart, October 4-6 (2006).
4. "Upscaling of water floods in fractured reservoirs via fracture-matrix flux ratio estimated by well testing," IEA Collaborative Project: Enhanced Oil Recovery Workshop, Saint Germain en Laye, France, September 21-22 (2006).
5. "What can single-well constant-rate pump tests really tell about fractured rocks?" International workshop on Model Concepts for Fluid-Fluid and Fluid-Solid Interactions, Freudenstadt, Germany, March 20-22 (2006),
6. "Upscaling water floods in fractured reservoirs via fracture-matrix flux ratio estimated by well testing," Structurally Complex Reservoirs conference, Geological Society of London, London, February 28– March 2 (2006),
7. "Two-phase flow properties for numerical simulations with discrete fractures," Fractured Reservoirs Conference, The Geological Society, Burlington House, London, November 16-17 (2004),
8. "Node-Centered control volume-finite-element simulation of multiphase flow in fractured rock," poster presentation, Gordon conference "Flow & Transport in Permeable Media", Kings College, Oxford, UK, July 11-16 (2004),
9. "Implicit-pressure implicit-saturation CVFE simulation of multiphase flow in fractured rock," poster presentation, AGU Fall Meeting, San Francisco, December 7-11 (2003),
10. "Fluid-flow partitioning between fractures and matrix: numerical experiments for realistic fracture geometries," AGU-EGS-EUG General Assembly, Nice, April 8-11 (2003),
11. "Rate-dependent recovery and water invasion in numerical models of fractured H.C. reservoirs," Gordon conference "Flow & Transport in Permeable Media," Proctor Academy, NH, USA, August 4-9 (2002),
12. "Drawdown-dependent recovery and water invasion in numerical models of fractured hydrocarbon reservoirs," IMA conference on "Modelling flow in oil reservoirs," BP Institute & Churchill College, Cambridge, UK, April 15-17 (2002),
13. "The Influence of deviatoric stresses in a deforming inhomogeneous rock pile on fluid flow in hydraulically-driven fractures," European Geophysical Society, 25<sup>th</sup> General Assembly, Acropolis, Nice, France, 654 (2000),
14. "Three-dimensional geometry and permeability of gold-mineralized faults in the Sigma and Lamaque Mines, Quebec, Canada," European Geological Union Meeting, March 28 - April 1, Strassbourg, France (1999),
15. "Fluid flow and reactant transport in anticlines," European Geological Union Meeting, March 28 - April 1, Strassbourg, France (1999).

**Exhibit 9**  
**James A. McMaster's Curriculum Vitae**

**James A. McMaster**  
5483 Bluff Head Road, P. O. Box 7  
Huletts Landing, New York 12841  
Tel: 518-499-0331 Cell: 518-879-5473 Fax: 518-499-0331  
E-mail: jimmcmaster@msn.com

**EDUCATION:** The Ohio State University, Columbus, Ohio  
1966 Bachelor of Welding Engineering (5 years)

Harvard Business School, Cambridge, Massachusetts  
1977 Program for Management Development - PMD 33 (14 weeks)

**EXPERIENCE:**

9/97-Present MC Consulting Titanium application and business development. Focus on titanium metal technical application, specifications and standards, technology, welding and manufacturing, business and market development. Providing concept design, estimating, sales support, project management, procurement support, and manufacturing support for titanium users and fabricators. Active in ASTM, AWS, ASME, and SAE-AMS. Member ASTM B10, ASME Boiler Code Committees. Obtained ASME Code approval for Grades 26/27/28/38 and Ti 0.8Ni-0.3Mo-0.1Ru (industrial sponsors), Code Case for parallel plate explosion welding. Instrumental in developing technical changes leading to revision of AWS A5.16-04 and 07. Instrumental in development of four new higher strength unalloyed grades in ASTM. Specifications, various revisions leading to 2008 changes. Developed and presented titanium welding course for engineers. Active in developments for titanium clad to improve on batten strip welding for clad pressure vessels as well as ignition resistance in oxygen environments. Providing welding and manufacturing support for titanium alloy hull for 6500 meter depth research submersible, application of new high strength alloys to mine resistant military vehicles.

(Titanium Industries acquired by Kamyr, Inc. in September 1980. Transferred to Kamyr in 1981. Kamyr, Inc. acquired by Ahlstrom Corporation in February 1990. Aquaflow sold to U. S. Filter in September 1997.)

4/93 - 9/97 Ahlstrom Aquaflow, Division of Kamtech, Inc., then Ahlstrom Machinery Inc.  
Managing Director. Starting from no business in North America, built Aquaflow pulp and paper mill effluent treatment system business unit, successfully and profitably completing several major effluent treatment system projects in North and South America on an Engineer, Procure, Construct basis.

4/91 - 4/93 Ahlstrom-Kamyr, Inc, Glens Falls, New York  
Developed international procurement sources and licensee network to support worldwide marketing of pulp mill equipment and systems. Developed program for technology transfer among workshops in the Ahlstrom (Finland) and Kamyr (North America) groups of companies.

10/87 - 4/91 Kamyr, Inc., Glens Falls, New York  
Manager, Mineral Processing. Developed existing R&D program in gold leaching technology. Established international marketing effort. Involved in construction and responsible for start up of demonstration scale counter-current tower gold leaching process in South Africa. Project abandoned due to falling gold prices.

**James A. McMaster**  
Huletts Landing, New York 12841

- 12/83 - 9/87    Kamtech, Inc. Glens Falls, New York  
Manager, Marketing and Engineering. Expanded construction market beyond parent company's mechanical installations to complete turnkey construction of major pulp mill facilities. Obtained first major orders for lime kiln mechanical construction, major recovery boiler rebuilds, and paper machine wet end rebuild, each representing a new field for the company. Established engineering function and set up quality control program to meet requirements of ASME U, S, A, and PP stamps and National Board R stamp.
- 7/81-12/83    Kamyr, Inc., Glens Falls, New York  
Staff consultant on materials, design, field welding, and failure analysis problems. Established formal quality assurance program. Implemented titanium pipe welding and digester weld overlay programs within subsidiary construction companies.
- 4/72 - 6/81    Titanium Industries, Fairfield, New Jersey  
Corporate cofounder (1972). Established corporate strategy/policy based on high quality standards that was significantly responsible for company growth and direction. Chief Engineer (1972-74). Set up engineering and quality control functions. Qualified company for ASME Code work. Elected Vice President (1974). Vice President, Engineering (1978-81). Directed all engineering activities, major project sales, and new product development. Vice President, Operations (1976-78). Implemented new systems to simplify and improve manufacturing including inventory planning, parts control, job costing, and reporting. Directed overall operation of engineering, manufacturing, and warehouse operations. Revenue grew to over \$33 million from 1972 to 1981.
- 11/69 - 3/72    Titanium Metals Corporation, West Caldwell, N.J.  
Manager, Commercial Research. Market research and forecasting for aerospace and industrial markets. Industrial Market Development Engineer. Successful programs in establishing titanium tubing in petroleum refining, industrial plate products, pulp and paper applications.
- 7/66 - 9-69    General Dynamics Corporation, Electric Boat Division, Groton, Connecticut  
Welding Engineer. Developed titanium welding technology for research submersibles. Metallurgical Engineer, ship component failure analysis, material and manufacturing liaison for advanced projects group.
- 1965 - 66    F. W. Bell, Inc., Columbus, Ohio  
Lab technician. Magnetic sensing devices.
- 1964 Summer    Dravo Corporation, Pittsburgh, Pennsylvania  
Engineering aide. Inland shipyard.
- Miscellaneous: Fourth two published papers and presentations to national technical societies. Guest lecturer at Liberty Bell Corrosion Course, and Titanium Design course, Philadelphia (4 years). International business experience in Europe, Scandinavia, Brazil, Argentina, and Chile, South Africa, Mexico, Japan, Australia.

## Papers Published or Presented (updated September 30, 2009)

1. "Changes in ASTM, ASME, and AWS Titanium Specifications", presented at the Corrosion Solutions Conference CSC2009, Park City, Utah, September 23, 2009.
2. "New Designs on an Old Porch", Old House Journal, July-August 2009, pp 38-43.
3. "Inert Gas Shielding and Purging for Titanium Welding ", Canadian Welding Association Journal", Fall 2008 Issue.
4. "Understanding the Relation of Oxygen and Titanium is the Key to Understanding Titanium Welding", Canadian Welding Association Journal, Spring 2008, p. 8.
5. "Purging for Welding", AWS Welding Journal, May 2008.
6. "Review of Mill Test Reports Leads to Code Case 2497-2 and ASTM H Grades", with Barry Greene and Stan Kirsch, Wah Chang Corrosion Solutions Conference CSC2007, Sunriver, Oregon, September 13, 2007.
7. "Titanium and Titanium Clad Ignition Studies in Simulated Pressure Oxidation Leaching Environments" with John G. Banker Wah Chang 2007 Corrosion Solutions Conference, Sunriver, Oregon, September 13, 2007.
8. "A New Grade for Titanium", with Barry N. Greene, Materials Technology Institute, ASTM Standardization News, pp. 32-35, October 2006
9. ASME Code Case 2532, with Jeff Kerr, Stainless Steel World, April 2006
10. ASME Code Case 2532, with Jeff Kerr, Wah Chang Outlook,
11. "ASME Code Case 2497-2 - Unalloyed Grade 2, 7, 16, and 26 Titanium with 58 ksi Minimum UTS", Stainless Steel World, November 2005 Titanium Special.
12. "Titanium Clad Ignition Studies in Simulated Pressure Oxidation Leaching Environments", with Renato DeSouza Costa, Companhia Vale do Rio Doce, Jennifer Defreyne, Cominco Engineering Services Ltd., Roman Stoiber, Cominco Engineering Services Ltd., Nathan C. Wayandt, Southwest Research Institute, Inc., and John R. Banker, DMC Clad Metals presented at the Wah Chang Corrosion Solutions Conference, Sunriver, Oregon, September 2005.
13. Joining of Titanium Clad Steel Plates", with Jose Ramirez, Edison Welding Institute, Barry Greene, Materials Technology Institute, and John Banker, DMC Clad Metals, presented at the Wah Chang Corrosion Solutions Conference, Sunriver, Oregon, September 2005.
14. "Inert Gas Shielding and Purging for Titanium and Zirconium Welding", presented at the Wah Chang Corrosion Solutions Conference, Sunriver, Oregon, September 2005.
15. "Requirements of Inert Gas Shielding and Purging for Successful Titanium Welding", Stainless Steel World, Vol. 17, April 2005, pp. 36-41.
16. "Titanium Filler Metal Specification Extensively Revised", with Richard Sutherlin, Welding Journal, May 2004
17. "AWS Revises A5.16 -90 Titanium Filler Metal Specification", Stainless Steel World, November 2003.
18. "Revision of AWS 5.16 -90 Addresses Important Changes in Titanium Industry Practice", presented at the Wah Chang Corrosion Solutions Conference, Coeur D'Alene, Idaho, September 2003.
19. "Simplifying the ASTM Titanium Grade Maze", Stainless Steel World, May 2003 Titanium Special issue.
20. "Rationalization of Unalloyed Titanium Material Specifications to Current Production Capabilities Offers Opportunities for the Titanium Industry", presented at Corrosion 2003, San Diego, California, March 16 to 20, 2003.

21. "First Commercial Application of Grade 26 Titanium 0.10 Ruthenium Alloy", presented at Corrosion 2002, Denver, Colorado, April 7 – 12, 2002.
22. "Titanium Users and Producers can Benefit from Modernization of the ASTM Specifications for Unalloyed Titanium", Stainless Steel World, November 2001.
23. "Is it Time to Modernize the ASTM Specifications for Unalloyed Titanium", accepted for the "Titanium, It's Role, It's Growth and It's Applications in the CPI" session, 49th CPI Exposition, Javits Convention Center, New York, New York, October 23-25, 2001
24. "First Commercial Application of Grade 26 Titanium 0.10 Ruthenium Alloy", presented at the Wah Chang Conference on Reactive Metals in Corrosive Applications", Sunriver, Oregon, September 10-13, 2001.
25. "The Case for Specified Interstitial Ranges in Unalloyed Titanium Filler Metal Specifications", presented at the Wah Chang Conference on Reactive Metals in Corrosive Applications", Sunriver, Oregon, September 10-13, 2001.
26. "Titanium 0.1 Ruthenium Alloys Move Out of the Laboratory – The First Commercial Application of ASTM Grade 26 Ti 0.1 Ru", Stainless Steel World, April 2001.
27. "Practical Titanium Welding", Practical Welding Today, pp. 22-28, Vol. 4, No. 4, July-August 2000.
28. "Titanium – Proven Performance in Hydrocarbon Processing", with Pieter Blauvelt, David Rowan, and Brent Willey, Corrosion 2000, Orlando, Florida, March 2000.
29. "The Role of Biological Wastewater Treatment in a Minimum Impact Effluent Mill for the Pulp and Paper Industry" with Jon E. Sointio, presented at Envirotech Sympo 96, April 2, 1996, Vancouver, British Columbia.
30. "Oxygen Enhanced Heap Leaching", with Charles W. Kenney, presented at the Randol Gold Forum 91, pp. 5680-5683, 1991.
31. "Update on the Kamyr CILCO Process". Presented at the Randol Gold Conference, Sacramento, California, October 1989.
32. "The Kamyr Countercurrent Tower Leaching Process". Presented at the Randol Gold Conference, Sacramento, California, October 1989.
33. "The Kamyr CILCO Process". Presented at the Randol Gold Conference, Fremantle, Perth, West Australia, October 1988.
34. "The Use of Titanium in the Bleach Plant and in Chemical Preparation". Presented at the Third International Symposium on Corrosion in the Pulp and Paper Industry, May 1980 Atlanta, Georgia, and in TAPPI, Vol. 54, No. 7, July 1971.
35. "Titanium for Mechanical Equipment for Industrial Corrosion Service". Presented at the Symposium on Industrial Applications of Titanium and Zirconium. October 15-17, 1979, New Orleans, Louisiana.
36. "Selection of Materials for Petroleum Refinery Components". Materials and Performance, Vol. 18, No. 4, pp 28-34. April 1979.
37. "Titanium-Economical Corrosion Control Tool for Petroleum Refineries", Paper No. 102, NACE Annual Conference, Corrosion 77, March 1977, San Francisco, California.
38. "Move Over for Titanium" with J. R. Inskeep and C. A. Trumbull, Welding Design and Fabrication, pp 83-89. April 1977.
39. "Titanium for Industrial Corrosion Service", presented at the 13th Annual Liberty Bell Corrosion Course, September 17, 1995, Philadelphia, Pennsylvania.

40. "The Use of Titanium in Pressure Vessel and Piping Construction". Presented as a Lecture No. 11 in the Short Course at the ASME Materials, Pressure Vessel and Piping Division Symposium, Philadelphia, Pennsylvania and at the Symposium on Titanium-Zirconium for Chemical Process Industries, November 19, 1975, New Orleans, Louisiana.
41. "Titanium Applications and Fabrication for Corrosive Bleach Plant Environments". Presented at International seminar on Pulp and Paper Industry Corrosion Problems. May 1974, Chicago, Illinois.
42. "Chemical and Process Technology Encyclopedia" Titanium Chapter, pp 1099-1102, McGraw Hill, (1972).
43. "Titanium", P. 64, Machine Design, Metals Reference Issue, February 17, 1972.
44. "How to Weld Titanium Alloys", with John R. Inskeep and Neil Normando, American Machinist, December 10, 1973, pp. 77-84.
45. "Titanium Tubing: Economical Solution to Heat Exchanger Corrosion" with R. L. Jacobs (Getty Oil). Materials Protection and Performance, Vol. 11, No. 7, pp33-38. July 1972. Originally presented at Corrosion 77, 1977 NACE Annual Meeting, San Francisco, California.
46. "Gas Tungsten Arc Welding of Titanium for Industrial Uses", with John Inskeep, March 1, 1972
47. "El uso de titanio en la industria de la pulpa y del papel", with Robert L. Kane, Industria Quimica Pan Americana, Volume 1, Number 4, September-October 1971, pp. 12-16 (reprinted from Tappi, 7-71)
48. "Use of Titanium in the Pulp and Paper Industry" with Robert L. Kane. TAPPI, Vol. 54, No. 7, July 1971.
49. "Titanium for Prosthetic Devices". Presented at IMD Medical Dental Conference. 1970. Cleveland, Ohio.

**Exhibit 10**  
**Dr. Maurice E. Morgenstein's Curriculum Vitae**



## **Maurice E. Morgenstein**

Maury Morgenstein  
 memgmi@gmail.com  
 510-295-3216  
 450 S. Walnut Drive  
 Monmouth, OR 97361 USA

### **EDUCATION:**

- 1974 Ph.D., in Geology and Geophysics, University of Hawaii.
- 1969 M.Sc., in Geology, Syracuse University.
- 1967 B.A., in Geology, Queens College, City University of New York.  
 New Mexico Institute of Mining and Technology, Socorro, N.M.

### **OVERVIEW:**

Trained at Lamont Doherty Geological Observatory of Columbia University and University of Hawaii Institute of Geophysics as a Deep Sea Geological Oceanographer/Sedimentologist specializing in authigenic mineralization reactions, metallic enrichment deposits (ocean mining) and hydration reactions of volcanic glass (sideromelane). Served at sea aboard research vessels as chief scientist and chief geologist.

Taught undergraduate and graduate classes (as appropriate) at the University of California, Berkeley; Syracuse University; Utica College; University of Hawaii, Hawaii Pacific College, and Rutgers NSF summer institute for geoscience teachers: Introduction to Oceanography, Geological Oceanography, Marine Sedimentation, Introduction to Geology, Laboratory in Geology, Sedimentology, Sedimentary Geochemistry, Clay and Zeolite Mineralogy, Geoarchaeology, Provenance of Ceramics and Lithics, Optical Petrography, Archaeology of Fire, Geomorphology, Advanced Archaeological Ceramics and Field School in Geoarchaeology.

Mining geologist in deep ocean manganese nodules, terrestrial placer gold and lithium pegmatite deposits. Partner in Mining and Mining consulting corporation in Tanzania specializing in precious and semi-precious gemstones, gold and transition metals.

### **RESEARCH INTERESTS:**

- Hydration of natural (obsidian and sideromelane) and man-made glass (such as borosilicate glass)
- Provenance of ceramics and chert lithic artifacts (geochemical and Petrographic studies)
- Micromorphology of soils-geochemical and physical sedimentology of sediments
- Stable isotope geographic patterns in meteoric water and plant and mammal consumers
- Neomineralization of zeolites and clays
- Development of new geochemical tools for chronology
- Isolation of High-Level Nuclear Waste
- Ocean mining (near shore and deep sea)

- Gemstone mining (metamorphic and igneous occurrences)

### **PRESENT POSITION:**

President, Geosciences Management International, Inc. (GMI, Inc.) 450 S. Walnut Drive,  
Monmouth, OR 97361 USA

### **ACADEMIC CLASSES TAUGHT WITHIN LAST 5 Years (at University of California, Berkeley):**

Graduate Seminar Spring 2005- NES Department, Pottery – Co-Taught with Prof Carol Redmount

Graduate Seminar Fall 2005 – NES Department, Archaeology of Fire

Graduate Class Fall 2005 – NES Department, Optical Petrography for Archaeologists

Graduate Seminar Spring 2006 – NES Department, Geochemistry and Petrography as Applied to Provenance Studies (Advanced Pottery Seminar)

### **PROFESSIONAL GEOLOGICAL ARCHAEOLOGY EXPERIENCE:**

2007-Present Geoarchaeologist, Morgantina, Sicily

2006-Present Partner and Senior Geologist, metamorphic, igneous and sedimentary gemstone mining, Tanzania

2005-2008 Adjunct Professor, Near Eastern Studies Department, University of California, Berkeley

2000-2008 Co-Director and Geoarchaeologist, El-Hibeh Project, Egypt, University of California, Berkeley

1998-2003 Visiting Scholar, Archaeological Research Facility, University of Cal., Berkeley

2004-2005 Visiting Scholar, Eastern Studies Department, University of California, Berkeley

1998-2002 Geoarchaeologist, Nemea Project, Greece, University of California, Berkeley.

1993-2000 Geoarchaeologist, Tel I el-Muqdam Project, Egypt, Univ. of Cal., Berkeley.

1993-1997 Geoarchaeologist, Consultant to State Parks, Research Fellowship, Utah. Humanities Council via Utah State Parks, Anasazi State Park, Coomb's Site.

1992-2003 Geoarchaeologist, BOAS, Inc., Seattle, WA.

1991-Present President and Geoarchaeologist, Geosciences Management Institute, Inc. (GMI), Boulder City, Nevada.

1974-1982 President and Geoarchaeologist, Hawaii Marine Research, Corporation, Honolulu, Hawaii.

1976-1979 Affiliate Faculty of the Graduate School of the University of Hawaii. (Anthropology Department, Geoarchaeology).

1977 Consultant - Historic Building Materials Restoration, and Geoarchaeology, State of Hawaii, Department of Land and Natural Resources, Division of State Parks.

1969-1976 Consultant, Geoarchaeologist, Pacific Basin.

**OTHER EXPERIENCE:**

- 2009            Researcher, Nemea Archaeological Site, paleo-climate and limestone provenance
- 1993-1998    Magnetic Survey Geophysics and Nile Delta Coring Program, Tell el-Muqdam Project Geologist - Geophysicist, Egypt, University of California, Berkeley.
- 1992-1998    Geophysics - EM, Ground Radar, and Magnetics, Geophysicist, BOAS, Inc., Seattle, WA.
- 1991-1998    Sedimentologist, Mineralogist, Geosciences Management Institute, Inc. (GMI), Boulder City, Nevada.
- 1982-1984    Senior Geologist, Geophysicist, Director of Operations, Gold Mine, Brim Partnership, Lake Havasu, Arizona.
- 1974-1982    Seismic Geophysicist, Hawaii Marine Research, Corporation, Honolulu, Hawaii.
- 1974-1982    Ocean Mining Geologist, Hawaii Marine Research, Corporation, Honolulu, Hi.
- 1974-1975    Assistant Researcher, Research Corporation of the University of Hawaii.
- 1965-1969    Chief Geologist - R/V Conrad, Lamont-Doherty Geological Observatory of Columbia University.
- 1964-1969    Assistant in Research, Lamont-Doherty Geological Observatory of Columbia Univ.
- 1975           Assistant Oceanographer, University of Hawaii.
- 1973-1975    Ferromanganese Program Coordinator, State Program, University of Hawaii.
- 1972-1974    Research Assistant, Research Corporation of the University of Hawaii.
- 1970-1974    Chief Scientist - R/V Teritu and R/V Kana Keoke.
- 1969-1972    Assistant in Geophysics, University of Hawaii.
- 1964-1969    Assistant in Research, Lamont-Doherty Geological Observatory of Columbia University.
- 1971&1972    Lecturer - Hawaii Pacific College and University of Hawaii (Geological Oceanography).
- 1967-1969    Teaching Assistant - Syracuse University (Geology); Lecturer Utica College (Geology).
- 1967           Lecturer - Department of Geology, Rutgers University, NSF Summer Institute.

**SELECTED PUBLICATIONS:**

- Emery, V. L. and M. Morgenstein. 2007. Portable EDXRF Analysis of a Mud Brick Necropolis Enclosure: Evidence of Work Organization, El-Hibeh Middle Egypt, *Journal Arch. Sci.* 34, 111-122.
- Pulvirenti, A. L., K. M. Needham, M. A. Adel-Hadadi, C. R. Marks, J. A. Gorman, M. E. Morgenstein, D. L. Shettel and A. Barkatt. *In Press*. Acid Generation upon Thermal Concentration of Natural Water: The Effects of Ionic Composition and Critical Water Content. *Applied Geochem.*
- Morgenstein, M. 2006. Geochemical and Petrographic Approaches to Chert Tool Provenance Studies: Evidence from Two Western USA Holocene Archaeological Sites. In: *Geomaterials in Cultural Heritage* (Eds: Maggetti, M. & Messiga, B.) Geol. Soc of London, Spec. Pub. 257, 307-321.

- Morgenstein, M. and C. A. Redmount. 2005. Using Portable Dispersive X-Ray Fluorescence (EDXRF) Analysis for On-Site Study of Ceramic Sherds at El-Hibeh, Egypt. *Jour. Arch. Sci.*, 32 (11), p. 1613-1623.
- Pulvirenti, A. L., Eddy, S. J., Calabrese, T. M., Adel-Hadadi, M. A., Barkatt, A., and M. Morgenstein, 2006. Interaction of Iron-Containing Silicate Glasses with Aqueous Salt Solutions. *Jour. of Physics and Chemistry of Glass: European Journal Glass Technology Part B*, V. 47 (1), 47-57.
- Hockett, B., and M. Morgenstein, 2003. Ceramic Production, Fremont Foragers, and the Late Archaic Prehistory of the North-Central Great Basin. *J. Utah Arch.*, 16(1), 1-36.
- Kirch, P.V., O'Day, S., Coil, J., Morgenstein, M., Kawelu, K., and M. Millerstrom, 2003. The Kaupikiawa Rockshelter, Kalaupapa Peninsula, Molokai: New Investigations and Reinterpretation of its Significance for Hawaiian Prehistory. *People of Culture in Oceania*, 19, 1-27.
- Morgenstein, M., Luo, S., Ku, The-Lung, and J. Feathers, 2003. Uranium-Series and Luminescence Dating of Volcanic Lithic Artefacts. *Archaeometry* 45(3), 513-528.
- Phillips, S. and M. Morgenstein, 2002. A Plains Ceramic Clays Source Characterization by Comparative Geochemical and Petrographic Analysis: Results from the Calhan Paint Mines, Colorado, U.S.A. , *Geoarchaeology*, vol. 17, no. 6, p.579-599.
- Morgenstein, M., and C. Redmount, 2000. Land and Soil. *The Oxford Encyclopedia of Ancient Egypt*, ed.: D. B. Redford, Volume I, Oxford University Press, New York, NY., p. 254 - 255.
- Morgenstein, M., C. L. Wickert, and A. Barkett, 1999. Considerations of Hydration-Rind Dating of Glass Artifacts: Alteration Morphologies and Experimental Evidence of Hydrogeochemical Soil-Zone Pore Water Control. *Jour. Archaeological Science*, Vol. 26, p. 1193-1210. (Abstract 51st Annual Northwest Anthropological Conference, April 16-18, 1998 Meeting, Missoula, Montana)
- Morgenstein, M., and W. Latady, 1997. Proveniencing Intrusive, Trade and Local Pottery by Magnetic Susceptibility Measurements, Geochemical and Petrographic Analysis: The Coombs Site, 42GA34. *Learning from the Land: The Grand Staircase-Escalante Natural Science Symposium*, Nov. 1-5, 1997, Proceedings.
- Morgenstein, M., and C. Redmount, 1998. Mud Brick Typology and Sedimentological Composition from Tell El-Muqdam, Egyptian Delta. *JARCE*, XXXV, 129-146.
- Redmount, C. A. and M. Morgenstein, 1996. Major and Trace Element Analysis of Modern Egyptian Pottery; *Jour. Archaeological Science*, v. 23, 741-762.
- Shettel, D. L. and M. Morgenstein, 1995. Radionuclide Releases from Borosilicate and Natural Glasses; 6th I.H.L.R.W.M. Conf. Proceedings, Amer. Nuclear Soc., Inc., La Grange Park, Ill.
- Morgenstein, M. and D. L. Shettel, 1994. Volcanic Glass as a Natural Analog for Borosilicate Waste Glass; *Mat. Res. Soc. Symp. Proc.*, vol. 333, p.605-615.
- Morgenstein, M. and D. L. Shettel, Jr., 1993. Evaluation of Borosilicate Glass as a High-level Radioactive Waste Form; HLRWM, 4Th International Conference Proceedings, Amer. Nuclear Soc., Inc., La Grange Park, Ill.
- Morgenstein, M., 1990. Hydration-Rind Dating of Basaltic Glass Artifacts: Reaction Dependence of Temperature and Chemistry; *Asian Perspectives*, vol. 27, no. 2, p. 68-71.
- Burns, R. G., V. Wood, and M. Morgenstein, 1990. Sorption of Cesium and Strontium by Zeolite Single Crystals; *Radionuclide Adsorption Workshop, Yucca Mountain Project*, Sept 11-

- 12, 1990, Los Alamos National Laboratory, Los Alamos, New Mexico.
- Burns, R. G., T.S. Bowers, V.J. Wood, J. D. Blundy, and M.E. Morgenstein, 1989. Reactivity of zeolites forming in vitric tuffs in the unsaturated zone at Yucca Mountain, Nevada (Abstract), American Nuclear society and Geological Society of America FOCUS '89, Nuclear Waste Isolation in the Unsaturated Zone, 18 to 21 September 1989; pp. 101-112.
- Morgenstein, M. and P. Rosendahl, 1976. Basaltic Glass Hydration Dating, In: *Advances in Obsidian Glass Studies: Archaeological and Geological Perspectives*, R. E. Taylor (Ed.), Park Ridge, New Jersey: Noyes Press; Chapter 8, pp. 141-164.
- Burnett, W. C. and M. Morgenstein, 1976. Growth Rates of Pacific Manganese Nodules as Deduced by Uranium Series and Hydration-rind Dating Techniques; In: *Earth and Planetary Science Letters*, 33, pp. 208-218.
- Burnett, W. C., M. Morgenstein, and D. Z. Piper, 1975. Geochemistry and Age of a Ferromanganese Crust from the Galapagos Spreading Center, Eastern Pacific; In: *EOS Trans. Am. Geophys., Union* 56, p. 1000.
- Morgenstein, M., 1975. Manganese Nodules and Crusts in the Hawaiian Archipelago; Statement of MEM, Dept. of Oceanography, Assoc. Director, State Ferromanganese Program, In: *Hawaiian Native Claims Settlement Act Part 1: Hearings before the Subcommittee on Indian Affairs of the Committee on Interior and Insular Affairs, House of Representatives, Ninety-fourth Congress, first session on H.R. 1944*, U.S. Gov. Printing Office, Serial No. 94-2, pp. 324-326.
- Morgenstein, M. and T. J. Riley, 1974. Hydration-Rind Dating of Basaltic Glass: A New Method for Archaeological Chronologies; In: *Asian Perspectives*, vol. XVII, (2), p. 145-159.
- Morgenstein, M., 1974. Dating Techniques for the Archaeologist Review, MIT Press; In: *Asian Perspectives*, vol. XVII (1).
- Morgenstein, M., 1973. Sedimentary Diagenesis and Rates of Manganese Accretion on the Waho Shelf Kauai Channel, Hawaii; Abstract Program, American Geophysical Union, Washington, D. C..
- Fein, C. and M. Morgenstein, 1973. Microprobe Analysis of Manganese Crusts from the Hawaiian Archipelago: Abstract A.G.U., Washington, D. C..
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- Morgenstein, M., Ed., 1973. *The Origin and Distribution of Manganese Nodules in the Pacific and Prospect of Exploration*, International Workshop and Symposium, Honolulu, Hawaii; NSF-IDOE, HIG of Univ. of Hawaii., State of Hawaii Marine Affairs Coordinator, State of Hawaii DPED., Preussag A.G.- Hanover, Salzgitter A.G., Bundes Ministerium fur Forschung und Technologie, Bonn , and AMR, 175 p.
- Morgenstein, M., 1972. Manganese Accretion at the Sediment - Water Interface at 400 to 2400 meters Depth Hawaiian Archipelago; Office of the International Decade of Ocean Exploration, NSF, Conference, Manganese deposits on the Ocean Floor, Arden House, New York, p. 131-138.
- Morgenstein, M., 1974. Sedimentary Diagenesis and Manganese Accretion on Submarine Platforms, Kauai Channel, Hawaii; University of Hawaii, Ph.D. Dissertation, 172 p.

