The Geological Heritage of County Laois

An audit of County Geological Sites in County Laois

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

2016

An Chomhairle Oidhreachta
The Heritage Council

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Laois County Council
Áras an Chontae, Portlaoise, Co Laois

Cover image by Matthew Parkes. Old Rossmore, with a coal seam exposed in the quarry floor.

The Geological Heritage of County Laois

An audit of County Geological Sites in County Laois

Section 1 – Main Report

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

2016

The County Laois Geological Heritage Project was supported by

An Chomhairle Oidhreachta
The Heritage Council

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Laois County Council
Áras an Chontae, Portlaoise, Co Laois

This report is an action of the County Laois Heritage Plan 2014 – 2019

For the:
Geoheritage Programme
Geological Survey Ireland
Beggars Bush
Haddington Road
Dublin 4
01-6782837

and

Catherine Casey
Heritage Officer
Laois County Council
Aras an Chontae
Portlaoise
Co. Laois
tel. 057 866 4129
email. ccasey@laoiscoco.ie

Contents

Section 1 – Main Report

Figures

The County Geological Sites

Executive Summary

County Laois is not widely known for its geological heritage. However, it has some fine but underappreciated geological sites. This report documents what are currently understood by the Irish Geological Heritage Programme (IGH) of the Geological Survey of Ireland (GSI) to be the most important geological sites within County Laois. It documents them as County Geological Sites (CGS), for inclusion within the County Development Plan (CDP). This audit provides a detailed study of sites to replace a provisional listing based on desk study which was adopted in the current 2011-2017 CDP, along with strong policies to protect it and enhance access where feasible.

Some 33 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 places County Laois at the current focus of geological conservation in Ireland.
This report is written in non-technical language for use by the Heritage Officer and the Planning department of Laois County Council. A chapter of the report includes recommendations on how to best present and promote the geological heritage of County Laois to the people of the county. It will also inform the work of the IGH Programme and be made available through the GSI website.

1. Laois in the context of Irish Geological Heritage

This report ensures County Laois 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 will hopefully encourage the remaining local authorities to follow 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 real statutory protection where it is required.

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 more recently 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, listed 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:

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 Laois 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 Laois, no sites have been so far considered to be of national importance nor been put forward as a Natural Heritage Area (NHA). Therefore, inclusion of all sites as County Geological Sites (CGS) in County Laois'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 Laois County Geological Sites

Site Name	Designation	IGH Primary	IGH Secondary	IGH Third	GIS Code
Abbeyleix Bog	County Geological Site	IGH7	IGH16		LS001
Arless Quarry	County Geological Site	IGH8			LS002
Ballyadams Quarry	County Geological Site	IGH8			LS003
Baunreagh Quarry	County Geological Site	IGH4			LS004
Carroll's Quarry	County Geological Site	IGH8			LS005
Castlecomer Borehole – Swan	County Geological Site	IGH16			LS006
Clogh River	County Geological Site	IGH14			LS007
Clonaslee Eskers	County Geological Site	IGH7			LS008
Clopook Cave	County Geological Site	IGH1			LS009
Darkin Well	County Geological Site	IGH1	IGH16		LS010
Farnans Quarry	County Geological Site; may be recommended for Geological NHA	IGH9	IGH15		LS011
Flemings Fireclay Quarries	County Geological Site; may be recommended for Geological NHA	IGH9			LS012
Glebe Quarry	County Geological Site	IGH10	IGH15		LS013
Glenbarrow	County Geological Site	IGH10	IGH7	IGH14	LS014
Hollymount	County Geological Site; may be recommended for Geological NHA	IGH3	IGH12		LS015
Killeany Quarry	County Geological Site	IGH8			LS016
Killeshin Glen	County Geological Site; may be recommended for Geological NHA	IGH3	IGH9		LS017
Kyle Spring	County Geological Site	IGH16			LS018
Lisduff Quarry	County Geological Site	IGH8			LS019
Luggacurren Fireclay Pit	County Geological Site	IGH9			LS020
Luggacurren Stream Section	County Geological Site; may be recommended for Geological NHA	IGH3	IGH9		LS021
M7 Road Cut Derryvorrigan	County Geological Site	IGH8			LS022
M8 Road Cut Addergoogle	County Geological Site	IGH8			LS023
Modubeagh	County Geological Site	IGH16	IGH15		LS024
Moyadd Stream	County Geological Site; may be recommended for Geological NHA	IGH9			LS025
Old Rossmore	County Geological Site; recommended for Geological NHA	IGH6	IGH9	IGH15	LS026
Poulastore	County Geological Site	IGH1			LS027
Rathleague Spring	County Geological Site	IGH16			LS028
Ridge of Portlaoise	County Geological Site	IGH7			LS029
Rock of Cashel	County Geological Site	IGH3	IGH8		LS030
Rock of Dunamase	County Geological Site	IGH1	IGH8	IGH12	LS031
Sluggory Cross Roads	County Geological Site	IGH1	IGH16		LS032
Timahoe Esker	County Geological Site	IGH7			LS033

1.2 Rejected sites

A range of sites had been previously flagged for consideration in the IGH Master site list, and included in the earlier County Development Plan, and some were assessed as unsuitable for County Geological Site status in this audit. Similarly a range of additional and new sites were assessed in the audit, based on new knowledge of County Laois'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.

Boley Pit
This site is listed on the Geological Survey of Ireland Active Quarries Directory of 2014. Located at Boley, west of Abbeyleix, the sand and gravel pit is still active today, but has little exposure and much backfilled area. Given the lack of good sections and any representative sedimentology, the site was rejected for inclusion as a County Geological Site.

Figure 1. Boley Pit

Killeany Pit II
This site was surveyed in the field following its discovery as a large pit, on the aerial photographs of the River Barrow valley in the east of County Laois. The site is not listed on the Geological Survey of Ireland Active Quarries Directory of 2014.

Located at Killeany, between Ballybrittas and Vicarstown, the sand and gravel pit is no longer active, though it was a considerable operation in the past. The pit is being backfilled and has no extant faces left. Owing to this lack of good sections and any representative sedimentology, the site is rejected for inclusion as a County Geological Site.

Figure 2. Killeany Pit II

Biddy Aghaboe's Well

This well is located at the grid reference given (in error) for the Darken Well in the Irish Geological Heritage Master Site List. The well, though present, has been covered by a railway bridge and is therefore no longer visible, though a plaque erected by CIE when the bridge was constructed records the well location.

The site is an important one in the folklore of Portlaoise, as Biddy Aghaboe, who found the well as she walked the road out of the town towards Mountrath, is supposed to have saved the town from drought with the well's discovery.

Figure 3. Biddy Aghaboe's Well

Right: Sketch of the legend of Biddy Aghaboe's Well. From 'Laois Folk Tales' by Nuala Hayes, The History Press, 2015.

River Barrow, Athy to Carlow

This stretch of the River Barrow, along the Laois county boundary between Athy and Carlow Town, was included in the IGH Master Site List, as a good example of 'glaciofluvial inheritance'. The landscape here is quite subdued though, with no well-defined glaciofluvial terraces occurring, or any other distinctive glaciofluvial features. With no exposure either, the locality seems like a subdued expression of potential glaciofluvial gravels, rather than a definitive landform sequence. On this basis the site is rejected.

Figure 4. River Barrow, Athy to Carlow

New Rossmore

This is the site of an underground coal mine developed in the 1970s and 1980s. Like Old Rossmore, 1 km to the southeast, the mine exploited the No. 2 or Marine Band seam. The site covers some 2.5 ha and contains some derelict buildings and processing plant, including the remains of a large shed and conveyor. The excavation on the western part of the site has no exposure of coal and appears to have been quarried for sandstone. None of the features observed on the site have extant geological heritage interest and therefore New Rossmore is rejected as a County Geological Site.

Figure 5. New Rossmore

Ross Flagstone Quarry

This site is one of two quarries where Clonaslee Flagstones are seemingly being extracted, at least on a sporadic basis. However, detailed examination of the quarried area shows extensive amounts of disturbed ground, and rock piles, but only one small face of exposed rock where it is possible to examine the gross characteristics of the Clonaslee Member of the Cadamstown Formation. The lack of actual exposure and interest here means that it does not qualify as a County Geological Site.

Figure 6. Ross Flagstone Quarry

Trooper's Quarry

This site has two very small old flagstone quarries. The named quarry on Ordnance Survey maps is very small, perhaps only about 10m long and 2-3m wide. It is totally overgrown, very shallow and displays no geology. A slightly larger quarry close by, without a name, at the end of the vehicular track which is the access road to a house, does have a small face exposed. This is partly because some recent extraction (the subject of legal dispute) has left a few metres of rock visible, with flags on top of thicker sandstone beds. However, neither quarry is significant enough to consider as a County Geological Site.

Figure 7. Trooper's Quarry

2. Laois Council Policies regarding geological heritage

It is worth drawing attention to the excellent treatment of geological heritage in the Laois County Development Plan, which could be a model for any local authority to follow. The policy section on Designated Areas, clearly recognises the underlying geodiversity foundation of many biodiversity designations and incorporates it in a more holistic way than is frequently encountered in such Plans.

The specific section on geology is a concise statement of all essentials that could be aspired to in regard to geological heritage within a County Council. The completion of this geological heritage audit will ensure that the largely desk-based study and listing of County Geological Sites (CGS) is superseded in the new Draft County Development Plan 2017-2023 by a robust selection of sites that are important in County Laois. Whilst some are candidates for NHA designation in the future if the geological NHAs ever become a reality, new CGS that are purely of local importance have been added. Equally some sites have been rejected after proper field auditing.

It is the policy of the Council to:

NH9 No projects giving rise to significant cumulative, direct, indirect or secondary impacts on Natura 2000 sites arising from their size or scale, land take, proximity, resource requirements, emissions (disposal to land, water or air), transportation requirements, duration of construction, operation, decommissioning or from any other effects shall be permitted on the basis of this plan (either individually or in combination with other plans or projects[6]).

NH10 Assess, in accordance with the relevant legislation, all proposed developments which are likely to have a significant effect (directly or through indirect or cumulative impact) on designated natural heritage sites, sites proposed for designation and protected species;

NH11 Protect Natural Heritage Areas (NHA) from developments that would adversely affect their special interests;

NH 12 Recognise and protect the significant geological value of sites in County Laois and safeguard these sites, in consultation with the Geological Survey of Ireland and in accordance with the National Heritage Plan and “Geological Heritage Guidelines for the Extractive Industry”;

NH 13 Support and co-operate with statutory authorities and others in support of measures taken to manage designated nature conservation sites in order to achieve their conservation objectives;

NH 14 Promote development for recreational and educational purposes that would not conflict with maintaining favourable conservation status and the meeting of the conservation objectives for designated sites.

NH15 Engage with the National Parks and Wildlife Service to ensure Integrated Management Plans are prepared for all Natura sites (or parts thereof) and ensure that plans are fully integrated with the County Development Plan and other plans and programmes, with the intention that such plans are practical, achievable and sustainable and have regard to all relevant ecological, cultural, social and economic considerations and with special regard to local communities.

Geology is an intrinsic component of the natural heritage of Laois. The Geological Survey of Ireland established the Irish Geological Heritage Programme in 1998. The programme is identifying and selecting the very best nationally important CGS sites for NHA designation,

to represent the country's geology. It is also identifying many sites of national or local geological heritage importance, which are classed as County Geological Sites (CGS). These sites will be protected primarily through their inclusion in the County Development Plan.

GEOLOGY

It is the policy of the Council to

GEOL1 Protect from inappropriate development the County Geological Sites listed in Table 28 as notified by the Geological Survey of Ireland;

GEOL2 Protect geological NHAs as they become designated and notified to the Local Authority, during the lifetime of the Plan;

GEOL3 Encourage, where practicable and when not in conflict with ownership rights, access to geological and geomorphological features.

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 Laois, with a high proportion of land area under grassland, the only such site is the Clonaslee Eskers. [See facing page]

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 Laois. A lack of awareness in the past, has led to the loss of important geological sites and local character throughout the country. In County Laois a 2010 Draft Landscape Characterisation Assessment was completed and incorporated into the County Development Plan 2011-2017. This provides a tool for planners to help maintain the character of the County. An action in the Heritage Plan is to keep heritage concerns at the forefront of the Assessment. The Strategic Environmental Assessment within the County Development Plan also provides tools. In addition, the now routine pattern of consultations with GSI, either by the planning department or by consultants carrying out Environmental Impact Assessment, plus strategic environmental assessment (SEA), has greatly improved the situation.

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

Farnans Quarry, Carroll's Quarry and Ballyadams Quarry are now included as County Geological Sites in County Laois. 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 Laois's sites are not likely to require such an approach.

Waste dumping

An occasional problem throughout the country, including in County Laois, 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 Laois 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 Laois.

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 Laois, because of the relatively subdued terrain, the opportunity for such rock road cuttings has been limited. The motorway improvements on the M8 and M7 have produced two long cuttings at Addergoole near Rathdowney and at Derryvorrigan near Borris in

Ossory, respectively, that are included as CGSs in this audit. Other roads in the county are less likely to be significantly upgraded but the option 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]. 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, we do not consider the geodiversity in the county as likely to meet the criteria for a Geopark application.

3.1 A Note on Esker Conservation in County Laois

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 plains'. 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. 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 Laois have been extensively quarried, to such an extent that little of them actually remain anymore. In particular, much of the Ridge of Maryborough has been removed, relatively recently, in the southern outskirts of Portlaoise, and of the five separate segments of the Timahoe Esker, only two remain intact. 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 Laois should help in this process.

4. Summary and Recommendations

Since it is one of the smaller Irish counties and because bedrock is generally not well exposed, County Laois is not widely known for its geological heritage. However, it has some fine but underappreciated geological sites. The County Council's support for this audit is critical in raising the profile of geological heritage in County Laois 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 the Geological Survey of Ireland (GSI) to be the most important geological sites within County Laois. It documents them as County Geological Sites (CGS), for inclusion within the County Development Plan (CDP). The audit provides a detailed study of sites to replace a provisional listing based on desk study which was adopted in the current 2011-2017 CDP, along with strong policies to protect it and enhance access where feasible. [See facing page]

County Geological Sites do not receive direct 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. Old Rossmore, for example, is perhaps the only good exposure of a coal measure sequence, including a coal seam, on a national basis. 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. In other counties, many of the sites fall within existing pNHAs and SACs where the ecological interest is actually founded upon the underlying geodiversity. In Laois, one CGS lies within a SAC/NHA: the Clonaslee Eskers (000859), whilst the Timahoe Esker CGS forms pNHA 000421.

The commission of this audit and adoption of the sites within the CDP ensure that County Laois 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 Laois 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 Laois County Council. It will also be made available via the Council website for the people of County Laois. A chapter of the report includes recommendations on how to best present and promote the geological heritage of County Laois 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 preliminary 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 on the geological heritage of County Laois, if the funding can be found to produce it.

