Professor W Mike Edmunds: A pioneer in applied hydrogeochemistry and champion of international collaboration

Mike Edmunds was a pioneer in modern applied hydrogeochemistry, helping to develop geochemical tools and their application to managing water resources. In a career spanning almost 50 years, Mike made major contributions to water resource science as well as promoting the role of chemistry in solving groundwater problems and championing the need to incorporate science into policy. There can be few hydrogeologists who travelled so extensively in order to study the vast range of groundwater environments of the world. Mike's contribution to water science was recognised through the many accolades he received including the Whittaker Medal (1999), OE Meinzer Award (2009) and Vernadsky Medal (2010). Perhaps his greatest contribution, however, was the generosity of spirit with which he approached his many collaborative ventures.

Mike's career started in the 1960s with the undertaking of a PhD at Liverpool University on contact metamorphism associated with the Ardara Pluton in Donegal, Ireland. This coincided with the advent of the electron microprobe, which he used to look at zoning in garnets (Atherton and Edmunds 1966). However, a change in geochemical outlook was required when he was appointed to the Institute of Geological Sciences, since renamed the British Geological Survey (BGS), which had just started a period of expansion to increase its capabilities in both physical hydrogeology and hydrogeochemistry. Mike's focus was on the hydrochemistry of groundwater in the UK and overseas, and he soon became immersed in a diverse range of scientific challenges that would provide a foundation and stimulus for many future initiatives. His knowledge of mineralogy was to stand him in good stead as he developed new ideas on the interactions between groundwater and the aquifer matrix: "It's all about the rocks" was one of his favourite sayings to students. Mike elaborated on his early career at his OE Meinzer Award ceremony: "Armed with two books – the classic by John Hem and probably the best book on hydrogeochemistry ever written – Solutions, Minerals and Equilibria – by Bob Garrels and Charles Christ, I never looked back". He worked tirelessly for the next 35 years building up a research group and analytical laboratory, and was a promoter and practitioner of the overarching importance of reliably measured data as the basis for good science and for interpreting hydrogeochemical concepts and calibrating quantitative models. Many of his early pioneering interests stayed with him for the remainder of his career even as the applications of his interests diversified. At the same time, Mike never lost his passion for applying knowledge to the benefit of others, especially in developing countries and through support to charities such as Wells for India. He was also a founding member of the International Association of GeoChemistry (IAGC) group Water-Rock Interaction (WRI) and was Chairman from 1992-2001 (Darling 2017).

Mike's passion for water and chemistry and his love of different cultures and history led him to many areas of the world. His applied approach allowed him to excel in attracting funding and he was a natural leader of multinational projects. His legacy of practical relevance - putting science to good use where it mattered - is widely recognised amongst his peers across the globe. Mike's interests were wide, and a detailed description is far beyond the scope of this profile. The focus will therefore be on three key areas which were pursued over most of his career: trace element geochemistry, arid zone hydrology/palaeohydrology, and translating science into policy.

Trace element geochemistry

Mike's first venture into the hydrochemistry of British groundwaters was a review and update of mineral and thermal waters (Edmunds et al. 1969). That was to be the launch pad for Mike's later contributions to major BGS projects to evaluate low enthalpy geothermal resources in both crystalline rock and onshore sedimentary basins of the UK (Andrews et al. 1982; Edmunds et al. 1980, 1984a; Edmunds 1986; Downing et al. 1987). He began to focus on the then poorly studied areas of trace elements in groundwater and groundwater residence time (Edmunds 1971). A key feature of Mike's philosophy was always to think about groundwater holistically, whether as a component of landscape, history or politics. This was emphasized in his early UK work on the Lincolnshire Limestone aquifer which highlighted sequential chemical changes along groundwater flow paths and the effect of confinement on groundwater quality (Edmunds 1973, Edmunds and Walton 1983). This work set up a conceptual framework for groundwater evolution, redox changes and the impacts of over-abstraction on water quality still relevant today. This approach was augmented in later years to include a range of residence time indicators to constrain geochemical evolution at regional scales and to indicate the impacts of modern anthropogenic inputs to groundwater (Edmunds and Morgan-Jones 1976, Edmunds 2009a).

