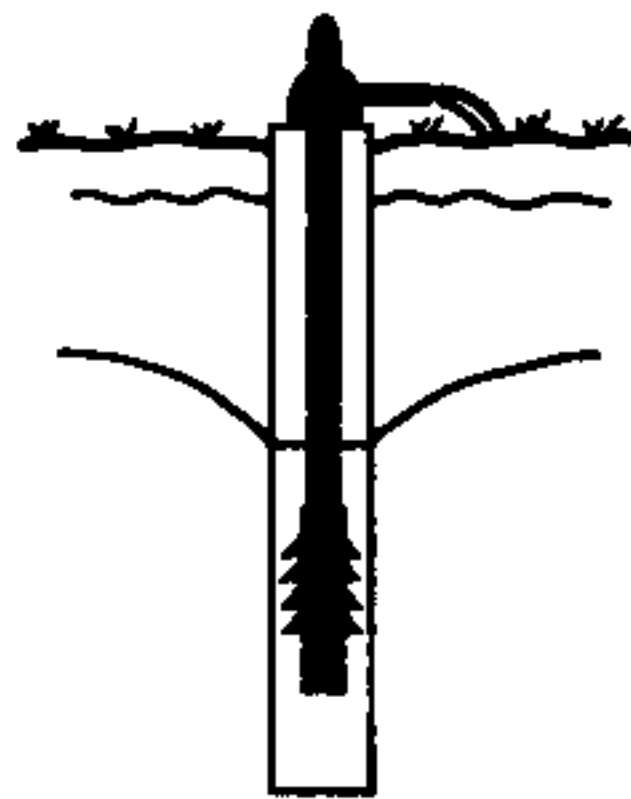


# THE GSI GROUNDWATER NEWSLETTER



# NUAHTÁN SCREAMHUISCE SGÉ

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### SYNTHETIC ORGANIC CHEMICALS

**Synthetic organic chemicals** could pose, in my view, one of the greatest threats to groundwater quality in Ireland - greater than the much publicised threat of nitrates or toxic metals. They are now ubiquitous in many aquifers in developed countries. A significant feature of trace organics is that only a small quantity is needed to cause widespread pollution. For instance 1kg of pentachlorophenol entering groundwater would pollute  $2 \times 10^6 \text{m}^3$  (440 million gallons). There is an urgent need for a greater knowledge of this environmental problem among hydrogeologists, water supply engineers and agricultural scientists in Ireland. To create greater awareness, the Irish Branch of I.A.H. are bringing Lewis Clark, an internationally respected scientist from the Water Research Centre in Britain, to give a lecture entitled "**Trace Organic Contamination in Groundwater Supplies**". (See page 8 for further details). On page 4 Richard Thorn and Noreen Hanna discuss the use of the **K/Na ratio** as an indicator of pollution. This is further highlighted in an article (page 2) on a **groundwater quality** investigation in **County Offaly**. The **hydrodynamics of peatlands** are poorly understood, but hopefully a study which is soon commencing involving a joint Dutch/Irish team of scientists (page 6) will help to rectify this.

Donal Daly, Geological Survey of Ireland.

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## GROUNDWATER QUALITY AND POLLUTION

### A Groundwater Quality Investigation in County Offaly

**Introduction:** An investigation of groundwater quality in a small (2km<sup>2</sup>) rural area in County Offaly was recently carried out by the Geological Survey of Ireland, assisted by Offaly County Council and the Midland Health Board. Water supplies in this area are obtained from privately owned dug and bored wells. The study involved sampling all the wells and a brief survey of each well site noting the type and depth of well, depth to rock, type of subsoil, depth to watertable and details on potential pollution sources including distance from soakage pits and farmyards.

**Geology:** The area is underlain by gravel with some clay and limestone bedrock, which is somewhat karstified.

**Groundwater Quality:** When sampled in June, six out of ten wells contained E. coli. When sampled in August, three out of eighteen wells contained E.coli. The chemical analyses showed contamination of six wells, as indicated by raised levels of conductivity, chloride, potassium and nitrate. Two sources were defined as polluted\* chemically due to high potassium (K) levels. The chemical contamination was localised and variable. For instance, nitrate (NO<sub>3</sub>) levels varied from 3 to 43 mg/l within short distances and from site to site.