4.1 Proposals for promotion of geological heritage in County Laois

The Laois Heritage Plan 2014-2019 included a specific action (20) regarding a geological heritage audit and the decision by the Heritage Officer to commission an audit of geological heritage sites in Laois (along with those in County Offaly in a joint approach) in conjunction with the Geological Survey of Ireland in 2016. This is a most welcome and positive step, for a topic that is often undervalued and poorly known in the wider community.

This section examines the existing objectives in the Laois Heritage Plan 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.

OBJECTIVES AND ACTIONS OF THE LAOIS HERITAGE PLAN

Objective 1: Increase understanding of the heritage of Laois

2. Develop the Laois Heritage website and use as a showcase for the heritage of Laois, the work of the Forum and as a portal allowing access to other sources of heritage information, including the Heritage Council's Heritage Map Viewer and the websites of State agencies which display valuable data on the heritage of the County.
Audit Action: It is hoped that the geological site data in this audit will contribute to the Laois Heritage website.

3. Continue to raise awareness of the benefits of new technology for interpretation of heritage sites – run training in the development of interpretation using new technology, in association with Laois Partnership.
Audit Action: The audit provides much data and material that could form an interpretation project using new technology, with a focus on training.

4. Disseminate information on the heritage of the County through the use of digital technologies such as Smartphone apps, multi-media presentations (audio, video guides, etc.) and social networking sites such as Facebook, Twitter, Google+, Pinterest, etc.
Audit Action: The audit provides much data and material that could form an interpretation project using new technology.

5. Continue publication of books, posters and leaflets on various aspects of the heritage of Laois (both by theme and by target group).
Audit Action: The audit report provides the material which could be readily distilled into an accessible book on the geological heritage of Laois, if sufficient resources are available for the preparation and production.

6. Investigate the feasibility of developing downloadable applications to increase awareness of heritage sites, *e.g.* Laois Gardens Trail, Timahoe Esker Trail, and important monuments, *e.g.* Rock of Dunamase.
Audit Action: The audit may provide sufficient raw material to provide applications on some geological heritage sites.

7. Continue to organise conferences, talks and seminars on heritage-related topics, including the annual *Celebrating Laois Heritage Conference*. Target staff of Laois County Council through awareness raising seminars and workshops at lunchtime.
Audit Action: The authors of this geological heritage audit could potentially provide a talk or seminar on geological heritage for an appropriate occasion and audience, by arrangement with the Heritage Officer.

9. Continue to promote wider awareness of all aspects of heritage in Laois through participation in national programmes and events such as Heritage Week, Water Day, Biodiversity Day and Tree Week.
Audit Action: The authors of this geological heritage audit could potentially provide an event on geological heritage for an appropriate programme, by arrangement with the Heritage Officer.

12. Liaise with Teagasc and the Farming Organisations to produce and distribute heritage related information of relevance to the farming community. Support the work of Teagasc in co-ordinating the delivery of agri environmental awareness events for farmers, to raise awareness of wildlife habitats, watercourses, farm built heritage (architecture and archaeology) and traditional orchards.
Audit Action: The authors of this geological heritage audit could potentially provide an input on geological heritage for an appropriate training programme or information publication, by arrangement with the Heritage Officer

14. Support efforts to promote heritage-related tourism, including in the Slieve Blooms and in particular Eco-tourism. Work with Laois Tourism and other tourism groups to promote and maximise the economic and tourism value of our heritage, particularly harnessing the goodwill and publicity associated with existing festivals and events.
Audit Action: The audit may provide some tourism providers with additional elements of interest, on the geological heritage, which could enhance their offerings.

Objective 2: Record the heritage of Laois

19. Audit existing surveys/inventories of heritage relating to Laois. Use these to develop and implement a prioritised programme for research and surveys where there are gaps in knowledge, in partnership with national and regional bodies. Continue to support the Heritage Council's Heritage Map Viewer and use this to highlight gaps in heritage data.
Audit Action: It is envisaged that the relevant data in the audit of geological heritage report will be added to the Heritage Council Map Viewer

20. Carry out an audit of County Geological Sites, using existing resources such as data held by the Geological Survey of Ireland, and the recent publication *The Geology of Laois and Offaly* by Dr. John Feehan. Use the results of this audit to inform County Development Plan policy in relation to geological heritage.
Audit Action: The delivery of this audit report achieves this action, once the County Development Plan has integrated the data and adopted appropriate policy.

23. Support Bord na Móna in the implementation of the Bord na Móna Biodiversity Action Plan 2010-2015, which includes plans to carry out a baseline ecological survey of its various properties within Laois.

Audit Action: The geodiversity foundation of many biodiversity sites, such as Abbeyleix Bog, should not be overlooked in this action.

24. Support Coillte in carrying out surveys of designated Biodiversity sites in its ownership and sites selected for inclusion in the various LIFE-Nature Programmes around the county.
Audit Action: The geodiversity foundation of many biodiversity sites should not be overlooked in this action.

25. Support the National Parks and Wildlife Service in protecting important sites for biodiversity and carrying out ecological survey work throughout Laois.
Audit Action: The geodiversity foundation of many biodiversity sites should not be overlooked in this action.

26. Work with NGOs such as the Irish Peatland Conservation Council, Bat Conservation Ireland, The Irish Wildlife Trust, BirdWatch Ireland and others in promoting awareness and collecting biodiversity data for Laois.
Audit Action: The geodiversity foundation of many biodiversity sites should not be overlooked in this action.

Objective 3: Protect and promote active conservation of the heritage of Laois

29. Work with relevant agencies and individuals to promote opportunities for ecological rehabilitation of disturbed sites such as quarries, landfills, cutaway peatland and forestry.
[In the cases where rehabilitation projects are in or adjacent to Natura 2000 sites then Appropriate Assessment Screening will required of individual projects.]
Audit Action: A holistic approach to such rehabilitation can ensure that both newly-engendered ecology and rock and subsoil exposures can complement each other in such localities.

32. Continue to work with communities to ensure the ongoing conservation and maintenance of graveyards.
Audit Action: The geodiversity component and character of local and imported rock types for gravestones should not be overlooked in this action.

35. Work with Bord na Móna and the Abbeyleix Bog Committee in their work to conserve and develop educational opportunities at Abbeyleix Bog, and provide advice when required through the Technical Advisory Group.
Audit Action: The geodiversity component of the site should not be overlooked and the site report and the authors of this geological heritage audit report may provide appropriate advice.

39. Support the development of Architectural Conservation Areas in Laois through collection of data, promotion of community participation and awareness raising
Audit Action: The importance of geological character of available local rock sources for both ashlar work and vernacular buildings and walls should not be overlooked in this action.

Objective 5: Promote enjoyment and accessibility of heritage

45. Publish a list with accompanying maps of heritage sites which are open to the public in Laois. This to be published online with interactive mapping.

Audit Action: The online mapping can include any County Geological Sites which are accessible to the public, such as the Timahoe Esker.

49. Investigate development of a Geological Heritage Trail using the recent publication *The Geology of Laois and Offaly* by Dr. John Feehan, and the results of the Survey outlined in Action 20.
Audit Action: The authors of this geological heritage audit are willing to collaborate on this and some suggestions are given elsewhere in the report.

50. Support the maintenance of existing way-marked ways and other recreational routes in Laois, and promote development of new walking and cycling routes in association with communities, landowners and State agencies. Promote the principle of heritage audits of routes and interpretation of heritage features along recreational routes. Work with Forward Planning and Sports Office to promote development of high quality new cycling and walking routes in association with communities, landowners and State Agencies
Audit Action: The authors of this geological heritage audit are able to provide relevant geological heritage and geodiversity input to any route developments that progress.

4.2 Ideas for projects

Leaflets
No existing leaflets on the geological heritage of County Laois are known, other than the Geoschol one included as an appendix here. There is some scope for other and different leaflets. Any leaflets produced could simply be made available as pdf downloads on the Council's website to avoid printing costs.

Guides
There are no known specific guides to the geology of County Laois, apart from the superb book 'The Geology of Laois and Offaly' by John Feehan, which is as comprehensive and readable an account as you could wish for. The 1:100,000 GSI map reports for Sheets 15, 16, 18 and 19 cover County Laois and are also essential resources.

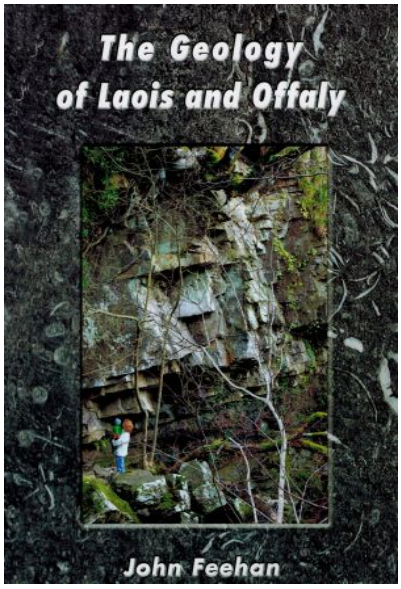


Figure 8. Cover of The Geology of Laois and Offaly

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 Laois**, in a broadly similar style to those books produced for Sligo, Meath, Fingal, Waterford, Roscommon and Clare following audits in those counties.

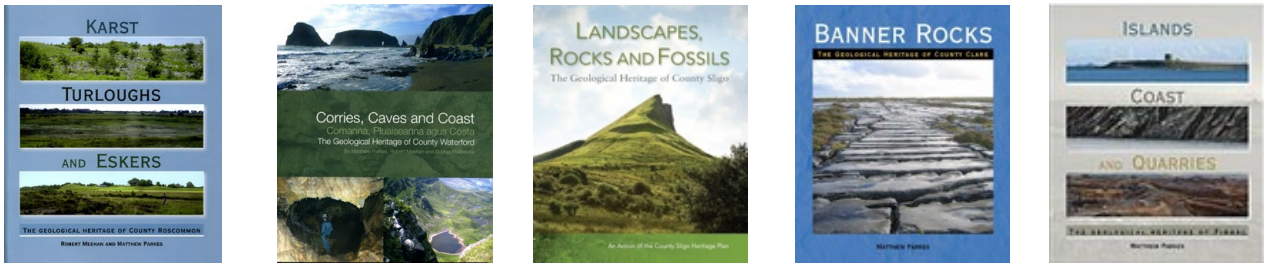


Figure 9. Covers of various county popular style books

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 Laois 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 Laois can already be found on the 'Laois Heritage Trail' audioguide app available to download for both Android and Apple Devices. See

http://abartaaudioguides.com/Laois%E2%80%93Heritage%E2%80%93Trail

It is to be hoped that in due course these apps 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 Laois'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 Laois is already part of

the available material (see Appendix 6). Working links to the Heritage section of County Laois 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 Laois 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 Laois 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).

5. A summary of the Geology of County Laois

A single paragraph summary

County Laois has three main episodes in its geological story. The oldest story 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 Carboniferous Limestone from around 330 million years ago. These are shelf limestones from open marine environments. Around 320 million years ago these limestone seas were replaced by the build-up of sandstones and shales in deltas that extended seawards from the land. Gradual shallowing of the nearshore led to the emergence of swampy environments filled with lycopod trees which formed the coal seams of the Leinster (or Castlecomer) coalfield. Around 5 million years ago, the limestones around Stradbally and Portlaoise may have been tropical tower karst with limestone pinnacles, but if so we see only remnants today, like the Rock of Dunamase, since the glaciers removed so much during the Ice Age. A veneer of till and some esker ridges are the other result of the Ice Age.

A simple summary

The landscape of Co. Laois is mostly rather low-lying. In the north-west lies the eastern part of the Slieve Bloom Mountains, which are formed of the oldest rocks in the county, while in the south-east is the northern tip of the Castlecomer Plateau, formed of the youngest bedrock in the county. The oldest rocks in the county 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 them 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 south of the county.

The low hills in the south-east corner of the county are of younger Carboniferous rocks, between 320 and 315 Ma. The earliest of these particular rocks are black mudstones and thin limestones. Above them lie sandstones and mudstones that were deposited by river deltas as sea level fell. Younger still is a series of sandstones and mudstones with thin coal seams, formed from plant material buried in a swamp, which formed the basis of the once thriving Leinster Coalfield.

A subtle but interesting component of the Laois landscape is the probable relict tower karst seen in the numerous small hills between Stradbally and Portlaoise, such as Killone Hill, the Rock of Dunamase, Clopook, Luggacurren and Hewson Hill. These are sometimes called hums, and are thought to be the glacially eroded remnants of tower karst, of the type seen today in China and SE Asia.

As elsewhere across Ireland, the ice sheets and glaciers of the last Ice Age have modified the Laois landscape, although in a more subdued way than in some of the more mountainous regions of Ireland. The main effect has been to blanket much of the lowlands with glacial till, or 'boulder clay'.

Many small quarries were opened in the Carboniferous limestones for building stone and agricultural lime but today only a few are still worked for limestone aggregate and agricultural lime. Mining of high grade anthracite coal formerly took place in the Leinster Coalfield, but all of the seams are thin and none of the mines, underground or opencast, are still working.

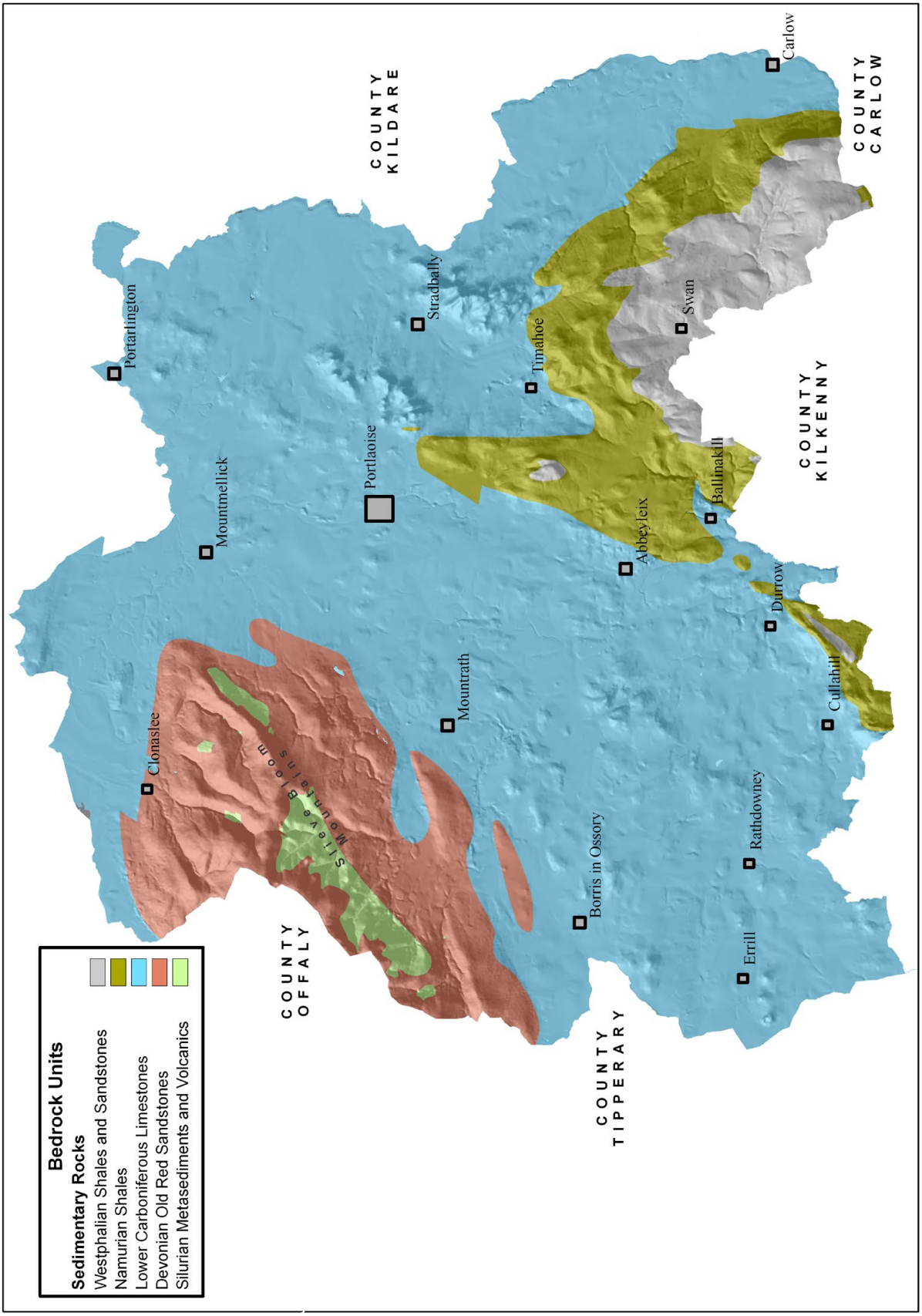


Figure 10. Simplified Geological Map of County Laois outlining the main geological units.

