The Geological Heritage of County Offaly

An audit of County Geological Sites in County Offaly

by Ronan Hennessy, Robert Meehan, Matthew Parkes, Vincent Gallagher and Sarah Gatley

2016

An Chomhairle Oidhreachta
The Heritage Council

ESTO FIDELIS

Geological Survey
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Cover photo by Matthew Parkes. A mushroom rock at Creevagh, near Clonmacnoise.

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Section 1 – Main Report

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Executive Summary

County Offaly has some fine but underappreciated geological sites. This report documents what are currently understood by the Geoheritage Programme (IGH) of Geological Survey Ireland (GSI) to be the most important geological sites within County Offaly. It documents them as County Geological Sites (CGS), for inclusion as a variation within the current County Development Plan (CDP) or as a new list in the next plan. This audit, based on fieldwork carried out in spring and summer of 2016, provides a detailed study of sites to replace a provisional listing based on desk study which was adopted in the current 2014-2020 CDP, along with strong policies to protect it and enhance access where feasible.

Some 28 County Geological Sites are documented, including photographs and site boundary maps that delimit the extent of the geological heritage interest. Additional data in GIS format are supplied to the County Council to complement the report. The commission of this audit and adoption of the sites within the CDP ensure that County Offaly is at the current focus of geological conservation in Ireland. Part 2 of this report contains details of all 28 sites surveyed and recommended as County Geological sites. Part one of the report outlines the survey methodology, results and recommendations.

1. County Offaly in the context of Irish Geological Heritage

This report ensures County Offaly remains active at the forefront of geological heritage within Ireland, as a majority of counties have now commissioned such an audit within the scope of the county-based Heritage Plan. By providing reliable data in a very cost-effective manner, it follows what is now a tried and trusted methodology. In the absence of significant political and economic resources available at a national level to the relevant bodies for conservation of geological heritage as Natural Heritage Areas (NHA), it represents a significant level of progress in defining and safeguarding Ireland's geological heritage. In essence, County Geological Site audits are the only effective geological conservation at present, but only with advisory capacity (within the context of County Development Plans) and no direct statutory protection.

It also represents a significant commitment on the part of the Local Authority to fulfil its obligations to incorporate geology into the spectrum of responsibilities under the Heritage Act 1995, the Planning and Development Act 2000, Planning and Development Regulations 2001, and the Wildlife (Amendment) Act 2000 and the National Heritage Plan 2002. GSI views partnerships with the local authorities, exemplified by this report, as a very important element of its strategy on geological heritage (see Appendix 1).

The Irish Geological Heritage Programme (IGH) in GSI complements other nature conservation efforts of the last decade, by assessing Ireland's geodiversity. Geodiversity is the foundation of the biodiversity addressed under European Directives on habitats and species by the designations of Special Areas of Conservation (SAC) and on a national scale by the introduction of Natural Heritage Areas (NHA) as the national nature conservation method. As a targeted conservation measure to protect the very best of Irish geology and geomorphology the IGH Programme fills a void which has existed since the abandonment of the Areas of Scientific Interest scheme, by An Foras Forbartha in 1981.

The IGH Programme does this by identifying and selecting the most important geological sites nationally for designation as NHAs. It looks at the entire spectrum within Irish geology and geomorphology under 16 different themes:

IGH THEMES

1. Karst
2. Precambrian to Devonian Palaeontology
3. Carboniferous to Pliocene Palaeontology
4. Cambrian-Silurian
5. Precambrian
6. Mineralogy
7. Quaternary
8. Lower Carboniferous
9. Upper Carboniferous and Permian
10. Devonian
11. Igneous intrusions
12. Mesozoic and Cenozoic
13. Coastal geomorphology
14. Fluvial and lacustrine geomorphology
15. Economic geology
16. Hydrogeology

A fundamental approach is that only the minimum number of sites necessary to demonstrate the particular geological theme is selected. This means that the first criterion is to identify the best national representative example of each feature or major sequence, and the second is to identify any unique or exceptional sites. The third criterion, identifying any sites of International importance, is nearly always covered by the other two.

Designation of geological NHAs will be by the GSI's partners in the Programme, the National Parks and Wildlife Service (NPWS). Once designated, any geological NHAs will be subject to normal statutory process within the County Offaly Planning Department and other relevant divisions. **However, compared to many ecological sites, management issues for geological sites are generally fewer and somewhat different in nature. The subsequent section considers these issues**.

From a national perspective, as a result of extensive comparison of similar sites to establish the best among them, there is now a good knowledge of many other sites, which are not the chosen best example, but which may still be of national importance. Others may be of more local importance or of particular value as educational sites or as a public amenity. All these various important sites are proposed for County Geological Site (CGS) listing in the County Development Plan.

Currently, in 2016, a Master List of candidate CGS and NHA sites is being used in GSI, originally compiled with the help of Expert Panels for all the 16 IGH themes. For several themes, the entire process has been largely completed and detailed site reports and boundary surveys have been done along with a Theme Report. Due to various factors, none have yet been formally designated. In County Offaly, few sites have been so far been put forward as a Natural Heritage Area (NHA), although Crancreagh Mushroom Rock has been proposed. Therefore, inclusion of all sites as County Geological Sites (CGS) in County Offaly's planning system will ensure that they are not inadvertently damaged or destroyed through lack of awareness of them outside of the IGH Programme in GSI.

The sites proposed here as County Geological Sites (CGS) have been visited and assessed specifically for this project, and represent our current state of knowledge. It does not exclude other sites being identified later, or directly promoted by the Council itself, or by local communities wishing to draw attention to important sites for amenity or education with an intrinsic geological interest. New excavations, such as major road cuttings or new quarries, can themselves be significant and potential additions to this selection.

It was not possible within the scope of this study to identify landowners except in a few sites, but it is emphasised that CGS listing here is not a statutory designation, and carries no specific implications or responsibilities for landowners. It is primarily a planning tool, designed to record the scientific importance of specific features, and to provide awareness of them in any consultation or decision on any proposed development that might affect them. It thus also has an educational role for the wider public in raising awareness of this often undervalued component of our shared natural heritage.

1.1 Offaly County Geological Sites

Site Name	Designation	IGH Primary	IGH Secondary	IGH Third	GIS Code
Ballyduff Esker	County Geological Site	IGH7			OY001
Ballylin Mushroom Rock	County Geological Site	IGH1			OY002
Ballynagarbry (Mount Temple) Esker	County Geological Site	IGH7			OY003
Camcor Forest Quarry	County Geological Site	IGH4			OY004
Clara Bog	County Geological Site; recommended for Geological NHA	IGH7			OY005
Clonbulloge Spring	County Geological Site	IGH16			OY006
Clonkeen Mushroom Rock	County Geological Site	IGH1			OY007
Clonmacnoise Esker	County Geological Site; recommended for Geological NHA	IGH7			OY008
Clorhane Mushroom Rocks	County Geological Site	IGH1			OY009
Clorhane Quarries	County Geological Site	IGH15			OY010
Crancreagh Mushroom Rock	County Geological Site; recommended for Geological NHA	IGH1			OY011
Creevagh Mushroom Rocks	County Geological Site	IGH1			OY012
Crinkill Mushroom Rocks	County Geological Site	IGH1			OY013
Croghan Hill	County Geological Site; recommended for Geological NHA	IGH11	IGH8		OY014
Derrinlough Mushroom Rock	County Geological Site	IGH1			OY015
Drinagh Mushroom Rock	County Geological Site	IGH1			OY016
Endrim Mushroom Rock	County Geological Site	IGH1			OY017
Kilcormac Esker	County Geological Site; may be recommended for Geological NHA	IGH7			OY018
Kinnitty Eskers	County Geological Site	IGH7			OY019
Little Brosna-Shannon Confluence	County Geological Site; recommended for Geological NHA	IGH14			OY020
Lough Boora Parklands	County Geological Site	IGH7			OY021
Marlow's Hole	County Geological Site	IGH1	IGH16		OY022
Mongan Bog	County Geological Site	IGH7	IGH16		OY023
Mount Briscoe Cave	County Geological Site	IGH1			OY024
Screggan Fan	County Geological Site	IGH7			OY025
Sillogue Spring	County Geological Site	IGH16			OY026
Silver River	County Geological Site	IGH10	IGH14		OY027
Toberdaly	County Geological Site	IGH16			OY028

1.2 Rejected sites

A range of sites had been previously flagged for consideration in the IGH Master Site List, and some were assessed as unsuitable for County Geological Site status in this audit. Similarly a range of additional sites were assessed in the audit, based on new knowledge of County Offaly's geology, and especially for Quaternary landscape sites and karst sites. Other sites were visited on spec during fieldwork. The rejected sites are listed below with brief notes as to why they were assessed as unsuitable for inclusion.

Clononey Beg Mushroom Rock
This site is listed in Louise Dunne and John Feehan's publications on mushroom rocks (2002, 2003). There are 5 individual stones listed at the same townland of Clononey Beg at Shannon Harbour. However, field investigation failed to find any mushroom rocks, nor even any outcrop of rock in the location. It would seem most likely that sometime after 2002 there has been some field clearance and drainage of the area which has eliminated the rocks that were here.

Esker Bridge
This site was listed on the IGH Master Site List for Offaly. Located along the R402 between Daingean and Edenderry (townlands of Esker More, Ballycon and Esker Beg). The site was earlier deemed of local habitat importance (geomorphological and ecological) in the county's list of Areas of Scientific Interest (An Foras Forbatha 1983). Excavations have led to the removal of esker material along the east-west feature. In addition, an absence of 'classic and characteristic' esker morphology, when compared to other sites in County Offaly (e.g. Clonmacnoise region), is such that this site was rejected for inclusion as a County Geological Site.

Figure 1. Esker Bridge, quarried gravel pit on north side of Daingean and Edenderry road (truck visible in background).

Gloster

This site is listed on the IGH Programme Master Site List of County Geological Sites for Offaly. The site is situated just off the N52 between Birr and Roscrea, just northeast of the road itself. The tufa is approximately 1m high and covers a lateral extent of approximately 3.5m. The site has been damaged by livestock as it lies beside an open pond, and is therefore disregarded as a site as it is in poor condition and it is difficult to see the tufa-forming water.

Figure 2. Gloster tufa deposit.

Millpark

This site is listed on the IGH Programme Master Site List for Offaly, and is also situated just off the N52 between Birr and Roscrea, just north of the road itself and along the Offaly-Tipperary county boundary. The tufa is set within the stream bed and is only approximately 2m lateral extent. The site has been damaged by landslip and sedimentation of silt; again, the locality is disregarded as a site as it is in poor condition and it is difficult to see the tufa-forming within the water.

Figure 3. Millpark tufa deposit.

2. Offaly Council Policies regarding geological heritage

It is worth drawing attention to the excellent treatment of geological heritage in the Offaly County Development Plan, which could be a model for any local authority to follow. Chapter 7 on Heritage and Landscape includes geodiversity amongst the detailed biodiversity policies and protected area classifications. The specific section (7.2.13) on Areas of Geological Interest is a concise statement of all essentials that could be aspired to in regard to geological heritage within a County Council. The particular national importance of mushroom rocks amongst Offaly's geological heritage is recognised in section 7.8.9. The subsequent specific policies and objectives listed below cement geological heritage's importance in proper planning for the County.

The completion of this geological heritage audit will ensure that the largely desk-based study and listing of County Geological Sites (Appendix Y) is superseded in the new County Development Plan by a robust selection of sites that are important in County Offaly. Whilst some are candidates for NHA designation in the future if the geological NHAs ever become a reality, new sites that are purely of local importance have been added. Equally some sites have been rejected after proper field auditing.

7.2.13 Areas of Geological Interest

Geology is recognised as an intrinsic component of natural Heritage. The Irish Geological Heritage (IGH) Programme is selecting the very best national sites for NHA designation and also identifying sites of national or local geological heritage importance, which are classed as County Geological Sites (CGS). CGS have been adopted into the National Heritage Plan. Offaly County Council recognises the importance of geological heritage and will have regard to the DECLG's recommendations where planning applications are referred. Appendix Y, Offaly Geological Heritage Sites includes a schedule of CGS identified by the Irish Geological Heritage programme for Protection in County Offaly.

It is a general objective to seek the preservation of important features of geological interest within the county identified in Appendix Y, Offaly Geological Heritage Sites. It is a particular objective to maintain the conservation value of those features or areas of geological interest that are listed in this chapter. Refer to Geology Publication, *Geology of Laois and Offaly*, (by John Feehan) for more on Geology of County Offaly.

NHP-15 It is Council policy to protect the identified Mushroom Stones listed in Table 7.8.1.
NHP-16 It is Council policy to protect from inappropriate development the scheduled list of geological heritage sites identified in Appendix Y, Offaly Geological Heritage Sites.
NHP-23 It is Council policy to consider, in consultation with the National Parks & Wildlife Service, Westmeath County Council, the Geological Survey of Ireland and others, the potential designation of the north Offaly esker landscape as a UNESCO geo-park, to promote the unique geological heritage of the area.

NHO-09 It is an objective of the Council to seek the preservation of important features of geological interest within the county, identified in Appendix Y, Offaly Geological Heritage Sites.

7.8.9 Mushroom Stones

County Offaly contains the best collection of Mushroom Stones in Ireland. These important geological features were shaped by the movement of water in postglacial lakes. Table 7.8.1 lists the Mushroom Stones in County Offaly.

It is clear from many other sections of the CDP that the fundamental importance of geology is better understood than may have been the case in the past. Geological features are listed as being of importance to protect when dealing with rural housing design (SSP-17). In section 2.8.6 the importance of sand and gravel extraction to the economic life of the county is recognised, but along with other nature conservation factors, geological significance is included in a policy not to damage areas of scientific importance through extraction.

3. Geological conservation issues and site management

Since **geodiversity is the often forgotten foundation for much of the biodiversity** which has been identified for conservation through SAC or NHA designation, it is unsurprising that many of the most important geological sites are actually in the same areas as SAC and NHA sites. In these areas, the geological heritage enhances and cements the value of these sites for nature conservation, and requires no additional designation of actual land areas, other than citation of the geological interest.

Broadly speaking, there are two types of site identified by the IGH Programme. The first, and most common, includes small and discrete sites. These may be old quarries, natural exposures on hilly ground, coastal cliff sections, or other natural cuttings into the subsurface, such as stream sections. They typically have a feature or features of specific interest such as fossils or minerals or they are a representative section of a particular stratigraphical sequence of rocks. **The second type of site is a larger area of geomorphological interest, i.e. a landscape that incorporates features that illustrates the processes that formed it**. The Quaternary theme and the Karst theme often include such sites. In County Offaly, with a high proportion of land area under grassland, such sites include the Clonmacnoise Esker, Ballyduff Esker and Kinnitty Eskers.

It is also important from a geological conservation perspective that planners understand the landscape importance of geomorphological features which may not in themselves warrant any formal site designation, but which are an integral part of the character of County Offaly. A lack of awareness in the past, has led to the loss of important geological sites and local character throughout the country. In County Offaly some Landscape Character Assessment (LCA) was incorporated into the County Development Plan 2014-2020. This provides a tool for planners to help maintain the character of the County. An objective in the CDP is to review the existing LCA in relation emerging National Guidelines from the Heritage Council. This audit may assist in that process in providing more data in an accessible format.

There are large differences in the management requirements for geological sites in comparison to biological sites. Geological features are typically quite robust and generally few restrictions are required in order to protect the scientific interest. In some cases, paradoxically, the geological interest may even be served better by a development exposing more rock. **The important thing is that the relevant planning department is aware of the sites and, more generally, that consultation can take place if some development is proposed for a site**. In this way, geologists may get the opportunity to learn more about a site or area by recording and sample collection of temporary exposures, or to influence the design so that access to exposures of rock is maintained for the future, or occasionally to prevent a completely inappropriate development through presentation of a strong scientific case.

In many counties, working quarries may have been listed because they are the best representative sections available of specific rock sequences, in areas where exposure is otherwise poor. No restriction is sought on the legitimate operation of these quarries. However, maintenance of exposure after quarry closure is generally sought in agreement with the operator and planning authority in such a case. At present, working quarries like the huge gravel pits in the Ballyduff Esker and the Kilcormac Esker are now included within County Geological Sites in County Offaly. These issues are briefly explored in a set of Geological Heritage Guidelines for the Extractive Industry, published jointly by the GSI and the Irish Concrete Federation in 2008.

A new quarry may open up a window into the rocks below and reveal significant or particularly interesting features such as pockets of fossils or minerals, or perhaps a karstic depression or cave. Equally a quarry that has finished working may become more relevant as a geological heritage site at that stage in its life. It may need occasional maintenance to prevent overgrowth of vegetation obscuring the scientific interest, or may be promoted to the public by means of a viewing platform and information panel.

Nationally, specific sites may require restrictions and a typical case might be at an important fossil locality or a rare mineral locality, where a permit system may be required for genuine research, but the opportunity for general collecting may need to be controlled. However, County Offaly's sites are not likely to require such an approach.

Waste dumping
An occasional problem throughout the country, including in County Offaly, is the dumping of rubbish in the countryside. The dumping of waste is not only unsightly and messy, but when waste materials are dumped in areas where rock is exposed, such as in quarries or disused gravel pits, they may leach into the groundwater table as they degrade. This can cause groundwater pollution and can affect nearby drinking water supplies in wells or springs. Groundwater Protection Schemes (DELG 1999) help to combat pollution risks to groundwater by zoning the entire land surface within counties into different levels of groundwater vulnerability. County Offaly was included in a national scheme for Groundwater Protection in 2012, thus ranking the county land surface into vulnerability categories of 'Extreme', 'High', 'Moderate' and 'Low', and helping planners to assess which developments are suitable or not in some areas of County Offaly.

New exposures in development
One less obvious area where the Local Authority can play a key role in the promotion and protection of geology is in the case of new roads. **Wherever major new carriageways are to be built,** or in other major infrastructural work, it should be a policy within the Planning Department, that **where new rock exposures are created, they be left open and exposed** unless geotechnical safety issues arise (such as where bedding dips are prone to rock failure). The grading and grassing over of slopes in cuttings is largely a civil engineering convenience and a mindset which is difficult to change. However, it leads to sterile and uninteresting roads that look the same throughout the country. Leaving rock outcrops exposed where they are intersected along the road, improves the character and interest of the route, by reflecting the geology and landscape of the locality. Sympathetic tree or shrub planting can still be done, but leaving bare rocks, especially where they show interesting features, not only assists the geological profession, but creates new local landmarks to replace those removed in the construction of the roadway. This can also potentially save money on the construction costs. It may also contribute to road safety by providing diversity of surroundings to maintain drivers' attention.

In Offaly, because of the relatively subdued terrain, the opportunity for such rock road cuttings has been limited. The road widening improvements on the N52 east of Tullamore have produced long cuttings into the Ballyduff Esker ridge, but owing to grading of the loose subsoils have not been included as CGSs in this audit. Other roads in the county are less likely to be significantly upgraded but the option of designating road cuttings as CGSs should be borne in mind for all future road improvements.

Geoparks

An extremely interesting development in geological heritage, not just in Europe but internationally, has been the rapid recent growth and adoption of the Geopark concept. A **Geopark is a territory** with a well-defined management structure in place (such as Local Authority support), **where the geological heritage is of outstanding significance and is used to develop sustainable tourism opportunities**. Initially it was largely a European Geoparks Network (EGN) but since 2004 has expanded worldwide as the Global Geoparks Network (GGN) and is fully assisted by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) [see www.globalgeopark.org and www.europeangeoparks.org]. In fact in 2015, UNESCO fully endorsed the Global Geopark brand, such that it now carries equivalent weight to a World Heritage Site; this means, however, as with World Heritage Sites, a long, somewhat protracted application process.

A fundamental theoretical basis of the Geopark is that it is driven from the bottom up – the communities in the Geopark are the drivers of the project and are the main beneficiaries. The Geopark branding therefore helps promote the geological heritage resource so that the community can benefit from it.

In Ireland there are three members of the Geoparks Network. One is the cross-border Marble Arch Caves Global Geopark in Fermanagh and Cavan [see www.marblearchcaves.net and www.cavancoco.ie/marble-arch-caves-global-geopark]. The Copper Coast Geopark in Waterford also joined the Network in 2001 [see www.coppercoastgeopark.com]. A now well established addition has been the Burren and Cliffs of Moher in County Clare [see www.burrengeopark.ie]. In addition there are aspirant groups exploring the work and infrastructure required for applications in other areas such as Joyce Country in Mayo and Galway, and the cross-border Mourne-Cooley-Gullion area.

At present, there is some scope for considering whether the eskers of Offaly and contiguous counties (principally Westmeath) could meet the criteria for a Geopark application. The Esker study of 2006 gave some consideration to this and the question is still open for examination. **The criteria for inclusion in the UNESCO Global Geoparks Network are now much more stringent than when the European Geoparks Network began, and realistically the strongest commitment of the local authority in providing infrastructure and administrative support is required to even consider applying to UNESCO**.

3.1 A Note on Esker Conservation in County Offaly

What is an esker?

Eskers are long, sinuous ridges of glaciofluvial sands and gravels. The term "esker" is an English rendering of the Gaelic word *eiscir* which means a high ridge separating two flat areas. They range from a few tens of metres to over a hundred kilometres in unbroken length, and range locally from a few metres to over 50m in height, and from ten metres to hundreds of metres in width at their base. Eskers have been reported from all over mid-latitudes, and are common in Ireland, Britain, Scandinavia, Canada, Alaska, the northeastern U.S., and Patagonia.

Since eskers are made up of highly permeable sand and gravel, they are frequently excavated for construction. They have been considered an endangered geomorphological species in many parts of the world for some time (notably, southern Quebec and Finland), since they have been used either to develop roadways, offering natural elevated, dry terrain, or they have been ripped up for gravel to build nearby roads. The latter has been the case in Ireland for some time, and recent efforts have focussed on conserving eskers for their geomorphological, habitat, groundwater and educational resource.

How are eskers formed, geologically?

Eskers are usually the infillings of ice-walled river channels. Just as rivers on land carry and deposit sediment, meltwater that flows in the openings beneath, above and within a glacier also carries and deposits sediment. Tunnels near the base of retreating glaciers fill with transported sediments, which remain as sandy or gravelly ridges that look like raised, upside-down stream beds after the glacier melts away.

Eskers in Ireland.

A large system of esker landforms spans the 'Irish Midlands', or central lowland portion of the country. These ridges have been the subject of geomorphological and geological study since the mid-nineteenth century. The eskers are composed of sorted, layered sediments but range in size, orientation and morphology, generally related to the movement patterns and ice margin locations of the last ice sheet to cover the country.

Esker conservation and the aggregate industry

Aggregates can only be extracted where they occur. This means extraction is limited to certain geological areas, which are often areas of inherent beauty or value because of the relationship between geology and the landscape. This is a problem particularly with eskers, as they are upstanding, dry ridges of sand and gravel which can be easily quarried, and yet are important in the landscape topographically, ecologically and historically.

Many of the best examples of eskers in County Offaly have been extensively quarried, to such an extent that little of them actually remain anymore. In particular, much of the Ballyduff and Kilcormac Eskers have been removed. It is imperative that the balance is found between geological heritage conservation and aggregate extraction in the future, to ensure that the best examples of our eskers are protected. The Irish Geological Heritage Audit of County Offaly should help in this process.

3.2 Mushroom rocks in County Offaly

Mushroom rocks are a curious phenomenon of which County Offaly has arguably the biggest representation in the whole country, with about one third of the national total. They vary greatly in the their appearance but are all characterised by having notches and undercuts which mark the long erosion by lapping waves at the edge of lakes or expanded river basins which have since disappeared. Some are truly shaped like a mushroom with a wide cap over a flared base, whilst others are simply overhanging in one or more convoluted shapes.

These rocks are sometimes also called wavestones, but as they occur only with limestone rocks, there must have also been some solution of the rock by slightly acid waters. This is something that could be expected after the Ice Age when there was extensive meltwater around, and temporary barriers of glacial moraine and sands and gravels that gradually were eroded down or drained rapidly by meltwater channels.

Research into these mushroom rocks by Louise Dunne and John Feehan (2003a,b) has attempted the difficult task of measuring the height of the lips in order to associate lip heights to putative former lake levels. Many of the mushrrom rocks at Clorhane and Creevagh for example may relate to a former wider basin of the River Shannon. A large number of the Offaly stones are potentially the result of a former larger Lough Boora. However, Dunne and Feehan (2003a, b) made it clear that other modes of formation, with dissolution beneath soil or bog, may have been in play for some rocks. Parry (2015) took up this theory and demonstrated evidence for this origin for a number of stones.

Some of these curious rocks appear on Ordnance Survey of Ireland maps as features with their individual names and clearly their quirky nature has helped preserve them over centuries (see comment in Dunne and Feehan, 2003a), but in a less religious and less superstitious present, many rocks are at risk from overzealous farm practices. The bulldozing of rocky scrubland, such as limestone pavement, in order to plant more grass, can destroy mushroom rocks that have not yet been catalogued or identified, being hidden by vegetation. Many of the pavement areas around known stones also carry subtle lips and notches which can be interpreted by a geologist but are missed by most people.

This loss of context has unfortunately happened in some of the fields alongside the River Shannon, but hopefully awareness will be raised through this audit work. However, clearly the significance of the stones has not been fully understood in recent times, where some near Birr have been moved intact and placed in another field altogether. In Dunne and Feehan's work, five rocks at Clononey Beg near Shannon Harbour were documented. Of these, there is now no trace and they were presumably lost in field clearances since that time.

Dunne, L. and Feehan, J. 2003a. *Ireland's Mushroom Stones. Relics of a Vanished Lakeland*. UCD, Department of Environmental Resource Management.

Dunne, L. and Feehan, J. 2003b. The origin and significance of mushroom stones in lowland karst regions. *Irish Journal of Earth Sciences*, 20: 33–40.

Parry, B. 2015. Ireland's wavestones: an appraisal of their development. *Irish Journal of Earth Sciences*, 33: 17–33.

4. Summary and Recommendations

County Offaly is not widely known for its geological heritage, yet as this audit report makes clear there are many sites of high value, and diverse geologically defined landscapes. However, it has some fine but underappreciated geological sites. The County Council's support for this audit is critical in further raising the profile of geological heritage in County Offaly and for maximising its potential, since some of the sites may be otherwise overlooked.

This report documents what are currently understood by the Irish Geological Heritage Programme (IGH) of Geological Survey Ireland (GSI) to be the most important geological sites within County Offaly. It proposes them as County Geological Sites (CGS), for inclusion within the County Development Plan (CDP). The audit provides a reliable study of sites to replace a provisional listing based on desk study which was adopted in the current 2014-2020 CDP, along with strong policies to protect it and enhance access where feasible. [See facing page]

County Geological Sites do not receive statutory protection like Natural Heritage Areas (NHA) but receive an effective protection from their inclusion in the planning system. Some of the sites described in this report are considered to be of national importance as a best representative example of a particular geological formation or feature. If resources within GSI and National Parks and Wildlife Service (NPWS) allow, such sites may be notified to the NPWS by the GSI for designation as a Natural Heritage Area (NHA) once due survey and consultation with landowners is complete. Crancreagh Mushroom Rock has already been proposed as one of three best such features for NHA status. In Offaly, many of the sites fall within existing pNHAs and SACs where the ecological interest is actually founded upon the underlying geodiversity (for example, the 'Pilgrim's Road Esker', which is part of the Clonmacnoise Esker, the Ballyduff Esker, Clara Bog and Mongan Bog).

The commission of this audit and adoption of the sites within the CDP ensure that County Offaly follows a now established and effective methodology for ensuring that geological heritage is not overlooked in the general absence of allocated resources for progress at national level. It places County Offaly at the current focus of geological conservation in Ireland.

This report is written in non-technical language (with a glossary for unavoidable geological terminology) as a working document for use by the Heritage Officer and the Planning department of Offaly County Council. It should also be made available via the Council website for the people of County Offaly. A chapter of the report includes recommendations on how to best present and promote the geological heritage of County Offaly to the people of the county. It will also inform the work of the IGH Programme and be made available through the GSI website.

The relevant sections, summary geological history and accompanying map, timescale and stratigraphical column particularly may be used as they stand to preface a booklet or as website information in the development of this work, and for information, as seen fit by the Heritage Officer. The contents also provide the essential ingredients for a public-oriented book or other publications on the geological heritage of County Offaly, if the funding can be found to produce them.

4.1 Proposals and ideas for promotion of geological heritage in County Offaly

This section examines the existing objectives in the Offaly Heritage Plan (2012-2016) relating in any way to geological heritage and provides specific suggestions as to how these may be implemented, supported or enhanced by this audit of geological heritage sites in the county.

1. OBJECTIVE
UTILISE TECHNOLOGY TO BRING HERITAGE INFORMATION TO A BROAD AUDIENCE
Actions
1. Keep www.offaly.ie/heritage current.
Audit Action: The audit may be added to the web pages and promoted strongly as a significant addition to the canon of work from the Heritage Office.
4. Explore the use of technology for interpretation i.e. town trails.
Audit Action: Some limited potential content is provided by the audit for trails and new digital methodologies.
5. In partnership with the library service, upload archive digital imagery of heritage sites and information.
Audit Action: A large collection of photographs of each CGS (including rejected sites and some miscellaneous features) have been collated for the Audit. These are available to add to the library resources
7. Develop a range of ½ day itineraries for heritage.
Audit Action: It will be possible to link related or complementary County Geological Sites into thematic or area based itineraries, possibly including those in Laois within Slieve Bloom for example. Landowner information has been provided to the Heritage Officer for 'one-off' special requests for access where a CGS is on private land and not normally accessible. The Audit site reports include information on whether a site is publicly accessible or not.
8. Promote Offaly heritage sites on line using audio slide shows, pod casts etc.
Audit Action: The content of the Audit may easily be modified into such promotional material. The authors may be able to assist with projects to develop materials. It is expected that an 'exhibition' of image rich panels will be provided to the Heritage Officer as part of this Audit project.

2. OBJECTIVE
INCREASE THE INVOLVEMENT OF CHILDREN WITH HERITAGE
Actions
1. Promote and develop the Teacher's Tools page on www.offaly.ie/heritage.
Audit Action: It is recommended in the Audit report that the Geoschol leaflet on the geology of the county should be added to the Teacher's Tools page.
6. Maximise the facilities and programmes developed through the Teacher Education Centres.
Audit Action: It is hoped that a planned Natural History Museum project to develop geological handling boxes in conjunction with the Teacher Education Centres will receive funding and the Audit will contribute to these resources if progressed.
9. Develop a range of worksheets for natural and built heritage sites.
Audit Action: It is hoped that the Audit may help provide ideas or content for worksheets. The authors of the Audit may be able to assist with creating such worksheets.

3. OBJECTIVE
PROVIDE INFORMATION TO LOCAL COMMUNITIES ABOUT THEIR HERITAGE AND FACILITATE THEM TO DEVELOP HERITAGE PROJECTS
Actions
1. Promote Heritage Week as an opportunity to showcase local heritage projects and the heritage of towns and villages.

Audit Action: It may be appropriate to plan an event for Heritage Week 2017 to showcase the geological heritage audit or a subsequent development from it.

2. Source speakers / leaders to help groups interpret their local heritage.

Audit Action: The authors may be able to assist in this action.

3. Continue to hold the annual seminar each autumn to provide feedback on Offaly heritage projects.

Audit Action: The audit team will contribute a talk and a tour to the 2016 seminar.

5. Publish high quality books / information on Offaly's heritage.

Audit Action: It is suggested in the Audit Report that a non-technical book could be produced on the geological heritage of Offaly, as a derivative of the audit, in similar style to Roscommon, Waterford or Fingal for example. The authors are able to assist with the creation of such a book, and the distillation of the absolutely essential information.

9. Submit regular articles and updates to local and national newspapers and to Heritage Outlook magazine.

Audit Action: The authors may be able to provide articles to promote the audit as opportunities arise.

10. Provide assistance in developing appropriate information panels for communities.

Audit Action: The expertise of the authors may be called upon to advise or provide suitable content for panels on request, where geological heritage is included.

4. OBJECTIVE

TO MAXIMISE HERITAGE DATA AND SITES FOR TOURISM

Actions

1. Develop the 'explore Offaly' section of www offaly ie/heritage adding in ½ day itineraries and suggested routes. These should include the wide range of heritage interest. Slideshows and You Tubes can be added incrementally for sites.

Audit Action: See Objective 1, actions 7 and 8.

3. Make presentations to tourism courses and guide training courses.

Audit Action: If suitable conjunctions of tourism guides or other courses are being run in the future, the authors may be available to make presentation of the geological heritage of Offaly.

4. Update and continue to develop innovative interpretation at appropriate sites

Audit Action: Some suggestions for specific promotion are included in an earlier section of the report.

5. Work with interested communities and individuals to present their sites physically or digitally as appropriate.

Audit Action: The Audit may provide background information, or pointers to resources, to assist communities or individuals with this action. The authors may be able to assist individually or collectively on request with specific projects.

6. Continue to develop the Eco-node network of www.offaly.heritage, walkways and options of greenways on railway lines.

Audit Action: The information made available in whatever form on these routes should include an element of geological heritage interest or underlying geodiversity where appropriate. The Audit report may assist with this or the authors may be contacted.

5. OBJECTIVE

TO BE PROACTIVE IN ENHANCING, PROTECTING AND RAISING AWARENESS OF OFFALY'S NATURAL HERITAGE

Actions

1. Carry out habitat mapping prioritising esker habitats in the south of the county and the Brosna Callows in the west.

Audit Action: Habitats are related to the geological character of the esker sands and gravels and an integrated approach of relating landforms, sediments and habitats is advisable. Some information from the Audit may assist with esker sites.

3. Explore the best way to utilise quarries for biodiversity during and after use.

Audit Action: Information about the geology of the county may help with planning for biodiversity in quarries that have reached or are nearing their end of life for extraction. Geodiversity is the foundation of biodiversity and understanding one will aid the other.

13. Select and promote geology visitor areas following publication of the 'Geology of Laois and Offaly' by John Feehan.

Audit Action: The most appropriate sites for visiting amongst the County Geological Sites will be identified in the individual site reports.

15. Publish appropriate heritage information in hard copy and online as appropriate.

Audit Action: The Audit report will be provided to the Heritage Officer in hardcopy and it is hoped that it will be made freely available on the Offaly heritage web pages as well as Geological Survey Ireland Geological Heritage Programme web pages.

6. OBJECTIVE

TO RECORD AND CONSERVE THE BUILT HERITAGE

Actions

10. Develop methodologies for works to be done for key sites in the county so they are ready when funding may come available.

Audit Action: The individual site reports indicate specific points where relevant that may help identify key sites or projects that may be prepared for readiness or appropriate funding schemes.

11. Collect geological data on where stone came from for medieval buildings.

Audit Action: The Audit may contribute to this action, through pointing to detailed resources.

4.2 Ideas for projects

Leaflets

A few existing leaflets on the geological heritage of County Offaly are known, other than the Geoschol one included as an appendix here. These include official leaflets on Clara Bog and an Irish Peatland Conservation Council leaflet on Slieve Bloom. There is some scope for other and different leaflets, *e.g.* along the Knockbarron Eco Walk. Any leaflets produced could simply be made available as pdf downloads on the Council's website to avoid printing costs.

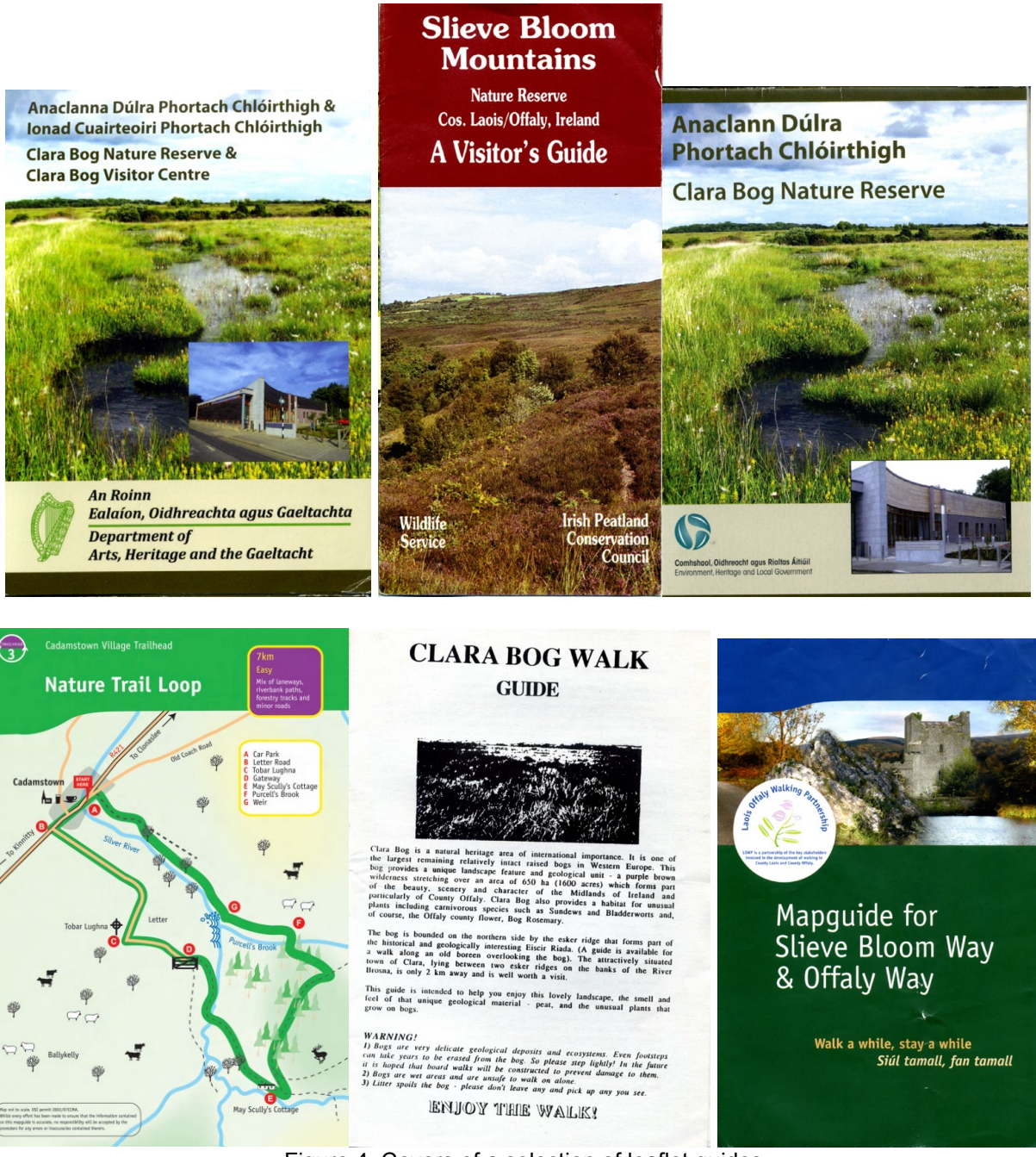
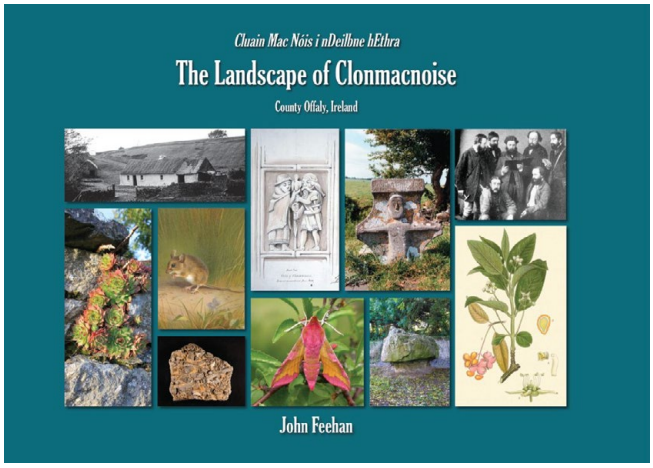


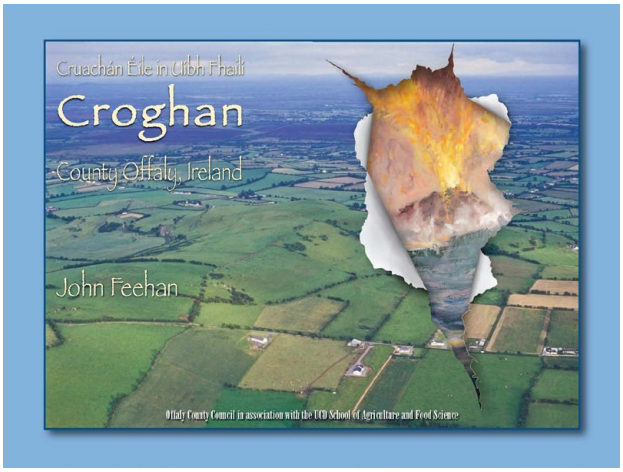
Figure 4. Covers of a selection of leaflet guides.

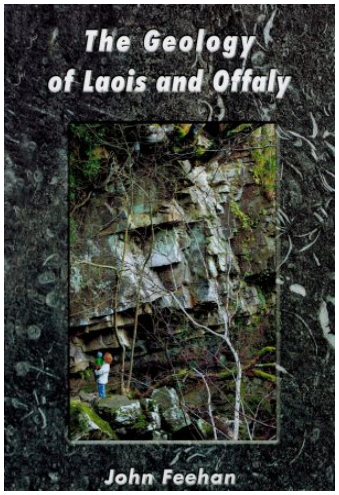
Guides

The 1:100,000 GSI map report for Sheet 15 covers most of County Offaly, with adjoining sheets having some minor overlap and all are essential resources. There are some specific

guides to the geology of County Offaly, the most notable of which is the superb book 'The Geology of Offaly and Offaly' by John Feehan, which is as comprehensive and readable an account as you could wish for. The Heritage Office has published several other works by John Feehan which include significant geology in their content. Although the format is rather unwieldy, the large size allows the inclusion of full quarter map sheets from the GSI archives, in the books on Clonmacnoise and on Croghan Hill. A further excellent book by Declan Ryan published by Offaly County Council covers the geology and the industrial and social history of quarrying at Clorhane, near Clonmacnoise.







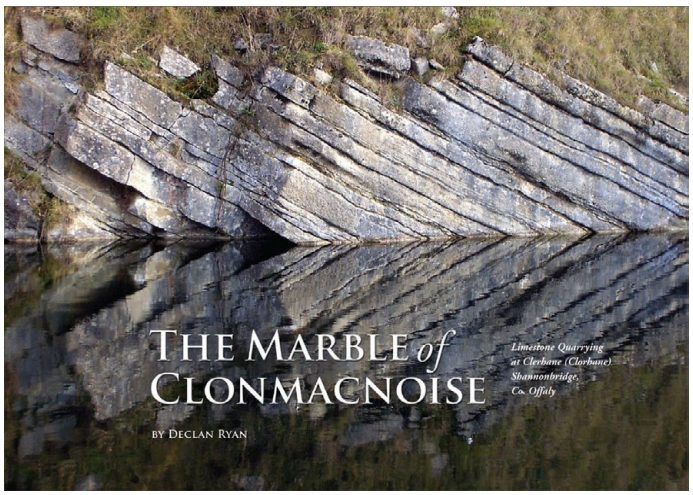


Figure 5. Covers of the geological based books published by the Heritage Office.

There is scope for guides at different levels of detail and accessibility to non-specialists. A wide range of leaflets, booklets, books and other media are all feasible, but the research and production of appropriate text and images is a difficult task to do well without appropriate experience, and adequate time and resources. It is suggested that **with only modest editing and reorganisation the main content of this report would distil into a good general short guide to the geological heritage of County Offaly**, in a broadly similar style to those books produced for Sligo, Fingal, Waterford, Roscommon and Clare following audits in those counties.