**Sources of Contamination/Pollution:** As two of the wells were dug and not properly covered or sealed it was concluded that bird faeces and/or surface runoff was the source of E.coli. One polluted dug well with E.coli and a high K level was located in a poorly managed farmyard. Out of the three boreholes with E.coli, two were considered to be polluted by septic tank effluent, although there was a slight possibility that a sinking stream in the area could be the cause. Both were located in an area with a thin subsoil and unsaturated zone. There was no obvious explanation for the presence of E.coli in the third borehole when sampled in June.

Two wells were polluted chemically, with K levels of 24.5 and 29.6 mg/l and potassium/sodium (K/Na) ratios of 1.94 and 3.0. Both were in farmyards. One, a dug well, contained E.coli; the second, a bored well, was

\*The term "pollution" is reserved for situations where contaminant concentrations are above the European Community (1980) maximum admissible concentrations.

protected from bacterial pollution by thick subsoil. Two further bored wells were contaminated chemically with K levels of 7.3 and 8.1 mg/l, K/Na ratios of 0.86 and 0.83 and nitrate levels of 43 and 31 mg/l, respectively. Both were close to farmyards where soakage pits were used for the disposal of high volumes of dirty (soiled) water. Filtration in the thick (10m) subsoil prevented bacterial pollution.

**Conclusions:** 1. The groundwater quality pattern that emerged depended not just on the pollution loading that was applied but also on the natural vulnerability of the groundwater as dictated by the geology and the hydrogeology. At three sites where the pollution loading was high from farmyard wastes there was no bacterial pollution because of the natural protection provided by a thick subsoil and unsaturated zone. Two sites with lower pollution loading - from septic tank systems - were persistently polluted by faecal bacteria because they are located where the subsoil and unsaturated zone are thin.

2. Dug wells are prone to bacterial pollution unless properly fenced around, covered and sealed.

3. In Ireland the presence of high nitrates in private wells cannot automatically be blamed on fertilizers. In fact in the study area, organic wastes at point locations - farmyards - were the sources of nitrate and fertilizers did not appear to be significant.

4. The investigation provided further evidence that the K/Na ratio can be a useful technique for distinguishing between local contamination by farmyard wastes and septic tank effluent. In the Offaly area, K/Na ratios greater than 0.4 indicate that farmyard organic wastes are the probable source of contamination. However care must be taken in using this technique as preferential attenuation of the K is possible as the contaminants move away from the pollution source (farmyard) thus giving a reduction in the K/Na ratio.

5. This investigation was very basic and simple. Yet a proper assessment of groundwater quality and resulting health hazards is not possible without such an investigation.

**Donal Daly, Geological Survey of Ireland, Niall Sweeney, Offaly County Council and Mary Kate Holahan, Midland Health Board.**

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## Potassium and the K/Na ratio as Indicators of Groundwater Pollution

Ellis (1980) showed that upon decay vegetable matter releases more potassium than sodium and thus elevated levels of this ion could indicate vegetable based contamination; Ellis used the elevated levels to identify contamination by leachate from a municipal waste landfill. Daly and Daly (1982) extended the interpretation of potassium data to include the K/Na ratio. They suggested that in Ireland potassium concentrations greater than 5 mg/l and K/Na ratios greater than 0.3 might indicate local, vegetable based contamination.

Two factors must be taken into consideration when interpreting potassium levels and K/Na ratios. First, elevated levels of potassium in groundwater may result from the leaching of potassium from a potassium rich rock or from the spreading of potassium fertilisers. It is clear that these possibilities should be eliminated before interpreting the data. Second, the extent to which the K/Na ratio can be used to indicate whether the contamination is locally based depends significantly on the geology. Since potassium is a positively charged ion it may be adsorbed by the negatively charged colloidal components of soil and rock i.e. the silicate clay minerals, iron and aluminium oxides and organic colloids. The extent to which the potassium will be adsorbed depends on the nature and amount of colloids present. Thus peat, which has a large number of highly charged organic colloids, will adsorb considerably more potassium than sand, which has few colloids. This was demonstrated clearly in an earlier issue of the **GSI Groundwater Newsletter** (No. 8, June 1988, p. 2).

