

Lecture by C.R. Aldwell at the opening meeting of the Irish Branch  
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#### GROUNDWATER IN IRELAND

It is a great pleasure and honour for me to be given the task of presenting the first paper of what I hope will be a long and varied series by our newly formed Association. As perhaps befits an opening paper it is on a very wide canvas, namely Groundwater in Ireland. I propose to interpret this as the hydrogeology of Ireland, North and South. As a person from the Republic, albeit with strong Northern connections, I hesitated slightly whether to include the North but Peter Bennett assured me to go ahead and I have done. In fact I have been in all parts of Northern Ireland except Rathlin Island. Regretably not so often in recent times, but much of what I will say is based on Peter Mannings paper "The development of the groundwater resources of Northern Ireland."

The way I plan to go is to run through the stratigraphic column of sedimentary and metamorphic rocks and then after them our igneous rocks.

#### Pre-Cambrian

These ancient metamorphic rocks occur most widely in the Northwest in a sread extending across Cos. Donegal, Londonderry, and Tyrone. We also have them in Counties Galway and Mayo with small amounts in Cos. Antrim, Leitrim and Sligo. In most cases water is confined to the small fissures in the weathered zone. In many of the Mountainous areas of the far West the heavy rainfall and acid environment result in high iron and manganese in the groundwater. However these rocks like those of every age vary both in their composition and subsequent history. Schists, slates, hornfelses and other clay rocks are particularly poor waterbearers. Quartzites, gneisses and rocks of strong and rigid physical qualities are most likely to develop tension fissures and thus some secondary permeability. Finally one has the marbles which as carbonate rocks are liable to chemical solution.

In summary, for boreholes of 50-150 ft in areas of (a) schist etc. yields of 10 to 300 gph.

(b) of quartzite 200-500 gph

(c) of marble several hundred to perhaps a couple of thousand gph, but these latter are usually small in areal extent.

#### The Lower Palaeozoics.

I see no valid reason to sub divide these "sedimentamorphic" rocks, except to mention in passing the volcanic rocks of the South East which I shall deal with in more detail later. These rocks occur most notably in the Longford-Down Massif and the South East and rather locally elsewhere. Normally yields are of the order of 50-300 gph in boreholes of 50-150 ft. Some areas are however better than others and the odd fluke does turn up. The biggest yield of a few thousand gph was recorded at Lough Egish in Co. Monaghan, over 1,000 gph near Ballylanders Co. Limerick and isolated yields of 500-1000 gph are on record for Cos. Down and Louth.

Significantly all the ones of which I know that produce such yields in these two counties were from boreholes of less than 100 ft. On the other hand a borehole at Killinchy Co. Down was reported dry at 400 ft. while at 700 ft. a boring at Inch Co. Wexford also failed. The Cambrian quartzites around Wexford Town on the other hand are much faulted and yields of 500-2000 gph are on record. An especially bad area is just south of Wicklow Town, where the rocks are mica schists and slates and there are sizeable areas of the Longford-Down region where yields of 10-100 gph are the order of the day.

#### The Devonian

The Old Red occurs extensively at the surface in the South in Cos. Cork, Kerry and Waterford, its outcrop becomes more intermittent in the midlands being overlain on low ground by the Carb Limestone. Northwards of the Slieve Bloom and Slieve Aughty Mountains it peeps up as small isolated outcrops until we get a sizable extent again in Cos. Fermanagh and Tyrone. It comprises slates, ortho quartzites and conglomerates. One naturally does not expect too much from the slates, but from the quartzites and conglomerates one should hope for better things. Yet to date I have heard of but a few good results, some not well documented, for example in Cork and 1,400 gph from a 100 ft. boring at Irvinestown Creamery Co. Fermanagh. Part of the trouble may be that the stronger,



more arenaceous facies form high relief which is not well suited for allowing recharge to take place. None the less I feel some of these rocks do have possibilities for groundwater where the right combination of facies, topography and tectonics coincide.

#### Lower Carboniferous Slates & Sandstones

These occur in two main areas, the South of Co. Cork and in patches in the North West, including Cos. Donegal, Fermanagh, Londonderry, Leitrim, Longford, Mayo, Sligo and Roscommon. Elsewhere they intermittently flank the Old Red and Silurian inliers.

Where argillaceous members predominate yields are often poor, e.g. Clonavaddy, Co. Londonderry and Brinny, Co. Cork. However yields of 6,000 gph at Brinny from a sandstone and 5,000 gph at Killala, Co. Mayo, 3696<sup>gph</sup> of at Ballykelly Co. Londonderry a couple thousand gph at Roosky Co. Roscommon and from several wells in Co. Cork, show that we have now come at last to our first somewhat encouraging aquifer.