AGE (Million Years Ago)	ERA	PERIOD	EVENTS IN LAOIS	IF THIS TIMESCALE WAS A DAY LONG ...
2.58	Cenozoic	Quaternary	Several ice ages smothering Laois, 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 of south and east Laois.	The Tertiary period begins at 11.40 pm
145	Mezozoic	*Cretaceous*	*Erosion.* *No record of rocks of this age in Laois.*	11.15 pm
201		*Jurassic*	*Uplift and erosion.* *No record of rocks of this age in Laois.*	The age of the dinosaurs, starting at 10.55 pm
252		*Triassic*	*Desert conditions on land.* *No record of rocks of this age in Laois.*	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 in the central, southern and eastern portions of Laois. Limestones remaining today are pure and unbedded in the south and east of the county, with areas of muddier limestones toward the Slieve Blooms at the west. Shales and sandstones with coal seams deposited in the Leinster Coalfield.	Much of Laois's current rocks (limestone, sandstone and shale) 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 Laois.*	Begins at 9.28 pm
541		*Cambrian*	Opening of the Iapetus Ocean. *No record of rocks of this age in Laois.*	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 11. The Geological Timescale and County Laois

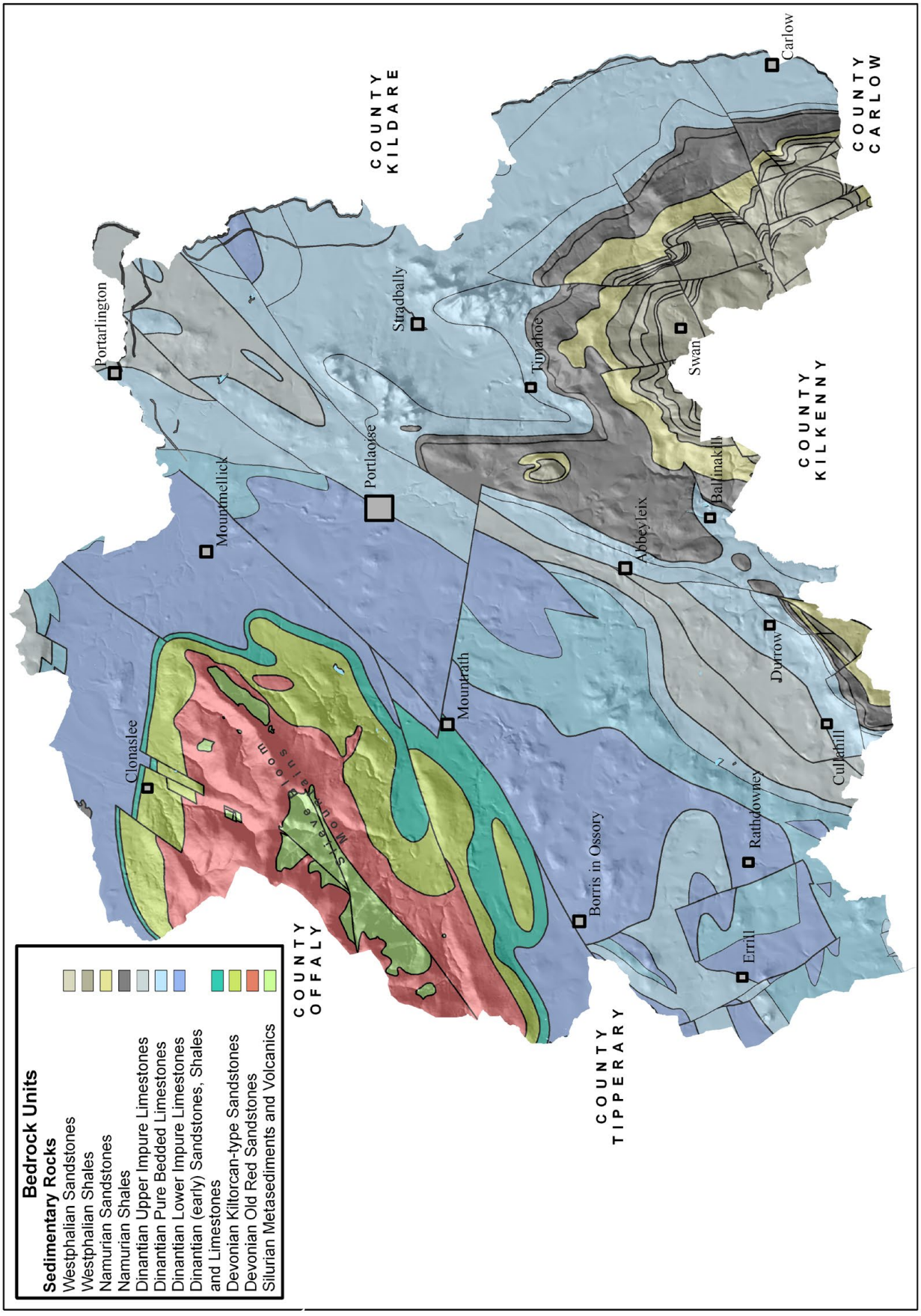


Figure 12. A detailed geological map of County Laois.

6. Acknowledgements

The authors would like to gratefully acknowledge the assistance of Catherine Casey, Heritage Officer from Laois County Council in the development of this project. Likewise Amanda Pedlow, Heritage Officer in County Offaly worked closely with Catherine and with the authors as the two counties were audited in a joint project. Funding from the Heritage Council and Laois 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.

Teddy Fennelly of the Laois Heritage Forum provided invaluable information on Biddy Aghaboe's Well and the Darkin Well, and Brendan McGarry provided access to the Darkin Well compound. Coran Kelly of Tobin Consulting Engineers and Stan Cullen of Laois County Council Environment Section are thanked for discussions on hydrogeological localities in County Laois.

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: Tony Maher, Mrs Whelan, Oliver Whelan, James Kavanagh**,** Michael Deevy, Kathleen Goucher, Kieran Cosey, Pat Kerwin, Michael Lynch, Raymond Lacey, Tom Mullen, Shannon Leech.

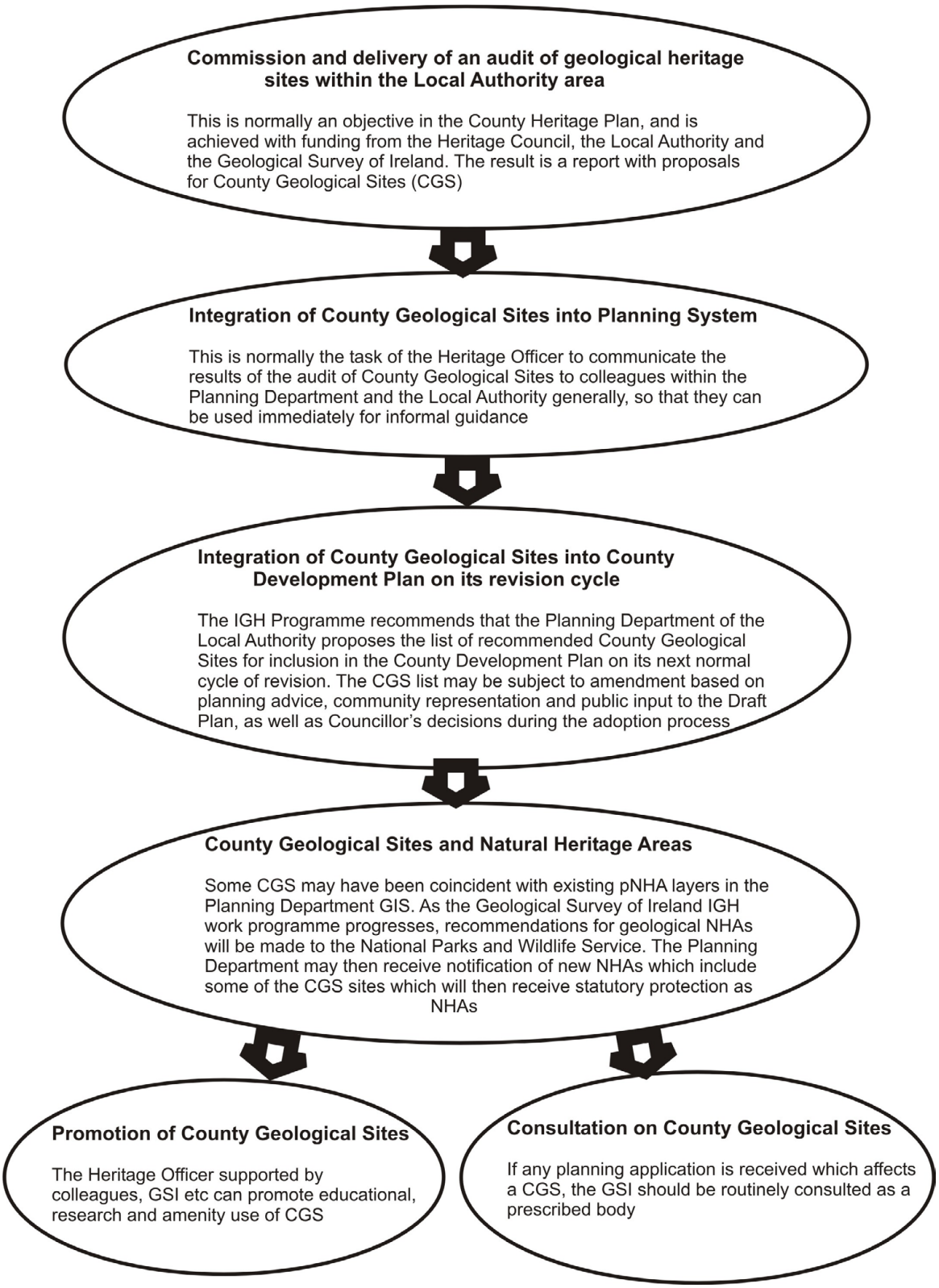
Appendix 1 – Geological heritage audits and the planning process

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 – References

Shortlist of Key Geological References

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

Archer, J.B., Sleeman, A.G. and Smith, D.C. 1996. *Geology of Tipperary. A geological description of Tipperary and adjoining parts of Laois, Kilkenny, Offaly, Clare and Limerick, to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 18, Tipperary, with contributions by K. Claringbold, G. Stanley (Mineral Resources) and G. Wright (Groundwater Resources),* Geological Survey of Ireland vii + 77pp.

Feehan, J. 1982. The Silurian rocks of the Slieve Bloom Mountains, Counties Laois and Offaly. *Proceedings of the Royal Irish Academy*, 82B, 153 – 167.

Feehan, J. 2013. The Geology of Laois and Offaly. Offaly County Council. 403pp.

Gatley, S., Somerville, I., Morris, J.H., Sleeman, A.G. and Emo, G. (Ed. A.G. Sleeman) (2005). *Geology of Galway-Offaly. A geological description of Galway-Offaly and adjacent parts of Westmeath, Tipperary, Laois, Clare and Roscommon to accompany the bedrock geology 1:100,000 scale map series, Sheet 15, Galway-Offaly*. Geological Survey of Ireland.

Hardman, E.T. 1881. Explanatory Memoir on the Geology of the Leinster Coalfields, to accompany parts of Sheets 127, 128, 136, 137, 145, 146, 147, 155, 156, and 166 of the Maps of the Geological Survey of Ireland, with Palaeontological notes by W.H. Baily*, Memoirs of the Geological Survey of Ireland,* 96pp.

McArdle, P. 2008. *Rock around Ireland*. A guide to Irish Geology. Science Spin Discovery 2. Albertine Kennedy Publishing. 112pp.

McConnell, B., Philcox, M.E., Sleeman, A. G., Stanley, G., Flegg, A.M., Daly, E.P. and Warren, W.P. 1994. *Geology of Kildare - Wicklow. A geological description to accompany the Bedrock Geology 1:100,000 Map Series, Sheet 16, Kildare - Wicklow. Edited by B. McConnell*, Geological Survey of Ireland, 57pp.

Tietzsch-Tyler, D., Sleeman, A. G., McConnell, B.J., Daly, E.P., Flegg, A.M., O'Connor, P.J., Philcox, M.E. and Warren, W.P. 1994. *Geology of Carlow- Wexford, a geological description to accompany the Bedrock Geology 1:100,000 Map Series, Sheet 19, Carlow- Wexford.* Geological Survey of Ireland, 56pp.

****

The following references are a list of all papers, books, articles and some unpublished reports etc. relating to the geology and geomorphology of County Laois that could be traced. Many papers that refer to the Midlands area in general, may or may not be specifically relevant to County Laois. Similarly there are many papers addressing the geology and wider development of the Leinster Coalfield. Many of these may have no significant detail on the rocks of Laois itself.

GEOLOGICAL REFERENCES WITH DIRECT REFERENCE TO LAOIS

Aldwell, C.R., and D.J. Burdon, 1986, Energy potential of Irish groundwaters, *Quarterly Journal of Engineering Geology*, 19, 133-141.

ALI, CH.M. 1967. *The Lower Carboniferous Limestones in parts of Counties Laois and Tipperary, Eire.* Unpublished Ph.D. thesis, University of London.