Some of Mike's early studies also included the unsaturated zone which he understood to be critical in determining the subsequent chemical evolution of groundwater. He was instrumental in developing techniques for extracting porewater (Edmunds et al. 1973; Edmunds and Bath 1976; Bath and Edmunds 1981) and applying this in early studies of the dual porosity Chalk aquifer in the UK (Edmunds 1974). The pore water extraction methods became a key tool in investigations of nitrate penetration through unsaturated Chalk that led to early modelling of diffusive exchange between fracture-borne groundwater and matrix pore waters, and he continued to study this unusual aquifer through subsequent decades (Edmunds et al. 1992a; Kloppmann et al. 1998; Edmunds and Shand 2008).

The Chalk and Permo-Triassic sandstone are major aquifers in the UK and much of Mike's career was devoted to understanding groundwater evolution and residence times in these aquifer systems. He developed many of his conceptual ideas based on these systems particularly the role of redox boundaries, chemical evolution, residence times, stratification and palaeowaters (Edmunds and Morgan-Jones 1976; Edmunds et al. 1982; Smedley and Edmunds 2002). A major output was the first compilation of trace elements in UK groundwaters (Edmunds et al. 1989). It was Mike's ability to combine traditional and state-of-the-art tools, data and skills (e.g. solute concentrations, age indicators, palaeo-temperature proxies, dating techniques) in a holistic manner that helped provide the complex understanding needed to interpret trace elements and provide sustainably managed groundwater resources.

Other key areas where Mike made a significant contribution by applying hydrochemical techniques included studies of deep basin brines (Edmunds 1975), geothermal resources - especially hot dry-rock (now EGS) reservoirs (Edmunds et al. 1984b, 1985), trace element geochemistry and health (Edmunds and Smedley 2005; Smedley and Edmunds 1996), acid deposition and related impacts on shallow aquifers (Edmunds and Kinniburgh 1986; Edmunds et al. 1992b), and surface water chemistry as an aid to geological interpretation (Edmunds and Key 1996; Cidu et al. 1995).

Arid zone hydrology and palaeohydrology

Mike started working in arid zones as part of a team in Libya in the late 1960s, and the study of non-renewable water resources become a lifelong passion. He carried out one of the earliest radiocarbon studies of North African groundwater and developed a palaeoclimatic recharge chronology (Edmunds and Wright 1979). This experience was the foundation for Mike's dedication to improving our understanding of recharge and sustainability of aquifers in arid and semi-arid regions. He became an authority on Saharan and sub-Saharan groundwater resources working with many international collaborators (Edmunds 2003; Edmunds et al. 2004). It also demonstrated the powerful role that environmental isotopes could play in hydrogeology and was the start of many collaborations with isotope laboratories in the UK and internationally that would develop isotopes as tools in groundwater studies in very diverse environments.

Mike was one of the earliest geoscientists to apply environmental tracer approaches to resolve recharge rates in arid zones, with profound implications for distinguishing between renewable and non-renewable groundwater resources. Concurrently with colleagues in Australia, he took the idea of using solute concentrations in groundwater to estimate recharge (Eriksson and Khunakasem 1969) and applied it to profiles in the unsaturated zone to estimate recharge (Allison and Hughes 1978; Edmunds and Walton 1980). This was then applied around the world as Mike's career became more and more international (Edmunds et al. 1988, 1992c; Edmunds and Gaye 1994; Edmunds and Tyler 2002, Fontes et al. 1991 Edmunds et al. 2006; Gaye and Edmunds 1996; Gates et al. 2008). Furthermore, it proved a relatively cheap and effective tool accessible to developing countries. This was later combined with numerical modelling (Cook et al. 1992) to validate how Cl and stable isotope profiles in the unsaturated zone could be preserved up to centuries. He developed further the idea of groundwater as an archive of climatic and environmental change (Edmunds 2005). Again, rather than just focussing on one aspect of the hydrological cycle, by combining unsaturated zone hydrology with groundwater chemistry and a range of dating and palaeo-environmental proxies, Mike helped build comprehensive conceptual models of some of the continental-scale arid zone aquifers of the world (Edmunds et al. 1998, 2003a, 2004).

Mike exploited the growing capabilities for environmental isotope hydrology through collaboration with John Andrews on dissolved noble gas analyses to investigate groundwater ages and palaeoclimatic signals in regional aquifers (Bath et al. 1979; Andrews et al. 1994; Elliot et al. 1999). One of the more notable outcomes was the identification of a major component of British groundwaters, potable and saline, that originated as recharge during the Pleistocene glacial climate stages (Darling et al. 1997). The integration of chemical, isotopic and dissolved gas methods to characterise the recharge history and hydrogeochemical evolution of groundwaters would be the approach that Mike and his colleagues brought to many diverse collaborations through very productive bilateral and multilateral European projects, international development projects and IAEA coordinated research programmes (e.g. Fontes et al. 1991; Kloppmann et al. 1998; Edmunds et al. 2003a).

