

SPECIALIA

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Tritium Analyses of Groundwater from the Gort Lowland of Western Ireland

An isotopic survey of groundwater in the Gort lowland of western Ireland was initiated by making tritium analyses of selected samples. The region comprises mainly lower Carboniferous limestone up to more than 3,000 feet thick, see DOUGLAS¹, and falls into the lowland type of Irish karst, see WILLIAMS². This is characterized by low altitude and relief coupled with gentle slopes. Dips rarely exceed 20°. The Gort plain, basically an extension of the Central Lowland of Ireland, never rises above 100 feet except for an occasional drumlin. Patchy mantling with glacial drift occurs so that 'covered karst' exists in places and this may have an important bearing on the transit time of water input to groundwater. Elsewhere, solution lakes, dry lakes and hums (residual hills resulting from corrosive planation of surrounding limestone) are found. North-west lies the desolate Burren plateau, an example of the upland type of Irish karst, with poljes such as the Carran depression on it. Growth of poljes was probably associated simultaneously with expansion of the groundwater system and solution processes are widely active in the area now. They facilitate direct infiltration of precipitation to groundwater and rates in the Burren are estimated as from 0.08 mm to 0.12 mm annually. WILLIAMS³ suggested a rate equivalent to 0.05 mm per year in the Fergus basin. After 1952, detonation of thermonuclear devices increased the concentration of tritium in the atmosphere by orders of magnitude and labelled the overall hydrologic cycle. The test ban treaty resulted in a continuous diminution from the highest levels attained in 1963 as shown by the records at Valentia, south-west Ireland, a contributing meteorological station of the World Precipitation Network. These are valuable because they represent tritium input to be expected in the sampling area situated about 100 miles north-west. 0.5-litre samples of groundwater were collected by one of us (P.W.W.). In principle, 'dating' of the groundwater could be effected following the relation $I_s = I_0 e^{-\lambda t}$ (I = observed activities at sampling point s and point of entry to aquifer o , λ = decay constant 0.055 y^{-1} and t = age of water). In practice, natural conditions probably always involve lateral and longitudinal diffusion phenomena precluding adoption of the piston-flow type model to which alone this relation may be applied. Tritium is one tool of the combined environmental isotope approach, discussions of which

may be found in PAYNE⁴, DAVIS⁵ and BOWEN⁶. RAMA⁷ indicated that questions which tritium may be used to solve include: 1. Is the groundwater of modern cycle, hence replenishable? 2. Does recharge reach the aquifer directly or only through stream channels? Results obtained are:

Localities	Values
1. Coole Lodge pump, Gort, Co. Galway	74.6 tritium units
2. Killourney rising, Boston, Co. Clare	92.2 tritium units
3. Scarriff pump, Tubber, Co. Galway	100.6 tritium units
4. Toberreendoney rising, Tubber, Co. Galway	79.2 tritium units
1 and 2 are in the Gort river basin lying north of a known watershed.	
3 and 4 are in the Fergus river basin south of the known watershed.	

Collection took place in early December 1970 and analyses were effected in spring 1971. On question 1 above, after 4 half-lives, i.e. roughly 50 years, natural tritium decays to 0.5 tritium unit, but thermonuclear injections mean that a sample of uncontaminated groundwater containing a significant quantity of tritium constitutes unequivocal evidence of the presence of a component of modern recharge. The above data show that recent (post-thermonuclear, i.e. post-1952) recharge has occurred which is to be expected in a karstic terrain. The samples were collected in the winter of 1970 and the precipitation values for this period were 35.6 tritium units in November

¹ J. A. DOUGLAS, Q. Jl. geol. Soc., Lond. 65, 538 (1909).

² P. W. WILLIAMS, Irish Geogr. 24, 105 (1970).

³ P. W. WILLIAMS, Aust. natn. Univ. Res. Sch., Pacific Studies, Dep. Geogr. Publs. G/5,1 (1968).

⁴ B. R. PAYNE, Geophys. Monogr. 11, 62 (1967).

⁵ G. H. DAVIS, Tech. Rep. IAEA, Wien 91, 118 (1968).

⁶ R. BOWEN, Sci. Prog., Oxford 57, 559 (1969).