A set of experiments was carried out in Sligo RTC in which the changes in potassium concentrations and K/Na ratios were observed as a range of effluents (including septic tank and animal manures) underwent simulated passage through a range of rock types. The results showed that gneiss and limestone have little if any effect on the ratio while passage of the effluents through peat, shale and a sand, clay and gravel mix did result in a decrease in the ratio. The findings suggest that where high ratios are found in groundwater in rocks with few clay minerals present e.g. clean limestones and sandstones and many metamorphic and igneous rocks, the source of the contamination may not necessarily be close by.

Daly, E.P. and Daly, D. (1982). A study of the nitrate levels in the aquifers of the Barrow River Valley, Ireland. Proceedings of IAH International Symposium on the Impact of Agricultural Activity on Groundwater. Part I 183-193. Prague, Czechoslovakia.

Ellis, J. (1980). A convenient parameter for tracing leachate from sanitary landfills. Water Research, 14, 1283-1287.

**Richard Thorn and Noreen Hanna, Sligo RTC**

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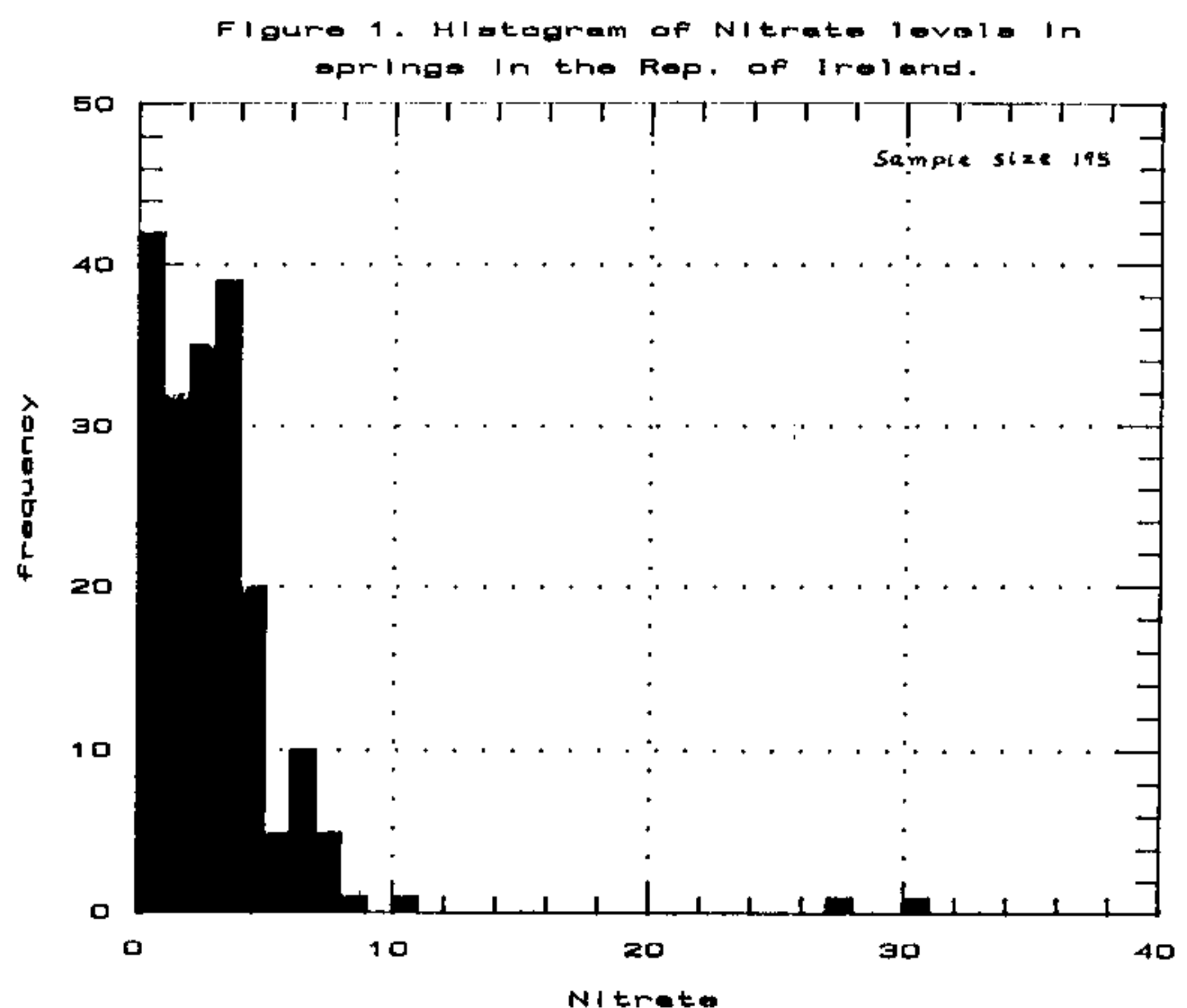
## Water Quality of the Major Springs in the Republic of Ireland in 1985/86