- Fein, C. and M. Morgenstein, 1974. New Artificial Reefs on Oahu; In: Proceedings of an International Conference on Artificial Reefs., L. Colunga & R. Stone Eds., TAMU-SG-74-103, Center for Marine Resources, Texas A&M University, College Station, Texas.
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- Morgenstein, M., 1972. Structural Analysis of Basaltic Glass Failure and Its Relationship to Palagonite Formation in the Marine Environment; [Abstract] Geological Society of America Meeting, Cordilleran Section, p. 203.
- Morgenstein, M., 1971. A Study of the Growth Morphologies of Two Deep-sea Manganese Meganodules; Pacific Science, vol. 25, no. 3, p. 301-307.
- Morgenstein, M. and J. Andrews, 1971. Manganese Resources in the Hawaiian Region, Marine Tech. Soc. Jour., vol. 5, no. 6, p. 27-30.
- Morgenstein, M., 1967. Authigenic Cementation of Scoriaceous Deep-Sea Sediments West of the Society Ridge, South Pacific; Sedimentology, vol. 9, p. 105-118.
- Morgenstein, M., 1969. The Composition and Development of Palagonite in Deep-sea Sediments from the Atlantic and Pacific Oceans; Syracuse University, New York, 137 p. (Master's Thesis).

#### **SELECTED REPORTS:**

- Hicks, B.A., Morgenstein, M., and S. Hamilton. 2005. Archaeological Test and Data Recovery Excavations of Seven Sites in East Yosemite Valley, Yosemite National Park. ENTRIX Corporation for USDI National Park Service, Yosemite National Park, 1 to 8-22.
- Morgenstein, M., 2001. Site Stratigraphy, Pedology and Sedimentation, Sections 5, Petrography, Sourcing, and Weathering of Lithic Materials. In: Onat, A. R. B., et al., *The Results of Archaeological Investigations at Stuwé 'yuq<sup>w</sup> – Site 45-KI-464, Tolt River, King County, Washington*. BOAS Corporation for Seattle Public Utilities.
- Morgenstein, M., 1999. Geomorphic Environmental History of Tell El-Muqdam: Two Field Seasons of Auger-Coring.
- Morgenstein, M. 1999. Petrographic Analysis of Seven Lithic and Potential Source Crystalline Volcanics (CVR) from White Pine County, Nevada. WCRM, Inc., Sparks, Nevada.
- Morgenstein, M. 1999. XRF and SEM-EDX Geochemical and Source Provenance Analysis of Lithics from White Pine County, Nevada WCRM, Inc., Sparks, Nevada
- Morgenstein, M. 1999. Petrographic Analysis of Chert Lithics from Site 7407. WCRM, Inc., Sparks, Nevada.
- Morgenstein, M. 1999. Petrographic Analysis of Chert Lithics from Seven Archaeological Sites in White Pine County, Nevada. WCRM, Inc. Sparks, Nevada.
- Shettel, D.L., M.E. Morgenstein, D.L. Krinsley and M. Zreda, 1998, Geochemistry and petrography of samples from borehole UE25-ONC#1 at Yucca Mountain, Nevada, Proceedings of the Eighth International Conference on High-Level Radioactive Waste Management, 244-247.
- Morgenstein, M., 1997. Petrographic and Geochemical Data Report For: Proveniencing

- Intrusive, Trade Ware and Local Pottery by Magnetic Susceptibility Measurements, Geochemical and Petrographic Analysis: The Coombs Site, 42GA34. Oct. 1997, 135 pp. For State of Utah, Dept. of Parks, Anasazi State Park, Boulder, Utah.
- Morgenstein, M., 1997. Petrology and Geochemistry of Ceramics and Natural Clays and Tempers From the Cove-Red Valley Archaeological Project. Report for The Navajo Nation, Farmington, New Mexico.
- Morgenstein, M., 1996. Petrographic and Geochemical Analysis of Pottery Sherds and Sediments from Outcrops and Archaeological Sites in the Sleeping Ute Mountain Area, Southwestern Colorado. Report to Soil Systems, Inc. Phoenix, AZ.
- Morgenstein, M., 1996. Petrographic and Geochemical Analysis of Pottery Sherds From Two Archaeological Sites: LA 82948 and LA 78810, Fruitland Coal Gas Data Recovery Project. Report to San Juan County Museum Association, Bloomfield, New Mexico.
- Morgenstein, M., 1995. Geochemical and Sedimentological Analysis of Adobe and Mortar Samples; Report to: Pecos National Historic Monument, Pecos, New Mexico.
- Morgenstein, M., 1995. Petrography, Geochemical and X-Ray Diffraction Analysis of Adobe and Mortar Samples. Report to: Pecos National Historic Monument, Pecos, New Mexico.
- Morgenstein, M. and D. Shettel, 1995. Petrographic and Geochemical Analysis of Pottery Sherds From 15 Archaeological Expansion Pipeline Project; WCRM, Inc., Farmington, New Mexico, May 1995. Sites, Southern Chuska Valley, Gallup, New Mexico: Studies for the El Paso Natural Gas North System
- Morgenstein, M. E., 1995. Analysis of Tohatchio Red-on-Brown Pigment: LA2506-4928-0-32-1. WCRM, 6 p.
- Hicks, B. A. and M. Morgenstein, 1994. Archaeological Studies in the Palouse Canyon Archaeological District; Vol. I and II: for Walla Walla District Corps of Engineers; BOAS Research Report No. 9212.2, BOAS, Inc., Seattle, WA .
- Draper, J. A. and M. Morgenstein, 1993. Archaeological Testing in the Palouse Canyon Archaeological District: 1992 Field Season; Vol. I and II., BOAS, Inc., Seattle, WA.
- Morgenstein, M. E., 1991. Geoarchaeological Survey of the Tolt River-MacDonald Park, King County, Washington. Report to BOAS, Inc., (Sept. 1991).
- Shettel, D. L., Jr., Morgenstein, M. E., and Nagy, B., 1991. *Exxon Valdez* oil spill damage assessment contamination of archeological materials, Chugach National Forest: Radiocarbon experiments and related analyses: Draft Final Report to U.S.D.A. Forest Service, Region 10, Juneau, AK, 159p.
- Morgenstein, M. E., Shettel, D. L., Jr., and Mifflin, M. D., 1989. Yucca Mountain Project: A summary of technical support activities: July 1988 to September 1989, 119 p., for NWPO.
- Morgenstein, M. E. and Shettel, D. L., Jr., 1989. Review of: Licensing Support System prototype thesaurus by Science Applications International Corporation, 25 January 1989, 51p., for NWPO.
- Morgenstein, M., 1984. Petrology of Oahu Volcanics, for Hydraulic Studies, Dam Construction, Oahu, for U.S. Army Corps of Engineers.
- Morgenstein, M., 1983. Micropaleontology and Chemical Stratigraphy for Paleotaro Fields, Oahu, for U.S. Army Corps of Engineers.
- Morgenstein, M., 1981. Archaeology survey and testing investigations, Orca Sea Farms Inc. property, Kahanui, Molokai.
- Morgenstein, M., 1981. Shallow Seismic Survey (Reflection and Refraction) of Groundwater,

- (KUOU II well site) Kaneohe, Hawaii, for State of Hawaii, Department of Land and Natural Resources. Circular C86, DLNR, State of Hawaii, 1981.
- Morgenstein, M. E., 1976. Kapuku Plan for Resource Management; State of Hawaii, for Department of Fish and Game.
- Morgenstein, M., C. Fein, and J. E. Andrews, 1974. Deepsea Ocean Mining: Report for AMAX, Denver, Colorado.
- Morgenstein, M., 1972. Sedimentary Diagenesis and Rates of Manganese Accretion on the Waho Shelf, Kauai Channel, Hawaii; HIG Report 72-23, p. 1-58, I DOE Phase 1 Report.
- Fan, P. F., M. Morgenstein, and W. Burnett, 1969. Clay Mineralogy and Geochronology, Semi-Annual Report HIG 70-04, Subtask 2-i-1; p. 45-47, Hawaii Institute of Geophysics, University of Hawaii.
- Fan, P. F., J. Southworth, and M. Morgenstein, 1969. Analysis of Cores taken by USN Sands, Sea Spider Site, Appendix G, p. G1-G36.

### **Selected Presentations:**

- Morgenstein, M., Emery V., and C. Redmount 2005. ARF. Excavations at El-Hibeh and Portable EDXRF Analysis of a Mud Brick Necropolis Enclosure Evidence of Work Organization, El Hibeh, Middle Egypt
- Morgenstein, M. and P. D. LeTourneau. Characterization of Fourth – Eighth Millennium BP Chert Artifacts from the Northwestern Cascades: Utilization of EDXRF, ICP, and ICP-MS Geochemistry and Optical and SEM Petrography for Provenance Analysis. Poster Session Abstract SAA 66th Annual Meeting, April 2001.
- Onat, A., and M. Morgenstein. 2001. Archaeological Components and Soil Sequums: constructing cultural chronology in mid-Holocene forested site. Abstract SAA 66th Annual Meeting, April 2001
- Morgenstein, M. 2000. Quaternary ‘Black Ore’ Uranium Silicate and Transition Metal Sulfide, Oxide and Silicate Mineralization in Tertiary Tuffs from Drill Hole NC-EWDP-3D, Devil’s Hole Workshop, May 2000
- Morgenstein, M, 2000. Micromorphological Characterization and Microstratigraphic Interpretation of a Mid-Holocene Site, 45-KI-464, in the Western Cascade Foothills. Abstract: SAA 65th Annual Meeting, April 5-9, 2000
- Morgenstein, M., 2000. Chert Provenance Analysis at a Mid-Holocene Site, 45-KI-464, in the Western Cascade Foothills, King County, Washington. Abstract: SAA 65th Annual Meeting, April 5-9, 2000
- Blukis Onat, A., R., and M. Morgenstein, 1999. Bringing it to your attention: Site Morphology at 45KI464 [Poster]. 52ed NW Anthropological Conference, Newport, Oregon. program abstracts page 26.
- Morgenstein, M., 1999. Rock Classification and Proveniencing Volcanic Lithics from 45-KI-464, King County, Washington. 52ed NW Anthropological Conference, Newport, Oregon. program abstracts page 54-55.
- Morgenstein, M., 1999. Sedimentation and Pedology in Fluvioglacial Benches at 45-KI-464, King County, Washington. 52ed NW Anthropological Conference, Newport, Oregon. program abstracts page 55.
- Morgenstein, M, 2000. Micromorphological Characterization and Microstratigraphic Interpretation of a Mid-Holocene Site, 45-KI-464, in the Western Cascade Foothills.



- Abstract: SAA 65th Annual Meeting, April 5-9, 2000
- Morgenstein, M., 2000. Chert Provenance Analysis at a Mid-Holocene Site, 45-KI-464, in the Western Cascade Foothills, King County, Washington. Abstract: SAA 65th Annual Meeting, April 5-9, 2000
- Morgenstein, M., Rock 1999. Classification and Proveniencing Volcanic Lithics from 45-KI-464, King County, Washington. Abstract: 52nd NW Anthropological Conference, Newport, Oregon, April 8-10, 1999
- Morgenstein, M., 1997. Anthrosol Development in Rockshelters and Open Sites in the Palouse Archaeological District, Eastern Washington. Abstract 50<sup>Th</sup> Annual Northwest Anthropological Conference, 1997 Meeting, Ellensburg, WA., p.51.
- Blundy, J. D., R. G. Burns, and M. Morgenstein, 1987. Authigenic Minerals in Rhyolite Tuff at Yucca Mountain. Nevada: Diagenesis In A Proposed Nuclear Waste Repository; [Abstract, poster paper], GSA Annual Meeting, p. 19, 592-3 (136950), Phoenix, Arizona.

### **Selected Nuclear Waste Presentations:**

- Morgenstein, 2006 (September) United States Nuclear Waste Technical Review Board, Workshop on Localized Corrosion of Alloy 22 in Yucca Mountain Environments, Las Vegas, Nevada
- Morgenstein, 2005 (June) Nuclear Regulatory Commission, Advisory Committee on Nuclear Waste, 151<sup>st</sup> ACNW meeting, Rockville, Maryland
- Morgenstein, 2003 (March) Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards 140<sup>th</sup> meeting, Rockville, Maryland
- Morgenstein, 2000 (October) Nuclear Regulatory Commission, Advisory Committee on Nuclear Waste (ACNW), Rockville, Maryland

### **Patents:**

#### **2 U.S. Patents in Deep-Sea Mining Equipment:**

- 1) Morgenstein, M., May 11, 1976. Elevator apparatus for towed deep-sea particle harvester, U.S. Patent 3,955,294.
- 2) Andrews, J. E. and M. Morgenstein, April 6, 1976. Process and apparatus for deep-sea particle harvesting, U.S. Patent 3,947,980

**Exhibit 11**  
**Dr. Jonathan T. Overpeck's Curriculum Vitae**

*JONATHAN TAYLOR OVERPECK*  
*CURRICULUM VITAE*

**ADDRESSES**

*Work:*

Institute of the Environment  
University of Arizona  
715 N. Park Ave., 2<sup>nd</sup> Floor  
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Telephone: (520) 615-3633

**PERSONAL:** Born June 29, 1957 in Iowa, USA.

**EDUCATION**

December 1985 - Ph.D. in Geological Sciences, Brown University, Rhode Island  
June 1981 - MSc in Geological Sciences, Brown University  
June 1979 - AB in Geology (Honors), Hamilton College, New York  
Summer 1978 - Geologic Field Mapping in Montana, Indiana University

**HONORS**

2009 – Leading Edge Researcher Award, University of Arizona Office of Economic Development  
2008 – NOAA Oceanic and Atmospheric Research Outstanding Scientific Paper Award  
2007 – Nobel Peace Prize – shared for role as a Coordinating Lead Author of the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC).  
2007 – Shared winner of Atmospheric Science Librarians International's Scientific and Technical Category for "high impact comprehensive publication" for *Climate Change 2007: The Physical Science Basis*.  
2005 – Bjerknes Lecturer, American Geophysical Union  
2005 – John Simon Guggenheim Fellowship Award  
2004 – Birbal Shani Institute of Palaeobotany, Lucknow, India Prof. T.M. Harris Medal for 2004 (awarded for best Indian co-authored paper in field in 2004)  
2001 - American Meteorological Society's Walter Orr Roberts 2001 Award  
1999 - US Department of Commerce Gold Medal  
1996 - US Department of Commerce Outstanding Performance Award  
1995 - National Geophysical Data Center Director Award  
1994 - US Department of Commerce Bronze Medal  
1992 - US Department of Commerce Outstanding Performance Award  
1991 - US Department of Commerce Unusually Outstanding Performance Award  
1979 - Sigma Xi  
1978 - Hamilton College Senior Fellowship

**PROFESSIONAL APPOINTMENTS**

2009-present – Founding *Co-Director*, Institute of the Environment, Univ. of Arizona, Tucson  
2006-present – *Director*, UA Translational Environmental Research Program and associated UA Technology and Research Initiative Fund (TRIF).  
2006-present – *Affiliated Faculty Member* – James E. Rogers College of Law, Univ. of Arizona, Tucson  
2004-present -- *Joint Professor*, Dept. of Atmospheric Sciences, Univ. of Arizona, Tucson

1999-2008 -- *Director*, Institute For Study of Planet Earth, Univ. of Arizona, Tucson  
 1999-present -- *Professor*, Dept. of Geosciences, Univ. of Arizona, Tucson  
 1992-00 -- *Adj. Assoc. Professor*, Dept. of Geological Sciences, University of Colorado  
 1990-9 -- *Fellow*, Institute for Arctic and Alpine Research, Univ. of Colorado  
 1992-9 -- *Director (and Founder)*, World Data Center for Paleoclimatology, Boulder, Colorado  
 1990-9 -- *Head (and Founder)*, NOAA Paleoclimatology Program, NGDC, Boulder  
 1991-7 -- *Adjunct Research Scientist*, Lamont-Doherty Geological Observatory,  
 1986-90 -- *Associate Research Scientist*, Lamont-Doherty Geological Observatory  
 1985-86 -- *Post-doctoral Res. Scientist*, Lamont-Doherty Geological Observatory  
 1985 -- *Teaching Fellow*, Stratigraphy and Sedimentation, Brown University  
 1980-84 -- *Research Assistant*, Brown University  
 1979 -- *Teaching Assistant*, Mineralogy, Brown University  
 1979 -- *Geologist*, U.S. Geological Survey, Menlo Park, California  
 1977 -- *Field Assistant*, AMAX Exploration, Helena, Montana

### **PRIVATE-SECTOR PARTNERSHIPS and TECH TRANSFER**

2006 – *present* - *Climate Appraisal Services LLC* – lead science partner  
 2006 – Competed Options Agreement, as well as Technical Information License Agreement, between *Climate Appraisal Services* and The Arizona Board of Regents on behalf of The University of Arizona  
 2006 – Launched *Climate Appraisal Services LLC* at *ClimateAppraisal.com* - the first address-based service for climate and environmental risks.

### **GRANT AWARDS (Not including NOAA 1991-99)**

2010-2015 – NSF “*IGERT: Abrupt and threshold behavior in climate and ecological systems: improving resilience to sudden environmental changes.*” – 5 years - (PI With 4 others). *Pending*.  
 2008-2009 – Science Foundation Arizona – “*Assessing the threat to Arizona sustainability posed by long-term monsoon failure*” – 1 year – \$97,000 Co-PI with J. Cole).  
 2008 – Qatar Foundation. *The Qatari Initiative for Solar Power and Desalinization* A proposed partnership with the University of Arizona submitted by invitation (Co-PI with 4 others) *Pending*.  
 2007-2008 – NOAA “*Reconciling Projections of Future Colorado River Stream Flow*” – 1 year - \$250,000 (Co-PI with 7 others at several institutions)  
 2007-2012 – NOAA “*Integrating Climate Science for Decision-Support, Mitigating Risk and Promoting Resilience*” – 5 years - \$4,899,080 (PI with 8 other UA Co-PIs)  
 2007-2009 – NOAA “*Variability in the Eastern Equatorial Pacific Climate, ENSO and North American Drought Impacts over the last 2000 years*” – 2 years - \$96,832 (UA component; Overpeck is project PI of overall project)  
 2006-2009 – NSF “*Collaborative Research: High-resolution, Low-Latitude Paleoclimatology From Newly Acquired Sediment Drill Cores from Lake Bosumtwi, Ghana*” – 3 years - \$244,687 (UA component)  
 2006-2008 – NSF “*Paleoclimatic Change, Landscape Evolution, and Cultural transformations in Far Western Tibet, 2500 BP-present*” – 3 years - \$725,789 (Co-PI with 5 others, including Prof. Jon Pelletier).  
 2005-2009 – NSF “*Collaborative Research: A Synthesis of the Last 2000 Years of Climatic Variability from Arctic Lakes*” – 4 years - \$1.85M (Co-PI with 12 others).  
 2004-2005 – NSF “*Collaborative Research: High-Resolution, Low-Latitude Paleoclimatology Through Scientific Drilling of Lake Bosumtwi, Ghana,*” – 1.5 years. \$677,889 (Co-PI with three others).  
 2004-2006 – NSF “*Management of Ecosystems in the US Southwest and Related Areas of Northern Mexico in the Context of Complex Uncertainties*” – 1 year - \$77,500 (Decision making under uncertainty planning proposal, Co-PI with 4 others).

- 2003-2005 – NSF “Acquisition of an analytical facility for high-resolution paleoclimatology” – 3 years – \$339,915 (Co-PI with 4 others).
- 2002-2005 – ARCUS “ARCSS Committee Chair Support” – 3 years - \$54,000/year (PI)
- 2002-2006 – NSF “ITR: Development of an enhanced computer assisted analysis system for earth science: investigation of laminated sediments and tree rings” – 3 years – \$436,480 (PI with 2 others).
- 2002-2004 – NSF “Varved Records of Decade- to Century-Scale Climate Variability in the Tropical Atlantic Sector” – 2 years - \$167,000 (PI with 1 other).
- 2002-2004 – NSF “Scientific Drilling at the Bosumtwi Impact Structure, Ghana, West Africa” – approx. 3 years - \$1,200,000 (CoPI with 3 others).
- 2002-2007 – NOAA “Climate Assessment for the Southwest Project (CLIMAS)” – 5 years - \$5,437,806 (PI with 12 others).
- 2000-2003 – EPA “Climate and human contributions to fire affecting ecosystems in the U.S. Southwest” – 3 years - \$1,260,993 (Co-PI with 5 others)
- 2000-2005 - Multiagency “Desert Southwest Cooperative Ecosystem Study Unit (DS-CESU) – cooperative agreement – no set award amount (multiple CoPI’s)
- 2000-2002 – National Science Foundation Grant ATM “Century-scale variability in the Asian southwest Monsoon” 2-years - \$119,402 (PI with J.Cole)
- 1998 to 2001 - National Science Foundation Grant ATM-98100254 “Lake Bosumtwi, Ghana: High-resolution paleoclimatology and seismic reflection site survey” 3-years - \$518,944 (PI with C. Scholz)
- 1997 to 2000 - National Science Foundation Grant ATM-97 “Radiocarbon, Ocean and Climate Changes over the Last Deglaciation” 3-years - \$300,000 (Co-PI with K. Hughen and S. Lehman)
- 1997 to 2001 - National Science Foundation Grant ATM-PALE 9709918 “ Labrador Sea variability over decade to millennial time-scales” 4-years - \$564,000 (PI with G. Miller)
- 1997 to 2000 - NASA Grant LCLUC-0003: Assessing Future Stability of U.S. High Plains Landcover: Integration of Process Modeling with Landsat, In Situ Modern and Paleoclimate Data” 3 years - \$530,000 (PI with 4 Co-PIs)
- 1996 to 1999 - National Science Foundation Grant ATM-9631282: "Climatic Change of the Last 500 Years: Simulations versus Data" 3 years - \$270,000 (PI)
- 1995 to 1997 — NASA Graduate Student Fellowship in Global Change Research: "A 14,000 Year Record of Decade- to Century-scale Tropical Climate Variability from Annually-laminated Sediments of the Cariaco Basin, Venezuela" 2 years - \$44,000 (funds graduate student Konrad Hughen).
- 1995 to 1997 — National Science Foundation Grant OCE-9521058: "Interannual to Century-scale Variability in the Tropical Caribbean/ Western Atlantic: Varve-based Reconstructions from the Anoxic Cariaco Basin" 2 years - \$52,000 (PI).
- 1994 to 1997 — National Science Foundation Grant ATM94-02657: "A PALE Lake Sediment Calibration Network for the Eastern Canadian Arctic" 3 years - \$350,000 (PI with G. Miller).
- 1993 to 1996 — National Science Foundation Grant ATM-930072: "Eastern Arctic Climate of the Past 2,000 years: The Lake Sediment Record." 3 years - \$262,000 (PI with R. Anderson).
- 1991 to 1994 — National Science Foundation Grant ATM-9006307: "Project ARRCC - Analysis of Rapid and Recent Climatic Change." 3 years - \$720,000 (PI with 5 others).
- 1991 to 1994 — National Science Foundation Grant ATM-9019023: "Paleoecologic Tests of Climate Model Simulations for the Past 18,000 Years in Eastern North America." 3 years - \$170,000 (Co-PI with S. Jackson).
- 1991 to 1993 — National Science Foundation Grant OCE91-15923: "Interannual- to Millennial-scale Environmental Variability as Recorded in the Laminated Sediments of the Cariaco Basin, Venezuela: Late Quaternary to Present." 2 years - \$200,000 (PI with L. Peterson).
- 1990 to 1992 — National Science Foundation Grant DPP90-00371: "High-resolution Holocene Climatic Reconstructions from the Eastern Canadian Arctic." 3 years - \$216,000 (PI).

- 1989 to 1991 — NOAA: "Project ARRCC - Analysis of Rapid and Recent Climatic Change." 2 years - \$121,217 (PI with David Rind).
- 1990 to 1992 — National Science Foundation Grant OCE89-11484: "High-resolution Paleoenvironmental Study of the Cariaco Basin, Venezuela: Late Quaternary to Present." 2 years - \$477,000 (PI with L. Peterson and D. Murray).
- 1989 — C.N.R.S. Laboratory Travel Award for study in France- 10,000 FF (Recipient).
- 1989 to 1991 — EPA Grant: "Modeling Future Climate and Vegetation Change." Awarded through NASA/GISS, 3 years - \$200,000 (PI).
- 1988 to 1990 — National Science Foundation Grant ATM88-15506: "Century to Millennium-scale Variability of the Indian Monsoon over the Past 40,000 years." 2 years - \$170,000 (PI).
- 1988 to 1989 — National Science Foundation Grant DPP88-00749: "High-resolution Paleoclimatic Time Series from Annually Laminated Lake Sediments: Baffin Island and Northern Labrador." 1 year - \$64,617 (PI with G. Jacoby).
- 1987 to 1988 — EPA Grant: "Assessing the Response of Vegetation to Future Trace-Gas-Induced Climate Change: The Application of Ecological Response Surfaces." Awarded through NASA/GISS, 1 year - \$50,000 (PI with P. Bartlein).
- 1987 — Subcontracts, EPA Contract to Columbia University and NASA Goddard Institute for Space Studies (J. Hansen, R. Levenson, and C. Chu, principal investigators): "Global Climate Model Development and Sensitivity Experiments." 1 year - \$20,000 and \$10,000.
- 1986 to 1988 — National Science Foundation Grant ATM86-12376: "Precisely Dated Time Series and the Synoptic Climatology of the Past 12,500 years in Eastern North America." 2 years - \$148,580 (PI with G. Jacoby).

## POST-DOCTORAL SUPERVISION

- 2002 to 2003 – Dr. Nan Schmidt  
 1997 to 1998 – Dr. Connie Woodhouse  
 1996 to 1997 – Dr. Elsa Cortijo  
 1995 to 1996 – Dr. Terri King

## GRADUATE STUDENT SUPERVISION

Sarah Trube (PhD)	2008 to present	Univ. of Arizona – GEO (Co-Advisor)
Sarah White (MS)	2008 to present	Univ. of Arizona – GEO (Advisor)
Diane Thompson (PhD)	2008 to present	Univ. of Arizona – GEO (Comm. Mem.)
Nicholas McKay (PhD)	2007 to present	Univ. of Arizona – GEO (Advisor)
Cody Routson (PhD)	2007 to present	Univ. of Arizona – GEO (Advisor)
Jessica Conroy (PhD)	2003 to present	Univ. of Arizona – GEO (Advisor)
Toby Ault (PhD)	2005 to present	Univ. of Arizona – GEO (Comm. Mem.)
Adam Csank	2007 to present	Univ. of Arizona – GEO (Comm. Mem.)
Jennifer Rice (PhD)	2006 to present	Univ. of Arizona – GRD (Comm. Mem.)
Rachael Novak (MS)	2005 to present	Univ. of Arizona – GEO (Advisor)
Sephania McAfee (PhD)	2005 to present	Univ. of Arizona – GEO (Co-Advisor)
Anna Felton (MS)	2005 to 2006	Univ. of Arizona – GEO (Comm. Mem.)
Toby Ault (MS)	2005 to 2006	Univ. of Arizona – GEO (Comm. Mem.)
Kevin Anchukaitis (PhD)	2004 to 2007	Univ. of Arizona – GEO (Comm. Mem.)
Scott St. George (PhD)	2004 to present	Univ. of Arizona – GEO (Comm. Mem.)
Jessica Conroy (MS)	2003 to 2006	Univ. of Arizona – GEO (Advisor)
Allison Drake (MS)	2003 to 2005	Univ. of Arizona – GEO (Advisor)
Thomas Damassa (MS)	2002 to 2005	Univ. of Arizona – GEO (Comm. Mem.)
David Brown (PhD)	2002 to 2004	Univ. of Arizona – GRD (Comm. Mem.)
John Burkhart (PhD)	2002 to 2005	Univ. of Arizona – HWR (Comm. Mem.)