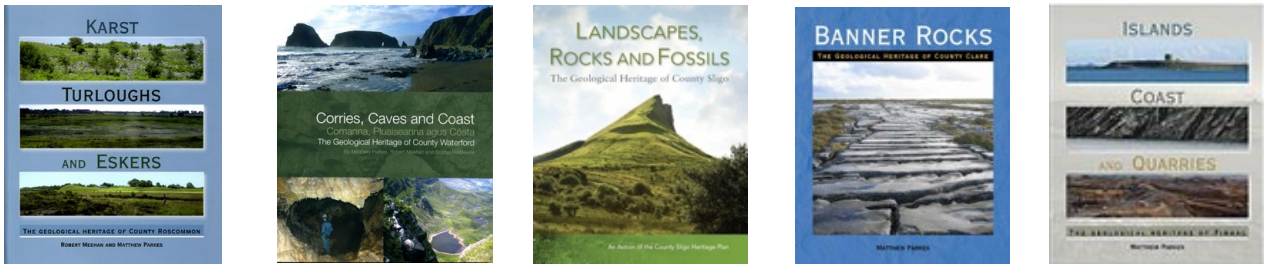


Figure 6. Covers of various popular county books derived from previous audits.

Signboards
Simple explanatory or interpretive signboards may be advisable at key geological heritage locations, but if these are considered, their locations and individual siting should be very selective, since a proliferation of different interest groups may provoke a 'rash' of panels all over the county. The Planning Section should clearly have a controlling input, in conjunction with the Heritage Office. It is most likely that a panel combining various heritage interests at a place is preferred to single interest panels. It is important to consult with potential partners in the planning stage so that duplication does not occur.

The successful integration of text and graphics on information panels is a fine art, and the IGH Programme in GSI can offer input if signs are planned for key visitor localities. The authors of this report are also able to write, review or provide content on geological heritage for any proposed panels.

Museum exhibitions
As a result of the work to produce this report, the material for a panel based exhibition has been largely compiled. With some extra research covering human dependence on geology and resources, an interesting exhibition can be put together for display in the Offaly Council Offices, County Library branches or other venues. The model followed was that used for Carlow, Dun Laoghaire-Rathdown and Waterford. Images of those and other similar ones can be seen on the Geological Heritage/Exhibitions section of the GSI website [www.gsi.ie].

New media
There are increasing numbers of examples of new methods of promoting Earth Sciences, via mobile phone applications and other electronic media. Self-guiding apps on specific sites would be one of these, such as those produced by Ingenious Ireland for Dublin city geology and the app for tourists in the Burren and Cliffs of Moher Geopark. Plans for such products would require some considerable effort to produce and imaginative effort, to link sites in any coherent ways, other than by their county.

Information on the heritage sites of County Offaly can already be found on the IPhone App to explore Birr Demesne and Clonmacnoise, available to download for both Android and Apple Devices. See

https://itunes.apple.com/us/app/lakeland-treasures/id773156551?mt=8

It is to be hoped that in due course this, and similar, apps or mobile enabled websites can be updated to include suitable geological heritage information arising from the audit.

Earth Science Ireland Group and magazine [www.earthscienceireland.org]
The group Earth Science Ireland is an all-Ireland group promoting awareness of Earth sciences and supporting educational provision in the subject. A main vehicle for the efforts

is the twice a year magazine *Earth Science Ireland* and this is distributed free to thousands of individuals, schools, museums, centres and organisations. The editors would welcome more material from the Republic of Ireland and on County Offaly's geological heritage.

Geoschol website [www.geoschol.com]
Geoschol is an educational project, now essentially represented by a website, which was largely aimed at producing educational materials on geology for primary schools. A four page pdf summarising the geology and some highlights of County Offaly is already part of the available material (see Appendix 7). Working links to the Heritage webpage on Offaly Council's website, as well as to other heritage websites, should be established.

Geological Heritage Research Archive
If the Heritage Officer wanted to do something similar to that produced in the Burren and Cliffs of Moher Geopark, with downloadable (or links to) free access papers, then a lot of groundwork is already provided by the reference lists in this audit. Making available technical references of direct relevance to County Offaly geology and geomorphology will assist many users and researchers into the future. An alternative is that a geological heritage section with a bibliography pdf on the Heritage web pages for Offaly could suffice for most users.

Maps
It is hoped that geological heritage sites as a data layer might be adopted by the Ordnance Survey of Ireland in their future map editions of the 1:50,000 Discovery Series, for all counties where an audit has been completed (similar to the East West maps of Wicklow which include such data from GSI).

Heritage Council Heritage Viewer
HeritageMaps.ie is a web-based spatial data viewer, co-ordinated by the Heritage Council, and working with the Local Authority Heritage Officer network, which focuses on the built, cultural and natural heritage around Ireland and off shore. This viewer allows you to look at a wide range of built and natural heritage data sets in map form. The outlines of and data on each individual County Geological Site in Offaly will be visible on the HeritageMaps.ie viewer.

5. A summary of the Geology of County Offaly

1) A single paragraph summary

County Offaly has three main episodes in its geological story. The first, and oldest, of these is represented by the Slieve Bloom Mountains, where older Silurian marine rocks, from around 425 million years ago are found in patches where erosion of the uplands has stripped off the younger Devonian sandstones and conglomerates from river environments, which overlay them. Over most of the county, the plains are founded on the second episode, that of the Carboniferous Limestone from around 340 million years ago. These are shelf limestones from open marine environments. During this period, volcanoes also erupted at Croghan Hill, where volcanic rocks are seen today. A veneer of till and some esker ridges are the result of the third major episode, that of the more recent Ice Age.

2) Simple summary

The landscape of County Offaly is mostly rather low-lying. In the southeast lies the western part of the Slieve Bloom Mountains, which are formed of the oldest rocks in the county. These old rocks occur in several patches towards the centre of the Slieve Bloom Mountains where erosion has stripped away the younger rocks, but they are only exposed in the banks of a few streams. These grey mudstones, siltstones and sandstones are Silurian in age, around 425 million years old (Ma), and were deposited on a deep ocean floor. Lying above these are red to brown mudstones, sandstones and pebble beds, with occasional peculiar knobbly limestones called 'cornstones'. All of these were deposited on river floodplains in an Equatorial semi-desert environment, with the 'cornstones' actually forming within the soils of the time. Spores are the only fossils that have been found, but they show that these rocks are of earliest Carboniferous age, just a little less than 360 Ma.

Soon after the start of the Carboniferous, sea level rose to flood across these low plains. The first of the marine rocks to be deposited were dark grey fossiliferous mudstones, but above these is a series of thick grey limestones which underlie much of the low ground across the county. At certain levels these limestones are quite fossiliferous, with shells of brachiopods and nautiloids, corals, fragments of crinoids, and rarer fossils such as trilobites. Mostly these limestones accumulated as horizontal layers on a fairly shallow 'shelf' sea floor although some of the younger layered limestones, around 325 Ma, are much darker in colour and were deposited in considerably deeper water. Although the limestones mostly form low ground across the centre of the county, they are well exposed in various working and disused quarries and on some of the low hills in the west of the county. At this time also, volcanoes erupted at Croghan Hill, leaving the only patch of igneous, volcanic rock in the county, visible today as a high ridge.

The most significant force to shape the form of the county as we see it today was the Ice Age which ended about 10,000 years ago. Large ice sheets several hundred metres in thickness covered the county for thousands of years and eroded the rocks beneath. As the ice eventually melted away, the meltwaters reorganised the sediments into iconic landforms like eskers, adjacent to large fans and deltas of sand and gravel. Eskers were formed by sub-glacial rivers, that is, they flowed in tunnels at the base of the ice sheets (see p. 14). Some eskers are small and local within Offaly, but the majority that traverse the county form extended networks and cross several counties.

Since the Ice Age, much of the exposed limestone in Offaly has developed into what is termed karstified bedrock. Water solution of the rock formed some caves, such as Mount Briscoe Cave, and swallow holes, such as Marlow's Hole near Blue Ball. Where some larger, temporary lakes were formed when meltwater was prolific, unusual mushroom shaped stones were created by dissolution of the rock that was submerged. County Offaly has the largest concentration of such mushroom rocks in Ireland. Geological processes continue to modify the landscape today, such as with seasonal flooding of the Shannon and Little Brosna River Callows.

AGE (Million Years Ago)	ERA	PERIOD	EVENTS IN OFFALY	IF THIS TIMESCALE WAS A DAY LONG ...
2.58	Cenozoic	Quaternary	Several ice ages smothering Offaly, followed in the last 10,000 years by the spread of vegetation, growth of bogs and arrival of humans. Deposition of till (boulder clay) in crag-and-tails and till plains, as well as sands and gravels in eskers, fans and deltas. Dissolution of limestone beneath Quaternary sediments.	The ice ages would begin 38 seconds before midnight
66		Tertiary	Erosion, especially of limestone. Caves, swallow holes, cavities and underground streams developing in the lowlands around Tullamore.	The Tertiary period begins at 11.40 pm
145	Mezozoic	*Cretaceous*	*Erosion. No record of rocks of this age in Offaly.*	11.15 pm
201		*Jurassic*	*Uplift and erosion. No record of rocks of this age in Offaly.*	The age of the dinosaurs, starting at 10.55 pm
252		*Triassic*	*Desert conditions on land. No record of rocks of this age in Offaly.*	10.42 pm
299	Palaeozoic	*Permian*		10.30 pm
359		Carboniferous	Land became submerged, limestones with some shales deposited in tropical seas across the lowlands throughout Offaly. Limestones remaining today are pure and bedded in the central portion of the county, with areas of muddier limestones in the rest of the county area. Volcanic basalts extruded during eruptions at Croghan Hill.	Much of Laois's current rocks (limestone, sandstone, shale and basalt) deposited around 10.10 pm
419		Devonian	Caledonian mountain building. 'Old Red' sandstones deposited in the Slieve Blooms.	'Old Red' Sandstone deposited at 9.52 pm
443		Silurian	Shallow seas, following closure of the Iapetus Ocean. Greywackes, siltstones, mudstones deposited in the central portion of Slieve Bloom.	Starts at 9.42 pm
485		*Ordovician*	Closure of the Iapetus Ocean. *No record of rocks of this age in Offaly.*	Begins at 9.28 pm
541		*Cambrian*	Opening of the Iapetus Ocean. *No record of rocks of this age in Offaly.*	Starts at 9.11 pm
2500	Proterozoic	*Precambrian*	*Some of Irelands oldest rocks deposited in Mayo and Sligo.*	Beginning 11.00 am
4000	Archaean		*Oldest known rocks on Earth.*	Beginning 3.00 am
4600			*Age of the Earth.*	Beginning 1 second after midnight

Figure 7. Geological Timescale and County Offaly

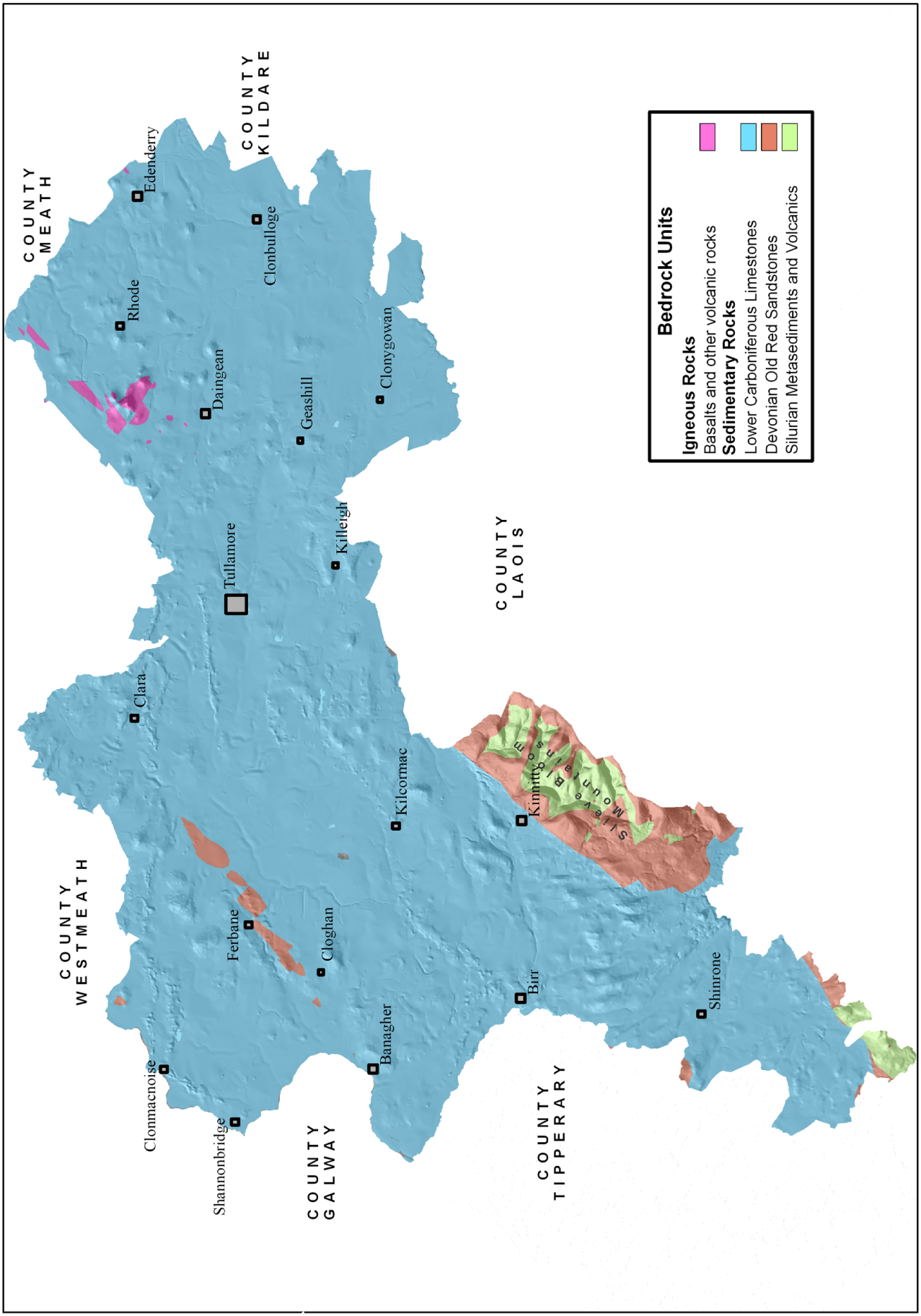


Figure 8. A simplified geology map of County Offaly outlining the main geological units.

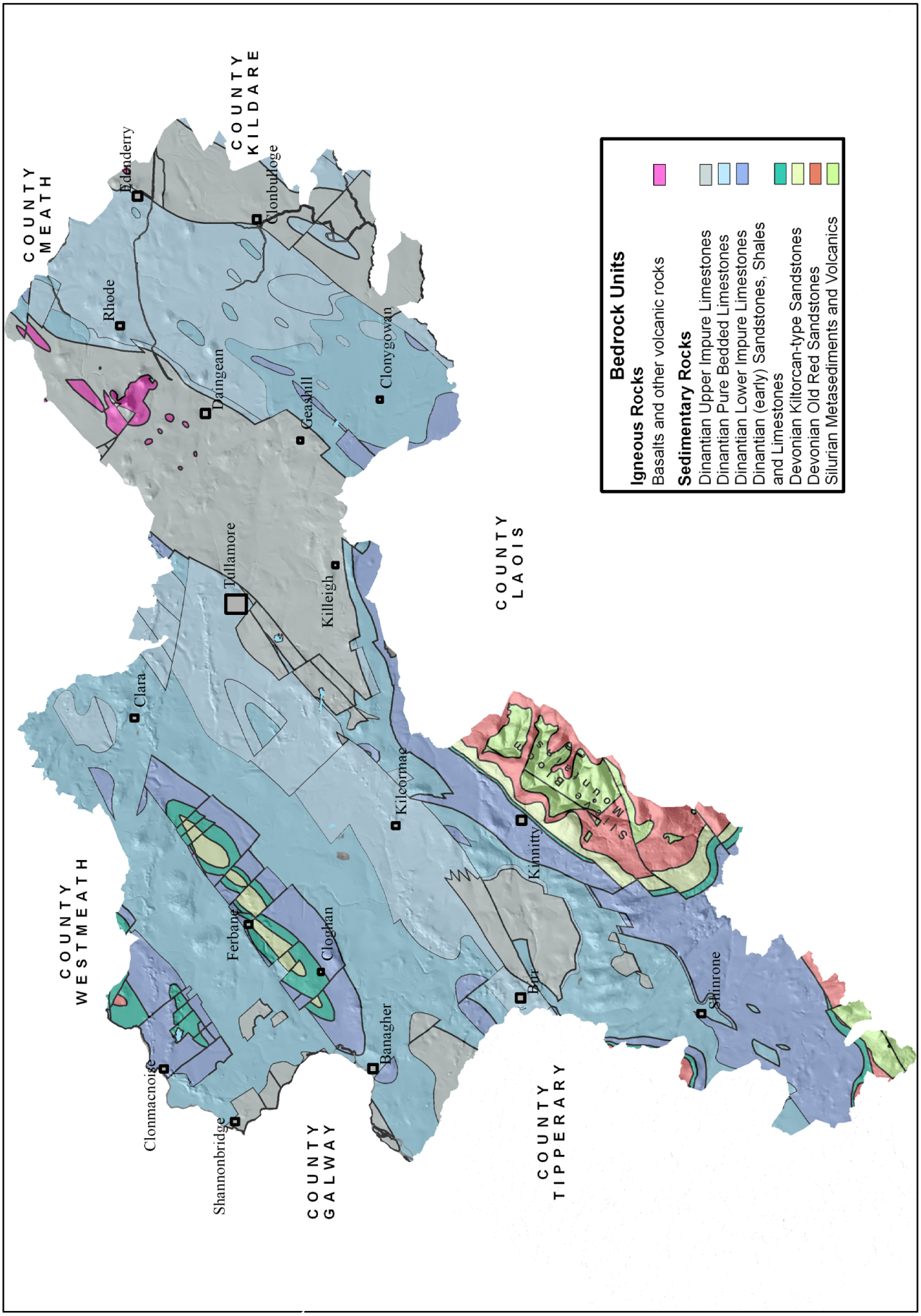


Figure 9. A detailed geological map of County Offaly.

6. Acknowledgements

The authors would like to gratefully acknowledge the assistance of Amanda Pedlow, Heritage Officer from Offaly County Council in the development of this project. Likewise Catherine Casey, Heritage Officer in County Laois worked closely with Amanda and with the authors as the two counties were audited in a joint project. Funding from the Heritage Council and Offaly County Council is also acknowledged. We also acknowledge the many members of the IGH Programme Expert Panels who helped define the sites which were considered for County Geological Site status.

The following are thanked for allowing access for the audit visits, and their kindness in answering questions and providing valuable assistance with information or guidance:

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Mr. Jimmy Shortt
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Mr. Tom Dolan
Mr. Dan Foley
Ms. Margaret Edgill
Mr. Henry Edgill
The staff at Lough Boora Parklands
Michael Byrne, Offaly History Centre

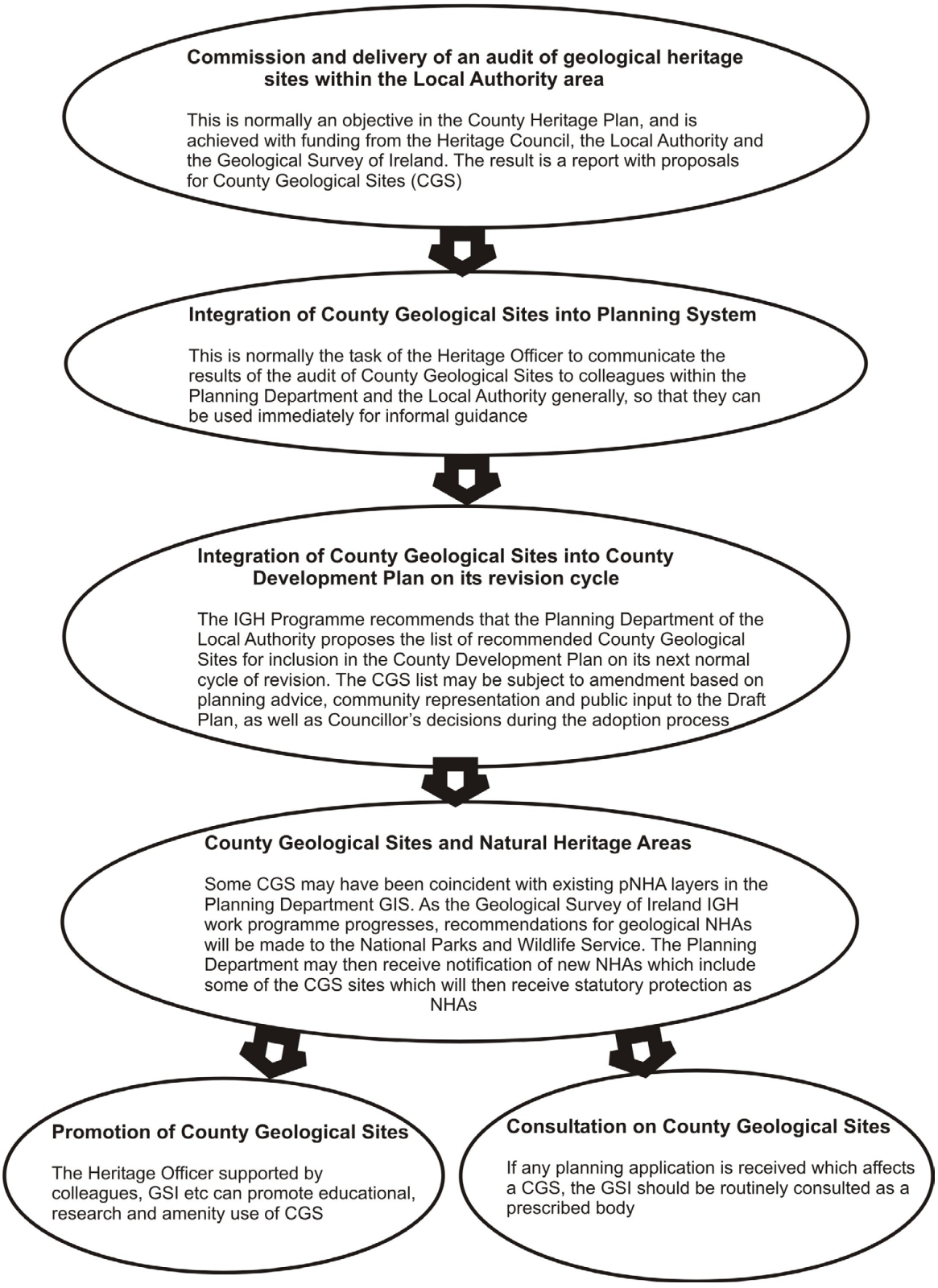
Appendix 1 – Geological heritage audits and the planning process

This appendix contains more detail on the legal framework behind geological heritage audits conducted by County Councils, and the process which operates as a partnership between the Geological Heritage and Planning Programme of the GSI and the local authority Heritage Officer.

Geology is now recognised as an intrinsic component of natural heritage in three separate pieces of legislation or regulations, which empower and require various branches of Government, and statutory agencies, to consult and take due regard for conservation of geological heritage features: the Planning and Development Act 2000 [e.g. Sections 212 (1)f; Part IV, 6; First Schedule Condition 21], the Planning and Development Regulations 2001, the Wildlife (Amendment) Act 2000 (enabling Natural Heritage Areas) and the Heritage Act 1995. The Planning and Development Act 2000 and the Planning Regulations, in particular, place responsibility upon Local Authorities to ensure that geological heritage is protected. Implementation of the Heritage Act 1995, through Heritage Officers and Heritage Plans, and the National Heritage Plan 2002, allow County Geological Sites to be integrated into County Development Plans.

The chart below illustrates the essential process, established by the Irish Geological Heritage Programme in GSI, over the course of numerous county audits since 2004.

County Geological Sites - a step by step guide



Appendix 2 - Bibliography – Geology of County Offaly

Shortlist of Key Geological References

This reference list includes a few **key** papers, books and articles on the geology and geomorphology of County Offaly that are recommended as access points to County Offaly's geological heritage.

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Appendix 4 - Geological heritage versus geological hazards

Ireland is generally considered to be a country with very low risk of major geological hazards: there are no active volcanoes, Ireland's location on stable tectonic plates mean earthquakes are relatively rare and its recorded human history is not peppered with disastrous landslides, mudflows or other geological catastrophes. There are of course risks of one-off events, and this section looks at the record and nature of geological hazards in Offaly and the relationship of the County Geological Sites to those hazards. The difference between human timescales and geological timescales can be difficult to comprehend but, for many geological processes, there are periods of sudden activity encompassing major events, and then quiet periods in between. The sites in this audit represent evidence of past geological environments and processes. However, in County Offaly there are few sites representing the active geomorphological or land-forming processes of today, although some of the sites like the Silver River, are actively eroding river valleys, and there are landslides of glacial till on the gorge walls.

Landslides and bog flows
Geological Survey Ireland has been compiling national data on landslides in the past decade. There were some 44 events recorded in Offaly, the great majority of which occurred in the Slieve Bloom uplands, and are possibly bog flows, although few have details recorded. See http://spatial.dcenr.gov.ie/GeologicalSurvey/LandslidesViewer/index.html

Flooding
There are two types of flooding which need consideration. River flooding occurs inland when the rainfall exceeds the capacity of the ground to absorb moisture, and the river channels cannot adequately discharge it to the sea. The OPW website, www.floods.ie, can be consulted for details of individual flood events in County Offaly, many of which are recurring events from the River Shannon and the River Brosna. The Carboniferous limestone bedrock in County Offaly is not known to become heavily karstified, like upland limestone areas such as the Burren or the Bricklieve Mountains, although newly recognised karst sites do occur such as at Marlow's Hole, where turlough-like behaviour may occur.

Radon
Radioactive minerals and gases can potentially cause cancer, particularly where humans are exposed to high concentrations over prolonged periods. Radon gas can seep into homes and workplaces and can be carried in water supplies. A map showing the areas predicted to be at particular risk from radon in Ireland, called High Radon Areas, can be seen on the EPA website at http://www.epa.ie/radiation/#.VRu9OVROPcs. A large part of Offaly is classified as low radon. The Office of Radiological Protection, a division of the EPA, is responsible for radiological protection in Ireland.

Groundwater pollution
Whilst not such an obvious hazard as physical collapses, flooding and landslides, the pollution of groundwater supplies carries a serious risk to human health. Offaly is a county quite dependent on groundwater supplies, and therefore the risk is more serious than for most other counties. As the groundwater is largely contained within limestone, it should be noted that karstic springs are especially vulnerable to pollution since the flow is mainly within fissure conduits allowing rapid transmission of pollution from source to water supply. The opportunity for microbial attenuation of pollutants is far less in both limestone fissures and sands and gravels (as the infiltration rate is very rapid and bacteria cannot die off) than it would be in moderate permeability deposits, which act as natural filters.

Appendix 5 Data sources on the geology of County Offaly

Data sources on the geology of County Offaly

This section is a brief summary of relevant GSI datasets, to assist any enquiry concerning geology and to target possible information easily. The GSI has very many datasets, accumulated since it began mapping Ireland's geology in 1845. A Document Management System (called GOLDMINE) is freely available online, into which about half a million documents and maps have been scanned. This means that any user can search on screen for data of relevance to them. **Data is available free of charge**.

Key datasets include:

GOLDMINE (**G**SI **O**n**L**ine **D**ocument, **M**aps and **I**nformatio**N** **E**xplorer). The GSI online digital archive enables visitors to search Geological Survey Ireland online data archive database and download full-size resampled pdfs and/or original high resolution TIFF image files. The data consists of: Scanned Capture of 450,000 pages and maps, including all of GSI principal datasets, (Mineral Exploration Reports-Open File, Geotechnical Reports, boreholes & tests, Historic 6":1 mile and 1":1 mile Geological Maps, GSI Publications, Bulletins, Published and Unpublished Reports, Groundwater Well Hydrographs, Marine Maps, Airborne Geophysical Maps, Mineral Locality Reports and Mine Record Reports and Maps). The database runs on Oracle© and the stored imagery is currently 1.4TB in size.

https://secure.dcenr.gov.ie/goldmine/index.html

1:100,000 Map Report Series

All historical, modern and other mapping has been compiled into very useful maps and reports that describe the geology of the entire country. Sheet 15 covers most of County Offaly.

19th century 6 inch to the mile fieldsheets

These were surveyed in the 1850s and 1860s, and provide an important historical and current resource, with very detailed observations of the geology of the entire country.

19th century one inch maps and Memoirs

Information from the detailed 19th century mapping, completed in the 1850s and 1860s, was distilled into one inch to the mile maps, of which parts of Sheets 108, 109, 110, 117, 118, 119, 126, 127 and 135 cover County Offaly. Each sheet or several sheets were accompanied by a Memoir which described the geology of that area in some detail. These still provide valuable records of observations even though interpretations may have changed with better geological understanding. Memoirs are in the GSI's Customer Centre library and scanned on GOLDMINE.

Historical geological mapping is now available via a website:
http://www.geologicalmaps.net/irishhistmaps/history.cfm

Open File Data

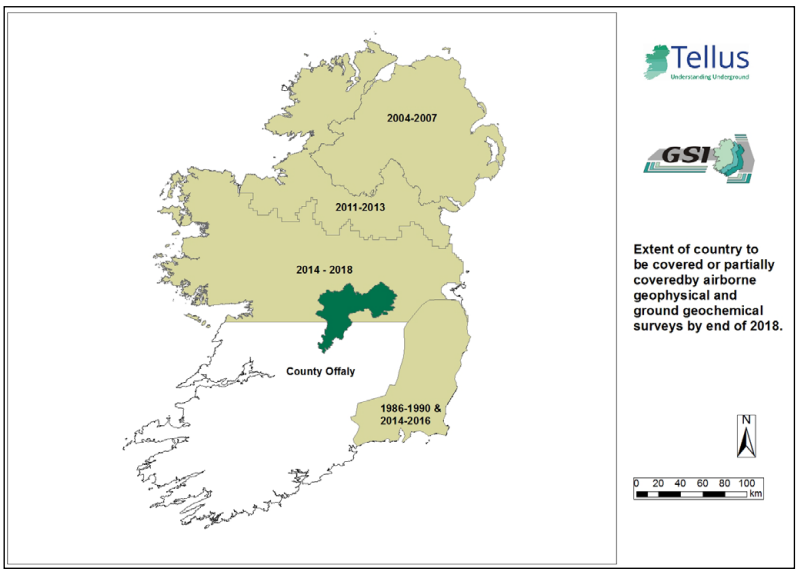
Each Mineral Prospecting Licence issued by the Exploration and Mining Division (EMD), currently of the Department of Communications, Climate Action and Environment, carries an obligation on the exploration company to lodge records of the work undertaken, for the

common good. These records are held by the Geological Survey and are available as Open File Data, once a period of time has expired. They may include geological interpretations, borehole logs, geophysical and geochemical surveys and so on. Licences relate to numbered prospecting areas, and these are available on a map from EMD. See also www.mineralsireland.ie

MinLocs Data
The MinLocs Database records all known mineral occurrences, however small, from GSI records, such as 19th century field sheets and Open File data.

Subsoils Mapping
Since a Groundwater Protection Scheme has been completed by GSI (2012) for the whole country, a modern map of the subsoil types and depths across County Offaly exists, as well as the previously completed bedrock mapping. This provides a significant resource in general terms as well as for groundwater protection. Customised output is possible. Furthermore, detailed compilation of glacial geology datasets, including a revision published by GSI in late 2014, now provides more data. Digital mapping of many different datasets is now available via an easy to use public viewer on the GSI website: www.gsi.ie

Tellus Mapping
Tellus is a regional mapping project, combining airborne geophysical and geochemical surveys to provide geoscientific information for the island of Ireland. Since 2004, more than 40,000 km^2 of the island of Ireland has been surveyed or partially surveyed through the **Tellus** surveys, which support mineral exploration, environmental management, agriculture and research activity. Geological Survey Ireland aims to complete both geochemical and geophysical Tellus surveying in 50% of the country by the end of 2018, with the view to completing the country in subsequent phases. Geophysical surveying has been completed over most of County Offaly with geochemical surveys to follow in 2017 and 2018. Data will be freely available from www.tellus.ie



Historic Mine Records
Abandonment plans and varied other material exists for the various mining ventures in the country. There is very little available for Offaly, excepting a modern survey completed on Blundell Mine near Edenderry (Critchley and Schwartz 2011a,b, see Appendix 2).

Appendix 6 - Further sources of information and contacts

Sarah Gatley of Geological Survey Ireland, who is the Head of the Geological Heritage and Planning Programme, can be contacted in relation to any aspect of this report. Amanda Pedlow, the Heritage Officer of Offaly County Council is the primary local contact for further information in relation to this report. Other contacts include the Conservation Rangers of the National Parks and Wildlife Service, currently in the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. The names and phone numbers of current staff may be found in the phone book, or at www.npws.ie.

Web sites of interest

www.gsi.ie - for general geological resources
www.geology.ie – the website of the Irish Geological Association who run fieldtrips and lectures for members, including many amateur enthusiasts
www.earthscienceireland.org - for general geological information of wide interest
http://www.iqua.ie - for information, fieldtrips, lectures etc in relation to Ireland's Ice Age history
http://www.progeo.se/ - for information about ProGEO the European Association for the Conservation of Geological Heritage

Appendix 7- Geoschol leaflet on the geology of County Offaly

OFFALY

AREA OF COUNTY: 1,999 square kilometres or 771 square miles

COUNTY TOWN: Tullamore

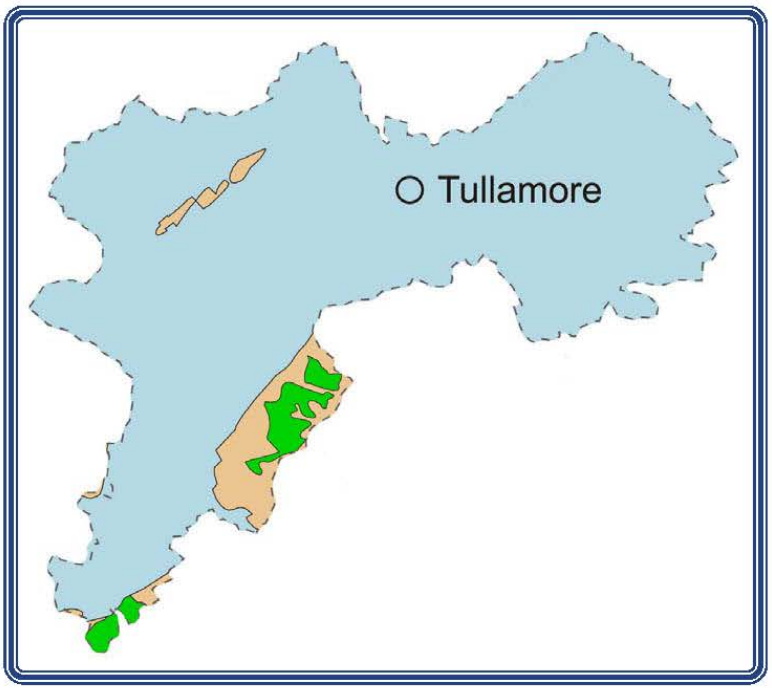
OTHER TOWNS: Banagher, Birr, Clara, Edenderry, Moneygall

GEOLOGY HIGHLIGHTS: Slieve Bloom Mountains, Mushroom Stones

AGE OF ROCKS: Silurian to Carboniferous

Camcor Valley in the Slieve Bloom Mountains

These mountains are composed of a core of older Silurian rocks surrounded by younger Devonian sandstones.



Geological Map of County Offaly

Green: Silurian; **Beige:** Devonian sandstones and conglomerates; **Light blue:** Lower Carboniferous limestone.

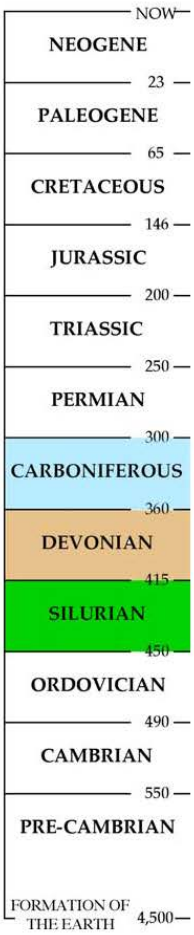
Geological history

The oldest rocks in Offaly are those of Slieve Bloom, an inlier of older rocks surrounded entirely by younger rocks. The core of the inlier are the hills of Silurian sedimentary slaty rocks, but these are poorly exposed. They are protected by thick sandstones of Devonian age. These can be seen in the eroded trenches of river valleys such as the Silver River, and were originally deposited by rivers around 380 million years ago. In the Carboniferous Slieve Bloom was probably an island in the shallow tropical seas.

Today, few of Offaly's rocks are exposed. They have been eroded down over millions of years to a low lying plain, and are now blanketed by bogs and glacial deposits left by the last Ice Age. Offaly has some of the largest and finest bogs in Ireland's midlands.

Eskers at Kilcormac

The most recent development occurred during the last 1.6 million years when ice ages came and went, the last ending about 10,000 years ago and leaving Offaly with some of the finest glacial deposits of sand and gravel across the lowlands. Eskers (the international name for these features comes from the Irish name: eiscir) formed around Tullamore in particular, from rivers flowing beneath the ice, leaving a long narrow ridge of sand and gravel such as that at Kilcormac (pictured above). The Eiscir Riada is famous in history, providing a dry route across the boggy plains of the Midlands, and to the monastic centre at Clonmacnoise.



Offaly's Mushroom Stones

These weird shaped stones (such as that at Ballylin, pictured right) are thought to have been formed by lake water dissolving away the limestone below the level of the lip leaving curious shapes, often in the form of a mushroom. The temporary lakes have long since drained away, sometimes replaced by bogs. Offaly has nearly half of the 70 or so of these features recorded throughout the country.

Geological timescale showing age of rocks in Offaly.

Peat harvesting at Derries Bog, Co. Offaly

Offaly fossils

Where limestone is exposed there is a good chance of finding fossils within it, of the typical types from the Carboniferous seas, such as crinoids, brachiopods, nautiloids, trilobites and corals.

Mining & Building Stones

Like most parts of the country, small limestone quarries have often been used for local building needs. The eskers too have been extensively dug into in old farmers' 'borrow pits' and modern aggregate quarries, as the stone is easily extracted. In modern times, Bord na Mona has been removing entire bogs to make peat briquettes for fuel and milling the top layers for garden peat and compost.

Suggested reading

• L. Dunne & J. Feehan 2003. *Ireland's Mushroom Stones. Relics of a Vanished Lakeland.* Environmental Resource Management, University College Dublin.

Map adapted with permission from Geological Survey of Ireland 1:1,000,000 map 2003.
Image credits: Graham Horn 1 ; Jonathan Billinger 4 (both licensed for reuse under the Creative Commons Licence); Mike Simms 3 (top); Matthew Parkes 3 (bottom).

Appendix 8 - Glossary of geological terms

Geological term	Definition
Alluvial Deposit	unconsolidated clay, silt, sand and gravel, deposited by a body of running water.
Alluvium	a term for unconsolidated clay, silt, sand and gravel, deposited by a body of running water.
Aquifer	a permeable water saturated rock unit.
Artesian Well	a well from which water flows under natural pressure without pumping.
Basin	low areas in the Earth's crust, of tectonic origin, in which sediments have accumulated.
Bedrock	a general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.
Bioclast	fragment of a shell or fossil forming part of a sedimentary rock.
Blanket Bogs	bog covering a large, fairly horizontal area, which depends on high rainfall or high humidity, rather than local water sources for its supply of moisture.
Boulder Clay	unconsolidated, unsorted glacial deposits consisting of boulders and cobbles mixed with very finely ground-up rock or silt. Also known as till.
Bryozoa	invertebrates belonging to the phylum Bryozoa, ranging from Ordovician to present, often found as frond-like fossils.
Calcite	a pale mineral composed of calcium carbonate, which reacts with dilute hydrochloric acid.
Calp	dark grey, fine-grained, muddy limestone.
Cave	a naturaly-formedl cavity underground, large enough for a human to enter.
Channel	a landform consisting of the outline of a path of relatively shallow and narrow body of fluid, most commonly the confine of a river, river delta or strait.
Chert	a sedimentary rock comprising of very fine-grained quartz.
Chironomid	a family of flies, similar in size and form to mosquitoes.
Crag and tail	a steep resistant rock mass (crag), with sloping softer sediments (tail) protected from glacial erosion or deposited as glacial debris on the crag's 'downstream' side.
Crinoid	a variety of sea-urchin, with a long flexible stem, usually anchored to the sea-floor and a body cup with arms which may be branching (a sea lily).
Diatom	a major group of algae, among the most common types of phytoplankton.
Dip/dipping	when sedimentary strata are not horizontal they are dipping in a direction and the angle between horizontal and the inclined plane is measured as the dip of the strata or beds.
Doline	circular/oval closed depression found in karst terrain.
Dolomite	calcium- and magnesium-bearing carbonate mineral; also a rock composed of the mineral.
Drumlin	a streamlined mound of glacial drift, rounded or elongated in the direction of the original flow of ice.
Echinoderm	marine organisms with interlocking plates (skeletal) covered by spines.
Erratic	a large rock fragment that has been transported, usually by ice, and deposited some distance from its source. It therefore generally differs from the underlying bedrock, the name "erratic" referring to the errant location of such boulders. Tracing their source can yield important information about glacial movements.

Esker	an elongated ridge of stratified sand and gravel which was deposited in a subglacial channel by meltwaters. Eskers are frequently several kilometers in length.
Fan	a usually triangular deposit of sand and gravel deposited by a glacial stream, either under a lake or under air.
Fault	planar fracture in rocks across which there has been some displacement or movement.
Floodplain	a flat or nearly flat land area adjacent to a stream or river that experiences occasional or periodic flooding.
Fluvial	pertaining to a river or stream.
Glacial	of or relating to the presence and activities of ice or glaciers.
Glaciofluvial	pertaining to the meltwater streams flowing from wasting glacier ice and especially to the deposits and landforms produced by such streams.
Grading	a sorting effect with the coarsest material at the base of the bed and finest grained material at the top.
Greywacke	an impure sandstone, characterised by poorly-sorted, angular grains in a muddy matrix, that was deposited rapidly by turbidity currents (submarine avalanches).
Hum	residual, isolated hill formed through karst processes, sometimes stubby and smoothed out by later erosional processes, e.g. glacialation
Hummock	a small hill or knoll in the landscape, which may be formed by many different processes.
Ice margin	the edge of an ice sheet or glacier.
Igneous	a rock or mineral that solidified from molten or partially molten material i.e. from a magma.
Inlier	area of older bedrock completely surrounded by younger bedrock.
Interglacial	the time interval between glacial stages, or pertaining to this time.
Joint	a fracture in a rock, which shows no evidence of displacement.
Karst	a landscape formed from the dissolution of soluble rocks such as limestone, dolomite, or gypsum, characterized by underground drainage systems with sinkholes and caves.
Lava	magma extruded onto the Earth's surface, or the rock solidified from it.
Limestone	a sedimentary rock consisting chiefly of calcium carbonate ($CaCO_3$), primarily in the form of the mineral calcite.
Lithology	the description of rocks on the basis of such characteristics as colour, composition and grain size.
Meander	a bend in a sinuous watercourse or river which forms when moving water in a stream erodes the outer banks and widens its valley, and the inner part of the river has less energy and deposits fine sediment.
Meltwater	water from melted snow or ice.
Meltwater channel	a channel cut by glacial meltwater, either under, along or in front of an ice margin.
Metamorphic	referring to the process of metamorphism or to the resulting metamorphic rock, transformed by heat and pressure from an originally igneous or sedimentary rock.
Metasediments	metamorphosed sediments.
Moraine	any glacially formed accumulation of unconsolidated debris, in glaciated regions, such as during an ice age.
Ore	a mineral which is concentrated enough to be exploited by mining.
Outcrop	part of a geologic formation or structure that appears at the surface of the Earth.