#### The Carboniferous Limestone.

The Carboniferous Limestone is our most extensively outcropping rock, covering nearly all the central plain of Ireland and present in 31 of the 32 counties. From the point of view of hydrogeology it varies tremendously in its waterbearing and water yielding properties. These depend of course on its degree of karstification which in turn relates to its initial purity and its geological formation and subsequent history. The chemical solution required for well developed karst needs limestone of a high carbonate content. Besides bedding planes, joints, faults, etc. are needed to enable the water to get to work and finally the limestone must be exposed to weathering over a reasonable period of time and of course their topographic position is important. One can divide the limestones into large numbers of groups depending on which criteria appears most important to you. To me there are four major types. (1) Well bedded pure limestones (2) Pure massive limestones (reef) (3) Dolomites (4) Argillaceous. These of course at times overlap but most of our limestone rocks fall into one of these groups. This however is only one part of the story as the factors of geological environment tectonic and stratigraphic history together with topography must then be taken into account.

A couple of examples may perhaps help to illustrate the point. Much of the Southern Syncline Limestone is reef. In these favourable topographical situations for advanced karst well developed solution has taken place resulting in high yielding aquifers. Much of the area around Askeaton Co. Limerick is also reef limestone and some good yields are on record. The number of such openings is however much less than in Cork and failures and very deep wells (300 ft.) are not uncommon there. Isolated reef knolls are found in <sup>the</sup> Midlands locally forming high ground, and reef limestones may even form Mountains in parts of the North. These usually are quite poor water prospects.

Then there are the limestones of the Gort lowlands, the Burren and the Aran Islands. These in many ways are petrologically at least superficially quite similar. However their post depositional history has been very different. The Gort lowlands have been very well karstified having been exposed to chemical solution for vast periods of time. Huge quantities of water are present in these limestones.

The Burren on the other hand was protected by an impervious cover until quite recently and solution has only worked down a couple of hundred feet which taking into account its high topography results in quite limited water expect for isolated often flash springs and some water held near the base of the zone of solution.

From what we have seen so far on the Arans it would appear that they are rather similar to the Burren except they lack the topography and mass to encourage solution for more than a few tens of feet. In summary yields of 10,000 gph have been obtained from the limestones of most of the Cork and Waterford synclines, South Wexford and at favourable spots in all the limestone counties south of a line Galway to Dublin with the possible exception of Offaly, and totalling about 40 to date. The largest yield has been 120,000 gph at Dungarvan with 50,000 gph at Mitchellstown and 30,000 gph at Carlow.

In the Northern half of the country there are rather fewer in number, but to me this seems partly due to lesser requirements of water in many of the Northern counties with large areas of limestones, especially Fermanagh, Longford, Mayo and Roscommon.



The largest yield I have details for is 29,000 gph at Cabragh near Dungannon Co. Tyrone. Yields of about 20,000 gph have been reported from Armagh, Killeshandra (7) Co. Cavan, Carrickmacross and Emyvale Co. Monaghan, at Athenry Co. Galway, again at Cabragh Co. Tyrone and Clogher Co. Tyrone. Boreholes with yields of at least several thousand gph have been sunk in most of the remaining counties.

Beside boreholes we must also remember springs which are groundwater and are a common feature of most limestone districts. Springs with measured flows of the order of 4 M gph are reported near Castlemartyr Co. Cork, near Dunmore in Co. Galway and Taughmaconnell Co. Roscommon. While one near Timahoe Co. Laois is credited with over 1 M gph. There are many lesser ones and undoubtedly some not yet measured. I do not have any spring data for the Northern Ireland Carboniferous limestones.

#### The Namurian.

These rocks, shales and sandstones, outcrop in 21 counties but are much more local than the underlying limestone. They remain capping the limestone often at an elevation of 500 - 1,000 ft. around the periphery of the Central Plain. Their most extensive spread is from Lisdoonvarna to Killarney and Mallow followed by the Tipperary - Laois - Kilkenny - Carlow coalfield area in the South East and the Fermanagh, Sligo, Leitrim, Roscommon belt in the North West. The important aquifers in the Namurian are the sandstones, which in favourable conditions can be strongly artesian. The area which up to now has caught <sup>the</sup> most attention and which may be unique from the others in some vital respects is the Castlecomer Plateau. During exploration for coal water sometimes shot 20 - 30 ft. into the air in quantities estimated at the time to be of the order of 1 M gpd. Some of these boreholes are still flowing after 30 years. The rock traditionally credited as the aquifer has been the relatively thin Glaygall Sandstone. Recent work by Eugene Daly however, suggests there are probably several artesian sandstones in the Leinster Coalfield.

Elsewhere yields of close to 10,000 gph were obtained at Kilrush Co. Clare and also at Charleville Co. Cork. Where shales predominate, however, yields are low and iron is an endemic if local problem with groundwater in this formation.

### The Permo Trias

The Permian strata seldom outcrop but their top member, the Upper Permian Marl forms an important impervious base to the overlying permeable Bunter Sandstone of Triassic Age. These rocks are generally relatively small in areal extent and occur with one exception around the edges of the Antrim - Derry Basalt Plateau. The most important stretch is the Lagan Valley - Newtownards - Comber. It also occurs Southeast of Dungannon, east of Dungiven to Limavaddy and Lough Foyle. Finally there is the small Kingscourt occurrence straddling the Co. boundaries of Cavan, Meath and Monaghan.

