Aspects of the last Ice Age in Ireland

Part II: Glacial sediments and landforms in Ireland, and their affects on humans

This article examines in more detail the landforms generated by the ice sheets of the last glaciation, and how these and their components interact with humans.

What materials and landforms are deposited underneath the ice?

Glacial ice scratches and erodes rock over which is passes by abrading and plucking this rock. This can be likened to bulldozing. Bedrock is crushed into either boulders, cobbles or pebbles and sand, silt and clay. A mixture of all of these materials is left behind after the glacier melts, and this material is called till or boulder clay. Boulder clay thus blankets much of the bedrock in Ireland, and makes up the soil and subsoil we all encounter when digging.

Boulder clay deposited in this fashion underneath the ice may take the form of drumlins, crag and tails, rogen moraine or ground moraine.

Drumlins are oval shaped hills which are often blunt at the up-ice end and elongated at the down-ice end, with a thinning tail. They are thus streamlined with their long axes in line with ice flow direction. This characteristic shape gave the feature its name which is derived from the Irish *droimnín* (small, round-backed hill). They occur mostly in clusters, or swarms, and are usually tens of metres wide and a few hundred metres long. Their long axes parallel ice flow direction. Sometimes they have rock cores. In many counties (*e.g.* Cavan and Monaghan) lakes often occupy poorly drained, interdrumlin areas. **Crag and tails** are types of drumlins which are formed when a mass of rock obstructs oncoming ice and boulder clay material collects in the lee of the obstruction, always being smoothed by the above ice. A tapering ridge of boulder clay therefore extends from the crag when the ice retreats.

Rogen moraines are crescentic ridges up to 40m high and 1 km wide which lie transverse to former ice flow. These arcuate ridges may be up to 15 km long and have their outer limbs bent downglacier. They are therefore much larger than drumlins generally. Drumlins are often superimposed on these huge ridges. Rogen moraines also occur in fields and there may be several hundred ridges in one field. They are common in Ireland and in fact the drumlin belt of Cavan/Monaghan/Leitrim is mostly superimposed on a field of Rogen, or 'ribbed', moraine (Figure 1).

Ground moraine is boulder clay which has little or no surface relief form. The landscape is rolling to gently undulating. In area where much bounder clay has been deposited but drumlins and rogen moraines are absent, chances are that the area is underlain by ground moraine. Examples of areas composed of ground moraine in Ireland are in south County Meath, County Kildare, north County Dublin and County Wexford.

What happens when the ice starts to melt?

When the ice sheet begins to melt and retreat this is the start of deglaciation. During this time huge amounts of meltwater are released, hence it is no surprise that the majority of landforms deposited during deglaciation are associated with glacial meltwater deposition. Most of the landforms are deposited at the edge of the ice sheet, or the ice margin. Others are deposited beneath or within the ice sheet in cavities, or originate on top of the melting glacier.

Moraines are accumulations of till, gravels, sands, silts or clays which have been transported by ice at its margin. **Terminal moraines** are ridges which define the maximum extent of the ice sheet during that glaciation. As the ice advances during glaciation it pushes material in front of it and when it begins to melt and retreat having reached its maximum extent this material is left as the upstanding end moraine ridge. Ridges left at the margin while the ice retreats towards its source are termed **recessional moraines**. Therefore recessional moraines are always situated up-ice from terminal moraines. Moraines in lowland Ireland are often hummocky and composed of sands and gravels. They are usually discontinuous ridges which are traceable over a long distance. They are typically characterised by steep ice proximal slopes and less steep ice distal slopes.

As the ice melts rivers flow from the melting glacier towards the sea. Often these rivers are very wide and braided and carry huge volumes of sediment from the glacier. The rivers sort the material and deposit it in an **outwash plain** (Figure 2). These plains are generally composed of well sorted sands and gravels. Many of Ireland's rivers were much wider during deglacial times and hence are today flanked by sands and gravels which were deposited when the river was much wider. Examples are the Barrow, the Liffey, the Boyne and the Lee.