Raised Bogs	an area of acid, peaty soil, in which the centre is relatively higher than the margins.
Shaft	a vertical or inclined hole dug in a mine for access, ventilation, for hauling ore out or for pumping water out.
Shale	a fine-grained sedimentary rock, formed by the compaction and lithification of clay, silt, or mud. It has a finely laminated (composed of layers) structure that gives it a fissility, or tendency to split along bedding planes.
Spring	the point where an underground stream reaches the surface.
Stratigraphy	the study of stratified (layered) sedimentary and volcanic rocks, especially their sequence in time and correlation between localities.
Swallow hole	also known as sinkholes, swallets or sluggeras, swallow holes are entrances to subsurface cavities whereby a surface stream sinks underground.
Terrace	terraces are remnants of the former floodplain of a stream of river, formed by the downcutting of a river or stream channel into and the abandonment and lateral erosion of its former floodplain.
Till	unconsolidated, unsorted glacial deposits consisting of boulders and cobbles mixed with very finely ground-up rock as sand, silt or clay.
Volcaniclastic	the process by which magma and its associated gasses rise into the crust and are extruded onto the Earth's surface and into the atmosphere.
Volcanic Rock	any rock produced from volcanic material, e.g. ash, lava.
Waulsortian	Lower Carboniferous age limestones consisting of skeletal debris and carbonate mud. The sediments commonly form individual and coalesced mounds with depositional dips of 20-40 degrees. Named after rocks in Belgium.

The Geological Heritage of County Offaly

An audit of County Geological Sites in County Offaly

Section 2 – Site Reports

by Ronan Hennessy, Robert Meehan, Matthew Parkes, Vincent Gallagher and Sarah Gatley

2016

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An Chomhairle Oidhreachta
The Heritage Council

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

ESTO FIDELIS

This report is a contribution to the programme of work in the County Offaly Heritage Plan 2012 – 2016

Section 2 - Site Reports

Site reports – general points
The following site reports are brief non-technical summaries of the proposed County Geological Sites for County Offaly. These have been specially prepared for this Report in order to make the information accessible to planners and others without geological training. For some sites more detailed reports and information files are held in the IGH Programme in Geological Survey Ireland. These are available for consultation if required. Each site report has primary location information, a mention of the main rock types and their age, and a short description of the key aspects of scientific interest. A section outlining any particular management or other issues specific to the site is included, along with several low resolution photographs exemplifying the site. Grid references are given for a central point in the site generated from the GIS mapping (a shapefile) of the site boundary. They are only indicative of the location, but the site extent is best shown on the included maps.

Coordinate Projection System – IRENET95 ITM
Irish Transverse Mercator (ITM) is the geographic projection co-ordinate system now in use for Ireland, and has been applied to all site localities in the site reports. It is the standard co-ordinate system for OSi maps, including the new Discovery map series, but a coordinate conversion tool is available on the OSi website at:
http://www.osi.ie/calculators/converter_index.asp?alias=/services/gps-services/co-ordinate-converter#results.

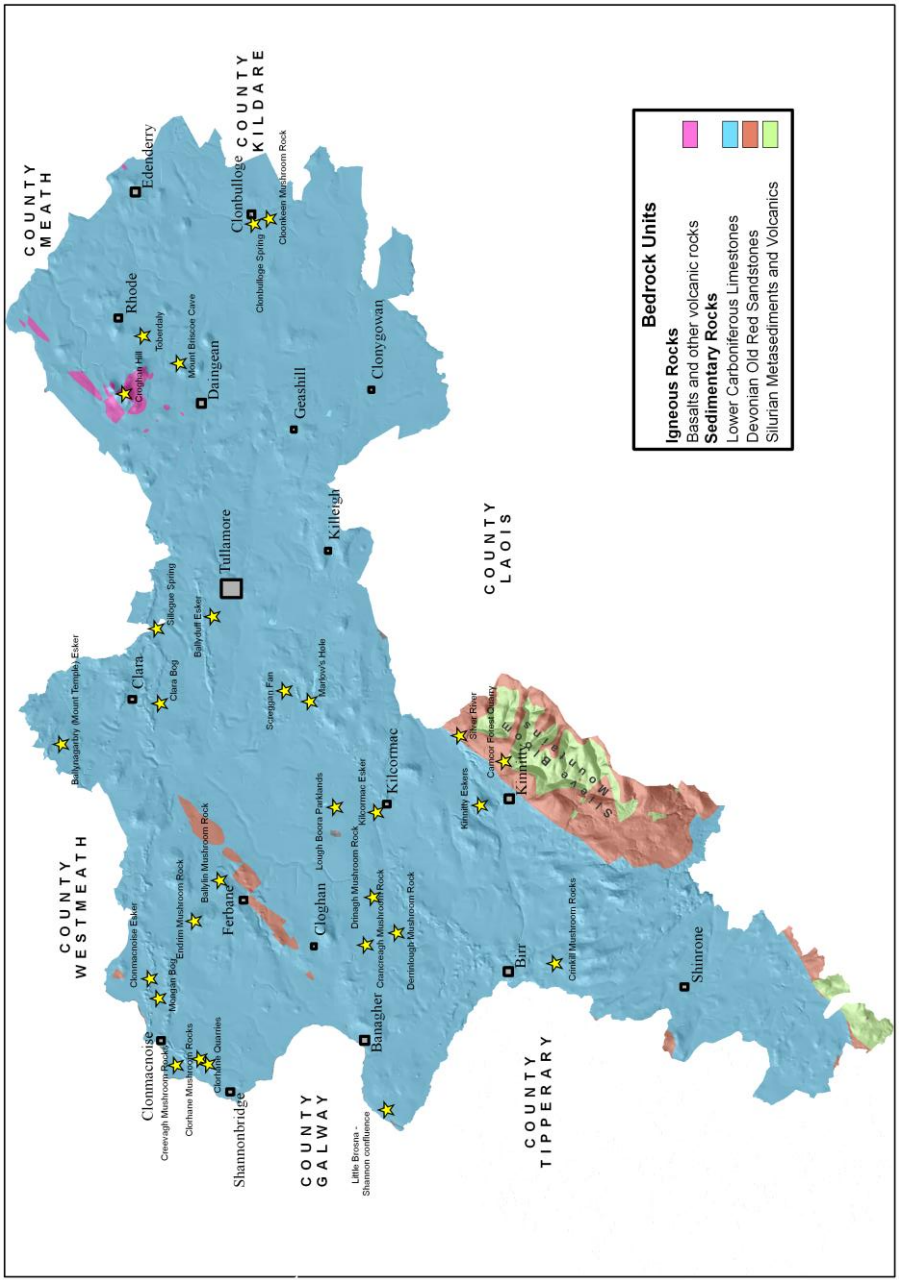
A series of maps are provided with an outline of the site boundary. It is important to note that these boundaries have no legal or definitive basis. They are indicative only of the limits of exposure or of geological interest, and not based on detailed field and boundary surveys, which were outside the scope of this contract. Boundaries are drawn to include the geological or geomorphological interest of the site, but are extended to the nearest mappable boundary, such as a field boundary, stream, road or edge of forestry. On a few sites, such as in open mountain terrain, it is impractical to find a boundary within a reasonable distance and an arbitrary line may be defined. County Geological Sites are non-statutory and so this is not problematic. If any such site is fully assessed for NHA status in the future, such a boundary may require small revisions.

For sites that have been recommended or which will be recommended for NHA designation, detailed site boundary maps will become available to the Local Authority through NPWS as the designation process is undertaken. Some areas may already be available if they are proposed NHAs (pNHA), under the Wildlife (Amendment) Act 2000. Areas which have been designated as Special Areas of Conservation (SAC) under European Habitats Directives will also have statutory boundaries already determined. The geological interest may be included within these wider areas of nature conservation.

In terms of any geological heritage site designation as NHA, due process of site reporting, boundary survey and very importantly, consultation with landowners where they can be readily identified, will take place before GSI finalises recommendations with NPWS on the most important sites to be designated. Any landowner with concerns over any site is encouraged to contact Sarah Gatley, Head of the Geoheritage Programme, in Geological

Survey Ireland, Beggars Bush, Haddington Road, Dublin 4. Phone 01-6782837. Email: sarah.gatley@gsi.ie

All topographic base maps in the following site reports are reproduced with permission of the Ordnance Survey of Ireland, Licence No. EN 0047215. For each site's outline, the Discovery Series Map shows the context of each site in relation to the nearest town or village, while aerial photographs from the Ordnance Survey flight of 2005 show the site boundary in a more localised context, whereby field boundaries and other features can be clearly seen. The same area as covered by the aerial photograph is then mirrored on the nineteenth century Ordnance Survey six inch sheet of the site locality, which often shows interesting local features no longer extant, or of cultural significance, at that time.



A simplified geology map of County Offaly with site locations indicated.

Section 2 – Site Reports

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballyduff Esker**
Other names used for site	The Ballyduff Esker-Rahugh Ridge, The Tullamore Esker, The Murphy's Bridge Esker
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Cornalaur, Ballincloghan, Cappaloughan, Goldsmithslot, Mountarmstrong, Aghadonagh, Tullybeg, Tullymorerahan, Aghalusky, Ballynasrah, Ballykilmurry, Ballyduff, Muiniagh, Ardan, Bracklin Big, Ballynasrah or Tinnycross, Rosnagowloge or Tirinchinan, Cartron East, Bracklin Little**
NEAREST TOWN/VILLAGE	**Tullamore**
SIX INCH MAP NUMBER	**3, 10, 16, 17**
ITM CO-ORDINATES	**630860E 727560N (centre of esker, at Ballykilmurry)**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description

The Ballyduff Esker and surrounding sands and gravels includes an exceptionally large accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew westwards across Offaly at the end of the last Ice Age.

The esker forms part of the larger Ballyduff Esker-Rahugh Ridge Esker System, which extends into County Westmeath to the northeast.

Geological System/Age and Primary Rock Type

The Ballyduff Esker and surrounding sands and gravels are formed entirely on Lower Carboniferous limestone rocks, across the lowlands of Central Offaly. The eskers themselves are Quaternary in age, having been deposited either under or at the edge of the westward-retreating ice sheet in deglaciation, approximately 14,000 years ago.

Main Geological or Geomorphological Interest

The esker ridges are striking features, standing proud of the flat landscape of till (boulder clay) upon which they were deposited. In many places the eskers have been surrounded by post-glacial alluvium or peat deposits in the Holocene, since the Ice Age. High, quarried portions visible from the N80 between Tullamore and Clara are especially impressive. Here, the eskers are comprised of a singular ridge of coarse gravels poking through hummocky topography of more haphazard arrangement.

The esker feature is important in that it records faithfully the ice movement across this area of Offaly during the final phase of deglaciation. Wide belts of associated sands and gravels north of Tulllamore, flanking the esker beads themselves, have long been studied and are part of associated ice marginal fan and delta systems. The sands and gravels within the esker are comprised chiefly of limestone clasts.

Site Importance – County Geological Site; may be recommended for Geological NHA

This system comprises a well-defined landform sequence and should be listed as a County Geological Site. The feature is a haphazardly arranged, high, striking example of a dry sand and gravel ridge, and stands proud of the surrounding landscape. This esker and its associated sands and gravels in the locality are a good example of a deglacial, meltwater-deposited complex, with portions deposited under the ice, and portions at the ice margin.

Management/promotion issues

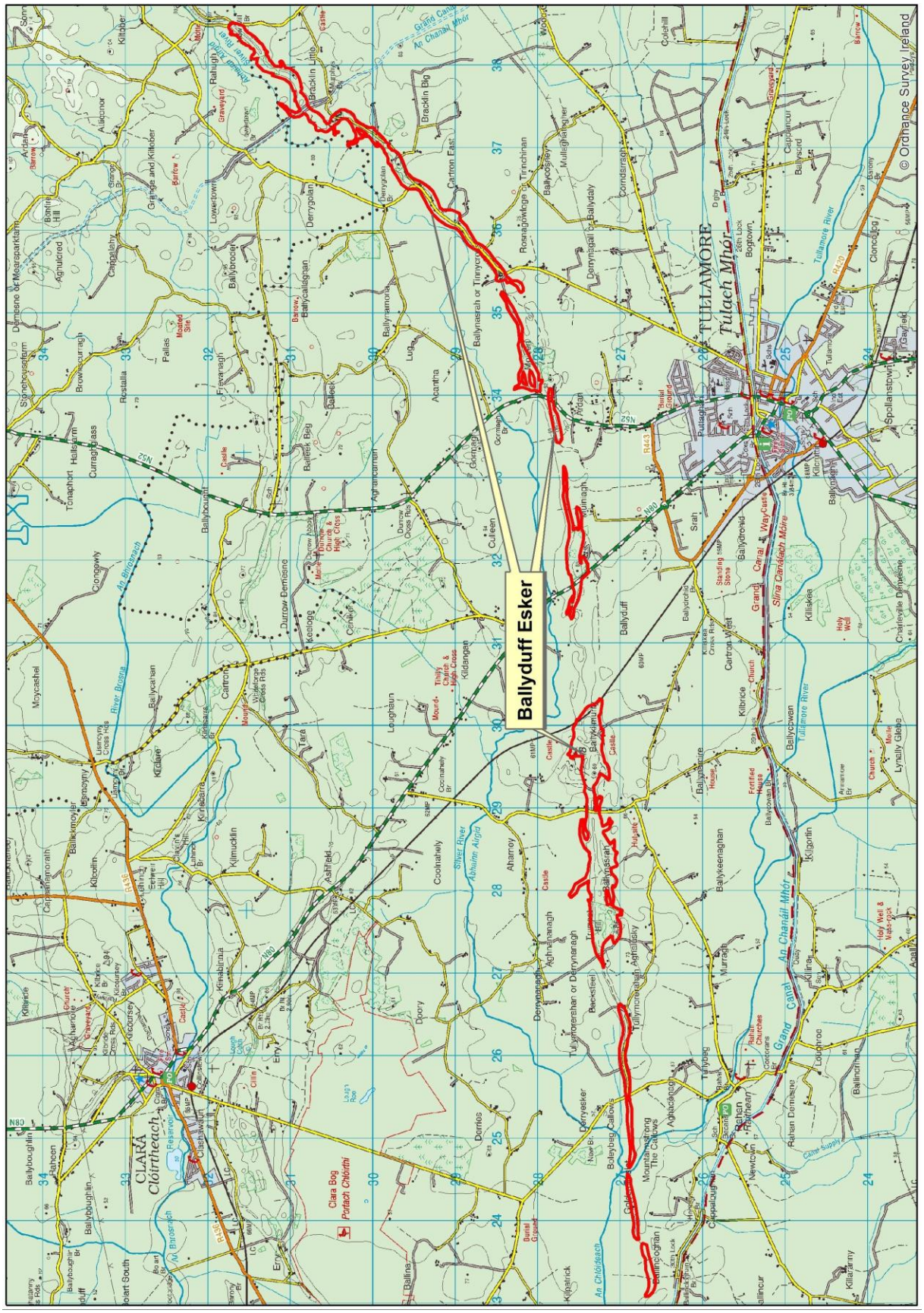
The Ballyduff Esker, Ballyduff Wood and Murphy's Bridge Esker pNHAs straddle the esker (sitecodes 000885, 001777 and 001775 respectively) and the entirety of these areas, as well as many adjacent, are proposed here as the County Geological Site. Many of the esker ridge segments themselves are worthy of pNHA status geologically and geomorphologically. A signboard about the esker along the N52 near the sculptures might prove worthwhile.

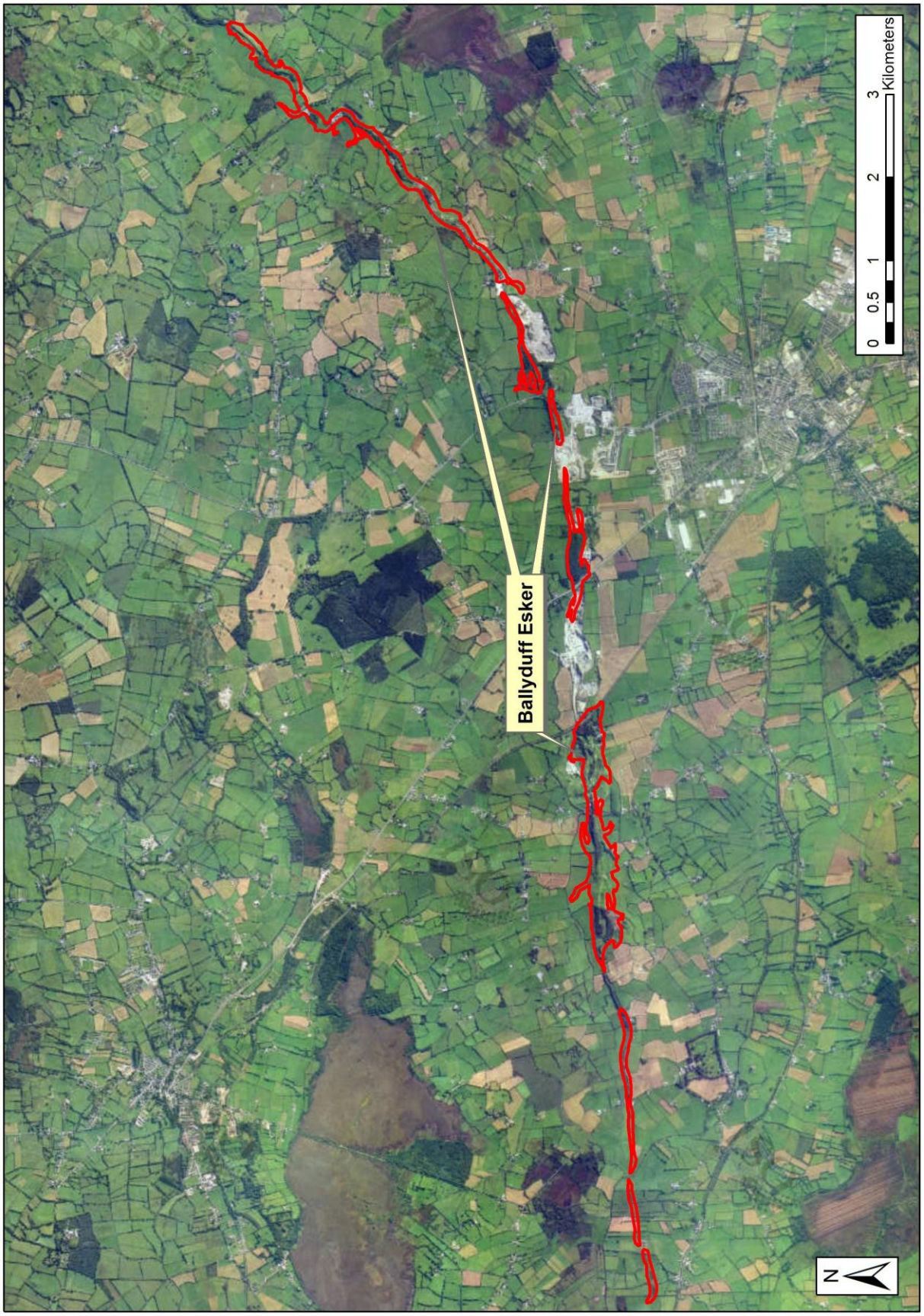
The main segment of the Ballyduff Esker on the N52 by-pass of Tullamore.

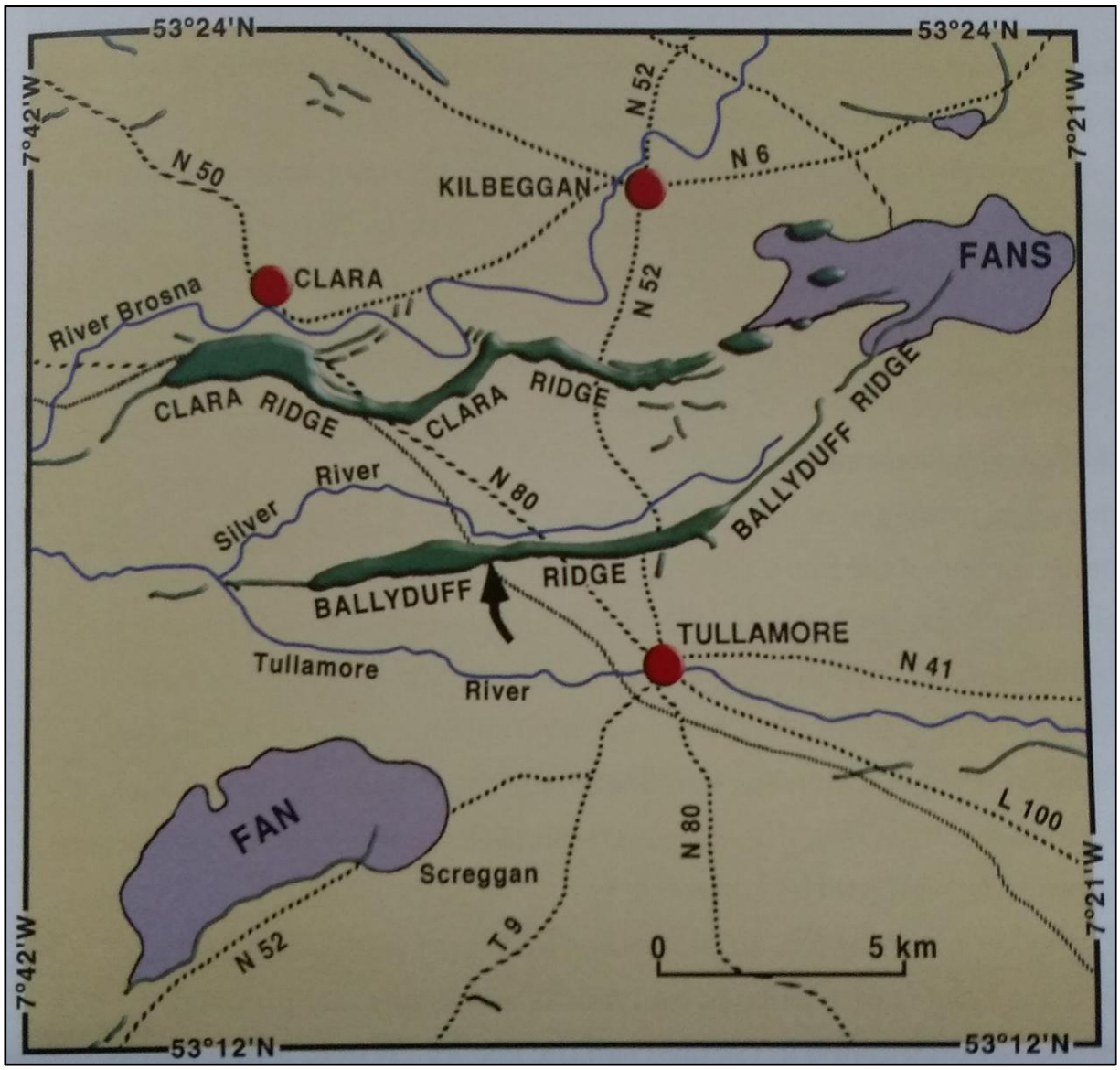
Exposure into the deltaic sediments overlying the esker in the huge pit at Ballykilmurry.

Cross section through the esker just north of Tullamore, in the small industrial unit there.

Roadstones Concrete Manufacturing Plant, within the esker pit, at Ballykilmurry.


Ballyduff Esker
© Ordnance Survey Ireland


Ballyduff Esker
0 0.5 1 2 3
Kilometers
N



The schematic of deglaciation in the Tullamore District, from Farrington and Synge's (1970) paper on the area (see Appendix 3 for reference details, image reproduced here as in Feehan, 2013).

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballylin Mushroom Rock**
Other names used for site	
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Ballylin**
NEAREST TOWN/VILLAGE	**Ferbane**
SIX INCH MAP NUMBER	**14**
ITM CO-ORDINATES	**611676E 726581N**
1:50,000 O.S. SHEET NUMBER	**47 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A Mushroom Rock – isolated upstanding rock in a wheat field.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

Main Geological or Geomorphological Interest
Ballylin is one of the relatively numerous examples of mushroom rocks in Offaly compared to most counties in Ireland. It is one of the most 'mushroom' shaped rocks amongst Offaly's representatives of this phenomenon. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes or expanded river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock.

Site Importance – County Geological Site
This is one of the spread of mushroom rocks that are particularly well represented in Offaly on a national basis, and deserves to be recognised and protected. Thus it is recommended as a County Geological Site.

Management/promotion issues
The rock is on private farmland and no access or promotion should be considered without the permission of the landowner. It is in a field that has been converted from grassland to arable usage within the last decade or so, but the rock has been left and worked around by tractors and so would seem to be respected locally as a feature of importance.

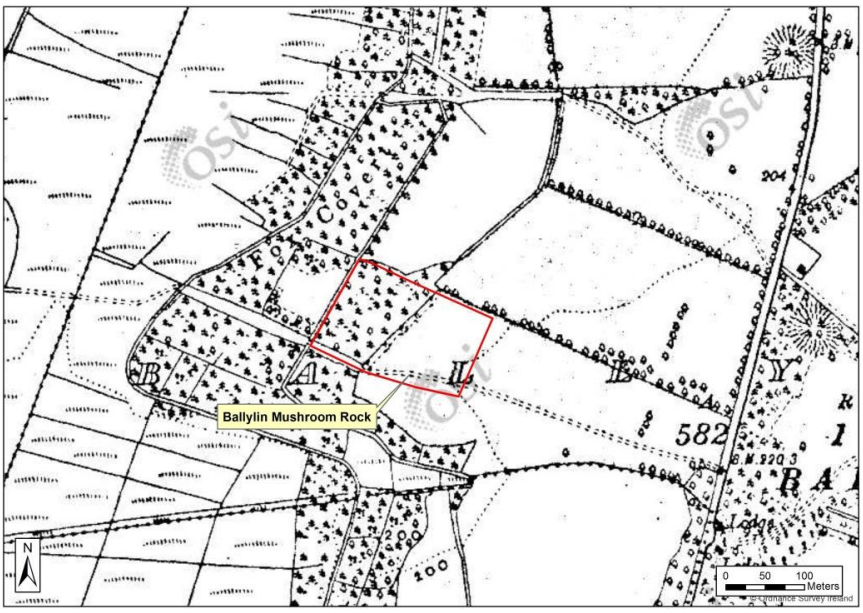
Ballylin Mushroom Rock.

The mushroom shaped Ballylin Rock.

Ballylin Mushroom Rock has been worked around in planting wheat in the field.


Ballylin Mushroom Rock
Burial Ground
Ballylin
Lisdermot
Ballylin Demesne
Derrica
Ballyvora
N62
Kells
Burial Ground
Ballyvora
Ballyvlin
Cages Br
Ferbane
Fire Stn.
Sch
PO
R436
Ferbane
An Féar Bán
Ballyclare
Dismantled Railway
Keeloge
Glebe
Aghaboy
Mound
Kincora
Conv Sch
N
0 50 100 Meters


Ballylin Mushroom Rock
N
0 50 100 Meters


Ballylin Mushroom Rock
N
0 50 100 Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballynagarbry (Mount Temple) Esker**
Other names used for site	The Garbh Esker, The Moate Esker
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Ballynahinch, Moyally, Parkwood, Burrow, Faheeran**
NEAREST TOWN/VILLAGE	**Moate (County Westmeath), Clara**
SIX INCH MAP NUMBER	**1**
ITM CO-ORDINATES	**622050E 738400N (centre of esker)**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 SHEET NO. 12**

Outline Site Description
The Ballynagarbry (Mount Temple) Esker and surrounding sands and gravels includes a large accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew northwestwards across north Offaly at the end of the last Ice Age.

The majority of the esker system is in County Westmeath, with only a small portion at the southeastern end in County Offaly.

Geological System/Age and Primary Rock Type
The Ballynagarbry (Mount Temple) Esker and surrounding sands and gravels are formed entirely on Lower Carboniferous limestone rocks in north Offaly. Further northwest, in Westmeath, the esker is formed partially on Devonain Old Red Sandstone rocks.

The eskers themselves are Quaternary in age, having been deposited either under or at the edge of the westward-retreating ice sheet in deglaciation, approximately 14,000 years ago.

Main Geological or Geomorphological Interest
The esker ridges are striking features, standing proud of the flat landscape of till (boulder clay) upon which they were deposited.

The esker feature is important in that it records faithfully the ice movement across this area of Offaly during the final phase of deglaciation. Wide belts of associated sands and gravels in Burrow and Faheeran Townlands flank the feature at the east. The sands and gravels within the esker are comprised chiefly of limestone clasts, though occasional sandstone cobbles are seen.

Site Importance – County Geological Site
The feature is a high, striking example of a dry sand and gravel ridge, and stands proud of the surrounding landscape. The esker should be designated as a County Geological Site.

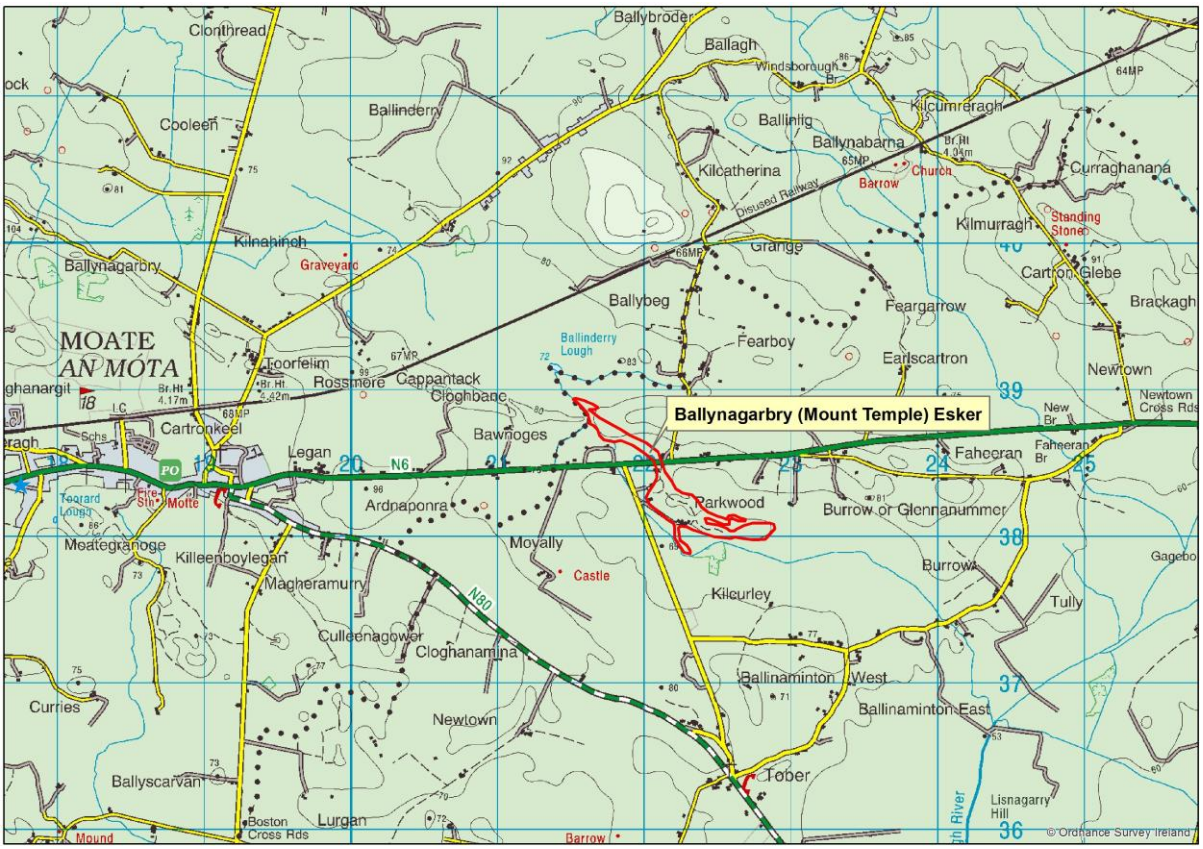
Management/promotion issues
A signboard along the R446 road at the lay-by adjacent to ‘The Well’ public house, where the forested features can be well seen, might help promote the feature.

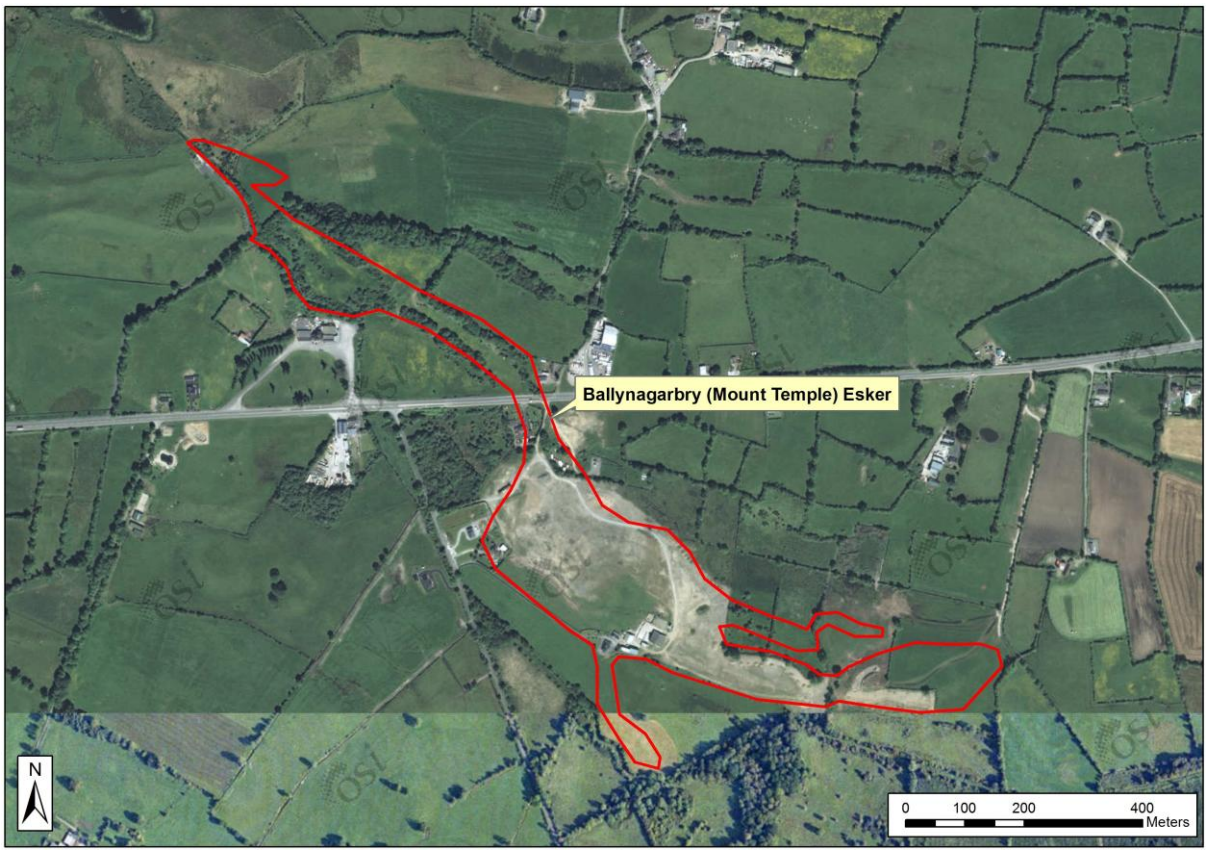
Anabranching segments of the Ballynagarbry (Mount Temple) Esker at Burrow.

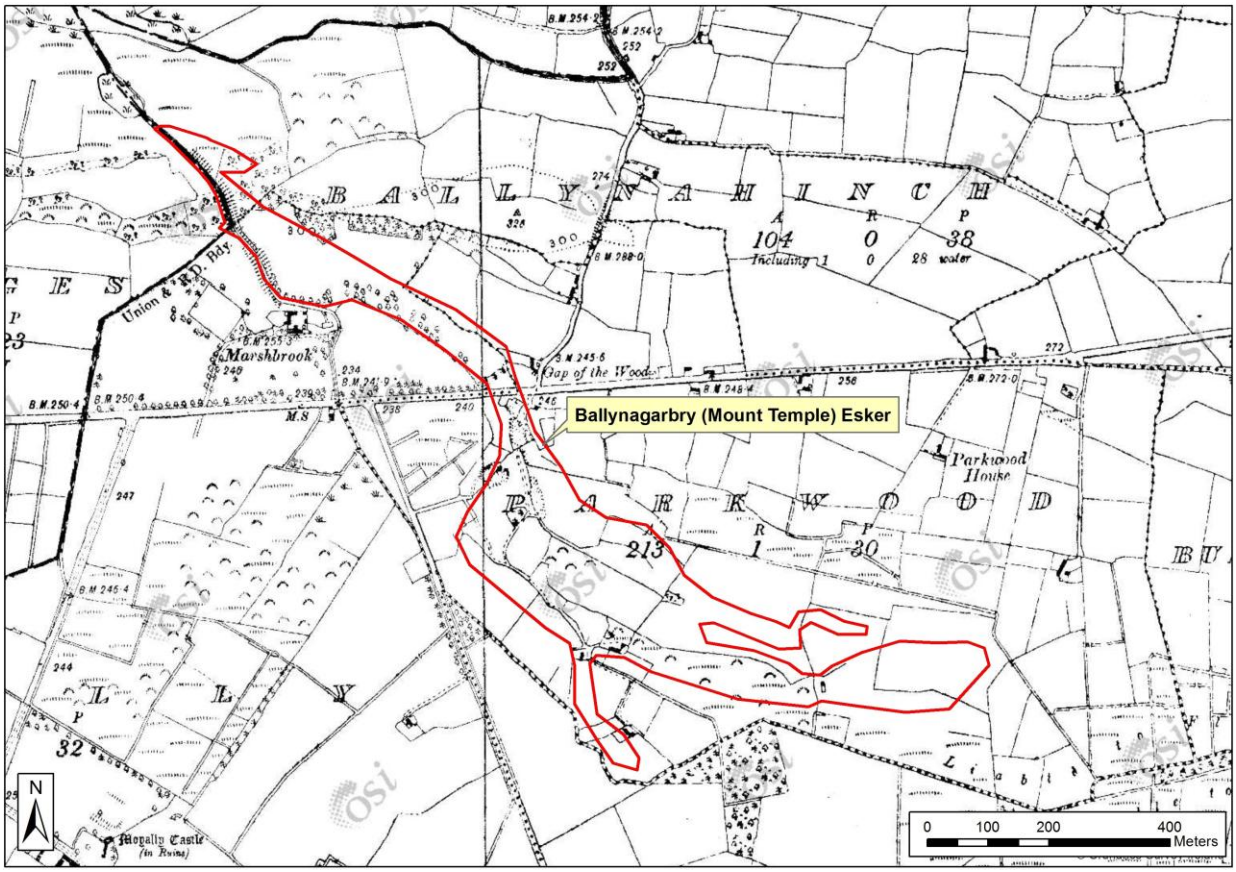
An exposure into the esker ridge along the R446 at Burrow.

A wooded portion of the esker at Moyally.

A high portion of the esker at Parkwood.


Ballynagarbry (Mount Temple) Esker
MOATE
AN MÓTA
Clonthread
Cooleen
Ballinderry
Ballybroder
Ballagh
Windsborough Br
Ballinlig
Ballynabarna
Kilcatherina
Barrow
Church
Curraghanana
Kilcumreragh
Kilmurragh
Standing Stone
Kilnahinch
Graveyard
Ballynagarbry
Grange
Ballybeg
Feargarrow
Carton Glebe
Brackagh
Fearboy
Earlscartron
Newtown
Newtown Cross Rds
Ballinderry Lough
Foorfelim
Rossmore
Cappantack
Cloghbane
Bawnoges
Cartronkeel
Legan
N6
Faheeran
Faheeran Br
Parkwood
Burrow or Glennanummer
Ardnaponra
Moyally
Castle
Meategranoge
Killeenboylegan
Magheramurry
Burrow
Tully
Kilcurley
N80
Culleenagower
Cloghanamina
Ballinaminton West
Ballinaminton East
Curries
Newtown
Ballyscarvan
Tober
Lisnagarry Hill
Boston Cross Rds
Lurgan
Mound
Barrow
© Ordnance Survey Ireland


Ballynagarbry (Mount Temple) Esker
N
0 100 200 400
Meters


Ballynagarbry (Mount Temple) Esker
Marshbrook
Gap of the Wood
Parkwood House
Hopally Castle (in Ruins)
N
0 100 200 400
Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Camcor Forest Quarry**
Other names used for site	
IGH THEME	**IGH4 Cambrian-Silurian**
TOWNLAND(S)	**Castletown and Glinsk**
NEAREST TOWN/VILLAGE	**Kinnitty**
SIX INCH MAP NUMBER	**37**
ITM CO-ORDINATES	**621120E 704600N (Camcor Forest Entrance, R440)**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A small and heavily overgrown quarry in woodland, approximately 50m from the roadside.

Geological System/Age and Primary Rock Type
The rocks exposed are of the Silurian Capard Formation, which underlies all of Slieve Bloom. The graptolite fossils recovered from these siltstones define the rocks as of Wenlock age, within the Silurian Period.

Main Geological or Geomorphological Interest
The rather uniform siltstones of the Capard Formation underlie all 13 of the inliers of Silurian rocks within the Slieve Bloom Mountains. Inlier is a geological term which is shorthand for an area of older rocks entirely surrounded by younger rocks. Slieve Bloom itself is one of a number of Silurian inliers in the Midlands of Ireland, where Silurian and Devonian rocks in uplands are surrounded by Carboniferous rocks in the lowlands. To date such inliers we generally require fossil evidence and this site has provided the best of very rare fossil evidence in Slieve Bloom.

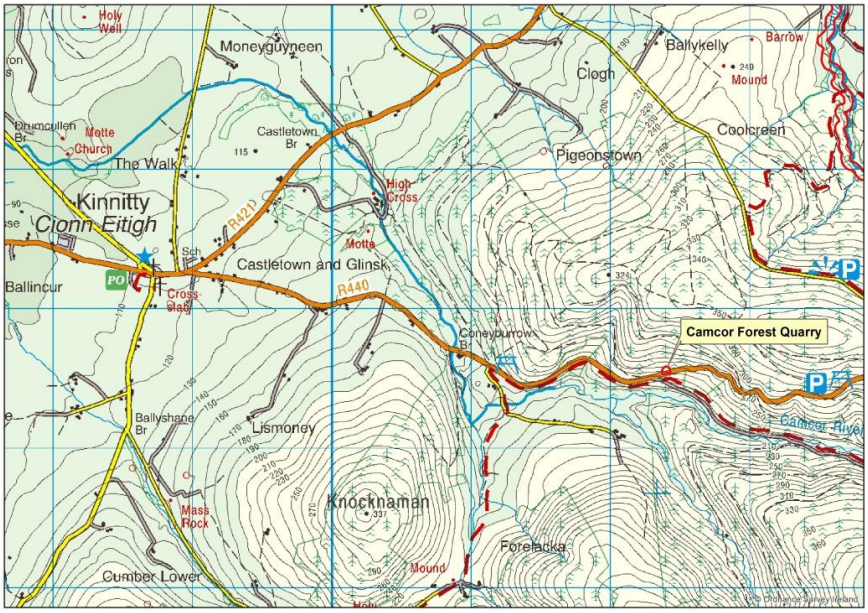
Graptolites are an extinct group of organisms, but in the Silurian they were prolific in the oceans and widespread. They also evolved rapidly so they provide a very good biostratigraphical indicator of the age of the rocks. In the Camcor Forest Quarry, an assemblage of only 3 species is enough to assign them to the *riccartonensis* Biozone of the Wenlock Period. This is approximately in the middle of the Silurian Period and is from around 435 million years ago. The graptolite species found here are *Monograptus priodon, Monoclimacis vomerina* and *Pristiograptus meneghini.*

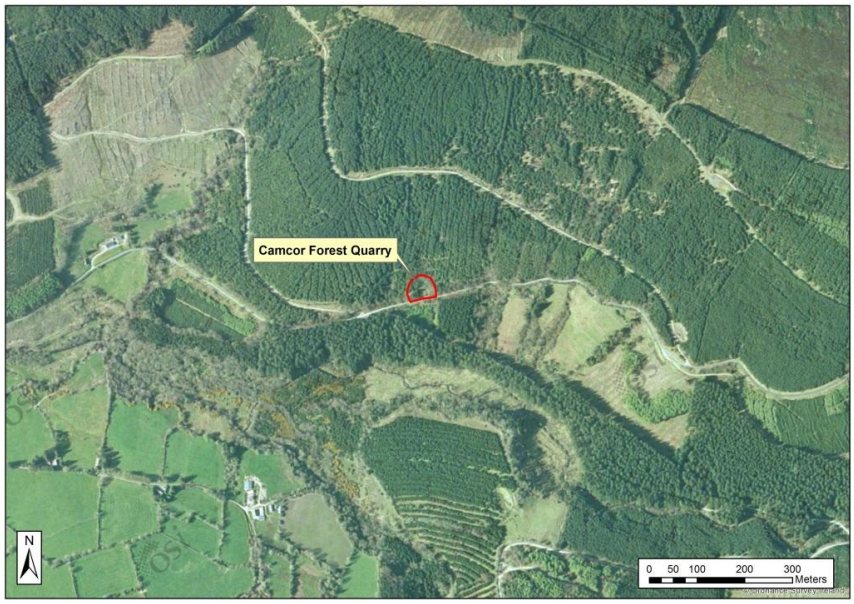
Site Importance – County Geological Site
This site is recommended as a County Geological Site in Offaly, providing the best evidence of the age of the oldest, Silurian rocks in Slieve Bloom.