At Derriaghy between Belfast and Lisburn a 300 borehole sunk in 1975 has been tested at 25,000 gph and at Kennel Bridge near Comber a 270 ft. boring got 21,000 gph. According to the Geological survey of Northern Ireland 35,000 gph represents the highest yield achieved in this sector while 12,000 gph was all that was obtained last year in a borehole at Englishtown which is interpreted as an indication of the generally tighter and finer nature of the Bunter Sandstone as one proceeds S.W. up the Lagan Valley. A yield of 10,000 gph has been obtained near Limavaddy and 6,000 gph near Dungiven. The only deep borehole at Kingscourt for which a flow has been measured is said to have yielded 6,000 gph. It is believed that fissure flow plays an important role in the permeability of the Bunter in Ireland and is at least partly the cause for somewhat variable results in some areas.

### The Jurassic.

The Rhaetic-Lias Shales occur beneath the chalk here and there around the edges of the Basalt Plateau and are not water bearing. Their hydrogeological significance is that they provide an underseal to the water in the overlying Cretaceous.

### The Cretaceous

The chalk and the basal Hibernian Greensands, both are water bearing. For those who have not seen the Irish Chalk, I should explain it has neither primary porosity nor permeability. In fact it is quite difficult to credit that the unconsolidated Cretaceous I saw in Alabama and the chalk



of the South of England or the North of France and these Irish Cretaceous rocks are all of the same age. As a consequence of the importance of fissure flow, strong springs discharge much of its groundwater. Near Larne, the Four Springs are reputed to yield 2 M gph and smaller ones occur elsewhere. A boring yielded 14,000 gph near Larne and 8,000 gph at White Mountain near Belfast.

#### The Tertiary

The Lough Neagh clays are practically impermeable and well yields are poor.

#### Igneous Rock

##### (a) Ordovician of Wexford and Waterford.

These rocks are mainly rhyolites and tuffs and occur most extensively in East Waterford and more irregularly up through Wexford. We do not fully understand as yet all the tectonic and related factors that have resulted in these rocks being quite good aquifers. Their pivotal position close to the hinge joint between the lines of the Hercynian and Caledonian trends may have helped to provide that extra tension needed to encourage good physical fissuring. Whatever be the cause some two dozen boreholes have yields of 1,500 to 6,000 gph which in the case of Waterford has been most fortuitous in a county with considerable water supply problems.

##### (b) Carboniferous of Limerick

In east County Limerick occur quite extensive volcanic rocks of Carboniferous age. They are rather more widespread than the Survey maps suggest and range from basalts to rhyolites with extensive beds of pyroclastic deposits often with carbonate cement.

As water bearers they are very variable and a great deal depends on their individual structure and topographic situation. In favourable conditions yields of up to a few thousand gph are certainly possible, but in cases where they form isolated lava ridges they can be very poor water bearers.

##### (c) Tertiary Lavas of Antrim and Londonderry.

These rocks cover 25% of the land area of Northern Ireland. Their hydrogeology, like so many of our Irish rocks is still but little known.

At Mossley a 400 ft. boring yields 9,000 gph. Yields of up to 6,000 gph have been reported from near Glengormley, while near Ahoghill a 150 ft. well yielded 4,000 gph. Like the two previous groups of volcanic rocks results thus tend to be erratic, but can be good.

#### The Granites

Four major occurrences of granite are present in Ireland. Donegal, Galway, Wicklow and the Mourne.

(i) The Donegal Granite has three main divisions and has usually but little overburden. It forms rugged wild country, often covered by bog and dotted with lakes. Few borings have been sunk in it and my expectation would be limited water in the weathered zone.

(ii) That of Galway is rather similar. In this case we have had some borings mostly for domestic supplies. One well of 300 ft. at Spiddal has yielded over 4,000 gph, perhaps due to local felstone dykes.

(iii) The Wicklow granite shows weathering for tens or even hundreds of feet, it also often has overburden, sometimes thick. There are lots of fissures in the weathered zone and borings of 40 - 100 ft. almost invariably yield a few hundred gph. I cannot however recall a case of over 1,000 gph and I have seen hundreds of borings in this Leinster Granite.

(iv) The Mourne Granite is said by my Northern Colleagues to contain water in rare joints.

#### The Quarternary

So we come to the last, but by no means the least of our geological deposits, the Quaternary. I reminded you earlier that the Carb Limestone was present in 31 of the 32 counties, well now we have come to the one present in them all. Of course its importance as an aquifer is by no means uniform, although we should also remember that even where it is impervious it may well perform the useful task of protecting the groundwater in the aquifer below, from pollution. Our main interest are the fluvio glacial sands and gravels. These are very wide spread and even quite a small deposit can act as a valuable water source. For example two borings at Ballyragget, Co. Kilkenny and Brinny Co. Cork have yielded over 20,000 gph. There seems little doubt that accurate mapping of these deposits combined with the



development of the techniques and technology of abstracting water from them will be one of the main jobs to be undertaken in the field of Irish water resource utilisation in the next couple of decades.

You will I hope see that we do know a little about the hydrogeology of Ireland, do not know a great deal and hopefully together we can as a profession help to start putting that position to rights in the years to come.