Mike was very successful in bringing together European teams through the EC Framework programme, with one of his most significant projects focussing on the coastal palaeowaters of Europe, using geochemical information to determine their history and the limits to the sustainability of such valuable resources. The publication of a Special Volume of the Geological Society of London (Edmunds and Milne 2001) was a major achievement building on prior decades of research by Mike and his colleagues. Such projects highlighted his effectiveness in bringing together and integrating interdisciplinary teams, as well as his ability to motivate, respect and communicate with younger scientists. This research also emphasized the importance of offshore fresh waters beneath the continental shelf, a topic which is gaining increasing momentum (Post et al. 2013).

Translating science into management and policy

Mike's focus was on understanding the behaviour of natural processes rather than pollution; but, ever determined to make his science relevant, he used the natural variations in groundwater to form a more robust approach to quantifying pollution (Edmunds et al. 1982). This developed over time into the baseline concept (Edmunds et al. 1987; Edmunds et al. 2003b; Edmunds and Gaye 1997; Edmunds and Shand 2008; Shand et al. 2007) to provide a robust basis for trying to quantify pollution. This allowed Mike and co-workers to bring together a knowledge of processes and residence time estimation to ultimately provide a science-based underpinning of water quality policy (Hinsby et al. 2007). It was particularly gratifying for Mike to see the term 'baseline' incorporated into EU policy, something he considered a major milestone in his career and in the development of water resource management in Europe.

Culture, teaching and dedication

Since his early studies in North Africa, Mike had been intrigued by the relationship between water and human culture, particularly the role of water in the history of civilisation; he simply saw the modern era of water policy as part of this history (Edmunds 2009a, b; Whitehead and Edmunds 2012). This was also linked to his longstanding interest in the origin of mineral and thermal waters (Andrews et al. 1982; Edmunds 2004; Edmunds et al. 1998b; Edmunds et al. 2014). Mike's presentations and the courses he taught often had reference to the early historical pioneers of hydrogeochemistry including Hippocrates and Pliny the Elder (Edmunds 2009a).

Following his retirement from BGS, Mike joined the University of Oxford as Research Director of the Water Research Centre at the School of Geography and the Environment. There he not only continued his scientific research but helped develop a new interdisciplinary MSc in Water Science, contributing to the establishment of a new generation of world water leaders by attracting participants from 50 countries. In fact, throughout his 35 years of research he devoted much time to training, educating, mentoring and inspiring hydrogeologists both in the UK and internationally through organisations such as UNESCO and the IAEA. He also remained passionate about water security for the poor and improving the lives of rural communities in Africa and Asia. At all times he shared his knowledge freely and strove to generate equity in the water sphere.

Many who had the privilege of working with Mike Edmunds would say that he was not only a scientific leader, an inspiring mentor and thinker, but, above all, a friend. Mike would often say "There is no such word as impossible, only opportunity"; that was his approach to most problems and one which often encouraged colleagues to go that little bit further. Mike continues to be remembered for his contributions to hydrogeochemistry and equitable water management, and also for his approachable, warm and generous spirit.

References

Allison GB, Hughes MW 1978 The use of environmental chloride and tritium to estimate total recharge to an unconfined aquifer. Australian Journal of Soil Research, **16**, 181-195.

Andrews JN, Burgess WG, Edmunds WM, Kay RLF, Lee DJ 1982 The thermal springs of Bath. Nature, **298**, 339-343.

Andrews JN, Edmunds WM, Smedley PL 1994 Chlorine-36 in groundwater as a palaeoclimatic indicator: the East Midlands Triassic sandstone aquifer (UK). Earth and Planetary Science Letters, **122**, 159-171.

Atherton MP, Edmunds WM 1966 An electron microprobe study of some zoned garnets from metamorphic rocks. Earth and Planetary Science Letters, **1**, 185-193.

Bath AH, Edmunds WM 1981 Identification of connate water in interstitial solution of chalk sediment. Geochimica et Cosmochimica Acta, 45, 1449-1461.