Cristina Luiz (MS)	2001 to 2004	Univ. of Arizona – GEO (Comm. Mem.)
Jim Morrison (PhD)	2003 to 2004	Univ. of Arizona – GEO (Advisor)
Camille Holmgren (PhD)	2001 to 2005	Univ. of Arizona – GEO (Comm. Mem.)
Jennifer Miller (PhD)	2001 to 2006	Univ. of Arizona – GEO (Comm. Mem.)
Katherine Likos (MS)	2000 to 2002	Univ. of Arizona – GEO (Advisor)
Tim Shanahan (PhD)	2000 to 2001	Univ. of Arizona – HWR (Comm. Mem.)
	2002 to 2006	Univ. of Arizona – GEO (Advisor)
Simone Alin (PhD)	2000 to 2002	Univ. of Arizona – GEO (Comm. Mem.)
Carrie Morrill (PhD)	1998 to 1999	Univ. of Arizona – GEO (Co-Advisor)
Carrie Morrill (PhD)	1998 to 1999	Univ. of Colorado (Co-Advisor)
Noah Daniels (MS)	1998 to 1999	Univ. of Colorado (Co-Advisor)
Mary Davis (PhD)	1998 to 2002	Ohio State Univ. (Committee Member)
Alex Robertson (MS)	1996 to 2000	University of Colorado (Advisor)
Jorunn Hardardottir (PhD)	1996 to 1999	Univ. of Colorado (Committee Member)
Frank Urban (MS)	1996 to 1999	Univ. of Colorado (Co-Advisor)
Ulrike Huber (PhD)	1996 to 1999	Univ. of Colorado (Committee Member)
Nathalie Smith (MS)	1996 to 1997	Univ. of Colorado (Committee Member)
Jennifer Mengan (PhD)	1996 to 2001	Univ. of Colorado (Co-Advisor, Comm. Mem)
Mike Kerwin (PhD)	1995 to 2000	University of Colorado (Advisor)
David Gorodetsky (MS)	1995 to 1996	Univ. of Colorado (Committee Member)
Lisa Doner (PhD)	1994 to 2000	Univ. of Colorado (Committee Member)
Konrad Huguen (PhD)	1992 to 1997	University of Colorado (Advisor)
Jay Moore (MS)	1995 to 1996	Univ. of Colorado (Committee Member)
Peter Sauer (PhD)	1993 to 1997	Univ. of Colorado (Committee Member)
Regina Figge (PhD)	1992 to 1996	Univ. of Colorado (Committee Member)
Lisa Barlow (PhD)	1992 to 1994	Univ. of Colorado (Committee Member)
Lysanna Anderson (PhD)	1991 to 1997	Univ. of Colorado (Committee Member)
Colin Price (PhD)	1990 to 1992	Columbia Univ. (Committee Member)

## COURSES TAUGHT

2009	<i>Western North American Drought Seminar</i> , The University of Arizona
2005-present	<i>Fundamentals of Past Climate Dynamics</i> – New graduate-level, The University of Arizona
2003	<i>Paleoclimate Seminar</i> , The University of Arizona
2002-present	<i>Paleoclimate Seminar</i> , The University of Arizona
2001-2003	<i>Life on Earth (included honors section)</i> , the University of Arizona
2001	<i>Paleoclimate Dynamics (North Atlantic Variability)</i> , the University of Arizona
2000	<i>Life on Earth (new course for non-science freshmen and sophomores)</i> , the Univ. of Arizona
2000	<i>Paleoclimate Dynamics (African and Asian Monsoons)</i> , the University of Arizona
1996	<i>Introduction to Climate System Modeling</i> at The University of Colorado, Boulder - Independent Study for three students. Co-taught with R. Webb
1994	<i>Methods of Quantitative Paleoenvironmental Reconstruction and Time series Analysis</i> at the Univ. of Colorado, Boulder - graduate seminar. Co-taught with R. Webb and D. Anderson
1985	<i>Stratigraphy and Sedimentation</i> at Brown University. Included leading spring a 10-day trip to study carbonate environments in South Florida

## SUPERVISON/MANAGEMENT TRAINING EXPERIENCE

- 2002 - Completed “Human Subjects” Training/Certification
- 1997 - NOAA Workshop for People with Disabilities

- 1996 - US Gov't Senior Executive Service Approved Course:  
"The Aspen Institute Executive Seminar for the Public Sector"
- 1995 - Department of Commerce Approved Management Course:  
"Merit System Principles: Understanding and Applying Them"
- 1995 - Department of Commerce Approved Diversity Management Course: "Conflict Resolution"
- 1994 - Department of Commerce Approved Management Course:  
"Improving Your Listening and Communication Skills"
- 1992 - Department of Commerce Approved Management Course: "Equal  
Employment Opportunity Training for Supervisors and Managers."
- 1992 - Department of Commerce Approved Management Course: "People Skills for Supervisors and  
Managers"

## **SERVICE ON UNIVERSITY COMMITTEES**

- 2009 to present – Coordinator (with D. Liverman) of Provost's Environmental Faculty Hiring Initiative
- 2008 to present – Member, Vice President for Research Advisory Council for Strategic Advancement
- 2008 – Member, Provost's Advisory Council for Strategic Advancement (committee formed to provide  
one report on research priorities for UA)
- 2008 to present – Member, UA Sustainability Committee
- 2007 to present – The University of Arizona president's point person for the American College and  
University Presidents Climate Commitment
- 2007 to present – Member, Biosphere 2 Advisory Board.
- 2006 to present – Director, UA Translational Environmental Research Program (TRIF funded)
- 2005 to 2006 Academic Year: on sabbatical, San Juan Mountains, Colorado
- 2005 to present - University of Arizona advisory committee for the UA NSF AMS Facility
- 2004 – University of Arizona representative to the Arizona governor's tri-university water sustainability  
planning group
- 2003 to 2005 – Member, Provost Focused Excellence Study Team for "Earth Science and Environmental  
Programs"
- 2003 to 2005 – Member, Executive Committee, University of Arizona -USGS Earth Surface Processes  
Research Institute (ESPRI)
- 2003 UA-USGS ESPRI Council of Advisors
- 2002 to 2003 – Co-Chair, UA Flandrau Science Center's Science and Technology Working Group (to  
provide science and technology input in the planning and development of a new 100,000 sq. ft.  
science center for the University of Arizona)
- 2002 - Member, Biosphere2 Center Research Advisory Board, Columbia University
- 2002 - Member, External Review Committee, University of New Mexico, Center for Advanced Studies
- 2001 to present - University of Arizona Representative to US Council of Environmental Deans and  
Directors
- 2001 - Chair, UA Institute for the Study of Planet Earth Program Review Self-Study Committee
- 2001 to 2002 – Member, UA Dean Search Comm., College of Social and Behavioral Sciences
- 2000 - UA Udall Fellowship Selection Committee
- 2000-2002 - Member of University of New Mexico Center for Advance Studies External Advisory Panel
- 2000 to 2001 - University of Arizona Campaign Water Committee
- 2000 - Member, Lab. for Tree Ring Res. Faculty Search Comm, Univ. Arizona
- 2000 to 2001 - Member and Co-Chair, Dept. of Atmos. Sci. Faculty Search Committee, Univ. Arizona
- 2000 to 2001 - College of Science rep. for Prop. 301 Water Initiative, Univ. Arizona
- 2000 – Promotion and Tenure Committee, Dept. Geosci., Univ. Arizona
- 2000 to present – Member, Global Change PhD Minor Faculty
- 1999 to 2000 - Self-Study Future Directions Committee, Dept. Geosci., Univ. Arizona
- 1996 to 1997 - Strategic Plan Committee, INSTAAR, University of Colorado
- 1995 to 1996 - Research & Uniqueness & Funding Committee, INSTAAR, University of Colorado



1993 to 1995 - Executive Committee, INSTAAR, University of Colorado  
 1992 to 1997 - Future Funding Committee, INSTAAR, University of Colorado  
 1992 to 1998 - Computer Committee, INSTAAR, University of Colorado

## **SERVICE ON LOCAL, NATIONAL and INTERNATIONAL SCIENCE and EDUCATION COMMITTEES**

2009 to 2011 – member, City of Tucson Climate Change Committee (appointed by Mayor and City Council)  
 2008 to 2009 – member, U.S. National Academy of Science, Committee on Ecological Impacts of Climate Change  
 2008 to present – member, Federal Advisory Committee focused on “Climate change and the United States: Analysis of the effects and projections for the future – Unified Synthesis Product”  
 2008 to present – Member, University Corporation for Atmospheric Research Membership Committee  
 2007 – Member, U.S. National Science Foundation advisory panel for the FY 2007 Human and Social Dynamics competition. Washington, DC.  
 2006 to 2007 – Member, Committee charged with drafting society’s new Statement on Climate Change Impact, American Meteorological Society  
 2004 to 2006 – Member, American Geophysical Union Global Environmental Change Executive Committee  
 2002 to 2005 – Member, Board on Higher Education, American Meteorological Society  
 2004 to 2007 – Convening Lead Author, Working Group 1, Chapter 6 (Paleoclimatology) UN/WMO Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment. Also, Lead Author for the Technical Summary, and also Lead Author for the Summary for Policy Makers.  
 2004 to 2005 – Member, Subcommittee for Global Change Research of the Department of Energy's Biological and Environment Research Committee (BERAC)  
 2003 to 2005 – Member, NOAA Ad Hoc Group on Paleoclimatology  
 2003 to 2009 – Member, NOAA Climate Working Group – formally the NOAA Climate and Global Change Working Group (also on Executive Committee of the latter)  
 2002 to 2007 – Chair/Member, NSF Arctic System Science (ARCSS) Committee (Chair to 2006)  
 2001 to 2003 – member, U.S. National Academy of Science, Committee on Coping with Increasing Demands on Government Data Centers  
 2000 to 2003 – member, U.S. National Academy of Science, Committee on Abrupt Climate Change: Science and Policy  
 1999 to 2004 – Co-chair (with M. Cane), US PAGES/CLIVAR Working Group  
 1999 to 2002 – member, NSF Study of Environmental Arctic Change (SEARCH) Steering Committee  
 1998 to 2008 – member, NSF Arctic System Science (ARCSS) Committee  
 1997 to 2003 - member, U.S. National Research Council National Committee for International Quaternary Association (INQUA)  
 1997 to 1999 - member, Ocean Drilling Program (ODP) Science Committee (SCICOM)  
 1995 to 2002 - Co-Chair (with J-C Duplessy), IGBP PAGES-WCRP CLIVAR Working Group  
 1994 to 1998 - member, Arctic System Science Data Management Working Group  
 1994 to 1999 - member, Steering Committee, US/NSF Earth System History Research Initiative  
 1993 to 1999 - member of IGBP PAGES (Past Global Changes) Scientific Steering (SSC) and Executive Committees, Vice Chairman SSC 1998-99.  
 1993 to 1999 - member, IGBP DIS (Data and Information System) Scientific Standing Committee  
 1991 to 1998 - member, Steering Committee, "Paleoclimate of Arctic Lakes and Estuaries (PALE)," NSF Sponsored research initiative with broad international participation.

## **NATIONAL AND INTERNATIONAL WORKSHOPS CONVENED**

- August, 2009 – “SynTrace-21 Workshop,” National Center for Atmospheric Research, Boulder, CO (member, organizing committee)
- January, 2009 – First Arizona Adaptation Stakeholder Work Group Meeting, Tucson, AZ (member, organizing committee)
- January, 2009 – “Adaptation to Climate Change in the Desert Southwest: Impacts and Opportunities,” Tucson, AZ (member, organizing committee)
- June, 2008 – PAGES/CLIVAR workshop “Reducing and representing uncertainties in high-resolution proxy climate data,” Treste, Italy (member, organizing committee)
- May, 2008 – NOAA RISA National Climate Service Visioning Workshop, Denver, CO (member, organizing committee)
- October, 2006 – Climate Variability & Change in the San Juan Mountains: A Scientist-Stakeholder Dialogue, Durango CO (member, organizing committee)
- July, 2006 – Retreat of the NOAA Climate Working Group focused on improving NOAA’s ability to provide the nation with drought information, Santa Fe, NM (member, organizing committee).
- May, 2006 – Workshop focused on methodologies for improved analysis of laminated lake and marine sediments, Tucson, AZ (Organizer and host)
- May, 2006 – Workshop focused on Arctic climate variability and change over the last 2000 years (co-organizer and host). Tucson, AZ
- May, 2005 – Second Sustainability Under Uncertainties in Arid and Semiarid Ecosystems workshop, Tucson, AZ (member, organizing committee).
- January, 2005 – First Sustainability Under Uncertainties in Arid and Semiarid Ecosystems workshop, Tucson, AZ (member, organizing committee).
- August, 2004 – Second NSF Retreat on Arctic System Science Synthesis, Lake Tahoe (lead convener with others on NSF Arctic System Science Committee).
- June, 2004, 1st International CLIVAR Science Conference, Baltimore, Maryland (member, organizing committee).
- February, 2004, NOAA Workshop “Enhancing Decision-making Through Integrated Climate Research: Alaska.” Anchorage, Alaska (member, organizing committee).
- November, 2003 - CLIVAR/PAGES/IPCC Workshop: A multi-millennia perspective on drought and implications for the future, Tucson, AZ (co-convended with K. Trenberth).
- August, 2003 – NSF Retreat on Arctic System Science Synthesis, Big Sky, MT (lead convener with others on NSF Arctic System Science Committee).
- March, 2003 – International Limnogeology Congress, Tucson AZ (organizing committee).
- May, 2002 – NRC Workshop on coping with Increasing Demands on Government Data Centers, Austin, TX (co-convended with several others on NRC Committee).
- September, 2001 – International Continental Drilling Programme Workshop on Scientific Drilling at the Lake Bosumtwi Impact Structure, Potsdam, Germany (co-convended with C. Koeberl, B. Milkereit, and C. Scholz).
- June, 2001 – NOAA funded workshop: International Workshop on Applications and Human Dimensions of Monsoon Research, Tucson, AZ (co-convended with B. Morehouse, A. Ray, and R. Webb).
- March, 2001 – NOAA and USDA funded Fire and Climate in the Southwest 2001, Tucson, AZ (co-convended with four others).
- February, 2001 – NOAA and USDA funded Fire and Climate 2001, Tucson, AZ (co-convended with four others).
- October, 2000 – IGBP PAGES Workshop: High-Resolution Climate Variability of the Holocene, Avignon, France (co-convended with K. Briffa, D. Raynaud, J-. Duplessy and R. Bradley).
- September, 2000 – NRC Abrupt Climate Change: Science and Policy Workshop, Palisades, NY (co-organized with R. Alley et al.).
- November, 1999 – Joint WCRP-IGBP PAGES-CLIVAR Workshop on “Climate Variations of the Last 300 to 1000 Years”, Venice, Italy (co-convended with J-C. Duplessy).
- June, 1999 - NOAA/NASA Workshop: Assessing the full range of central North America Droughts and Associated Landcover Change, Boulder, Colorado (co-convended with R. Webb and C. Woodhouse)

- January, 1999 - Joint WCRP-IGBP PAGES-CLIVAR Data Management Workshop, Boulder, CO (co-convened with R. Webb and D. Anderson).
- April, 1998 — IGBP PAGES (Past Global Changes) First Open Science Meeting, London, England (Co-organized with 5 other).
- April, 1997 — Joint IGBP-World Data Center sponsored workshop on meeting the scientific data management needs of the IGBP, Boulder (co-organized with G. Szejjwach)
- September, 1996 — Joint CLIVAR (World Climate Research Program)-PAGES (International Geosphere Biosphere Program) sponsored “PAGES-CLIVAR Working Group” workshop on climate variability and predictability, Villefrance, France (co-convened with J-C. Duplessy)
- March, 1996 — NSF sponsored Earth System History Workshop “Geologic records of terrestrial processes and systems,” Portland OR (co-organized with P. Olsen, N. Pisias and T. Webb III).
- November, 1994 — Joint CLIVAR (World Climate Research Program)-PAGES (International Geosphere Biosphere Program) sponsored workshop on climate variability and predictability, Venice Italy (co-convened with J-C. Duplessy)
- August, 1993 — IGBP PAGES Sponsored "Global Paleoenvironmental Data," Bern Switzerland (co-convened with J. Pilcher).
- January 1988 — NSF sponsored meeting of the Coordination Group for "The global reconstruction and modeling of interannual, decadal, and century-scale climate variability," New York (co-convened with G. Jacoby).

## **SYMPOSIA and SPECIAL SESSIONS CONVENED**

- December, 2003 – “The Last Interglacial” 2003 Fall Meeting of the American Geophysical Union, San Francisco (co-convened with G. Miller and B. Otto-Bleisner).
- December, 1997 — "Tropical Ocean and Climate Records From the Anoxic Cariaco Basin” 1997 Fall Meeting of the American Geophysical Union, San Francisco (co-organized with L. Peterson and F. Muller-Karger)
- December, 1995 — "Abrupt Climatic Change During the Current Interglacial” 1995 Fall Meeting of the American Geophysical Union, San Francisco (co-organized with L. Keigwin)
- October, 1992 — "WDC/IGBP Paleoclimate Data" 13th International CODATA Conference, Beijing, China.
- May, 1992 — "Decadal to millennial-scale climatic variability" 1992 Spring Meeting of the American Geophysical Union, Montreal (co-chaired with D. Murray).
- February, 1992 — "High-resolution studies of past climate" 1992 American Society of Limnology and Oceanography Aquatic Sciences Meeting, Sante Fe, New Mexico (co-chaired with W. Curry).
- August 1989 — "The past as a key to understanding future global change," 74th Annual Meeting of the Ecological Society of America, Toronto, Canada (co-convened with G. King).

## **FIELD EXPERIENCE**

- 2009 – Leader, Lake coring expedition to Peruvian Amazon
- 2007- Co-leader, Lake coring expedition to Tibet
- 2004 – Co-leader, Lake coring in the Galapagos
- 2000 - Co –leader, Lake coring expedition to Ghana
- 1999 - Co –leader, Lake coring expedition to Ghana
- 1999 - Leader, Lake and tree coring expedition to Northern Labrador
- 1998 - Co-leader, Lake coring expedition to Southern Greenland
- 1997 - Co-leader, Lake coring expedition to Southern Greenland
- 1997 - Climbed Cerra Aconcagua, 6962m (with D. Anderson)
- 1996 - Co-leader, Lake coring Baffin Island, Canada and West Greenland.
- 1996 - Co-leader, Lake coring expedition to Ghana.
- 1995 - Co-leader, Lake coring expedition to Tibet.

1995 - Co-leader, Lake coring expedition to Nepal.  
 1994 - Co-leader, Lake coring expedition to Tibet.  
 1993 - Leader, Lake coring expedition to Nepal.  
 1993 - Leader, Arctic lake coring expedition, Baffin Island, Canada.  
 1991 - Leader, Arctic lake coring expedition, Baffin Island, Canada.  
 1990 - Co-chief Scientist, R/V Washington, Cruise PLUME 7, Cariaco Basin, Venezuela.  
 1989 - Leader, Arctic lake coring expedition, Baffin Island, Canada.  
 1989 - Leader, Arctic lake and tree coring expedition, northern Labrador, Canada.  
 1986 - Scientist, R/V Conrad, Cruise RC27-04, Arabian Sea.  
 Four winters - Leader, lake coring trips to Upper Midwest US and Canada.

## SELECTED PRESS INTERACTION

September, 2009 – Featured in *NPR All Things Considered* story on “Tipping Points” in environmental and other systems.  
 September, 2009 – Featured in many media stories (e.g., AP story, *Tucson Daily Star*, BBC story, NY Times) related to Arctic climate change and our new report in *Science*. Included NSF Press Release and being featured on the NSF home page.  
 June, 2009 – Featured in regional media in stories on new federal climate report on “Global Climate Change Impacts in the United States”  
 May, 2009 – Featured in widely syndicated AP story on sea level change and survival of the Maldives  
 April, 2009 – Received major international press coverage related to new African drought report in *Science*, including AP, NY Times and front pages of *Arizona Daily Star* and *The Arizona Republic*. Included NSF Press Conference and being featured on the NSF home page.  
 January, 2009 – Appeared on *Arizona Illustrated* evening TV show.  
 October, 2008 – Featured and quoted in stories in the *Arizona Daily Star* (front page) and *Tucson Citizen* regarding the new Institute for Environment and Society at the University of Arizona  
 May 1, 2008 - Quoted in story on decadal climate prediction and the next 10 years of climate change, *Christian Science Monitor*  
 April, 2008 – Featured in three-day Earth Day series on drought and climate change in the Southwest, *Arizona Daily Star*, Tucson, Arizona.  
 April, 2008 – Featured on Earth Day, *KOLD TV NEWS 13*, Tucson, Arizona.  
 March 28, 2008 – Part of an hour-long NPR program *On Point*, focused on the Medieval Warm Period and implications for the future, particularly in the U.S. West.  
 March 24-28, 2008 – Featured in week-long TV series “Winds of Change” on climate change, KPNX-TV 12 News, Phoenix, AZ  
 March, 2008 – *Nature Geoscience* paper stories (Neff et al., 2008) reported on by NPR (story on *All Things Considered*) and *New York Times*.  
 February 1, 2008 – Quoted in a front-page story in the *Washington Post* on climate change and the west being attributed to human causes.  
 December 29, 2007 – Featured in story about California climate change in an AP story  
 December 28, 2007 – Featured in climate change and La Niña story in the *Arizona Republic*  
 November 18, 2007 – Featured in front-page story on climate change in the *San Francisco Chronicle*  
 November, 2007 – Featured in *History Channel* documentary “‘A Global Warning’”.  
 October 22, 2007 – Featured along with Vice President Gore in NPR program “U.N. Panel Shares Nobel with Gore”. Also, featured in multiple newspaper stories around Arizona for sharing Nobel Peace Prize for role as a Coordinating Lead Author in the IPCC Fourth Assessment.  
 September, 2007 – Featured in widely published *Associated Press* stories on rising sea level.  
 September, 2007 – Featured in story on university campus sustainability in the *Arizona Daily Star*.  
 September, 2007 – Featured in story on Arizona climate change and the Western Climate Initiative in the *Havasupai News-Herald* (Arizona)  
 August, 2007 – as of this month, we’ve had over 100 requests from journalists, media, educators and

- other outreach entities for future sea level data, images and information. This does not count general use of our lab web resource.
- August 24-29, 2007 – Interviewed for KUAT-FM Arizona Spotlight on subject of water sustainability; also was the guest for a 1-hour live talk-radio segment on KVOI-AM, and a shorter interview on KJLL-AM, both focused on the same topic.
- July, 15, 2007 – Graduate student Rachael Novak featured in NPR All Things Considered radio show “[CLIMATE CONNECTIONS: Drought Threatens Navajo's Crops, Culture](#)”.
- July, 2007 – Featured in a half-hour documentary by Blur to Focus Productions and The NM State Engineer, entitled: “*Climate Change: What does it mean for New Mexico?*”
- July, 2007 – Featured in two stories in the *Wilmington Star* (NC) on future climate and sea level change.
- July 9, 2007 – Featured in NPR *Morning Edition* show “[CLIMATE CONNECTIONS: A Family Vacations Amidst Changing Landscape](#)” as well as in an NPR *All Things Considered* show “[CLIMATE CONNECTIONS: Ancient Culture Prompts Worry for Arid Southwest](#).”
- June, 2007 – Filmed at Mesa Verde for History Channel documentary on climate change.
- May, 2007 – Featured in article in *Nature* on start-up company Climate Appraisal Services.
- March, 2007 – Featured in story in *USA Today* (and follow-on stories elsewhere) on start-up company Climate Appraisal Services.
- February, 2007 – Widely featured in national and international press for role in UN Intergovernmental Panel on Climate Change
- November, 2006 – Featured in stories in the Arizona Republic and Arizona Daily Star regarding Supreme Court global warming case.
- November, 2006 – Featured in Associated Press story on climate change, Arctic wildfire and greenhouse gas feedback.
- October 30, 2006 – Featured in story in the *Albuquerque Journal* on future drought and reduced river flow in the Southwest.
- October, 2006 – Featured in stories in the *Denver Post*, *Farmington Daily Times* and *Grand Junction Sentinel* on climate change and the impacts of this change in the U.S. West and San Mountains of Colorado. Also was focus of 30minute radio interview on the same topic (KDUR, Durango).
- August 24, 2006 – Featured in NPR on *All Things Considered* interview about the freshening of the Arctic and potential impacts on the North Atlantic.
- August 11 & 15, 2006 – Featured in stories in the *Wall Street Journal* and *USA Today* about accelerating mass loss of the Greenland Ice Sheet
- May, 2006 – Featured in major climate change series in *USA Today*
- May, 2006 – Taped two 30 minute shows (one on global warming, and one on drought) for *Earthtalk Today* with Alexandra Paul and Peter Kreitler (in Los Angeles, CA).
- March and April, 2006 – Expensive global media coverage of two *Science* papers (with cover). Included front page coverage in papers in the US and Canada, NPR interview, and talk radio. Also reported on in *Time Magazine*, *Scientific American.com*
- January 30, 2006 – Featured in *Geotimes* online story on record 2005 global temperatures
- December, 2005 – Feature guest on Earth Changes TV radio show (ca. 45 minutes of talk radio)
- August, 2005 – extensive press coverage of *EOS* paper, at least 130 print media articles in first week. Press interest still alive at end of year. Included request from U.S. Congress for article.
- May 26, 2005 – Guest on KUAT TV *Arizona Illustrated* TV show
- February 16, 2005 – Featured in front-page article on climate change and forest health in the *Arizona Daily Star*.
- February 14, 2005 – Featured in front-page article on the climate change debate in the *Wall Street Journal*.
- February 6, 2005 – Featured in article on drought and climate change in the *Washington Post*.
- February 5, 2005 – Guest on talk radio show “Weather Talk with Paul Huttner”
- January 24, 2005 – Featured in cover story on past climate change in the West. *High Country News*.

January 30, 2005 – Featured in article on global warming in the *Arizona Daily Star*.

January 10, 2005 – Featured in article on Arctic climate change – United Press International (including the *Washington Times*)

January 5, 2005 – Guest on KUAT TV *Arizona Illustrated* TV show.

December, 2004 – Co-author full page Op-Ed “Perspective” on climate change in December 13, 2004 *Tucson Citizen*.

July, 2004 – Featured in Weather Channel special on climate change: “Forecast Earth: A Planet in Change”

June, 2004 – Participant in CLIVAR (World Climate Research Programme Climate Variability and Predictability Programme) Open Science Conference Press Conference, Baltimore MD

May 25, 2004 – Participant in press conference and pre-screening of 20<sup>th</sup> Century Fox Feature Movie: “Day after Tomorrow,” Tucson, AZ.

April 22, 2004 (Earth Day Week) – Sea level research and web site (UA Dept of Geoscience Environmental Studies Lab) featured on National Geographic Web site main page.

April, 14, 2004 -- Live interview on KTAR Radio, Phoenix morning show – drought issues

April, 2004 -- Interviewed for NPR Feature on abrupt climate change

April, 2004 -- Interviewed for article(s) on arctic environmental change for *New Yorker* magazine.

April, 2004 -- Interviewed for Evening News, Channel 4 TV, Tucson

October 29, 2003 -- Featured in articles on arctic climate that appeared in the *Seattle Post-Intelligencer* and elsewhere.

June 15, 2003 -- Featured in story on water crisis in the *Houston Chronicle*

June 22, 2003 – Featured in story “Climate Boom & Bust: High Population Suffers More in Dry Times” in the *Albuquerque Journal*.

May 21, 2004 – Interviewed about drought on KUAT-TV show *Arizona Illustrated*.

May 9, 2003 -- Featured in story on drought in the *Arizona Daily Star*

April, 2003 – Multi-day film shoot in Tucson region for documentary “The Venus Theory – a documentary film on climate change” (52 minutes) Talent House, Helsinki 2004.

December 16, 2002 -- Guest for 20 minutes on KPRA (Berkley CA) radio morning show

December 8 2002 -- Featured in climate change stories in Los Angeles Times and Seattle Times

May 9, 2001 -- Authored invited 2-page “Insight and Opinion” article titled “Global warming is all too real,” Albuquerque Tribune

April 19, 2001 -- Featured in story on NSF-sponsored Holocene climate change workshop, Richmond Times-Dispatch

April 12, 2001 -- Featured in story on global warming and mathematics in Tucson Citizen

March 15 2001 -- Guest on one-hour AM990 (KTKT-Tucson) Reed Schmidlin talk radio show

March 8, 2001 -- Featured in lead story on Tucson Channel 13 (CBS) report on global warming and how it could impact the US and US Southwest

January, 19 2001 -- Featured in climate change story – Honolulu Star-Bulletin “Climate prediction could ease global warming’s impact, geologist says”

Spring, 2000 -- Featured in Los Angeles Times front page story on climate change, 2000

April, 2000 -- Featured in NOVA/Frontline 2-hour documentary “What’s up with the weather?”

February, 2000 -- Guest Opinion titled “Global Warming Is Not Pseudo-Science” published in Sunday Feb. 13 issue of Arizona Daily Star (co-authored with Julie Cole).

December, 1999 -- Science results featured on www by University Science ([unisci.com/](http://unisci.com/)) and Yahoo! News

December, 1999 -- Interview with University of Arizona News Services aired on state-wide radio program

December, 1999 -- Interviewed for article on paleoclimatology in the Christian Science Monitor – 1 page article appeared Jan 18, 2000

August, 1999 -- Interviewed by South Africa Broadcast Company television story on climate change and first World Data Center in Africa.

July, 1999 -- Interviewed on National Public Radio Story on Siberian Environmental Change

July, 1999 -- Interviewed by US News & World Report for background on climate story

June, 1999 -- Interviewed for South African radio show – climate change

May, 1999 -- Interviewed for NOVA/FRONTLINE documentary on global warming

May, 1999 -- Interviewed for global warming article in “Rolling Stone”

April, 1999 -- Interviewed for global warming story in “Popular Science”

March, 1999 -- BBC film team accompanied Overpeck research team on Arctic field expedition for three days of filming/interviewing for documentary on Atlantic climate change. Results featured in 60 minute documentary “The Bill Chill”

December, 1998 -- Lead scientist in NOAA Press Conference on drought variability (at National Press Club, Washington). Reported live on national network television and radio programs, plus reports appeared around nation in print media

July, 1998 -- Interviewed on National Public Radio’s “All things considered” – helping to put the summer 1998 heat wave in perspective

February, 1998 -- Arctic Warming Press Kit requested by, and provided to Executive Office of the President, Council on Environmental Quality

January, 1998 -- Interview on Arctic environmental change distributed by Arctic Science Journeys radio news service

December, 1997 -- Interviewed for story in Earth Magazine that was published early in next year

November, 1997 -- Lead scientist in joint NOAA-NSF Press Conference on Arctic Climate Change, Washington, DC. Reported on in newspapers across US and Canada (often on front page), as well as on TV (CNN) and National Public Radio. Also covered in Europe.

November, 1997 -- Interviewed for background on 4-day series on Global Warming that appeared in the Washington Post during the week of Nov. 10.

August, 1997 -- Quoted in Washington Post “Horizon” feature on Little Ice Age. Included photos taken during 1997 Greenland field season

March, 1997 -- Research mentioned in “Computer Life”

January, 1997 -- Featured in “Science News”

December, 1996 -- Featured in “Washington Times”

December, 1996 -- Featured as lead article in Discovery Section of “Boulder Daily Camera”

November, 1996 -- Focus of 8-page interview in “Environmental Review”

September, 1996 -- Participated in “State of the Climate” briefing at the National Press Club, Washington. Broadcast on CSPAN and reported by over 150 newspapers nation-wide.

June, 1996 -- Appeared on “ABC Nightly News”

June, 1996 -- Featured in “Sea Technology”

May, 1996 -- Featured in “New York Times”

March, 1996 -- Featured in cover story in “Science News”

Pre-1996 -- Didn’t keep track of press interaction, but was featured several times in print media, including “Wall Street Journal” and “Washington Post.” Also appeared on National Public Radio.

## **SERVICE ON EDITORIAL BOARDS**

Spring, 2007 – Founding Editor (with M. Miller and B. Morehouse) of the new “*Environmental Science, Law, and Policy*” book series, University of Arizona Press and partners (to present).

May, 2006 – Appointed to Board of Reviewing Editors, *Science* (to present)

January, 1993 -- Appointed to the Editorial Advisory Board of *Quaternary Science Reviews* (to 2008)

January, 1993 -- Appointed to the Editorial Board of *Geology* (2-year term).

## **OTHER PROFESSIONAL ACTIVITIES**

September, 2009 – Invited participant NSF-NASA WAIS Antarctic systems workshop, Pack Forest, WA

September, 2009 – Invited Speaker Brown University, Providence, RI

August, 2009 – Invited Plenary Speaker, Joint Water Symposium of the Arizona Hydrological Society and the American Institute of Hydrology, Scottsdale, AZ.

July, 2009 – Invited Participant – IPCC Fifth Assessment Report Scoping Meeting, Venice, Italy

July, 2009 – Invited keynote speaker IGBP PAGES Open Science Meeting, Corvallis, OR

May, 2009 – Invited to present testimony at hearing on “The Effects of Water Quality Issues in the Lower Colorado River”, Subcommittee on Water and Power, U.S. House of Representatives, Tucson, AZ.