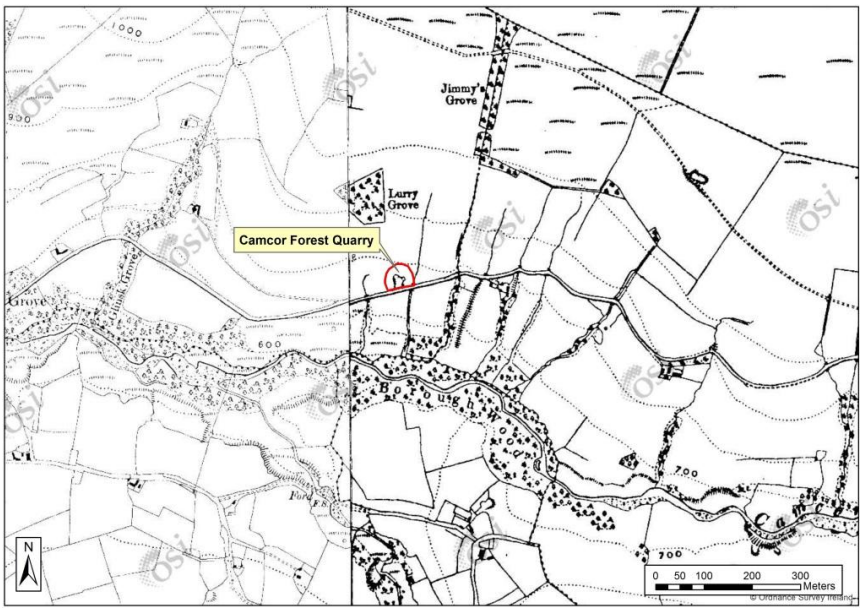
Management/promotion issues
The quarry is heavily overgrown, mainly with grass, but vegetation could easily be cleared if required for a geological research project. Appropriate, commercial forestry clear felling of the trees in the immediate area may reveal much more of interest. For a potential fossil hunter, there are also small exposures in adjacent streams and in the forest tracks that have been recently disturbed, and roadside cuttings in the vicinity, although the large one beside the quarry has become totally vegetated.

The quarry is quite small and shallow, but now heavily overgrown..

There is very limited exposure of the siltstone, loose in a patch and in a face on the side.


Holy Well
Moneyguyneen
Ballykelly
Barrow
Mound
Clogh
Drumcullen Br
Motte
Church
The Walk
Castletown Br
Pigeonstown
Coolcreen
Kinnitty
Cionn Eitigh
High Cross
R421
Sch
Motte
Castletown and Glinsk
Ballincur
PO
Cross slab
R440
Coneyburrows Br
Camcor Forest Quarry
Ballyshane Br
Lismoney
Camcor River
Knocknaman
Mass Rock
Forelacka
Cumber Lower
Mound


Camcor Forest Quarry
N
0 50 100 200 300
Meters


Jimmy's Grove
Larry Grove
Camcor Forest Quarry
N
0 50 100 200 300
Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clara Bog**
Other names used for site	
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Erry (Armstrong), Erry (Maryborough), Doory, Derries, Ballina, Bohernagrisha**
NEAREST TOWN/VILLAGE	**Clara**
SIX INCH MAP NUMBER	**8**
ITM CO-ORDINATES	**624890E 730400N (Boardwalk)**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
An expansive area of raised peat bog situated 2km south of Clara town.

Geological System/Age and Primary Rock Type
Following the end of the last Ice Age, the site now occupied by Clara Bog was a shallow depression in the landscape (Early Holocene, 11,500 years ago). The central part of this basin was occupied by a shallow lake.

Main Geological or Geomorphological Interest
The area is situated at an elevation of 60m-70m OD. The bog is bordered to the north by a large esker complex and by an undulating topography consisting of mainly glacial till to the east, south and west. The topographic depression in which the bog sits is floored by Carboniferous (Waulsortian) limestone, which is overlain by unconsolidated till (sand, gravel, boulders) subsoil, which is considered to be an aquifer and hosts the regional groundwater table. Overlying the till subsoil is a clay bed of glaciolacustrine origin (sediments deposited in a lake that come from glaciers). In central areas of the old lake basin, marl (lime-rich lake muds) overlie the clays, which are all succeeded by thick layers of peat. The peat varies from <1m to 10m deep. The bog comprises hummocks and hollows, open pools and active *Sphagnum* and peat growth. The bog is recognised for its unique variety and development of natural soak systems, which are almost extinct due to large scale peat extraction in Ireland.

Site Importance – County Geological Site; recommended for Geological NHA
This site is recommended as a County Geological Site, but is of international importance. Clara Bog is regarded as the best remaining example of active midland raised bog in Western Europe, mainly owing to the significant area of uncut bog and the presence of unusual 'soak systems' throughout. Active raised bogs are now rare and vulnerable, and have been recognised by the EU as habitats of international importance. The Nature Reserve is protected as a designated National Nature Reserve, a Special Area of Conservation (000572), RAMSAR Wetland Site (415) and Natural Heritage Area.

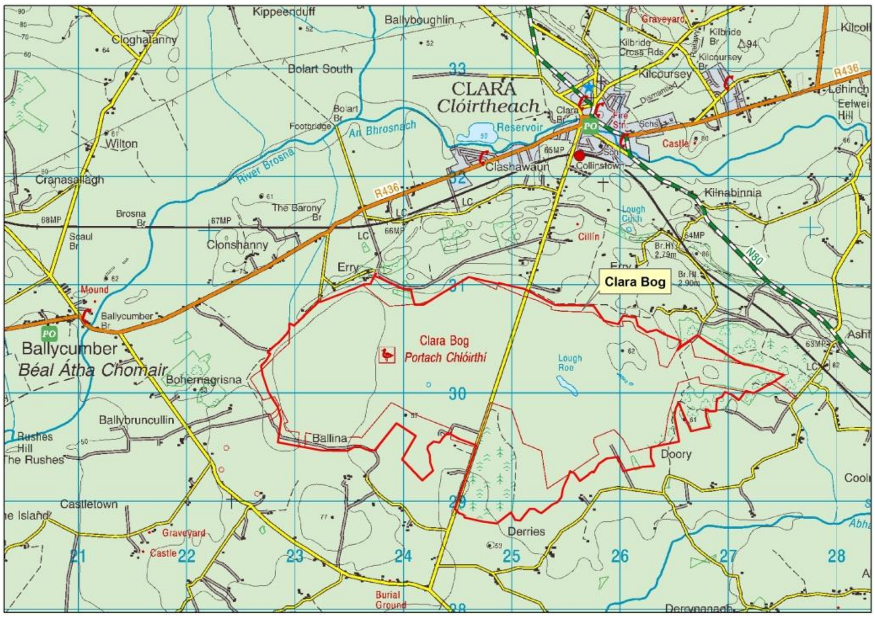
Management/promotion issues
A 1km wooden loop boardwalk has interpretive panels that communicate the natural heritage of the bog. Clara Bog Nature Reserve and Visitor Centre (co-located within the town library in Clara) are managed by National Parks and Wildlife Service. Clara Bog Nature Reserve (464 Ha) is the largest of the four nature reserves in Co. Offaly. The bog is thought to have been at its maximum extent around AD 1800, prior to major human disturbance. The road between Clara and the village of Rahan bisects the bog. Marginal drainage along this road has resulted in bog subsidence of up to 6m in the last 200 years. (Today less than 50% of its original surface remains). Drainage associated with peat cutting has, and can further, permanently alter the hydrological flow patterns; however, Clara Bog is one of six bogs in Offaly to benefit from being part of the National Parks and Wildlife Service LIFE Active Raised Bog Restoration Project, so negative impacts associated with drainage should be minimised in the future.

View over Clara Bog from boardwalk towards Erry (Armstrong) esker.

Bog asphodel (yellow) and pools alongside boardwalk.

Information sign at entrance and parking area at Clara Bog

Information panel halfway along the boardwalk.


Kippeenduff
Ballyboughlin
Graveyard
Cloghatanny
Bolart South
CLARA
Clóirtheach
Kilcoursey
R436
Wilton
An Bhrosnach
Reservoir
River Brosna
Clashawaun
Collinstown
Castle
Cranasallagh
R436
The Barony
Kilnabinnia
Brosna Br
Clonshanny
Cillín
Lough Coura
Erry
Clara Bog
Mound
Ballycumber
Ballycumber
Béal Átha Chomair
Clara Bog
Portach Chlóirthí
Lough Roe
Bohernagrisna
Ballybruncullin
Ballina
Doory
Rushes Hill
The Rushes
Castletown
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Graveyard
Castle
Burial Ground
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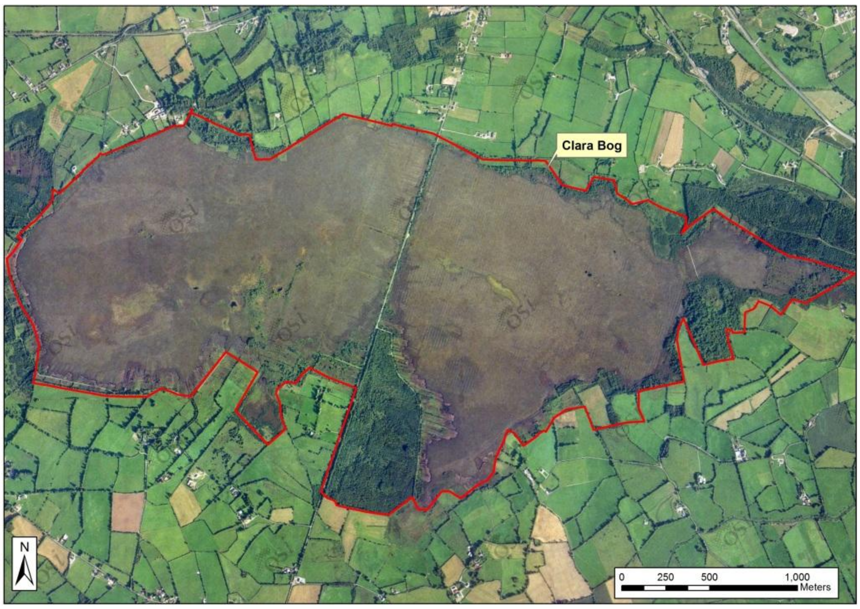
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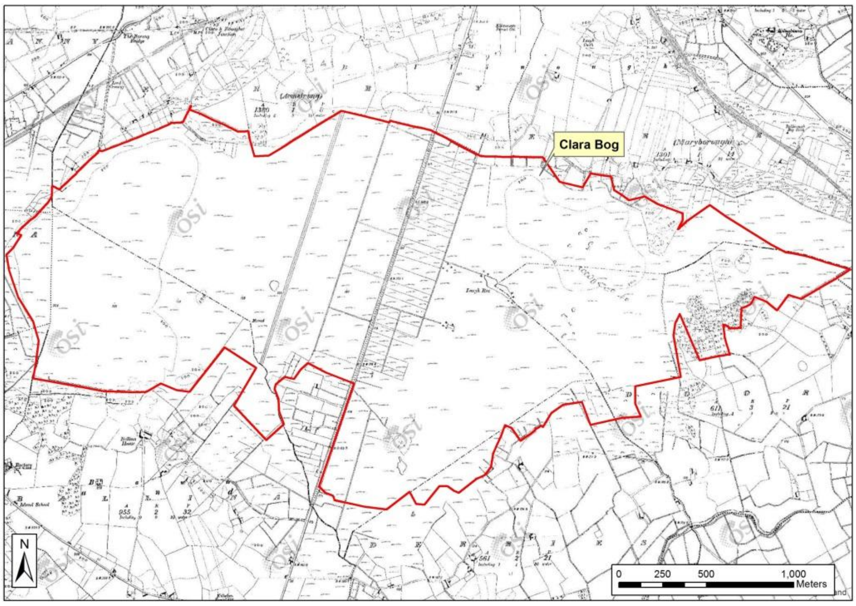
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OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clonbulloge Spring**
Other names used for site	Clonbulloge Hot Spring
IGH THEME	**IGH16 Hydrogeology**
TOWNLAND(S)	**Clonbulloge**
NEAREST TOWN/VILLAGE	**Clonbulloge**
SIX INCH MAP NUMBER	**19**
ITM CO-ORDINATES	**660696E 723690N**
1:50,000 O.S. SHEET NUMBER	**49 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
This site comprises a significant spring rising situated 2m from the eastern bank of the Figile River, just west of Clonbulloge Village.

Geological System/Age and Primary Rock Type
The feature is a hydrogeological and karstic geology spring that is post-glacial in age, but which flows through impure Lower Carboniferous 'Calp' limestone. This limestone is buried deep beneath the site and the general area by Quaternary deposits of till (boulder clay) and alluvium.

Main Geological or Geomorphological Interest
The spring has a large diameter concrete pipe installed around it, with a sump 1.55m deep. A small pumphouse has been built next to the chamber. The temperature of the groundwater issuing from the spring is almost 15^{o} C, which is considered to be warm for a typical Irish spring, as warm springs are considered to have a mean temperature of equal to or greater than 13^{o} C.

A major northeast to southwest fault is mapped 200m north of the spring, but it is possible that the fault is at the spring. The chemistry and quality indicate that the groundwater at the spring is a mixture of shallow and deep groundwater. The fault is assumed to be the mechanism that allows deep groundwater circulation in the area to cause the increased temperatures observed at the spring. Groundwater flow is assumed to be from the north and northeast, along the direction of the fault. A "window" in the subsoils, perhaps due to the presence of a localised sand/gravel unit, in association with the fault network, may allow groundwater to reach the surface at the spring.

Site Importance – County Geological Site
The site, as an unusual element of the hydrogeology of County Offaly, is recommended as a County Geological Site.

Management/promotion issues
Aside from wider issues of protecting groundwater quality, the site is managed by Irish Water, but promoting it would not be advisable without active partnership with Irish Water.

The compound housing the spring and adjacent pumphouse.

The pumphouse compound with the spring completely encased within the subsurface chamber.

View of the spring chamber and river (2004).

View of spring within the chamber (2004).


Cloncreen
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Clonbulloge
Sch
Cluain Bolg
PO
Clonbulloge Spring
Clonbulloge
Br.
R442
© Ordnance Survey Ireland


Clonbulloge Spring
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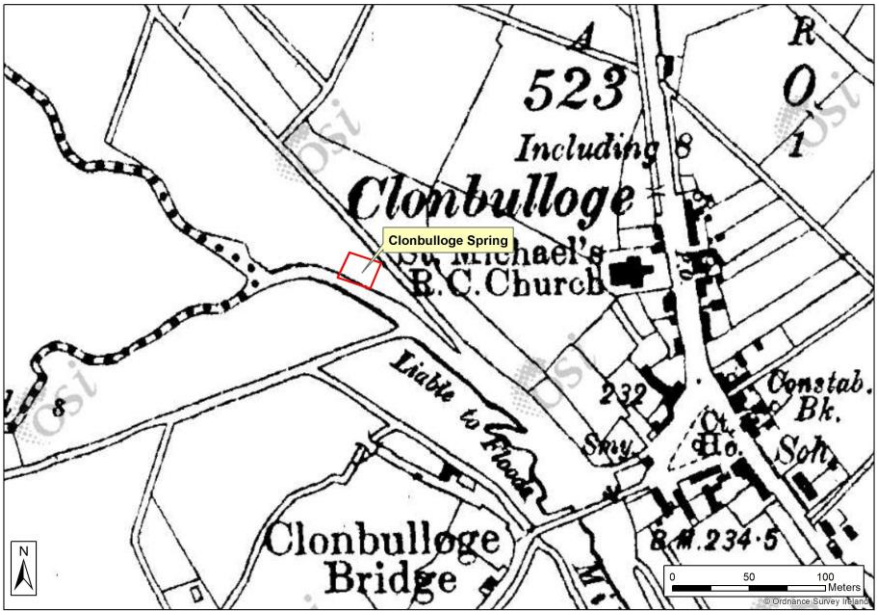
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Clonbulloge Spring
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Liable to Floods
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© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clonkeen Mushroom Rock**
Other names used for site	Fin MacCool's Stone
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Clonkeen**
NEAREST TOWN/VILLAGE	**Clonbulloge**
SIX INCH MAP NUMBER	**19**
ITM CO-ORDINATES	**660080E 723125N**
1:50,000 O.S. SHEET NUMBER	**49 GSI BEDROCK 1:100,000 Sheet No. 16**

Outline Site Description
A Mushroom Rock – isolated upstanding rock in a grass field.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

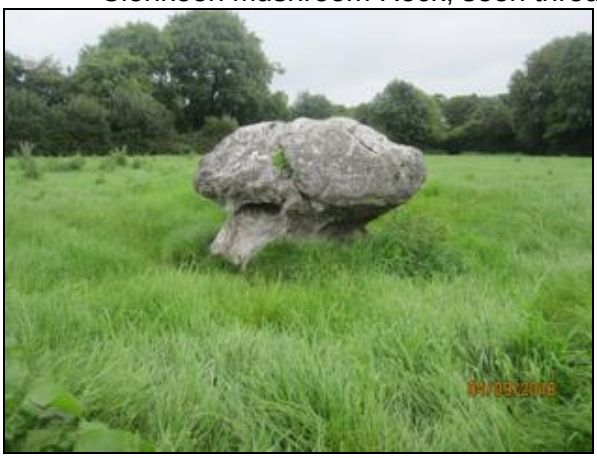
Main Geological or Geomorphological Interest
Clonkeen is one of the relatively numerous examples of mushroom rocks in Offaly compared to most counties in Ireland. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes or expanded river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock.

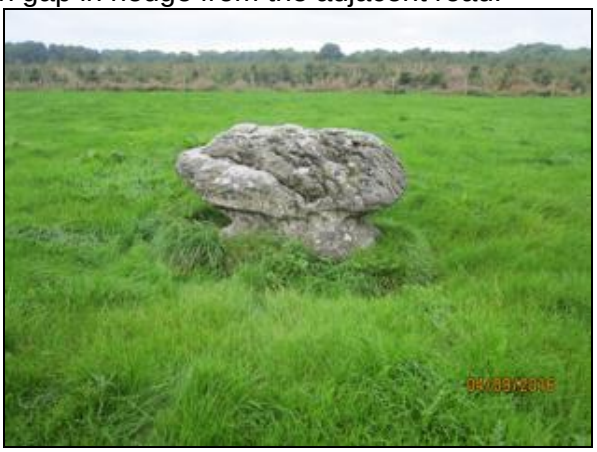
Site Importance – County Geological Site
This is one of the spread of mushroom rocks that is particularly well represented in Offaly on a national basis. It is the most easterly, and less clearly associated with a former larger river basin or lake. It warrants recognition and protection, and is recommended as a County Geological Site.

Management/promotion issues
The rock has been left untouched in a managed grass field so seems to be recognised as important. However this may be due to its inclusion in the Record of Sites and Monuments as an archaeological megalithThis may have resulted in the grass field around it being maintained when the larger part of the field was afforested. The online record of the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs on www.archaeology.ie (RMP OF019-006, as at September 2016) recognises it as a mushroom rock and not a megalithic monument, although it is present on some amateur antiquarian website listings as such. Inclusion of it as a County Geological Site in the Offaly County Development Plan should help prevent possibility of future damage.

Clonkeen Mushroom Rock, seen through gap in hedge from the adjacent road.

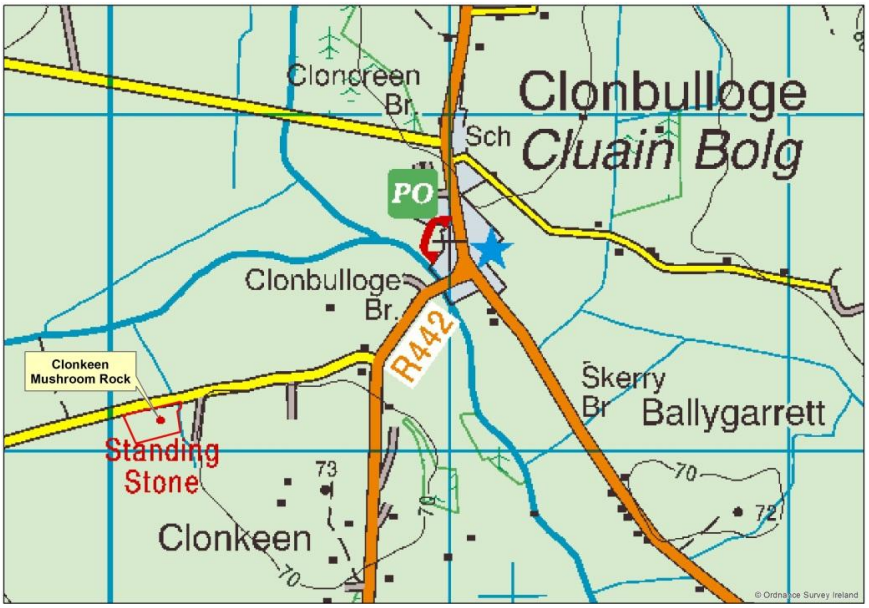


Clonkeen Mushroom Rock.



Clonkeen Mushroom Rock.

Clonkeen Mushroom Rock.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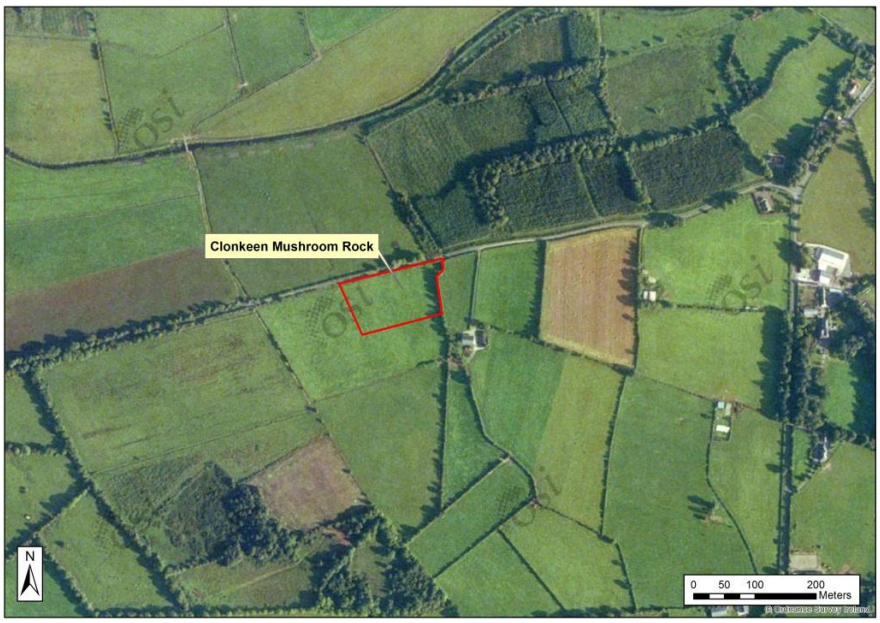
Ballygarrett
73
70
72
Clonkeen
70
© Ordnance Survey Ireland


Clonkeen Mushroom Rock
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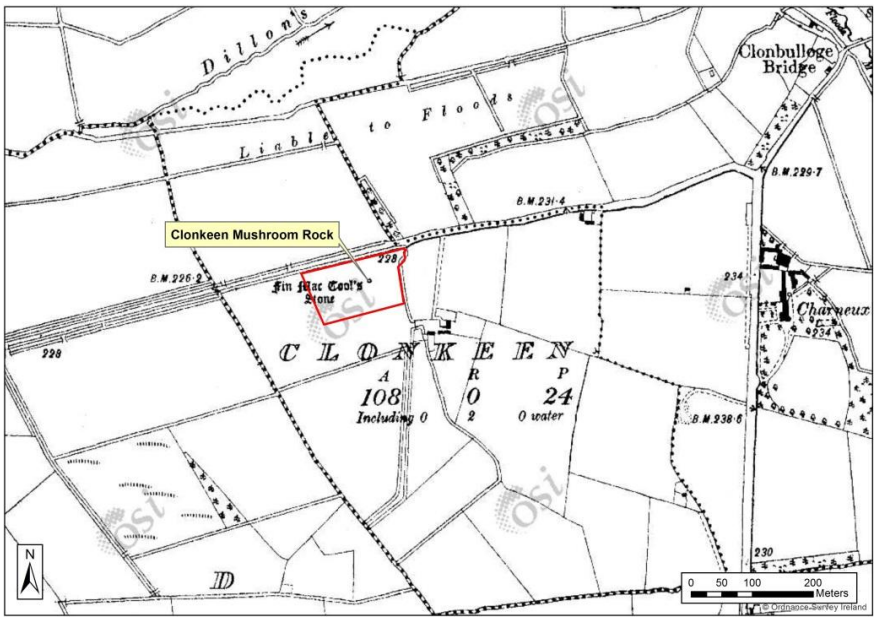
Dillons
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Bridge
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B.M.231·4
Clonkeen Mushroom Rock
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OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clonmacnoise Esker**
Other names used for site	The Ballinasloe-Split Hills-Clonmacnoise-Clara Esker System, The Clara Esker, The Pilgrim's Road, The Long Road, The *Eiscir Riada,* Lough Nanag Esker
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Clorhane, Creevagh, Clonmacnoise, Clonascra, Ballyduff, Clonaderg, Doon Demesne, Esker, Togher, Corracullin, Cooldorragh, Cappanalosset, Cornafurrish and Corrabeg, Castletown, Ballybruncullin, Bohernagrisha, Erry, Kilnabinnia, Kilmucklin, Ashfield, Tara, Cartron, Durrow Demesne, Ballybought, Balleek, Ballycallaghan**
NEAREST TOWN/VILLAGE	**Clara, Ballycumber**
SIX INCH MAP NUMBER	**5, 6, 7, 8, 9**
ITM CO-ORDINATES	**600870E 730650N (centre of esker at Clonmacnoise)**
1:50,000 O.S. SHEET NUMBER	**47, 48 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description

The Clonmacnoise Esker and surrounding sands and gravels includes an exceptionally large accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew westwards across Offaly at the end of the last Ice Age.

The esker forms part of the larger Ballinasloe-Split Hills-Clonmacnoise-Clara Esker System, which extends from Galway, through Offaly, and into Westmeath, and is the traditional route defined as the '*Eiscir Riada*' in ancient Irish Folklore.

Geological System/Age and Primary Rock Type

The Clonmacnoise Esker and surrounding sands and gravels are formed entirely on Lower Carboniferous limestone rocks, across the lowlands of north Offaly. The eskers themselves are Quaternary in age, having been deposited either under or at the edge of the westward-retreating ice sheet in deglaciation, approximately 14,000 years ago.

Main Geological or Geomorphological Interest

The esker ridges are striking features, standing proud of the flat landscape of till (boulder clay) upon which they were deposited. In many places the eskers have been surrounded by post-glacial alluvium or peat deposits in the Holocene, following the Ice Age. This is especially impressive along the Shannon at Clonmacnoise itself. At Clonmacnoise the esker grades from a singular ridge of coarse gravels to a more haphazard, hummocky topography.

The esker feature is important in that it records faithfully the ice movement across this area of Offaly during the final phase of deglaciation. Wide belts of associated sands and gravels east of Clonmacnoise, and east of Clara, flanking the esker beads themselves, have long been studied and are part of associated ice marginal fan and delta systems. The sands and gravels within the esker are comprised chiefly of limestone clasts.

Site Importance – County Geological Site; recommended for Geological NHA

The feature is a haphazardly arranged, high, striking example of a dry sand and gravel ridge, and stands proud of the surrounding landscape. This is the longest esker system in the country and is a superb example of a relict subglacial conduit system. Though recommended as a County Geological Site it is of international importance and is also recommended as a Geological NHA.

Management/promotion issues

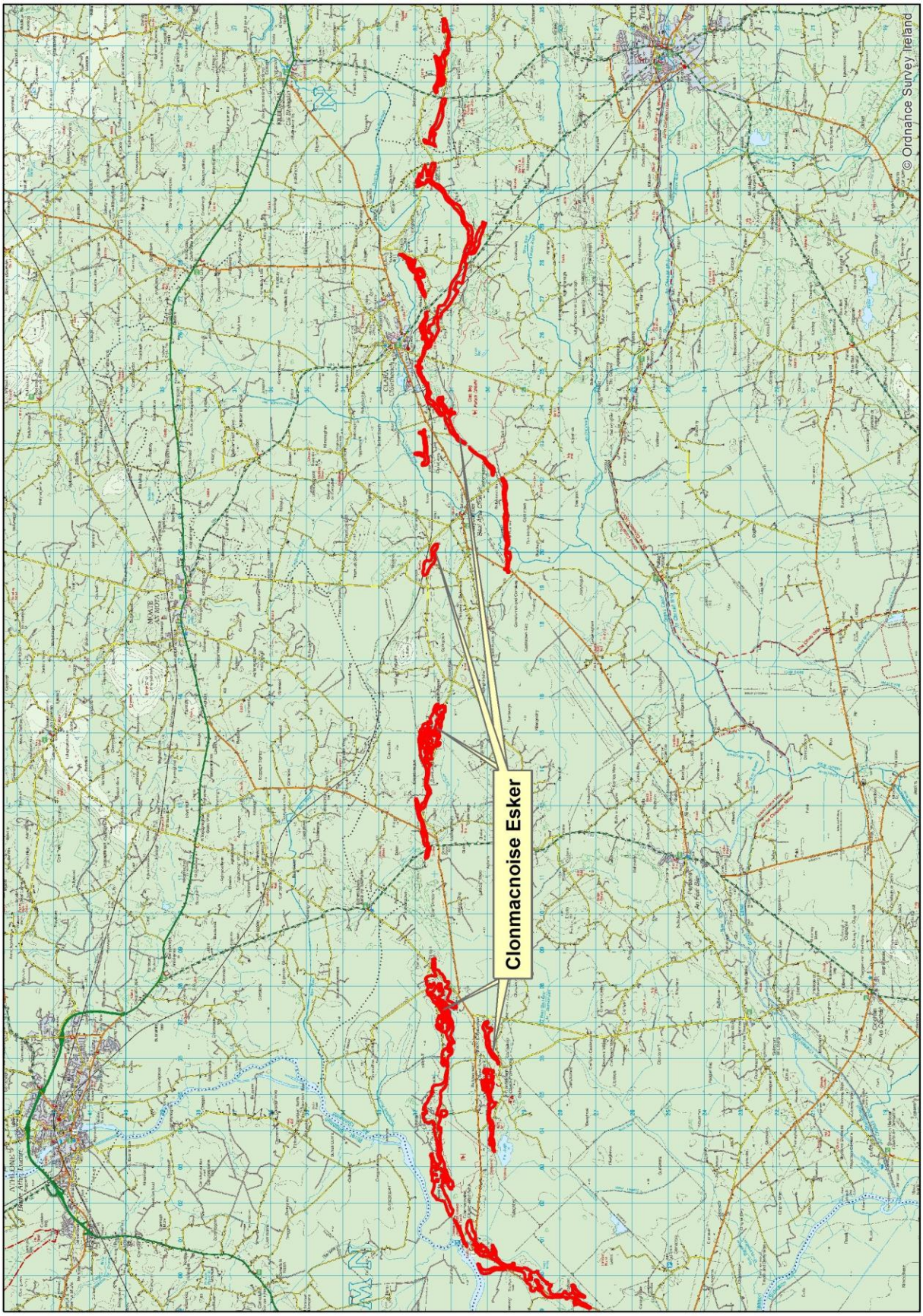
The Lough Nanag Esker and Clonfinlough Esker pNHAs straddle the esker (sitecodes 000910 and 000892 respectively), as does a portion of the Clara Bog SAC (sitecode 000572), and the entirety of these areas, as well as many adjacent, are proposed here as the site. Geological information on the esker could form some elements of the literature associated with the Clnmacnoise Monastery site.

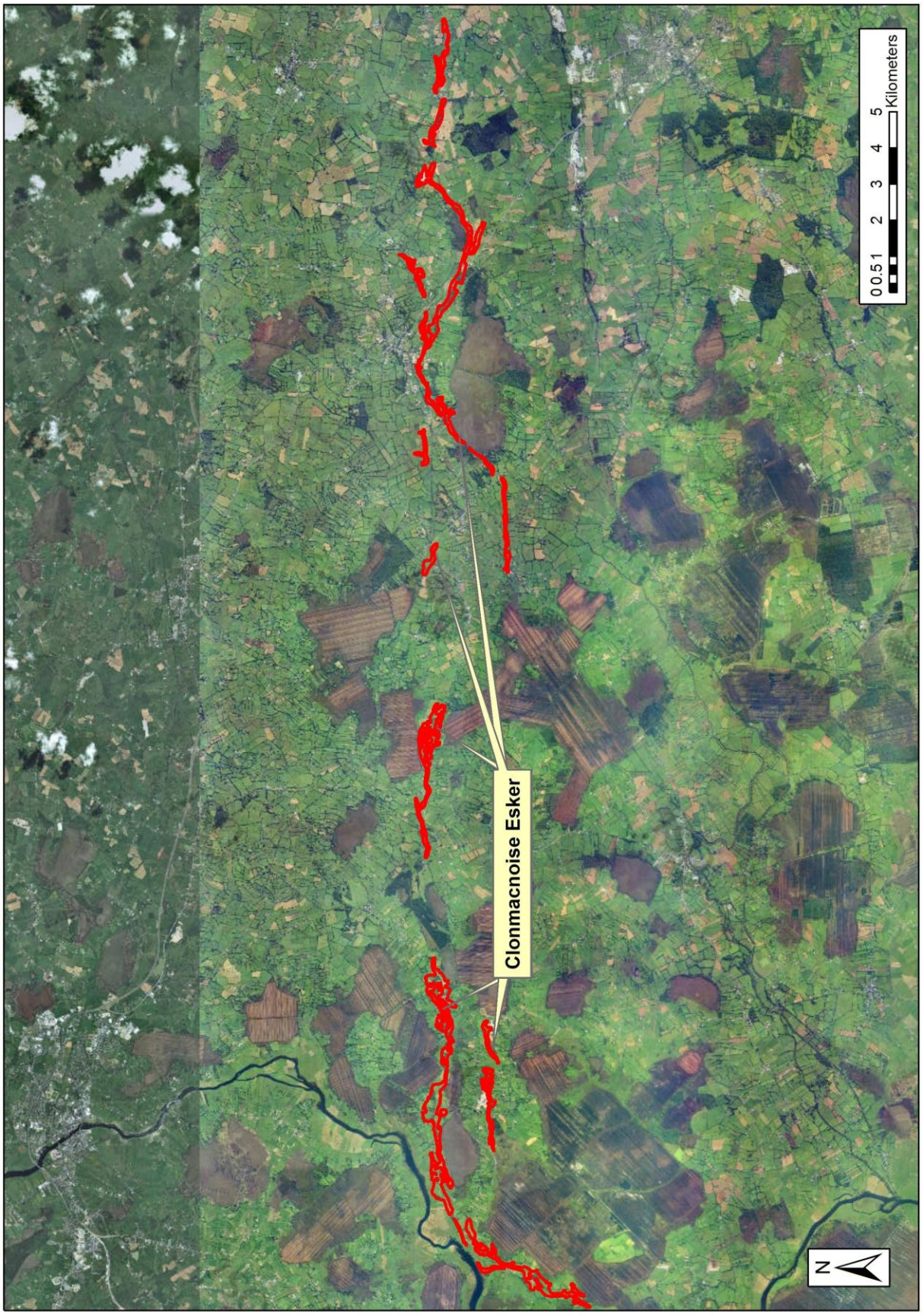
An anabranching segment of the Clonmacnoise Esker near ‘The Pinnacle’, just east of Clonmacnoise.

The steep-sided esker ridge approaching Clonmacnoise.

A sinuous portion of the esker, at Clonmacnoise.

A small gravel pit into the esker complex at Cooldorragh.


Clonmacnoise Esker
© Ordnance Survey Ireland


Clonmacnoise Esker
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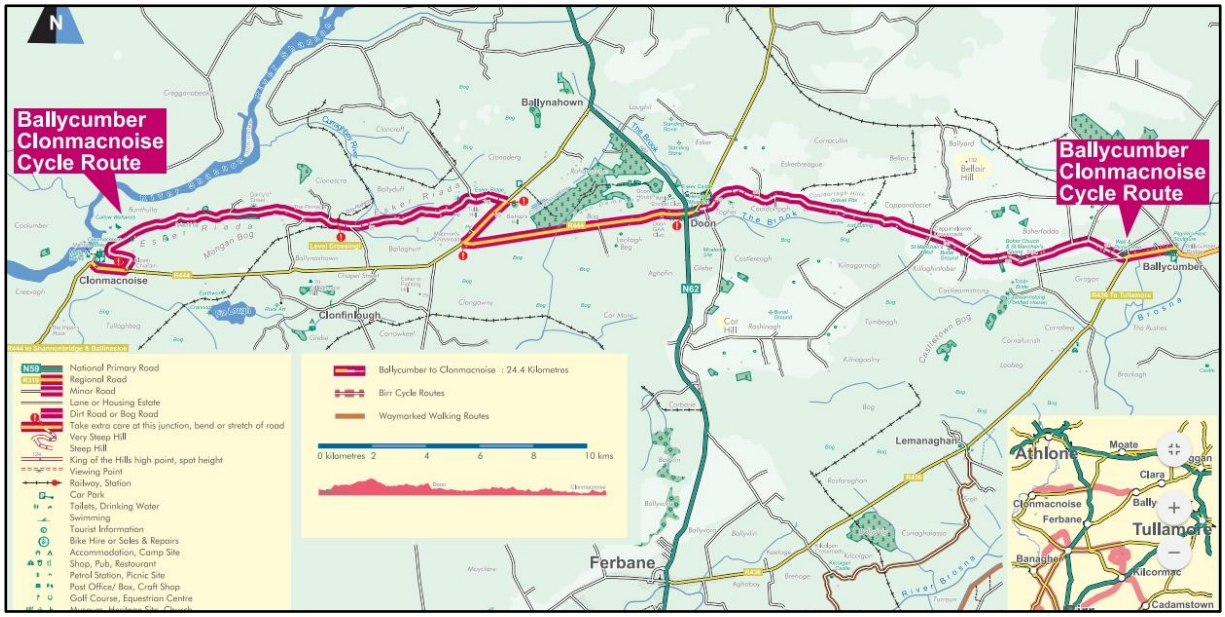
A sketch of the ‘Pilgrim’s Road’ Esker, by George Victor du Noyer of the Geological Survey of Ireland, from the mid-1800s (image reproduced from Feehan, 2013).



The ‘Pilgrim’s Path’ Cycle Route, which traverses the Clonmacnoise Esker.

A flyer for National ‘Pilgrim’s Path’ Day, focussed around the Clonmacnoise Esker.

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clorhane Mushroom Rocks**
Other names used for site	
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Clorhane**
NEAREST TOWN/VILLAGE	**Shannonbridge**
SIX INCH MAP NUMBER	**5**
ITM CO-ORDINATES	**598775E 728172N**
1:50,000 O.S. SHEET NUMBER	**47 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A complex of Mushroom Rocks – isolated upstanding rocks in a grass field.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

Main Geological or Geomorphological Interest
Clorhane is a complex of mushroom rocks in Offaly adjacent to the Shannon River, with three documented examples in a small area. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake and river levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes and enlarged river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock. However, Clorhane is right on the flank of the River Shannon basin and is almost certainly derived from water solution.

Site Importance – County Geological Site
This collection of mushroom rocks is part of the spread of mushroom rocks that are particularly well represented in Offaly on a national basis. It is therefore recommended as a County Geological Site.

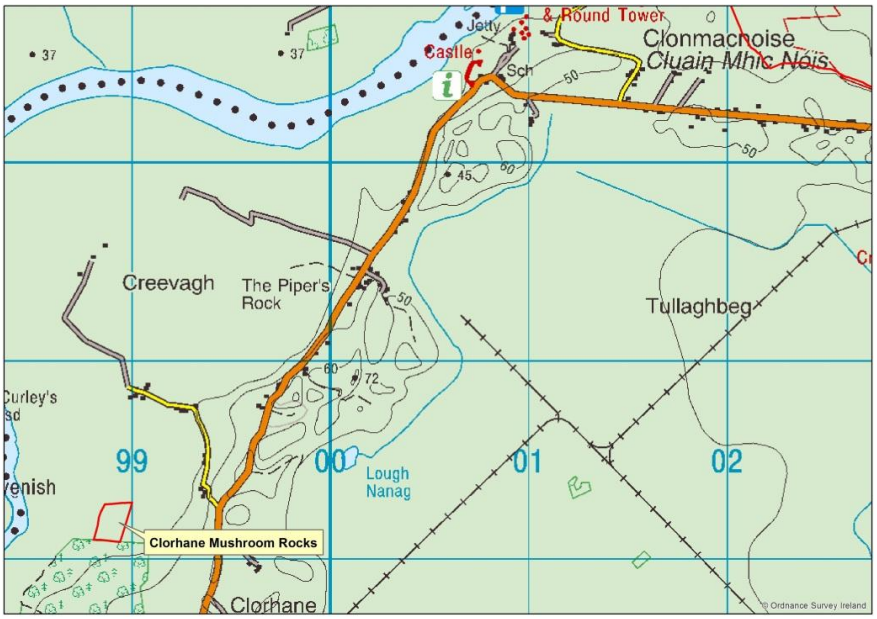
Management/promotion issues
The rocks are on private farmland and may not be visited without landowner permission. No promotion of these rocks should be made without full engagement with the landowner.

Clorhane 1 stone on the left, Clorhane 2 in the hedge.

Clorhane 3 stone.

View of Clorhane 1 stone.