Temperature readings and water samples (for chemical analysis by the State Laboratory) were taken from most of the major springs in the Republic of Ireland in 1985/86, as part of the European Community Geothermal Project. Although this was not a comprehensive survey it provided useful information on groundwater quality throughout the country at 195 widely dispersed locations.

Rainfall in the two years (85/86) was average although both summers were considered to have been "wet". Most of the springs sampled flow from the limestone and sand and gravel aquifers, which are the most productive in the Republic. Furthermore the samples were taken mainly from large springs and therefore represent conditions over a reasonably substantial aquifer area at each sampling location. Hence these results reflect the water quality in the upper (generally unconfined) and most vulnerable parts of the principal aquifers in the Republic.

The results show that these groundwaters are normally hard (T.H. of 200-400 mg/l) with low mineralization (T.D.S. of 200-500 mg/l) and generally good quality although there were exceptions. Nitrate levels (Figure 1) were normally low (85% less than 5.0mg/l as N) and only 1% in excess of 11.2 mg/l (the MAC). Nitrate levels in the spring waters of the Connaught/Ulster region were much lower than elsewhere. Potassium concentrations were generally quite low (less than 3.0mg/l). A number of spring waters in County Galway had significant concentrations of ammonia which is not surprising in view of the karstic nature of the limestones in the county.

Copies of the complete report are available from the Geological Survey. Price £5.00.



Eugene Daly, Michael Geraghty and Bob Aldwell, Geological Survey of Ireland.

## **Joint Dutch/Irish Peatland Geohydrology Project**

Raised bogs are fascinating and extraordinary earth environments. Peats are physically unique geological deposits because water is an essential part of their structure, forming more than 85% of their volume. They are sensitive to the amount and quality of the water available. However the ability of raised bog ecosystems to withstand changes in the water balance or hydrochemistry are two factors which remain poorly understood. Yet the key elements in the actual conservation of raised bogs are often the understanding and control of the hydrology and hydrogeology. This realisation has led to the setting up of an exciting joint research project by the Irish and Dutch governments.

Ireland unlike the Netherlands is lucky to still have several relatively intact raised bogs. The study will enable the Wildlife Service in Ireland to prepare management programmes for the conservation of certain raised bogs. It will assist the Dutch in their restoration projects because the Irish raised bogs can be compared to the original Dutch systems and can form an ideal reference for the areas to be restored in the Netherlands.

Two raised bogs in County Offaly - Clara and Raheenmore - have been chosen for detailed study. The aims of the research are:

- 1) To investigate the various elements of the water balance;
- 2) To understand the mechanisms and parameters that control the hydrodynamics of the two raised bogs;
- 3) To study the impact of drainage, turf cutting and agricultural development of the margins; and
- 4) To assess the influence of groundwater in the surrounding glacial and glaciofluvial deposits (tills, sands and gravels).

Geological, geophysical, botanical, drilling, groundwater, hydrological, hydrometrical, hydrochemical, computer and modelling techniques will be employed. Particular emphasis will also be given to developing good relations with the local people because without their assistance and support the conservation of the bogs is unlikely to be successful.