May, 2009 – Invited Speaker, U.S. Congress House and Senate Briefings on Adaption to Climate Change, Focus on Water. Washington DC

April, 2009 – Invited Speaker, Tucson Committee on Climate Change Inaugural Meeting

March 2009 – Invited speaker, Pacific Science Conference, Tahiti

February, 2009 – Invited Lunch Speaker, Urban Land Institute Water Summit, Las Vegas, NV

February, 2009 – Invited speaker, Annual Meeting of American Association for the Advancement of Science, Chicago, IL

February, 2009 – Invited Speaker, Colorado State University, Fort Collins, CO

January, 2009 – Invited speaker and panelist, “Adaptation to Climate Change in the Desert Southwest: Impacts and Opportunities,” Tucson, AZ

January, 2009 – Invited speaker and panelist, Annual meeting of the American Meteorological Society Climate Services session, Phoenix, AZ

May, 2008 – Invited to present testimony at hearing on “Water Supply Challenges for the 21<sup>st</sup> Century”, Committee on Science and Technology, U.S. House of Representatives, Washington, DC.

April, 2008 – Invited Speaker, Texas A&M University, College Station, TX

April, 2008 – Invited Speaker, University of Washington public evening lecture

April, 2008 – Invited Speaker, Rotary Club luncheon lecture, Seattle, WA

April, 2008 – Invited Speaker, Pacific Science Center Evening Lecture, Seattle, WA

March, 2008 – Invited speaker, “Solar Rock” event, Tucson, AZ

March, 2008 – Invited dinner speaker, Spring meeting of the Montrose Memorial Hospital staff and friends.

March, 2008 – Invited Speaker, Yale Club, Tucson, AZ

March, 2008 – Invited Speaker, Arizona Science Center, Phoenix, AZ

March, 2008 – Invited Speaker, Honors College Luncheon

March, 2008 – Invited Speaker, BIO5 and other units, University of Arizona, Tucson, AZ

February, 2008 – Invited Speaker, Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO.

January, 2008 – Invited Speaker, Frankel Foundation Board Retreat, Phoenix, AZ.

November, 2007 – Invited Speaker and Panel Member, Climate Change and the Role of Higher Education in Arizona: *Preparing our Students for a Changing World*, Phoenix, AZ.

October, 2007 – Invited Speaker, Water Policies and Planning in the West: Ensuring a Sustainable Future, Western Governors’ Association and the Western States Water Council, Salt Lake City, UT.

October, 2007 – Invited Speaker, Department of Soil, Water and Environmental Sciences, University of Arizona, Tucson.

October, 2007 – Invited Evening Speaker, Arizona Association for Environmental Educators conference, Tucson, Arizona.

October, 2007 – Invited speaker, series of three lectures sponsored by the State Engineer of New Mexico, Albuquerque and Santa Fe, New Mexico.

October, 2007 – Invited Speaker - New Mexico Climate Change Ecology and Adaptation Workshop, Albuquerque, New Mexico.

October, 2007 – Invited Evening Speaker on Climate Change, Public Forum Co-sponsored by The Nature Conservancy and the University of Chicago, Chicago, Illinois.

October, 2007 – Invited Workshop Participant, "Future Climate Change Research and Observations: GCOS, WCRP and IGBP Learning from the IPCC Fourth Assessment Report," Sydney, Australia

September, 2007 – Taaffe Lecturer, Ohio State University, Columbus, Ohio.



September, 2007 – Invited Speaker, Border Institute-IX: Security, Development and the Environment at the U.S.-Mexican Border.

August, 2007 – Invited Speaker, 2007 Regional Water Symposium: “Sustainable Water, Unlimited Growth, and Quality of Life: Can We Have It All?”, Tucson, AZ

July, 2007 – Invited Seminar Speaker, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

May, 2007 – Invited Speaker, “Dividing the Waters: Science for Judges Workshop IV,” Boulder, Colorado

March, 2007 – During a visit to the U.S. House of Representatives, gave an hour-long briefing "Global Warming and the Impacts in the American West" hosted by the House Committee on Science, and also met w/ staffers of two western Congressmen (Rep. Renzi and Rep. Matheson).

March, 2007 – Invited Speaker – National Science Foundation Earth System History Meeting, Washington, DC.

March, 2007 – Invited Speaker, OUT LOUD Program, Telluride, Colorado.

March, 2007 – Invited Speaker, Arizona Board of Regents Meeting.

March, 2007 – Invited Speaker, UK Royal Society Meeting on Climate Change.

February, 2007 – Briefed Congresswoman Giffords on climate change, the IPCC, and what it means for Arizona.

February, 2007 – Met with Congressman Bart Gordon, and participated a House Committee on Science and Technology Briefing on “Sea Level Rise - The State of the Science;” in the afternoon repeated the briefing for staff members of the U.S. Senate Committee on Environment and Public Works

February, 2007 – Invited Speaker, UN/WMO IPCC Working Group I Plenary.

December, 2006 – Invited Speaker, American Geophysical Union Fall Meeting

December, 2006 – Invited Panelist, Interfaith Discussion of Climate Change, Tucson, AZ

November, 2006 – Invited speaker, Earth System Science Partnership, Beijing, China.

October, 2006 – Invited speaker, Governor of New Mexico’s Fourth Annual Drought Summit

October, 2006 – Invited speaker, San Diego Natural History Museum

October, 2006 – Invited speaker, University of Arizona College of Science Public lecture series “Global Climate Change,” Tucson

October, 2006 – Invited speaker, Climate Variability & Change in the San Juan Mountains: A Scientist-Stakeholder Dialogue, Durango, CO

October, 2006 – Invited evening speaker, Fort Lewis College, Durango, CO

September, 2006 – Invited speaker, Arizona Academy Village, Tucson

August, 2006 – Invited speaker – 36<sup>th</sup> American Quaternary Association Biennial Meeting, Bozeman, MT.

July, 2006 – Invited participant, UN/WMO Intergovernmental Panel on Climate Change Fourth Lead Authors Meeting, Bergen, Norway.

June, 2006 – Invited participant and speaker, IGBP PAGES/ WCRP CLIVAR Workshop on ‘Past Millennia Climate Variability’, Wengen, Switzerland.

June, 2006 – Invited speaker (1 hour plenary) – 11<sup>th</sup> Annual Community Climate System Model Workshop, Breckenridge, CO.

May, 2006 – Invited speaker – MountainFilm, Telluride, CO

May, 2006 – Scientific co-author/member of *Amici Curiae* brief to the U.S. Supreme Court – focused on climate change

April, 2006 – Dinner speaker, Climate and Energy Funders Group, Phoenix, AZ.

February, 2006 – Invited speaker, Alaska Forum on the Environment, Anchorage, AK.

January, 2006 – Invited speaker (1 hour plenary), 5<sup>th</sup> Annual conference of the Quivira Coalition - 'Bridging the Urban-Rural Divide', Albuquerque, NM.

January 2006– Elected Vice President of the Board for the Mountain Studies Institute, Silverton, Colorado

December, 2005 – Invited seminar speaker, Fort Lewis College

December, 2005 – Invited participant and speaker, UN/WMO Intergovernmental Panel on Climate Change Third Lead Authors Meeting, Christchurch New Zealand

November, 2005 – Invited speaker, Climate, Oceans and Policies – Challenges for the 21<sup>st</sup> Century Conference, Royal Norwegian Embassy and The Carnegie Institution, Washington, DC.

October, 2005 – Invited speaker and participant, Climate Change and Conservation Workshop, The National Center for Ecological Analysis and Synthesis (NCEAS), Santa Barbara, CA.

September, 2005 – Invited speaker and participant, National Research Council Board on Atmospheric Sciences and Climate Workshop on Multiple Environmental Stresses, Irvine, CA.

September, 2005 – Invited dinner speaker and participant, Conference on Urban Water Supplies and Climate Change in the West, Las Vegas, NV.

August 2005 – Elected Member of the Board for the Mountain Studies Institute, Silverton, Colorado

July, 2005 – Gave public lecture on climate change (“Climate Change: What's Ahead for the West”) sponsored by the New Mexico State Environment Department, Santa Fe, NM

July, 2005 – Invited lunch speaker, State of New Mexico Climate Change Advisory Group Meeting #1, Santa Fe, NM

July, 2005 – Discussion speaker, Pinhead Institute Town Talk, Telluride, CO.

June, 2005 – Participant/speaker, San Juan Mountains Research Retreat, Mountain Studies Institute, Silverton, CO

May, 2005 – Invited speaker and participant, NASA-NOAA Workshop on “Observational and modeling requirements for predicting drought on seasonal to decadal time scales,” University of Maryland

May, 2005 – Invited participant, UN/WMO Intergovernmental Panel on Climate Change Second Lead Authors Meeting, Beijing, China.

April, 2005 – Invited Speaker, University of Arizona Dean of Students Faculty Lecture Series; talk title: “Drought: Lessons from the Future.”

April, 2005 – Dinner Speaker at informal meeting of water managers for Albuquerque and the state of New Mexico

March, 2005 – Invited speaker, Arizona Geological Society meeting, Tucson, AZ.

February, 2005 – Invited speaker and participant, Workshop on “Climate Change & Ecosystem Impacts in Southwest Forests and Woodlands,” Sedona, AZ.

February, 2005 – Guest lecturer, Environmental Law Seminar, University of Arizona.

April, 2004 – Invited Speaker - “Perspectives on Abrupt Climate and Environmental Change,” Briefing for the NSF Geosciences Directorate.

February, 2004 – Testified in support of Arizona State Senate Bill 1227 (State Climate Change Study Committee); Senate Natural Resources and Transportation Committee

February, 2004 – Panel Member, Plenary Session on “Managing Fish and Wildlife in the face of Climatic Variability,” 37<sup>th</sup> Annual Joint meeting of the Arizona and New Mexico Chapters of The Wildlife Society and the Arizona/New Mexico Chapters of the American Fisheries Society, Safford AZ.

November, 2003 – Invited Speaker New Mexico Council of Churches conference “Is Global Warming Too Hot to Handle?,” Albuquerque MN

October, 2003 – Invited Plenary Speaker, Panel Member and Press Conference Participant, Study of Environmental Arctic Change (SEARCH) Open Science Meeting, Seattle, Washington

September, 2003 – Invited Participant and Speaker, UN Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Second Scoping Meeting, Potsdam, Germany

May, 2003 – Invited speaker, Inagural Meeting of the Arizona Governor’s Drought Task Force

April, 2003 – Invited Participant and Speaker, UN Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment First Scoping Meeting, Potsdam, Germany

April, 2003 – Invited Keynote Speaker, University of New Mexico Center for the Southwest Conference “Heating up: Coping with Climate Change in the Southwest”

April, 2003 – Invited Plenary Speaker, International Limnogeology Congress, Tucson, AZ

April, 2002 -- Keynote Speaker, NSF Workshop on “Antarctic Peninsula Climate Variability: A Historical and Paleoenvironmental Perspective,” Clinton, NY.

April, 2002 -- Invited Speaker, University of New Mexico  
 March, 2002 -- Invited seminar speaker, University of New Mexico  
 March, 2002 -- Invited SEPM 2002 Annual Business Meeting Luncheon Distinguished Speaker, Houston, TX  
 January 2002 -- Invited lunch speaker. "Regional climate services: The RISA\* Experience" NOAA Climate Services Workshop, Columbia, Maryland.  
 December 2001 -- Invited plenary speaker "Building Native Nations: Environmental, Natural Resources, and Governance" conference, Tucson, AZ  
 August 2001 -- Invited plenary speaker, *IGBP PAGES - PEP3: Past Climate Variability Through Europe and Africa*, August 2001, Aix-en-Provence, France.  
 November, 2001 -- Laboratory for Tree-ring Research, Colloquium, November 2001  
 April 2001 -- Invited Speaker, NOAA Climate Diagnostics Lab, Boulder, CO  
 April 2001 -- Attended lunch briefing with Arizona Congressmen Kolbe and Flake to discuss University of Arizona interaction with Columbia University and the Biosphere 2 Center, Washington, DC  
 April 2001 -- Invited Speaker, NSF Workshop "Reconstructing Late Holocene Climate," Charlottesville, VA  
 April 2001 -- Invited speaker, University of Arizona Math Awareness Week  
 March 2001 -- Invited seminar speaker, Scripps Institute of Oceanography  
 March 2001 -- Invited seminar speaker, University of Minnesota  
 March 2001 -- Invited speaker at NSF PARCS workshop, Amherst Massachusetts  
 March 2001 -- Invited speaker and Earth System Science advisor, University of Wyoming  
 February 2001 -- "Climate, fire and the need for a national climate service." NOAA-USDA Fire and Climate 2001 Workshop, Tucson, AZ.  
 January, 2001 -- Invited speaker at *NASA/IPRC Colloquium on Decadal Climate Variability*, Honolulu HI  
 September 2000 -- Invited speaker, Annual Meeting of The Nature Conservancy, Tucson, AZ  
 July 2000 -- Invited participant and speaker, Yale/NBER/IIASA program on International Environmental Economics Workshop on "Potential Catastrophic Impacts of Climate Change", Snowmass, CO  
 August 2000 -- Gave invited lecture to UA Ecology and Evolutionary Biology Dept. as part of their seminar series  
 May 2000 -- Gave talk "A global perspective on climate change" to US Department of State "Senior Seminar," Tucson, AZ  
 March 2000 -- Gave invited Holmes lecture, Syracuse University.  
 December, 1999 -- Gave invited lecture to UA Geography Dept. as part of their seminar series  
 October, 1999 -- Invited Speaker/Panelist "Hot Topics" Session entitled "Climates Change, Get With It!" at 1999 Annual Meeting of the Geological Society of America, Denver, CO.  
 November, 1999 -- Invited Panelist and Speaker in "Special Symposium on Global Warming" at the 1999 American Nuclear society Winter Meeting (Long Beach, CA). Talk titled "Measuring climate change: climates and climate changes of the past."  
 August, 1999 -- Invited participant and speaker, Aspen Global Change Institute on "Ecological and Agricultural Consequences of Past, Present and Future Climatic Extremes," Aspen, CO.  
 August, 1999 -- Gave invited seminar on recent climate change at University of Durban, South Africa  
 August, 1999 -- Gave three invited short-course/demonstration of The World Data Center-A for Paleoclimatology system, International Quaternary Association Meeting, Durban, South Africa. Included television interviews with South African Broadcasting Service.  
 May, 1999 -- Invited speaker/participant NASA Team Meeting (Arlie, VA) Presented overview of "Assessing Future Stability of US High Plains Landcover: Integration of Process Modeling with Landsat, In Situ Modern and Paleoclimate Data"  
 Spring, 1999 -- Invited lecturer, Trinity College, Dublin  
 June, 1998 -- Invited lecturer, European Commission Advanced Study Course on Holocene Climate Reconstruction, Environmental Change Research Centre, University College, London  
 June, 1998 -- Invited Participant, US-European Commission Conference "New Vistas in Transatlantic Science and Technology Cooperation," Washington, DC.  
 April, 1998 -- Invited Speaker, IGBP PAGES Open Science Meeting, London, England.

February, 1998 -- Invited Participant, Sixth Japan-U.S. Workshop on Global Change Research, Honolulu, Hawaii

February, 1998 -- Nominated for Lead Author, 2000 Intergovernmental Panel on Climate Change (IPCC)

February, 1998 -- Invited Plenary Speaker and Participant, IGBP PAGES 2nd International Workshop on Global Paleoenvironmental Data, Boulder, Colorado

January, 1989 -- Invited Speaker, National Science Foundation Earth System History Interagency Briefing, Washington, DC

January, 1989 -- Invited Speaker, US Global Change Research Program Congressional Seminar Series, Washington, DC

January, 1998 to 2000 -- Invited Content Advisor, Smithsonian Institution's planned new "Forces of Change" National Museum of Natural History exhibit and "From Grass to Grain" traveling exhibit.

January, 1997 to 1998 -- Senior US Scientist, Gore-Chernomyrdin US-Russia Environmental Working Group.

December, 1997 -- Invited Seminar Speaker - University of Alaska-Fairbanks

November, 1997 -- Preprint of Science paper "Arctic Environmental Change of the Last Four Centuries" sent by Dr. James Baker (Under Secretary for Oceans and Atmosphere) to Vice President Gore, along with explanatory memo).

November, 1997 -- Invited seminar speaker - McGill University, Montreal

November, 1997 -- Invited seminar speaker - University of Montreal, Montreal

November, 1997 -- Invited seminar speaker - UC Santa Cruz, Santa Cruz, CA

November, 1997 -- Invited participant, IGBP PAGES (Past Global Changes) Leader Meeting, Hilterfingen, Switzerland

September, 1997 -- Invited participant and speaker, WCRP CLIVAR Science meeting, Abisko, Sweden.

June, 1997 -- Invited participant and speaker, National Center for Atmospheric Research "Climate System Model" workshop. Breckenridge, CO

May, 1997 -- Invited Speaker, NSF ARCSS OAII Principal Investigators Meeting, Virginia Beach.

Winter, 1997 -- Member - NSF Arctic System Science (ARCSS) Science Integration Plan Writing Team.

April, 1996 -- Plenary Speaker and Working Group Co-Chair, Arctic System Science (ARCSS) All-Hands Workshop, Utah

Spring, 1996 -- Member, Ocean Drilling Program Leg 165 Science Party

February, 1996 -- invited speaker at first ever joint meeting of the NRC (National Research Council) "GOALS" and "DEC-CEN" climate research panels, Irvine, CA.

October, 1995 -- Speaker and Working Group Leader, All World Data Center Meeting, Netherlands

April, 1995 -- Invited participant, speaker and discussion leader "International Himalayan/Tibetan Plateau Paleoclimate Workshop" Kathmandu, Nepal

1994-1997 -- Collaborator on funded National Science Foundation Grant ATM-94: "Long-term dynamics of the SW Indian monsoon: New high-resolution paleoclimatic data from Tibet" (funding thru Dr. K-B Liu).

April, 1994 -- Invited participant, IGBP PAGES workshop and planning meeting "PEPII - Pole-Equator-Pole Australasia transect," Beijing, China.

1991 to present -- Invited participant, and representative of the NOAA Paleoclimatology Program, at 2-3 meetings per year of the NOAA Panel on Climate and Global Change

October, 1994 -- Invited participant, NATO Workshop "Climatic variability and forcing mechanisms of the last 2000 years." Tuscany, Italy

December, 1993 -- Guest Editor, Special Issue of *Quaternary Science Reviews*, "Decadal to Millennial-scale Variability in the Climate System"

- December, 1993 -- Invited participant and co-author of IGBP PAGES workshop report "PEPIII - Pole-Equator-Pole Europe-Africa Transect," Bern Switzerland.
- October, 1993 -- Invited participant, NATO Workshop "Strategies for the use of paleoclimatic data sets in climate model intercomparison and evaluation," Aussois, France.
- April, 1993 -- Invited participant, speaker, and group leader at IGBP Workshop "High-resolution records of past climate from monsoon Asia," Taipei, Taiwan.
- March, 1993 -- Invited participant and speaker, NSF-Russian Workshop "Paleoclimates of Arctic Lakes and Estuaries," Vladivostok, Russia. Co-authored protocols for international collaboration in the study of Arctic paleoclimates using lake sediments.
- December, 1992 -- IGBP PAGES representative to meeting of the IGBP-DIS Standing Committee and to discussions of joint PAGES-IGBP GCTE (Global Change and Terrestrial Ecosystems) research, Canberra, Australia.
- December, 1992 -- Invited lecturer at the Research School of Biological Sciences at the Australian National University.
- November, 1992 -- Invited participant and speaker at the Advisory Committee on Nuclear Waste Working Group Meeting: "On the impact of long-range climate change in the area of the southern Basin and Range," Washington, DC.
- September, 1992 -- Invited participant in NOAA-sponsored workshop "Human Dimensions of Global Change," Washington, DC.
- September, 1992 to May, 1994 -- Gave hour-long invited seminars at the University of Colorado (Geological Sciences), the NOAA Geophysical Fluid Dynamics Lab (Princeton), the Colorado School of Mines (Geology), The University of Wyoming (Geology), the University of Massachusetts (Geography and Geology) and the University of Washington (Quaternary Research Center - two lectures).
- December, 1991 -- Invited participant, Dahlem Workshop on "Global Changes in the Perspective of the Past," Berlin, Germany.
- November, 1991 -- Invited participant and discussion leader, NOAA/NASA/NSF Workshop: "Late Quaternary Paleoclimate Model Boundary Conditions," New York.
- September, 1991 -- Invited Guest and Lecturer, Center for Climate System Research, University of Tokyo.
- June, 1991 -- Invited member, US delegation to meeting of Working Group VIII (Influences of Environmental Changes on Climate) of the US/USSR Agreement on Protection of the Environment, Bellagio, Italy.
- March, 1991 -- Invited participant and Theme Leader, First meeting of the Scientific Steering Committee of the IGBP Past Global Changes (PAGES) Core Project, Mainz, Germany.
- August, 1990 -- Invited participant and paleoclimatology representative - U.S. (NSF/NASA) Bilateral Agreement with the People's Republic of China (State Meteorology Agency) Climate Workshop, Shanghai, PRC.
- January, 1990 -- Invited participant, GICME II Workshop - "Geological Indicators of Climate from Marine Environments," St. Petersburg, FL.
- November, 1989 -- Invited participant, EPA/OPPE "Workshop on Tropical Forests," Washington DC.
- August - September 1989 -- Visiting Scientist, Laboratoire de Palynologie C.N.R.S., Montpellier, France.
- July - August 1989 -- Invited participant, Second UCAR/OIES Global Change Institute, "Explaining records of past global change," Snowmass, Colorado.
- July, 1989 -- Invited contributor and speaker, "Global Climate Change and its Effects on California," Davis, California.
- 1989 - 1990 -- Original member of the NOAA Paleoclimate Advisory Panel.
- November-December 1988 -- Visiting Scientist, Laboratoire de Palynologie C.N.R.S., Montpellier, France.

- September 1988 -- Invited participant, Committee on the Earth Sciences review of methodologies for EPA's reports to Congress, Washington DC.
- August 1988 -- Elected Vice-Chairperson/ Chair-Elect of the Paleoecology Section of the Ecological Society of America.
- April 1988 -- Invited participant, NSF workshop on Arctic Lake Coring, Boulder, Colorado.
- April 1988 -- Review workshop for EPA's Report to Congress on the Effects of a Global Warming, Bethesda, Maryland.
- February 1988 -- Invited participant and speaker, NSF/NOAA Paleoecology workshop: "A meeting on the present status and future of studies of the paleosedimentary records of nearshore marine and freshwater lakes related to climate and global change," Boston, Massachusetts.
- October 1987 -- Invited participant, U.S. EPA Meeting of the Principal Investigators for "The Report to Congress on the Effects of a Global Warming," Alexandria, Virginia.
- September 1987 -- Invited participant, U.S. EPA Workshop: "Global Climate Change Research Plan," Raleigh, North Carolina.
- May 1987 -- Invited participant and speaker, NSF (Division of Polar Programs) workshop: "The Contribution of Lake Sediments to Arctic Paleoenvironmental Reconstructions," Boulder, Colorado.
- April 1987 -- Invited participant, U.S. EPA Workshop: "Ecological Effects of Global Climate Change," Boulder, Colorado.
- April 1987 -- Invited participant and speaker: "United Nations Meeting of Experts on Space Technology and its Applications within the Framework of Educational Systems," Lagos, Nigeria.
- 1986 to present -- Reviewer for U.S. EPA, NSF, DOE, NOAA, NGS, ODP, USGS, NPS, several foreign funding agencies, and numerous scientific journals.
- 1986 - Consultant to the U.S. EPA.
- 1984 to 1986 -- Member COHMAP (Cooperative Holocene Mapping Project).

## PROFESSIONAL MEMBERSHIPS

American Association for the Advancement of Science  
 American Geophysical Union  
 American Meteorological Society  
 American Quaternary Association  
 Ecological Society of America  
 Geological Society of America  
 Sigma Xi

## PUBLICATIONS (Peer-reviewed journals and book chapters)

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4. Overpeck, J.T. 1987. Pollen time series and Holocene climate variability of the Midwest United States. *In: Abrupt Climatic Change - Evidence and Implications* (W.H. Berger and L.D. Labeyrie, eds.), Reidel Publishing Co., Holland, p. 137-143.
3. Clark, J.S., J.T. Overpeck, T. Webb III, and W. Patterson III. 1986. Barrier island dynamics of the past 500 years: the use of pollen stratigraphic correlation and dating. *Review of Palaeobotany and Palynology* 46: 145-168.
2. Overpeck, J.T., T. Webb III, and I.C. Prentice. 1985. Quantitative interpretation of fossil pollen spectra: dissimilarity coefficients and the method of modern analogs. *Quaternary Research* 23: 87-108.
1. Overpeck, J.T. 1985. A pollen study of a late Quaternary peat bog: south-central Adirondack Mountains, New York. *Geological Society of America Bulletin* 96:145-154.

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22. Peck, J., C. Scholz, J. King, J. Overpeck (2004). The Lake Bostumtwi Drilling Project: Paleoclimatic Research Through Scientific Drilling, *DOSECC Newsletter*, December, 2004.
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19. Overpeck J. and K. Trenberth, 2004. "CLIVAR/PAGES/IPCC Workshop: A multi-millennia perspective on drought and implications for the future." Workshop Report. UCAR, Boulder CO.
18. Trenberth, K., J. Overpeck and S. Solomon, 2004: Exploring drought and its implications for the future. *Eos*, 85, No. 3, 20 Jan. 2004, p27.
17. Swanberg, N. and J. Overpeck, 2003. An Overview of the Arctic System Science Program. *Arctic Research* 17, 2-8.
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- Overpeck, J.T. 2006. "Lessons from the paleoclimatic record of extreme climate events," Earth System Science Partnership, Beijing, China
- Overpeck, J.T. 2006. "Paleoclimatology and Society: Science in Support of Decision-making," American Quaternary Association, 19<sup>th</sup> Biennial Meeting, Bozeman, MT.
- Overpeck, J.T. 2005. "The Realities of Climate Change," Annual Conference of the New Mexico Public Health Association, Albuquerque, New Mexico.
- Overpeck, J.T. 2005. "Climate Change in the Southwest: Past, Present and Future," Climate Change & Ecosystem Impacts in Southwest Forests and Woodlands Workshop, Sedona, Arizona.
- Overpeck, J.T., B. L. Otto-Bleisner and J.T. Kiehl 2004. "Paleoclimatic Evidence for Future Greenland Ice Sheet Instability and Rapid Sea Level Rise," IPCC Workshop on Climate Sensitivity, Paris, France
- Overpeck, J.T. and R. Alley 2004. "Paleoclimatic perspectives on abrupt climate change," First International CLIVAR (Climate Variability and Predictability) Science Conference, Baltimore, MD.
- Overpeck, J.T. 2004. "A Paleoenvironmental Perspective on Future Climate Change." 37<sup>th</sup> Annual Joint meeting of the Arizona and New Mexico Chapters of The Wildlife Society and the Arizona/New Mexico Chapters of the American Fisheries Society, Safford AZ.
- Overpeck, J. Wheeler, W., Cole, J. Beck, W., Scholz, C., Brooks, K., Arko, J., and Sharp, E. 2003. "A new 800-year varved sediment record of West African hydrologic change from Lake Bosumtwi, Ghana," third International Limnogeology Congress, Tucson AZ.
- Overpeck, J.T., S. Avery, B. Morehouse. 2002. "Regional Climate Services: Research perspectives and mechanisms for communication," Annual Meeting of the American Meteorological Society, Orlando, Florida.
- Overpeck, J.T. 2001. "Climate, fire and the need for a national climate service." NOAA-USDA Fire and Climate 2001 Workshop, Tucson, AZ.
- Overpeck, J.T. 2001. "Climate Variability and Society: Are we fooling ourselves?" Annual Meeting of the American Meteorological Society, Albuquerque, NM
- Hughen, K A., Southon, J. Lehman, S. J. Overpeck, and L. Peterson. 2000. "Radiocarbon Calibration and Abrupt Changes in Atmospheric C14 Concentration During Marine Isotope Stage 3." Annual Fall Meeting of the American Geophysical Union, San Francisco, CA.
- Overpeck, J. 2000. "The role of mineral dust in climate change over the last glacial cycle," IGBP PAGES PEP II Synthesis Workshop, Okayama, Japan
- Morrill, C., J. Overpeck\*, J. Cole, K-b Liu, L. Tang, and C. Shen. 2000 "Century to millenium-scale variations in the SW Asian monsoon," Hayashibara Forum on "Water, Earth and Life," Okayama, Japan
- Overpeck, J. and R. Webb. 2000. "Circum-North Atlantic Climate Variability: The Last Glacial Cycle, The Last 1000 Years and the Future," 16<sup>th</sup> Biennial Meeting of the American Quaternary Association, Fayetteville, Arkansas
- Robertson, A.D. J.T. Overpeck, D.Rind, E. Mosley-Thompson, and G.A. Zielinski. 2000. A new zonally-averaged record of volcanic climate forcing for the last 5000 years., 16<sup>th</sup> Biennial Meeting of the American Quaternary Association, Fayetteville, Arkansas
- Overpeck, J.T. 2000. "Overview: Paleoclimate Records," NASA Workshop on Solar Influences on Climate, Tucson, AZ.
- Overpeck, J. K. Liu, L. Tang, G. MacDonald, S. Trumbore and D. Anderson. 1998. "Climate coupling of the North Atlantic, Eurasia and the Asian Monsoon over the last 18,000 years:

- data and climate model results." Annual Fall Meeting of the American Geophysical Union, San Francisco, CA.
- Overpeck, J.T. 1998. "Assessing future climate change and its impacts: the role of PAGES data," IGBP PAGES Open Science Meeting, London, UK.
- Overpeck, J.T. 1997. "Understanding the Full Range of Natural Interannual to Century-Scale Climate Variability: Observations at Risk?" Annual Fall Meeting of the American Geophysical Union, San Francisco, CA.
- Murray, D.W., L C Peterson, H-L Lin and J T Overpeck. 1996. "Biogenic opal, carbon, and carbonate accumulation in the Cariaco Basin over the past 25,000 years under varying redox conditions," Annual Fall Meeting of the American Geophysical Union, San Francisco, CA.
- Webb, R.S., J.T. Overpeck, and J. Keltner. 1996. "The role of the World Data Center-A for Paleoclimatology and other international efforts in the coordination of global pollen databases." IXth International Palynological Congress, Houston, Texas.
- Overpeck, J.T. 1996. "The rapidly changing Arctic environment: a paleoenvironmental perspective." Arctic System Science (ARCSS) All-Hands Workshop, Snowbird, UT.
- Overpeck, J.T. 1995. "The Need for Improved Global Paleoenvironmental Databases," 14th Symposium de l'Association des Palynologues de Langue Francaise, Paris.
- Overpeck, J.T. 1995. "Abrupt Past Changes in the SW Asian Monsoon System," International Himalayan/Tibetan Plateau Paleoclimate Workshop" Kathmandu, Nepal
- Overpeck, J.T. 1994. "Climate of the present interglacial: stable or not?," SW and Rocky Mountain Division of the American Association for the Advancement of Science Annual Meeting, Durango, CO
- Overpeck, J.T. 1994. "The paleoclimate record and its role in understanding the greenhouse effect" International Conference on Global Climate Change: Science, Policy, and Mitigation Strategies, Phoenix, AZ
- Webb, R.S., P.J. Bartlein, and J.T. Overpeck. 1993. "The paleoclimate record of long-term climate variability." Ecological Society of America Annual Meeting.
- Barlow, L.K., J.W.C. White, J.T. Overpeck, and R.G. Barry. 1993. "Evaluation of deuterium signals from the GISP2 ice core with Greenland temperature records: groundwork for high resolution interpretation for the last 1000 years." AGU Spring Meeting.
- Lin, H-L., L.C. Peterson, D.W. Murray, and J.T. Overpeck. 1993. "Isotopic indicators of late Quaternary hydrography and productivity: foraminiferal O-18 and C-13 records from the Cariaco Basin (Venezuela)." AGU Spring Meeting.
- Overpeck, J., E. Cook, K. Gajewski, and J.S. Clark. 1992. "Assessing the potential of fossil pollen data for reconstructing annual to century-scale climatic change." 12th biennial Meeting of the American Quaternary Association, Davis, California (Plenary talk).
- Overpeck, J. 1992. "Global view of the Little Ice Age: A model perspective." 13th International CODATA Conference, Beijing, China.
- Peterson, L.C., H-L. Lin, J.T. Overpeck, D.W. Murray, S.E. Trumbore, and C. Schubert. 1992. "The late Quaternary record of anoxia in the Cariaco Basin (Venezuela)." AGU Ocean Sciences Meeting, New Orleans, Louisiana.
- Overpeck, J.T. and D. Rind. 1992. "Modeling the possible causes of decade- to century-scale climatic change." American Society of Limnology and Oceanography Aquatic Sciences Annual Meeting, Santa Fe, New Mexico
- Overpeck, J.T., D. Anderson, S. Trumbore, W. Wolfli, and W. Prell. 1991. "Abrupt change in the monsoon climates of Africa and Asia during the last deglaciation." XIII INQUA Congress, Beijing, China
- Overpeck, J.T. 1991. "The Late-Quaternary record of global climate change." American Association of Stratigraphic Palynologists Annual Meeting, San Diego.
- Overpeck, J.T. 1990. "Modeling the transient response of vegetation to climatic change." Geological Society of America Annual Meeting.