Eskers are long narrow sinuous ridge of sand and gravel deposited by a stream which flowed under the ice and left behind after the ice melted. They are composed of alternate layers of sorted sands and gravels. They may be up to 30m high and are often several kilometres long. They are very common in Ireland and occur extensively in the Midlands. Examples are the Clara and Clonmacnoise eskers in County Offaly, the Trim Esker system in County Meath and the Athlone esker system in Westmeath/Roscommon.

Kames are formed in depressions in the glacier surface and other cavities within the ice. They usually contain rounded glaciofluvial sands and gravels. They appear as rounded or irregular hills. As the ice melts, the sands and gravels which accumulate in cavities on and in the ice are let down onto the ground surface in the form of irregular mounds. They are commonly interspersed with **kettle holes**, which are rounded depressions left when blocks of dead ice from the ice sheet melted. Hummocky, pitted and irregular landscapes are thus said to have 'kame and kettle' topography. Kame and Kettle topography is common in the Irish Midlands, in Westmeath, south Roscommon and Offaly.

Humans and glaciation.

Living in a country like Ireland which has been covered by ice several times in the recent geological past, the effect of glaciation on humans is bound to be a marked one. There are several aspects of the Irish landscape which are a result of glaciation which have a profound effect on us in our daily lives. These are examined here in turn.

The glacial landscape and tourism.

Ireland was almost completely covered by ice during the last glaciation. Thus our landscape is essentially a glacial one. Only about 5% of the countryside consists of bedrock outcrop (usually in mountainous areas) and the remainder of Ireland's area is underlain by glacial material or glacially influenced materials (river alluvium, peat or coastal deposits). The simple fact that in order to reach bedrock over the majority of the country you must dig through several metres of soft debris (boulder clay) is testament to the huge effect glaciers have had on our landscape. Furthermore, the sculpting effect of the ice has been astounding, especially in mountainous areas where bedrock crops out. The attractiveness of the rugged glacial landscapes containing steep valley sides, waterfalls and scoured rock surfaces makes these areas very attractive to tourists. Just think of many of our most famous scenic sites: Glendalough, Glenmacnass and Glenmalure (U-Shaped Valleys); Connemara (ice sculpted rock – Figure 3); the Poisoned Glen (U-Shaped Valley); Killary harbour (a fjord); the list is endless. In other lowland parts of the country features like the Cavan-Monaghan lakes (interdrumlin ponds) and the Curragh (outwash plain) are again glacial features. Much of Ireland attractiveness to foreigners is therefore a result of glaciation.

Soil parent materials.

Ireland has a long and well established agricultural heritage and this is a direct result of the suitability of Irish soils to agriculture. However, again this is directly related to glaciation. The fact that the majority of our soils are deep, well drained and suitable for tillage is related to the characteristics of the parent material. This parent material is of course the boulder clay, sands and gravels or clay which has been deposited by glaciers and their meltwater over the countryside. So without deep well drained parent materials we would have no deep, well drained soils. We would not have these parent materials without glaciation.

Sand and gravel aquifers.

Groundwater is an extremely important resource in Ireland and about 25% of Ireland's drinking water comes from groundwater. In some counties, such as Roscommon and Laois, groundwater accounts for up to 80% of drinking water supplies. Much of this water is sourced in the Carboniferous limestone bedrock but the second most important source are the sands and gravels which were deposited by glacial meltwater at the end of the ice age. These sands and gravels are very porous and hold millions of gallons of water in their interstices. When this reserve is tapped into the water is clean and easily extracted.

Engineering aspects.