Archer, J.B., Sleeman, A.G. and Smith, D.C. 1996. *Geology of Tipperary. A geological description of Tipperary and adjoining parts of Laois, Kilkenny, Offaly, Clare and Limerick, to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 18, Tipperary, with contributions by K. Claringbold, G. Stanley (Mineral Resources) and G. Wright (Groundwater Resources),* Geological Survey of Ireland vii + 77pp.

Boulter, M.C. (1980). Irish Tertiary plant fossils in a European context. *Journal of Earth Sciences of the Royal Dublin Society* **3**, 1-11.

Burgess, P. (1973). *A pollen study of an Upper Pliocene Deposit, Hollymount, Co. Laois.* Unpublished undergraduate thesis, Trinity College Dublin.

Conry, M.J. (1987). *Soils of County Laois*. Teagasc, Soil Survey Bulletin 41, National Soil Survey of Ireland.

Conry, Michael J. (1999). *Culm Crushers. Edge-runner Grinding Stones for Tempering Culm*. Carlow, Chapelstown Press.

Conry, Michael J. (2001). Dancing the *Culm. Burning Culm as a Domestic and Industrial Fuel in Ireland*. Carlow, Chapelstown Press.

Cozar, P and Somerville, I.D. 2005. Stratigraphy of upper Visean carbonate platform rocks in the Carlow area, southeast Ireland, *Geological Journal*. 40, 35–64.

Daly, D., J.W. Lloyd, B.D.R. Misstear and E.P. Daly (1980). Fault control of groundwater flow and hydrochemistry in the aquifer system of the Castlecomer Plateau, Ireland. *Quarterly Journal of Engineering Geology, Geological Society of London.* 13, 167-175.

Daly, D. and Misstear, B.D.R. (1976). *A preliminary hydrogeological survey of the Castleccomer Plateau, S.E. Ireland*. Unpublished M.Sc. Dissertation, University of Birmingham. 65pp.

Daly, E.P. 1983. Water in the landscape: Groundwater resources in Co. Laois, an environmental history. *In:* J. Feehan (ed.), *Laois an environmental history.* Ballykilcavan Press, Co. Laois, 59-70.

Deakin, J. and Pracht, M. 1998. *Devonian Sandstones and Aquifer Development in the Slieve Phelims, Slieve Bernaghs, Slieve Aughtys and Slieve Blooms*. Internal report on a field visit, Geological Survey of Ireland, 7pp.

Deakin, J., Fitzsimons, V., Gately, C. and Wright, G. (2004). *County Laois groundwater protection scheme. Main Report*. Geological Survey of Ireland.

Department of Industry and Commerce (1964). *Report of the Diamond Drilling Programme 1959-63 carried out in the Leinster Coalfield*. Geological Survey of Ireland.

Dooley, Michael and Feehan, J. (1981). *Exploring Northeastern Slieve Bloom*. County Laois Vocational Education Committee, 18pp.

Dowds, J. 1987. Some caves of the Midlands. *Irish Speleology,* 4, 1, 23-25.

Drew, D.P. and Jones, G.Ll. (2000). Post-Carboniferous Pre-Quaternary karstification in Ireland. *Proceedings of the Geologists' Association* **111**, 345-307.

Du Noyer, G.V., Forbes, E., Jukes, J.B., Baily, W.H., Wilson, W/L. and Wynne, A.B. (1858). *Data and Descriptions to accompany Quarter Sheet 35 N.E. [one-inch sheet119] of the Maps of the Geological Survey of Ireland* (Parts of Counties Kildare, King's and Queen's Counties). Dublin, HMSO, 32pp.

EPA, 2011. Water Framework Directive Groundwater Monitoring Programme Kyle Spring. Available at: www.epa.ie/pubs/reports/water/ground/gwmpinfo/EPA_GWMP_Kyle%20PWS.pdf. Accessed on 02/05/2016

Feehan, J. (1973). *Looking at Local Rocks. Aspects of the Geology of Laois and North Kilkenny*. Salesian Press.

Feehan, J. 1977. *The Lower Palaeozoic and Old Red Sandstone rocks of north western Slieve Bloom, County Offaly,* Unpublished M.Sc. thesis, University of Dublin.

Feehan, J. 1980a. *The Geology of the Slieve Bloom and North Eastern Devilsbit Mountains,* Unpublished Ph.D. thesis, University of Dublin.

Feehan, J. 1980b. Alluvial fan sediments from the Old Red Sandstone of the Devilsbit Mountain, County Tipperary, *Journal of Earth Sciences Royal Dublin Society*, 3, 179-194.

Feehan, J. (1979). *The Landscape of Slieve Bloom: a study of its natural and human heritage*. Dublin, Blackwater Press.

Feehan, J. (1979). *The Landscape of Slieve Bloom*. Blackwater Press, reprinted 2008 by Slieve

Bloom Rural Development Association.
Feehan, J. 1982a. The Silurian rocks of the Slieve Bloom Mountains, Counties Laois and Offaly. *Proceedings of the Royal Irish Academy*, 82B, 153 – 167.
Feehan, J. 1982b. The Old Red Sandstone rocks of the Slieve Bloom and northeastern Devils bit Mountains, Counties Laois, Offaly, and Tipperary. *Journal of Earth Sciences Royal Dublin Society,* 5, 11-30.
Feehan, J. 1983. *Laois, an environmental history.* Ballykilcavan Press, Stradbally, Ireland.
Fitzsimons, V. and Wright, G. (2000. *An assessment of the quality of public and group scheme groundwater supplies in County Laois*. Unpublished Report. Geological Survey of Ireland.
Flegg, A. (1980). Brick clays at Tinwear, County Laois. Extracts from the Minerals Inventory of the Geological Survey of Ireland, with some comments.
Gatley, S., Somerville, I., Morris, J.H., Sleeman, A.G. and Emo, G. (Ed. A.G. Sleeman) (2005). *Geology of Galway-Offaly. A geological description of Galway-Offaly and adjacent parts of Westmeath, Tipperary, Laois, Clare and Roscommon to accompany the bedrock geology 1:100,000 scale map series, Sheet 15, Galway-Offaly*. Geological Survey of Ireland.
Griffith, R. (1814). *Geological and mining report on the Leinster Coalfield*. Royal Dublin Society.
Hardman, E.T. 1881. Explanatory Memoir on the Geology of the Leinster Coalfields, to accompany parts of Sheets 127, 128, 136, 137, 145, 146, 147, 155, 156, and 166 of the Maps of the Geological Survey of Ireland, with Palaeontological notes by W.H. Baily*, Memoirs of the Geological Survey of Ireland,* 96pp.
Heery, S. (2007). A survey of tufa-forming (petrifying) springs in the Slieve Bloom, Ireland. A Report for Offaly and Laois County Councils.
Higgs, K.T. (1986). The stratigraphy of the Namurian rocks of the Leinster Coalfield. *Geological Survey of Ireland Bulletin* **3**, 2576-276.
Higgs, K.T. and O'Connor, G. (2005). Stratigraphy and palynology of the Westphalian strata of the Leinster Coalfield, Ireland. *Irish Journal of Earth Sciences* **23**, 65-84.
Holland, C.H. and Smith, D.G. (1979). Silurian rocks of the Capard inlier, county Laois. *Proceedings of the Royal Irish Academy* **79B**, 99-113.
Howes, M.J. 1991. *Mineral Resources of County Laois*. Internal Report, Geological Survey of Ireland.
Jukes, J.B. and Kinahan, G.H. 1859. Explanations to accompany Sheet 128 (Formerly Quarter sheet 35 S.E.) of the Maps of the Geological Survey oflreland, illustrating parts of the County of Kildare and Queen's County. *Mem. geol. Surv. Ire.* 31pp.
Jukes, J.B. and Wynne, A.B. 1860. *Explanations to accompany Sheet 135 of the Maps of the Geological Survey of Ireland illustrating parts of the Co. of Tipperary and of King 's and Queen's Counties, with Palaeontological Notes by W.H.Baily.* Memoirs of the Geological Survey of Ireland, 32pp.
Keegan, J. and Feehan, J. (1981). Palynofloras from Tournaisian lacustrine and tidal sequences in Slieve Bloom, Counties Laois and Offaly. *Geological Journal* **16**, 271-85.
McConnell, B. and Philcox, M. (1994). *A geological description to accompany the Bedrock Geology 1:100,000 scale map series, Sheet 16, Kildare-Wicklow*. Geological Survey of Ireland, 70pp.
McHugh, M. and Wright, G. 2000. Kyle & Orchard Springs. Groundwater Source Protection Zones. *Published by Geological Survey of Ireland and Laois County Council.*
McConnell, B., Philcox, M.E., Sleeman, A. G., Stanley, G., Flegg, A.M., Daly, E.P. and Warren, W.P. 1994. *Geology of Kildare - Wicklow. A geological description to accompany the Bedrock Geology 1:100,000 Map Series, Sheet 16, Kildare - Wicklow. Edited by B. McConnell*, Geological Survey of Ireland, 57pp.
Misstear, B.D.R., E.P. Daly, Daly, D. and J.W. Lloyd (1980). The groundwater resources of the Castlecomer Plateau. Geological Survey of Ireland Report Series RS 80/3, 31 pp.
Nevill, W.E. (1956). The Millstone Grit and Lower Coal Measures of the Leinster Coalfield. *Proceedings of the Royal Irish Academy* 58B (1), 1-16 + 5 plates.
O'Conor, K. 1996. Dunamase Castle. The Journal of Irish Archaeology, 7, 97-115.
O'Kelly, J. (1866). *Explanations to accompany sheets 117 and 118 of the maps of the Geological Survey of Ireland, illustrating a portion of the King's and Queen's Counties and the counties of Galway and Tipperary*. Dublin, HMSO.

O'Kelly, J. and Baily, W.H. (1862). *Explanations to accompany Sheet 127 of the Maps of the Geological Survey of Ireland, illustrating a portion of the Queen's County.* Revised Edward T. Hardman 1879; Silurian revised J.R. Kilroe 1901. Dublin, HMSO.

O'Kelly, J. and Wynne, A.B.(1866). *Explanations to accompany sheets 117 and 118 of the maps of the Geological Survey of Ireland, illustrating a portion of the King's and Queen's Counties and the counties of Galway and Tipperary*. Silurian revised J.R. Kilroe 1901. Dublin, HMSO, 32pp.

O'Meara, M. (1964). *Leinster Coalfield, 1959-1963*. Unpublished drilling report, Geological Survey of Ireland.

Orr, P.J. and Briggs, D.E.G. (1999). Exceptionally preserved conchostracans and other crustaceans from the Upper Carboniferous of Ireland. *Spec. Pap. Palaeontol. Ser.* **62**, 5-68.

Orr, P.J. and Briggs, D.E.G. and Parkes, M.A. (1996). The 'Castlecomer Fauna': a new *Konservat-Langerstätte* from the Upper Carboniferous of Ireland. *Spec. Pap. Palaeontol. Ser.* **15**, 93-106.

Somerville, I.D. and Cozar, P. 2005. Late Asbian to Brigantian (Mississippian) foraminifera from southeast Ireland: comparison with northern England assemblages. *Journal of Micropalaeontology*, 24: 131–144.

Stanley, G., Gallagher, V., Ní Mhairtín, F., Brogan, J., Lally, P., Doyle, E., and Farrell, L. (2010). Historic Mine Sites – Inventory and Risk Classification, Volume 1: A joint study carried out by The Environmental Protection Agency and The Geological Survey of Ireland. EPA, Wexford.

Tobin Consultants, 2010. Establishment of Groundwater Source Protection Zones - Portlaoise Water Supply Scheme Meelick Borehole. *Prepared by:* Coran Kelly, Robert Meehan and Jenny Deakin. *Published by Geological Survey of Ireland and Laois County Council.*

Tietzsch-Tyler, D., Sleeman, A. G., McConnell, B.J., Daly, E.P., Flegg, A.M., O'Connor, P.J., Philcox, M.E. and Warren, W.P. 1994. *Geology of Carlow- Wexford, a geological description to accompany the Bedrock Geology 1:100,000 Map Series, Sheet 19, Carlow- Wexford.* Geological Survey of Ireland, 56pp.

Wright, G. 2000. Swan Water Supply Scheme. Groundwater Source Protection Zones. *Published by Geological Survey of Ireland and Laois County Council.*

Wright, G. (2001). *County Laois groundwater protection scheme – summary report*. Geological Survey of Ireland.

GEOLOGICAL REFERENCES ON A NATIONAL OR REGIONAL TOPIC WITH INFORMATION CITED ON SITES OR AREAS IN LAOIS

ALLEN, J.R.L. 1960. Cornstones. *Geological Magazine*, 97, 43.

ALLEN, J.R.L. 1965. A review of the origin and characteristics of Recent alluvial sediments. *Sedimentology*, 5, 89-191.

ANDREW, C.J. 1992. Basin development chronology of the lowermost Carboniferous strata in the Irish north-Central Midlands, *In*: Bowden, A.A., Earls, G., O'Connor, P.G. and Pyne, J.F. 1992 (eds). *The Irish Minerals Industry 1980 - 1990,* Irish Association for Economic Geology, 143-169.

ANDREW, C.J. 1993. Mineralization in the Irish Midlands, *In*: Patrick, R.A.D. and Polya, D.A. (eds) *Mineralization in the British Isles,* Chapman and Hall, London, 208-269.

ANON. 1998. *The 'Top 55' Deposits*. Exploration and Mining Division Ireland Publication MP 3/99, 14pp. Geological Survey of Ireland **73**

BEESE, A.P. BRÜCK, P.M., FEEHAN, J. and MURPHY, T. 1983. A silica deposit of possible Tertiary age in the Carboniferous Limestone near Birr, County Offaly, Ireland. *Geological Magazine*, 120, 331-40.

BISHOPP, D.W. and McCLUSKEY, J.A.G. 1948. Sources of industrial silica in Ireland. *Geol. Surv. Ire.* book Series 21, 3-23.

BRITISH MINING CONSULTANTS LTD. 1982. *Report on Irish Coal to the Minister for Industry and Energy, Republic of Ireland,* 3 vols.