- Overpeck, J.T. 1990. "The past as a key indicator for assessing future climate-induced ecologic change." International Symposium on Ecological Indicators, Fort Lauderdale.
- Overpeck, J.T. 1990. "A data-model approach to understanding decade- to century-scale climatic variability: Project ARRCC." Workshop on Climate Studies, Shanghai.
- Overpeck, J., D. Anderson, S. Trumbore, W. Wolfli, and W. Prell. 1990. "The Southwest Indian Monsoon, the Tibetan Plateau, and abrupt climatic change over the last deglaciation." Beijing International Symposium on Climatic Change, Beijing.
- Overpeck J.T. 1989. "Lake sediments, climate modeling, and global climate change." Keynote speaker in workshop on "Large Lakes and Global Climate Change," 24th Congress of the International Association of Theoretical and Applied Limnology, Munich, FRG.
- Peterson, L.C., J.T. Overpeck, N.Kipp, J.Imbrie, and D.Rind. 1989. "A high-resolution record of the last deglaciation from the anoxic Cariaco Basin." Third International Conference on Paleoceanography, Cambridge, Great Britain.
- Overpeck, J.T. and D. Rind 1989. "Climate and biotic change: past, present, and future." Ecological Society of America Annual Meeting, Toronto.
- Overpeck, J.T. 1988. "Modeling the transient response of vegetation to climatic change: a paleoecologic time series perspective." Ecological Society of America Annual Meeting, Davis, California
- Overpeck, J.T. 1987. "Paleoclimatic perspectives on the global carbon cycle: past, present, future." Symposium Inaugurating the University of London Quaternary Research Centre and celebrating Agassiz and 150 years of Quaternary Research, Surrey, England.
- Overpeck, J.T. and E.R. Cook. 1987. "A Quaternary perspective on how trace-gas-induced climate change might affect natural vegetation: data and methods." XII-th Congress of the International Quaternary Association, Ottawa, Canada.
- Overpeck, J.T. 1987. "Pollen, vegetation, climate, and the interval 18,000 to 9000 YR B.P.: numerical techniques in the search for truth." XII-th Congress of the International Quaternary Association, Ottawa, Canada.
- Overpeck, J.T. 1985. "Pollen time series and Holocene climate variability of the Midwest United States." NATO/NSF Conference of Abrupt Climate Change, Grenoble, France.
- Overpeck, J.T. and P.J. Bartlein. 1984. "Time series analysis of a 1000-year high-resolution pollen record from north-central Wisconsin." International Palynological Conference.



**Exhibit 12**  
**Dr. Lawrence D. Phillips' Curriculum Vitae**

## Dr Lawrence D. Phillips

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### Overview

**Dr Lawrence Phillips** is a Visiting Professor of Decision Sciences at the London School of Economics and a Director of Facilitations Limited. After completing an undergraduate degree in Electrical Engineering at Cornell University, he served for three years in the US Navy where he became interested in the interaction between people and machines. To pursue this, he took up post-graduate study in engineering psychology, human learning and decision making at the University of Michigan, where he studied under Professor Ward Edwards, the founder of the field of behavioural decision making. Post-doctoral research on how people in other countries take risks brought him to England, and led to an appointment at Brunel University in the newly created School of Social Sciences. There he taught Bayesian statistics, introductory psychology, observation and interviewing, social and personality psychology, decision theory and behaviour in organisations. He trained in observation and group processes at the Tavistock Clinic and Institute of Human Relations.

His early research focused on how individuals deal with risk and uncertainty. One of his discoveries, with Ward Edwards, was that people fail to become as certain as they could when faced with objective data. Then in the mid-1970s, he discovered, with George Wright, substantial East/West differences in the way people deal with uncertainty. Research then shifted to how groups of people form preferences, consider uncertainty, make judgements and take decisions, with particular emphasis on how a group can outperform even its best member.

Work with insurance underwriters in the 1970s led to developing structured methods for obtaining risk assessments from groups of interacting experts, each of whom has a different perspective on the risk. These methods have been used by various organisations, including the US Nuclear Regulatory Commission, AEA Technology, Nirex and, most recently, the Committee on Radioactive Waste Management.

Dr Phillips created the Decision Analysis Unit at Brunel in 1974 as a self-funding research unit, which moved to the LSE in 1982. At the DAU he developed decision conferencing, a process for helping groups of key players to find solutions to complex issues of concern to their organisation. At the LSE, he teaches behavioural decision theory and decision analysis to undergraduates and post-graduates, including students enrolled in the School's MSc in Decision Sciences. He has authored 100 publications spanning organisation theory, behavioural decision theory, decision and risk analysis, Bayesian statistics, group processes and cultural differences in dealing with uncertainty. He has served on the editorial boards of *Acta Psychologica*, the *Journal of Forecasting* and the *Journal of Behavioral Decision Making*, and he is an editor of the new INFORMS journal *Decision Analysis*.

In his consultancy work, he acts as a process consultant, facilitating work groups and decision conferences, helping individuals and teams to use their differing perspectives on the issues to arrive at an agreed way forward. His expertise is in applying a wide variety of approaches, such as decision and risk analysis, scenario planning and the theory of multiple objectives, to issues of strategic and operational management, option evaluation, prioritisation, resource allocation, policy analysis, risk analysis and crisis management.

### Personal Information

- Married. Two children, Matthew and Joseph.
- Nationality: USA and British citizen
- Date of Birth: 13 June 1934
- Place of Birth: Ithaca, New York, USA
- Director, Facilitations Ltd

**Fields of Interest**

- Decision making, risk taking, human judgement
- Decision and risk analysis
- Multi-criteria decision analysis
- Cultural differences in dealing with uncertainty
- Strategic management
- Bayesian statistics
- Group processes

**Education**

1993

Team Management System Accreditation Workshop, TMS Development International Ltd, 128 Holgate Road, York YO2 4DL

1988

Tavistock Working Conference: Rethinking individual, group and organizational change in current and future contexts, Tavistock Institute of Human Relations, 120 Belsize Lane, London NW3.

1968

Conference on the Examination of Group Behaviour, Tavistock Clinic, 120 Belsize Lane, London NW3.

1967-69

Infant Observation Course, Tavistock Clinic.

1960-66

University of Michigan, PhD in Psychology

1951-57

Cornell University, BEE (Bachelor of Electrical Engineering)

Certificate of Advanced Study in Electrical Engineering (MSc equivalent)

1948-51

Ithaca High School, Ithaca, New York, USA

1945-48

Boynton Junior High School, Ithaca, New York, USA

1939-45

East Lawn School, Ithaca, New York, USA

**Military Service**

1967-59

Electronics Officer, USS John Paul Jones (DD 932)

1958-59

Instructor, Officer Candidate School, Newport, Rhode Island, USA

1959-60

Projects Officer, Destroyer Development Group 2, Newport Rhode Island, USA

**Employment**

1955

Laboratory Superintendent, Cornell Aeronautical Laboratory, Buffalo, New York, USA.

1960-61

Assistant in Research, Institute of Science and Technology (IST), University of Michigan, Ann Arbor, Michigan, USA.

1963-65

Research Assistant, IST.

1965-66

Research Associate, IST; Instructor, Department of Psychology.

1966-67

Associate Research Psychologist (on leave).

1967-73

Lecturer in Psychology, Brunel University, Uxbridge, Middlesex UB8 3PH.

1973-82

Senior Lecturer in Psychology, Brunel University.

1974-82

Director, Decision Analysis Unit, Institute of Organisation and Social Studies, Brunel University.

1976-77

Senior Research Analyst, Decisions and Designs, Inc., McLean, Virginia, USA (on leave from Brunel).

1982-92

Director, Decision Analysis Unit, London School of Economics and Political Science (LSE), Houghton Street, London WC2A 2AE.

1992-94

Senior Research Fellow, LSE.

1994-present

Visiting Professor of Decision Sciences, LSE.

From January 2009

Expert, European Medicines Agency

### **Professional Societies**

- American Psychological Association.
- British Psychological Society; Mathematical and Statistical Section (Chairman of the Section in 1975); Cognitive Psychology Section.
- Institute for Operations Research and the Management Sciences (INFORMS); Decision Analysis Society.
- Operational Research Society
- Judgment and Decision Making Society
- European Association for Decision Making

- International Decision Conferencing Forum (founding member)

## Honours

- Sigma Xi, The Scientific Research Society of North America
- Phi Kappa Phi (post-graduate scholastic honorary)
- Meritorious Service award from Destroyer Development Group 2, 1960
- Frank P. Ramsey award from the Decision Analysis Society for "Distinguished Contributions in Decision Analysis," November 2005

## Teaching

- University of Michigan

Teaching Fellow for Dr Paul Fitts's course on Human Factors Engineering. Introductory Psychology for honours students. Teaching Assistant for the Department of Engineering's summer short course on Engineering Psychology.

- US Navy

Naval Operations (over 500 hours lecturing to college and university graduates).

- Brunel University

Bayesian statistics for social science students. Field Methods (observation and interviewing). Decision Making. Empirical Study of Social Relations. Empirical Study of Personality. Introductory Psychology. Behaviour in Organisations. Research Methods.

- Brunel Management Programme

New Perspectives on Decision Making. Decision Analysis. Dealing with Uncertainty. Principles and Techniques of Decision Analysis. New Techniques for Decision Making. New Perspectives on Risk. Investment for Production. Managing R&D.

- London School of Economics

Major role in the MSc in Decision Sciences. Decision Analysis in Theory and Practice. Advanced Topics in Decision Analysis. Decision Analysis in Social Context. Various guest lectures, on other LSE MSc courses, in organisation theory, group processes, risk and facilitation skills.

- Enterprise LSE

Executive Education: Decision Making for Managers. Cardean/UNext: Quantum course on Behavioral Decision Theory; MBA course, Decision Making for Managers. BBC Decision Making Workshop.

- External courses and lectures since 1969 on decision analysis, risk analysis, Bayesian statistics, multi-attribute decision making, decision support systems, prioritisation and resource allocation in R&D, strategic management, theory and practice of facilitation, group decision making for:

Glacier Institute of Management, Cranfield Institute of Technology, Brunel Management Programme, Time Sharing Ltd., The Open University, The Police College at Bramshill, The National Defence College at Latimer, The London Graduate School of Business Studies, Unilever, The Electricity Council, Commercial Union Assurance, British Petroleum, London Life Association, Nestles, Programmes Analysis Unit of the UK Atomic Energy Authority at Harwell, The International Labour Office of the United Nations, IBM, Shell International, Shell Canada, Shell Greece, Shell Turkey, General Motors, Ocean Transport and Trading, C.D. Searle, Joint Research Centre of the Commission of the European Communities, Institute of Engineering Production, Civil Service College, H.J. Heinz, Institute of Public Administration (Dublin), Sussex Constabulary, Ministry of Defence, ICL, Royal Air Force Staff College, GKN, UNICOM, Royal Statistical Society,

Operational Research Society, Butler Cox, PA Computers & Telecommunications, Oasis Kelco, British Coal, CEEB, Strategic Planning Society, Warwick Business School, Kingston University, Association of Insurance and Risk Managers in Industry and Commerce (AIRMIC), EA Technology, Management Centre Europe, Curtin University, Institute of Risk Management, Management Forum, IIR Ltd., Strategic Decisions Group, The Pharmaceutical Society, University of Surrey, Medical Benefit/Risk Foundation, OECD, Drug Information Agency, Medical Decision Making Society, IFORS, Centre for Medicines Research International, Vision in Business, IQPC, UK Government Operational Research Society, Catalyze Limited courses on Value for Money, Procurement, Decision Skills: Theory and Practice, Facilitation Skills.

**External  
Examining**

1988 - 1994  
Professional Judgement course, Open University.

**Consultancy**

Since 1974, I have facilitated over 200 applications of decision and risk analysis for the following 87 organisations:

Lake Pontchartrain Bridge Commission; Universal-Cyclops, Inc.; Gas Gathering Pipeline Company; ICI Pharmaceutical Division; Commercial Union Assurance Company; Decisions and Designs, Inc; The Post Office; Dashwood Underwriting Agency; British Oxygen Company; Mars Ltd; Butler Cox & Co; ICL; Insurance Technical Bureau; The Frizzel Group; Shell; CEEB; CAP-Scientific; Plessey; Smith Kline & French; British Sugar; Edwardes High Vacuum; London Life; BUPA; Dell Computer Corporation; Ciba-Geigy; Boehringer Ingelheim; International Federation of Health Funds; Lipha; Action Aid; London Lighthouse; AEA Technology; Nirex; SmithKline Beecham; Vosper Thornycroft; Glaxo; BBC; Amylin; Coopers Lybrand; DEGW; Bath College of Higher Education; Ministry of Defence; Mobil; National Audit Office; Sequent; Procter & Gamble; Upjohn; Pfizer; Eagle Star; Sun Life of Canada; Allergan; EA Technology; Yorkshire Electricity; Scottish Hydro Electric; Barnardo's; Janssen Pharmaceutica Research Foundation; Bristol-Myers Squibb; Vertex; Ministry of Agriculture, Fisheries and Foods; Pharmacia; AIG Europe; 3M; PMA Education; YARD; Department of Trade and Industry; Allied Dunbar; Barclays Life Assurance; Horizon IJVC; Astra Hässle; London School of Economics; National Economic Research Associates; F. Hoffman-La Roche; BAE Systems; DEFRA; HM Customs & Excise; Environment Agency; City University; North East London Strategic Health Authority; Jigsaw; Committee on Radioactive Waste Management; Marks & Spencer; Centre for Medicines Research International; Wyeth; Astra-Zeneca; CREATE at the University of Southern California; Egan, Fitzpatrick & Malsch, PLLC; NATO; Ontario Ministry of Health; UK Government's Advisory Council on the Misuse of Drugs.

Examples of work for public sector organisations include:

- Examination of the Department of Trade and Industry's Support for Industrial Innovation. National Audit Office report published in 1995.  
Evaluated eight schemes against 5 cost and 14 innovation criteria to show the relative cost effectiveness of the schemes.
- Prioritisation of the Innovation and Technology Support budget, for the Department of Trade and Industry.  
Prioritised 27 strategies in five areas defined by the purposes of the ITS programmes and activities, considering yearly costs and four benefit criteria, July 1995.
- Evaluation of strategies for updating the Hunt minesweeper, for the Ministry of Defence, 1995.

- **Evaluation of options for an automatic landing system to winch the Merlin helicopter onto a Type 23 frigate, for the Ministry of Defence, 1995.**
- **Affordability study for Project Horizon, a multi-national project to design a new generation of advanced frigates, 1997-8.**  
MCDA was used in three 3-day working group sessions to examine the best collection of technical solutions over 21 functional areas (e.g., survivability/vulnerability, or anti-aircraft warfare—inner layer defence system) in light of conflicting objectives associated with cost, performance, time to in-service, and risk. Naval personnel and civilian contractors from the three nations, UK, France and Italy, attended all the meetings. The decision conferencing format enabled the group to develop a shared understanding of the issues, with the result that an affordable, tentative “Preferred solution” was agreed.
- **Affordability study for the Type 45 destroyer, for the Ministry of Defence, 1999.**  
Used decision conferencing and MCDA modelling in a manner similar to Project Horizon. The process greatly shortened the time to final approval of the ship's design, mainly by gaining the buy-in of all the key players during the process. The approach was favourably commented on in the National Audit Commission's *Major Projects Report 2002* for the Ministry of Defence.
- **Balance of Investment for the Director of Equipment Capability, Above Water Battlespace, for the Ministry of Defence, 2000.**  
A project to prioritise investment on all the major equipments in this sector of the Royal Navy's procurements. Used decision conferencing and MCDA to engage all the key players and gain their commitment to the final prioritisation.
- **Balance of Investment for the MoD Equipment Programme 02, 2001**  
In December 2000 the Joint Capabilities Board of the MoD authorised the use of decision conferencing and MCDA modelling for prioritising all equipment procurement across the services. The JCB engaged Enterprise LSE to assist with implementing this new system. The project included training 12 MoD personnel to facilitate decision conferences and oversee MCDA modelling across all the Directorates of Equipment Capability, as well as participating in selected decision conferences. The process of decision conferencing and Equity modelling was well received, and is now institutionalised as part of the Smart Acquisition process in the JCB, providing a value-for-money prioritisation for the MoD's annual £6 billion equipment budget.
- **Prioritisation of projects for the National Measurement System Directorate, 2002**  
A trial to test the applicability of MCDA and decision conferencing for prioritising resource allocation to projects in the Length programme. The trial was deemed a success, and the approach is now being applied to all the projects in the NMSD's portfolio, facilitated by the DTI's Operational Research group.
- **Comparison of MCDA with cost-benefit analysis for UK air quality policy, 2003**  
A project jointly funded by DEFRA and the Environment Agency to assess how MCDA techniques compare with currently-employed CBA techniques employed by DEFRA, to demonstrate the benefits of using MCDA techniques as a supplement to existing processes and to identify areas of AQS work where MCDA techniques can most appropriately be used.
- **Prioritisation of the Environment Agency Science Programme, 2004**  
A project resulting in a value-for-money prioritisation of programmes and options across 20 areas of work in the Agency. The purpose was to establish priorities for the emerging Science Strategy.
- **North East London Strategic Health Authority, 2004**  
The purpose of this two-day decision conference was to examine the applicability of decision conferencing and multi-criteria modelling for prioritising programmes and strategic initiatives across the Trusts and Strategic Health Authority. The process showed how priorities could be established to provide best value-for-money, and it generated new insights as a result of the in-depth discussions provoked by the modelling process.
- **Committee on Radioactive Waste Management, 2005-2006**  
A multi-criteria decision analysis that appraised 14 options for the management of the United Kingdom's radioactive waste against over two dozen criteria. This is the largest public consultation exercise ever conducted in the country, with inputs to the MCDA from citizens, stakeholders and specialists. The MCDA was used by CoRWM members to help formulate their preliminary recommendations to the UK Government in April 2006.
- **Naval Base Review, 2007**  
Several workshops and decision conferences helped the Royal Navy to explore options for improving the cost effectiveness of its main three naval bases in the United Kingdom.

- **NATO, 2008 & 2009**  
Several decision conference prioritised projects that, if funded, would enable NATO to perform with greater military effectiveness and interoperability.
- **Ontario Ministry of Health, 2008**  
A two-day decision conference explored the feasibility of using the process for prioritising investments in health care for the province of Ontario, Canada.



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**Exhibit 13**  
**Dr. Don L. Shettel's Curriculum Vitae**



## **Don L. Shettel**

### **Employment History and Professional Experience**

- Fall 2008      Adjunct Professor of Geology:  
College of Southern Nevada, Las Vegas, NV.
- 7/91-      Consulting Geochemist: GeoData Systems, Boulder City, NV.  
Experience: Technical expert for Egan, Fitzpatrick, and Malsch, PLLC, regarding the proposed high-level nuclear waste repository at Yucca Mountain, NV, for the State of Nevada. Evaluated groundwater and sediment geochemical data from east-central Minnesota for potential mineral exploration targets. Computer consultant.
- 6/91-12/07      Senior Geochemist, Project Manager, Chairman, and Vice President: Geosciences Management Institute, Inc., Boulder City, NV.  
Experience: Review technical documents of U.S. Dept. of Energy and their subcontractors related to the proposed high-level nuclear waste repository at Yucca Mountain, NV. Planned, designed, and helped install lysimeters in two shallow holes in Area 25 for sampling soil waters above the repository footprint of Yucca Mountain. Set up field procedures for sampling groundwater and sampled Early Warning Drilling Program wells for Nye Co. Nuclear Waste Repository Project Office. Reviewed technical documents concerning geochemistry, hydrogeology, and geostatistics, and performed geochemical modeling and geostatistical calculations for a low-level radioactive waste disposal facility in Wake/Chatham Counties, North Carolina. Made presentations at technical meetings and at high-level governmental agencies. Evaluated pit water geochemistry of a gold mine in southern California for environmental problems. Monitor and evaluate federal environmental assessment and site characterization efforts at the Yucca Mountain proposed nuclear waste repository. Principal investigator/manager of three contracts with Nye County (NV) Nuclear Waste Repository Project Office. Appeared as expert witness before the Shorelines Advisory Board, State of Washington.
- 8/92-10/93      Geochemist (part-time): Energy & Environmental Services Corp., Columbus, OH.  
Experience: Performed geochemical modeling (utilizing EQ3/6) to determine source terms for transport modeling and risk assessment of the Fernald Environmental Remediation Site, OH.
- 9/86-6/91      Senior Geochemist, Associate, and Treasurer: Mifflin & Associates, Inc., Las Vegas, NV.  
Experience: Co-manager of geochemical research on the suitability of Yucca Mountain as the nation's first high-level nuclear waste repository. Perform hydrogeochemical modeling (on both mainframe and personal computers) of the vadose zone to help assess the extent of "disturbed zone" for the high-level nuclear waste repository. Oversaw development of a quality assurance and quality control program for a vadose zone drilling and sampling project in the vicinity of Yucca Mountain. Prepare or assist in the preparation of research proposals and budgets for

submission to state or federal governmental agencies for funding. Managed subcontracts to research scientists at major universities: Virginia Polytechnic Institute and State University, University of Toronto, and University of Oregon. Principal Investigator on U.S.D.A. Forest Service project for archaeological damage assessment of the *Exxon Valdez* oil spill in Alaska. Supervised drilling crew on water supply project.

- 1/82-7/86 Senior Research Geochemist: Reservoir Diagenesis Section, Exxon Production Research Company, Houston, TX.  
Experience: Investigated sandstone diagenesis by geochemical modeling, isotopic methods, mass balance calculations, and microscopy. Established a stable isotope laboratory for carbon and oxygen isotopic measurements on carbonates in rocks and calcareous microfossils that resulted in improved turnaround time and quality control of isotopic analyses. Developed model for carbonate cementation in sandstones based in part on stable isotope geochemistry and microscopy of sandstones from around the world. Made quarterly presentations to management. Taught portions of short courses. Supervised and trained a technician to operate a stable isotope laboratory.
- 6/78-1/82 Staff Geoscientist: Data Integration Group, Geology Division, Bendix Field Engineering Corporation, Grand Junction, CO.  
Experience: Interpreted over 250,000 hydrogeochemical and stream-sediment samples consisting of over 5 million analyses and reported results. Assisted in the development of mainframe computer software and standardization of statistical analysis procedures for the interpretation and display (including mapping) of geochemical exploration data to aid uranium resource assessment. Combined water-rock interaction computer models on a mainframe computer with standard interpretation techniques of geochemical data to assist uranium resource assessment. Directed three professionals and one technician in the development and use of software for interpretation of geochemical exploration data.
- 7/77-5/78 Faculty Research Associate: Arizona State University, Department of Chemistry (Geochemistry Section), Tempe, AZ.  
Experience: Designed and tested a mixing cell for performing calorimetry on geothermal brines.
- 9/71-6/77 Graduate Research Assistant: Department of Geosciences, Pennsylvania State University, University Park, PA.  
Experience: Participated in data collection of PVT properties of water at high temperatures and pressures. Conducted hydrothermal experiments and stable isotope mass spectrometry of H<sub>2</sub>O-saturated magmas. Built fluorination line for oxygen isotopic analyses of silicates. Trained other research assistants in use of fluorination line for extraction of oxygen isotopes.
- 5/71-8/71 Assistant Field Geologist: Mineral Exploration Division, Humble Oil & Refining Company, Bangor, ME.  
Experience: Conducted reconnaissance geologic mapping and geochemical and

geophysical surveys that resulted in base metal prospects for drilling.

## Education

- 1978      Ph.D. in Geochemistry and Mineralogy, The Pennsylvania State University, University Park, PA  
Dissertation: *Experimental determination of oxygen isotopic fractionation between H<sub>2</sub>O and hydrous silicate melts*: 115 p.  
Thesis advisers: Drs. H. Ohmoto and C. Wayne Burnham.
- 1974      Masters of Science in Geochemistry, The Pennsylvania State University, University Park, PA  
Dissertation: *The solubility of quartz in supercritical H<sub>2</sub>O-CO<sub>2</sub> fluids*: 52 p.  
Thesis Adviser: Dr. C. Wayne Burnham.
- 1971      Bachelors of Science in Geology (with honors), University of Michigan, Ann Arbor, MI  
Honors Adviser: Dr. William C. Kelly

## Professional Affiliations

American Association for the Advancement of Science  
American Geophysical Union  
Association of Exploration Geochemists  
Geochemical Society  
International Association of Geochemistry and Cosmochemistry

## License

Registered Geologist, State of Washington, #1466

## Recent Short Courses

Groundwater Hydrology and Pollution: by Princeton Groundwater, Inc., San Francisco, CA, Summer 2007.  
Groundwater Remediation: by Princeton Groundwater, Inc., Las Vegas, NV, Summer 2008.

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## Publications:

Nye County Nuclear Waste Repository Project Office, 2001. Independent Scientific Investigations Program Final Report, Fiscal Years 1996-2001: prepared for the U.S. Dept. of Energy.

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Morgenstein, M.E. and D.L. Shettel, Jr., 1993, Evaluation of borosilicate glass as a high-level radioactive waste form: *High Level Radioactive Waste Management*, Proc. Fourth Annual International Conference, April 26-30, 1993, Las Vegas, NV, ANS-ASCE, La Grange Park, IL, vol. 2, p. 1728-1734.

Rimstidt, J.D., W.D. Newcomb, and D.L. Shettel, Jr., 1989, A vertical thermal gradient experiment to simulate conditions in vapor dominated geothermal systems, epithermal gold deposits, and high level radioactive waste repositories in unsaturated media: Proc. 6th International Symposium on Water-Rock Interaction, Malvern, England, p.585-8.

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- Shettel, D.L., 2000. Early Warning Drilling Program (Nye Co., Nevada): Preliminary Hydrogeochemical Results: Geol. Soc. America, Abs. With Program, Annual Mtg. Reno, NV.
- O'Hara, P.F. and D.L. Shettel, 1994. Generating Proterozoic precious metals targets using groundwater chemistry and aqueous speciation models: Soc. Min. Metall. Explor., Abstracts with Programs, p.51.
- Shettel, D. L., Jr., 1981, Comparison of solution-mineral equilibria with single- and multi-element statistical techniques for uranium exploration: east-central Minnesota detailed hydrogeochemical survey: Talk presented at the *Joint USGS-DOE-BFEC Uranium Geology Symposium* at the Colorado School of Mines, Golden, Colorado, May 4-5, 1981.
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- Morgenstein, M. and D. Shettel, 1995 (draft). Petrography and Geochemical Analysis of Pottery Sherds from 15 Archaeological Sites, Southern Chuska Valley, Gallup, New Mexico: Studies for the El Paso Natural Gas North System Expansion Pipeline Project: for WCRM, Inc., Farmington, New Mexico.

- Shettel, D.L., and M.E. Morgenstein, 1995. Analyses of Samples from the Marked Boulder, Site 45SK222, Tewalt Property, Skagit County, Washington. Phase I: Scanning Electron Microscopy: A confidential technical report prepared for Miller, Nash, Wiener, Hager & Carlson (Seattle, WA), representing Citizens Committee of Skagit County and the Upper Skagit Tribe.
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- Kaufmann, R.F., and Shettel, D.L., 1994. Data Compilation and Work Plan Review: Task 1, Hydrogeology of the South Pit, Colosseum Mine, San Bernardino County, CA. Report from Terracon Consultants Western, Inc. to Colosseum, Inc. (Las Vegas).
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- Shettel, D.L., 1992 to 1995. Reports, Memos, and Technical Review Documents on vadose zone hydrogeochemistry, radionuclide retardation, and water-rock interaction at Yucca Mountain, for the Nye County [Nevada] Nuclear Waste Repository Project Office, Tonopah.
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- Morgenstein, M.E., and Shettel, D.L., 1993. Petrographic and Geochemical Analyses of Pottery Sherds and Potential Sediment Sources, Site LA78812: for Daggett and Chenault, Inc., Farmington, NM.
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- Survey of Site SBA-225, Vandenberg Air Force Base, CA: for Chambers Group, Inc., Irvine, CA.
- Parsons Engineering, Inc., 1993. Fate and Transport Modeling Transition Report: Operable Unit 5, Project Order 61, Revision A, Environmental Remedial Action Project, Fernald Environmental Management Project, Fernald, OH. [section on geochemical modeling of leachate concentrations.]
- Shettel, D.L., Jr. and O'Hara, P.F., 1992. Reevaluation of Geochemical Data from East-Central Minnesota: Report to Minnesota Dept. of Natural Resources, Minerals Division, Hibbing, 63pp., Appendices, 145 geochem. maps at 1:250,000 scale.
- Shettel, D.L., 1992. Normative salt composition and precipitate density of a waste water pond for a power plant: report to Broadbent & Associates, Inc., Boulder City, NV.
- Shettel, D.L., Jr., and Morgenstein, M.E., 1991. Preliminary Report on radionuclide releases from DWPF glass: for the Nevada Nuclear Waste Project Office (NWPO).
- Shettel, D.L., Jr., Morgenstein, M.E., and Nagy, B., 1991. *Exxon Valdez* oil spill damage assessment contamination of archeological materials, Chugach National Forest: Radiocarbon experiments and related analyses: Final Report to U.S.D.A. Forest Service, Region 10, Juneau, AK, 159p.
- Shettel, D.L., Jr., 1990. Addendum to Map Overlays [Project to Generate Seventy-Eight 1°x2° N.T.M.S. Quadrangle Single-Element Geochemical Maps of the Southeastern United States]: 89p., for a French-Canadian mining company.
- Shettel, D.L., Jr., 1990. Quality assurance of hydrogeochemical calculations performed by the FORTRAN computer program PHREEQE: for the Nevada NWPO, 269p.
- Shettel, D.L., Jr., 1990. Quality assurance of hydrogeochemical calculations performed by the FORTRAN computer program WATEQ4F: for the Nevada NWPO, 264p.
- Shettel, D.L., Jr., 1990. Quality assurance of hydrogeochemical calculations performed by the U.S.G.S.'s FORTRAN computer program BALANCE: for the Nevada NWPO, 29p.
- Morgenstein, M.E., Shettel, D.L., Jr., and Mifflin, M.D., 1989. Yucca Mountain Project: A Summary of Technical Support Activities: July 1988 to September 1989, 119p., for the Nevada NWPO.
- Mifflin & Associates, Inc., 1989. Review of: Site Characterization Plan, Yucca Mountain Site, Nevada Research and Development Area, Nevada (DOE/RW-0199, December 1988), 72p. + Appendices.
- Mifflin & Associates, Inc., 1989. Yucca Mountain Project: A Summary of Technical Support Activities : January 1987 to June 1988, 128p., for Nevada NWPO.