The research, which is funded by the Wildlife Service, the Geological Survey of Ireland and the Dutch government, will be undertaken by scientists from the Geological Survey of Ireland (Donal Daly and Willie Warren), the Wildlife Service (John Cross, Pat Warner and Jim Ryan), Teagasc (Bob Hammond), Sligo Regional Technical College (Richard Thorn), University College Galway (Paul Mohr and Colin Brown), Trinity College Dublin (David Jeffrey), the University of Amsterdam, the Agricultural University at Wageningen and the National Forest Service in the Netherlands, with appropriate student labour.

Progress reports will be given in future issues of the Newsletter.

**Donal Daly, Geological Survey of Ireland.**

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## EDUCATION

### **IQUA Symposium "Conservation of Earth-Science Areas of Scientific Interest in Ireland"**

The Irish Association for Quaternary Studies (IQUA) in association with the National Committee for Geology and the Geological Survey of Ireland is organising a symposium "Conservation of Earth-Science Areas of Scientific Interest". The aims of the symposium are, firstly to act as a forum for discussion, secondly to increase the awareness and knowledge of conservation issues among earth scientists, thirdly to highlight the special needs of earth-science conservation in Ireland and fourthly to generate momentum for improvements. The symposium will not only be of interest to geologists and geographers who are concerned about conservation and environmental issues, but also to engineers, planners and biologists who are responsible for the conservation of earth-science areas of scientific interest.

The keynote address will be given by Dr. Bill Wimbleton from the Nature Conservancy Council in Britain. He will give the pros and cons of the situation there and will suggest lessons that we could learn from their experience. His paper will be followed by a series of short papers from people with a wide variety of backgrounds - John Feehan, Environmental Resources Analysis; George Sevastopulo and David Jeffrey, T.C.D.; Willie Warren and Donal Daly, Geological Survey of Ireland; Alan Craig and Pat Warner, O.P.W.; Terry Doherty; Joe Furphy, Department of the Environment for Northern Ireland; Bob Hammond, Teagasc; and John Barnet, consultant.

The seminar will be held on Friday 1st December 1989 at the Geological Survey of Ireland commencing at 9.30 am. There will be a small entry charge to cover the cost of publishing the extended summaries of the papers. Non-members are welcome. For further information contact me at the Geological Survey (tel. (01) 609511).

**Donal Daly, Geological Survey of Ireland.**

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## I.A.H. NEWS

### **Autumn Lecture: "Trace Organic Contamination in Groundwater Supplies"**

Dr. Lewis Clark of the Water Research Centre in Britain will give a lecture in the Geological Survey on Thursday the 12th of October at 6.0 pm.

**Abstract:** Two groups of trace organic contaminants are causing particular concern for the UK groundwater supplies; pesticides and chlorinated solvents. These contaminants are the subject of major research studies by the Groundwater Quality Section of WRc at Medmenham.

The impact of agricultural pesticides on water resources has been studied in a small catchment on the Chalk aquifer of Eastern England. To date, this study has included a three year survey of the land-use patterns and pesticide usage in the catchment. A multi-residue method of analysis for 20 'target' pesticides used in the catchment has been developed and used to monitor pesticide concentrations in rain water, river water and groundwater. The results of one years monitoring will be presented and the implications for the water industry discussed.

The research is being extended to a site on the Bunter Sandstone aquifer in Central England. The proposed programme will be presented together with the philosophy of the developing research trends.

Several cities in the UK are built on major aquifers and inevitably have contaminated the underlying groundwater resources. The chlorinated solvents, used in large quantities in the engineering and related industries, are now common contaminants in the groundwaters.

The solvent contamination beneath two cites studied by the WRc will be described briefly. Emphasis will be laid on the historical land-use in such areas, the difficulties with the investigation methods in solvent investigations and the options open for a water undertaking when such contamination is discovered.

All those interested in this topic are welcome to attend.

**Enquiries to: Eugene Daly, Geological Survey of Ireland. Tel. (01) 609511**

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### **CONTRIBUTIONS FOR THE NEXT ISSUE OF THE NEWSLETTER**

They should reach the Geological Survey before **15th November, 1989**. All items should be as short (**maximum 350 words**), interesting and as newsworthy as possible.