Panorama view from Clorhane woods of Clorhane 1 and 2 on the left, with large heaps of cleared rocks seen on the right, and stone 3 beyond them.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The Piper's Rock
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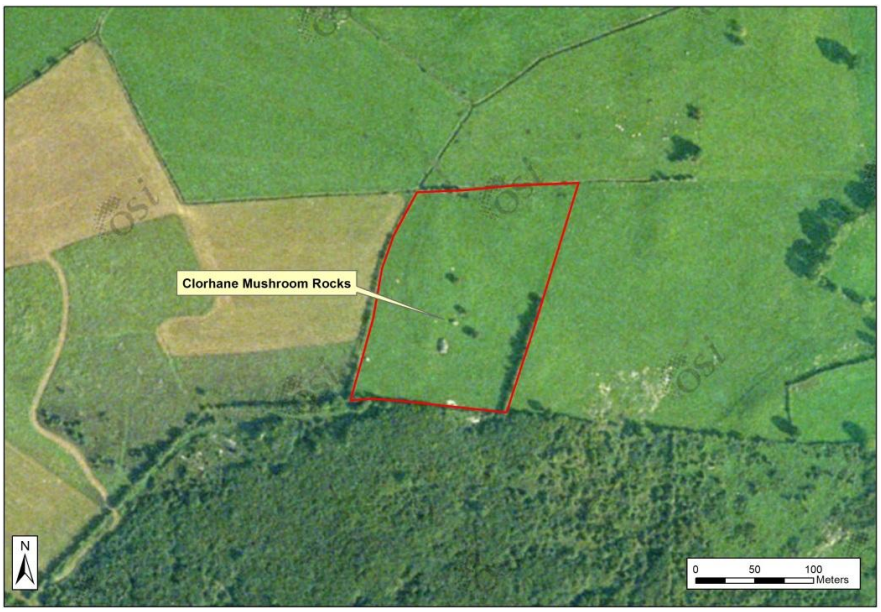
Lough Nanag
Clorhane Mushroom Rocks
Clorhane
© Ordnance Survey Ireland


Clorhane Mushroom Rocks
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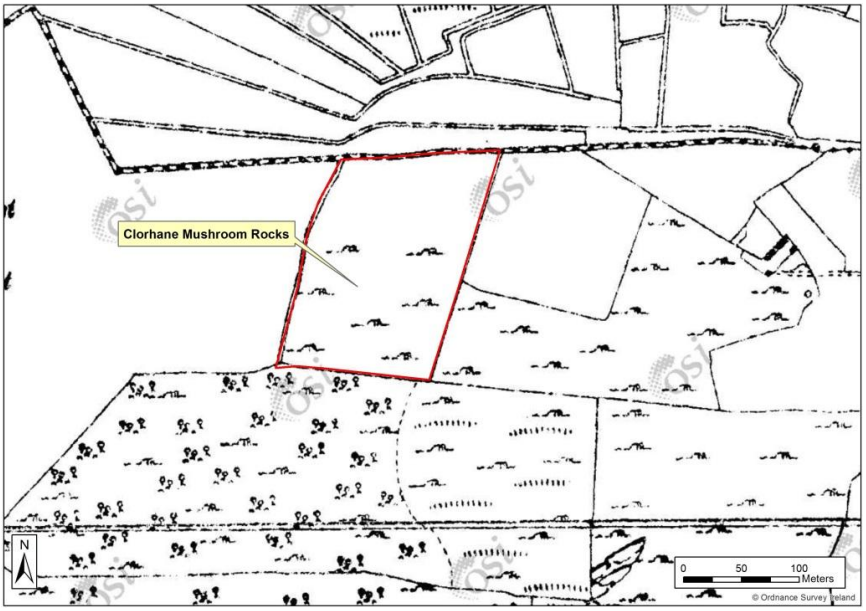
Clorhane Mushroom Rocks
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OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clorhane Quarries**
Other names used for site	Clerhane Quarries, Egan's Quarry, Claffey's Quarry, Clonmacnoise Marble Quarries
IGH THEME	**IGH15 Economic Geology**
TOWNLAND(S)	**Clorhane**
NEAREST TOWN/VILLAGE	**Shannonbridge**
SIX INCH MAP NUMBER	**5**
ITM CO-ORDINATES	**598800E 727695N**
1:50,000 O.S. SHEET NUMBER	**47 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
Two disused quarries, now flooded, situated within woodland.

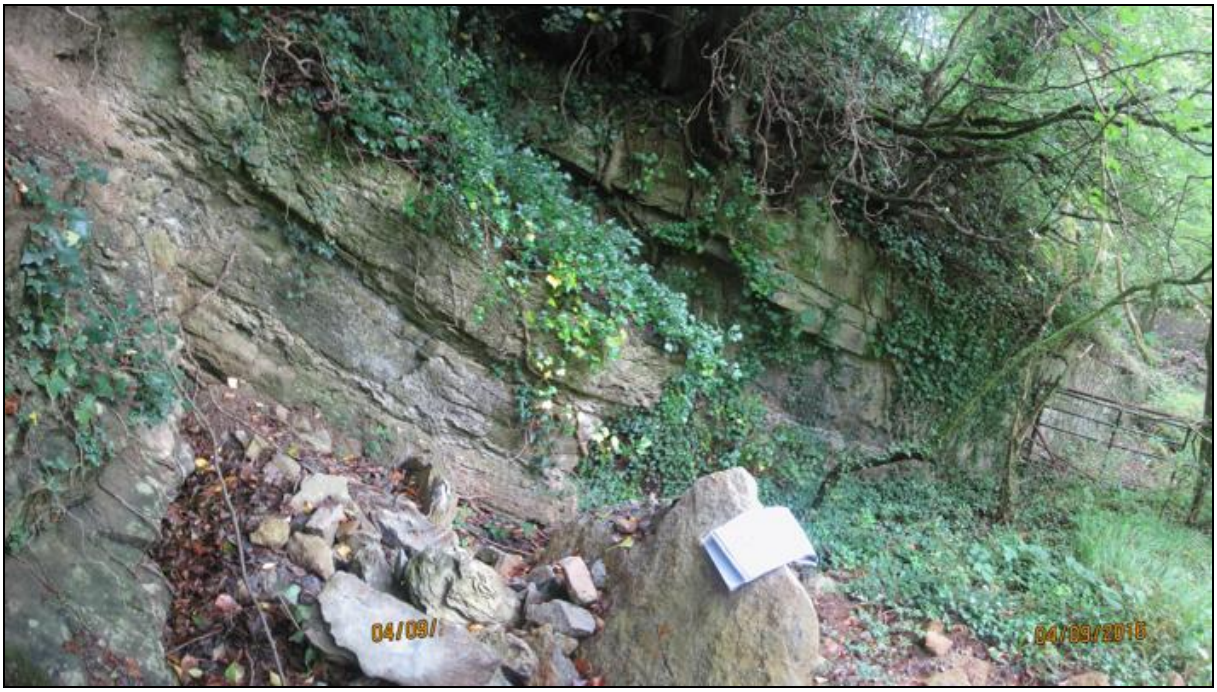
Geological System/Age and Primary Rock Type
The quarries, when they operated, were extracting Carboniferous Limestone beds, classified as a part of the Waulsortian Limestone. In particular, some highly fossiliferous crinoidal limestone beds were worked and traded, and often referred to as Clonmacnoise Marble.

Main Geological or Geomorphological Interest
Two disused and now flooded quarries were once an important local industry in Offaly, extracting limestone for use in Shannon navigation works and other local construction. Of particular note here were the beds of richly crinoidal limestone, which were prized for making mantelpieces, doorsteps, windowsills and other decorative stonework. This distinctive rock became known as Clonmacnoise Marble (in the stone trade the term 'marble' is used for any polished limestone, contrary to the geological definition, which is restricted to metamorphic limestone).

Two separate quarries, Egan's and Claffey's operated and a detailed history of the family quarries has been written by Declan Ryan in an excellent book published by Offaly County Council. It also provides much detail on many building and monumental or gravestone works which used stone from Clorhane. This book also outlines the industrial archaeology of the area, whereby rock was taken by track down to the River Shannon for travel north to Athlone. It was also shipped south along the Shannon to Killaloe in Tipperary where extensive slate quarrying provided facilities for sawing and polishing large slabs and blocks. The limestone bedrock is at the surface in the Clorhane area and there were shoals in the River Shannon that provided a barrier to navigation, until removed in the late 1840s. A canal from the river across part of the Callows was constructed, with a pier on the Shannon itself. There were a few minor quarries to the west of Egan's Quarry, which can now be seen as depressions through the vegetation in the side of the track, but no rock is exposed.

Site Importance – County Geological Site
The site is an important part of the history of Offaly, demonstrating the importance of geology to the economic lives of people and to the buildings that form part of society. It is recommended as a County Geological Site.

Management/promotion issues
The quarries are within woodland of great importance for biodiversity, and they part of the site is managed by the National Parks and Wildlife Service and part is still privately owned. However, as they are both flooded they are not accessible, and Egan's Quarry in particular is almost inaccessible due to growth of trees and scrub all around the quarry. They are not suitable for general promotion without significant interventions.

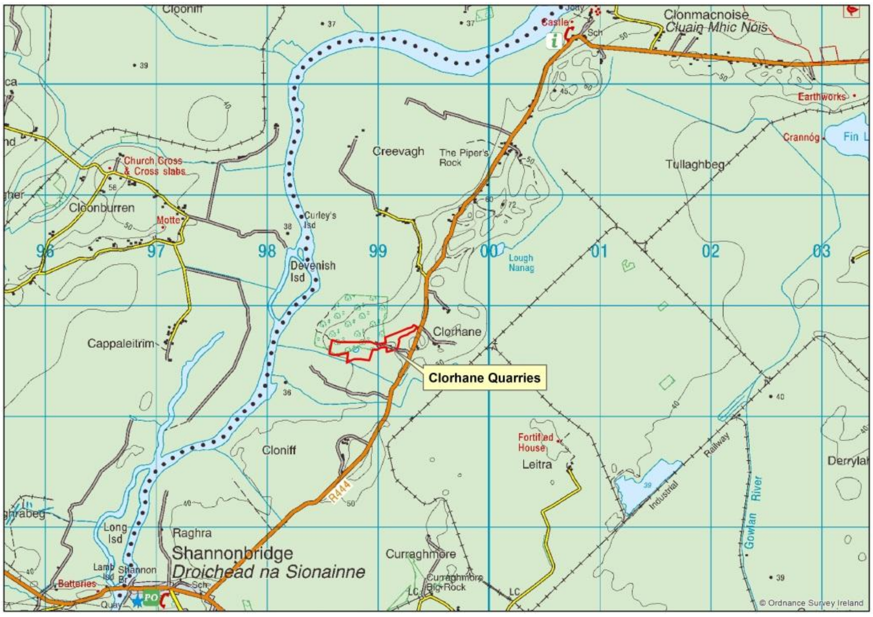


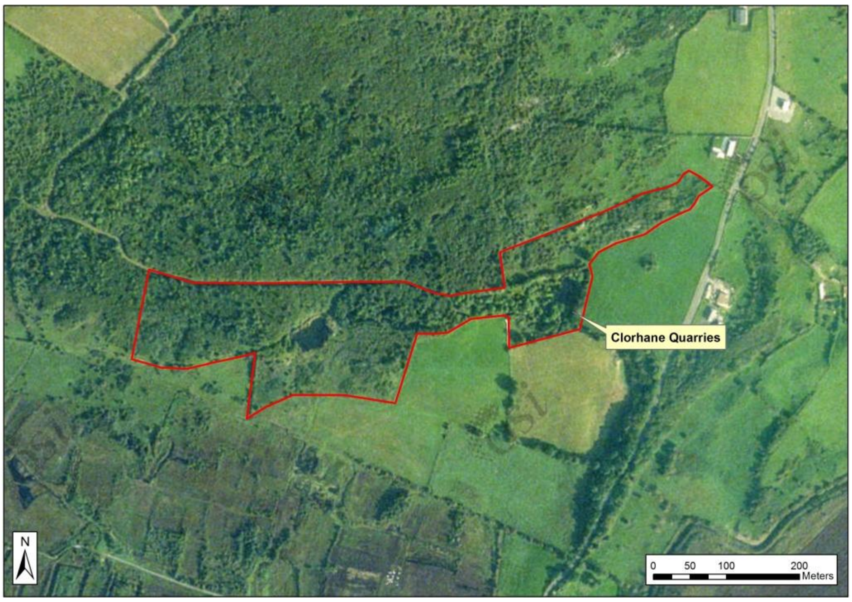
The one remaining face of crinoidal limestone in Egan's Quarry.

Egan's Quarry is flooded and virtually inaccesible.

The dipping beds of Claffey's Quarry in cross section.

The flooded Claffey's Quarry.


Clonmacnoise
Cluain Mhic Nóis
Creevagh
The Piper's Rock
Tullaghbeg
Church Cross & Cross slabs
Cloonburren
Motte
Curley's Isd
Devenish Isd
Lough Nanag
Cappaleitrim
Clorhane
Clorhane Quarries
Cloniff
Fortified House
Leitra
Derrylahan
Industrial Railway
Gowlan River
Long Isd
Raghra
Shannonbridge
Droichead na Sionainne
Curraghmore
Earthworks
Crannóg
R444
© Ordnance Survey Ireland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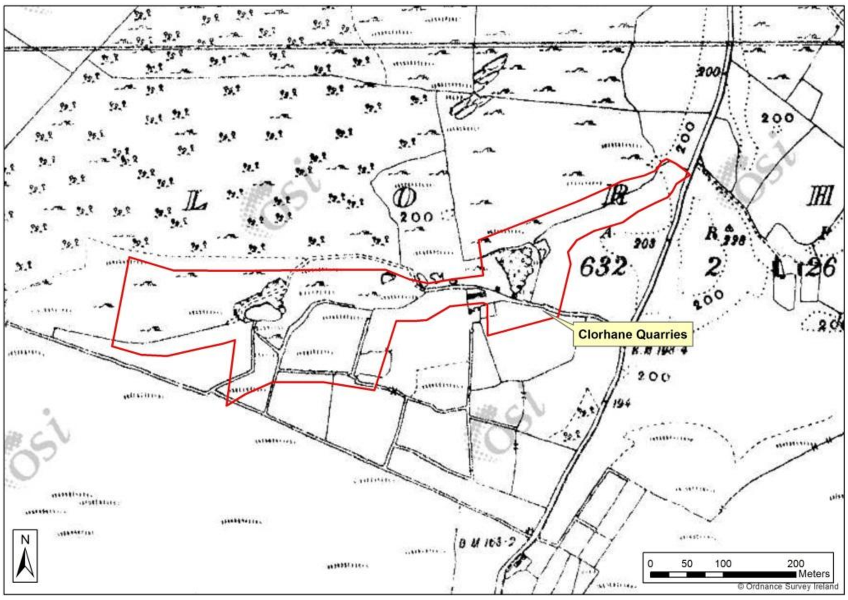
Clorhane Quarries
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© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Crancreagh Mushroom Rock**
Other names used for site	
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Crancreagh**
NEAREST TOWN/VILLAGE	**Kilcormac**
SIX INCH MAP NUMBER	**22**
ITM CO-ORDINATES	**607500E 716495N**
1:50,000 O.S. SHEET NUMBER	**53 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A Mushroom Rock – isolated upstanding rock in a grass field.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

Main Geological or Geomorphological Interest
Crancreagh is one of the best examples of a mushroom rock in Offaly, where undercut lips and shapes are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets. In the case of Crancreagh it is possible that Lough Boora had a formerly more extensive area which created the mushroom rock. The double undercut would suggest a shorter period of near submergence with a subsequent lowering of lake level to the height of the lower more marked undercut. Nearby is the conical remnant of a probable companion which may have dissolved more fully or have been broken and moved in historical field clearance work.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock. There is insufficient evidence to be certain of the origins at Crancreagh, although a more extensive former Lough Boora seems a more likely cause.

Site Importance – County Geological Site; recommended for geological NHA
As well as being recommended as a County Geological Site, this is one of the best mushroom stones nationally this has been recommended to NPWS for designation as a Geological NHA of national importance.

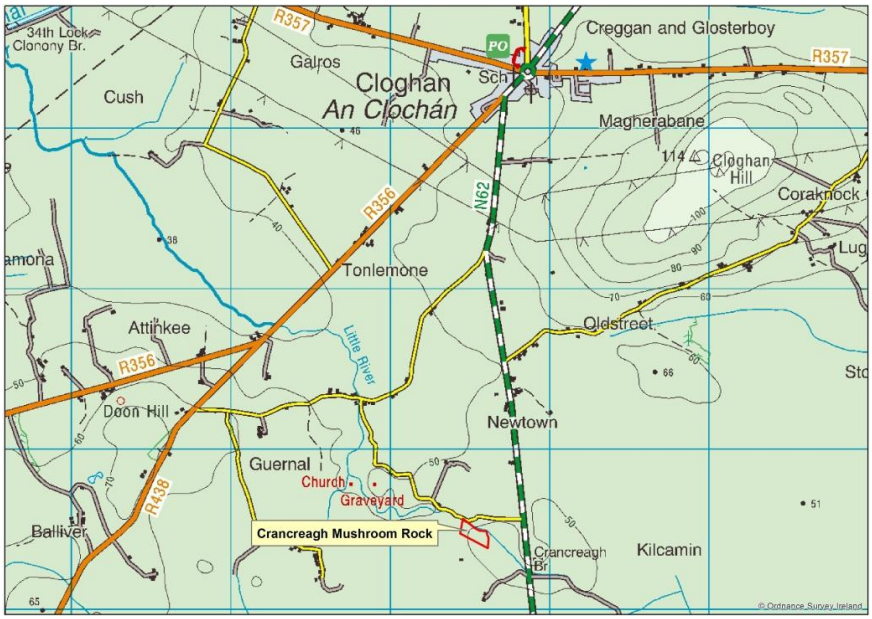
Management/promotion issues
The Crancreagh rock needs protecting from deliberate or inadvertent damage.

The rocks are in private farmland and not accessible without the permission of the landowner.

Crancreagh Mushroom Rock.

'Side' view of Crancreagh Mushroom Rock.

Conical remnant of another mushroom rock in the same field.


34th Lock
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Galros
Cloghan
An Clochán
Sch
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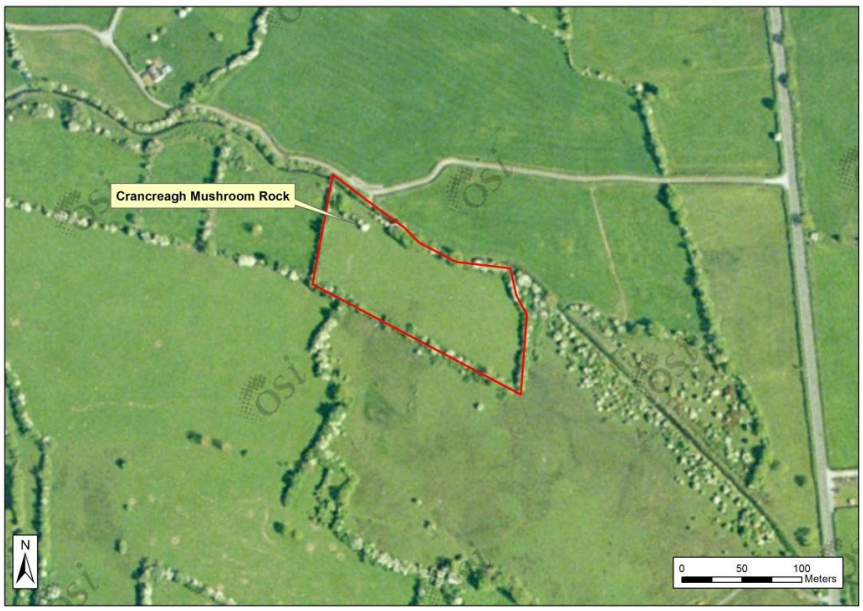
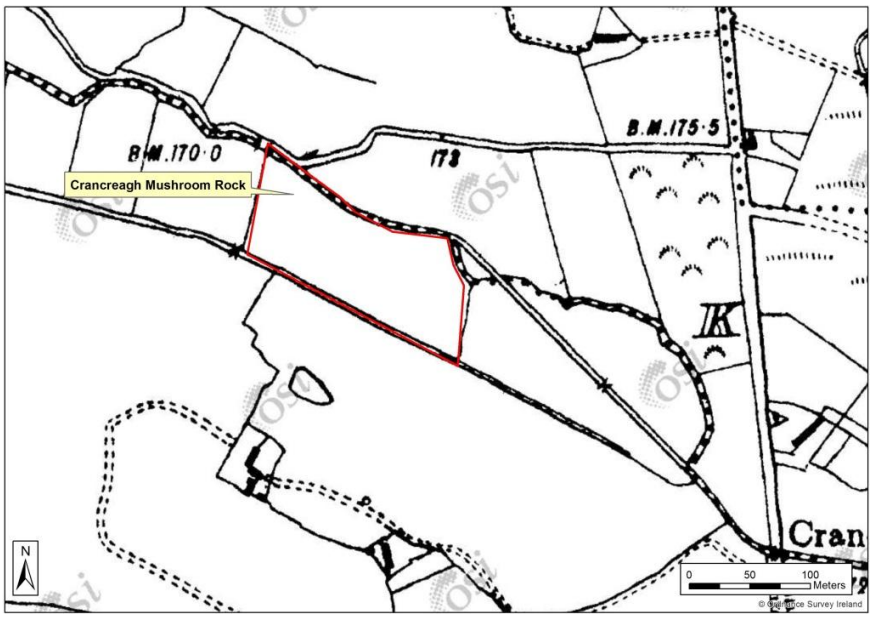
Creggan and Glosterboy
R357
Cush
Magherabane
114
Cloghan
Hill
Coraknock
R356
N62
Tonlemone
Lug
Attinkee
Little River
Oldstreet
R356
Doon Hill
Newtown
Guernal
Church
Graveyard
R438
Ballivor
Crancreagh Mushroom Rock
Crancreagh
Bri
Kilcamin
© Ordnance Survey Ireland


Crancreagh Mushroom Rock
N
0 50 100
Meters


B.M.170·0
Crancreagh Mushroom Rock
178
B.M.175·5
K
Cran
N
0 50 100
Meters
© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Creevagh Mushroom Rocks**
Other names used for site	The Piper's Rock
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Creevagh**
NEAREST TOWN/VILLAGE	**Shannonbridge**
SIX INCH MAP NUMBER	**5**
ITM CO-ORDINATES	**699760E 729270N**
1:50,000 O.S. SHEET NUMBER	**47 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A complex of Mushroom Rocks – isolated upstanding rocks in grass fields.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

Main Geological or Geomorphological Interest
Creevagh is a complex of mushroom rocks in Offaly adjacent to the Shannon River, with numerous examples in a small area. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes or enlarged river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock. The difference in height of undercuts on different stones has been used to argue this case at Creevagh in particular amongst Offaly's mushroom rocks.

Site Importance – County Geological Site
Although multiple large rocks with complex solutional shapes remain upstanding across several fields, there has been past clearance of intervening limestone pavement areas that had some less obvious undercuts and which provided much context. As a result it is recommended as a County Geological Site only, and not as a geological Natural Heritage Area.

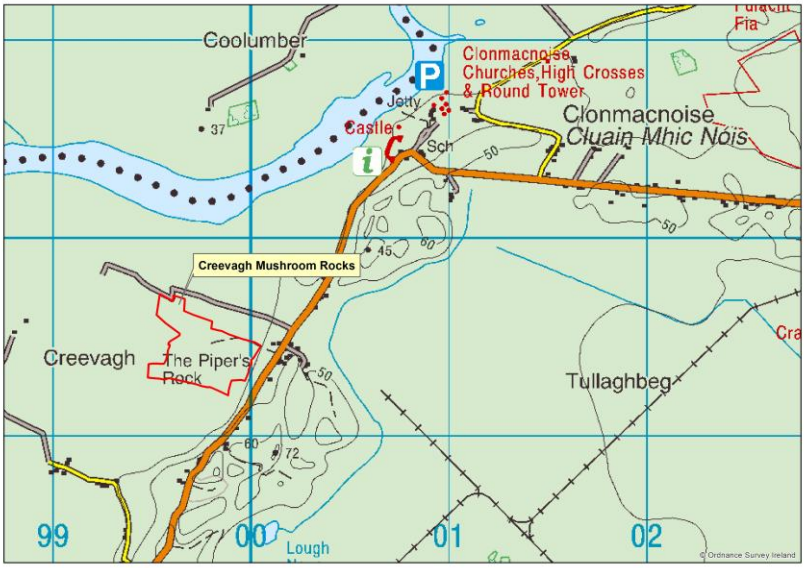
Management/promotion issues
The known obvious mushroom rocks are protected by the landowner. However, they are all on private farmland and there is no public access.

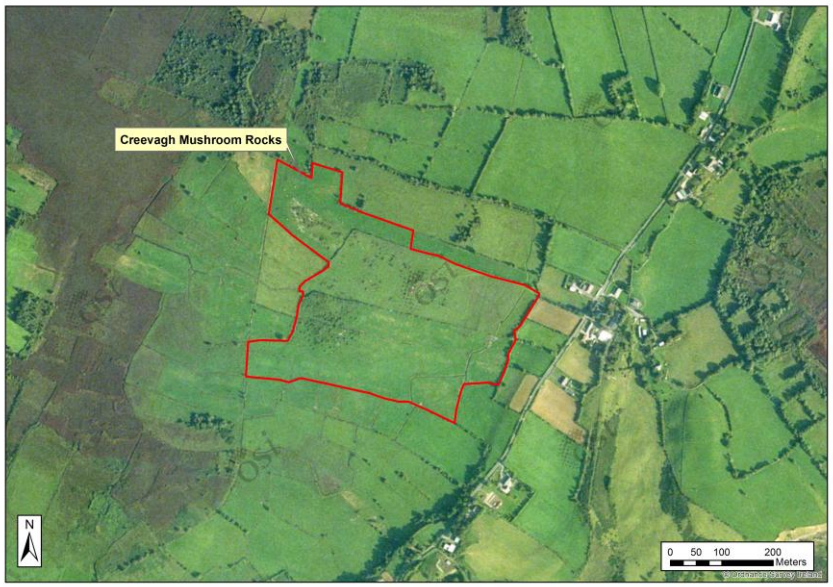
Two rocks called ‘The Piper’s Rock’, given as the local name on the Ordnance Survey six inch to the mile map, see bottom of following page.

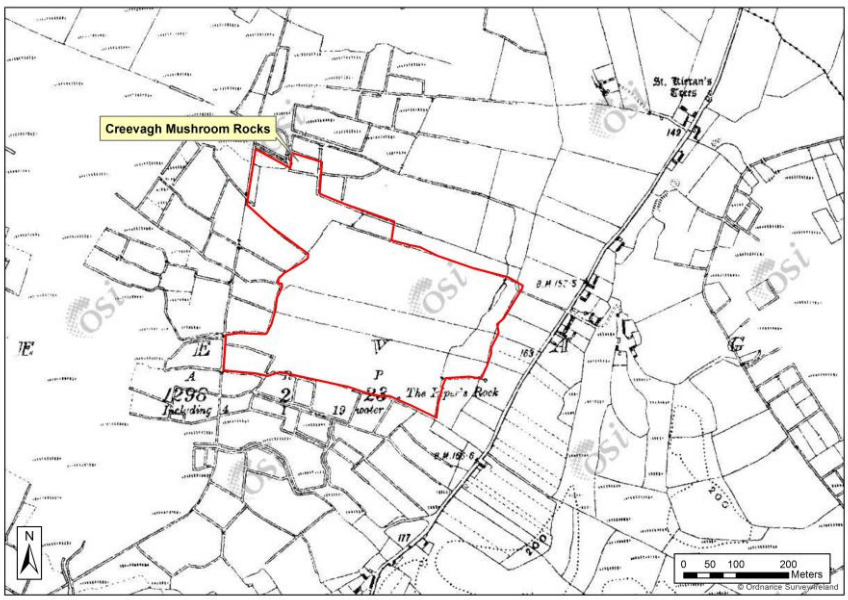

The ‘Piper’s Rock’ (of the OS map).


One of the Creevagh rocks (Creevagh 5).


A Creevagh rock, with other remnants beyond.


Coolumber
Clonmacnoise
Churches,High Crosses
& Round Tower
Jetty
Castle
Sch
Clonmacnoise
Cluain Mhic Nois
Creevagh Mushroom Rocks
Creevagh
The Piper's
Rock
Tullaghbeg
99
00
01
02
Lough
© Ordnance Survey Ireland


Creevagh Mushroom Rocks
N
0 50 100 200
Meters


Creevagh Mushroom Rocks
St. Kieran's Cross
N
0 50 100 200
Meters
© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Crinkill Mushroom Rocks**
Other names used for site	The Nun's Stone
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Crinkill**
NEAREST TOWN/VILLAGE	**Birr**
SIX INCH MAP NUMBER	**35**
ITM CO-ORDINATES	**605810E 703123N**
1:50,000 O.S. SHEET NUMBER	**53 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A complex of Mushroom Rocks – isolated upstanding rocks in a grass field.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

Main Geological or Geomorphological Interest
Crinkill is a complex of mushroom rocks near Birr, with a few examples in a small area. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes or enlarged river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock.

At Crinkill, the Nun's Stone (Crinkill 1) is extant, and some metres away is a sloping base or 'stump' of an incomplete, eroded stone. Crinkill 3 is located in a separate field but was not found due to extensive blackthorn growth over the location which prevented access. Two mushroom rocks were located in an adjacent field on the west side of the road, but these have reportedly been moved by a landowner from the original location to the east of the road. The moved rocks are now at totally different heights in the field, even though they have been placed the correct way-up.

Site Importance – County Geological Site
Crinkill 1 alone warrants classification and is recommending as a County Geological Site, given its local name and recognition, and that other stones have been damaged or removed from the vicinity.

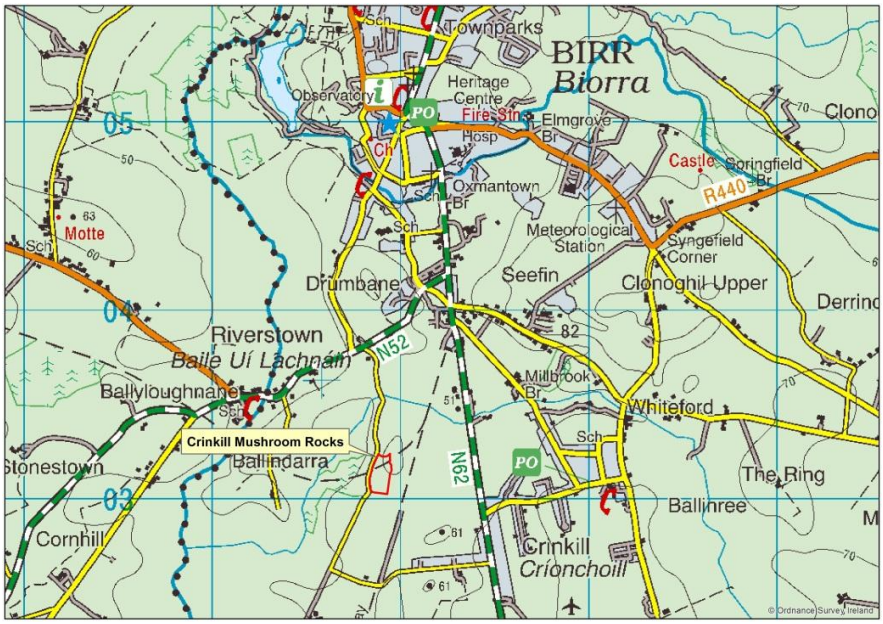
Management/promotion issues
The apparent removal of at least two other stones from this site is highly detrimental since their natural position is key to any scientific measurements to determine possible former lake levels or other features. The remaining stone should be protected from any disturbance or damage.

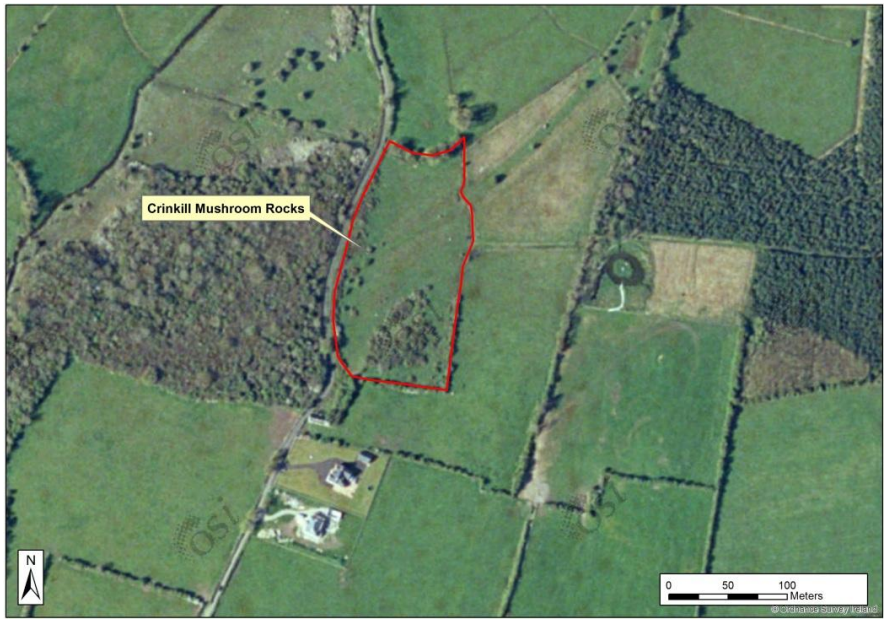
The site is on private farmland and no access to the stone should be made without permission of the landowner.

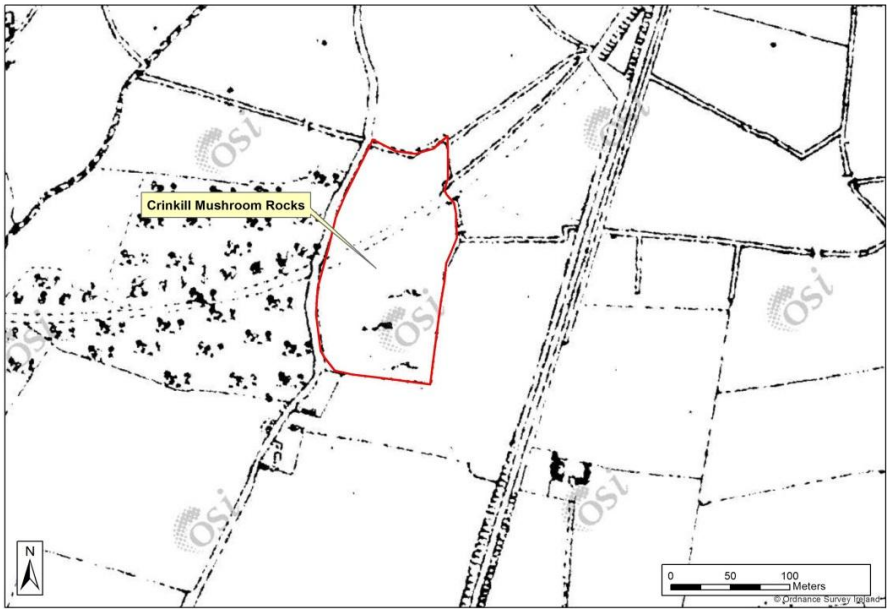
Crinkill 1, the Nun's Stone is visible from the adjacent road.

A 'stump' of a former mushroom rock close to Crinkill 1.

The Nun's Stone, Crinkill 1.


Townparks
BIRR
Biorra
Heritage Centre
Observatory
Fire Stn
Elmgrove Br
Hosp
Castle
Boringfield Br
R440
Oxmantown Br
Meteorological Station
Syngefield Corner
Motte
Drumbane
Seefin
Clonoghil Upper
Riverstown
Baile Uí Lachnáin
N52
Millbrook Br
Whiteford
Ballyloughnane
Crinkill Mushroom Rocks
Ballindarra
N62
The Ring
Ballinree
Cornhill
Crinkill
Crionchoill
© Ordnance Survey Ireland


Crinkill Mushroom Rocks
N
0 50 100 Meters
© Ordnance Survey Ireland


Crinkill Mushroom Rocks
N
0 50 100 Meters
© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Croghan Hill**
Other names used for site	Cruchan Éile, Cnoc Cruacháin, Brí Éile
IGH THEME	**IGH11 Igneous Intrusions, IGH8 Lower Carboniferous**
TOWNLAND(S)	**Croghanhill, Cannakill, Ballybeg**
NEAREST TOWN/VILLAGE	**Daingean, Rhode**
SIX INCH MAP NUMBER	**10**
ITM CO-ORDINATES	**648050E 733140N**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A prominent hill rising from an otherwise flat landscape of midland raised bogs and low-lying pasture.

Geological System/Age and Primary Rock Type
The volcanic rocks and limestones are Lower Carboniferous (Mississippian, Viséan) in age, formed around 340 million years ago.

Main Geological or Geomorphological Interest
Croghan Hill (234m OD) is the remains of an extinct volcano that erupted and rose up from the sea that covered this region during the Carboniferous Period. A variety of volcanic rocks occur on and around Croghan Hill, including extrusive alkali basalts and limburgites, and pyroclastic agglomerates and tuffs. The rocks are interbedded with the limestones which formed in the warm seas into which the volcano erupted its volcanic material. These rocks record episodes of volcanic activity consisting of lava flows and violent explosive eruptions.

Some columnar jointing in a basalt flow (formed by a similar process to The Giant's Causeway), on the northeastern side of Croghan Hill, suggests ponding and cooling of the lava in a subaerial environment.

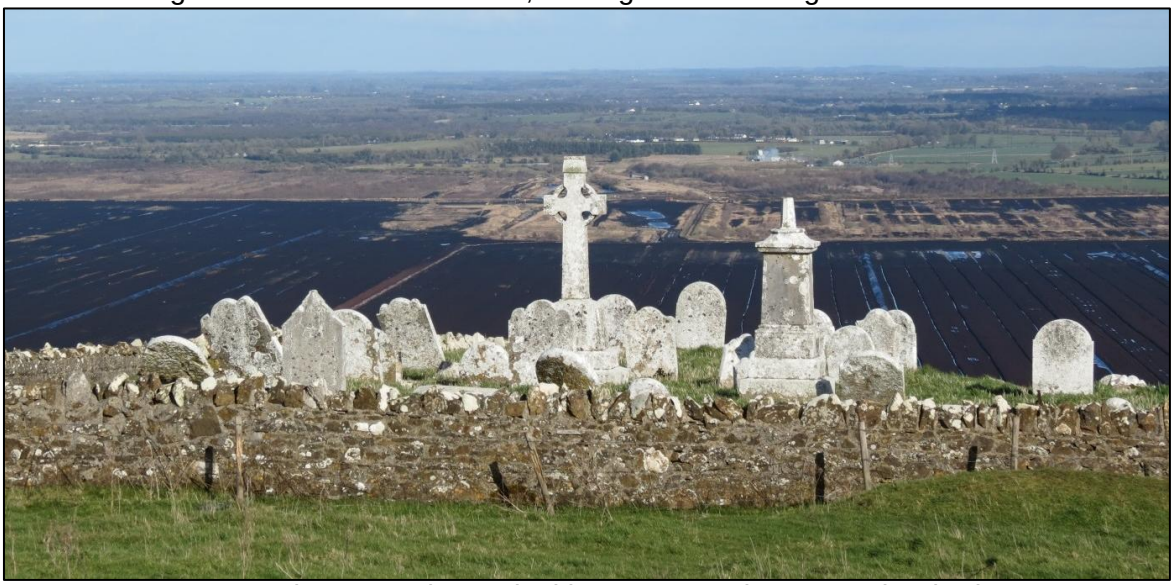
Gneiss xenoliths (fragments of rock of different composition enclosed in igneous rock) have been described (*Nature, Vol. 250 1974*) occurring in agglomerate outcrops to the west of Croghan village, and in basalts south of the village. It has been suggested that these high-grade metamorphic gneiss are derived from the sub-Palaeozoic lower crust in this region.

The hill is largely surrounded by low-lying pastures and peatland underlain by limestone and shale beds of the Carboniferous Lucan Formation.

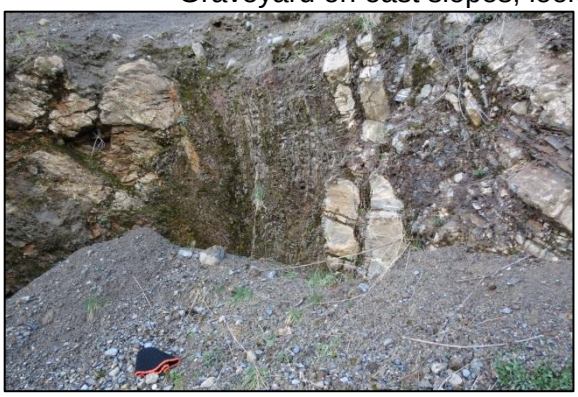
Site Importance – County Geological Site; recommended for geological NHA
This is an important County Geological Site in terms of volcanic igneous geology, particularly in this region of the low-lying midlands, which is predominantly underlain by Carboniferous limestones covered by bog. The site should also be recognised as a geological NHA owing to its importance in understanding the environmental conditions during the Carboniferous, and as it is one of only a few such Carboniferous-age volcanic sites in Ireland.

Management/promotion issues
The hill is capped by a cairn (RMP OF010-00401), believed to be a Bronze Age burial place. An enclosed graveyard on the SE slopes occupies the site of a 5th century Early Christian church. The *Clustucka* (RMP OF010-014) standing stone in Barrysbrook townland on the SE slope of the hill is a fine example of an agglomerate.

Trig Point on the summit cairn, looking east over bog towards Rhode.

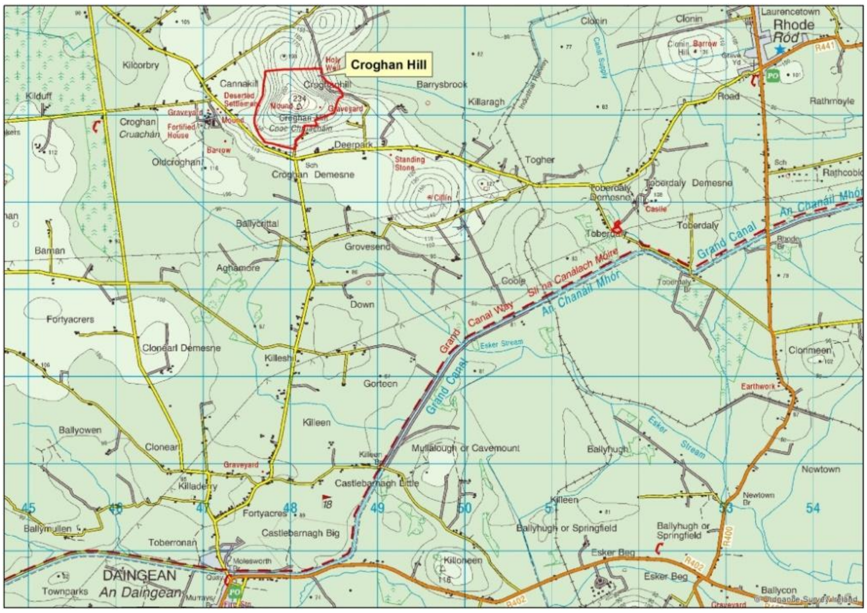


Graveyard on east slopes, looking east over bog towards Rhode.



Inclined carbonate strata in sand quarry at NE foot of hill.

Agglomerate rock forms the *Clustucka* stand-stone southeast of the hill.