Bath AH, Edmunds WM, Andrews, JN 1979 Palaeoclimatic trends deduced from the hydrochemistry of a Triassic sandstone aquifer, United Kingdom. In: Proc Intl. Symp. Isotope Hydrology, Neuherberg 1978, Vol 2, 545-566. IAEA, Vienna.

Cidu R, Fanfani L, Shand P, Edmunds WM, Van't Dack L, Gijbels R 1995. Hydrogeochemical exploration for gold in the Osilo area, Sardinia, Italy. Applied Geochemistry, **10**, 517-530.

Cook PG, Edmunds WM, Gaye CB 1992 Estimating paleorecharge and paleoclimate from unsaturated zone profiles. Water Resources Research, **28**, 2721-2731.

Darling WG 2017 Mike Edmunds: fifty years of water, rock and interaction. Procedia Earth and Planetary Science, **17**, 17-20.

Darling WG, Edmunds WM, Smedley PL 1997 Isotopic evidence for palaeowaters in the British Isles. Applied Geochemistry, 12, 813-829.

Downing RA, Edmunds, WM, Gale IN 1987 Regional groundwater in sedimentary basins in the U.K. In: Geol. Soc. London. Spec. Publ. Vol 34, 105-125.

Edmunds WM 1971 Hydrogeochemistry of groundwaters in the Derbyshire Dome with special reference to trace constituents. Report No. 71/7, Institute of Geological Sciences.

Edmunds WM 1973 Trace element variations across an oxidation-reduction barrier in a limestone aquifer. In Ingerson E editor. Proc. Symp. On Hydrogeochemistry and Biogeochemistry, Tokyo, 1970, 1973, Vol. 1, p. 500–520.

Edmunds WM 1974 Chemical variation of pore waters from the Cretaceous chalk of England. 1974 In, J Cadek and T Paces (eds.), Proceedings of the First International Symposium on Water–Rock Interaction, Prague, 1974, 266–267.

Edmunds WM 1975 Geochemistry of brines in the Coal measures of northeast England. Transactions/Section B of the Institution of Mining and Metallurgy, **84**, B39-B52.

Edmunds WM 1986 Geochemistry of geothermal waters in the UK. Chapter 6 in: Downing RA and Gray DA (eds.) Geothermal Energy: The potential in the United Kingdom, pp 111-123. British Geological Survey, HMSO. ISBN 11 884366 4.

Edmunds WM 2003 Hydrogeochemical processes in arid and semi-arid regions – focus on North Africa. In I Simmers (ed.), Understanding Water in a Dry Environment: Hydrological Processes in Arid and Semi-Arid Zones. UNESCO International Contributions to Hydrology, vol. 23, Chapter 7, Balkema, 251-287.

Edmunds WM 2004 Bath thermal waters: 400 years in the history of geochemistry and hydrogeology. In, JD Mather (ed.), 200 years of British Hydrogeology. Geological Society of London Special Publication No. 225, 193-199.

Edmunds WM 2005 Groundwater as an archive of climatic and environmental change. In, PL Aggarwal, PK Gat and K Froehlich (eds.), Isotopes in the Water Cycle: Past, Present and Future of a Developing Science, Springer, 341-352.

Edmunds WM 2009a Geochemistry's vital contribution to solving water resource problems. Applied Geochemistry, **24**, 1058-1073.

Edmunds WM 2009b Water Sheiks and Dam Builders: Stories of People and Water in the Middle East. Journal of Islamic Studies, **20**(1), 118-120.

Edmunds WM, Bath AH 1976 Centrifuge extraction and chemical analysis of interstitial waters. Environmental Science and Technology, **10**, 467-472.

Edmunds WM, Gaye CB 1994 Estimating the spatial variability of groundwater recharge in the Sahel using chloride. Journal of Hydrology, **156**, 47-59.

Edmunds WM, Gaye CB 1997 Naturally high nitrate concentrations in groundwaters from the Sahel. Journal of Environmental Quality, **26**(5), 1231-1239.

Edmunds WM, Key RM 1996 Hydrogeochemistry as an aid to geological interpretation: the Glen Roy area, Scotland. Journal of the Geological Society of London, **153**, 839-852.

Edmunds WM, Kinniburgh DG 1986 The susceptibility of UK groundwaters to acidic deposition. Journal of the Geological Society of London, **143**, 707-720.

Edmunds WM, Miles DL, Cook JM 1984a A comparative study of sequential redox processes in three British aquifers. In: Proceedings of Hydrochemical Balances of Freshwater Systems, Uppsala Symposium, vol. 150, pp. 55-70. IAHS Publication.