This aspect is very important and not so often realized. Glacial deposits provide the foundation for almost all major engineering undertakings. This has always been the case throughout history. The first people who came to live in Ireland after the end of the Ice Age 10,000 years ago made little impact on the landscape. They made their tools by working pebbles from streams or beaches. They had little ability to modify their environment. We can say they were reactive rather than proactive and would have chosen camping and dwelling sites in response to the amenities offered by existing shape of the landscape. When the first farmers came about 5,000 years ago with more advanced skills and technology they interacted in a more proactive way with the landscape. They built walls around fields, and they built tombs, often on hill-tops. They were builders in stone. They sought out particular types of stone from both local and distant sources and they used existing landscape features to great advantage. They appreciated the natural resources and used them to best advantage. Bronze Age cultures that followed used the landscape in a similar way and left their distinctive mark on the landscape often modifying the existing Stone Age monuments. Human nature changes very little and still many of our roads still lie atop eskers, and drumlin tops still attract house builders. To-day decisions as to road routes and other major engineering undertakings must take foundation conditions and topography into account and aggregate and other mineral resources must be properly planned. Planners must take account of all heritage considerations in planning. Glacial geology is critical in all of these areas.

Building materials.

Glacial deposits provide us with much of our basic building materials (Figure 4). Sorted sands and gravels are easily extracted and require little sieving into various size ranges, so are prefect when used in making concrete blocks, pillars and other goods. Boulder clay is often used for fill. It is estimated that building materials extracted from glacial deposits is worth more than £100 million to the Irish economy each year.

Groundwater protection.

All water is vulnerable to pollution, and groundwater is no exception. The glacial deposits are the most important natural feature in influencing the vulnerability of groundwater to pollution. They can act as a protecting, filtering layer over the groundwater, depending on their type, permeability and thickness.

In general, the higher the clay content, the lower the permeability and the greater the thickness, the greater the protection of groundwater from pollution. Were it not for glacial deposits *all* groundwater would be *extremely vulnerable*. Groundwater is most vulnerable where glacial deposits are absent or very thin. The mapping of the glacial deposits thereby allows a groundwater vulnerability assessment to be made for any area or site (Figure 5).

Education.

Ireland has a glacial landscape fantastic by any standards. Basically the whole country has been affected in one way or another by ice and we possess relic landforms of every variety and size range. Much of the pioneering work on glacial landscapes in the mid-nineteenth century was carried out in Ireland, and the Irish language has added many names and terms to the glacial literature *e.g.* drumlin, esker. Our landscape therefore provides a base for teaching about glacial studies at every level. As time goes on more and more glacial geology and geology students from abroad spend time in Ireland studying our landscape. So the next time you're tired walking up that hill, ponder a moment on why its there, and enjoy interpreting the landscape like geologists do too!!

Figure Captions:

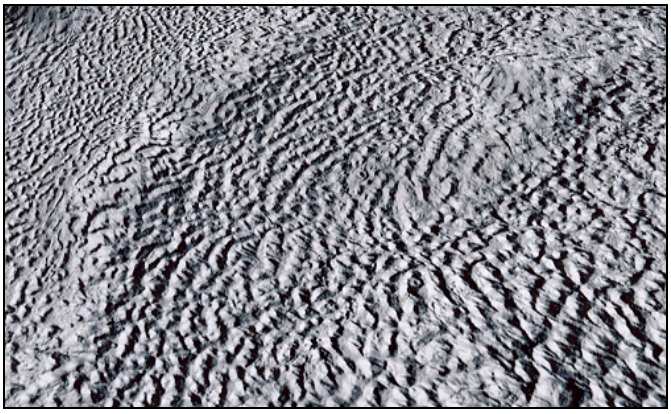

Figure 1: Rogen moraines displayed on a Digital Elevation Model of County Monaghan. The image is approximately 40 km across; ice flow was left to right. Note that many of the ridges have streamlined drumlins superimposed on them.

Figure 2: Outwash river issuing from a glacier snout in Iceland. Note the braided nature of the river.

Figure 3: The ice sculpted slopes of the Maumturk Mountains in Connemara provide spectacular scenery for the hillwalker.

Figure 4: Gravel pit cut into glacial sands and gravels in County Meath.

Figure 5: Groundwater protection is vital. These animals have been dumped into a pit cut into sands and gravels. The effluent seeps down into the groundwater which is then extracted for drinking! A well situated close to this pit would spell disaster for anyone drinking from it …