Croghan Hill
Kilcorbry
Kilduff
Croghan
Cruachán
Oldcroghan
Cannakill
Barrysbrook
Killaragh
Deerpark
Croghan Demesne
Togher
Clonin
Rhode
Ród
Laurencetown
Rathmoyle
Toberdaly
Toberdaly Demesne
Grand Canal
An Chanáil Mhór
Ballycrittal
Grovesend
Baman
Aghamore
Down
Fortyacrers
Clonearl Demesne
Killeshil
Gorteen
Clonmeen
Ballyowen
Clonearl
Killeen
Mullalough or Cavemount
Ballyhugh
Newtown
Killaderry
Castlebarnagh Little
Fortyacres
Castlebarnagh Big
Ballymullen
Toberronan
DAINGEAN
An Daingean
Townparks
Killoneen
Ballyhugh or Springfield
Esker Beg
Ballycon
Earthwork
Graveyard
Standing Stone
Castle
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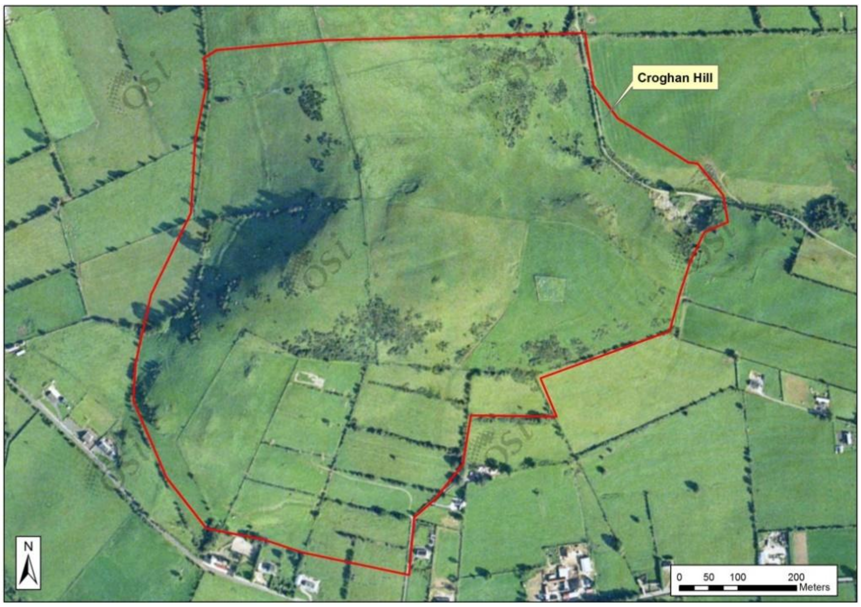
48
49
50
51
53
54
R441
R400
R402


Croghan Hill
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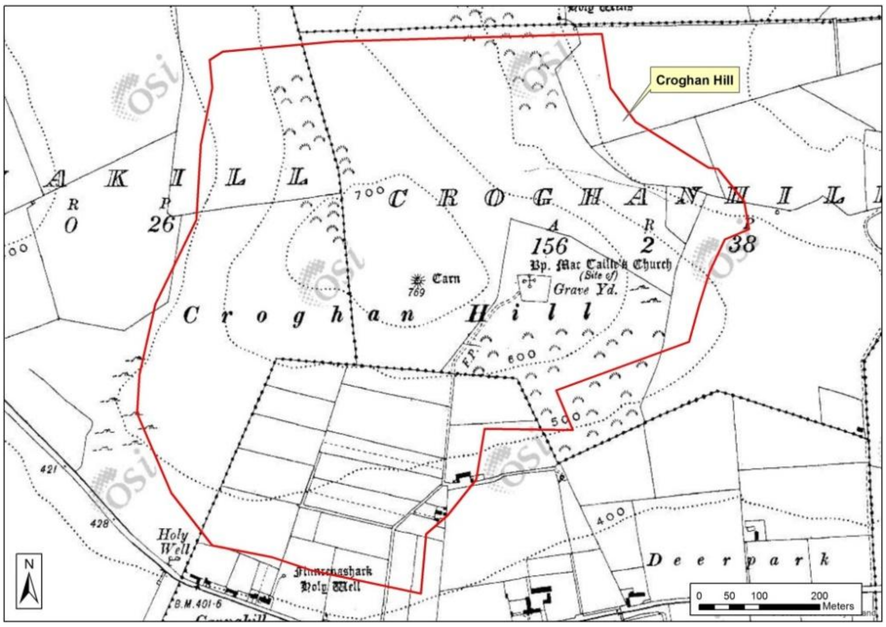
Meters


Croghan Hill
A K I L L
C R O G H A N H I L L
Croghan Hill
Carn
789
Bp. Mac Caille's Church
(Site of)
Grave Yd.
156
26
38
Holy Well
Deerpark
700
600
500
400
421
428
B.M. 401·6
N
0 50 100 200
Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Derrinlough Mushroom Rock**
Other names used for site	
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Derrinlough**
NEAREST TOWN/VILLAGE	**Birr**
SIX INCH MAP NUMBER	**30**
ITM CO-ORDINATES	**608509E 715093N**
1:50,000 O.S. SHEET NUMBER	**53 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A Mushroom Rock – isolated upstanding rock in a woodland track beside a Bord na Mona briquette factory.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

Main Geological or Geomorphological Interest
Derrinlough is one of the relatively numerous examples of mushroom rocks in Offaly compared to most counties in Ireland. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes or expanded river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock. Derrinlough has the characteristics that suggest a water solution is far more likely, with an extensively undercut area that is also of a scalloped appearance from flowing water.

Site Importance – County Geological Site
This is one of the spread of mushroom rocks that is particularly well represented in Offaly on a national basis, and is marking the edge of a large depression now filled with bog. It is warrants recognition and protection, and is recommended as a County Geological Site.

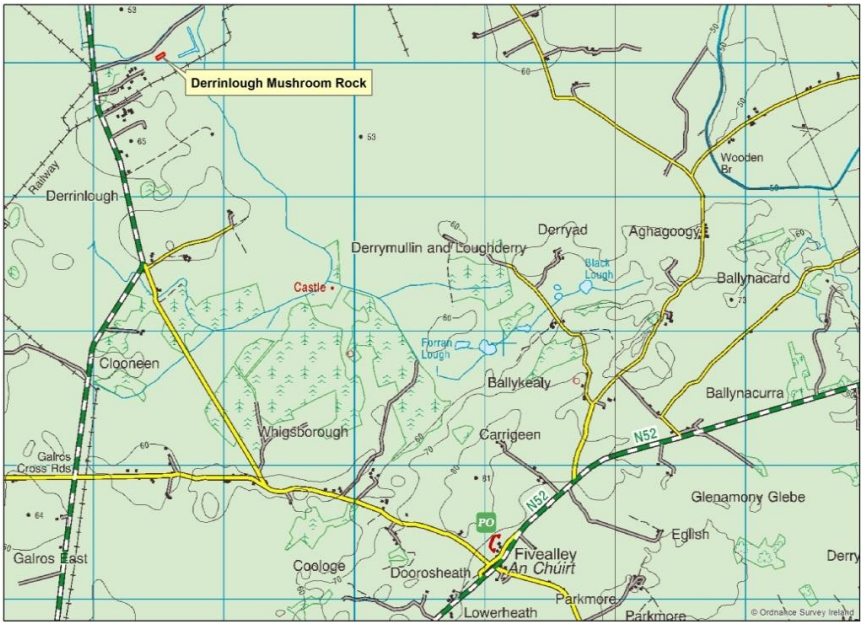
Management/promotion issues
Jimmy Shortt, a Supervisor in the briquette factory, and also an active member of the Birr Historical Society, takes an active role in protecting the Derrinlough mushroom rock as it is situated in a busy works environment. He also prevents the weeds from colonising the top of the rock.

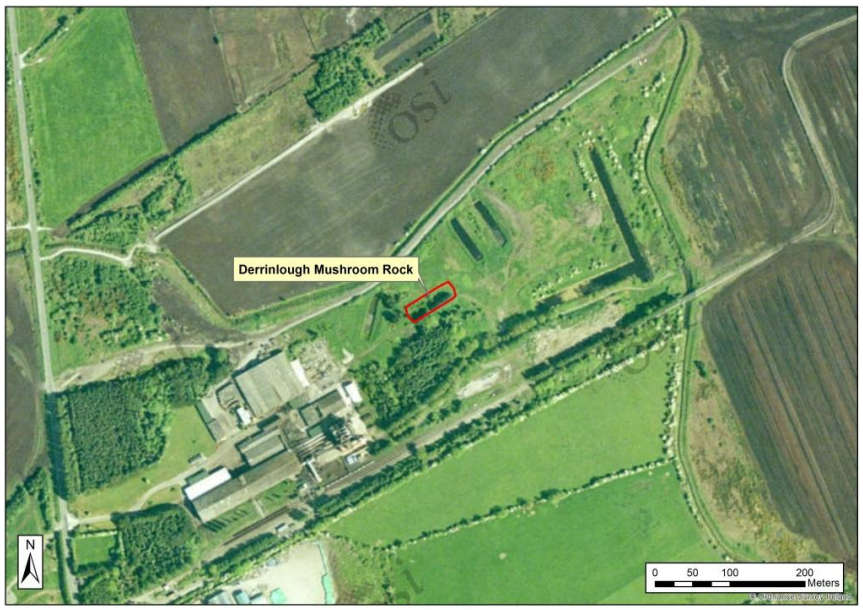
The Derrinlough Mushroom Rock is close to the Bord na Mona briquette factory.

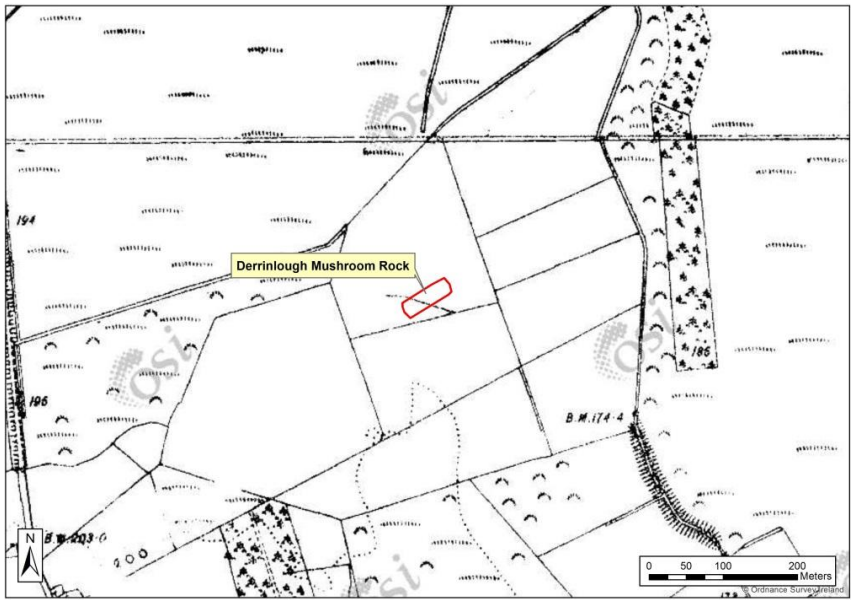
Jimmy Shortt keeps the rock free of weeds.

Derrinlough is heavily dissolved underneath.

The Derrinlough stone is adjacent to massive raised bogland, once a lakeland.


Derrinlough Mushroom Rock
Derrinlough
Derrymullin and Loughderry
Derryad
Aghagoogy
Wooden Br
Ballynacard
Castle
Black Lough
Forran Lough
Clooneen
Ballykealy
Ballynacurra
Whigsborough
Carrigeen
N52
Galros Cross Rds
Glenamony Glebe
PO
Eglish
Galros East
Coologe
Doorosheath
Fivealley
An Chuirt
Parkmore
Lowerheath
Derry
© Ordnance Survey Ireland


Derrinlough Mushroom Rock
N
0 50 100 200
Meters


Derrinlough Mushroom Rock
194
196
185
B.M.174·4
N
0 50 100 200
Meters
© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Drinagh Mushroom Rock**
Other names used for site	
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Drinagh**
NEAREST TOWN/VILLAGE	**Banagher**
SIX INCH MAP NUMBER	**22**
ITM CO-ORDINATES	**610560E 715868N**
1:50,000 O.S. SHEET NUMBER	**53 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A Mushroom Rock – isolated upstanding rock in a grass field.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

Main Geological or Geomorphological Interest
Drinagh is one of the relatively numerous examples of mushroom rocks in Offaly compared to most counties in Ireland. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes or expanded river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets.

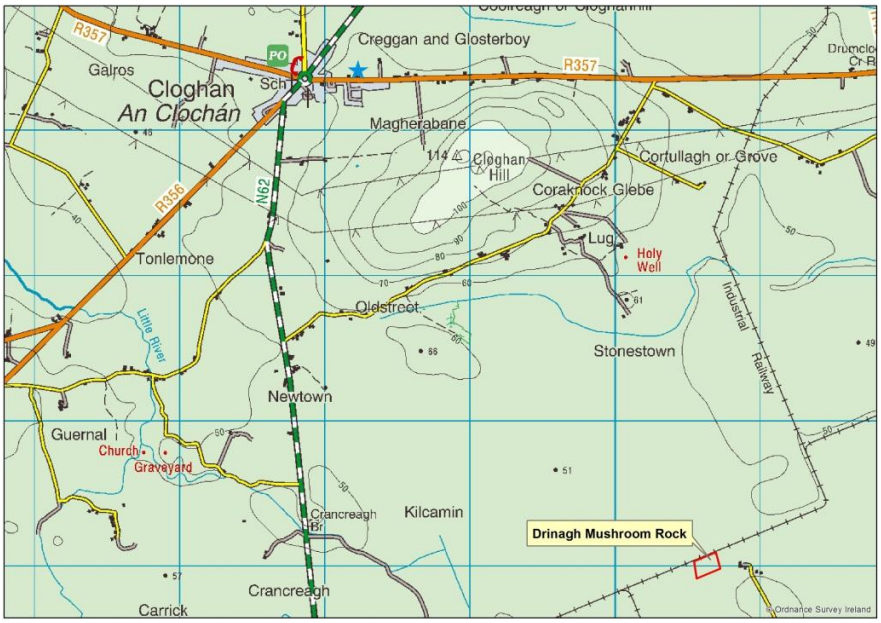
An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock.

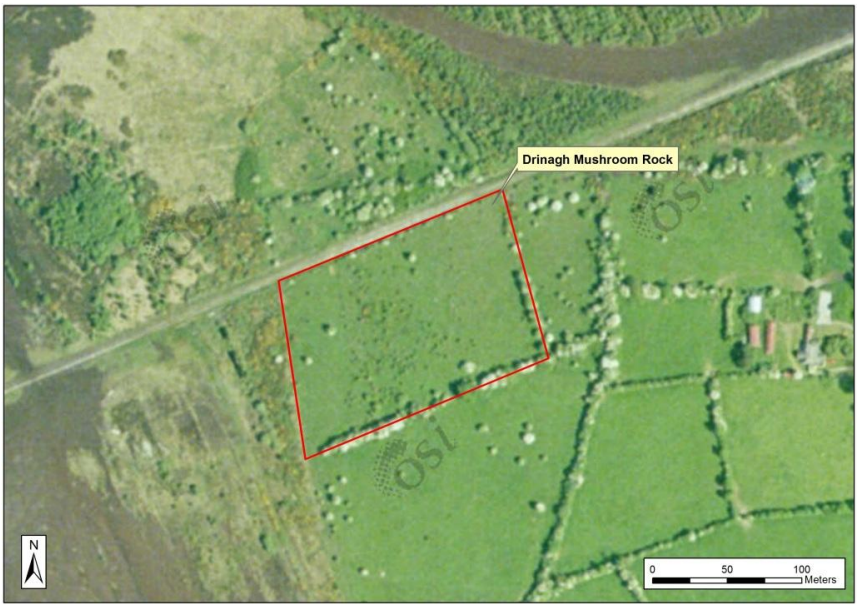
Site Importance – County Geological Site
This is a good example of a mushroom rock and merits recommendation for County Geological Site status as part of a suite of excellent representatives in Offaly.

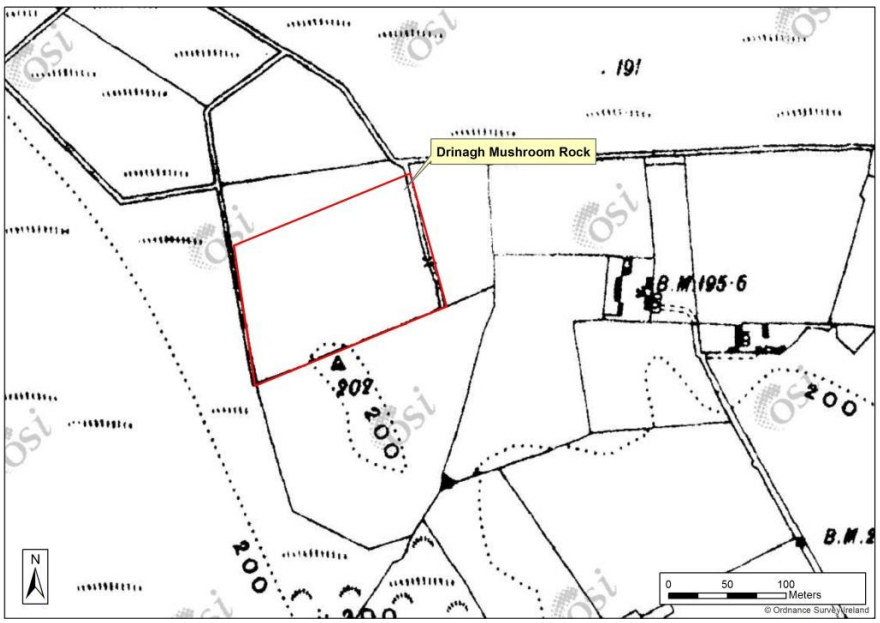
Management/promotion issues
The site is at risk from being overwhelmed by vegetation, as the trees have grown extensively in the area in the last 15 years, and some are now in close proximity, compared with when it was situated in open grass fields. Any change in landowner may place the rock at risk from a lack of awareness, especially with the potential for agricultural field clearances.

Drinagh Mushroom Rock.

Drinagh Mushroom Rock with a second mushroom rock in the foreground.


R357
Galros
Cloghan
An Clochán
PO
Sch
Creggan and Glosterboy
R357
Magherabane
Cloghan Hill
Corrullagh or Grove
Corakinock Glebe
R356
N62
Tonlemone
Lug
Holy Well
Oldstroot
Stonestown
Industrial Railway
Little River
Newtown
Guernal
Church
Graveyard
Crancreagh Br
Kilcamin
Drinagh Mushroom Rock
Crancreagh
Carrick
© Ordnance Survey Ireland


Drinagh Mushroom Rock
N
0
50
100
Meters


191
Drinagh Mushroom Rock
B.M 195·6
200
200
200
B.M.
N
0
50
100
Meters
© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Endrim Mushroom Rock**
Other names used for site	The Fairy Stone
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Endrim**
NEAREST TOWN/VILLAGE	**Ferbane**
SIX INCH MAP NUMBER	**6**
ITM CO-ORDINATES	**608900E 728785N**
1:50,000 O.S. SHEET NUMBER	**47 GSI BEDROCK 1:100,000 Sheet No. 15**

Outline Site Description
A Mushroom Rock – isolated upstanding rock in a grass field.

Geological System/Age and Primary Rock Type
The rock is composed of Carboniferous Limestone but the solutional weathering is post glacial – that is, Holocene in age.

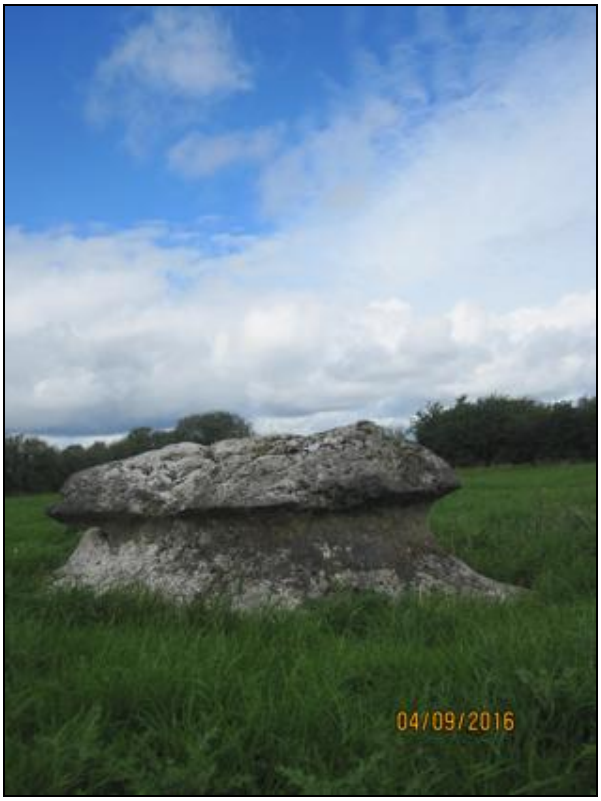
Main Geological or Geomorphological Interest
Endrim is one of the relatively numerous examples of mushroom rocks in Offaly compared to most counties in Ireland. Isolated upstanding rocks with undercut lips and shapes sometimes resembling mushrooms are believed to be the result of former temporary lake levels where the undercut section of the rock was submerged below lake water which was acid enough to dissolve the limestone it was in contact with. Such lakes or expanded river basins were common in the period at the end of the Ice Age when extensive meltwaters could be trapped behind temporary dams of glacial till and remaining ice sheets. Endrim mushroom rock is on the flanks of Endrim Hill and may once have been submerged on the edge of a much larger Shannon Basin.

An alternative hypothesis for some mushroom rocks is that they were dissolved below a soil or bog deposit which has subsequently either shrunk or been eroded away to reveal the weathered section of the rock.

Site Importance – County Geological Site
Offaly has a high concentration of mushroom rocks, which are rare on a national basis, and therefore this site is recommended for County Geological Site status that form part of the county's suite.

Management/promotion issues
The rock needs to be protected from inadvertant removal or damage as part of field 'improvements'; when it might be seen simply as a rock in the way of machinery. However, as it sits within a field of grass which must have been reseeded, compared to adjacent fields, it would appear that it was recognised as important to leave undamaged. As it is on private farmland it should only be promoted with the landowner's permission and engagement regarding any such effort.

Endrim Mushroom Rock is one isolated rock in the middle of a field.

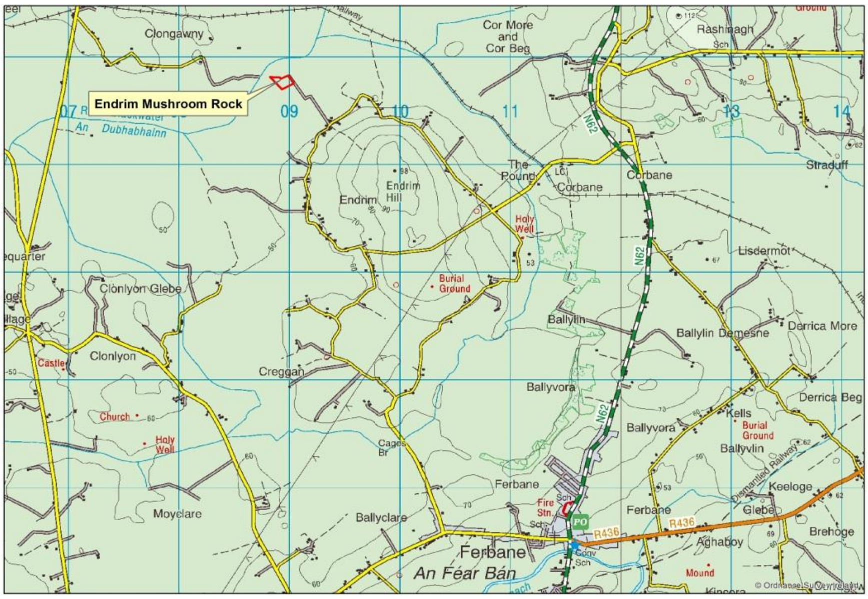


Endrim has the classic features of a mushroom rock.

Endrim Mushroom Rock.

Endrim Mushroom Rock is more complex on one side, with extensive undercutting.

Endrim Mushroom Rock viewed from grass level.


Endrim Mushroom Rock
Clongawny
Cor More
and
Cor Beg
Rashinagh
An Dubhabhainn
Endrim
Endrim
Hill
Holy
Well
The
Pound
Corbane
Corbane
Straduff
Lisdermot
Burial
Ground
Clonlyon Glebe
Ballylin
Ballylin Demesne
Derrica More
Castle
Clonlyon
Creggan
Ballyvora
Derrica Beg
Church
Holy
Well
Cages
Br
Ballyvora
Kells
Burial
Ground
Ballyvlin
Ferbane
Keeloge
Moyclare
Ballyclare
Fire
Stn.
PO
Ferbane
Glebe
Brehoge
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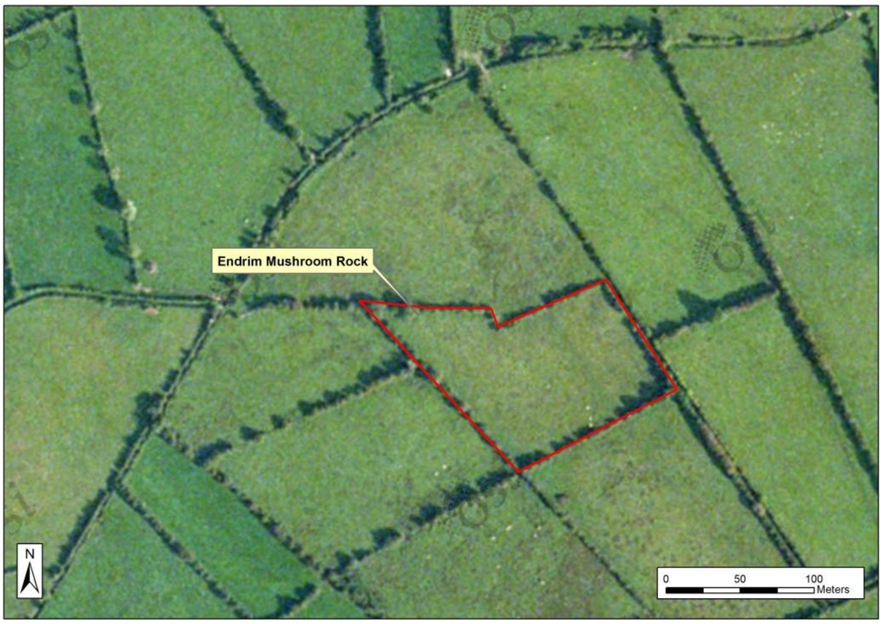
© Ordnance Survey Ireland


Endrim Mushroom Rock
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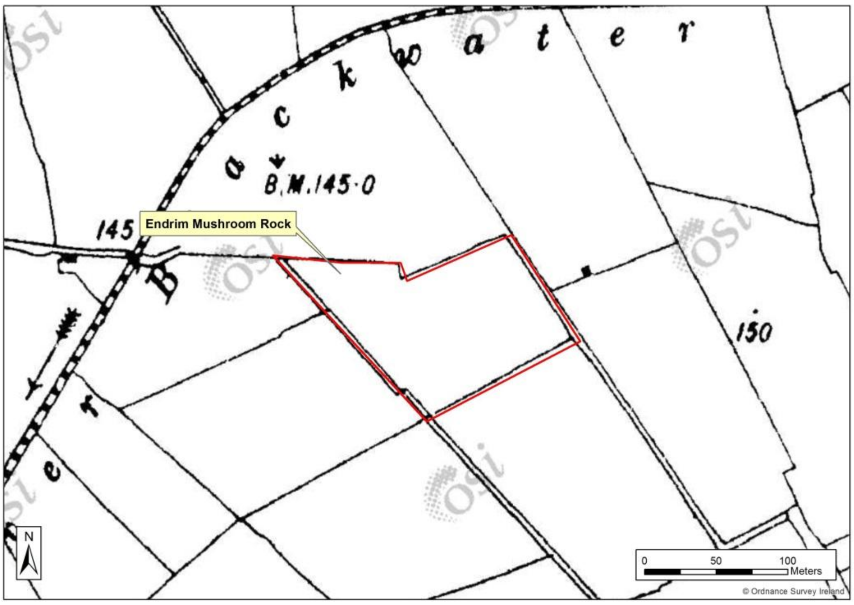
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© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Kilcormac Esker**
Other names used for site	The Killimor-Birr-Fivealley-Kilcormac Esker, The Fivealley Esker, The Lusmagh-Birr-Tullamore Esker, The Geashill Esker, The Ross and Glenns Eskers
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Too many to list … this esker system covers over 50 individual townlands, along a linear extent of over 45 km**
NEAREST TOWN/VILLAGE	**Birr, Fivealley, Kilcormac, Tullamore, Geashill**
SIX INCH MAP NUMBER	**17, 18, 21, 23, 24, 25, 26, 29, 30, 35**
ITM CO-ORDINATES	**616500E 714700N (centre of main esker segment, near Kilcormac)**
1:50,000 O.S. SHEET NUMBER	**48, 53, 54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
The Kilcormac Esker and surrounding sands and gravels include an exceptionally large accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew westwards across Offaly at the end of the last Ice Age. The esker forms part of the much larger Killimor-Birr-Fivealley-Kilcormac Esker System, which extends across the Midlands for over 70 km linear extent.

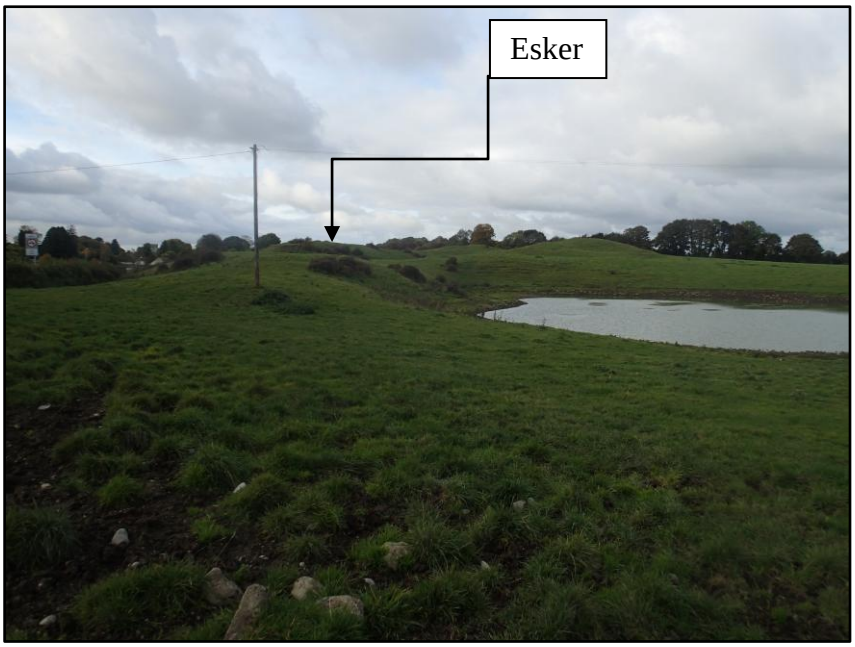
Geological System/Age and Primary Rock Type
The Kilcormac Esker and surrounding sands and gravels are formed entirely on Lower Carboniferous limestone rocks, across the lowlands of Central Offaly. The eskers themselves are Quaternary in age, having been deposited either under or at the edge of the westward-retreating ice sheet in deglaciation, approximately 14,000 years ago.

Main Geological or Geomorphological Interest
Where present the esker ridges are striking features, standing proud of the flat landscape of till (boulder clay) upon which they were deposited. In many places the eskers have been surrounded by post-glacial alluvium or peat deposits in the Holocene, following the Ice Age. Intact portions along the N52 between Tullamore and Birr, and well exposed along the roadside, are especially impressive. Here, the eskers are comprised of a singular ridge of coarse gravels; near Fivealley and Birr the arrangement is more haphazard. Some of the hollows between the ridges in this zone are remarkably deep and wide.

The esker feature is important in that it records faithfully the ice movement across this area of Offaly during the final phase of deglaciation. Wide belts of associated sands and gravels near Fivealley and north of Birr, flanking the esker beads themselves, are probably part of associated ice marginal fans. The sands and gravels within the feature are comprised chiefly of limestone clasts.

Site Importance – County Geological Site; may be recommended for Geological NHA
The features are haphazardly arranged, high, striking examples of dry sand and gravel ridges, that stand proud of the surrounding landscape. These eskers and their associated sands and gravels in the locality are a good example of a deglacial, meltwater-deposited complex, with portions deposited under the ice, and portions at the ice margin, and are recommended as a County Geological Site.

Management/promotion issues
A number of pNHA and SACs straddles the esker (000564 Little Brosna Callows, 000920 Ross and Glenns Eskers, 000919 Ridge Road SW of Rapemills, 000566 All Saints Bog, 000927 Woodville Wood, 000909 Lough Coura, 000906 Kilcormac Esker, 000571 Charleville Wood) and all of these areas, as well as many adjacent, are proposed here as the County Geological Site. Many of the esker ridge segments themselves are worthy of pNHA status geologically and geomorphologically.

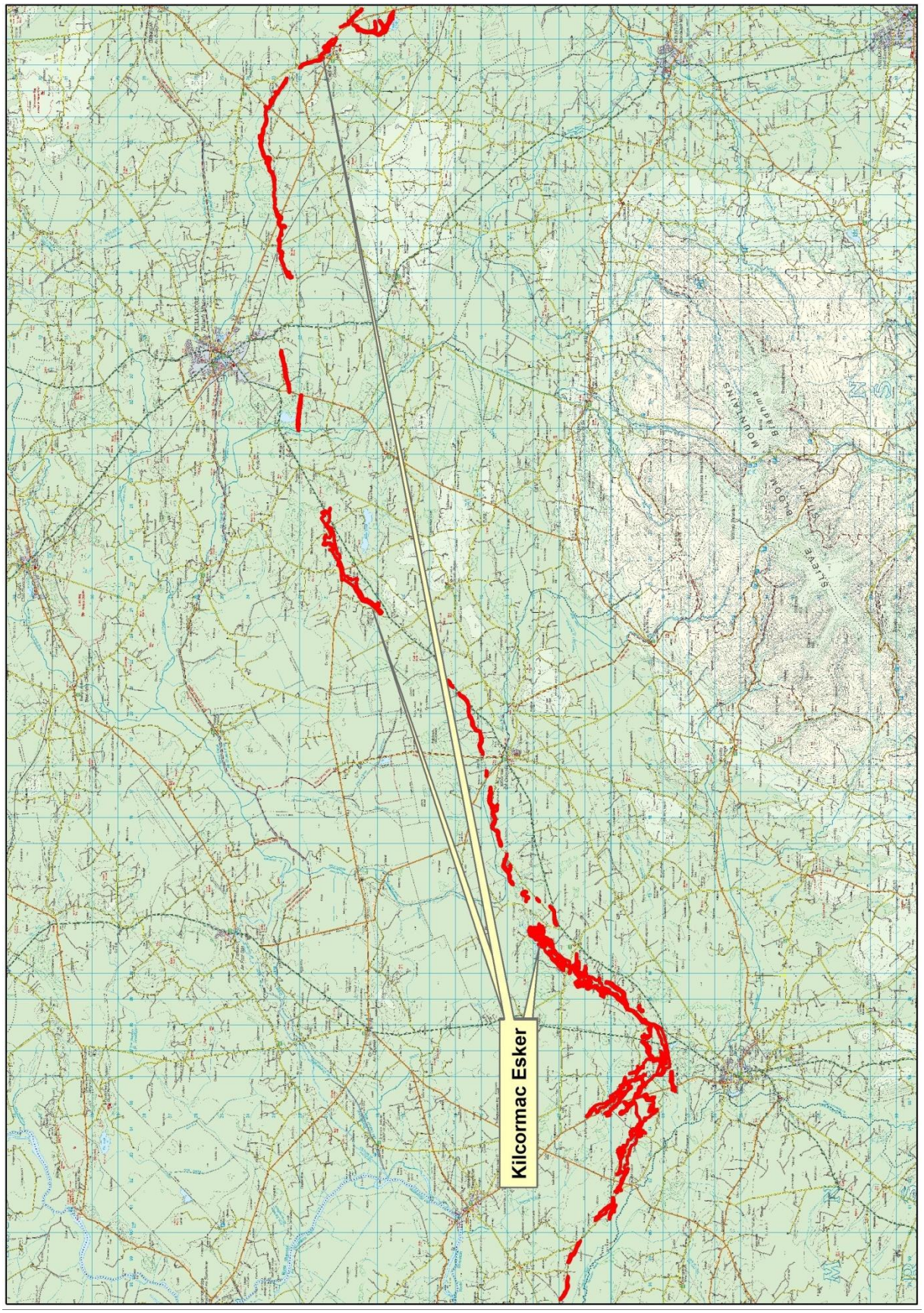


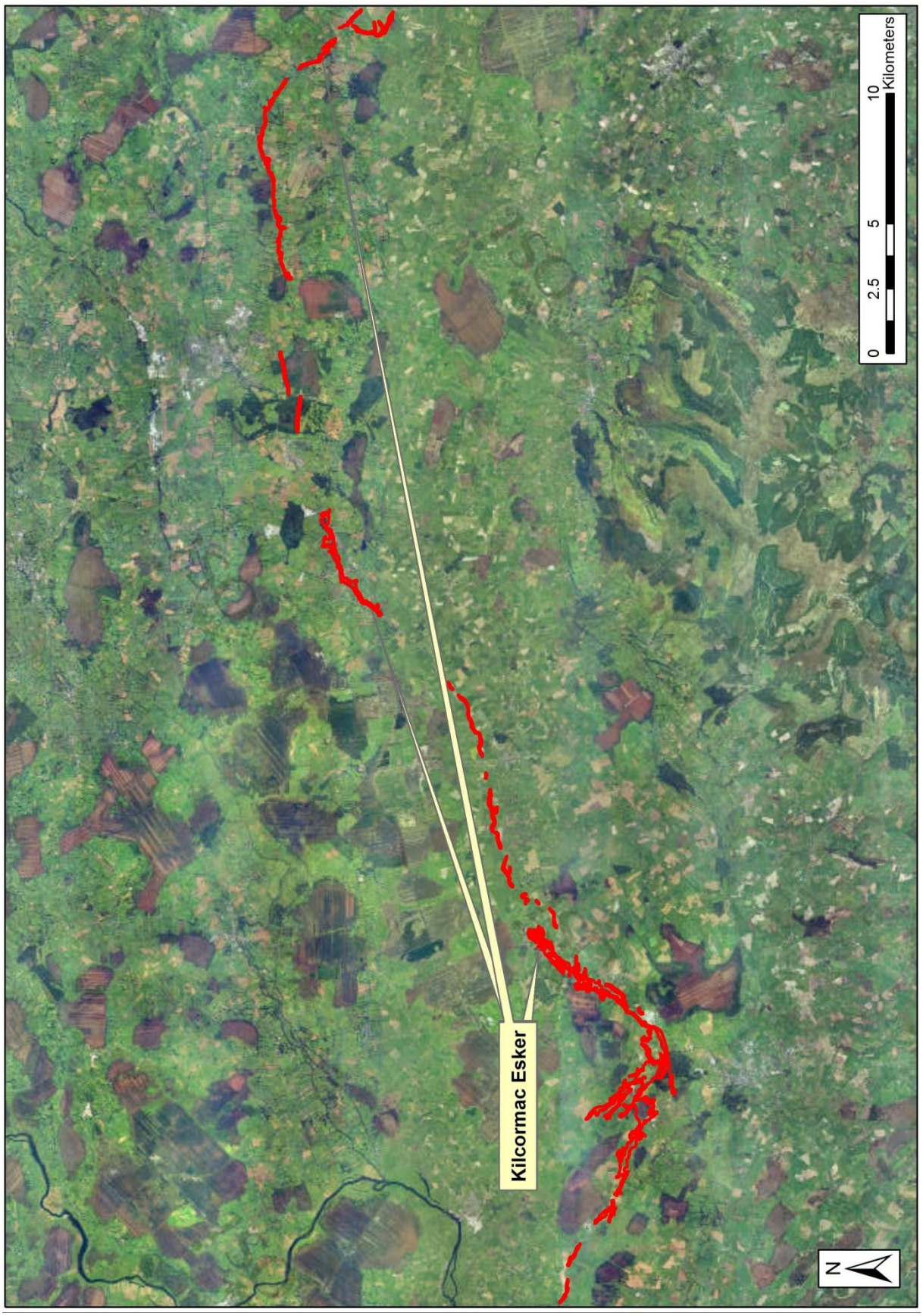
The main segment of the Kilcormac Esker just southeast of Geashill.

An exposure into the esker along the N52 at Brackagh.

Cross section through the esker just north of Kilcormac.

The view from the first tee at Tullamore Golf Club, where the fairway follows the esker.


Kilcormac Esker


Kilcormac Esker
0
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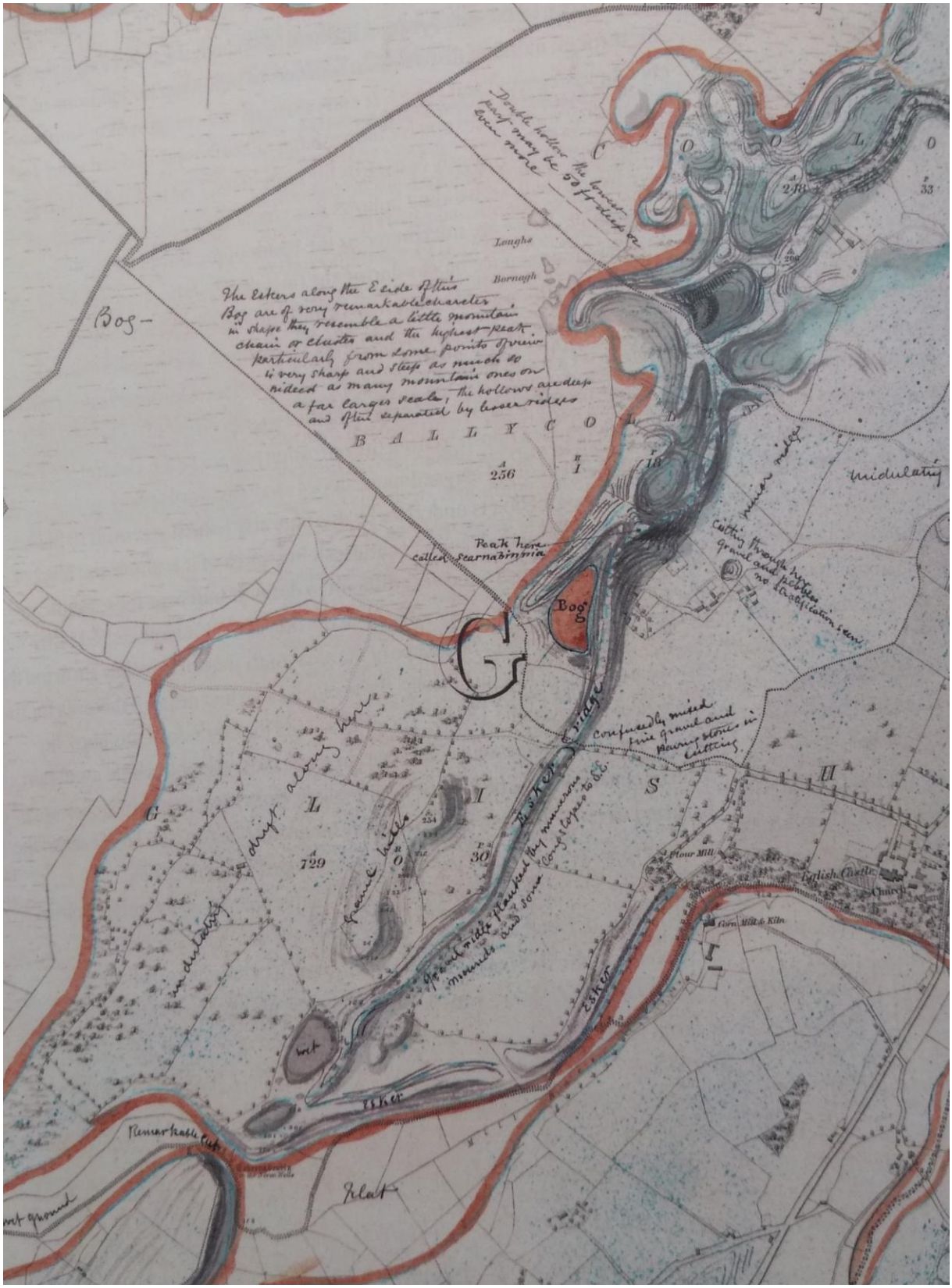


A portion of the Kilcormac Esker as depicted on the original six inch field sheets of the Geological Survey of Ireland (1865).

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Kinnitty Eskers**
Other names used for site	The Kinnitty-Clonaslee Eskers, The Knockbarron Esker, The Knockbarron Eskers, The Knockbarron Esker complex
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Annaghmore and Annaghbeg, Knockbarron, Droughville, Cloghanmore, Killinure, Streamstown, Fortel**
NEAREST TOWN/VILLAGE	**Kinnitty**
SIX INCH MAP NUMBER	**35, 36**
ITM CO-ORDINATES	**617335E 707535N (centre of main esker segment)**
1:50,000 O.S. SHEET NUMBER	**53, 54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
The Kinnitty Eskers and surrounding sands and gravels include a large accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew westwards across east Offaly, north of Slieve Bloom, at the end of the last Ice Age.

Geological System/Age and Primary Rock Type
The Kinnitty Eskers and surrounding sands and gravels are formed along the line of suture between the Devonian Old Red Sandstones of the Slieve Bloom Mountains, and the Lower Carboniferous limestones of the lowlands surrounding them.