⁷ S.N.I. RAMA, Tech. Rep. IAEA, Wien, 91 167 (1968).

and 23.7 tritium units in December, substantially below the groundwater ones. The latter reflect earlier inputs, perhaps from the preceding summer with 118 tritium units in May, 126.3 tritium units in June, 99.1 tritium units

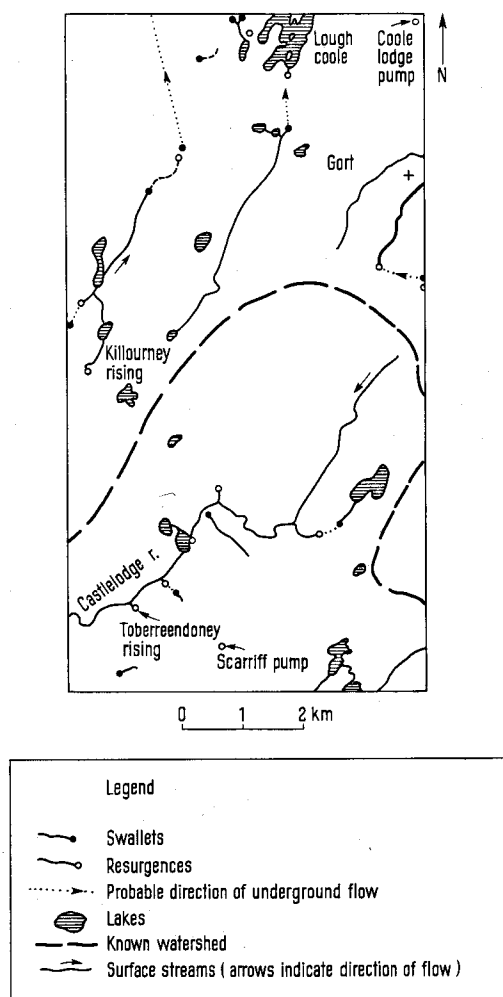
in July and 117.2 tritium units in August. This is consistent with karst studies showing that percolation water in the vadose zone passes to groundwater within a year. However, most summer rain is evapotranspired and also the limestone at the 4 sampling points is overlaid by calcareous boulder clay probably acting as a delaying mechanism. Consequently, a model employing a year with winter precipitation having tritium values of the right order of magnitude is proposed and this is 1966 where October had 98.04 tritium units and November 99.12 tritium units. Underground karstic interconnections exist and promote good mixing, thus eliminating one of the causes of groundwater stratification, namely, density stratification. Hence, the possible placing of the data into 2 groups (100.6, 92.2 and 79.2, 74.6) implies insufficient sampling rather than stratification. In summary, recent, i.e. late 1966, recharge is indicated with slow throughput and, referring to question 2 above, it is known to result from direct infiltration, at least in the cases considered here (although not in general throughout the Clare-Galway area). A stable isotope survey is now in progress⁸.

Zusammenfassung. Grundwasserproben aus der Gort-Ebene (West-Irland) wurden auf Tritium-Gehalt analysiert und die Ergebnisse mit dem bereits bekannten Tritium-Einstrom dieser Gegend verglichen. Registrierungen des «World Precipitation Network» in Wien ergaben den Nachweis eines offenbar langsamen Durchflusses in das Grundwasser-Aquifer-System.

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Phosphatidyl-N-(2 Hydroxyethyl)-Alanine Synthesis of Distearoyl L- α -Glycerolphosphoryl-N-(2 Hydroxyethyl)-Alanine^{1,2}

KEMP and DAWSON³ reported in 1969 that they obtained evidence of a new phospholipid during their investigations of the Ciliatine containing phospholipids of rumen micro-organisms. This novel lipid gave N-(2 hydroxyethyl)-alanine as a product of hydrolysis.

The present communication describes the synthesis of the title compound V with the structure and configuration in which all the naturally occurring phospholipids occur. Stearic acid has been chosen as the fatty acid part, as this happens, more often than not, to be prevalent in the natural lipids.

DL-N-(2 hydroxyethyl)-alanine has been prepared according to the method of VIELES and SEGUIN⁴ with some modifications. The N-carbobenzoxy derivative of this amino acid has been prepared according to the method of BAER and PAVANARAM⁵. The product which gave correct

nitrogen values, without further purification, has been benzylated with an excess of benzyl chloride and triethylamine at 70°–75° and worked out as usual⁶.

¹ Dedicated to Professor Dr. ERICH BAER in honour of his 70th birthday.

² The nomenclature used in this communication is that used by FISCHER and BAER for well-nigh 4 decades. However, according to the rules of IUPAC-IUB commission this should be 1,2-distearoyl-sn-glycero-3-phosphoryl-N-(2-hydroxyethyl)-alanine.

³ P. KEMP and R. M. C. DAWSON, *Biochim. biophys. Acta* **176**, 678 (1969).

⁴ P. VIELES and J. SÉGUIN, *C. r. Soc. Biol., Paris* **238**, 1819 (1954).

⁵ E. BAER and S. K. PAVANARAM, *J. biol. Chem.* **236**, 1270 (1961).

⁶ E. BAER, D. BUCHNEA and H. C. STANCER, *J. Am. chem. Soc.* **81**, 2166 (1959).