Edmunds WM, Milne CJ (eds.) 2001 Palaeowaters in Coastal Europe: Evolution of Groundwater since the Late Pleistocene. Geological Society of London Special Publication No. 189.

Edmunds WM, Morgan-Jones MM 1976 Geochemistry of groundwaters in British Triassic sandstones: The Wolverhampton-East Shropshire area. Quarterly Journal of Engineering Geology, **9**, 73-101.

Edmunds WM, Shand P (eds.) 2008 Natural Groundwater Quality. Blackwell, Oxford, 469pp. ISBN 978-14051-5675-2.

Edmunds WM, Smedley PL 2005 Fluorine in natural waters – occurrence, controls and health aspects. In, O Selenius, B Alloway, JA Centeno, JA Finkleman, RB Fuge, R Lindh, PL Smedley (eds.), Essentials of Medical Geology, Academic Press, 301-329.

Edmunds WM, Tyler SW 2002 Unsaturated zones as archives of past climates: toward a new proxy for continental regions. Hydrogeology Journal, **10, 216-228.**

Edmunds WM, Walton NRG 1980 A geochemical and isotopic approach to recharge evaluation in semi-arid zones, past and present. In, Arid Zone Hydrology, Investigations with Isotope Techniques. IAEA, Vienna, 47-68.

Edmunds WM, Walton NRG 1983 The Lincolnshire Limestone – hydrogeochemical evolution over a ten-year period. Journal of Hydrology, **61**, 201-211.

Edmunds WM, Wright EP 1979 Groundwater recharge and palaeoclimate in the Sirte and Kufra Basins, Libya. Journal of Hydrology, **40**, 215-241.

Edmunds WM, Andrews JN, Burgess WG, Kay RLF, Lee DJ 1984b The evolution of saline and thermal groundwaters in the Carnmenellis granite. Mineralogical Magazine, 48, 407-424.

Edmunds WM, Bath AH, Miles DL 1982 Hydrochemical evolution of the East Midlands Triassic sandstone aquifer, England. Geochimica et Cosmochimica Acta, **46**, 2069-2081.

Edmunds WM, Cook JM, Darling WG, Kinniburgh DG, Miles AH, Bath AH, Morgan-Jones M, Andrews JN 1987 Baseline geochemical conditions in the Chalk aquifer, Berkshire, U.K.: a basis for groundwater quality management. Applied Geochemistry, **2**, 251-274.

Edmunds WM, Cook JM, Kinniburgh DG, Miles DL, Trafford JM 1989 Trace element occurrence in British Groundwater. British Geological Survey Research Report SD/89/3, Keyworth, Notts. UK.

Edmunds WM, Darling WG, Kinniburgh DG 1988 Solute profiles for recharge estimation in semi-arid and arid terrain. In, I Simmers and D Reidel (eds.) *Estimation of Natural Groundwater Recharge*, Dordrecht, 139-157.

Edmunds WM, Darling WG, Kinniburgh DG 1992c Sources of recharge at Abu Delaig, Sudan. Journal of Hydrology, **131**, 1-24.

Edmunds WM, Darling WG, Kinniburgh DG, Dever L, Vacher P 1992a Chalk groundwater in England and France: hydrogeochemistry and water quality. Research Report SD/92/2. British Geological Survey.

Edmunds WM, Darling WG, Purtschert R, Alvarado JAC 2014 Noble gas, CFC and other geochemical evidence for the age and origin of the Bath thermal waters, UK. Applied Geochemistry, **40**, 155-163.

Edmunds WM, Dodo A, Djoret D, Gasse F, Gaye CB, Goni IB, Travi Y, Zouari K, Zuppi G-M 2004 Groundwater as an archive of climatic and environmental change: Europe to Africa. In, RW Battarbee et al. (eds.), Past Climate Variability through Europe and Africa. Springer, Dordrecht, The Netherlands, 279-306.

Edmunds WM, Fellman E, Babi Goni I, McNeil G, Harkness DD 1998a Groundwater, palaeoclimate and palaeo-recharge in the southwest Chad Basin, Borno State, Nigeria. Proceedings of an International Symposium on isotope techniques in the study of past and current environmental changes in the hydrosphere and atmosphere, IAEA Vienna, 693-707.