BRITISH MINING CONSULTANTS LTD. 1982. *Report on Irish coal.* Unpubl. Rep. to Geol. Surv. Ire. Vol. 1 & 2.
BROWN, C. and WILLIAMS, B. 1985. A gravity and magnetic interpretation of the structure of the Irish Midlands and its relation to ore genesis, *Journal of the Geological Society of London*, 142, 1959-1975.
BRÜCK, P.M. 1985. The Geology of the country between Slieve Aughty, the Silvermines-Devilsbit Mountains and Slieve Bloom, Central Ireland*., Department of Geology, University College Cork, Occasional Report series,* RS85/12, 60pp.
BRUCK, P.M., GARDINER, P.R.R., MAX. M.D. & STILLMAN, C.J. with contributions from BALL, D., CLAYTON, G., HAUGHEY, N., SEVASTOPULO, G.D. & BURNETT, R. 1989. *Thermal maturation levels in the Devonian and Carboniferous rocks in Ireland.* Geol. Surv. Ire. 36pp and map.
CARLISLE, P. 1992. *The stratigraphy of the Slieveardagh Coalfield Co. Tipperary* Unpublished M.Sc. thesis, National University of Ireland (UCC).
CLARINGBOLD, K., FLEGG, A., MAGEE, R. and VONHOF, J. 1994. The Directory of Active Quarries, Pits and Mines. *Geological Survey of Ireland, Report Series,* 94/4, 111pp.
CLAYTON, G. HIGGS, K., KEEGAN, J.B. and SEVASTOPULO, G.D. 1978. Correlation of the palynological zonation of the Dinantian of the British Isles, *Palinologica,* 1, 137-147.
COLE, G.A.J. 1922. *Memoir and map of localities of minerals of economic importance and metalliferous Mines in Ireland.* Memoirs of the Geological Survey of Ireland, 155 pp.
CÓZAR, P. and SOMERVILLE, I.D. 2002. Problems in lithostratigraphic correlation of Upper Viséan rocks in the Carlow district, SE Ireland, *Abstracts, 45thrd Annual Irish Geology Research Meeting,* University College Dublin, p.27.
CRUISE, M.D. 1996. Replacement Origin of Crinkill Ironstone: Implications for Genetic Models of Base Metal Mineralization, Central Ireland. *Exploration and Mining Geology*, 5, 241-249.
DALY, D. and MISSTEAR, B.D.R. 1976. *A preliminary hydrogeological survey of the Castlecomer Plateau, S.E. Ireland.* Unpublished M.Sc. thesis, University of Birmingham.
DEVUYST, F.X. and LEES, A. 2001. The initiation of Waulsortian buildups in Western Ireland, *Sedimentology,* 48, 1121-1148.
EAGAR, R.M.C. 1964. The Succession and Correlation of the Coal Measures of south eastern Ireland. *CR. 5me. Cong. int. Strat. Geol. Carb.,* Paris 1963 359-374.
EAGAR, R.M.C. 1975. Neuere Arbeiten uber das Westfal in Irland. *Zbl. Geol. Palaont.* 1, 291-308.
EDWARDS, D. and FEEHAN, J. 1980. Records of Cooksonia-type sporangia from late Wenlock strata in Ireland. *Nature.* 287,41-42.
FLEGG, A. 1978. *Brick clays of County Offaly*. Unpublished Report, Geological Survey of Ireland, 3pp.
FLEGG, A.M. 1980. *Clay report.* Geological Survey of Ireland Unpublished Report.
GRAHAM, J.R. 2001a. Devonian. *In: The Geology of Ireland* (Ed) C.H. Holland, Dunedin Academic Press,
GRAHAM, J.R. 2001b. Variscan Structures *In*: C.H. Holland (Ed), *The Geology of Ireland.* Dunedin Academic
GRIFFITH, R. 1838. *Second Report of the Commissioners appointed to consider and recommend a general system of railways for Ireland*.
GRIFFITH, R. *et al.* 1811. *The Second Report of the Commissioners Appointed to enquire into the Nature of the several Bogs in Ireland and the Practicability of Draining and Cultivating them.*
HAUGHEY, N. & McARDLE, P. 1990. Vitrinite reflectance data from a preliminary study on selected Irish coal seams. *Geol. Surv. Ire. Bull.* 4, 201-209.
HITZMAN, M. 1992. *Bedrock geological maps of the Carboniferous of Central Ireland (1:100,000 scale.O.S. Sheets 12. 13, 15, 16, 17, 18 and 19*. Geological Survey of Ireland.
HOLLAND, C.H. and SMITH, D.G. 1979. Silurian rocks of the Capard Inlier, County Laois, *Proceedings of the Royal Irish Academy*, 99-110.
HOWES, M.J., BOLAND, M.A., FLEGG, A.M. and MacKENNA, K. 1988. Quarry directory of active quarries and pits in Ireland. *Geol. Surv. Ire. Rep. Ser.* RS88/3.
HUXLEY, T.H. AND WRIGHT, E.P. 1867. On a collection of Fossil Vertebrata from the Jarrow Colliery, County Kilkenny, Ireland. *Sci. Trans. R. Irish Acad.* 24, 1-19.

JOHNSTON, I.S. 1976. The Conodont Biostratigraphy of some Lower Carboniferous (Courceyan Stage) rocks of Central Ireland. Unpublished Ph.D. thesis, University of Dublin.
JOHNSTON, J.D., COLLER, D., MILLAR, G. and CRITCHLEY, M.F. 1996. Basement structural controls on Carboniferous-hosted base metal mineral deposits in Ireland, *In* : *Recent Advances in Lower Carboniferous Geology* (eds) Strogen, P., Somerville, I.D., and Jones, G.Ll.), Geological Society, Special Publication, No. 107, 1-21.
JONES, G.LL. and SOMERVILLE, I.D. 1996. Irish Dinantian biostratigraphy: practical application. *In*: Strogen, P., Somerville, I.D. and Jones, G.Ll (eds). *Recent Advances in Lower Carboniferous Geology*. Geological Society, Special Publication, No. 107, 253-262.
JUKES, J.B. and WYNNE, A.B. 1860. *Explanations to accompany sheet 145 of the Maps of the Geological*
JUKES, J.B., KINAHAN, G.H.K., BAILY, W.H. & DU NOYER, G.V. 1859. Explanation of Sheet 137 (F orillerly Quarter Sheet 40 N .E.) of the Maps of the Geological Survey oflreland. *Me m. Geol. Surv. Ire.* 54pp.
KANE, R. 1844. *Industrial Resources of Ireland.* Dublin. pp. xii + 417.
KANE, R., 1844. *The Industrial Resources of Ireland.* Dublin, 417pp.
KINAHAN, G.H. 1886. Irish marbles and limestones. *Scientific Proceedings of the Royal. Dublin Society*, **5**, 372- 444.
KINAHAN, G.H. 1888. Slates and clays (Bricks, etc.). *Scientific Proceedings of the Royal. Dublin Society*, **6**, 69-106.
KINAHAN, G.H. 1889. Economic geology of lreland. *JR. Geol. Soc. Jr.* 8.
LEES, A. 1964. The structure and origin of the Waulsortian (Lower Carboniferous) 'reefs' of west-central Eire. *Philosophical Transactions of the Royal Society London,* 247B, 483-531.
LEES, A. and MILLER J. 1985. Facies variation in Waulsortian buildups: Part 2 : Mid Dinantian buildups from England and North America, *Geological Journal,* 20, 159-180.
LEES, A. and MILLER, J. 1995. Waulsortian Banks, *Special Publications of the International Association of Sedimentologists*, 23, 191-271.
LEWIS, H. and COUPLES, G.D. 1999. Carboniferous basin evolution of central Ireland –simulation of structural controls on mineralization. *In*: McCaffrey, K.J.W., Lonergan, L and Wilkinson, J.J. (eds). *Fractures, Fluid flow and Mineralization* Geological Society, Special Publication No. 151, 233-245.
LOUGHLIN, W.E. 1976. Graptolites of Lower Wenlock age from the Slieve Bloom Inliers, Kinnity, Co. Offaly. *Irish Naturalists Journal*, 18, 282–283.
MacDERMOT, C.V. and SEVASTOPULO, G.D. 1972. Upper Devonian and Lower Carboniferous stratigraphical setting of Irish Mineralization. *Geological Survey of Ireland Bulletin*, 1, 267-280.
MARCHANT, T.R. and SEVASTOPULO, G.D. 1980. The Calp of the Dublin District, *Journal of Earth Sciences Royal Dublin Society,* 3, 195-203.
MILLER, J. 1986. Facies relationships and diagenesis in Waulsortian mudmounds from the Lower Carboniferous of Ireland and N. England. *In* : (eds) Schroeder, J.H. and Purser, B.H. *Reef diagenesis*, Springer-Verlag, Berlin, 311-335.
MORRIS, P. and MAX, M.D. 1995. Magnetic crustal character in Central Ireland. *Geological Journal*, 30, 49-68.
MURPHY, F.C. 1988. *Southern Uplands Workshop: Itinerary for Central Ireland*. Southern Uplands/Longford-Down Field Workshop guide, unpublished, 5pp.
MURPHY, F.C., ANDERSON, T.B., and 17 co-authors. 1991. An appraisal of Caledonian Suspect Terranes in Ireland. *Irish Journal of Earth Sciences*, 11, 11-41.
MURPHY, F.C., ANDERSON, T.B., DALY, J.S., GALLAGHER, V., GRAHAM, J.R., HARPER, D.A.T., JOHNSTON, J.D., KENNAN, P.S., KENNEDY, M.J., LONG, C.B., MORRIS, J.H. , O'KEEFFE, W.G., PARKES, M., RYAN, P.D., SLOAN, R.J., STILLMAN, C.J., TIETZSCH-TYLER, D., TODD, S.P. and WRAFTER, J.P. 1991. Appraisal of Caledonian suspect terranes in Ireland. *Irish Journal of Earth Sciences,* 10, 181-198.
NAGY, ZS. R., SOMERVILLE, I.D., BECKER, S., GREGG, J. M., WRIGHT, W. JOHNSON, A.W. and SHELTON, K. L. 2001. Petrology and biostratigraphy of carbonate rocks from the ?lower to upper Viséan (Lower Carboniferous) Milford Formation, Co. Carlow, Ireland. Abstracts, *Geological Society of America* Annual Meeting, Boston, November 5-8, 2001, A-443.

NEVILL, W.E. 1956. The Millstone Grit and Lower Coal Measures of the Leinster Coalfield, with an appendix on the non-marine fauna by R.M.C. Eagar. *Proc. R. Jr. Acad.* 58, Sect. B, 1-16.
NEVILL, W.E. 1957b. Sand volcanoes, sheet slumps and stratigraphy of part of the Slieveardagh Coalfield, Co. Tipperary. *Scient. Proc. R. Dub/. Soc.* 27, 313-324.
NEVILL, W.E. 1961. The Westphalian of Ireland; Monaghan Coalfield by J.S.Jackson, with a note on the non-marine lamellibranch faunas and their zonal significance in the Leinster, Slieveardagh and Kanturk Coalfields by R.M.C. Eagar. *CR. 4me. Cong. int. Strat. Geol. Carb.,* Heerlen 1958 2, 453-460.
O'MEARA, M. 1964. *Leinster Coalfield, 1959-63 drilling report.* Geol. Surv. Ire. Unpubl. Rep. 169pp.
PHILCOX, M.E. 1984. *Lower Carboniferous lithostratigraphy of the Irish Midlands*, Irish Association for Economic Minerals. special publication, 89pp.
PHILCOX, M.E. 1994. Summary of the Succession in GSI Borehole 91-25 (Milford, Co. Carlow). *Geol. Surv. Ire. Unpubl. Rep.* 11 pp.
PHILCOX, M.E. 1994a. The Lower Carboniferous Geology of 1:100,000 Sheet 16, Kildare-Wicklow. *Geol. Surv. Ire. Unpubl. Rep.* 25pp.
SEVASTOPULO, G.D. 1981. Carboniferous (Silesian). *In:* Holland, C.H. (ed.). *A Geology of Ireland,* Dunedin Academic Press, Edinburgh, 289-312.
SEVASTOPULO, G.D. 1981. Upper Carboniferous. *In:* C.H. Holland (ed.) *A geology of Ireland.* Scottish Academic Press, 173-187.
SEVASTOPULO, G.D. and WYSE JACKSON, P.N. 2001. Carboniferous (Dinantian). *In:* Holland, C. H. (ed.). *The Geology of Ireland,* Dunedin Academic Press, Edinburgh, 241-288.
SLEEMAN, A. G. 1990. *Preliminary Geological Map of the Rathdowney District.* 1:100,000 scale Geological Map, Special Edition, Geol. Surv. Ire.
SMITH, D.G. 1979. The distribution of trilete spores in Irish Silurian rocks. *In*: Harris, A.L., Holland, C.H., and Leake, B.E. (eds). *The Caledonides of the British Isles-Reviewed* Geological Society of London Special Publication, 8, 423431.
SOMERVILLE, I.D. 2002. Review of Irish Lower Carboniferous (Mississippian) mud-mounds: depositional setting, biota, facies and evolution*. Society for Economic Paleontologists and Mineralogists Special Publication.* In press.
SOMERVILLE, I.D. and COZAR, P. 2002. Depositional setting and palaeocecology of *Siphonodendron* biostromes in Upper Viséan of SE Ireland. *Abstracts 46th Annual Meeting Palaeontological Association, Cambridge, December 15-18, 2002.*
SOMERVILLE, I.D., JONES, G.LL. and PHILCOX, M.E. 1996. *Supra-WaulsortianWorkshop*. Irish Association for Economic Geology. Dublin, p. 1-78.
STROGEN, P. 1974. The sub-Palaeozoic basement in Central Ireland. *Nature* 250, 562-563.
WYNNE, A.B. 1862. Explanation to accompany Sheets 126 and 125 (eastern part) of the maps of the Geological Survey of Ireland. *Memoirs of the Geological Survey of Ireland,* 40pp.
YOUNG, C.P. 1963/64. *Field mapping notes and unpublished interpretation of the sedimentary geology of the Old Red Sandstone of the Slieve Bloom Mountains.* Unpublished manuscript, 19 pp, 10 enclosures.

Appendix 3 - Bibliography – County Laois Quaternary References

These references all cover the Quaternary, or Ice Age, geology of County Laois. They are split into references specifically covering sites or features in County Laois, and a section of national or regional papers which have some data from or on County Laois included.

QUATERNARY REFERENCES WITH DIRECT REFERENCE TO LAOIS

ADAMS, A.L., 1878. On the recent and extinct Irish mammals. *Scientific Proceedings of the Royal Dublin Society*, **2**, 45-86.

BOWEN, D.Q., PHILIPPS, E.M., MCCABE, A.M., KNUTZ, P.C. and SYKES, G.A., 2002. New data for the last glacial maximum in Great Britain and Ireland. *Quaternary Science Reviews*, **21**, 89-101.

BRADSHAW, R.H.B. and BROWNE, P., 1987. Changing patterns in the post-glacial distribution of *Pinus sylvestris* in Ireland. *Journal of Biogeography*, **14**, 237-248.

CHARLESWORTH, J.K., 1928. The glacial retreat from central and southern Ireland. *Quarterly Journal of the Geological Society of London*, **84**, 293-344.

CHARLESWORTH, J.K., 1963a. Some observations on the Irish Pleistocene. *Proceedings of the Royal Irish Academy*, **62B**, 295-322.

CHARLESWORTH, J.K., 1963b. *Historical geology of Ireland*. Oliver and Boyd, 565 pp..

CHARLESWORTH, J.K., 1973. Stages in the dissolution of the last ice sheet in Ireland and the Irish Sea Region. *Proceedings of the Royal Irish Academy*, **73B**, 79-85.

CLOSE, M.H., 1867. Notes on the General Glaciation of Ireland, *Journal of the Royal Geological Society of Ireland*, **1**, 207-242.

