The Geological Society

HOGG

Contaminant Hydrogeology – A Backward Look

17 December 2004

at Burlington House, The Geological Society, London

A meeting convened by The Hydrogeological Group and the History of Geology Group of the Geological Society, London

9:50 Doors open, registration and coffee

10:30 Welcome and morning session

Erasmus Darwin (1731-1802) and improvements to his well in Derby. John Mather (Royal Holloway, University of London)

What goes in will come out - eventually: a personal perspective on agricultural pollution. John Chilton (British Geological Survey)

Has 20 years of groundwater protection achieved anything: why is groundwater pollution increasing? Bob Harris (Environment Agency)

12:00 Hydrogeological Group AGM

Lunch (not provided)

13:15 Early afternoon session

From dump and depart to wait and see – the early years of research into the impact of waste disposal on groundwater. Chris Young (Water Research Centre)

Waste disposal – Sustainable practices or ticking time-bomb. Marion Carter (MJCA)

30 years of radwaste research; 25 years of barking up the wrong trees. John Black (In-Situ Solutions)

14: 45 Afternoon tea

15:15 Late afternoon session

A civil action in Sawston: the landmark Cambridge Water Company case. Bruce Misstear (Trinity College University of Dublin), Paul Ashley (Mott MacDonald)

The UK and World's first published case of chlorinated solvent contamination of groundwater. Michael Rivett (University of Birmingham) & Lewis Clark* (Clark Consult Ltd)

Whitaker medal presentation – Glyn P. Jones

16:15 Cheese and wine (additional payment and booking required) **Close at: 17:25**

Convenors: Michael Rivett (University of Birmingham), John Mather (Royal Holloway, University of London)

ABSTRACTS

Erasmus Darwin (1731-1802) and improvements to his well in Derby

J D Mather (Royal Holloway University of London)

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Erasmus Darwin, the grandfather of Charles, has been credited as the first person to site a well on the basis of scientific reasoning and the first to give a clear explanation of the principle underlying the artesian well. In 1783 he moved with his new wife from Lichfield to Derby and one of the improvements he carried out prior to the move was to the water supply. He noted the excellent water quality and copious flow in St Alkmund's Well about half a mile from his house in Full St.

Darwin considered that this water originated from Radbourne Common about 5 miles to the northwest. From here it had moved down, through a stratum of sand to St Alkmund's Well. He supposed that the strata feeding this well might be found by deepening a disused, shallow, polluted well close to his house. On boring down to 36 ft sand was brought up and a spring gradually rose until it overflowed at the surface. The theory behind his well was that waters sliding between different strata would descend until they either found or made themselves an outlet where they would in consequence rise to a level with the part of the mountain where they originated.

Darwin's work is examined from the viewpoint of a modern hydrogeologist. It is recognised that, although the principle was fine, the local geology was more complex than he supposed and the improvement made to his water supply owed more to chance than to his scientific reasoning. Although he did give a clear explanation of why artesian overflows occur, Bernard Palissy had done so some 200 years before.

What goes in will come out - eventually: a personal perspective on agricultural pollution

John Chilton (British Geological Survey)

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The presentation reviews the history of nitrate pollution in the UK from a hydrogeological perspective, ie concentrating on the investigations of nitrate occurrence and behaviour in groundwater rather than on legislative and regulatory aspects and associated control measures. Some of the early evidence of rising nitrate concentrations in groundwater is presented, and its role in initiating hydrogeological investigations is discussed. Investigations in the 1970s by both BGS and WRc initially focussed on determining the scale of nitrate leaching, and then broadened to cover a range of land use types and different aquifers in several parts of the country. From the late 1970s and through the 1980s, predictive modelling of nitrate concentrations, led by WRc, was applied to simulating unsaturated zone profiles and to predicting future nitrate concentrations in public supplies derived from groundwater. More recently, modelling has been used to simulate the effects of change in land use and agricultural inputs ie the beneficial impacts of measures to control pollution. These latter illustrate the long timescales over which groundwater quality responds to changes at the land surface; hence the "eventually" of the title. Not surprisingly, the extensive body of scientific endeavour devoted by many to studying nitrate pollution over the last thirty years has produced advances in our collective hydrogeological understanding, some of which are briefly illustrated.

Has 20 years of groundwater protection achieved anything: why is groundwater pollution increasing?

Bob Harris (Environment Agency)

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The development of modern approaches to groundwater protection in the UK were driven by the Control of Pollution Act and the role given to Regional Water Authorities over the siting of waste disposal facilities. Severn-Trent RWA adapted existing European approaches to publish first in 1976, followed by Southern and leading ultimately to a national "policy" in 1992 with associated maps and zones. A whole raft of guidance and tools for what we now term risk assessment has been produced, but why is there a growing problem in water quality? Data from a recent UKWIR/EA/BGS study shows that despite our efforts with controlling point sources of pollution, raw groundwater is deteriorating quickly under the threat of diffuse sources. Treatment cannot be the long-term solution and new approaches are needed…. but are our current institutional arrangements best able now to address the problems?

From dump and depart to wait and see – the early years of research into the impact of waste disposal on groundwater.