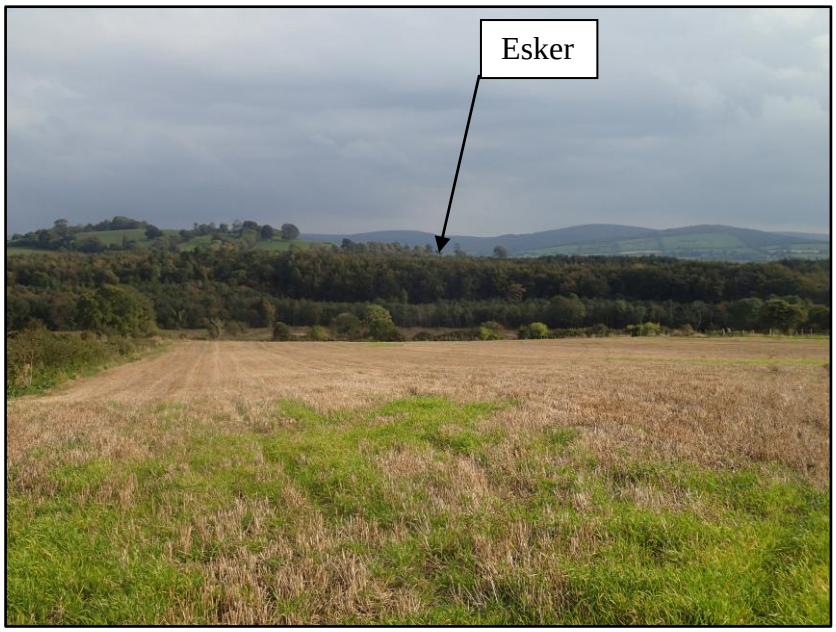
The eskers themselves are Quaternary in age, having been deposited either under or at the edge of the westward-retreating ice sheet in deglaciation, approximately 14,000 years ago.

Main Geological or Geomorphological Interest
The esker ridges are striking features, that stand proud of the flat landscape underlain by till (boulder clay), upon which they were deposited. In many places the eskers have been surrounded by post-glacial alluvium or peat deposits laid down during the Holocene. Intact portions within Knockbarron Wood, and forming part of the Eco-Walk there, are especially impressive. Here, the eskers are comprised of a haphazard arrangement of raised, elevated ridges of sands and gravels. Some of the hollows between the ridges are remarkably deep and wide.

The esker complex is important in that it records faithfully the ice movement across this area of southeast Offaly, where the ice flow swept around the Slieve Bloom Mountains. As the glacier retreated across the area north of the mountains, the margin began to break up and the irregular, hummocky topography of these eskers records this ‘dead ice’ environment. Associated sands and gravels in Streamstown and Cloghanmore Townlands, flanking the esker beads themselves, are probably part of associated ice marginal fans. The sands and gravels within the features are comprised chiefly of limestone clasts, but with portions of shale and sandstone also.

Site Importance – County Geological Site
The features are haphazardly arranged, high, striking examples of dry sand and gravel ridges, which stand proud of the surrounding landscape. As a well-defined landform sequence they should be listed as a County Geological Site. These eskers and their associated sands and gravels in the locality are a good example of a deglacial, meltwater-deposited complex, with portions deposited under the ice, and portions at the ice margin.

Management/promotion issues
A signboard dedicated to eskers, within Knockbarron Wood, might help promote the features.

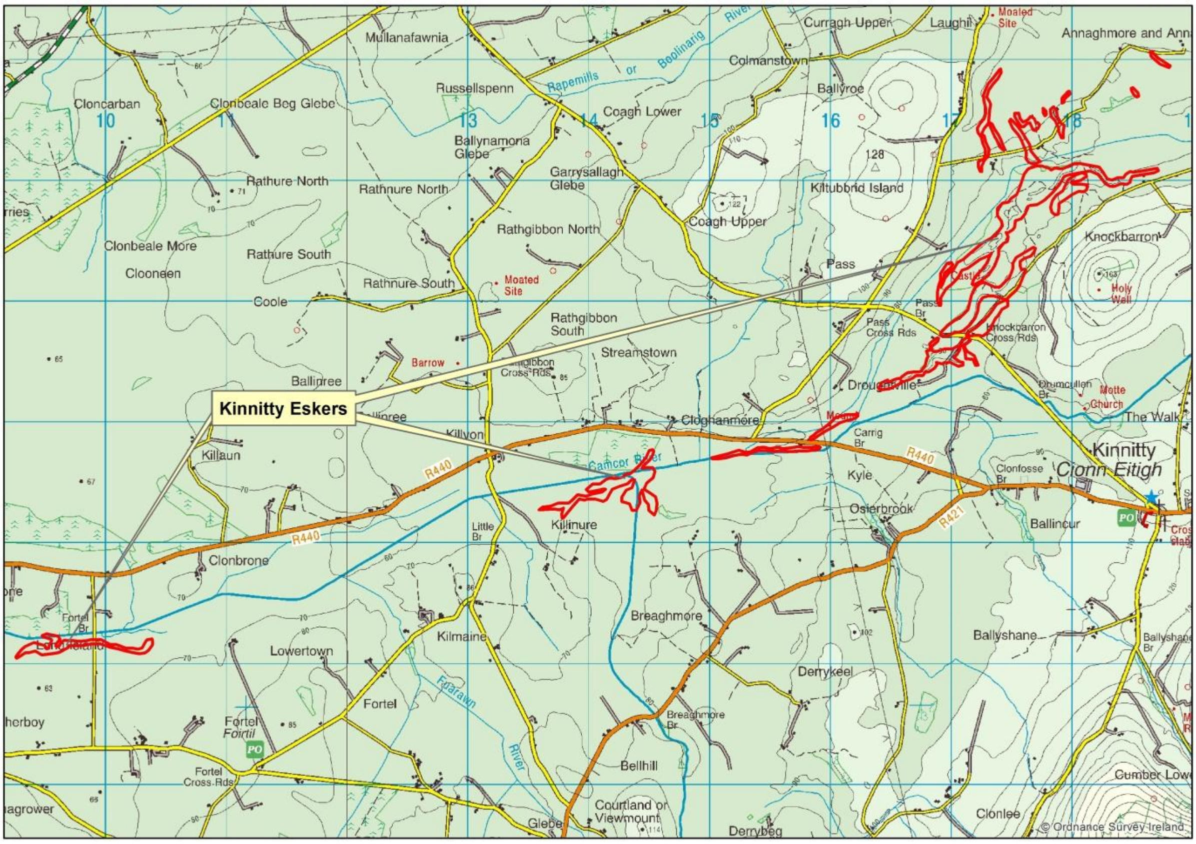


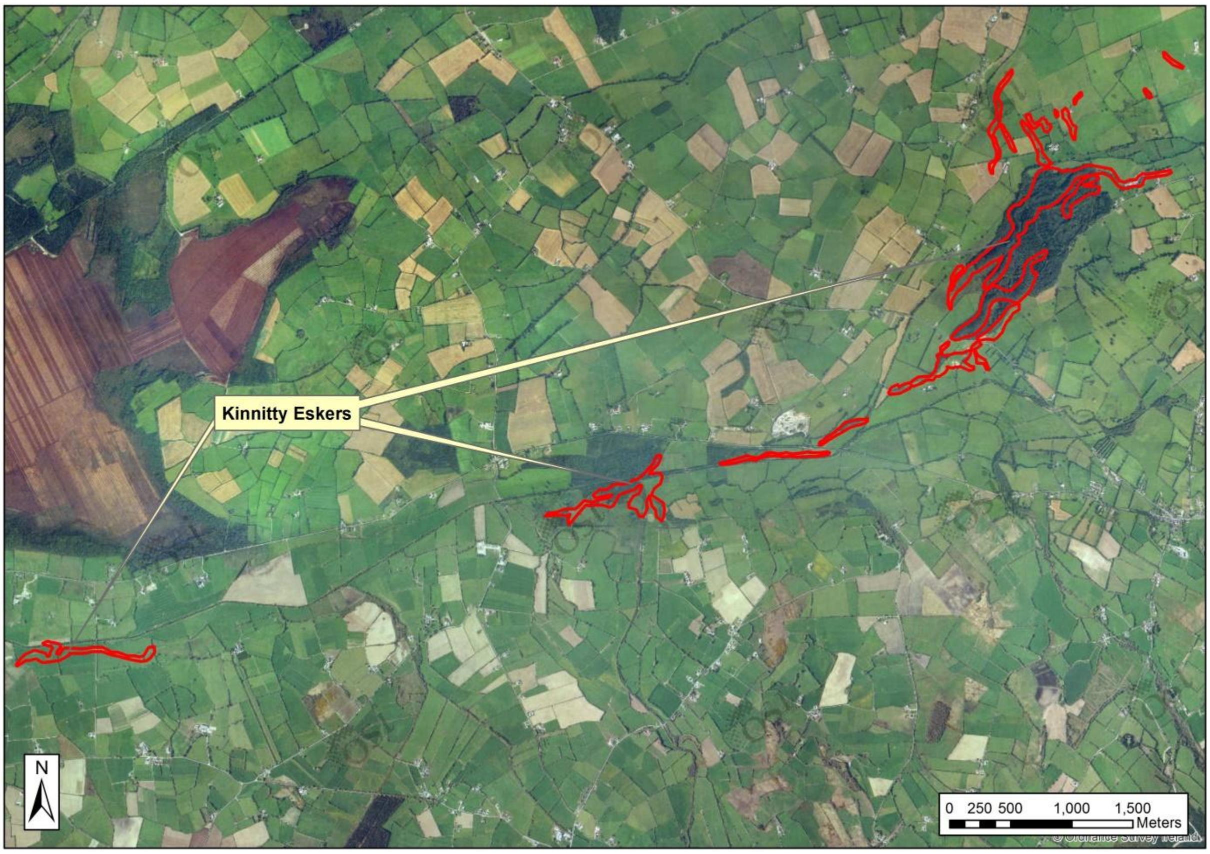
The main segment of the Kinnitty Esker in Knockbarron Wood, looking south.

Looking west across haphazard esker topography in Knockbarron.

Knockbarron Wood, with ridged, hummocky topography just inside the entrance.

An exposure into the main esker ridge in Cloghanmore.


Kinnitty Eskers
Kinnitty
Cionn Eitigh
R440
R421
Camcor River
Pass
Killinure
Clonbrone
Breaghmore
Fortel
Coagh Upper
Knockbarron
© Ordnance Survey Ireland


Kinnitty Eskers
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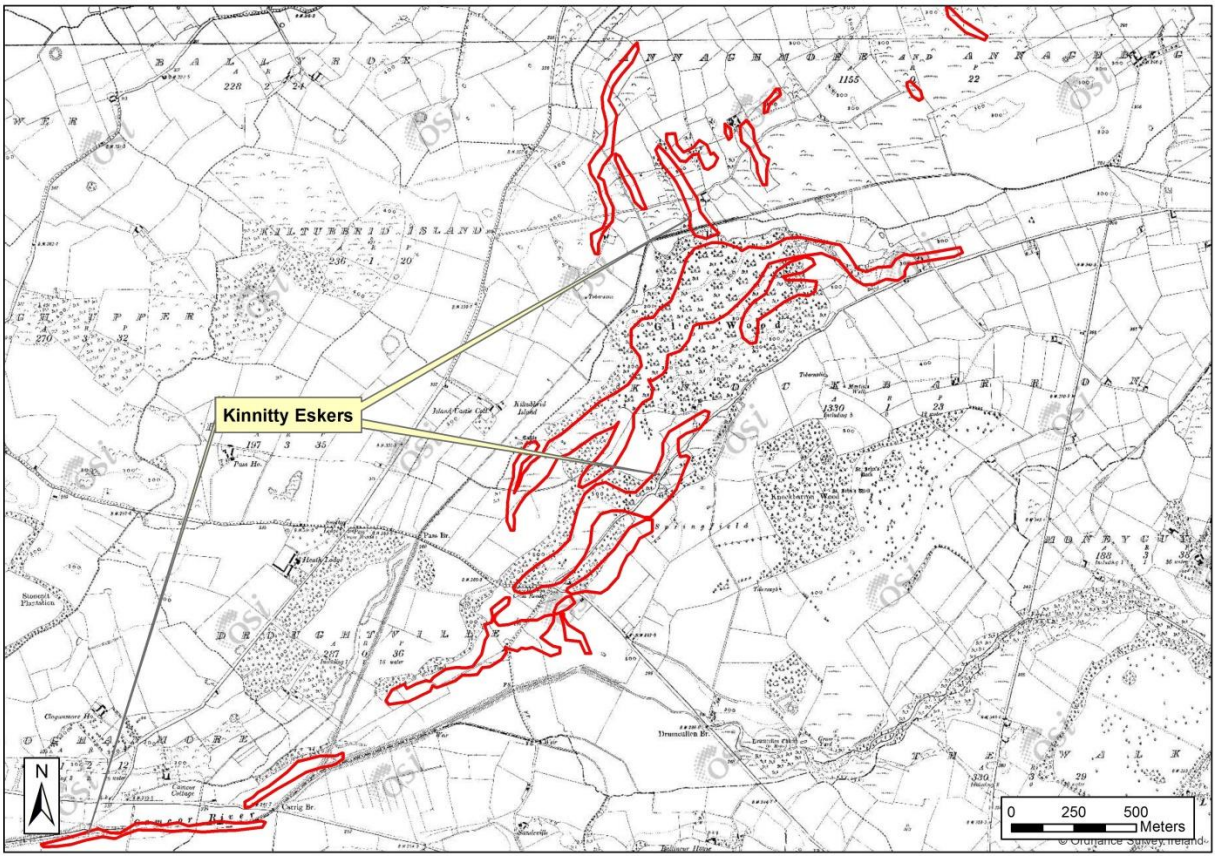
Kinnitty Eskers
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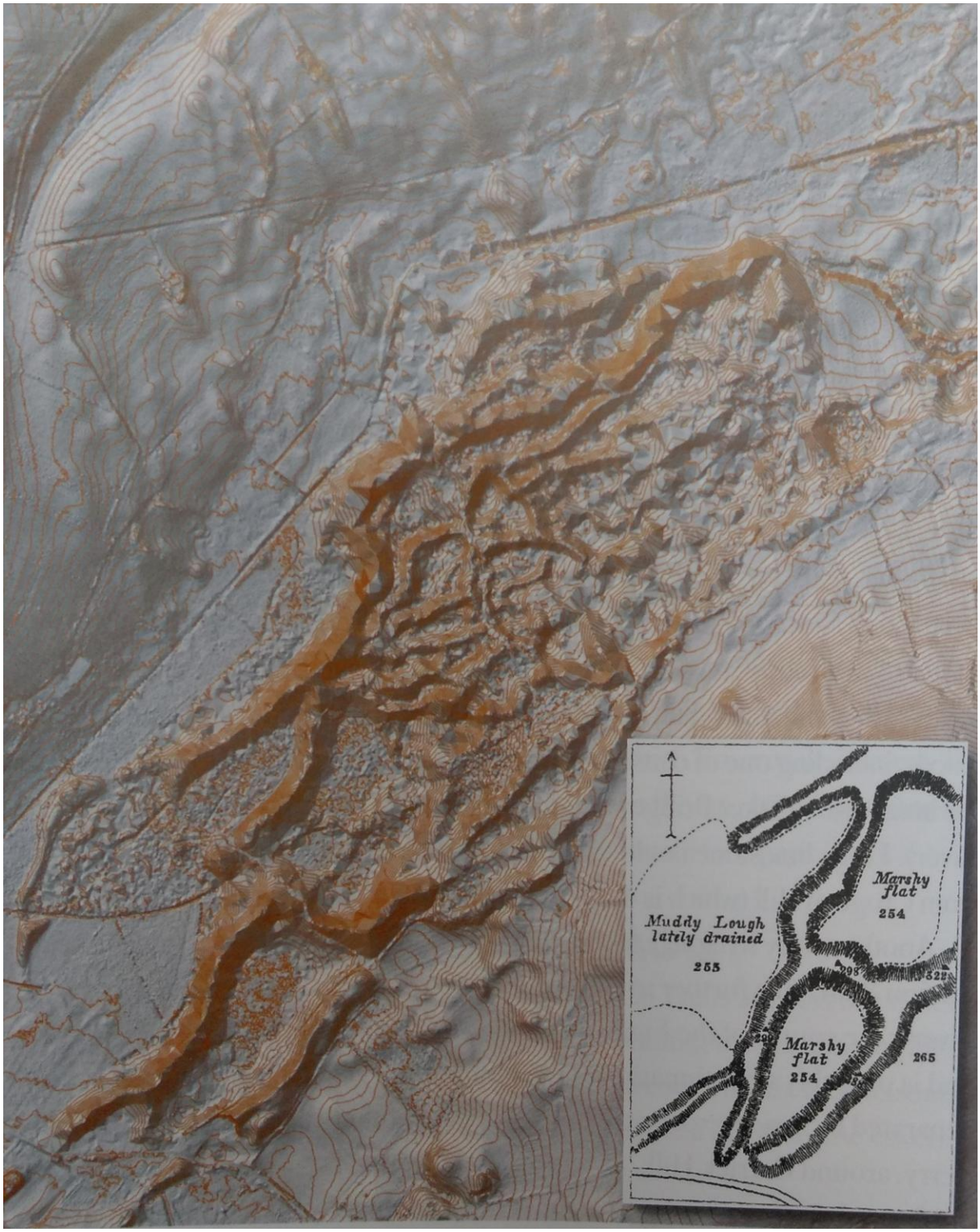


LIDAR image of the Kinnitty Eskers at Knockbarron (Feehan, 2013, image by Pat Healy).

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Little Brosna-Shannon Confluence**
Other names used for site	
IGH THEME	**IGH14 Fluvial and Lacustrine Geomorphology**
TOWNLAND(S)	**Cloonahenoge, Incherky, Lavagh, Gortachallow, Ballymacoolaghan**
NEAREST TOWN/VILLAGE	**Banagher**
SIX INCH MAP NUMBER	**29**
ITM CO-ORDINATES	**594750E 713000N (Little Brosna-Shannon confluence)**

1:50,000 O.S. SHEET NUMBER 53 GSI BEDROCK 1:100,000 SHEET NO. 15

Outline Site Description
A low-lying, callow grassland and bog landscape amid the floodplains where the Little Brosna River flows into the multi-branched River Shannon.

Geological System/Age and Primary Rock Type
The underlying bedrock is Carboniferous age limestone (Lucan Formation; Waulsortian). Subsoils along the Little Brosna comprise alluvium along the river course, bounded by either peat or marl sediments, of post-glacial Holocene age. Limestone tills originating during the Ice Age occur to a lesser extent near the site. The main river course is Holocene in age, having adopted its present course in the last 10,000 years.

Main Geological or Geomorphological Interest
The course of the Little Brosna River demarcates the Offaly-Tipperary county boundary. A tributary of the Shannon, the Little Brosna empties into the Shannon near Victoria Canal Lock (Shannon Navigation). This stretch of the Shannon to the west of Banagher is a good example of an *anastomosing* channel – a category of river that comprises multiple, interconnected, stable channels. The channels branch and flow around large and small islands, including Incherky, Inishee, Esker Island, Friar Island and Big Island.

The Little Brosna empties into the Shannon around 100m east of Victoria Lock, although the mouth of the river is not easily visible from the lock grounds. On its course from Birr, the Little Brosna cuts a sinuous channel across lowland for around 12km to the river mouth at the River Shannon. Along this course, the Little Brosna is confined by raised bogs with callows along its final 8km. The callows on the floodplains are subject to prolonged flooding, particularly in winter and early spring.

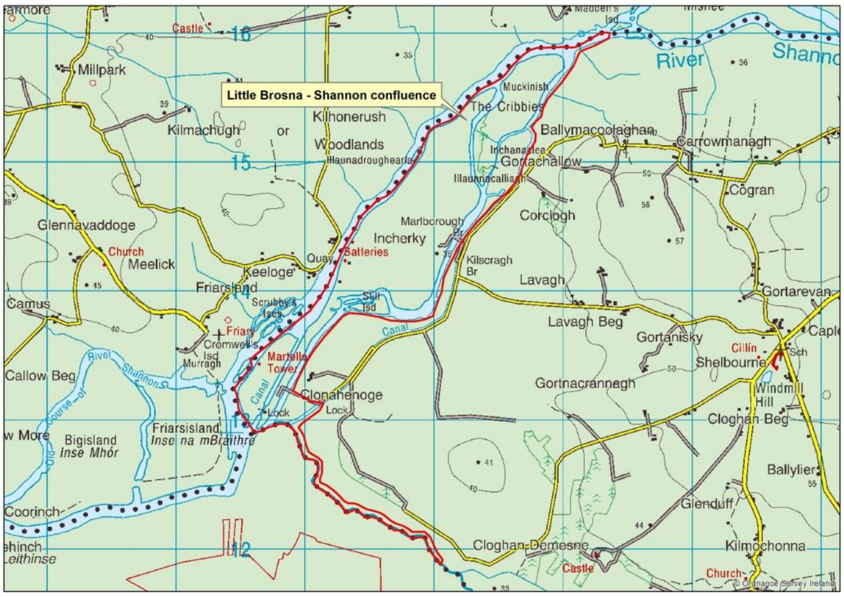
Site Importance – County Geological Site, recommended for Geological NHA
This important County Geological Site is recognised as an area of international significance for its waterfowl importance, and is already designated an SPA (River Little Brosna Callows 004086) and NHA (River Little Brosna Callows 000564). At 328km, the River Shannon is the longest river system in Britain and Ireland, with a catchment area greater than 16,000km^2.

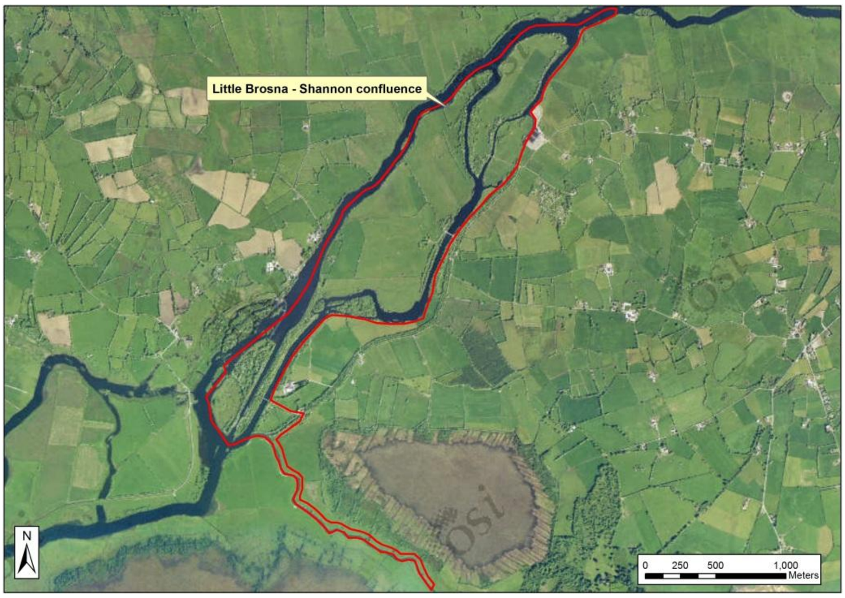
Management/promotion issues
The interconnected channels that make this site so interesting in terms of river morphology could be highlighted in literature pertaining to the area, particularly that which is aimed at river navigators. As a natural floodplain on the largest river in Ireland, the land in the vicinity is liable to flooding in the winter creating a habitat of international importance.

View looking east to mouth of Little Brosna River from Victoria Lock.

Looking south from lock grounds to confluence of natural course of Shannon (far right), the canal, and ‘New Cut’ (left). Little Brosna flows into Shannon at the south end of ‘New Cut’.

View south from Victoria Lock. Natural course of Shannon on right.


Little Brosna - Shannon confluence
River Shannon
Millpark
Kilmachugh
or
Kilhonerush
Woodlands
Muckinish
The Cribbies
Ballymacoolaghan
Carrowmanagh
Gortachallow
Cogran
Glennavaddoge
Church
Meelick
Keeloge
Quay
Batteries
Incherky
Marlborough Br
Corclogh
Kilscragh Br
Friarsland
Lavagh
Gortarevan
Camus
Friary
Canal
Lavagh Beg
Gortanisky
Cillín
Shelbourne
Callow Beg
Martello Tower
Clonahenoge
Gortnacrannagh
Windmill Hill
Lock
Cloghan Beg
Bigisland
Inse Mhór
Friarsisland
Inse na mBráithre
Ballylier
Coorinch
Glenduff
Cloghan Demesne
Kilmochonna
Castle
Church
© Ordnance Survey Ireland


Little Brosna - Shannon confluence
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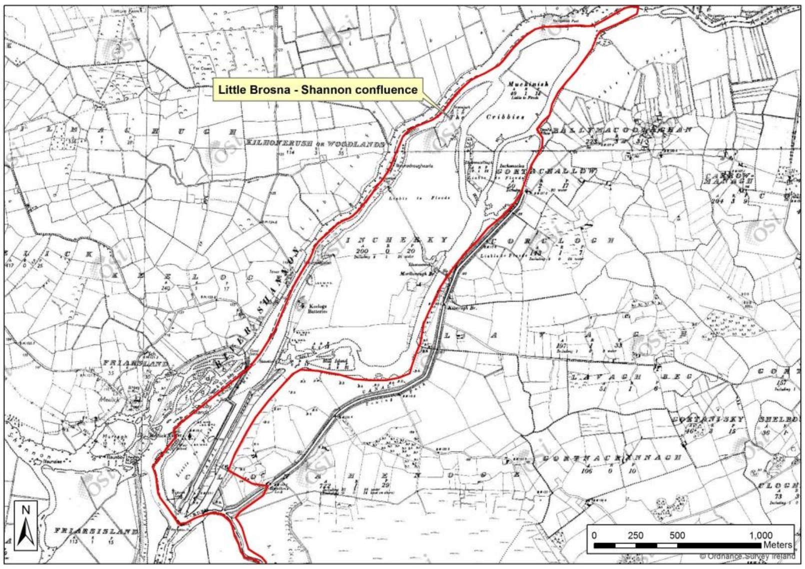
Little Brosna - Shannon confluence
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Meters
© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Lough Boora Parklands**
Other names used for site	Lough Boora Discovery Park, Boora Bog
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Lea Beg, Lea More, Broughal, Barnaboy, Kilnagall, Ballybracken Litte, Ballybracken, Bunakeeran, Oughter**
NEAREST TOWN/VILLAGE	**Cloghan, Kilcormac**
SIX INCH MAP NUMBER	**23**
ITM CO-ORDINATES	**618200E 719050N (at centre of feature)**
1:50,000 O.S. SHEET NUMBER	**48, 54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
The Lough Boora Parklands comprises a series of walks and visitor attractions, including an extensive sculpture park and angling lakes, set in and around an extensive area of cutover peat near Lough Boora.

Geological System/Age and Primary Rock Type
The Lough Boora Parklands are situated within an area dominated by bedrock of Lower Carboniferous limestone. The parklands themselves are set in cutover peat which is Quaternary in age, having formed as an extensive envelope of the landscape in the area since deglaciation, and mostly approximately 7,000-10,000 years ago.

Main Geological or Geomorphological Interest
The site has a visitor centre where visual records of peat harvesting are shown as photo montages on the cafe walls, and the relic of former equipment surround the centre. Many of these have been reworked into impressive sculptures. Other features of interest are included within the site boundary, such as intact and drained peat, industrially-cutover peat, peat cut by locals, wetlands, and recovering peat.

Site Importance – County Geological Site
As the various forms of peat are all accessible within a small locality, and as the parklands (and their visitor centre) exist due to the geological and hydrogeological processes of peat growth, the locality is recommended as a County Geological Site.

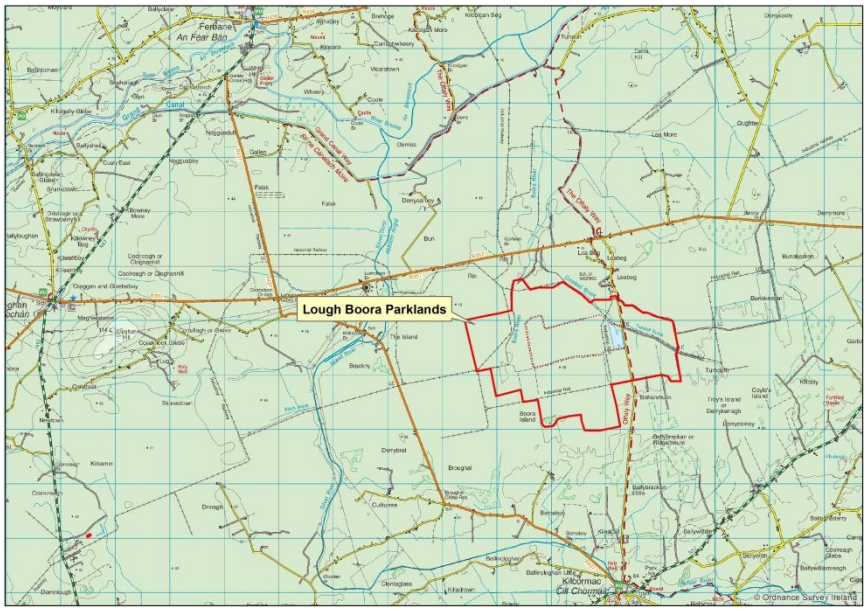
Management/promotion issues
The Lough Boora Parklands are run by Bord na Mona. The geological aspects of the bogs of the region could be highlighted more in some of the promotional material.

The entrance avenue to the Parklands, with the old railway preserved in the hardstand.

The visitor centre and adjacent lake.

Some of the marshy vegetation in regenerating bog along one of the trails.

'Skytrain' before it became vegetated over (December 2001).


Lough Boora Parklands
Ferbane
An Fear Bán
Kilcormac
Cill Chuirmaic
© Ordnance Survey Ireland


Lough Boora Parklands
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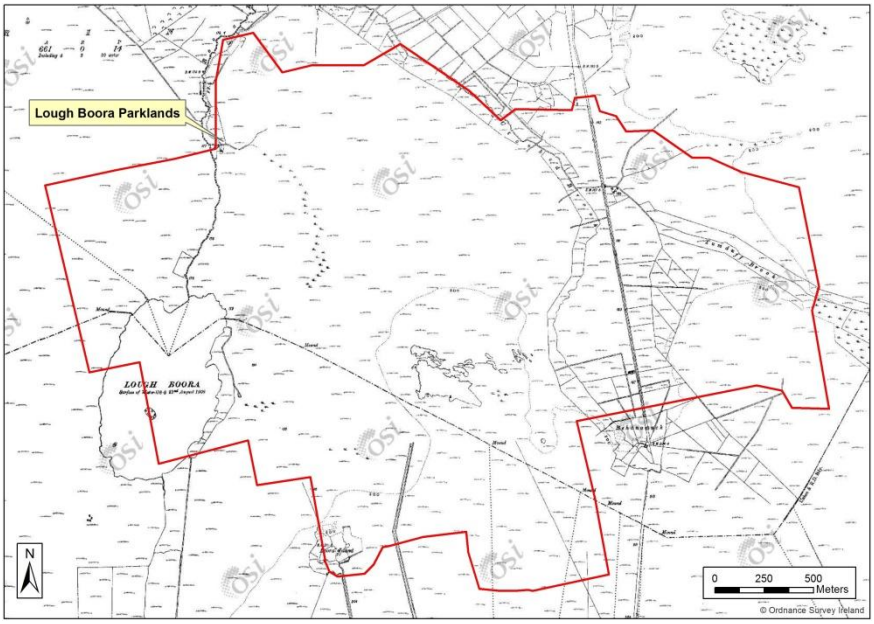
Lough Boora Parklands
LOUGH BOORA
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© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Marlow's Hole**
Other names used for site	
IGH THEME	**IGH1 Karst, IGH16 Hydrogeology**
TOWNLAND(S)	**Pallaspark**
NEAREST TOWN/VILLAGE	**Tullamore**
SIX INCH MAP NUMBER	**24**
ITM CO-ORDINATES	**626340E 719725N**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
This site is a complex active sinkhole in karstic limestone, southeast of Tullamore and at the northern edge of Pallas Lough.

Geological System/Age and Primary Rock Type
The sinkhole, drainage and cavity development are probably all post-glacial in age, formed over the last 11,000 years.

The karstified limestone itself is pure bedded, undifferentiated Visean limestone, and is of Lower Carboniferous age.

Main Geological or Geomorphological Interest
The site includes three individual stream sinks and the large enclosed depression containing them. One small stream flowing northwestwards out of Pallas Lough sinks into the southernmost sink and (during higher stream flow or flood conditions only) into the northernmost two. All sinks are on the northern side of the enclosed depression. There is probably a significant cavity beneath the site, though no entrance has currently been found.

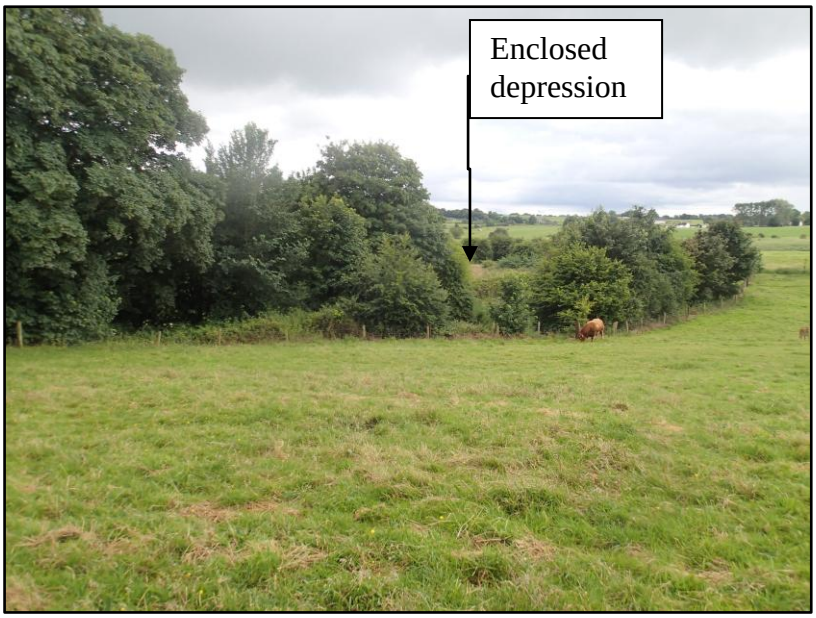
The site may be linked to Agall Springs, an important public water supply several kilometres to the north of Pallas Lough, although dye tracing would be required to confirm this.

The entire sinkhole fills with water in times of heavy or prolonged rain and wells up within the base of the enclosed depression to become part of the lake. Owing to this, for much of the year, 'Marlow's Hole' itself is actually invisible.

Site Importance – County Geological Site, may be recommended for Geological NHA
This is one of a small number of active karst sites in the limestone district around Tullamore and is recommended as a County Geological Site.

Management/promotion issues
The input of high volumes of water into active conduits in karstified limestone is recognised as a high-risk issue for groundwater supplies and the site should be protected from pollution from agricultural or road spills, or runoff.

The sinkhole has been designated as part of the Pallas Lough pNHA (sitecode 000916), and is already protected as a National Monument for the adjacent castle site (RMP No. OF024-015001, see www.archaeology.ie). The site is on private land and is not suitable for general promotion.

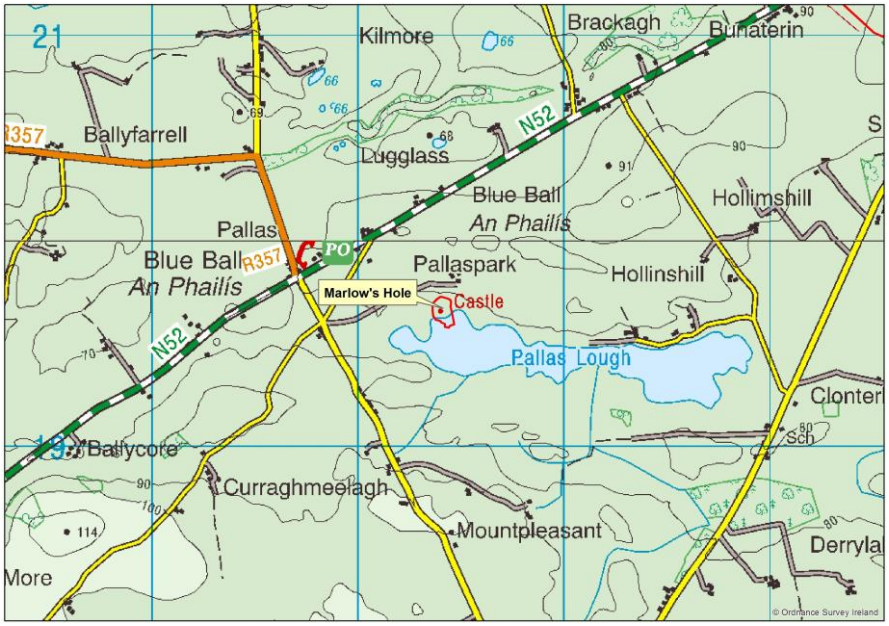


The view from the entrance laneway to Pallas House across the enclosed depression hosting the swallow holes.

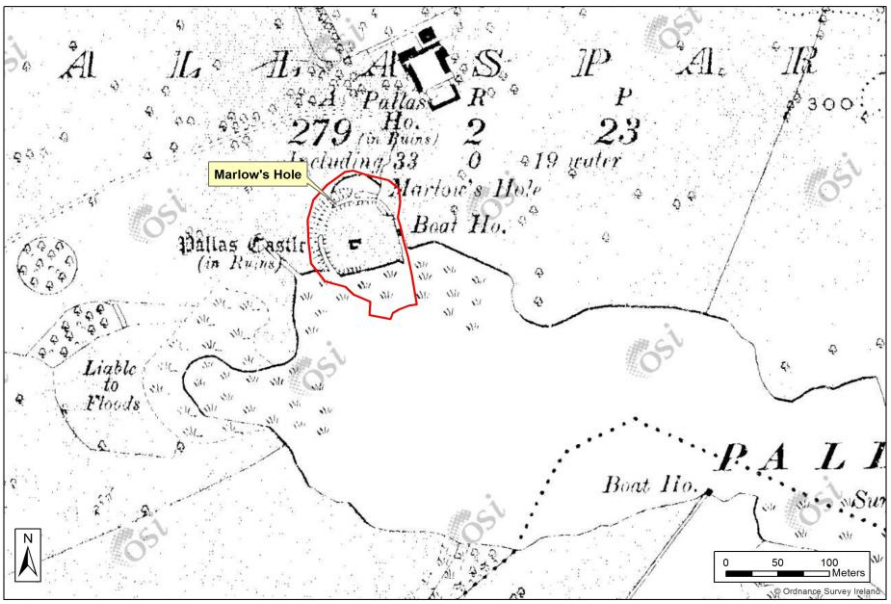
Looking northwards across the enclosed depression; see the stream entering at the base.

The stream as it flows from Pallas Lough into the enclosed depression

The stream heading towards the swallow holes and bedrock outcrop.


Kilmore
Brackagh
Bunaterin
Ballyfarrell
Lugglass
Blue Ball
An Phailís
Hollimshill
Pallas
Blue Ball
An Phailís
Palaspark
Hollinshill
Marlow's Hole
Castle
Pallas Lough
Ballycore
Curraghmeelagh
Mountpleasant
More
N52
R357
PO
© Ordnance Survey Ireland


Marlow's Hole
N
0 50 100 Meters


Marlow's Hole
Pallas Castle
(in Ruins)
Boat Ho.
Liable to Floods
N
0 50 100 Meters
© Ordnance Survey Ireland

A photograph of Marlow's Hole from 1974, showing the lake level much higher than it is now. Note the absence of vegetation around the swallow hole locality.
Photograph courtesy of Offaly Historical and Archaeological Society.

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Mongan Bog**
Other names used for site	
IGH THEME	**IGH7 Quaternary, IGH16 Hydrogeology**
TOWNLAND(S)	**Clonmacnoise, Tullaghbeg, Clonascra, Clonfinlough**
NEAREST TOWN/VILLAGE	**Ballycumber**
SIX INCH MAP NUMBER	**5**
ITM CO-ORDINATES	**603300E 730850N (centre of bog)**
1:50,000 O.S. SHEET NUMBER	**47 GSI BEDROCK 1:100,000 SHEET NO. 12**

Outline Site Description
Mongan Bog comprises an extensive area of peatland extending in a lowlying hollow for approximately 2 kilometres, north to south, just east of Clonmacnoise.

Geological System/Age and Primary Rock Type
Mongan Bog is situated within an area dominated by bedrock of Lower Carboniferous limestone. The bog peat is Quaternary in age, having formed in marshy conditions as an extensive envelope of the landscape in the area since deglaciation, and mostly approximately 7,000-10,000 years ago.

Main Geological or Geomorphological Interest
Mongan Bog is unusual in that it is relatively restricted in extent, surrounded almost entirely by the much higher ground of the Clonmacnoise Esker and associated sands and gravels. While today a generally flat and open landscape, the locality of Mongan Bog was covered by bog, marsh, quicksand, and ponds thousands of years ago as the bog formed. At that time the marshy ground would have been surrounded by dense woodlands of birch, willow, hazel and alder. Today, though drained, the bog is relatively intact and only suffers from extensive peat harvesting at its eastern end.

The bog itself comprises partially decomposed vegetation, which gradually sank into marshland within the wide, wet basin. This material accumulated layer upon layer for thousands of years, as the fibrous peat formed and eventually decayed into amorphous organic material over time.

The locality was therefore gradually covered by the rising bogland, which formed a dome-shaped, ‘raised’ bog. The high bog has a very well-developed micro-topography of hummocks, pools and lawns, with the active core area being particularly wet.

Site Importance – County Geological Site
As various forms of peat, including intact and drained peat, small pockets of industrially-cutover peat, peat cut by locals, wetlands, and recovering peat are all accessible within a small locality, and as the bog and its amenity value exist due to the geological and hydrogeological processes of peat growth, the locality is recommended as a County Geological Site.

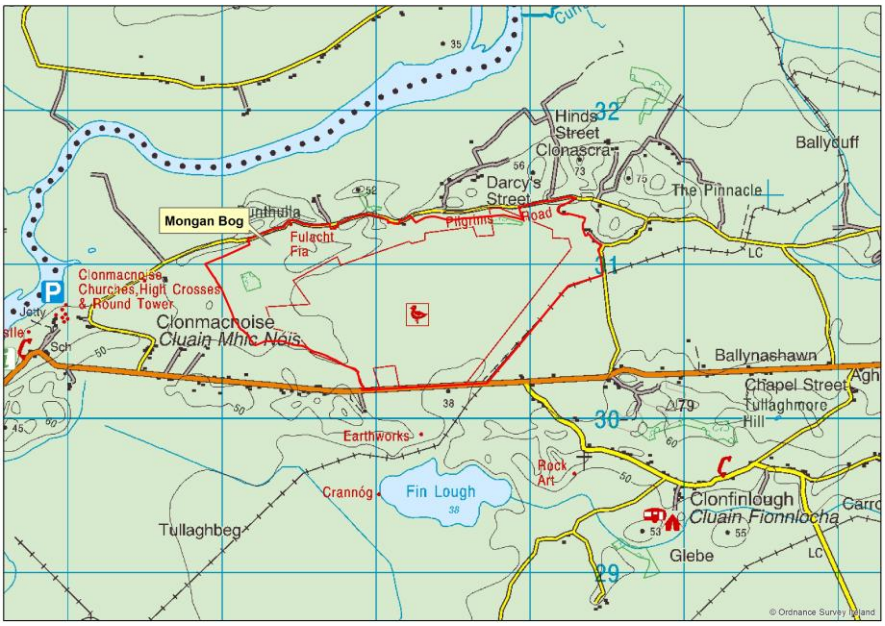
Management/promotion issues
Mongan Bog has been designated an SAC, pNHA and SPA (sitecodes 000580 and 004017), and is part owned by *An Taisce*. The geological aspects of the feature could be highlighted more in some of the promotional material on both the bog itself and nearby Clonmacnoise, as the esker and bog complement each other both in terms of genetic processes and geological history, as well as land use and aesthetic value today. Mongan Bog is one of six bogs in Offaly to benefit from being part of the National Parks and Wildlife Service LIFE Active Raised Bog Restoration Project.