CONRY, M., 1987. *Soils of County Laois*. Soil Survey Bulletin Number **41**. An Forás Talúintais, Dublin, 260pp.

COXON, P. and BROWNE, P., 1991. Glacial deposits of central and western Ireland. In: Ehlers, J., Gibbard, P.L. and Rose, J. (Editors), Glacial deposits in Great Britain and Ireland. Balkema, Rotterdam, pp. 355-365.

COXON, P. and MCCARRON, S., 2009. Cenozoic, Tertiary and Quaternary. In: Holland, C.H. and Sanders, I.H. (Editors) *The Geology of Ireland*. Second Edition, 355-396.

CRUSHELL, P., 2000. Irish Fen Inventory – a review of the status of fens in Ireland. *Irish Peatland Conservation Council*, Dublin, 100 pp.

DALY, D. AND MISSTEAR, B.D.R., 1976. *A preliminary hydrogeological study of of the Castlecomer Plateau, S.E. Ireland*. Unpublished MSc. Dissertation, University of Birmingham, 65pp.

DALY, D., LLOYD, J.W., MISSTEAR, B.D.R. and DALY, E.P., 1980. Fault control of groundwater flow and hydrochemistry in the aquifer system of the Castlecomer Plateau, Ireland. *Quarterly Journal of Engineering Geology,* **13**, 167-175.

DALY, E.P., 1983. Water in the landscape: groundwater resources. In: Feehan, J. (Editor) Laois: an environmental history. Ballykilcavan Press, Stradbally,

DEAKIN, J., FITZSIMONS, V., GATELY, C. and WRIGHT, G., 2004. *County Laois Groundwater Protection Scheme: Main Report*. Geological Survey of Ireland, Dublin, 48pp.

DOWLING, L.A. and COXON, P., 2001. Current understanding of Pleistocene stages in Ireland. *Quaternary Science Reviews*, **20**, 1631-1642.

FEEHAN, J., 1979. *The landscape of Slieve Bloom: a study of its natural and human heritage*. Dublin, Blackwater Press, 284pp.

FEEHAN, J., 1980. *The geology of Slieve Bloom and the northern Devilsbit Mountains.* Unpublished PhD. Thesis, Trinity College, Dublin.

FEEHAN, J., 1983. Laois: an environmental history. Ballykilcavan Press, Stradbally, 552pp.

FEEHAN, J., 2010. *The spirit of place: sacred character in the landscape of Laois*. O'More College of Design, 2010 Anthology, 68-124. Franklin, Tennesse.

FEEHAN, J., 2013. *The Geology of Laois and Offaly*. Offaly County Council in association with Laois County Council and the Geological Survey of Ireland, 405pp.,

FEEHAN, J. and O'DONOVAN, G., 1996. *The Bogs of Ireland*. The Environmental Institute, University College Dublin.
FEEHAN, J., O'DONOVAN, G., RENOU-WILSON, F. And WILSON, D., 2008. *The Bogs of Ireland: an introduction to the Natural, Cultural and Industrial Heritage of Ireland Peatlands* (Revised Edition). The Environmental Institute, University College Dublin.
FITZSIMONS, V. and WRIGHT, G., 2000. *An assessment of the quality of public and group scheme groundwater supplies in County Laois*. Unpublished report, Geological Survey of Ireland, Dublin, 32pp.
FLEGG, A., 1980. *Brick clays at Tinwear, County Laois*. Extracts from the Minerals Inventory of the Geological Survey of Ireland, Dublin.
GALLAGHER, C.J.D., 1991. *Geomorphology of alluvial heavy mineral distributions in the Slieve Bloom Mountains, central Ireland*. Unpublished PhD Thesis, National University of Ireland.
GALLAGHER, C.J.D., 1997. Alluvial heavy minerals as indicators of Late Pleistocene Ice Flow in the Irish Midlands. *Irish Geography*, **30(1)**, 37-48.
GALLAGHER, C.J.D. and THORP, M., 1995. The fluvial concentration of alluvial heavy minerals in the Slieve Bloom Mountains, central Ireland. *Irish Geography*, **28**, 14-34.
GALLAGHER, C.J.D., THORP, M. and STEENSON, P., 1996. Glacier dynamics around the Slieve Bloom Mountains, central Ireland. *Irish Geography*, **29(2)**, 67-82.
GEISSEL, H., 2006. *A road on the long ridge: in search of the ancient highway of the eiscir riada*. CRS Publications, 72pp.
GIBSON, P., 2007. *Heritage Landscapes of the Irish Midlands*. Geography Publications, Dublin, 340 pp.
HAMMOND, R.F. and DALY, D., 1987. *Offaly and West Kildare: Field Guide Number 10*. Irish Association for Quaternary Studies, Dublin.
HEERY, S., 2007. *A survey of tufa-forming (petrifying) springs in the Slieve Bloom, Ireland*. Unpublished report for Offaly and Laois County Councils.
KILROE, J.R., 1907. The River Shannon: its present course and geological history. *Proceedings of the Royal Irish Academy*, **26B**, 74-96.
MCCABE, A.M., 1985. Glacial geomorphology. In: Edwards, K.J. and Warren, W.P., (Editors), *The Quaternary history of Ireland*, pp. 67-93. Academic Press, London.
MCCABE, A.M., 1987. Quaternary deposits and glacial stratigraphy in Ireland. *Quaternary Science Reviews*, **6**, 259-299.
MCCABE A.M., 1991. The distribution and stratigraphy of drumlins in Ireland. In: Ehlers J, Gibbard PL, Rose J. (Editors), *Glacial deposits in Great Britain and Ireland*. Balkema, Rotterdam, 421-435.
MCCABE, A.M., 2008. *Glacial Geology and geomorphology: The Landscapes of Ireland*. Dunedin Academic Press, 274pp.
MISSTEAR, B.D.R., DALY, E.P., DALY, D. and LLOYD, J.W., 1980. *The groundwater resources of the Castlecomer Plateau*. Geological Survey of Ireland Report Series **RS 80/3**, 31pp.
MITCHELL, F.J.G., 2009. The Holocene. In: Holland, C.H. and Sanders, I.H. (Editors) *The Geology of Ireland*. Second Edition, 397-404.
MITCHELL, F. and DELANEY, C., 1997. The Quaternary of the Irish Midlands. *Irish Association for Quaternary Studies (IQUA) Field Guide Number 21*.
MITCHELL, G.F., 1998. The Ice Age. Chapter 2 of Mitchell, G.F. and Ryan, M., *Reading the Irish Landscape*, Townhouse Press, pp. 35-80.
O'KELLY, J., 1866. *Explanation to accompany Sheets 117 and 118 of the maps of the Geological Survey of Ireland, illustrating portions of the King's and Queen's Counties and the counties of Galway and Tipperary*. Geological Survey of Ireland, Dublin.
SOLLAS, W.J.,1896. A map to show the distribution of eskers in Ireland. *Scientific transactions of the Royal Dublin Society* **5** Series 2, 795-822.
STEENSON, P., 1993. *A study of preserved till fabrics east of the Slieve Bloom Mountains, County Laois*. Unpublished B.A. dissertation, Geography Department, University College Dublin.
SYNGE, F.M., 1983. The Quaternary Period: the Ice Age and its deposits. In: Feehan, J. (Editor) *Laois – An Environmental History*, 49-57.
SYNGE, F.M. and STEPHENS, N., 1960. The Quaternary period in Ireland-an assessment,

Irish Geography, **4**, 121-130.
TEDD, K., MISSTEAR, B.D.R., COXON, C., DALY, D., HUNTER WILLIAMS, N.H., CRAIG, M. and MANNIX, M, 2011. *Review of groundwater level data in the South Eastern River basin District. EPA STRIVE Programme 2007-2013*. Environmental Protection Agency, Dublin, 254pp.
TEDD, K., MISSTEAR, B.D.R., COXON, C., HUNTER WILLIAMS, N.H. and DALY, D., 2012. Hydrogeological insights from groundwater level hydrographs in SE Ireland. *Quarterly Journal of Engineering and Hydrogeology,* **45***, 19-30.*
TEDD, K.M., COXON, C.E., MISSTEAR, B.D.R., DALY, D., CRAIG, M., MANNIX, A. and HUNTER WILLIAMS, N.H., 2014. An integrated pressure and pathway approach to the spatial analysis of groundwater nitrate: a case study from the southeast of Ireland. *Science of the Total Environment*, **46**, 460-476
VAN DER MEER, J.J.M. and WARREN, W.P., 1997. Sedimentology of late glacial clays in lacustrine basins, Central Ireland. *Quaternary Science Reviews*, **16**, 779-791.
WARREN, W.P., 1987a. Pleistocene Geology. In: Hammond, R.F. and Daly, D. (Editors). *Offaly and West Kildare: Field Guide Number 10*. Irish Association for Quaternary Studies, Dublin, 14-16.
WARREN, W.P., 1987b. Site 8: Slieve Bloom. In: Hammond, R.F. and Daly, D. (Editors). *Offaly and West Kildare: Field Guide Number 10*. Irish Association for Quaternary Studies, Dublin, 49-56.
WARREN, W.P., 1991. *Ireland 1991: INQUA Commission on formation and properties of glacial deposits. Field Guide for excursion*, Geological Survey of Ireland, Dublin, 65pp.
WARREN, W.P., 1992. Drumlin orientation and the pattern of glaciation in Ireland. *Sveriges Geologiska Undersokning, Research Papers*, Series Ca **81**, 359-366.
WARREN, W.P. and ASHLEY, G., 1994. Origins of the ice contact stratified ridges (eskers) of Ireland. *Journal of Sedimentary Research*, **64A**, 433-449.
WARREN, W.P., SMYTH, M., VAN DER MEER, J.J.M. and HAMMOND, R.F., 2002. Chapter 2: Geology. In: Schouten, M.G.C. (Editor) *Conservation and restoration of raised bogs. Geological, Hydrological and Ecological Studies*. Dublin and Driebergen, Duchas, Staatsbosbeheer and the Geological Survey of Ireland, 16-31.
WYNNE, A.B., 1862. *Explanation to accompany Sheet 126 of the one-inch map of the Geological Survey of Ireland, illustrating portions of County Tipperary and the King's and Queen's Counties*. Geological Survey of Ireland, Dublin.

QUATERNARY REFERENCES ON A NATIONAL OR REGIONAL TOPIC WITH INFORMATION CITED ON SITES OR AREAS IN LAOIS

AALEN, F.H.A., WHELAN, K. and STOUT, M., 1997. *Atlas of the Irish Rural Landscape*. Cork University Press, 352pp.
ASHLEY, G.M. and WARREN, W.P., 1995. *Irish Eskers; Origin of ice contact stratified deposits. INQUA Commission on Formation and properties of Glacial Deposits Symposium and field excursion handbook*. Geological Survey of Ireland, Dublin. 59pp.
BELLAMY, D., 1986. *The Wild Boglands: Bellamy's Ireland*. Country House Publishers, Dublin, 178pp.
CARVILLE LEWIS, H., 1894. *Papers and notes on the glacial geology of Great Britain and Ireland*. Longman, Green and Company, London, 649pp.
CHARLESWORTH, J.K., 1963. Some observations on the Irish Pleistocene. *Proceedings of the Royal Irish Academy* **62B**, 295-322.
COLE, G.A.J., 1901. The topography and geology of Ireland. In: Coyne, W.P. (Editor) *Ireland Industrial and Agricultural*. Department of Agriculture, Dublin, 450 pp.
COXON, C.E., 1987a. The spatial distribution of turloughs. *Irish Geography* **20**, 11-23.
COXON, C.E., 1987b. Irish lake Marls. *Appendix 1 in 'Offaly and West Kildare' Irish Quaternary Association Field Guide,* No. 10, pp. 69-72.
COXON, P., 1993. Irish Pleistocence biostratigraphy. *Irish Journal of Earth Sciences* **12**, 83-105.

DAVIES, G.L., 1970. The Enigma of the Irish Tertiary. In: Stephens, N. and Glasscock, R.E. (Editors), *Irish Geographical Studies*. Queens University of Ireland, Belfast, pp. 1-16.
EDWARDS, K.J. and WARREN, W.P., 1985. *The Quaternary history of Ireland*. Academic Press, London.
EHLERS, J., GIBBARD, P. and ROSE, J., 1989 *Glacial Deposits in Great Britain and Ireland*. Balkema, Rotterdam.
FARRINGTON, A. and SYNGE, F.M., 1970. Three local studies of the Irish Pleistocene. In: Stephens, N. and Glasscock, R. (Editors) *Irish Geographical Studies in honour if E. Estyn Evans*. Queens University of Belfast, 49-52.
FEALY, R.M., GREEN, S., LOFTUS, M., MEEHAN, R.T., RADFORD, T., CRONIN, C. and BULFIN, M., 2009. *Teagasc EPA Soil and Subsoil Mapping Project –Final Report. Volumes I and II*. Teagasc, Kinsealy, Dublin.
FEEHAN, J., 2007. Periglacial ventifacts in Ireland. *Irish Geography*, **40(2)**, 206-209.
FEEHAN, J. and O'DONOVAN, G., 1996. *The Bogs of Ireland*. The Environmental Institute, University College Dublin.
FLINT, R.F., 1930. The origin of the Irish 'eskers'. *Geographical Review* **20**, 615-620.
GALLAGHER, P.H. and WALSH, T., 1943. Characteristics of Irish Soil Types – I. *Proceedings of the Royal Irish Academy* **42**, 205-250.
GARDINER, M. and RADFORD, T., 1980. Soil Associations of Ireland and their land-use potential. *Soil Survey Bulletin* **No. 36**, An Foras Taluintais, Dublin, 142 pp.
GLANVILLE, C. and WARREN, W.P., 1995. Eskers and associated gravels map of Ireland (Draft), 1:120,000 scale. Quaternary Section, Geological Survey of Ireland, Dublin.
GREENWOOD, S.L. and CLARK, C.D., 2008. Subglacial bedforms of the Irish ice sheet. *Journal of Maps* 2008, 332-357.
GREENWOOD, S.L. and CLARK, C.D., 2009a. Reconstructing the last Irish Ice Sheet 1: changing flow geometries and ice flow dynamics deciphered from the glacial landform record. *Quaternary Science Reviews* **28**, 3085-3100.
GREENWOOD, S.L. and CLARK, C.D., 2009b. Reconstructing the last Irish Ice Sheet 2: a geomorphologically-driven model of ice sheet growth, retreat and dynamics. *Quaternary Science Reviews* **28**, 3101-3123.
GREGORY, J.W., 1920. The Irish Eskers: Royal Society (London), *Philosophical transactions* Ser. B, v. 210, 115-151.
HAMMOND, R.F., 1981. The Peatlands of Ireland. *Soil Survey Bulletin* **No. 35** (to accompany the Peatland Map of Ireland, 1978). An Foras Taluintais, Dublin, 60pp.
HOLLAND, C.H., 2001. *The Geology of Ireland* (Second Edition). Edinburgh, Dunedin Academic Press, 532 pp.
HULL, E., 1878. *The physical geology and geography of Ireland*. London, 328pp.
KILROE, J.R., 1907. *A description of the soil geography of Ireland*. Her Majesty's Stationery Office, Dublin, 300pp.
KINAHAN, G. H., 1878. *Manual of the Geology of Ireland*. Dublin. 444pp.
KINAHAN, G.H, 1887a. Irish arenaceous rocks – sands, sandstones, grits, conglomerates, quartz rocks and quartzytes. *Scientific Proceedings of the Royal Dublin Society*, **5**, 507-620.
KINAHAN, G.H, 1887b. Irish marbles and limestones. *Scientific Proceedings of the Royal Dublin Society*, **5**, 372-444.
KINAHAN, G.H, 1888. Slates and clays of Ireland. *Scientific Proceedings of the Royal Dublin Society*, **6**, 143-166.
LEWIS, C.A., 1978. Periglacial features in Ireland: an assessment. *Journal of Earth Science, Royal Dublin Society* **1**, 135-142.
LEWIS, C.A., 1985. Periglacial features. In: Edwards, K.J. and Warren, W.P. (Editors) *The Quaternary History of Ireland.* Academic Press, London, pp. 95-113.
MEEHAN, R.T., 2006. A regional glacial readvance in Ireland: self-promulgating theory, or science-based reality? In: Knight, P.G., *Glacier Science and Environmental Change*. Blackwell Scientific Publishing, pp. 264-266.
MIR PELLICER, X., WARREN, W.P., GIBSON, P. and LINARES, R., 2012. Construction of an evolutionary deglaciation model for the Irish Midlands based on the integration of