Morgenstein, M. E. and Shettel, D. L., Jr., 1989. Review of: Licensing Support System Prototype Thesaurus by Science Applications International Corporation, 25 January 1989, 51p.

Shettel, D.L., 1988-89. Various Detailed Technical Procedures for Vadose Zone Water Sampling and Field Geochemistry of Water Samples in the Vicinity of Yucca Mountain, for Nevada NWPO.

Mifflin & Associates, Inc., 1988. Review of: Consultation Draft of the Site Characterization Plan, Yucca Mountain Site, Nevada Research and Development Area, Nevada (DOE/RW-0160, Jan. 1988), 247p.

Mifflin & Associates, Inc., 1987. Technical Review Comments on the Environmental Assessment: Yucca Mountain Site, Nevada Research and Development Area, Nevada ( May 1986, Vols. I, II, III [DOE/RW-0073]), 187p., for Nevada NWPO

Johnson, C. L., Shettel, D. L., and Johnson R. J., 1987. Colloid Sampling in Oasis Valley and Ash Meadows, Nevada, 6p, for Nevada NWPO.

Johnson, C.L., M.D. Mifflin, and D.L. Shettel, Jr., 1986. Review and Recommendations on: Draft Generic Technical Position on Groundwater Travel Time by R. Codell, U.S.N.R.C., 30 June 1986.

### **Formal Presentations:**

Staehle, R.W., and Shettel, D.L. 2006. Environments of Corrosion: Update. U.S. Nuclear Waste Technical Review Board, Sept. 26, Las Vegas.

Shettel, D.L. 2004. State of Nevada's Perspective on Sorption: 151<sup>st</sup> Advisory Committee on Nuclear Waste, U.S. Nuclear Regulatory Commission, Rockville, MD, June 23, 2004. [regarding Yucca Mt., on behalf of the State of Nevada]

Shettel, D.L. 2004. Alternative Conceptual Models for Corrosion and the Near-Field Environment: presentation to U.S. Nuclear Waste Technical Review Board, Washington, D.C. [regarding Yucca Mt., on behalf of the State of Nevada]

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Shettel, D.L., 2000, Nye County [Nevada] Early Warning Drilling Program: Update and Geochemistry, Presentation to the U.S. Nuclear Waste Technical Review Board, in Pahrump, NV, May 1<sup>st</sup>.

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Shettel, D.L., 12/16/93, Engineered Barriers: Radionuclide Releases from Glass Waste Forms. Presentation to National Academy of Sciences / National Research Council, Commission on Geosciences, Environment, and Resources, Committee on Technical Bases for Yucca Mountain Standards, Washington, D.C.

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Shettel, D. L., Jr., R. F. D'Andrea, Jr., and R. J. Zinkl, 1980a, LLLSRT: A FORTRAN program for processing Lawrence Livermore Laboratory hydrogeochemical and stream sediment reconnaissance data: U.S. Dept. of Energy, Grand Junction, CO, GJBX-247(80), 54p.

Shettel, D. L., Jr., R. F. D'Andrea, Jr., and R. J. Zinkl, 1980b, FACEDT: A FORTRAN program to process hydrogeochemical and stream sediment reconnaissance data for multivariate statistical analysis: U.S. Dept. of Energy, Grand Junction, CO, GJBX-246(80), 42p.

**Manuscripts in Preparation:**

Shettel, D.L. Geochemical aspects of a ventilated high-level nuclear waste repository at Yucca Mountain, Nevada: to be submitted to *Environmental & Engineering Geoscience*.

Shettel, D.L. Saturated zone Hydrogeochemistry along the northern edge of the Amargosa Valley, Nye County, Nevada: to be submitted to *Applied Geochemistry*.

**Exhibit 14**  
**Dr. Eugene I. Smith's Curriculum Vitae**



**CURRICULUM VITAE  
EUGENE I. SMITH**

October 1, 2009

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Cell: (702) 232-9609

Educational Background:

<u>University</u>	<u>Degree</u>	<u>Year</u>
University of New Mexico	Ph.D.	1970
University of New Mexico	M.S.	1968
Wayne State University	B.S.	1965

Specialties: Volcanology, Igneous Petrology, Geochemistry, Tectonics, Planetary Geology

Professional Experience:

8/88 to present: Professor of Geology, UNLV

7/83-7/86: Chair, Department of Geoscience, UNLV

9/80 to 8/88: Associate Professor of Geology, UNLV

9/76-8/80: Associate Professor of Earth Science, University of Wisconsin-Parkside

9/72-9/76: Assistant Professor of Earth Science, University of Wisconsin-Parkside

- 9/70-6/72: Post-doctoral Research Associate to Professor W.E. Elston,  
Department of Geology, University of New Mexico
- 9/68-8/70: Graduate Research Assistant to Professor W.E. Elston, Department  
of Geology, University of New Mexico
- 8/68-8/80: Geologist WAE, U.S. Geological Survey, Branch of Astrogeology,  
Flagstaff, AZ
- 6/66-7/68: Geological Field Assistant WAE, U.S. Geological Survey, Branch of  
Astrogeology, Flagstaff, AZ
- 6/64-9/64: Undergraduate Research Assistant to Professor A.J. Mozola,  
Department of Geology, Wayne State University, Detroit, MI

Professional Society Memberships:

American Association for the Advancement of Science  
 American Geophysical Union  
 Geological Society of America (Fellow)  
 Geological Society of Nevada  
 IAVCEI-International Association of Volcanology and Chemistry of the Earth's Interior  
 Mineralogical Society of America  
 Phi Kappa Phi  
 Sigma Gamma Epsilon  
 Sigma Xi

Grants and Contracts: \* indicates current contracts or grants:

*Studies of Yucca Mountain Nevada*

- \*Clark County Nevada contract to study basaltic volcanism about Yucca Mountain (July 2007-July 2010)
- \*Inyo County California contract to study the geology of the Greenwater Range, Death Valley (January 2008-January 2010).
- \*Nevada Agency for Nuclear Projects contract to study basaltic volcanism about Yucca Mountain (1986-1996, 2000-2010).
- Nevada Agency for Nuclear Projects and Clark County Nuclear Waste Office-contract to study basaltic volcanism about Yucca Mountain (July 2005-July 2007).

*Bureau of Land Management Contracts*

- \*Bureau of Land Management contract to study the geology of the Sloan Canyon NCA (2005-2010).

- Bureau of Land Management contract to prepare a compilation of the geology of the Eldorado Valley, Nevada to evaluate gold in calcrete mining claims (2003).

#### *U.S. Navy Geothermal Project Office Contracts*

- U.S. Navy Geothermal Office Grant to study volcanic rocks in the Lava Mountains, (1998-1999).
- U.S. Navy Geothermal Office Grant *with Rodney Metcalf* to study volcanic rocks in the Lava Mountains, California and the Mt. Perkins Pluton, Arizona (1996-1998).

#### *Lake Mead and River Mountain Projects*

- \*Lake Mead Intake #3 project; contract with CH2M Hill (2008-2010).
- \*SCOP project; contract with Black and Veatch (2007-2010).
- State Route 710 California project; contract with CH2M Hill (2009).

#### *Previous Grants of Note*

- NSF Grant with J. Faulds and P. Gans to study the structural and geochemical development of the northern Colorado River extensional corridor (1991-1993).
- UNLV Research Council grant to support the study of Tertiary volcanic rocks in Clark County, Nevada (1983).
- NASA Grant NGR 50-009-001 for the study of volcanic fields in California, New Mexico and Wisconsin. The grant also funded the study of volcanic domes and craters on Mars, Mercury, Moon and Earth (6 years of funding)(1973-1979).
- Four University of Wisconsin research grants to support the study of Precambrian igneous rocks of south-central Wisconsin (1973-1977).

#### Awards:

- Recipient of the Harry Reid Nevada Star Award for Research (2006).
- Recipient of UNLV College of Sciences Distinguished Researcher Award (1999).
- National Defense Education Act (NDEA) Title IV Fellowship, 9/65-6/68

#### Current Research:

1. Geology of Quaternary-Pliocene basalts in the southern and central Great Basin and Colorado Plateau.
2. Volcanic hazard studies related to placing a nuclear waste repository at Yucca Mountain, Nevada.
3. Geology of basalts in the Yellowstone Plateau volcanic field, implications for the future development of the Yellowstone volcanic system.
4. Geochemical, structural and field study of the volcanic and plutonic rocks of the Lake Mead Volcanic Field.
5. The formation of intermediate composition igneous rocks in an extensional environment.

## Editorial Responsibilities

- Associate editor of the Geological Society of America Bulletin 1999-2008
- Associate editor of the Journal of Geophysical Research (Geochemistry and Volcanology)- 1996-1999

## Research Advisor for the following students:

### University of New Mexico:

- Anthony Sanchez

### University of Wisconsin-Parkside:

- James Grimes
- Bill Stupak
- Jill Hartnell
- Ray Spangers
- Cliff Brandon

### UNLV:

- **Crow, H. Clay, III**, 1984, *Geochemistry of shonkinites, syenites, and granites associated with the Sulfide Queen carbonatite body, Mountain Pass, California [MS thesis]*: Las Vegas, University of Nevada, 56 p.
- **Myers, Ingrid A.**, 1984, *Geology and mineralization at the Cyclopic mine, Mohave County, Arizona [MS thesis]*: Las Vegas, University of Nevada, 64 p.
- **Mills, James G., Jr.**, 1985, *The geology and geochemistry of volcanic and plutonic rocks in the Hoover Dam 7 1/2 minute quadrangle, Clark County, Nevada and Mohave County, Arizona [MS thesis]*: Las Vegas, University of Nevada, 119 p.
- **Timm, John J.**, 1985, *Age and significance of paleozoic sedimentary rocks in the southern River Mountains, Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 62 p.
- **Feuerbach, Daniel L.**, 1986, *Geology of the Wilson Ridge pluton : a mid-Miocene quartz monzonite intrusion in the northern Black Mountains, Mohave County, Arizona and Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 79 p.
- **Naumann, Terry R.**, 1987, *Geology of the central Boulder Canyon quadrangle, Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 68 p.
- **Schmidt, Casey S.**, 1987, *A mid-Miocene caldera in the central McCullough Mountains, Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 78 p.
- **Sewall, Angela J.**, 1988, *Structure and geochemistry of the upper plate of the Saddle Island detachment, Lake Mead, Nevada [MS thesis]*: Las Vegas, University of Nevada, 84 p.

- **Cole, Erin D.**, 1989, *Petrogenesis of late Cenozoic alkalic basalt near the eastern boundary of the Basin-And-Range: Upper Grand Wash trough, Arizona and Gold Butte, Nevada [MS thesis]*: Las Vegas, University of Nevada, 68 p.
- **Larsen, Lance L.**, 1989, *The origin of the Wilson Ridge pluton and its enclaves, northwestern Arizona: Implications for the generation of a calc-alkaline intermediate pluton in an extensional environment [MS thesis]*: Las Vegas, University of Nevada, 81 p.
- **Bridwell, Hayden L.**, 1991, *The Sloan Sag: A mid-Miocene volcanotectonic depression, north-central McCullough Mountains, southern Nevada [MS thesis]*: Las Vegas, University Of Nevada, 147 p.
- **Cascadden, Tracy E.**, 1991, *Style of volcanism and extensional tectonics in the eastern Basin and Range Province: northern Mojave Co., Arizona [MS thesis]*: Las Vegas, University Of Nevada, 156 p.
- **Morikawa, Shirley A.**, 1993, *The Geology of the Tuff of Bridge Spring: southern Nevada and northwestern Arizona [MS thesis]*: Las Vegas, University of Nevada, 165 pp.
- **Rash, Kelly B.**, 1995, *Geology and geochemistry of Tertiary volcanic rocks in the northern Reville and southern Pancake Ranges, Nye County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 171 p.
- **Sánchez, Alexander**, 1995, *Mafic volcanism in the Colorado Plateau / Basin-and-Range transition zone, Hurricane, Utah [MS thesis]*: Las Vegas, University of Nevada, 92 p.
- **Boland, Kelly A.**, 1996, *The petrogenesis of andsites produced during regional extension: Examples from the northern McCullough Range, Nevada and Xitle volcano, Mexico [MS thesis]*: Las Vegas, University of Nevada, 127 p.
- **Dickson, Loretta D.**, 1997, *Volcanology and geochemistry of Pliocene and Quaternary basalts on Citadel Mountain, Lunar Crater volcanic field, Pancake Range, Nevada [MS thesis]*: Las Vegas, University of Nevada, 146 p. (Received the UNLV Alumni Association award for the most outstanding thesis for the academic year 1997-98)
- **Downing Reina**, 2000, *Imaging the Mantle in Southwestern, Utah Using Geochemistry, and Geographic Information Systems [MS thesis]*: Las Vegas, University of Nevada, 129 p.
- **Keenan, Deborah L.**, 2000, *A study of the Lava Mountians, San Bernadino County, California [MS thesis]*: Las Vegas, University of Nevada, 81p.
- **Herrington, Juliana**, 2000, *Significance of the prevolcanic conglomerate of the Colorado River extensional corridor, Nevada and Arizona [MS thesis]*: Las Vegas, University of Nevada, 83p.
- **Sanford, Aaron L.**, 2000, *Geologic history of the McCullough Pass caldera [MS thesis]*: Las Vegas, University of Nevada, 111p.

- **Elizabeth Stickney**, 2004, *Quaternary basaltic volcanism in the northern part of the Lunar Crater volcanic field, Nevada*., 103 p.
- **Matt Faust**, 2005, *Petrogenesis and geochemistry of Pleistocene and Pliocene basalt flows of the Pine Valley Volcanic Field, Utah and their relationship to the tectonics of the Utah Transition Zone* [MS thesis]: University of Nevada), 116 p.
- **Denise Honn**, 2005, *Nested Calderas of the northern Kawich Range, central Nevada* [MS thesis]: University of Nevada), 92 p.
- **Denise Honn Ph.D.** *Linking a volcanic-plutonic system in the River Mountains and Wilson Ridge Pluton.* (work in progress).
- **Shara Leavitt**, 2006, *Volcanology and Petrogenesis of the Navajo Lake Volcanic Field, Utah* : [MS thesis]: University of Nevada, 94 p.
- **Kristeen Bennett**, 2006, *Petrogenesis of Pleistocene basalts in the Norris-Mammoth Corridor, Yellowstone National Park* : [MS thesis]: University of Nevada, 120 p.
- **Matt McKelvey**, 2007, *Geology of the southern Reveille Range, Nye County Nevada*: [M.S. thesis]: University of Nevada, 97 p.
- **Audrey Rager (Ph.D.)**, *Fragmentation of Martian regolith and the formation of pedestal craters* (work in progress).
- **Ashley Tibbetts**, *Geology of the Death Valley volcanic field* (work in progress).
- **Christi Emery**, *Volcanology of the southern Quinn Canyon Range, central Nevada* (work in progress).
- **Racheal Johnsen (Ph.D.)**, *Bimodal volcanism from the Miocene to Recent: a study of three volcanic fields* (work in progress).

*Students who left UNLV before completing their degrees*

- Jeff Nejedly
- Robert Yasek
- Tom Wickham
- Joe Blaylock
- Heather Putnam

Post-Doctoral Research Associates

- Jim Faulds (now an research scientist with the Nevada Bureau of Mines and Geology)
- Mark Martin (now a geologist at Shell Oil in Houston, Texas)
- Jim Mills (now an associate professor at DePauw University, Indiana)
- Tim Bradshaw (now a science advisor to the House of Lords, London)
- Gene Yagodzinski (now an assistant professor at the University of South Carolina)

Research Associates (*Professional Staff with M.S. degrees*)

- Dan Feuerbach
- Terry Naumann
- Alex Sánchez
- Shirley Morikowa
- Deb Keenan
- Denise Honn
- Racheal Johnsen

PUBLICATIONS:

A. Journal Articles in refereed journals, symposium volumes and maps:

1. Elston, W.E., Lambert, P.W. and Smith, E.I., 1968, Striated cones: wind abrasion features, not shatter cones: *in* Short, N.M., and French, B.M., eds., Shock Metamorphism of Natural Materials, Mono Book Corporation, Baltimore, p. 287- 290.
2. Mozola, A.J. and Smith, E.I., 1969, Glacial drift thickness map of Wayne County, Michigan: *in* Mozola, A.J., Geology for land and ground-water development in Wayne County, Michigan: Geological Survey of Michigan, Report of Investigation 3, 25 pp.
3. Elston, W.E., and Smith, E.I., 1970, Determination of flow direction of rhyolite ash-flow tuffs from fluidal textures: Geological Society of America Bulletin, v. 81, p. 3393- 3406.
4. Elston, W.E., Aldrich, M.J., Smith, E.I., and Rhodes, R.C., 1971, Non-random distribution of lunar craters: Journal of Geophysical Research, v. 76, no. 23, p. 5675- 5682.
5. Smith, E.I., 1971, Determination of the origin of small lunar and terrestrial craters by depth-diameter ratio: Journal of Geophysical Research, v. 76, no. 23, p. 5683- 5689.
6. Rhodes, R.C., and Smith, E.I., 1972, Directional fabric of ash-flow sheets in the northwest part of the Mogollon Plateau, New Mexico: Geological Society of America Bulletin, v. 83, p. 1863-1868.
7. Smith, E.I., and Rhodes, R.C., 1972, Flow direction of lava flows: Geological Society of America Bulletin, v. 83, p. 1869-1874.
8. Rhodes, R.C., and Smith, E.I., 1973, Geology and tectonic setting of the Mule Creek Caldera, New Mexico, USA: Bulletin Volcanologique, v. 36, no. 3, p. 401-411.
9. Smith, E.I., 1973, Mono Craters, California: A new interpretation of the eruptive sequence: Geological Society of America Bulletin, v. 84, p. 2685-2690.

10. Smith, E.I., 1973, Identification, distribution and significance of lunar volcanic domes: *The Moon*, v. 6, nos. 1/2, p. 3-31.
11. Smith, E.I., and Sanchez, A.G., 1973, Fresh lunar craters: morphology as a function of diameter, a possible criterion for crater origin: *Modern Geology*, v. 4, p. 51-59.
12. Elston, W.E., Damon, P.E., Coney, P.J., Rhodes, R.C., Smith, E.I., and Bickerman, M., 1973, Tertiary volcanic rocks, Mogollon Plateau, New Mexico and surrounding regions: K-Ar dates and patterns of eruption: *Geological Society of America Bulletin*, v. 84, p. 2259-2274.
13. Elston, W.E., and Smith, E.I., 1973, Mars, evidence for dynamic processes from Mariners 6 and 7: *Icarus*, v. 19, p. 180-194.
14. Smith, E.I., and Rhodes, R.C., 1974, The Squirrel Springs volcanotectonic depression, a buried cauldron in southwestern New Mexico: *Geological Society of America Bulletin*, v. 85, p. 1865-1868.
15. Smith, E.I., 1974, Rumker Hills, a lunar volcanic dome complex: *The Moon*, v. 10, no. 2, p. 175-182.
16. Smith, E.I., and Sanchez, A.G., 1975, Fresh lunar craters: morphology as a function of diameter, a possible criterion for crater origin, Reply: *Modern Geology*, v. 5, p. 175-176.
17. Smith, E.I., 1976, Comparison of the crater morphology-size relationship for Mars, Moon and Mercury: *Icarus*, v. 28, p. 543-550.
18. Rhodes, R.C., and Smith, E.I., 1976, Stratigraphy and structure of the northwestern rim of the Mogollon Plateau volcanic province, Catron County, New Mexico: *New Mexico Geological Society Special Publication No. 5*, p. 57-62.
19. Smith, E.I., 1976, Structure and morphology of the John Kerr Peak dome complex, southwestern New Mexico: *New Mexico Geological Society Special Publication No. 5*, p. 71-78.
20. Smith, E.I., Aldrich, M.J., Deal, E.G., and Rhodes, R.C., 1976, Fission track ages of Tertiary volcanic rocks, Mogollon Plateau, southwestern New Mexico: *New Mexico Geological Society Special Publication No. 5*, p. 117-118.
21. Smith, E.I., 1978, Introduction to the Precambrian rocks of south-central Wisconsin: *Geoscience Wisconsin*, v. 2, p. 1-17.
22. Smith, E.I., Paull, R.A., and Mudrey, M.G., 1978, Precambrian inliers in south-central Wisconsin: *Wisconsin Natural History and Geological Survey Field Trip Guide Book No. 2*, 89 pp.



23. Smith, E.I., 1978, Precambrian rhyolites and granites in south-central Wisconsin: field relations and geochemistry: Geological Society of America Bulletin, v. 89, p. 975- 980.
24. Smith, E.I., and Stupak, W.A., 1978, A Fortran IV program for the classification of volcanic rocks using the Irvine and Baragar classification: Computers and Geoscience, v. 4, p. 89-99.
25. Smith, E.I., and Hartnell, J.A., 1978, Crater size-shape profiles for the Moon and Mercury: The Moon and Planets, v. 19, p. 479-511.
26. Smith, E.I., Slagle, M.J., and Luzader, S., 1980, Impact cratering experiment for a course in lunar and planetary geology: Journal of Geological Education, v. 28, p. 204-209.
27. Bell, J., and Smith, E.I., 1980, Geological map of the Henderson quadrangle, Clark County, Nevada: Nevada Bureau of Mines and Geology, Map 67.
28. Parolini, J.R., Smith, E.I., and Wilbanks, J.R., 1981, Fission track dating of gravity slide blocks in the Rainbow Gardens, Clark County, Nevada: Isochron/West, no. 30, p. 9-10.
29. Smith, E.I., 1982, Geology and geochemistry of the volcanic rocks in the River Mountains, Clark County, Nevada and comparisons with volcanic rocks in nearby areas: in Frost, E.G., and Martin, D.L. eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River Region, California, Arizona and Nevada: San Diego, California, Cordilleran Publishers, p. 41-54.
30. Smith, E.I., 1984, Geochemistry and evolution of the early Proterozoic Post-Penokean rhyolites and granites, and related rocks of south-central Wisconsin: Geological Society of America Memoir 160, p. 113-128.
31. Smith, E.I., 1984, Geologic map of the Boulder City quadrangle, Nevada: Nevada Bureau of Mines and Geology, Map 81.
32. Choukroune, Pierre, and Smith, E.I., 1985, Detachment faulting and its relationship to older structural events on Saddle Island, River Mountains, Clark County, Nevada: Geology, v. 13, p. 421-424.
33. Myers, I.A., Smith, E.I., and Wyman, R.V., 1986, Control of gold mineralization at the Cyclopic Mine, Gold Basin District, Mohave County, Arizona: Economic Geology, v. 81, no. 6, p. 1553-1557.
34. Smith, E.I., 1986, Field Guide to the Geology of the eastern River Mountains and the Hoover Dam area, Clark County, Nevada: in Rowland, S.R., Field Guide to the Geology of Southern Nevada, prepared for the NAGT-FWS Meeting, Las Vegas, Oct. 3-5, 1986, p. 22-64.

35. Smith, E.I., Anderson, R.E., Bohannon, R.J. and Axen, Gary, 1987, Structure, volcanology, and sedimentology of mid-Tertiary rocks in the eastern Basin-and- Range Province, Southern Nevada: in Davis, G.H. and VandenDolder, Geologic Diversity of Arizona and its Margins: Excursions to Choice Areas: Arizona Bureau of Geology and Mineral Technology, Geological Survey Branch Special Paper 5, p. 383-397.
36. Weber, M.E., and Smith, E.I. 1987, Structural and geochemical constraints on the reassembly mid-Tertiary volcanoes in the Lake Mead area of southern Nevada: *Geology*, v. 15, p. 553-556.
37. Guth, Peter and Smith, E.I., 1987, Discussion of the paper by Ron and others, "Strike-slip faulting and block rotation in the Lake Mead Fault System", *Geology*, v. 15, p. 579-580.
38. Smith, E.I., Schmidt, C.S., and Mills, J.G., 1988, Mid-Tertiary volcanoes of the Lake Mead area of southern Nevada and Northwestern Arizona: in Weide, D.L., and Faber, M.L., This Extended Land, Geological Journeys in the southern Basin and Range, Geological Society of America, Cordilleran Section Field Trip Guidebook; UNLV Department of Geoscience, Special Publication No. 2, p. 107-122.
39. Faulds, J.E., Hillemeier, F.L., and Smith, E.I., 1988, Geometry and kinematics of a Miocene "Accommodation Zone" in the central Black and southern Eldorado Mountains, Arizona and Nevada: in Weide, D.L., and Faber, M.L., This Extended Land, Geological Journeys in the southern Basin and Range, Geological Society of America, Cordilleran Section Field Trip Guidebook; UNLV Department of Geoscience, Special Publication No. 2, p. 293-310.
40. Smith, E.I., Feuerbach, D.L., Naumann, T.R. and Faulds, J.E., 1990, The area of most recent volcanism about Yucca Mountain, Nevada: Implications for volcanic risk assessment: in Proceedings of the International Nuclear Waste Symposium, v. 1, American Nuclear Society and American Society of Civil Engineers, p. 90-97.
41. Smith, E.I., Feuerbach, D.L., Naumann, T.R. and Mills, J.E., 1990, Geochemistry and evolution of mid-Tertiary igneous rocks in the Lake Mead area of Nevada and Arizona: in Anderson, J.L., Cordilleran Magmatism: Geological Society of America Memoir 176, p. 169-194.
42. Larsen, L.L. and Smith, E.I., 1990, Mafic enclaves in the Wilson Ridge Pluton, northwestern Arizona: Implications for the generation of a calc-alkaline intermediate pluton in an extensional environment: *Journal of Geophysical Research*, v. 95, p. 17693-17716.
43. Duebendorfer, E.M., Sewall, A.J., and Smith, E.I. 1991, The Saddle Island Detachment fault, an evolving shear zone in the Lake Mead area of southern Nevada: in Wernicke, B., Mid-Tertiary extension at the latitude of Las Vegas: Geological Society of America Memoir 176, p. 77-97.

44. Duebendorfer, E.M. and Smith, E.I., 1991, Tertiary structure, magmatism and sedimentation in the Lake Mead region, southern Nevada, in Seedorf, E., ed., Tertiary geology and volcanic-hosted gold deposits of the southern Great Basin: Geological Society of Nevada Special Publication 13, p. 66-95.
45. Naumann, T.R., Smith, E.I., Shafiquallah, M., and Damon, P.E., 1991, New K-Ar ages for mafic to intermediate volcanic rocks in the Reville Range, Nevada: Isochron West, p. 12-16.
46. Feuerbach, D.L., Smith, E.I., Shafiquallah, M., and Damon, P.E., 1991, New K-Ar dates for mafic late-Miocene to Pliocene volcanic rocks in the Lake Mead area, Arizona and Nevada: Isochron West, p. 17-20.
47. Ho, Chih-Hsiang, Smith, E.I., Feuerbach, D.L. and Naumann, T.R., 1991, Eruptive probability calculation for the Yucca Mountain site, USA: statistical estimation of recurrence rates: Bulletin of Volcanology, v. 53.
48. Metcalf, R.V., Smith, E.I., and Mills, J.G., 1993, Magma mixing and commingling in the northern Colorado River extensional corridor: constraints on the production of intermediate magmas: *in* Lahren, M.M., Trexler, J.H., and Spinoso, C., eds., Crustal evolution of the Great Basin and Sierra Nevada: Cordilleran/Rocky Mountain Section, Geological Society of America Guidebook, Department of Geological Sciences, University of Nevada, Reno, p. 35-56.
49. Smith, E.I., , 1993, 1.76 b.y. old granites and rhyolites in the conterminous United States: *in* Reed, J.C., Bickford, M.E., Houston, R.S., Link, P.K., Rankin, D.W., Sims, P.K., and Van Schmus, W.R., Precambrian: Conterminous U.S., Geological Society of America, Decade of North America Geology (DNAG), v. C-2, p. 64-66.
50. Feuerbach, D.L., Smith, E.I., Walker, J.D. and Tangeman, J.A., 1993, The role of the mantle during crustal extension: constraints from geochemistry of volcanic rocks in the Lake Mead area, Nevada and Arizona: Geological Society of America Bulletin, v 105, p. 1561-1575.
51. Rowell, A.J., Rees, M.N., Duebendorfer, E.M., Wallin, E.T., Van Schmus, W.R., and Smith, E.I., 1993, An active Neoproterozoic margin: evidence from the Skelton Glacier area, Transantarctic Mountains: Journal of the Geological Society, London, v. 150, p. 677-682.
52. Duebendorfer, E.M., Smith, E.I., and Faulds, J.E., 1994, Geologic setting of the area between Lake Mead Nevada, and Needles, California in Sherrod, D. and Nielson, J., eds., Tertiary stratigraphy of highly extended terranes: U.S. Geological Survey Bulletin 2053, p. 1-5.