Edmunds WM, Guendouz AH, Mamou A, Moulla A, Shand P, Zouari K 2003a Groundwater evolution in the Continental Intercalaire aquifer of southern Algeria and Tunisia: Trace element and isotopic indicators. Applied Geochemistry, 18, 805-822.

Edmunds WM, Kay RLF, McCartney RA 1985 Origin of saline groundwaters in the Carnmenellis granite (Cornwall, England) – natural processes and reaction during hot dry rock reservoir circulation. Chemical geology, **49**, 287-301.

Edmunds WM, Kinniburgh DG, Moss PD 1992b Trace metals in interstitial waters from sandstones: acidic inputs to shallow groundwaters. Environmental Pollution, **77**, 129-141.

Edmunds WM, Lovelock PER, Gray DA 1973 Interstitial water chemistry and aquifer properties in the Upper and Middle Chalk of Berkshire, England. Journal of Hydrology, **19**, 21-31.

Edmunds WM, Ma J, Aesbach-Hertig W, Kipfer R, Darbyshire DPF 2006 Groundwater recharge history and hydrogeochemical evolution in the Minqin Basin, North West China. Applied Geochemistry, **21**, 2148-2170.

Edmunds WM, Robins NS, Shand P 1998b The saline waters of Llandrindod and Builth, Central Wales. Journal of the Geological Society of London, **155**, 627-637.

Edmunds WM, Shand P, Hart P, Ward R 2003b The natural (baseline) quality of groundwater in England and Wales: a UK pilot study. Science of the Total Environment. **310**, 25-35.

Edmunds WM, Taylor BJ, Downing RA 1969 Mineral and thermal waters of the United Kingdom. Proceedings XXIII International Geological Congress, Vol 18, pp 139-158.

Elliot T, Andrews JN, Edmunds WM 1999 Hydrochemical trends, palaeorecharge and groundwater ages in the fissured Chalk aquifer of the London and Berkshire Basins, UK. Applied Geochemistry 14 333-363.

Eriksson E, Khunakasem V 1969 Chloride concentration in groundwaters, recharge rates and rate of deposition in the Israel Coastal Plain. Journal of Hydrology, **7**, 178-197.

Fontes J-C, Andrews JN, Edmunds WM, Guerre A, Travi Y 1991 Paleorecharge by the Niger River (Mali) deduced from groundwater geochemistry. Water Resources Research, **27**, 199-214.

Gates JB, Edmunds WM, Ma J, Scanlon BR 2008 Estimating groundwater recharge in a cold desert environment in northern China using chloride. Hydrogeology Journal, **16**, 893-910.

Gaye CB, Edmunds WM 1996 Groundwater recharge estimation using chloride, stable isotopes and tritium profiles in the sands of northwestern Senegal. Environmental Geology, **27**, 246-251.

Hinsby K, Purtschert R, Edmunds WM 2007 Groundwater age and quality. In: Quevauviller P. (ed.) Groundwater Science and Policy: An International Overview. RSC publishing, 217-239. Print ISBN: 978-0-85404-294-4, PDF eISBN: 978-1-84755-803-9, DOI:10.1039/9781847558039.

Kloppmann W, Dever L, Edmunds WM 1998 Residence time of Chalk groundwaters in the Paris Basin and the North German Basin: a geochemical approach. Applied Geochemistry, **13**(5), 593-606.

Post VEA, Groen J, Kooi H, Person M, Ge S, Edmunds WM 2013 Offshore fresh groundwater reserves as a global phenomenon. Nature, **504**, 71-78.

Smedley PL, Edmunds WM 2002 Redox patterns and trace-element behaviour in the East Midlands Triassic Sandstone Aquifer, UK. Ground Water, **40**, 44-58.

Shand P, Edmunds WM, Lawrence AR, Smedley PL, Burke S 2007 The Natural (Baseline) Quality of Aquifers in England and Wales. British Geological Survey, 72pp. ISBN 978-085272595-5.

Smedley PL, Edmunds WM, Pelig-Ba 1996 Mobility of arsenic in groundwater in the Obuasi gold-mining area of Ghana: Some implications for human health. Geological Society Special Publication No. 113, 163-181.

Whitehead PG, Edmunds WM 2012 Modelling and reconstruction of the River Kennet palaeohydrology and hydrogeology: Silbury Hill and Avebury in 4,400 BP. Hydrology Research, 43(5), 551-559.

Mike (left of centre with folded arms) with the Baseline project team, a ten country European collaboration studying natural groundwater quality led by Mike.