morphostratigraphic and geophysical data analyses. *Journal of Quaternary Science*, **27(8)**, 807-818.
MITCHELL, G.F., 1980. The search for Tertiary Ireland. *Journal of Earth Sciences of the Royal Dublin Society*, **3**, 13-33.
PRAEGER, R.L., 1937. *The Way that I Went*. Collins Press, Dublin. 394pp.
SMITH, M.J. and KNIGHT, J., 2011. Palaeoglaciology of the last Irish Ice Sheet reconstructed from striae. *Quaternary Science Reviews* **30** (1-2), 147-160.
SYNGE, F.M., 1970. The Irish Quaternary: current views 1969. In: Stephens, N. and Glasscock, R.E. (Editors) *Irish Geographical Studies in honour of E. Estyn Evans*. Geographical Society of Ireland, Dublin.
WARREN, W.P., 1985. Stratigraphy. *In* Edwards, K.J. and Warren, W.P. (Editors), *The Quaternary history of Ireland*. Academic Press, London, pp. 39-65.
WATTS, W. A., 1970. Tertiary and interglacial floras in Ireland. In: Stephens, N. and Glasscock, R.E. (Editors), *Irish Geographical Studies in honour of E. Estyn Evans*, Queens University Belfast, pp. 17-33.
WATTS, W.A., 1985. Quaternary vegetation cycles. *In* Edwards, K. And Warren, W.P. (Editors), *The Quaternary History of Ireland*, Academic Press, London, 155-185.
WHITTOW, J.B., 1974. *Geology and scenery in Ireland*. Dublin, Penguin Books, 304 pp.
WILLIAMS, P.W., 1970. Limestone morphology in Ireland. In: Stephens, N. and Glasscock, R.E. (Editors), *Irish Geographical Studies in honour of E. Estyn Evans*, Geographical Society of Ireland, Dublin. 105-124.
WOODMAN, P. C., McCARTHY, M. and MONAGHAN, N. T. 1997. The Irish Quaternary fauna project. *Quaternary Science Reviews* **16**, 129-15.

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 County Laois 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 and major events, with quiet periods in between. The sites in this audit represent evidence of past geological environments and processes, such as the building of high mountain chains, ice sheets covering the land surface and so on. However, in Laois there are few sites representing the active geomorphological or land-forming processes of today, although some of the stratigraphical sites like Killeshin Glen, are actively eroding river valleys.

Landslides and bog flows
The Geological Survey of Ireland has been compiling national data on landslides in the past decade. There were 50 events recorded in Laois, the majority of which occurred in the Slieve Bloom uplands. http://www.gsi.ie/Programmes/Quaternary+Geotechnical/Landslides/

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 individual flood events in County Laois. Karstic flooding can occur when underground passages are unable to absorb high rainfall events. The Carboniferous limestone bedrock in County Laois is not known to become heavily karstified, like upland limestone areas such as the Burren or the Bricklieve Mountains, although significant karst sites occur at Sluggory Cross Roads and the Darkin Well, just outside Portlaoise.

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. The Office of Radiological Protection, a division of the EPA, is responsible for radiological protection.

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. Laois 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 limestone fissures (as there are no natural barriers to stop pollutants) than it would be in granular deposits, which act as natural filters.

Appendix 5 - Data sources on the geology of County Laois

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 the Geological Survey of 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. Sheets 15 and 16 covers most of County Laois.

19th century 6 inch to the mile fieldsheets
These 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 was distilled into one inch to the mile maps, of which parts of Sheets 125, 126, 127, 128, 135, 136 and 137 cover County Laois. 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

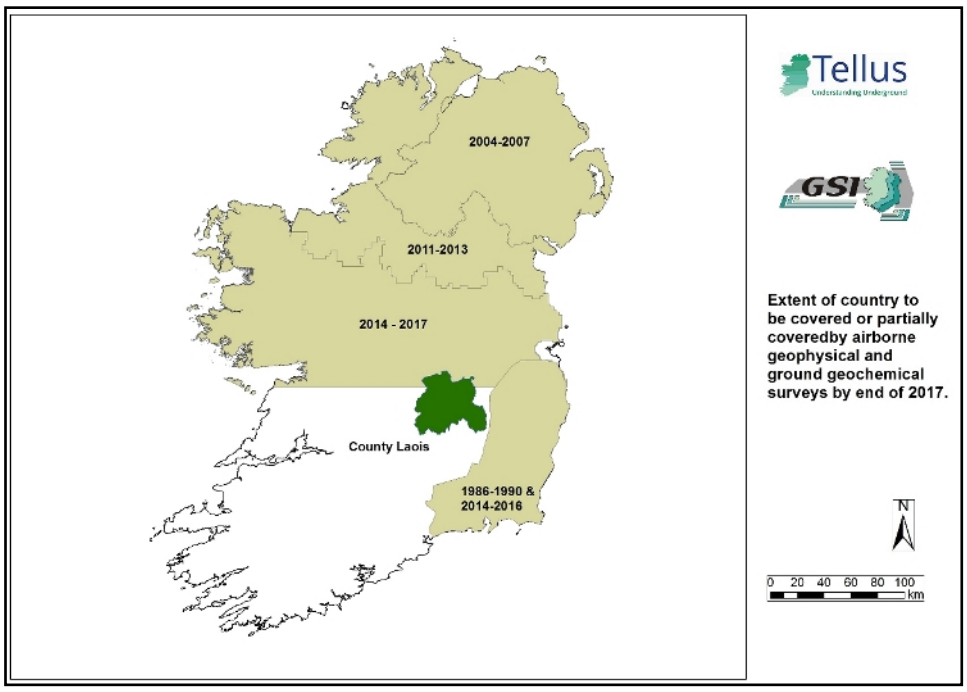
Open File Data
Each Mineral Prospecting Licence issued by the Exploration and Mining Division (EMD), currently of the Department of Communications, Energy and Natural Resources, carries an obligation on the exploration company to lodge records of the work undertaken, for the common good. These records 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 Laois 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. The Geological Survey of Ireland aims to complete Tellus surveying in 50% of the country by the end of 2017, with the view to completing the country in subsequent phases. This will include the northern portion of County Laois. Data will be freely available from www.tellus.ie



Tellus North Midlands Survey Area

Historic Mine Records
Abandonment plans and varied other material exists for the various mining ventures in the country.

Appendix 6 - Further sources of information and contacts

Sarah Gatley of the Geological Survey of Ireland, who is the Head of the Geological Heritage and Planning Programme, can be contacted in relation to any aspect of this report. Catherine Casey, the Heritage Officer of Laois 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 and the Gaeltacht. 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 Laois

[see page 25 for information on Geoschol]

LAOIS

AREA OF COUNTY: 1,719 square kilometres or 663 square miles

COUNTY TOWN: Portlaoise

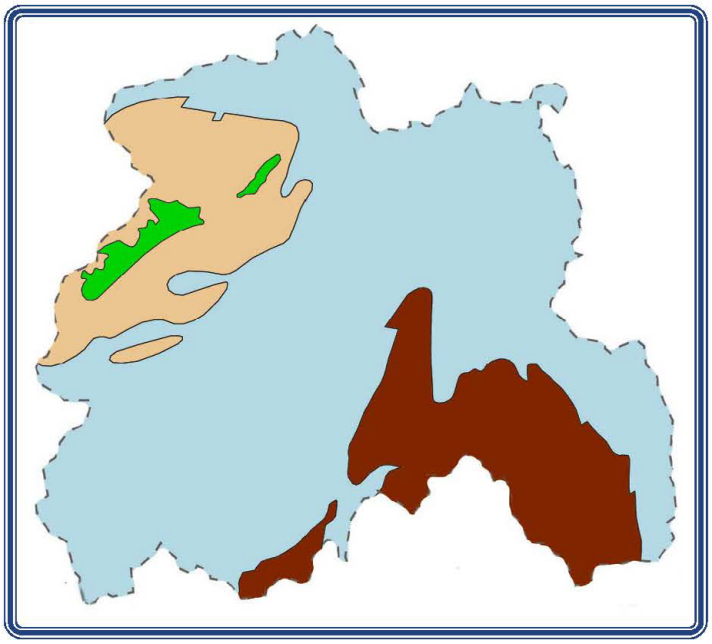
OTHER TOWNS: Abbeyleix, Mountmellick, Mountrath

GEOLOGY HIGHLIGHTS: Limestone quarries, Rock of Dunamase and the Stradbally Hills

AGE OF ROCKS: Silurian - Carboniferous, Pleistocene

Rock of Dunamase

Carboniferous limestone forms the Stradbally Hills and the Rock of Dunamase.



Geological Map of County Laois

Green: Silurian; **Beige:** Devonian; **Light blue:** Lower Carboniferous limestone; **Brown:** Upper Carboniferous shales.

Geological history

The landscape of Co Laois is mostly rather low-lying. In the north-west lies the eastern part of the heavily wooded Slieve Bloom Mountains, which are formed of the oldest rocks in the county, while in the south-east is the northern tip of the Castlecomer Hills, formed of the youngest bedrock in the county.

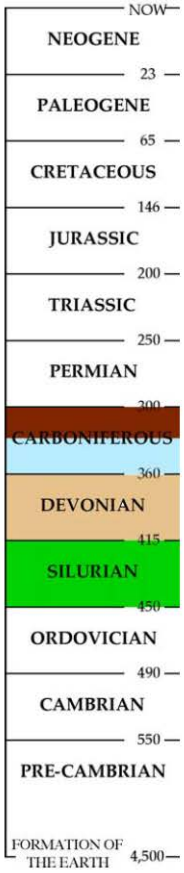
The oldest rocks in the county occur in several patches towards the centre of the Slieve Bloom Mountains where erosion has stripped away the younger rocks, but they are only exposed in the banks of a few streams. These grey mudstones, siltstones and sandstones are Silurian in age, around 425 million years old (Ma), and were deposited on a deep ocean floor. Lying above them 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

Waterfall on the River Barrow flowing over Carboniferous sediments in the Slieve Bloom Mountains

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 sea floor but for a time, around 340 Ma, peculiar steep-sided limestone 'mud mounds' formed on the sea bed. 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 south of the county, notably the Rock of Dunamase.

The low hills in the south-east corner of the county are of younger Carboniferous rocks, between 320 and 315 Ma. The earliest of these particular rocks are black mudstones and



Geological timescale showing age of rocks in Laois.

thin limestones, often containing patches of iron pyrite or 'fools gold', that accumulated in deep, poorly oxygenated water. Above them lie sandstones and mudstones that were deposited by river deltas as sea level fell. Younger still is a series of sandstones and mudstones with thin coal seams, formed from plant material buried in a swamp, that formed the basis of the now defunct Leinster Coalfield.

As elsewhere across Ireland, the ice sheets and glaciers of the last Ice Age have modified the Laois landscape, although in a more subdued way than in some of the more mountainous regions of Ireland. The main effect has been to blanket much of the lowlands with glacial till, or 'boulder clay'.

Laois fossils

Fossils, particularly corals and brachiopods, are common in the Carboniferous limestones exposed in quarries and hillside crags. Slightly younger fossils, particularly plant remains and marine animals called goniatites (right), occur in some of the rocks of the Leinster Coalfield but since the abandonment of the coal mines these rocks are seldom exposed.

Mining & Building Stones

Flagstone Quarry (Upper Carboniferous) at Wolfhill

Many small quarries were opened in the Carboniferous limestones for building stone and agricultural lime but today only the large Ballyadams Quarry is still worked for limestone aggregate and agricultural lime. Mining of high grade coal formerly took place in the Leinster Coalfield, but all of the seams are thin and none of the mines, underground or opencast, are still working.

Map adapted with permission from Geological Survey of Ireland 1:1,000,000 map 2003.
Image credits: Mike Simms 1, 4 (bottom); Kevin Higgins 3 (licensed for reuse under the Creative Commons Licence).