53. Wallin, E.T., Duebendorfer, E.M. and Smith, E.I., 1994, Tertiary stratigraphy of the Lake Mead region in Sherrod, D. and Nielson, J., eds., Tertiary stratigraphy of highly extended terranes: U.S. Geological Survey Bulletin 2053, p. 33-35.
54. Bradshaw, T.K., and Smith, E.I., 1994, Polygenetic Quaternary volcanism in Crater Flat, Nevada: Journal of Volcanology and Geothermal Research, v. 63, p. 165-182
55. Purkey, B.W., Duebendorfer, E.M., Smith, E.I., Price, J.G., and Castor, S.B., 1994, Geologic tours in the Las Vegas area: Nevada Bureau of Mines and Geology, Special Publication 16, 156 pp.
56. Metcalf, R.V. and Smith, E.I., 1995, Introduction to special section: Magmatism and Extension: Journal of Geophysical Research, v. 100, no. B7, p. 10,249-10,253.
57. Metcalf, R.V., Smith, E.I., Walker, J.D., Reed, R.C., and Gonzalas, D.A., 1995, Isotopic disequilibrium among commingled hybrid magmas: evidence for a two-stage magma mixing-commingling process in the Mt. Perkins Pluton, Arizona: Journal of Geology, v. 103, p. 509-527.
58. Yogodzinski, G.M., Naumann, T.R., Smith, E.I., Bradshaw, T.K. and Walker, J.D., 1996, Crustal assimilation by alkalic basalt, and the evolution of a mafic volcanic field in the central Great Basin, south-central Nevada: Journal of Geophysical Research, v. 101, p. 17,425-17,445.
59. Ho, C.-H. and Smith, E.I., 1997, Volcanic hazard assessment incorporating expert knowledge: application to the Yucca Mountain Region, Nevada, U.S.A.: Journal Mathematical Geology, v. 29, no. 5, p. 615-627.
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2. Eggleton, R.E., and Smith, E.I., 1967, Geologic map of the Rumker Quadrangle of the Moon: U.S. Geological Survey Open File Report.

Plus over 300 reports to the Nevada Nuclear Project Office, U.S. Navy's Geothermal Project Office and the Bureau of Land Managment.

**Exhibit 15A**  
**Dr. Michael C. Thorne's Curriculum Vitae**

# **MIKE THORNE AND ASSOCIATES LIMITED**

## **(DIRECTOR: DR M C THORNE)**

Abbotsleigh, Kebroyd Mount, Sowerby Bridge, Halifax, West Yorkshire, HX6 3JA  
Telephone: 01422 825890; Fax: 01422 500169; e-mail: [MikeThorneLtd@aol.com](mailto:MikeThorneLtd@aol.com)

## **MICHAEL CHARLES THORNE**

Qualifications: PhD FSRP FInstP CRadP    Year of birth: 1950    Nationality: British

### **PROFESSIONAL ACTIVITIES AND MEMBERSHIP**

Visiting Fellow at the Climatic Research Unit, School of Environmental Sciences, University of East Anglia

Fellow of the Society for Radiological Protection and a Past President of the Society

Member of the Editorial Board of the Journal of Radiological Protection

Member of the National Dose Assessment Working Group (NDAWG) and Chairman of the Habits Subgroup

Member of the Eco-ethics International Union

Consultant to the Institute for Energy and Environmental Research, Washington DC.

Quintessa Associate

Director, Mike Thorne and Associates Limited



### **ACADEMIC RESPONSIBILITIES**

Formal supervision of two PhD students at the University of East Anglia:

P Burgess, Future Climatic and Cryospheric Change on Millennial Timescales: An Assessment using Two-dimensional Climate Modelling Studies, PhD awarded 1998.

M Hoar, Reconstructing Climate Gradients across Europe for the Last Glacial-interglacial Cycle, PhD awarded 2004.

Informal supervision of PhD students at the University of Edinburgh (development and retreat of ice sheets) and at Imperial College of Science, Technology and Medicine (radionuclide transport in vegetated soil columns – experimental studies and modelling interpretations).

Teaching on the MSc course on Environmental Radioactivity at the University of Surrey.

Teaching on the MSc course in Environmental Technology at Imperial College of Science, Technology and Medicine.

Supervision of Post-doctoral research activities at the Universities of East Anglia; University of Newcastle and Imperial College of Science, Technology and Medicine on behalf of various commercial clients.

## **CAREER HISTORY (Selection of Projects)**

### **Mike Thorne and Associates Limited, 2001 onward**

#### ***Development of Climate and Landscape Change Scenarios, Biosphere Factors and Characteristics of Potentially Exposed Groups for the LLWR near Drigg, West Cumbria***

***Client - Nexia Solutions Ltd***

Project building on previous work for BNFL relating to the LLWR and for the NDA relating to vulnerabilities of various sites.

#### ***Radiological Impact of NORM Discharges to the Marine Environment***

***Client - Scotoil Services Ltd***

Support to an appeal against a SEPA decision to curtail such discharges from North Pier, Aberdeen. Including appearance as a witness at the Public Inquiry into this issue.

#### ***Development of Proposals for Setting Radiation Protection Standards based on Consideration of More Sensitive Individuals in a Population***

***Client – Institute for Energy and Environmental Research, Washington DC***

Overall project review and development of techniques for calculating radiation doses to the early embryo from internally incorporated radionuclides.

#### ***Review of Impacts of Coastal Erosion at Hunterston***

***Client – ERM Limited***

Evaluation of the potential radiological implications of coastal erosion on the VLLW pits at Hunterston Nuclear Power Station. Similar work on coastal erosion has also been undertaken at Dounreay.

#### ***Advice on Dose Reconstruction***

***Client – S A Cohen & Associates for NIOSH***

Advice on dose reconstructions for workers at DOE facilities from 1941 onward.

#### ***Advice on Effects of Radionuclides on Organisms other than Man***

***Client – Nuclear Safety Solutions Limited, Canada***

Provision of guidance on dosimetry, reference levels and effects relevant to selected protected species.

#### ***Participation in Safety Assessment Studies for the Baita Bihor Repository, Romania***

***Client – Quintessa/for the European Union***

Compilation of inventory data, shielding studies and development of both operational and post-closure safety cases.

***Review of the Yucca Mountain Project***

***Client – State of Nevada***

Co-ordination of technical activities involved in a review of the proposed License Application by US DOE for disposal of radioactive wastes at Yucca Mountain.

***Co-ordination of biosphere research and participation in BIOCLIM and BIOPROTA***

***Client – UK Nirex Ltd (NDA/RWMD)***

Co-ordination of research on climate change, ice-sheet development, near-surface hydrology and radionuclide transport, as well as participation in an international programme on the implications of climate change for radioactive waste disposal. Also includes development of new models for radionuclide transport in the biosphere and for the gas pathway.

***Development of a Handbook on Radionuclide Behaviour in the Environment***

***Client – Serco Assurance***

Development of a handbook for Environment Agency staff outlining the behaviour of a wide variety of radionuclides in terrestrial and aquatic environments.

***Development of a Simplified Dose Assessment Model***

***Client – Serco Assurance***

Development of a simplified spreadsheet-based dose assessment tool for use by Environment Agency staff in determining Authorisations.

***Provision of Biosphere Advice***

***Client – Ciemat, Spain***

Provision of advice on models and data relevant to geological disposal of radioactive wastes.

***Provision of Advice on Safety***

***Client – NNC Ltd/Defra***

Provision of expert advice to the UK Committee on Radioactive Waste Management (CoRWM).

***Effects of Radiation on Organisms Other Than Man***

***Client – AEA Technology/Serco Assurance***

Study for ANDRA to identify appropriate indicator organisms and develop appropriate dosimetry and effects models for those organisms.

***Member of the Site Investigation Expert Review Group (SIERG)***

***Client – SKB***

Oversight reviews of site investigation activities and the associated research and assessment programmes.

***Advice on the Short-, Medium- and Long-term Effects of Climate Change on Nuclear Licensed Sites***

***Client – BNFL and Nexia Solutions Ltd***

Interpretation of results from the international BIOCLIM project in relation to decommissioning and solid radioactive waste management, with particular emphasis on the potential significance of sea-level changes. Review of information on coastal vulnerabilities at NDA sites.

***Advice on Submarine Reactor Accidents and the Development of Detailed Emergency Planning Zones***

***Client – Electrowatt-Ekono***

Assistance to MoD in revising emergency planning criteria in the light of recent changes of views on Emergency Reference Levels and other technical developments. Also studies on tritium analyses and migration from transfer tanks.

***Review of Continuing Operational Safety Cases***

***Client – Electrowatt-Ekono***

Review of COSRs developed by BNFL for contaminated land.

***Development of a New Soil-Plant Model for use in Radiological Assessments***

***Client – Food Standards Agency/Quintessa***

Development of the specification for a new soil-plant model (PRISM) to replace that implemented in the SPADE suite of codes (implementation of the model has been by Quintessa) and extension of that work to new models for  $^3\text{H}$  and  $^{14}\text{C}$ .

***Review of Probabilistic Safety Assessment and Criticality Issues relating to a Proposed Surface Storage Facility for Spent Nuclear Fuel***

***Client – State of Utah***

Review of the potential for criticality in breached storage casks and of the probability of breaching by aircraft impacts. Also, supervision of various criticality and radiation shielding calculations.

***Development of Models for Radionuclide Transfers to Sewage Sludge and for Evaluating the Radiological Impact of Sludge applied to Agricultural Land***

***Client – Food Standards Agency***

Includes a review of literature and the development and implementation of probabilistic models for such transfers.

***Development of Biokinetic Models for Radionuclides in Animals***

***Client – Serco Assurance***

Development of updated biokinetic models for use by the Food Standards Agency in their SPADE and PRISM modelling systems.

***Review Studies for the Proposed Australian National Radioactive Waste Repository***

***Client – RWE NUKEM***

Reviews of reports on animal transfer factors and of the potential effects of climate change on the repository plus development of a model for the biokinetics of the  $^{226}\text{Ra}$  decay chain in grazing animals.

***Development and Application of a Model for Assessing the Radiological Impacts of  $^3\text{H}$  and  $^{14}\text{C}$  in Sewage Sludge***

***Client – NNC Ltd***

Development of a model based on physical, chemical and biochemical principles for the uptake of  $^3\text{H}$  and  $^{14}\text{C}$  into sewage sludge and their subsequent distribution and transport after application of the sludge to agricultural land.

***Support for development of the Drigg Post-closure Radiological Safety Assessment***

***Client - BNFL***

Support in the areas of FEP analysis, biosphere characterisation, human intrusion assessment and the effects of natural disruptive events. In addition, provision of advice of future research initiatives that should be pursued by BNFL.

***Review of Parameter Values***

***Client – AEA Technology/Serco Assurance***

Review of biosphere parameter values for use in the ANDRA assessment model AQUABIOS.

***Development of a Database related to Emergency Planning***

***Client – AEA Technology (Rail)***

Identification of relevant international, overseas and national legislation, regulations and guidance, and production of brief summaries of the documents.

***Dose Reconstruction for Workers on a Uranium Plant***

***Client - McMurtry and Talbot***

Dose reconstruction for the plaintiffs in a case relating to the Paducah Gaseous Diffusion Plant.



***Dose Reconstruction for a Worker Exposed to Pu and Am***  
***Client – Pattinson and Brewer***

Dose reconstruction for a worker exposed by a puncture wound in the finger while working at a glove box.

***AEA Technology, 1998-2001***

***Revision of Exemption Orders Made Under the Radioactive Substances Act***  
***Client – DETR***

Review of requirements for revision and preparation of a draft text for the purposes of consultation.

***Assessment of Remediation Options for Uranium Liabilities in Eastern Europe***  
***Client - European Commission***

Studies of remediation requirements relating to mines, waste heaps and hydrometallurgical plant in Bulgaria, Slovakia and Albania.

***Evaluation of Unusual Pathways for Radionuclide Transport from Nuclear Installations***  
***Client – Environment Agency***

Review of literature and conduct of formal elicitation meetings to determine potential pathways and evaluate their radiological significance.

***Support Studies on the Drigg Post-closure Performance Assessment***  
***Client - BNFL***

Support in the areas of FEP analysis, biosphere characterisation, human intrusion assessment and the effects of natural disruptive events. In addition, provision of advice of future research initiatives that should be pursued by BNFL.

***Development of Models for the Biokinetics of H-3, C-14 and S-35 in Farm Animals***  
***Client - FSA***

Review of relevant literature, development of appropriate biokinetic models and implementation in stand-alone software.

***Integration of Aerial and Ground-based Monitoring in the Event of a Nuclear Accident***  
***Client - FSA***

Desk-based review and simulation study designed to determine optimum monitoring strategies for different types of accidents.

***Elicitation of Parameter Values for use in Radiological Impact Assessment Models***

***Client - FSA***

Expert elicitation study to provide distributions of parameter values for use in the suite of assessment models currently used by the FSA for routine and accidental releases.

***Biosphere Research Co-ordination and Assessment Studies***

***Client - United Kingdom Nirex Ltd***

Continuation of a programme of work originally undertaken at Electrowatt Engineering (UK) Ltd

***Site Investigation and Risk Assessment - Hilsea Lines***

***Client - Portsmouth City Council***

Radiological assessment of a radium-contaminated site.

***Electrowatt Engineering (UK) Ltd, 1987-1998***

***Development of a Siting Policy for Nuclear Installations: Harbinger Project and Follow-up Study***

***Client - HSE/NSD***

Review of existing policy and development of alternatives as a precursor to application to a wide range of installations, not restricted to commercial reactors.

***Support to the Rock Characterisation Facility Public Enquiry***

***Client - UK Nirex Ltd***

Preparation of position papers and rebuttals of evidence.

***Rongelap Resettlement Project***

***Client - Marshall Islands Government***

Participation in an oversight committee evaluating the radiological safety of Rongelap in the context of resettlement by its evacuated community.

***Evaluation of Inhalation Doses from Uranium***

***Client - Baron & Budd***

Provision of expert witness support in a class action relating to environmental exposure from a uranium plant.

***Biosphere Studies Relating to Drigg***

***Client - BNFL***

Provision of advice on time-dependent biosphere modelling for the Drigg low-level radioactive waste disposal facility.

***Radiation Doses to an Individual as a Consequence of Working on the San Onofre Nuclear Power Plant***

***Client - Howarth & Smith***

Interpretation of personal and area monitoring data for legal purposes.

***Interpretation of Uranium in Urine Data for the Fernald, Ohio Feed Materials Processing Center***

***Client - Institute for Energy and Environmental Research***

Interpretation of urinalysis and lung counting data, and appearance as an expert witness in the associated trial.

***Determination of Failure Probabilities for use in PRA***

***Client - Nuclear Installations Inspectorate***

Development of new approaches to the use of Bayes Theorem in defining component failure probabilities for use in PRA when statistics on actual failures are limited.

***Review of Inventory Information***

***Client - UK Nirex Ltd***

Review of uncertainties in inventories of individual radionuclides.

***ALARP Study of Options for the Treatment, Packaging, Transport and Disposal of Plutonium Contaminated Material***

***Client - UK Nirex Ltd***

Use of multi-attribute utility analysis to establish which option is preferred.

***Expert Judgement Estimation of Intrusion Model Parameters***

***Client - British Nuclear Fuels plc***

Project Manager of a study assessing the risks of human intrusion into Drigg radioactive disposal site using expert judgement techniques.

***Brainstorming Study of Risks Associated with Building Structures***

***Client - Building Research Establishment***

Participation in a classification study of the health risks associated with buildings including both injuries and disease.

***Radiological Consequences of Deferred Decommissioning of Hunterston A***

***Client - Scottish Nuclear Ltd***

Project Manager of a study of the radiological impacts of groundwater transport of radionuclides, releases to atmosphere and intrusion.

***Reviews of Safety Documentation***

***Client - UK Nirex Ltd***

Review of safety related documentation for Packaging and Transport Branch.

***The Sheltering Effectiveness of Buildings in Hong Kong***

***Client - Ove Arup & Partners***

Project Manager of a study evaluating the shielding effectiveness of all types of building in Hong Kong for volume sources of photons in air and surface deposition sources.

***Assessment of the Radiological Impact of Releases of Radionuclides from Premises other than Licensed Nuclear Sites***

***Client - Ministry of Agriculture, Fisheries and Food***

Project Manager of a study to identify representative premises, obtain data on their releases of radionuclides and assess radiological impacts using a new methodology developed for the project.

***Assessment of the Radiological Implications of Uranium and its Radioactive Daughters in Foodstuffs***

***Client - Ministry of Agriculture, Fisheries and Food***

Project Manager of a review study of concentrations of uranium and its daughters in foodstuffs, taking local and regional variations in uranium concentrations in soils, sediments and waters into account.

***Radionuclides in Sewage***

***Client - Her Majesty's Inspectorate of Pollution***

Project Manager of a study including a desk review on alternative methods of disposal of sewage sludges, interpretation of monitoring data relating to radionuclide discharges from Amersham International to the public sewer system, development of a model for radionuclide transport in sewers, and collection and analysis of effluent, foul water, sediment, sludge and other samples suitable for use in model validation studies.

***Accident Consequence Calculations***

***Client - Nuclear Installations Inspectorate***

Project Manager of a study to assess the radiological consequences of various atmospheric releases using the MARC code.

***Definition of Threshold Recording Levels for Drums of ILW***

***Client - UK Nirex Ltd***

Project Manager of a study of the implications of post-closure radiological impacts of radioactive waste disposal in defining Threshold Recording Levels for radionuclides in individual waste drums.

***Definition of Expert Judgment Exercises Relating to Nuclear Safety***

***Client - Commission of the European Communities***

Project Manager for a study defining expert judgment exercises relating to conceptualisation, representation and input data specification. Included a comprehensive review of available formal expert judgment procedures, and mathematical and behavioural aggregation techniques.

***Definition of Research Requirements Relating to the Use of Expert Judgment in Parameter Value Elicitation for Reactor Safety Studies in a UK Context***

***Client - Nuclear Safety Research Management Unit, HSE***

Development of proposals for using combined behavioural and mathematical aggregation procedures in formal elicitations of expert judgment.

***Development Priorities for the Drigg Technical Development Programme***

***Client - British Nuclear Fuels plc***

Provision of detailed advice to BNFL on future design options, and research and development priorities, in relation to radioactive waste disposal at Drigg.

***Channel Tunnel Safety Studies***

***Client - Channel Tunnel Safety Authority***

Provision of advice and guidance on safety criteria appropriate to the Fixed Link, on the classes of Dangerous Goods that may properly be carried and on the overall characteristics of the proposed Safety Case.

***Development of Societal Risk Criteria***

***Client - Marathon Oil***

Interpretation of F-N curves in the context of the offshore oil/gas industry, taking risk aversion into account.

***Impacts of Salt Dispersal on Plant Communities***

***Client - Sir William Halcrow***

Evaluation of salt dispersal from a major road in winter in relation to adjacent Sites of Special Scientific Interest.

***Offsite Consequence Assessments***

***Client - Nuclear Electric***

Studies of the offsite radiological impacts of atmospheric and liquid releases of radioactive materials from Magnox stations.

***Dry Run 3***

***Client - Her Majesty's Inspectorate of Pollution***

Uncertainty and bias studies involving formal expert judgment procedures to develop a conceptual model of those factors and interrelationships which are of significance in determining the post-closure radiological impact of a deep geological repository for radioactive wastes. This project also included advice on data and models to be used for post-closure radiological assessments.

***Radiological Assessments of Drigg***

***Client - British Nuclear Fuels plc***

Project Manager for post-closure radiological impact assessments of the Drigg LLW disposal site. Also included specification and development of computer codes relating to the radiological impact of fires, releases of radioactive gases produced by microbial action and metal corrosion, and human intrusion.

***Biosphere Co-ordination***

***Client - UK Nirex Ltd***

Co-ordination of the UK Nirex Ltd Biosphere Research Programme from its inception, including requirements definition, technical management of all projects and QA surveillance as the Client's Representative.

***Biosphere Support for the Nirex Disposal Safety Assessment Team***

***Client - AEA Technology***

Development of approaches for assessing the radiological impact of releases of radionuclides to the biosphere, plus advice on radiological protection criteria, definition of individual risk, implications of conventionally toxic chemicals in wastes and a variety of other matters.

***Evaluation and Radiological Assessment of Liquid Effluent Releases from Various Premises***

***Client - Her Majesty's Inspectorate of Pollution***

Reviews of monitoring data and evaluations of radiological impact, primarily related to Harwell, Aldermaston, Capenhurst and Amersham International.

***Evaluation of the Radiological Impact of Overseas Nuclear Accidents***

***Client - Her Majesty's Inspectorate of Pollution***

Studies of the impact of potential overseas nuclear accidents on the UK, with emphasis on survey and monitoring requirements, and the selection of appropriate radiation detection equipment for monitoring.

***Bilsthorpe Power Station***

***Client - British Coal/East Midlands Electricity***

Preparation of an Environmental Statement with emphasis on atmospheric dispersion of SO<sub>2</sub> and NO<sub>x</sub>.

***Gas Generation in Radioactive Waste Disposal Facilities***

***Client - AEA Technology***

Development of a coupled microbial degradation and corrosion model for gas generation in repositories for LLW and ILW.

***Effects of Chernobyl on Drinking Water Supplies***

***Client - Her Majesty's Inspectorate of Pollution***

Evaluation of the radiological implications of enhanced concentrations of radionuclides in water supplies in England and Wales subsequent to the Chernobyl accident.

***Sea Disposal of Radioactive Wastes***

***Client - UK Nirex Ltd***

Participation in an Environmental Impact Assessment of the proposed resumption of sea-dumping of radioactive wastes.

***UK Research Related to Radioactive Waste Management***

***Client - Her Majesty's Inspectorate of Pollution***

Identification of gaps in the UK national research effort related to radioactive waste management.

***Research Requirements for Repository Design and Site Investigations***

***Client - UK Nirex Ltd***

Review of research requirements for repository design and site investigations in relation to LLW and ILW disposal in near-surface and deep repositories.

***International Commission on Radiological Protection, Sutton, Surrey, England, 1985-1986***

Scientific Secretary responsible for arranging and minuting meetings, administrative arrangements, technical review of reports, editing of the Commission's journal, liaison with other international organisations and public relations.

***ANS Consultants Ltd, Epsom, Surrey, England, 1979-1985***

Reviews of data on the distribution at transport of radionuclides in terrestrial and aquatic ecosystems (see publications list).

Development of a dynamic model for radionuclide transport in agricultural ecosystems and implementation of the model on various microcomputer systems.

Photon and neutron shielding studies of radiochemical plant, together with area classification and ALARA studies.

A review of UK use of the criticality code MONK and other approaches to criticality safety assessment.

Radiological and conventional safety aspects of Magnox reactor decommissioning.

Development of metabolic models for inclusion in ICRP Publication 30.

Development of pharmacodynamic models for toxic chemicals.

Review of neutron activation analysis in studies of radionuclide transport in soils and plants.

Experimental studies on radionuclide transport in soils and plants using various photon-emitting radionuclides.

Support for DoE work on probabilistic risk assessment of LLW and ILW disposal.

Review of UK research requirements for HLW disposal.

Post-closure radiological impact assessment of the proposed LLW and ILW facility at Elstow, Bedfordshire.

Development of a generalised biosphere model for use in probabilistic risk assessments of solid radioactive waste disposal.

Initial development of a mathematical model for use in assessing the radiological impact of contaminated groundwater.

Development, computer implementation and comprehensive documentation of a model to calculate the radiological impact of intrusion into radioactive waste repositories.

Development of a general-purpose computer code for solving first-order differential equations using a hybrid Predictor-Corrector/Runge-Kutta method.

Studies on the potential radiological consequences of Magnox reactor accidents.

#### **Medical Research Council Radiobiology Unit, Chilton, Didcot, Oxon, England, 1974-1979**

Development of dosimetric and metabolic models for use in ICRP Publication 30.

Studies on the metabolism of plutonium in bone and relationships to blood flow.

Theoretical studies on radionuclide metabolism and dosimetry.

Development of techniques in neutron-induced autoradiography and alpha imaging.

Image analysis studies of plutonium in bone, uranium in lungs, lysosomal inclusions in cells and heterochromatin.



Studies on the clearance of inhaled  $\text{UO}_2$ .

Alpha spectroscopy in support of toxicity studies with Ra-224.

Data analysis in connection with experimental animal studies on the potential efficacy of neutron therapy using 42 MeV neutrons.

### **University of Sheffield, 1971-1974**

Experimental studies on the reaction  $\gamma + p \rightarrow \pi^0 + p$  at photon energies between 1 and 3 GeV, using a linearly polarised photon beam.

### **SELECTION OF PUBLICATIONS**

A measurement of the beam asymmetry parameter for neutral pion photoproduction in the energy range 1.2 - 2.8 GeV. P.J. Bussey, C. Raine, J.G. Rutherglen, P.S.L. Booth, L. Carroll, G.R. Court, A.W. Edwards, R. Gamet, C.J. Hardwick, P.J. Hayman, J.R. Holt, J.N. Jackson, J. Norem, W.H. Range, F.H. Combley, W. Galbraith, V.H. Rajaratnam, C. Sutton and M.C. Thorne. London Conference (1974) Abstract 997.

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The polarised beam asymmetry in photoproduction of eta mesons from protons 2.5 GeV and 3.0 GeV. P.J. Bussey, C. Raine, J.G. Rutherglen, P.S.L. Booth, L.J. Carroll, P.R. Daniel, A.W. Edwards, C.J. Hardwick, J.R. Holt, J.N. Jackson, J. Norem, W.H. Range, W. Galbraith, V.H. Rajaratnam, C. Sutton, M.C. Thorne and P. Waller. Physics Letters, 61B, (1976) 479-482.

Aspects of the dosimetry of plutonium in bone. M.C. Thorne. Nature, 259, (1976) 539-541.

The toxicity of Sr-90, Ra-226 and Pu-239. M.C. Thorne and J. Vennart. Nature 263, (1976) 555-558.

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The distribution and clearance of inhaled uranium dioxide particles in the repository tract of the rat. Donna J. Gore and M.C. Thorne. In "Inhaled particles IV", Ed. W.H. Walton, (Pergamon Press, Oxford, 1977) pp. 275-284.

Theoretical aspects of the distribution and retention of radionuclides in biological systems. M.C. Thorne. J. Theor. Biol., 65, (1977) 743-754.

Aspects of the dosimetry of emitting radionuclides in bone with particular emphasis on Ra-226 and Pu-239. M.C. Thorne. *Phys. Med. Biol.*, 22, (1977) 36-46.

A new method for the accurate localisation of Pu-239 in bone. D. Green, G. Howells and M.C. Thorne. *Phys. Med. Biol.*, 22, (1977) 284-297.

The measurement of blood flow in mouse femur and its correlation with Pu-239 deposition. E.R. Humphreys, G. Fisher and M.C. Thorne. *Calcif. Tiss. Res.*, 23, (1977) 141-145.

The distribution of plutonium-239 in the skeleton of the mouse. D. Green, G.R. Howells, M.C. Thorne and J. Vennart. In "Proceedings of the IVth International Congress of the International Radiation Protection Association Vol. 2 (Paris 1977).

The visualisation of fissionable radionuclides in rat lung using neutron induced autoradiography. D.J. Gore, M.C. Thorne and R.H. Watts. *Phys. Med. Biol.*, 23 (1978) 149-153.

Lymphoid tumours and leukaemia induced in mice by bone-seeking radionuclides. J.F. Loutit and T.E.F. Carr with an appendix by M.C. Thorne. *Int. J. Radiat. Biol.*, 33, (1978) 245-263.

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Treatment of Chemotoxic Species (2) Review of Additive and Synergistic Effects, M C Thorne and J Wilson, Quintessa Report to NDA RWMD QRS-1378M-2, Version 1.1, April 2009.

**Exhibit 15B**

**Dr. Michael C. Thorne's Testimonies in the Last Four Years**

## **MIKE THORNE AND ASSOCIATES LIMITED**

(Director: Dr M C Thorne; Company No. 4155738; Registered in England and Wales)

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Prior testimony over the last four years has been in relation to the following studies.

- 1) Probabilistic Safety Assessment and Criticality Issues relating to a Proposed Surface Storage Facility for Spent Nuclear Fuel (Client – State of Utah)

This comprised a review of the potential for criticality in breached storage casks and of the probability of breaching by aircraft impacts. It also involved supervision of various criticality and radiation shielding calculations.

Testimony was given before the Nuclear Regulatory Commission in 2005. I provide the Record of Decision relating to Docket No. 72-22-ISFSI. This should give you all the information required to trace this hearing.

- 2) Radiological Impact of NORM Discharges to the Marine Environment (Client - Scotoil Services Ltd)

This comprised support to an appeal against a SEPA decision to curtail such discharges from North Pier, Aberdeen. It included appearance as a witness at the Public Inquiry into this issue. This was held before the Recorder in Aberdeen, Scotland in March/April 2008. The full title is: RADIOACTIVE SUBSTANCES ACT 1993: PUBLIC LOCAL INQUIRY: APPEAL BY SCOTOIL SERVICES LIMITED IN RESPECT OF CONDITIONS IMPOSED IN A VARIATION OF AUTHORISATION TO DISPOSE OF AND ACCUMULATE RADIOACTIVE WASTE IN PREMISES AT DAVIDSON HOUSE, MILLER STREET, ABERDEEN. The QC for the plaintiffs was Roy L Martin and the solicitors for the plaintiffs were Paull and Williamsons, Aberdeen.

- 3) Evaluation of the relevance of uranium exposures to the causation of cancer. Deposition held on July 10, 2008 in Las Vegas, Nevada, Relevant Case: The United States District Court for the Western District of Pennsylvania: Donald F Hall and Mary Ann Hall et al. (Plaintiffs) v. Babcock & Wilcox Company et al. (Defendants) (Civil Action No. 94-951) and Mark Allen Clowes (Plaintiff) v. Babcock & Wilcox Company et al. (Defendants) (Civil Action No. 94-2088).

**Exhibit 16A**  
**Dr. Howard S. Wheater's Curriculum Vitae**

# Curriculum Vitae

## PROFESSOR H.S. WHEATER

<b>Name:</b>	Howard Simon Wheeler		
<b>Date of Birth:</b>	24.6.49		
<b>Nationality:</b>	British		
<b>Present Appointment:</b>	Professor of Hydrology, Department of Civil & Environmental Engineering, Imperial College, University of London Director, Imperial College Environment Forum		
<b>Degrees:</b>	B.A. (1st Class Honours) Engineering Science		
	University of Cambridge		1971
	M.A. University of Cambridge		1974
	Ph.D. University of Bristol		1977
<b>Awards:</b>	Rolls-Royce Industrial Scholarship		1968
	Entrance Exhibition, Queens' College, Cambridge		1968
	Senior Scholarship, Queens' College, Cambridge		1971
	Institution of Civil Engineers Overseas Premium		1984
	British Hydrological Society President's Prize		1996
	Institution of Civil Engineers Baker Medal		2004
	Prince Sultan bin Abdulaziz International Water Prize		2006
<b>Membership of Professional Bodies and Learned Societies:</b>			
	Fellow, Royal Academy of Engineering (FREng)		2003
	Life Member, International Water Academy (Oslo)		1999
	Fellow, Institution of Civil Engineers (C.Eng, FICE)		1999
	(Member 1978)		
	Member, British Hydrological Society		1983
	Fellow, Royal Meteorological Society		1985
	Member, American Geophysical Union		1983
<b>Appointments:</b>			
<b>1978-</b>	<b>Imperial College of Science, Technology &amp; Medicine</b>		
2008-2009	Director, Imperial College Environment Forum		
1995-1998	Head, Environmental and Water Resource Engineering		
1993-	Professor of Hydrology		
1990-1993	Reader in Engineering Hydrology, Department of Civil Engineering		
1987-1990	Senior Lecturer in Engineering Hydrology, Department of Civil Engineering		
1978-1987	Lecturer in Engineering Hydrology, Department of Civil Engineering		
<b>1972-1978</b>	<b>University of Bristol, Department of Civil Engineering</b>		
1976-1978	Research Associate		
	Integration of tidal power within the UK electricity generating network (SERC).		
1975-1976	Research Assistant		
	Regional analysis of rainfall-runoff relations. Effects of urbanization on flood runoff (Water Research Centre).		
1972-1975	Research Assistant		
	Research into catchment hydrology, physical simulation of hydrological processes, rainfall-runoff simulation techniques for flood management.		
<b>1968-1972</b>	<b>Rolls-Royce Ltd (Aero Engine Division).</b> Engineering apprenticeship		
	Fluid Mechanics research.		