The main dome of Mongan Bog, with the green fields of the Clonmacnoise Esker in the distance.

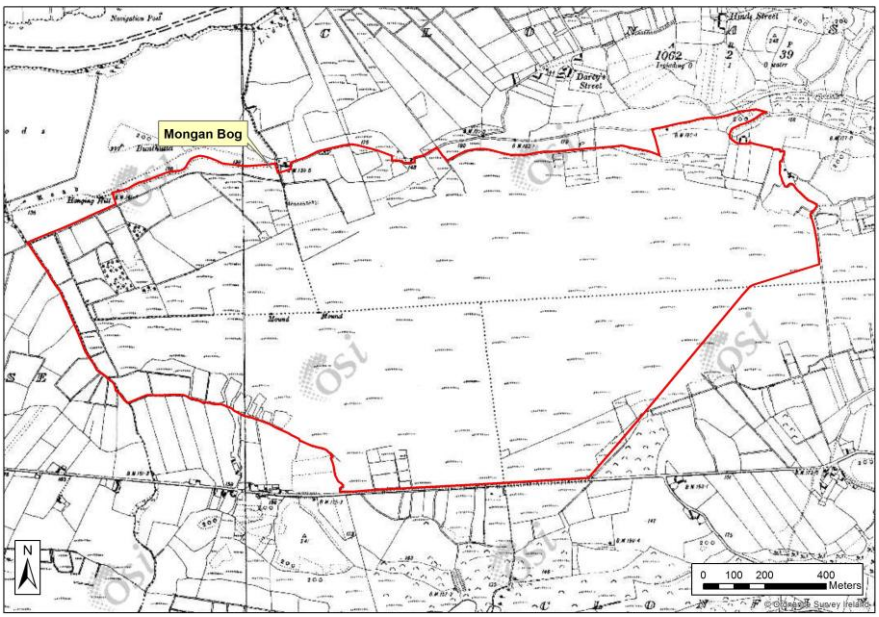
The Bord na Móna railway cutting through the heather-covered bog.

Pools on top of the wet, intact bog dome.

Sphagnum mosses, carnation sedges and heather on the bog dome.


Mongan Bog
Fulacht Fia
Pilgrims Road
Hinds Street
Clonascra
Darcy's Street
Ballyduff
The Pinnacle
Clonmacnoise Churches, High Crosses & Round Tower
Clonmacnoise
Cluain Mhic Nóis
Ballynashawn
Chapel Street
Tullaghmore Hill
Earthworks
Rock Art
Crannóg
Fin Lough
Clonfinlough
Cluain Fionnlocha
Tullaghbeg
Glebe
© Ordnance Survey Ireland


Mongan Bog
N
0 100 200 400
Meters


Mongan Bog
N
0 100 200 400
Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Mount Briscoe Cave**
Other names used for site	Cavemount
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Mullalough or Cavemount**
NEAREST TOWN/VILLAGE	**Daingean**
SIX INCH MAP NUMBER	**10**
ITM CO-ORDINATES	**649740E 729200N**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 Sheet No. 15, 16**

Outline Site Description
A small, inactive cave.

Geological System/Age and Primary Rock Type
The cave is in Carboniferous limestone, in thick bedded strata of the Allenwood Formation. The age of the cave is unknown, but presumed to be older than Holocene (i.e. more than 10,000 years old).

Main Geological or Geomorphological Interest
The Mount Briscoe Cave is found in an elevated ridge of limestone rock and although not a long cave, the width and height of chambers within the cave would suggest that it was formed at a time when the water table was much higher. The present hill does not have enough catchment to have created this cave and so it may have originated from an inter-glacial period or even pre-glacial. However, no dating techniques have been applied and the prospects of doing so are poor.

The cave is 'T' shaped and descends so that there is 27m or more of depth to the cave. One aven (a void in the roof of the cave) near the end has connected to the surface, and other small voids nearby suggest there may be other caves within the ridge, but only the one cave is actually known and mapped.

Site Importance – County Geological Site
There is little elevation in the limestone bedrock across Offaly to allow caves to form in the post-glacial period, and so the rarity of this possibly quite old cave warrants its inclusion as being recommended a County Geological Site.

Management/promotion issues
The cave is not accessible as it is on private land, and it is not suitable for visiting or promotion. A celebrated, but very difficult rescue took place in 1977, when the landowner saved the life of a person who had entered the cave and became stuck in a narrow section. It is not an event that needs repeating.

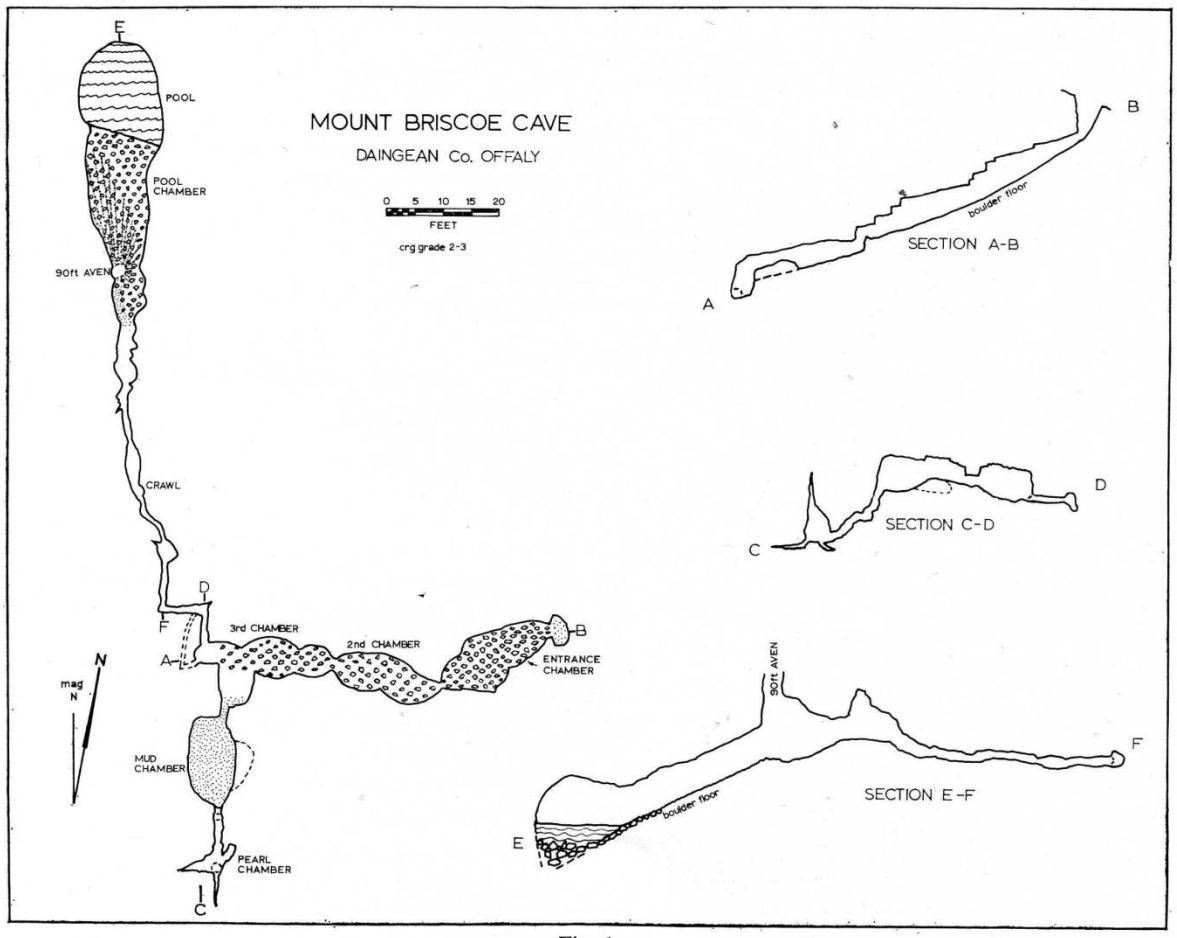
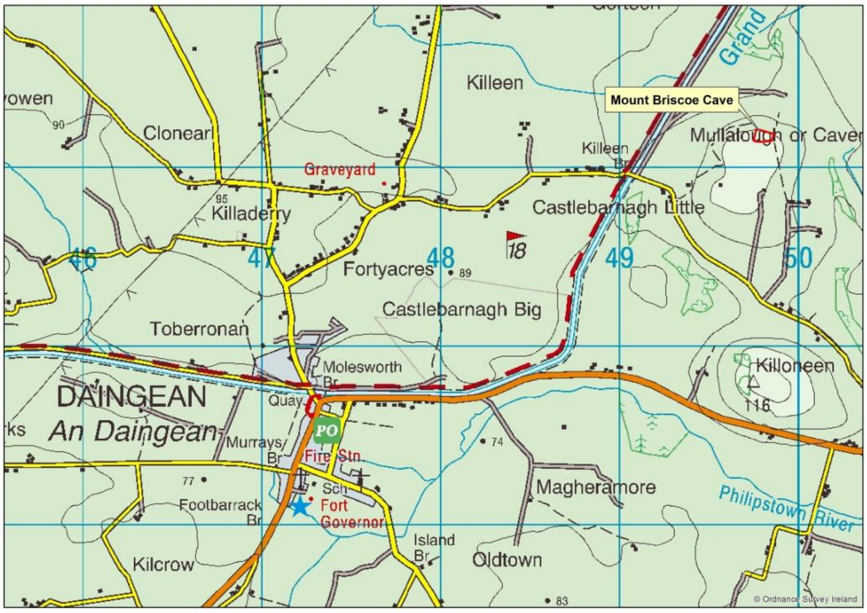


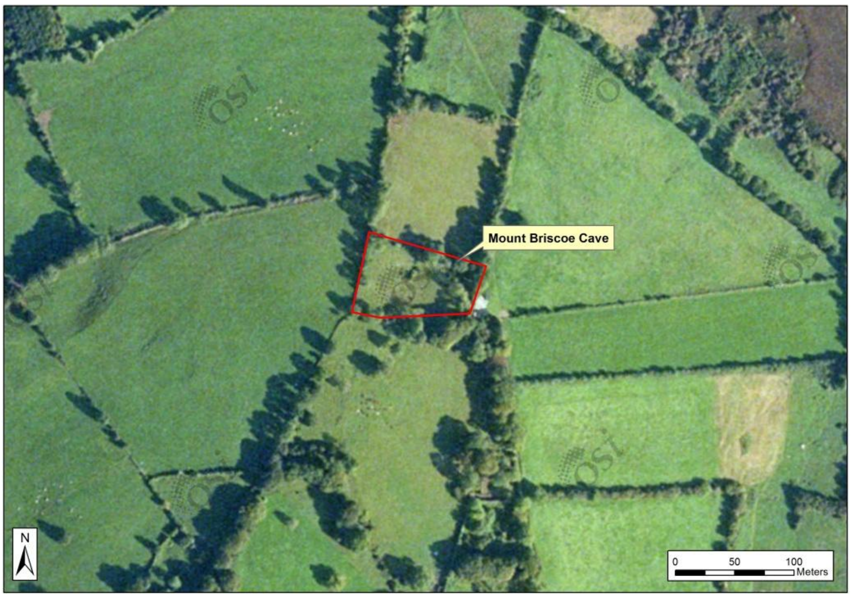
Fig. 1.

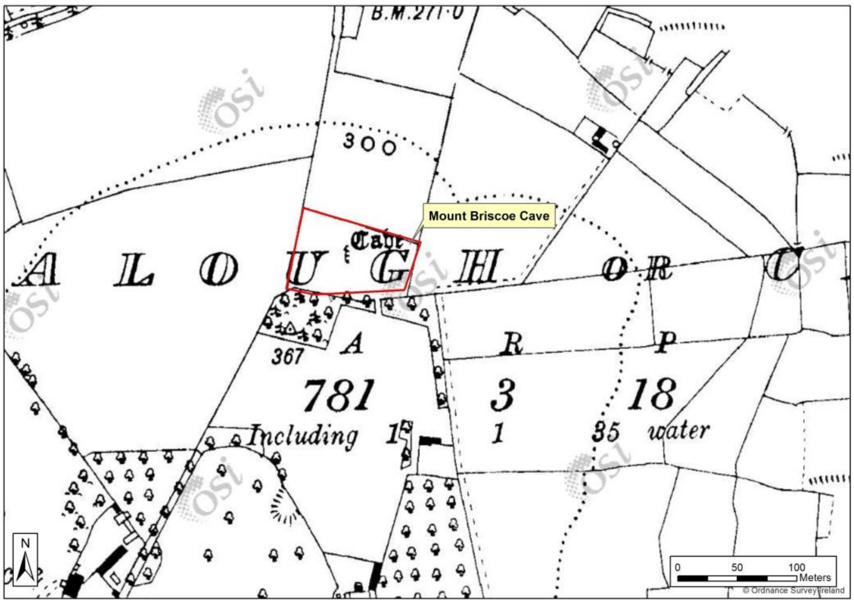
The cave survey does not convey the extremely tight nature of the entrance and of several connections between chambers.

Mount Briscoe Cave survey reproduced from Pelling, M.J. 1966. Mount Briscoe Cave, Co. Offaly. *Irish Speleology*, Volume 1, No. 2, 36-37.

The cave entrance is an extremely narrow slot in the ground surface.


Mount Briscoe Cave
Killeen
Clonearl
Graveyard
Killaderry
Castlebarnagh Little
Fortyacres
Castlebarnagh Big
Toberronan
Molesworth Br
DAINGEAN
An Daingean
Quay
PO
Murrays Br
Fire Stn
Sch
Fort Governor
Footbarrack Br
Kilcrow
Island Br
Oldtown
Magheramore
Philipstown River
Killoneen
Grand
© Ordnance Survey Ireland


Mount Briscoe Cave
N
0 50 100 Meters


B.M.271·0
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Mount Briscoe Cave
Cave
A L O U G H O R C
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Including 1 1 35 water
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0 50 100 Meters
© Ordnance Survey Ireland

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Screggan Fan**
Other names used for site	Tullamore
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Screggan, Claragh, Mucklagh, Cloghanbane, Heath, Bunaterin**
NEAREST TOWN/VILLAGE	**Mucklagh**
SIX INCH MAP NUMBER	**16, 17**
ITM CO-ORDINATES	**629170E 722250N**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A hummocky landform covered by well-drained tillage, grazed land and gravel pits, to the southwest of Tullamore.

Geological System/Age and Primary Rock Type
The site comprises glaciofluvial fan sands and gravels that were deposited during the final deglaciation stage of the last Ice Age. Bedrock underlying the sand and gravel cover is Carboniferous-age muddy limestone.

Main Geological or Geomorphological Interest
This site is representative of extensive areas in this part of County Offaly which comprise sands and gravels (mainly derived from limestones) deposited as subaqueous fans in meltwaters that issued from the nearby melting ice sheet into a glacial lake. The fans were most likely associated with the Kilcormac Esker. The depositional environment may have evolved into a glacio-delta system when the build-up of sediment reached the water level of the ancient lake. The thickness of the deposits is evident from the depth of the local quarries and the N52 Tullamore By-pass road excavations at Screggan.

Well-sorted glacio-deltaic sediments exposed in a quarry face at Agall vary from bottom-most muddy sands (which have ‘dropstones’, or stones dropped into them), overlain by silt and sand beds that dip NNE at 20°-30°, and succeeded by horizontal and cross-bedded gravels. The sediments are taken to reflect the presence of a large glacial lake, with water levels of around 75mOD when the sediments were deposited.

Site Importance – County Geological Site
This is an important recommendation as a County Geological Site in terms of understanding the final, deglaciation stages of the last Ice Age. (Screggan Bog NHA 000921 is located 2km south of Mucklagh, in the townlands of Ross and Killurin and is not within this site.)

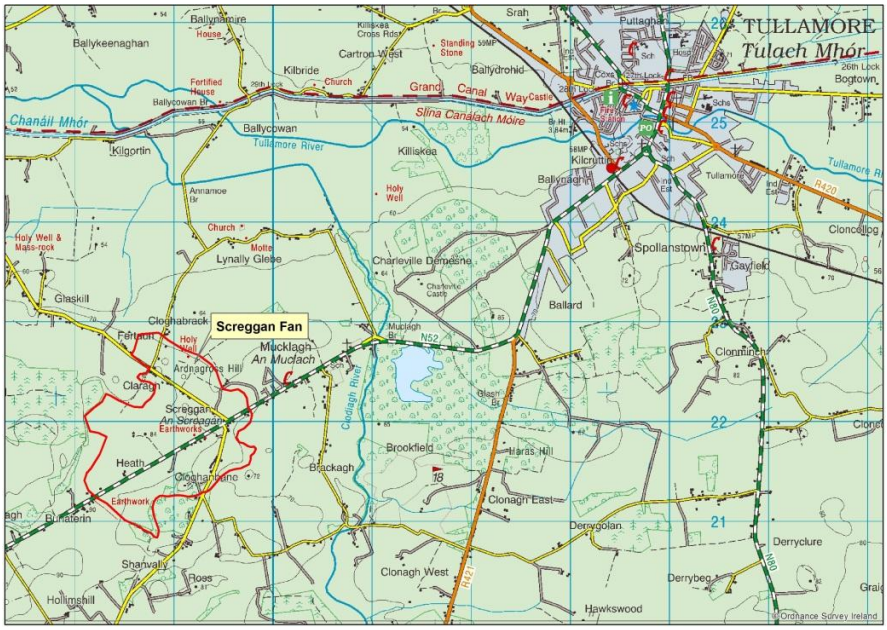
Management/promotion issues
Quarrying of sand and gravel occurs in the locality, and a disused (2016) pit at Screggan provides good exposures of cross-bedding in the quarry faces. Kilsaran Concrete Ltd. operates an active sand and gravel pit nearby, at Bunaterin. The lowland topography of the county is largely dominated by glaciofluvial landforms (of which eskers are the most well-known) and bog-land. The well-drained glaciofluvial sediments are suitable for both tillage and grazing. The site was the location for the 2016 Irish National Ploughing Championships.

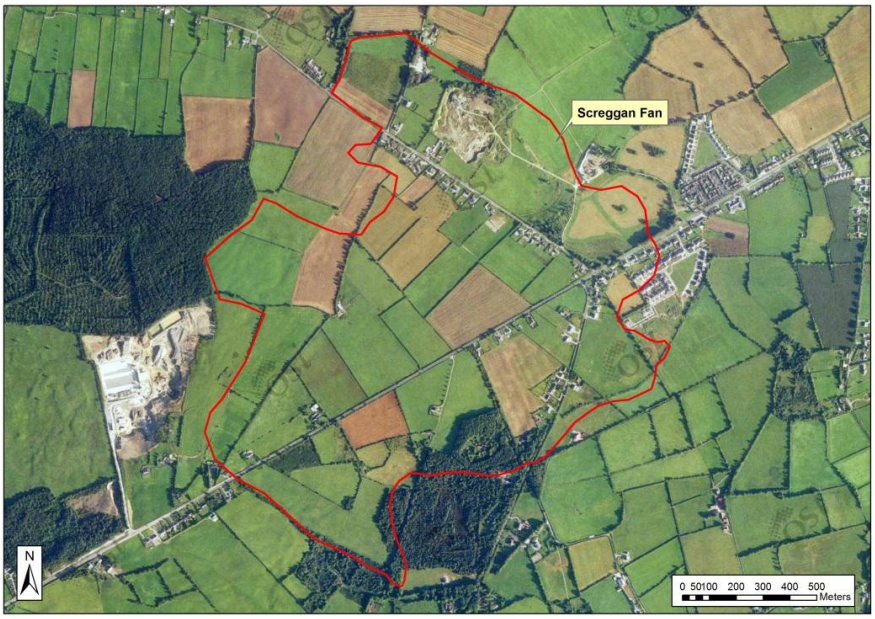
The hummocky topography of the Screggan Fan.

View SW from L2011 road bridge over N52 road (Mucklagh Bypass). Road excavations into Screggan Fan visible.

Screggan: site of National Ploughing Championships 2016.

Sand and gravel quarry at Bunaterin


Scregggan Fan
TULLAMORE
Tulach Mhór
Ordnance Survey Ireland


Scregggan Fan
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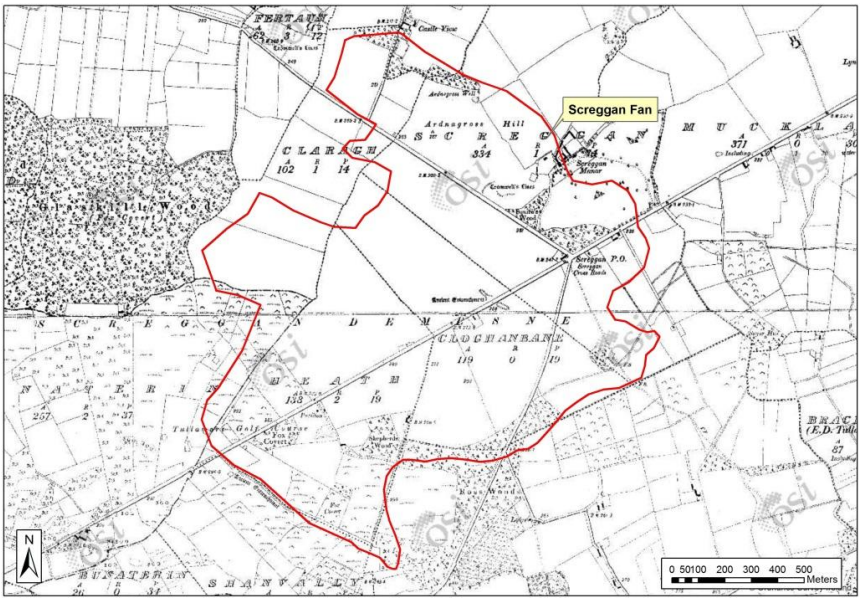
Meters


Scregggan Fan
N
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Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Sillogue Spring**
Other names used for site	Sillogue Well
IGH THEME	**IGH16 Hydrogeology**
TOWNLAND(S)	**Coniker**
NEAREST TOWN/VILLAGE	**Tullamore**
SIX INCH MAP NUMBER	**8**
ITM CO-ORDINATES	**631360E 730290N**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A natural freshwater spring and a local public water supply system source.

Geological System/Age and Primary Rock Type
The spring emerges from Dinantian pure bedded limestones of Lower Carboniferous (Mississippian) age.

Main Geological or Geomorphological Interest
Located in Durrow Abbey Woods, roughly halfway between Tullamore and Clara, Sillogue Spring is a high yielding spring. The waters issue from a regionally important karstified limestone aquifer, overlain by a locally important gravel aquifer.

At an elevation of 60mOD, the spring has an average abstraction rate of up to 3,500m^3 to 3,900m^3 per day (770,000 to 858,000 gallons per day). The water is categorised as 'excessively hard', falling within a range of 303-477 milligrams per litre $CaCO_3$.

Site Importance – County Geological Site
This is an important site in terms of hydrogeology, and as a source for the local drinking water supply. The spring and its compound are recommended as County Geological Site.

Management/promotion issues
The site is located in Durrow Abbey Woods. A Coillte owned woodland, the woods are promoted by Coillte as a recreational site with looped trails, and are accessible on a 3.2 kilometre long, circular walk. (Note that there is no information at the site about the walk, and only locals know the walk is looped). Sillogue Spring and the associated works are fenced off. The site does not present any significantly interesting aspects for recreational walkers passing by to see. Erection of an information plaque on the locked, gated entrance would serve to communicate information about the spring, the hydrogeology and how this site serves as a public water supply.

Sillogue Well pump house – northwest side.

The gated entrance to Sillogue Well.

Sillogue Well pump house – southwest side.

Entrance (west) to Durrow Woods, and to Sillogue Well - viewed from roadside.


Sillogue Spring
Tara
Keeloge
Durrow Abbey
Motte
Durrow Church & High Cross
Balleek Beg
Balleek
Barrow
Ballycallaghan
Derrygolan
Conik
Aghancarnan
Loughaun
Durrow Cross Rds
Ballynamona
Derrygolan Br
Lug
Mound
Tihilly Church & High Cross
Acantha
Kildangan
Cartron East
Gormagh
Ballynasrah or Tinnycross
Culleen
Gormagh Br
Coleraine
Rosnagowloge or Tirinchinan
Moleen
Ballyduff Br
Ballycosney
Castle
Mullaghato
Ballykilmurry
Muiniagh
Ardan
Derrynagall or Ballydaly
Castle
Corndarragh
Ballyduff
N52
N80
R443
Burial Ground
Ballydrohid Br
Srah
Killiskea Cross Rds
Puttaghan
TULLAMORE
Tulach Mhór
Standing Stone
Cartron West
Digby Br
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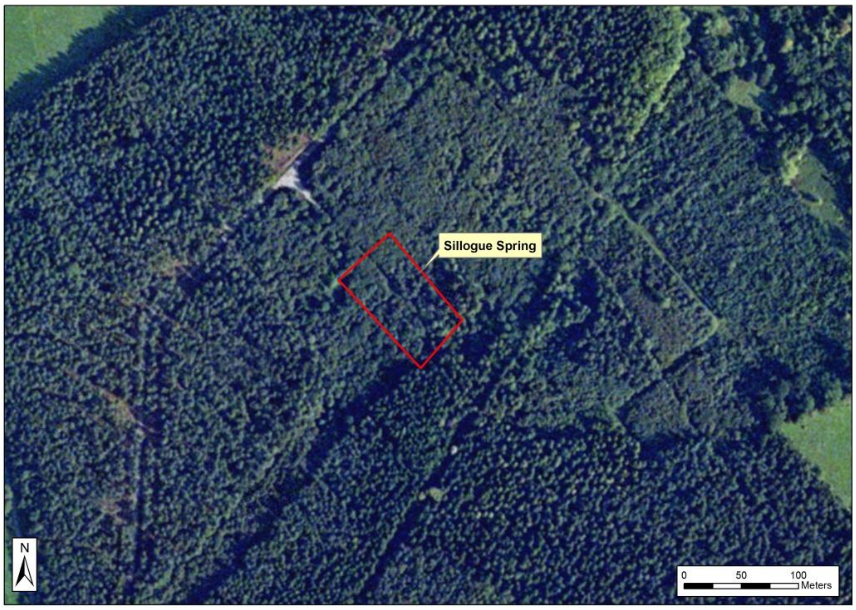
Sillogue Spring
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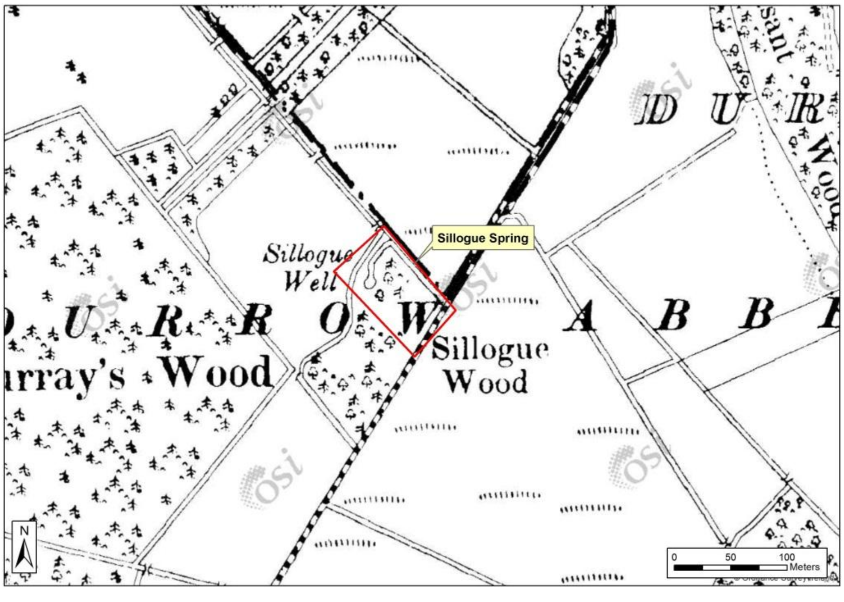
Meters


Sillogue Spring
Sillogue Well
D U R R O W
A B B
rray's Wood
Sillogue Wood
D U R
N
0
50
100
Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Silver River**
Other names used for site	*Abhainn Airgid*
IGH THEME	**IGH10** Devonian, IGH14 Fluvial and Lacustrine Geomorphology
TOWNLAND(S)	**Cadamstown, Deerpark, Magherabane, Coolgreen, Glenletter**
NEAREST TOWN/VILLAGE	**Cadamstown**
SIX INCH MAP NUMBER	**32, 37**
ITM CO-ORDINATES	**622700E 708515N (Cadamstown Bridge)**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A steep-sided river channel, gorge and waterfall at the northwest foot of the Slieve Bloom Mountains.

Geological System/Age and Primary Rock Type
Upper Devonian age Cadamstown Formation mudstones, siltstones, sandstones, conglomerates (Old Red Sandstone), and Silurian shale. Post-glacial (Holocene) tufa deposits. The Silver River gorge is post-glacial in age.

Main Geological or Geomorphological Interest
The Silver River flows north from the Slieve Blooms, through Cadamstown, and north/northwest towards Ballyboy. The sandstones and conglomerates exposed along the Silver River comprise sands and gravels deposited in the channel of an ancient Devonian river. Muds and silts deposited on the ancient river's floodplain are also seen in the mudstones and siltstones of the Cadamstown Formation. Collectively, these are referred to as fluviatile sediments. Some 600m upstream from Cadamstown, the lowest Old Red Sandstone beds are exposed in a 10m cliff. Further upstream, the contact (unconformity) between Devonian and Silurian rocks can be seen in the river bed. The older Silurian beds are noticeably inclined (due to folding), whereas the Devonian sandstone and conglomerate beds are near-horizontal. This site is the type section of the Cadamstown Formation, where an almost continuous section can be followed downstream from the unconformity, as far as the Carboniferous Lower Limestone Shales (~1km along the river north of Cadamstown).

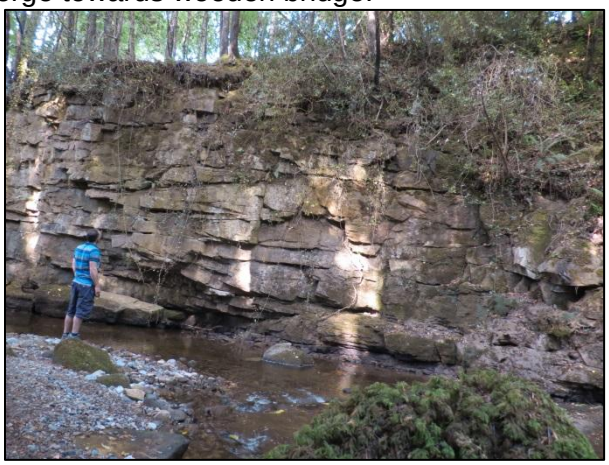
Tufa springs can be seen on the west bank of the river at the unconformity location, where calcium-carbonate has been deposited from emerging groundwater springs. The Silver River gorge is post-glacial in age. It formed during deglaciation of the Slieve Blooms, when meltwaters flowing from the mountains eroded and exploited weak fractures in the bedrock, enlarging channels and deepening the gorge. To the west of Cadamstown, the channels of an ancient stream (a phenomenon known as stream capture and diversion) delineate the townland boundary of Drummin (also Kilmacuddy and Castlefield).

Site Importance – County Geological Site
This is an important recommendation as a County Geological Site in terms of understanding the past environments during Devonian times. The Old Red Sandstone succession in the Slieve Blooms comprises a single formation - the Cadamstown Formation. The Silver River is the type section of this formation.

Management/promotion issues
The Silver River Nature Trail (National Loop Trail) and EcoWalk is a well-maintained and sign-posted trail that follows the river south of Cadamstown. The illustrated panels explaining the geological history of the locality and river are of great value and are exemplary to the promotion of geological heritage along trails and at public recreation sites.

View looking upstream from gorge towards wooden bridge.

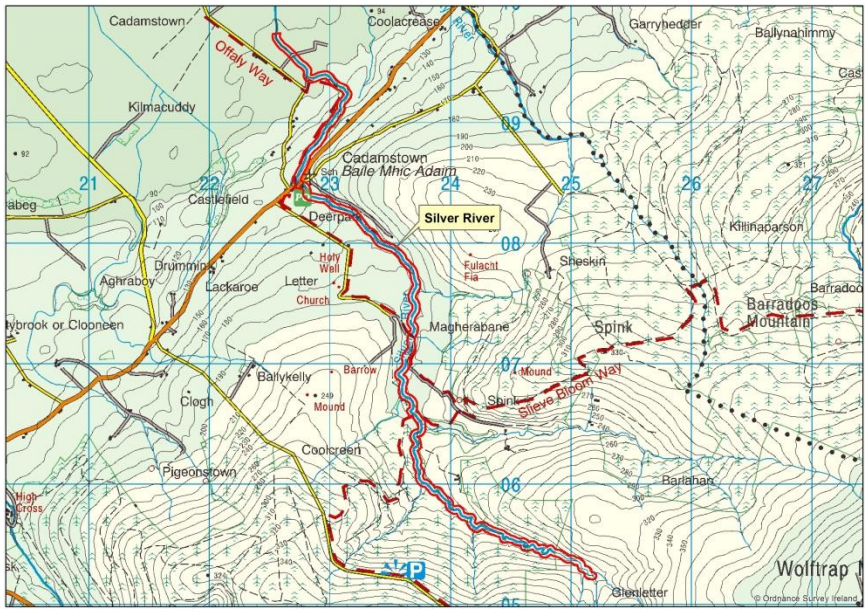
Tufa springs on west bank, near unconformity.



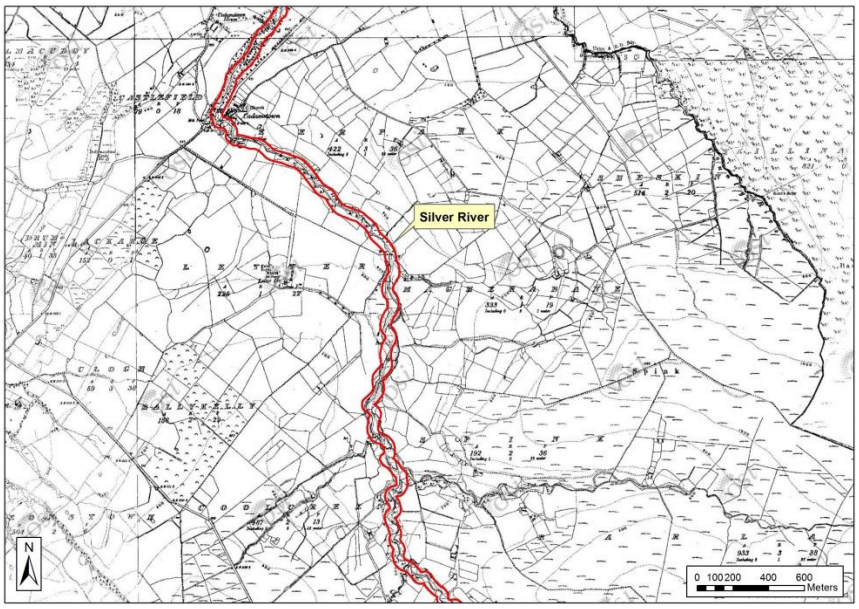
Old Red Sandstone exposed in cliff, north of Cadamstown.

'Wildlife and Geology' information panel along trail.

Silurian strata on west bank of river bed, dipping south.


Cadamstown
Coolacrease
Garryhedder
Ballynahimmy
Kilmacuddy
Offaly Way
Cadamstown
Baile Mhic Adaim
Castlefield
Deerpark
Silver River
Killinaparson
Holy Well
Fulacht Fia
Sheskin
Aghraboy
Drumming
Lackaroe
Letter
Church
Barraduoos Mountain
Magherabane
Spink
Ballykelly
Barrow
Mound
Slieve Bloom Way
Clogh
Coolcreen
Pigeonstown
Barlahan
High Cross
Glenletter
Wolftrap
© Ordnance Survey Ireland


Silver River
N
0 250 500 1,000
Meters


Silver River
N
0 100 200 400 600
Meters

OFFALY - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Toberdaly**
Other names used for site	Rhode RWWS A Toberdaly, *Tobar Dálaigh*
IGH THEME	**IGH16 Hydrogeology**
TOWNLAND(S)	**Toberdaly**
NEAREST TOWN/VILLAGE	**Rhode**
SIX INCH MAP NUMBER	**11**
ITM CO-ORDINATES	**651670E 731710N**
1:50,000 O.S. SHEET NUMBER	**48 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A natural freshwater spring that supplies the Rhode rural water supply scheme.

Geological System/Age and Primary Rock Type
The spring emerges from Dinantian Upper Impure Limestones of Carboniferous age (Missippippian).

Main Geological or Geomorphological Interest
Toberdaly is located southwest of Rhode, at a T-junction 1km northwest of the Toberdaly bridge over the Grand Canal. At an elevation of 79m OD, the spring has an average abstraction rate of up to 2,500m^3 (550,000 gallons per day).

There are three springs at the site: Pool Well, Heavey's Well and Mount Well. Pool Well is currently the only well in operation. The three wells were springs which were deepened in order to increase the natural yield. Pool Well is covered by a corrugated steel shed. Mount Well and Heavey's well are covered by concrete.

The water is categorised as 'hard' (average 332 mg/l $CaCO_3$), falling within a range of 210-592 milligrams per litre $CaCO_3$.

At the surface, the spring is situated at a contact between impure limestones and pure bedded limestones, around 300m south of a fault. Toberdaly spring is classed as a tepid spring with water temperature values of 12.65°C (recorded in 1983).

Site Importance – County Geological Site
This is an important site in terms of hydrogeology. Water from Pool Well is pumped to three separate group schemes at Fahy, Croghan and Rhode. The site is recommended as a County Geological Site.

Management/promotion issues
All wells and the site are fenced off. The Mount Well supplied water to the now closed peat-fuelled power station at Rhode. The site does not present any significantly interesting aspects for passers-by. However, a panel could be erected on the entrance gate to communicate information about the springs, the local hydrogeology and how this site serves as a public water supply.

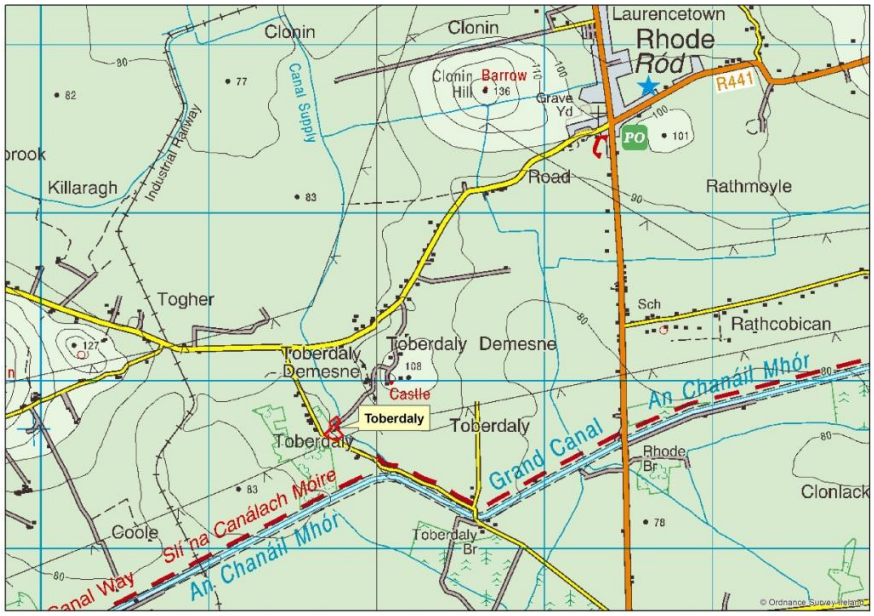
Gated entrance to Toberdaly works.

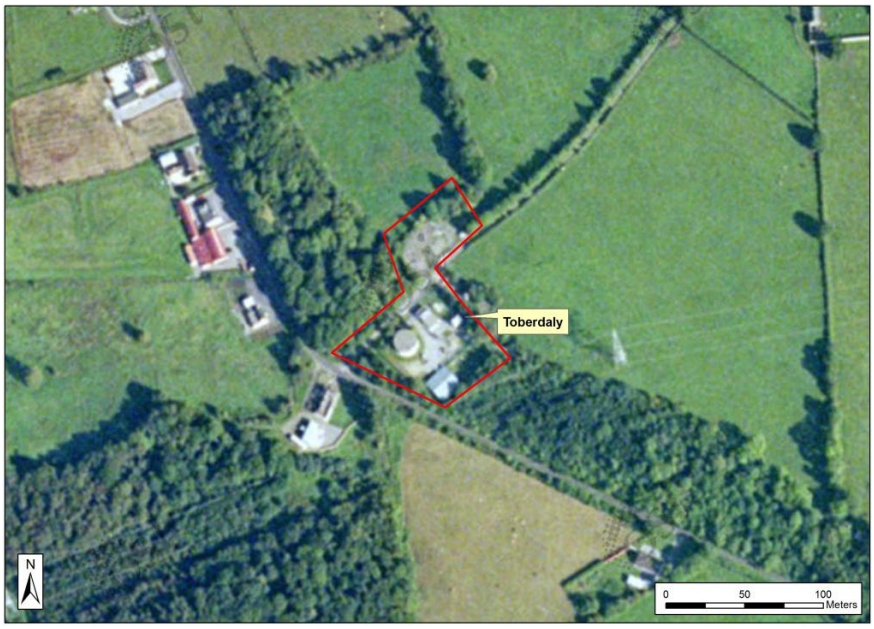

View NE along road. Heavey's Well far left side of road. Main works on right.


Main works site at Toberdaly. Pool Well in corrugated shed on rear-left.


Pool Well in shed and Mount Well (left).


Heavey's Well borehole.


Clonin
Clonin
Laurencetown
Rhode
Ród
Clonin Hill
Barrow
Grave Yd
R441
PO
Killaragh
Industrial Railway
Canal Supply
Road
Rathmoyle
Togher
Sch
Rathcobican
Toberdaly Demesne
Toberdaly Demesne
Castle
Toberdaly
Toberdaly
Toberdaly
An Chanáil Mhór
Grand Canal
Rhode Br
Clonlack
Goole
Sli na Canálach Móire
An Chanáil Mhór
Toberdaly Br
Canal Way


Toberdaly
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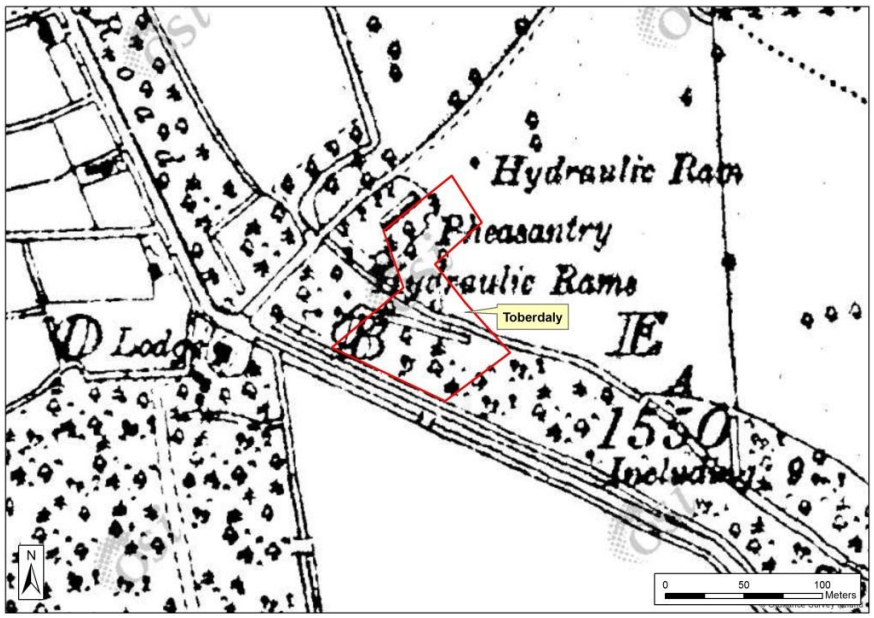
Hydraulic Ram
Pheasantry
Hydraulic Rams
Toberdaly
Lodge
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