C.P.Young (WRc plc)

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Practical study of waste pollution potential began in the 1950s. Early 1970s reports of cyanide and PCBs in West Midlands and South Wales landfills precipitated waste management control legislation and the establishment of a national programme of research into the impact of landfills on groundwater. During the first five years the work was undertaken by a small number of contractors, who worked through a steep learning curve developing field and laboratory investigation procedures. The contractor pool expanded to include more commercial and academic research bodies. By the mid 1980s the knowledge base had grown sufficiently for the issue of Waste Management Paper No 26 – Landfilling Wastes. By then landfill practice had moved from pre-1960s Dump and Depart procedures, through controlled Dilute and Disperse landfilling, towards the Contain and Collect philosophy. At that time research diverged into themes, including the impact of leachates on groundwater, landfill gas control, waste characterisation and landfill engineering. Early on it was recognised that the processes that control groundwater pollution may be slow and a long time may pass before predicted outcomes can be judged against reality. The present stage may be described as the Wait and See phase.

Waste disposal – Sustainable practices or ticking the time-bomb

Marion Carter (MJCA)

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Despite the ‘prophets of doom’ we have not seen gross contamination of vast areas of groundwater in this country as a result of our waste disposal practices. In fact our hydrogeologically driven approach to the location and operation of landfills, regulated under UK land use planning and environmental law long before the Landfill Directive, provided a cost effective answer to one of society’s greatest challenges – disposing of our waste.

Problems with leachate and gas in the 1970s were solved by the rapidly developing waste management industry working with the regulatory bodies. The Groundwater Directive reinforced by the Landfill Directive

forced us down the engineering driven route of containment. Worse was to follow with the separation of hazardous and nonhazardous waste creating landfills which will be a hazard in perpetuity. The components of our wastes come out of the ground, air or water and will go back again. Sustainable practices will re-introduce to the environment the components of the waste in a form and concentration that is not damaging. We were moving towards sustainable practices in the early 1980s. The research and experience gained then will be relevant to the future development of sustainable landfill practices.

30 years of rad waste research, 25 years of barking up the wrong trees

J. H. Black (In Situ Solutions Ltd)

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This is my personal view of the history of rad waste research in the UK. I believe we failed politically because we failed scientifically, or should I say, as a community, we proved to be slow learners. Only since the rejection of the so-called 'rock characterisation facility' at Sellafield have we begun to rethink the practical science of the deep geological disposal of radioactive waste. In this talk, I will identify two major aspects that have had a harmful effect on our ability to win hearts and minds to our proposal.

The first aspect is the slowness with which we have come to recognise the essential character of the geological environment that we have been investigating. The geosphere that we have observed relevant to radioactive waste repositories is one where geological processes such as glacial unloading and density driven flows are the dominant groundwater processes, not present-day water tables. For too long we tried to force our observations to match our readily available "resources style" models. This was not credible and only recently have we begun to adopt more realistic concepts.

The second harmful aspect has been our narrow minded view of the paramountcy of performance assessment within "safety cases" and our disregard for the need to "demonstrate in some simple tangible way that we understand the geosphere under investigation". On the contrary, we have tried to communicate with our peers through the medium of complex and abstruse performance assessment models that, in reality, are only understood by a small clique. We must return to simple demonstrations of the effectiveness of geological isolation such as reliable samples of very old groundwater, or evidence of rock-water systems still trying to adjust to a glacier that melted 10,000 years ago.

I will illustrate my argument with examples from the UK.

A civil action in Sawston: the landmark Cambridge Water company Case

Bruce Misstear (Trinity College University of Dublin) & Paul Ashley (Mott MacDonald)

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In 1986 Cambridge Water Company sued Eastern Counties Leather (and a second tannery) for the damage caused by pollution of the former's Sawston Mill groundwater source by tetrachloroethene, a solvent used as a leather degreasant. The subsequent investigations were not only pioneering studies of DNAPL behaviour in dual-porosity media, but also precursors to a House of Lords judgment that set a limit on the extent of polluters' liability for historical pollution – an outcome greeted with a collective sigh of

relief by the insurance industry. The paper describes the history of the CWC v ECL case, from both a technical and legal perspective. Particular attention is given to the complex behaviour of the pollutant in the Chalk aquifer and its significance for the final legal judgment, which placed great emphasis on the issue of "foreseeability". The case is also considered in the context of subsequent European and UK legislation - and in terms of its social impact on students of law and environmental science through the examination system.

The UK and World's first published case of chlorinated solvent contamination of groundwater

Michael Rivett (University of Birmingham) & Lewis Clark* (Clark Consult Ltd)

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Lyne and McLachlan (1949) is believed to be the UK and World's first published case concerning chlorinated solvent contamination of groundwater. It is a near unknown publication in *The Analyst* that significantly pre-dates the general onset in UK awareness of solvents such as trichloroethylene (TCE) in ground water in the 1980s and even later. Due to its historical significance, research was undertaken to uncover author details and the two case studies reported (locations were undisclosed). Both authors were "public analysts" with wide environmental and public-health responsibilities with the Borough of Reading and elsewhere. Lyne and McLachlan lived into the era where TCE emerged as a major ground-water issue, however, knowledge (albeit still limited) in the ground-water community of their paper did not occur until after their deaths, around 1996 in North America and it would appear not until 2004 in the UK. The most probable location of the two sites is in the Reading area Thames Valley gravel aquifer where efforts were focused to locate them based upon given descriptions, well records, river proximity and probable TCE use. The latter was widespread as Reading had a significant engineering-industry base with several active centres for war-time aircraft manufacture. Although the sites could not be unequivocally identified, candidate sites were proposed that are worthy of further attention. Examination of the international historical case study and chemical analysis literature suggests that the contamination of groundwater by solvents could have perhaps been diagnosed significantly earlier than is generally appreciated in the UK.

* Author now deceased.