July 1978 to date      Present Appointment

**Teaching:**

Lecturer to Engineering Hydrology MSc/DIC Course  
Lecturer to Environmental Engineering MSc/DIC Course  
Lecturer to Environmental Technology MSc/DIC Course  
Lecturer to Civil Engineering and Civil and Environmental Engineering, MEng

**Current Research Group:**

1 temporary lecturer, 2 research fellows, 4 research associates, 13 research students.

**Current/Recent Research Grants & Contracts:**

Radionuclide transport in vegetated soils  
UK Nirex/ANDRA 1988-2007, £3.5 million  
Initiated £10 million NERC LOCAR Thematic Programme  
National Infrastructure for Catchment Hydrology Experiments  
(NICHE)/Lowland Catchment Research (LOCAR)  
Joint Infrastructure Fund 1999-2004, £2 million  
Hydrogeochemical functioning of lowland permeable catchments: from  
process understanding to environmental management  
NERC/Environment Agency 2002-2006, £500k  
Generation of spatially-consistent rainfall data,  
DEFRA 2003-2006, £680K  
Spatial-temporal rainfall modelling with climate change scenarios  
DEFRA 2003-2006, £154K  
EPSRC Flood Risk Management Research Consortium, co-PI (£5.6 million  
Phase1, £8.5 million Phase2)  
Land use management research, EPSRC Flood Risk Management Research  
Consortium, 2004-2008, £720k; 2008-2011 £525k; NERC FREE £175k  
Modelling groundwater flood risk from extreme events  
NERC FREE thematic programme, 2007-2010, approx £600k

**Research training:**      52 Ph.D students, approx 100 MSc projects (past and present).

**College Administration:** Department of Civil & Environmental Engineering

Director, Imperial College Environment Forum, 2008-2009  
Head, Environmental & Water Resource Engineering Section, 1995-  
2008 (13 academic staff, 45 researchers, 65 MSc students)  
Member, Departmental Management Committee, 1995-2008  
Chairman, Departmental Examiners' Board, 2005-2008  
Director, Engineering Hydrology MSc/DIC Course (1984-2006)  
Previously Chair, Departmental Research Committee  
Member, Grantham Institute for Climate Change Executive Group  
College  
Founder, College ENTRUST Panel  
Member, various College research centres and initiatives

**Learned Society Activities, UK and International Scientific Administration:**

British Hydrological Society  
President 1999-2001  
Chairman, Southern Section, 1984-96  
Chairman, Research Sub-Committee, 1994-1999  
Chairman, Scientific Programme Committee, Intl Conf on  
Hydrology in a Changing Environment, Exeter, 1998  
Chairman, Intl Conf on Hydrology, Science and practice for the 21<sup>st</sup>  
century, Imperial College London, 2004

Chartered Institute of Water and Environmental Management  
 Member, Water Resources Panel, 1999-2001

Institution of Civil Engineers  
 Member, Water Board, 1999-2001  
 Member, Reservoir Safety Advisory Panel, 2000 – 2006

HYDRA Water Sciences Consortium (Universities of Oxford, Reading, Imperial, University College London, Queen Mary University, Centre for Ecology and Hydrology, British Geological Survey)  
 Founding Chair 2007-

Natural Environment Research Council  
 Chairman, Land & Water Resources Review Panel, Centre for Ecology and Hydrology, 1996-2003  
 Member, CEH Programme Development Group, 2003-  
 Chairman, LOCAR Working Group, 1998-9 (initiated £10million national research programme)  
 Member, Freshwater Sciences Research Grants & Training Awards Committee, 1993-7  
 Member, HYREX Programme Committee, 1992-6  
 Member, Environmental Diagnostics Programme Committee, 1995-2000  
 Member, LOCAR Programme Committee, 1999-  
 Member, FREE Ad-hoc steering group, 2002-2004

Ministry of Agriculture, Fisheries and Food  
 Member, Flood Estimation Handbook Advisory Committee, 1994-1999

Environment Agency of England and Wales  
 Member, Flood Warning and Management R&D Advisory Group, 1999-2001  
 Member, Scientific Advisory Panel, 2004  
 Member, Nitrate Vulnerability Assessment Advisory Panel 2006  
 Reviewer, Catchment Flood Management Plans, 2007-8  
 Member, Climate change and flood risk impacts assessment project steering group, 2008-  
 Member, Science advisory panel for catchment science research, 2009

Department of Environment, Food and Rural Affairs/EA Broad Scale Modelling Thematic Advisory Group 2000-2005  
 Chair, Criteria Review Panel (development of guidelines for exclusion criteria for the siting of a subsurface repository for high and intermediate level nuclear waste) 2007-2008  
 Member, Extreme rainfall research project steering group, 2007-2009

Department of Innovation Universities and Skills, Land Use Foresight Panel member, 2008-

#### UNESCO

Member, International Hydrological Programme Advisory Panel, 2002-  
 Chair, G-WADI Steering Committee, 2002-  
 Reviewer, Flemish Government Trust Fund  
 Member, UNESCO Mission to Sudan, 2007

Prince Sultan bin Abdulaziz International Prize for Water, Council member, 2007-  
 World Climate Research Programme  
 Member, Global Water Experiment (GEWEX) steering committee, 2008-

Scientific Advisor to the Ministry of Foreign Affairs, Republic of Hungary with respect to the Gabčíkovo-Nagymaros Barrage System (GNBS) case and Counsel and Advocate for Hungary, at the International Court of Justice, The Hague, 1993-97

Scientific Advisor to the Republic of Argentina with respect to environmental impacts of proposed industrial developments on R Uruguay water quality at the International Court of Justice, The Hague, 2006-

Consultant to the State of Nevada, USA concerning a proposed US Department of Environment licence application for a nuclear waste repository at Yucca Mountain, 2003-

**Editorial Activities:**

International Board of Advisers, ASCE Journal of Hydrologic Engineering, 2004-  
Editor, Nordic Hydrology 2003-2007  
Editor, Hydrology Research, 2007-  
Editor, Progress in Environmental Science, 1998-2001  
Editor, Environment International, 2001-2008  
Reviewer for: Proc. Roy. Soc., Water Resources Research, Geophysical  
Research Letters, J. Hydrology, J. Hydrological Processes, Hydr. Sci. Jnl.,  
HESS, Hydrology Research, Nordic Hydrology, Advances in Water Resources,  
Forestry Journal, Flood Risk Management Journal, Env'tl Modelling and  
Software, Geotechnique, Hydrogeology Journal, Proc. Instn. Civil Engrs ,  
CIWEM journal, etc.

**External Examining & Assessment:**

Referee: Stockholm Water Prize  
Professorial Appointments: Elector, University of Cambridge; University of Tufts,  
USA, University of Wales, University of Arizona, USA, University of California,  
Irvine, USA, Trinity College Dublin, University of Aberdeen  
Academic Appointments/Promotions: University of Edinburgh, Heriot Watt  
University, Cranfield University, Sheffield University, Newcastle University,  
Technical University of Denmark, Catholic University of Leuven, Belgium,  
University of Khartoum, University of Jordan, University of Riyadh, Khumasi  
University, Ghana, University of Botswana, Institute of Hydrology/Centre for  
Ecology and Hydrology, Wallingford, Macaulay Institute, Aberdeen.  
DSc: Universities of Bristol, Birmingham  
PhD: Universities of Bradford, Bristol, Birmingham, Lancaster, London,  
Melbourne, Newcastle, Reading, Salford, Southampton, Woollangong  
External Examiner, University of the West Indies Department of Civil  
Engineering, 2001-2007  
External Examiner, National University of Ireland, Galway, Department of  
Engineering Hydrology, 2005-2008  
External Examiner, University of Bristol, 2006-2009  
Research Grant Assessment: NERC, EPSRC, MAFF, British Council,  
Leverhulme Foundation, Royal Society, NOAA (USA), Swiss National Science  
Foundation, Austrian Science Fund, US-Israel BSF, etc.

**Overseas Development:**

	Overseas lecture courses given include:-
1979-1984	University College, Galway, Eire, International Hydrology MSc course
1982	University of Dar-es-Salaam, ANSTI/UNESCO International Hydrology MSc
1984	Catholic University of Chile, Santiago, Hydrology short course
1986	CETESB, Sao Paulo, Brazil, Hydrology & Water Quality short course
1990	Tsinghua University, Beijing, China, Water Quality lectures
1998	UNESCO Workshop, Amman, Jordan, Wadi Hydrology
2005	Chair and Organiser, G-WADI International Workshop on Hydrological Modelling of Arid and Semi-Arid Areas, Roorkee, India
2006	UNESCO/ICARDA workshop on rainwater harvesting, Aleppo, Syria
2006	International Conference on Dryland Management, Tunis
2007	Chair and Organiser, G-WADI International Workshop on Groundwater Modelling in Arid and Semi-Arid Areas, Lanzhou, China
2008	UNESCO workshop, Arid Zone Water Resources Management, Santiago, Chile
2009	International Workshop on Arid Zone Water Resources Management under Climate Change, Trieste, Italy
2009	UNESCO workshop on Arid Zone Water Resources, Amman, Jordan

**Recent Invited International Lectures:**

UNESCO Arab Region, IHP Workshops, Beirut (1999); American Geophysical  
Union Fall Meeting, San Francisco (1999); Intl Water & Energy Conference, Las



Vegas (2000); Intl Arid Zone Hydrology Conference, Cairo (2000); Starker Lecturer, Oregon State University (2000); American Geophysical Union Fall Meeting, San Francisco (2002); Kyoto Water Summit (2003), International Conference of Water Resources in Arid and Semi-Arid Regions, Muscat (2007), International Conference on Developments in Water Resource Management, Malaysia (2009), International Council of Academies of Engineering and Technological Sciences, CAETS, Calgary (2009); American Geophysical Union Fall Meeting, San Francisco (2009)

### ***Principal Areas of Expertise:***

#### ***Rainfall modelling and climate change studies***

Stochastic models of rainfall have been developed for various applications with support from NERC and DEFRA. Poisson-process based single site models have been developed for UK and US applications, including regional UK application in conjunction with continuous simulation rainfall-runoff modelling for flood design and management. A suite of models for spatial rainfall analysis and spatial-temporal simulation has been developed for UK government, ranging from radar-based continuous space-continuous time methods to Generalised Linear Modelling of daily rainfall including both temporal and spatial non-stationarity. Applications include modelling impacts of climate variability on flooding in W. Ireland, next-generation rainfall-runoff modelling for UK flood practice, rainfall-runoff modelling for Iran, land use change in the Upper Nile. Recent developments include the development of GLMs for statistical downscaling of GCM and RCM climate change scenarios, providing spatial fields of precipitation and evaporations for impacts assessment. Applications include UK and Southern Africa flood and water resources assessment.

Prof Wheeler currently leads on water for Imperial's Grantham Institute for Climate Change, and advises British Energy on climate change impacts assessment.

#### ***Unsaturated zone and groundwater hydrology***

Extensive research has been undertaken into modelling of unsaturated flow and solute transport, and the soil-plant-atmosphere continuum. A major (20 year) research contract with UK Nirex Ltd. involved lysimeter experiments of radionuclide transport in soils and vegetation uptake, and the integrated modelling of these processes for safety assessment of radioactive waste management. 1, 2 and 3D models have been developed, including redox-dependent geochemical interactions and the representation of uncertainty. The research has been summarised in a recent book.

Research over the last 10 years has focussed on the Chalk of southern England. A £10 million Thematic Research Programme was initiated, including a £2million infrastructure grant to Imperial, to support national research into groundwater-dominated catchments. Research has included the development of experimental and modelling research to represent flow and transport in the fractured porous medium of the Chalk unsaturated zone, including diffuse pollution (nitrate transport). Current research is focussing on the response to hydrological extremes – a major project is funded under the NERC Flood Risk from Extreme Events programme, to develop tools for groundwater flood risk assessment, and parallel research is investigating the role of the deep unsaturated zone in supporting river flows under drought conditions, linked to climate change scenarios.

Research in groundwater contaminant transport has included numerical methods for advectively-dominated contaminant transport, field and modelling studies of saline intrusion, field and laboratory studies of non-aqueous phase liquids in groundwater, laboratory and numerical modelling of microbial de-nitrification processes, and modelling of chemically-reactive contaminant transport. A recent

EPSRC/BG project has investigated microbial degradation of organic pollutants at a Gas works site and developing models for coupled flow, transport, geochemical interactions and microbial degradation. Other research is developing a framework for uncertainty analysis for well protection zones and investigating the value of data in risk reduction.

Groundwater recharge studies include UK applications and research into surface water/groundwater interactions in ephemeral flow systems, in Saudi Arabia, Oman, Botswana and the USA.

Recent consultancy includes advice to British Nuclear Fuels Ltd. on hydrological, hydrogeological and groundwater modelling studies at the Drigg nuclear repository, Cumbria and a study of Karst groundwater flooding in the Irish Republic. Currently Prof Wheeler is a consultant to the State of Nevada concerning safety assessment of a proposed high level nuclear waste repository at Yucca Mountain. He has also recently advised UK government on siting criteria for a deep nuclear waste repository.

#### *Rainfall-runoff modelling, flood hydrology and urban hydrology*

Major flood investigations have been carried out for the Water Research Centre, Severn-Trent Water, Thames Water, the Basque Regional Government, the Oman Government and numerous consultants. UK studies have included urbanisation effects, with respect to a new town development in Hampshire. New point and spatial rainfall modelling methods have been developed for continuous simulation modelling with NERC and MAFF/DEFRA support.

A suite of MATLAB-based rainfall-runoff modelling software tools has been developed for rainfall-runoff modelling, recently extended from lumped to semi-distributed models; the toolbox has had wide international uptake. A major effort has gone into model regionalisation studies for ungauged catchment rainfall-runoff modelling, with application to the UK, USA and Southern Africa; a book on this work has been popular; a second edition has been requested and is in preparation.

A study of Karst flooding problems in W. Ireland has included analysis of non-stationarity in rainfall (Southern Water, on behalf of Irish Govt.).

Prof. Wheeler is currently leading a national programme of research on land use impacts on flooding as part of a £15million EPSRC research programme, co-sponsored by NERC, DEFRA, the EA, Scottish Executive, Northern Ireland Rivers Authority. An extensive multi-scale hydrological experiment has been developed in Wales, working with a cooperative of farmers, to investigate effects of land use intensification on flood response at plot, hillslope and catchment scales, and new modelling tools have been developed to address the upscaling problem, based on detailed physics-based models and meta-modelling. This work has been integrated with sediment and water quality research, and with social analysis and the development of decision support visualisation tools.

Research on groundwater flooding is underway under the NERC FREE (Flood Risk from Extreme Events) programme.

#### *Surface water quality*

Water quality research overseas has included development of integrated river and lake water quality models for decision support for pollution control in China (EU, in collaboration with Tsinghua University, Beijing and Suez Lyonnaise-des-Eaux), and advice to the Republic of Hungary concerning the water quality impacts of the Gabčíkovo-Nagymaros Barrage system. Recent UK research funded by NERC and the Environment Agency of England and Wales focussed on the development of decision support models of nutrients for lowland catchment management, including diffuse and point source loads and in-stream processes. A recent EU contract has developed modelling systems for nutrient response of the Wash catchments in Eastern England, as a pre-pilot study for the EU Water Framework Directive. Earlier research into hydrology and water quality in upland Britain has addressed surface water acidification (Royal Society

funding (in collaboration with Norwegian and Swedish Academies of Science) and NERC (Environmental Diagnostics) support). Published research includes field process and modelling studies.

#### *UK water resource management*

A major (£10million) national initiative (LOCAR) has been developed to study lowland permeable catchments, including a £2million infrastructure grant to Imperial College. A principle focus is to improve interdisciplinary science to support integrated water resources management of the UK's major aquifers, the Chalk and the Triassic Sandstone Three catchments have been instrumented in detail to monitor hydrological fluxes and water quality, including special instrumentation to investigate aquifer properties and stream-aquifer interactions. A £500k grant from NERC and the Environment Agency is focussing on the development of decision support modelling tools for nutrient management. See also surface water quality.

Recent research on water resource systems sponsored by Thames Water has focussed on new methods of assessment of risk and uncertainty in water resources management. This work was awarded the ICE Baker Medal in 2004.

#### *Arid zone hydrology and water resource development*

Major projects include:- Northern Oman Flood Study (1981) (Principal Investigator) and Five Wadis Study, S.W. Saudi Arabia (1985-88) (Senior Expert) in addition to numerous smaller-scale flood and water resource studies in the Middle East and Africa (Yemen, Jordan, Oman, UAE, Botswana). Published research includes rainfall analysis and simulation, rainfall-runoff modelling, groundwater recharge management. Recent research includes sustainable development of alluvial groundwater (Botswana), stochastic spatial-temporal rainfall modelling and rainfall-runoff processes (Iran), climate change impacts on water resources (Botswana) Flood Hydrology (Oman). Currently Chair of the UNESCO G-WADI programme, which seeks to disseminate state-of-the-art hydrology and water resources management practice for arid and semi-arid areas. Prof Wheeler was recently awarded the Prince Sultan bin Abdulaziz International Prize for Water for his arid zone work.

#### *Large-scale hydrological modelling*

Research into improved hydrological modelling for global climate models has included new methods for disaggregation of spatial rainfall and evaluation of SVAT schemes at point and catchment scale, contributing to the NERC TIGER programme and the GCIP study of the Mississippi. Recent research in collaboration with the Hadley Centre has focussed on improved GCM modelling of the Nile, including representation of lakes and wetlands, and the assimilation of surface hydrological observations. Prof. Wheeler has recently been appointed to the World Climate Research Programme GEWEX steering committee.

#### ***International Consultancies & Research Contracts:***

Royal Oman Police & Diwan of HM Sultan Qaboos of Oman; Ministry of Agriculture & Water, Riyadh (as consultant to Dames & Moore); Royal Commission of Jubail, Saudi Arabia; Dar Al Handasah (flood protection of Medinah & Mecca); Howard Humphries (UAE); Balfour Beatty International (Sri Lanka); Maunsells (Oman); Zambian Cons. Copper Mines; CETESB, Sao Paulo (Brazil); Basque Regional Government (Spain); Dar Al Handasah (Yemen); Shimizu Corporation (Japan); European Community (Nepal); JCE (Jordan); Travers Morgan (Oman); Government of Hungary; Southern Water Global (Eire); DANIDA (Botswana); European Union (China); UNESCO; Republic of Argentina.

#### ***UK Consultancies and Research Contracts:***

Anglian Water Authority, Severn Trent Water Authority, Thames Water Authority, Royal Society, UK Nirex Ltd., British Nuclear Fuels Ltd., Balfours, W.S. Atkins, Watson Hawksley, Hydro-logic Ltd., Electrowatt, Her Majesty's Inspectorate of Pollution, Eagle Star Property Management, Natural Environment Research

Council, Binnie and Partners, Thames Water Utilities Ltd, EPSRC, Halcrow, Environment Agency, Department of Environment, Food and Rural Affairs, British Energy, Department for Innovation, Universities and Skills.

## **PROFESSOR H.S. WHEATER : PUBLICATIONS**

### ***Scientific & Technical Journals***

Stillman, J.M. & Wheeler, H.S. "The prospects of tidal power". Proc. Instn. Civ. Engrs., 62 (1977), 701-705.

Wheater, H.S., Shaw, T.L. & Rutherford, J.C. "Storm runoff from small lowland catchments in South West England". J. Hydrol., 55 (1982), 321-337.

Wheater, H.S. & Bell, N.C. "Northern Oman flood study". Proc. Instn. Civ. Engrs., 75 (Part 2) (1983), 453-473. (Awarded Institution of Civil Engineers Overseas Premium).

Sherratt, D.J. & Wheeler, H.S. "The use of surface resistance-soil moisture relationships in soil water budget models". Ag. & Forest. Met., 31, 2 (1984), 143-157.

Ngirane-Katashaya, G.. & Wheeler, H.S. "Hydrograph sensitivity to storm kinematics". Water Resour. Res., 21, 3 (1985), 337-345.

Wheater, H.S., Bishop, K.H. & Beck, M.B. "The identification of conceptual hydrological models for surface water acidification". J. Hydrol. Proc. 1 (1986), 89-109.

Parissopoulos, G. & Wheeler, H.S. "On numerical errors associated with the Iterative Alternating Direction Implicit (IADI) Finite Difference Solution of the two-dimensional transient saturated-unsaturated flow (Richards) equation". J. Hydrol. Proc., 2 (1988), 187-201.

Hall, M.J., Johnston, P.M. & Wheeler, H.S. "Evaluation of overland flow models using laboratory catchment data. I. An apparatus for laboratory catchment studies. Hydr. Sci. Jnl., 34, 3 (1989), 277-288.

Bell, N.C., Wheeler, H.S. & Johnston, P.M. "Evaluation of overland flow models using laboratory catchment data. II. Identification of physically-based models". Hydr. Sci. Jnl., 34 (1989), 289-317.

Wheater, H.S., Bell, N.C. & Johnston, P.M. "Evaluation of overland flow models using laboratory catchment data III. Intercomparison of conceptual models". Hydr. Sci. Jnl., 34 (1989), 319-337.

Wheater, H.S., Larentis, P., Hamilton, G.S. "Design rainfall characteristics for SW Saudi Arabia". Proc. Instn. Civ. Engrs. Part 2, 87 Dec (1989) (517-538).

Kleissen, F.M., Wheeler, H.S., Beck, M.B. and Harriman, R. "Conservative mixing of water sources: analysis of the behaviour of the Allt a'Mharcaidh Catchment". J. Hydrol., 116 (1990) 365-374.

Muscutt, A.D., Wheeler, H.S. and Reynolds, B. "Stormflow hydrochemistry of a small Welsh upland catchment". J. Hydrol., 116 (1990) 239-249.

Parissopoulos, G.A. and Wheeler, H.S. "Numerical study of the effects of layers on unsaturated-saturated two-dimensional flow". Water Resources Mgmt 4 (1990) 97-122.

Beck, M.B., Kleissen, F.M. and Wheeler, H.S. "Identifying flow paths in models of surface water acidification". Reviews of Geophysics, 28, 2 (1990) 207-230.

Abeliuk, R. and Wheeler, H.S. "Parameter identification of solute transport models for unsaturated soils". J. Hydrol., 117 (1990) 199-224.

Kleissen, F.M., Beck, M.B. & Wheeler, H.S. "Identifiability of conceptual hydrochemical models". Water Resources Research, 26, 2 (1990) 2979-2992.

Wheater, H.S., Langan, S.J., Brown, A. & Beck, M.B. "Hydrological response of the Allt a Mharcaidh catchment - inferences from experimental plots". J. Hydrol. 123 (1991) 163-199.

- Wheater, H.S., Butler, A.P., Stewart, E.J. & Hamilton, G.S. "A multivariate spatial-temporal model of rainfall in S.W. Saudi Arabia. I. Data characteristics and model formulation". *J. Hydrol.*, 125 (1991) 175-199.
- Wheater, H.S., Onof, C., Butler, A.C. & Hamilton, G.S. "A multivariate spatial-temporal model of rainfall in S.W. Saudi Arabia. II. Regional analysis and model validation". *J. Hydrol.*, 125 (1991) 201-220.
- Parissopoulos, G.A. & Wheeler, H.S. "Effects of wadi flood hydrograph characteristics on infiltration". *J. Hydrol.*, 126 (1991) 247-263.
- Koide, S. & Wheeler, H.S. "Subsurface flow simulation of a small plot at Loch Chon, Scotland". *J. Hydrol. Proc.*, 6 (1992), 299-326
- Parissopoulos, G.A. & Wheeler, H.S. "Experimental and numerical infiltration studies in a wadi stream-bed". *J. Hydr. Sci.* 37, (1992), 27-37.
- Parissopoulos, G.A. & Wheeler H.S. "Effects of hysteresis on groundwater recharge from ephemeral flows" *Water Resour.Res.* (1992) 28, 11, 3055-3061.
- Muscutt, A.D., Reynolds, B., Wheeler, H.S. "Sources and controls of Aluminium in storm runoff from a headwater catchment in mid-Wales. *J.Hydrol.* 142 (1993), 409-425.
- Wheater, H.S., Tuck, S., Ferrier, R.C., Jenkins, A., Kleissen, F.M., Walker, T.A.B, Beck, M.B. "Hydrological flow paths at the Allt a' Mharcaidh catchment" *J. Hydrol.Proc.* 7 (1993), 359-371.
- Chapman, P.J., Reynolds, B., Wheeler, H.S. "Hydrochemical changes along stormflow pathways in a small headwater moorland catchment in mid-Wales, U.K." *J. Hydrol.* 151 (1993) 241-265.
- Onof, C. and Wheeler, H.S. "Modelling of British rainfall using a random parameter Bartlett-Lewis rectangular pulse model" *J. Hydrol.* 149 (1993), 67-95.
- Tompkins, J.A., Gan, K.C., Wheeler, H.S., Hirano, F. "Prediction of solute dispersion using a stochastic numerical methodology" *J. Hydrol.* 159 (1994) 105-123.
- Burne, S., Wheeler, H.S., Butler, A.P., Johnston, P.M., Wadey, P., Shaw, G., and Bell, J.N.B. Radionuclide transport above a near-surface water table I. An automated lysimeter facility for near-surface contaminant transport studies. *J. Env. Quality* 23, 6, (1994), 1318-1329.
- Onof, C. and Wheeler, H.S. "Improvements of the modelling of British rainfall using a modified random parameter Bartlett-Lewis rectangular pulse model" *J. Hydrol* 157 (1994) 177-195.
- Onof, C., Wheeler, H.S. and Isham, V. "Note on the analytical expression of the inter-event time characteristics for Bartlett-Lewis type rainfall models" *J. Hydrol.* 157 (1994) 197-210.
- Wheater, H.S., Armstrong, A.C. and Raats, P.A.C." Field, laboratory & modelling studies of flow and transport processes - Introduction". *J. Hydrol* 159 (1994) ix- xxii.
- Onof, C and Wheeler H.S. "Improved fitting of the Bartlett-Lewis Rectangular Pulse Model for hourly rainfall". *Hydr. Sci. Jnl.*, 34 (1994) 663-680.
- Freeman, C., Chapman, P.J., Gilman, K., Lock, M.A., Reynolds, B and Wheeler H.S. "Ion exchange mechanisms and the entrapment of nutrients by river biofilms". *Hydrobiologia* 279 (1995) 61-65.
- Onof, C., and Wheeler, H.S. Modelling of rainfall time-series using the Bartlett-Lewis model. *Proc. Instrn. Civ. Engrs, Wat., Marit. & Energy*, 112, Dec (1995), 362-374.
- Chapman, P.J., Reynolds, B. and Wheeler, H.S. (1995). The seasonal variation in soil water acid neutralizing capacity in peaty podzols in Mid-Wales. *Water, Air & Soil Pollution* 85, 1089-1094.

Butler, A.P., Burne, S. and Wheater H.S. "Observations on freezing induced redistribution in soil lysimeters". J. Hydrol. Proc. 10 (1996), 471-474.

Onof, C. and Wheater H.S. "Analysis of the spatial coverage of British rainfall fields". J. Hydrol. 176 (1996), 97-113.

Onof, C. and Wheater H.S. "Modelling of the time-series of spatial coverages of British rainfall fields". J. Hydrol. 176 (1996) 115-131.

Jolley, T.J. and Wheater, H.S. A large-scale grid-based hydrological model of the Severn and Thames catchments. J. Water & Envtl Mgmt, 10, 4, 253-262 (1996).

Hutchins, M.G., Wheater, H.S., Beck, M.B., Reynolds, B. Uncertainty, risk and transient pollution events. Water Sci. Technol., 33 (2), 51-64 (1996).

Onof, C., Faulkner, D. and Wheater, H.S. (1996). Design rainfall modelling in the Thames catchment. Hydr. Sci. Jnl. 41 (5), 715-733.

Chapman, P.J., Reynolds, B. and Wheater, H.S. (1996) Experimental investigation of potassium and nitrate dynamics in a headwater stream in mid-Wales. Chemistry & Ecology, vol. 13, pp 1-19.

Onof, C. Northrop, P., Wheater, H.S., and Isham, V. (1996) Spatiotemporal storm structure and scaling property analysis for modeling. J. Geophys. Res., vol. 101, No. D21, 26,415-26,425.

Chapman, P.J., Reynolds, B. and Wheater, H.S. (1997) Sources and controls of calcium and magnesium in storm runoff: the role of groundwater and ion exchange reactions along water flowpaths. Hydrology and Earth System Sciences, 1(3), 671-685.

Foster, H.J., Alexander, S., Locks, T., Wheater, H.S., Lees, M.J. and Reynolds, B. (1997) Scale dependence of the episodic hydrochemical responses of nested catchments at Plynlimon. Hydrology and Earth System Sciences, 1 (3), 639-651.

Jolley, T.J. and Wheater, H.S. (1997) An investigation into the effect of spatial scale on the performance of a one-dimensional water balance model. J. Hydrol. Proc., 11, 1927-1944.

Wheater, H.S., Jolley, T.J., Onof, C., Mackay, N., Oh, L. and Chandler, R. (1997) Large Scale Hydrological Modelling: Aggregation and Disaggregation Issues for the Representation of Land Surface Hydrology. The Globe Special Issue, 40, December 1997, UK GER Office.

Jolley, T.J. and Wheater, H.S. (1997) The introduction of runoff routing into large scale hydrological models. J. Hydrol. Proc., 11, 1917-1926.

Eigbe, M.B., Beck, H.S., Wheater, H.S., Hirano, F. (1998) Kalman filtering in groundwater flow modelling: problems and prospects. Stochastic Hydrology and Hydraulics, 12, 15-32.

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**Exhibit 16B**  
**Dr. Howard S. Wheeler's Testimonies in the Last Four Years**

### **Testimony of Howard S. Wheeler**

CR 2009/12, International Court of Justice at The Hague, September 14, 17, and 28, 2009, in the case concerning Pulp Mills on the River Uruguay (*Argentina v. Uruguay*).