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.
Anthracite	a coal of high rank, that is high in carbon and low in gas and volatile components.
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.
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.
Coal Seam	a coal seam is a strata or bed of coal, outcropping over a wide area, but not necessarily very thick.
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 kilometres 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. glaciation.
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.
Lava	magma extruded onto the Earth's surface, or the rock solidified from it.
Limestone	a sedimentary rock consisting chiefly of calcium carbonate (CaCO3), 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.
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 Laois

An audit of County Geological Sites in County Laois

Section 2 – Site Reports

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

2016

The County Laois Geological Heritage Project was supported by

An Chomhairle Oidhreachta
The Heritage Council

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Laois County Council
Áras an Chontae, Portlaoise, Co Laois

This report is an action of the County Laois Heritage Plan 2014 – 2019

Section 2 - Site Reports

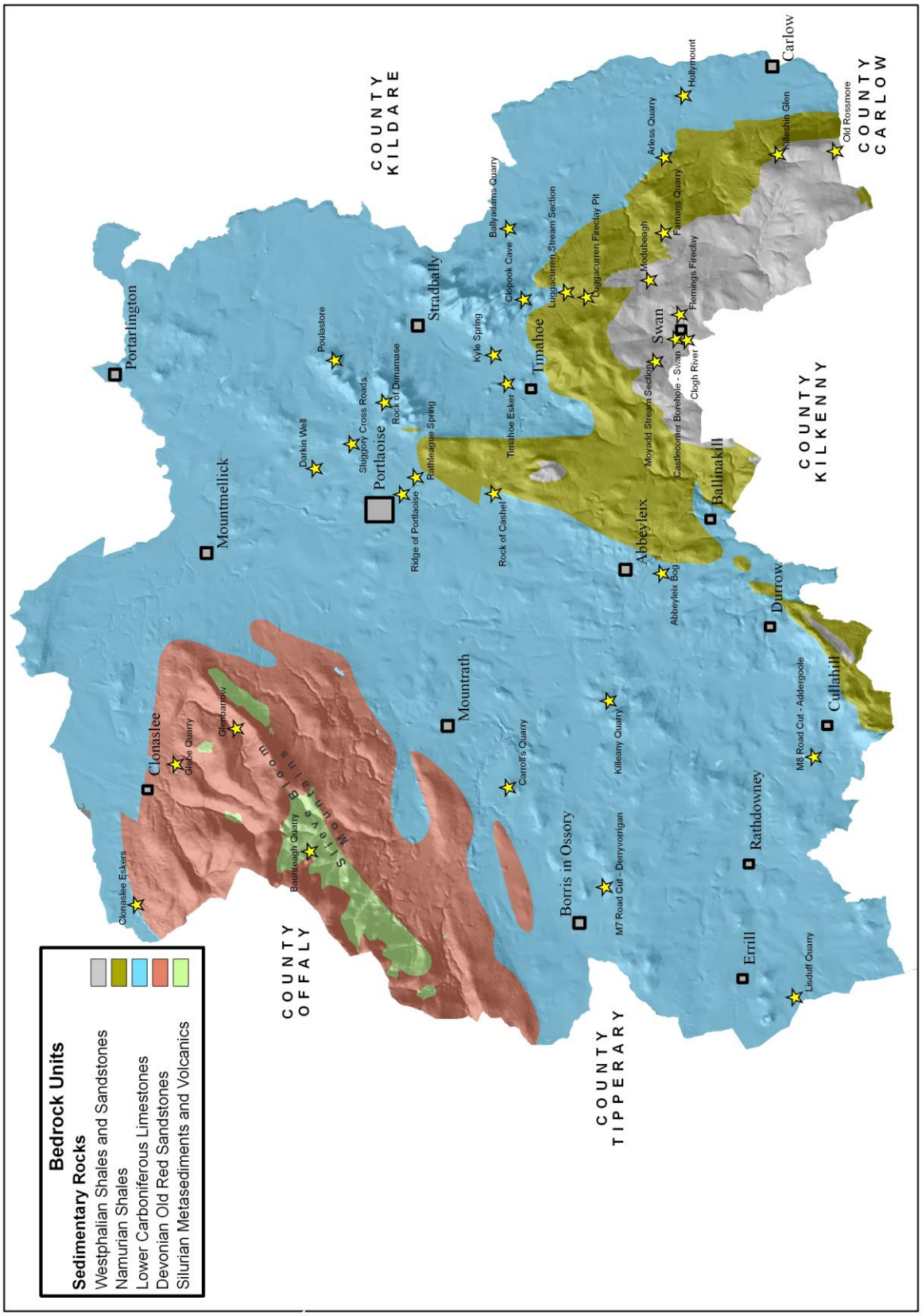
Site reports – general points
The following site reports are brief non-technical summaries of the proposed County Geological Sites for County Laois. These have been specially prepared for this Report in order to make the information accessible to planners and others without geological training. For some sites more detailed reports and information files are held in the IGH Programme in the Geological Survey of 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. 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, 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 the Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin 4. Phone 01-6782837. Email: sarah.gatley@gsi.ie



Simplified Geological Map of County Laois with County Geological Site locations indicated, also outlining the main geological units.

The County Geological Sites

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Abbeyleix Bog**
Other names used for site	Killamuck Bog, Collin's Bog
IGH THEME	**IGH7 Quaternary, IGH16 Hydrogeology**
TOWNLAND(S)	**Tullyroe, Abbeyleix Demesne, Killamuck, Clonkeen, Granafallow,Ballymullen, Knocknamoe**
NEAREST TOWN/VILLAGE	**Abbeyleix**
SIX INCH MAP NUMBER	**23, 29**
ITM CO-ORDINATES	**643300E 682700N (centre of bog)**
1:50,000 O.S. SHEET NUMBER	**60 GSI BEDROCK 1:100,000 SHEET NO. 15, 18**

Outline Site Description
Abbeyleix Bog comprises an extensive area of peatland extending in a low-lying hollow, north to south, for approximately 3 kilometres south of Abbeyleix Town.

Geological System/Age and Primary Rock Type
Abbeyleix 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 from about 7,000-10,000 years ago.

Main Geological or Geomorphological Interest
While today a generally flat and open landscape, the locality of Abbeyleix 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, the bog is also surrounded around its perimeter by broadleaf forestry, recently planted after the peat was cut.

The bog itself comprises partially decomposed vegetation, which sank into marshland within the wide, wet basin. This material was laid 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 site has had a boardwalk built across it recently, as a number of walks have been developed across the site. Other features of peat interest are included within the site boundary, such as intact and drained peat, small pockets of 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 bog and its amenity walks exist due to the geological and hydrogeological process of peat growth, the locality is ranked as a County Geological Site.

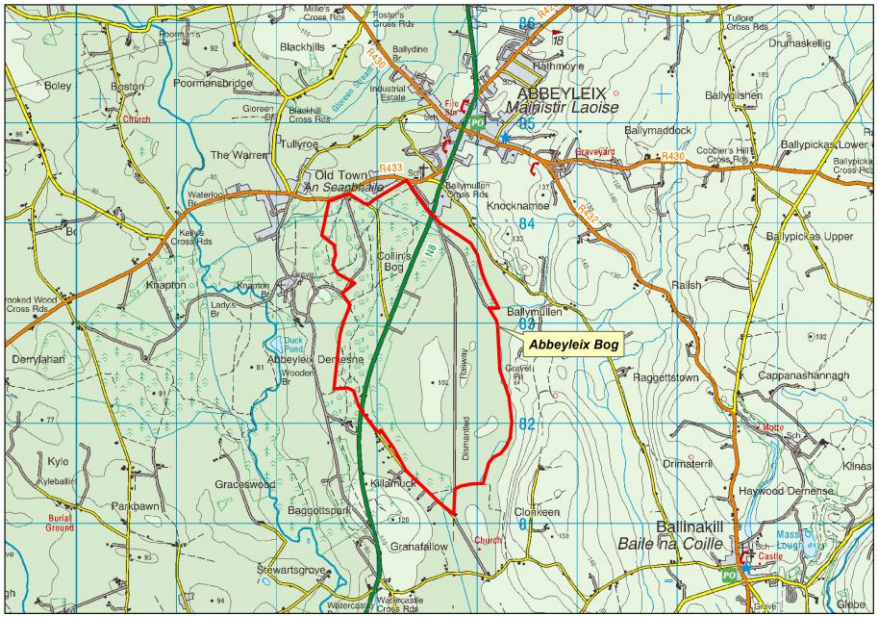
Management/promotion issues
Abbeyleix Bog has a number of walkways within, which were developed by local interests in conjunction with Bord na Móna. The geological aspects of the feature could be highlighted more in some of the promotional material.

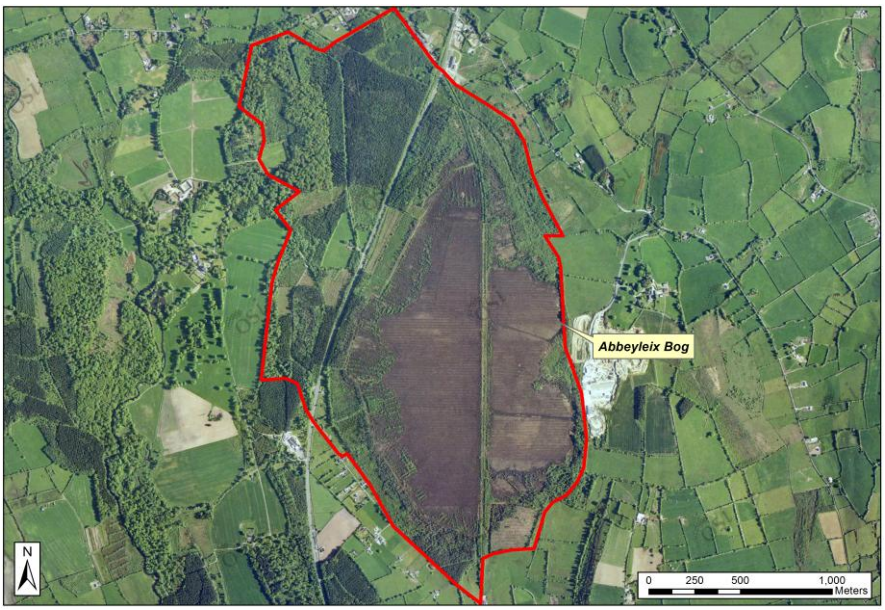
The main dome of Abbeyleix Bog, with the boardwalk across the feature also visible.

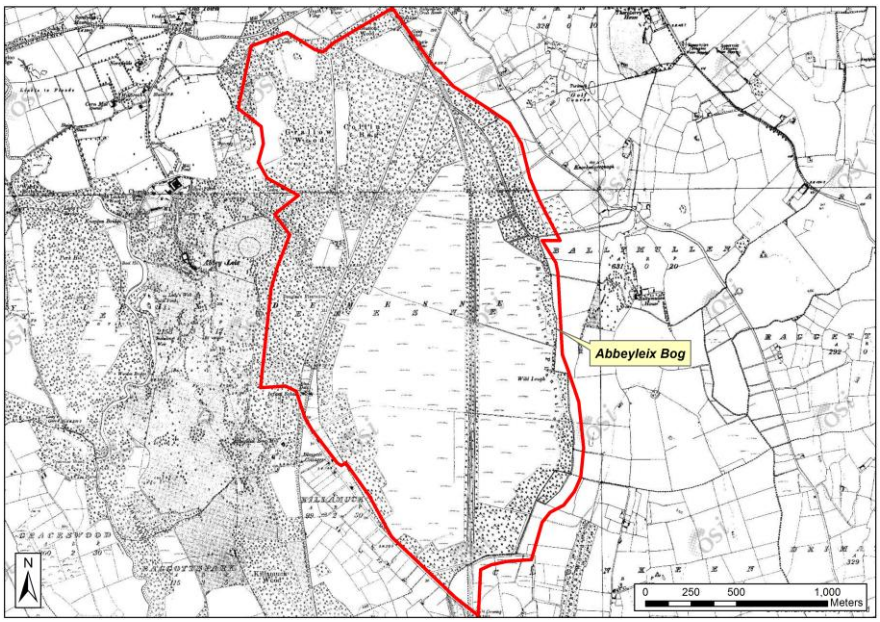
One of the drainage channels exiting the northern side of the bog.

A signboard detailing the flora and fauna of the bogland.

Some of the narrow borardwalk through birch woodland at the edge of the feature.


ABBEYLEIX
Mainistir Laoise
Old Town
An Seanbhaile
Abbeyleix Bog
Ballinakill
Baile na Coille
Blackhills
Poormansbridge
Boley
Boston
The Warren
Tullyroe
Knocknamise
Ballymullen
Collins Bog
Knapton
Derrylahan
Abbeyleix Demesne
Kyle
Graceswood
Killamuck
Parkdawn
Baggotspark
Granafallow
Stewartsgrove
Cloakeen
Drimsterne
Haywood Demense
Raggettstown
Cappanashannagh
Ballypickas Upper
Ballypickas Lower
Ballymaddock
Rathmoyle
Ballyglishen
Drumaskellig
Tullore
Raish
Klinas
Glebe
R433
R430
N8


Abbeyleix Bog
N
0 250 500 1,000
Meters


Abbeyleix Bog
N
0 250 500 1,000
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Arless Quarry**		
Other names used for site	Arless Contact, Arless, Arles Quarry		
IGH THEME	**IGH8 Lower Carboniferous**		
TOWNLAND(S)	**Ballynagall**		
NEAREST TOWN/VILLAGE	**Ballickmoyler**		
SIX INCH MAP NUMBER	**32**		
ITM CO-ORDINATES	**666480E 682575N (centre of quarry)**		
1:50,000 O.S. SHEET NUMBER	**61**	**GSI Bedrock 1:100,000 Sheet No.**	16

Outline Site Description
A small, disused quarry with a restricted area of bedrock outcrop.

Geological System/Age and Primary Rock Type
The quarry is excavated into bedrock where the contact between the Upper Carboniferous (Namurian) age shale of the Luggacurren Shale Formation and the Lower Carboniferous limestone of the Clogrenan Formation can be seen. The Upper Carboniferous shale overlies the limestone in the quarry, and is stratigraphically younger in age.

Main Geological or Geomorphological Interest
The quarry itself is a nice feature, at the base of the slope scarp at the eastern end of the Castlecomer Plateau, and picked out by mature whitethorn trees. The quarry has not been used for some time, and the faces are somewhat overgrown by the surrounding trees.

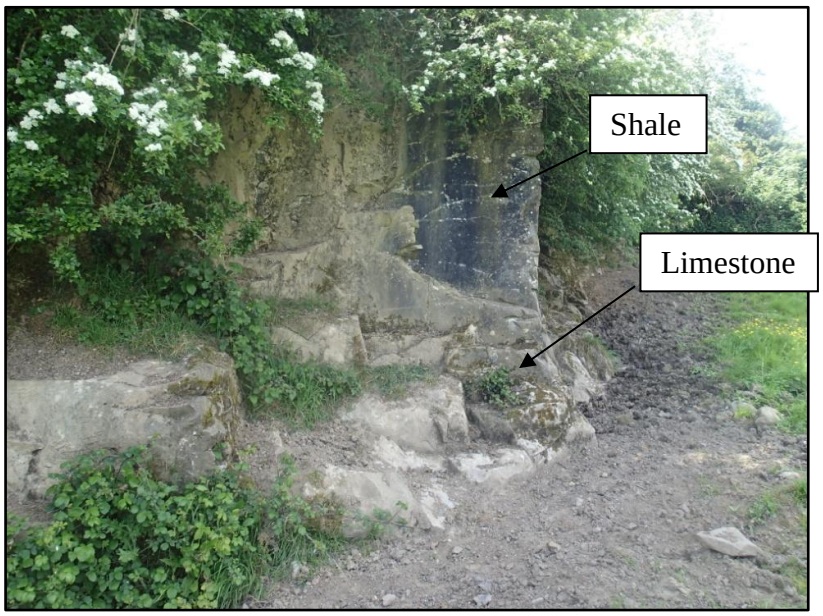
This is a good site for observing two rock types separated within the stratigraphic column as they are of two different ages, but the younger bedrock sits on top of the older bedrock here in a small, disused quarry outcrop within a restricted area only a few metres across.

The shale at the top of the rock face is black and massive, while the underlying grey limestone is grey and karstified, with fissures enlarged by dissolution of the rock. Both the colour and structure of the two rock types therefore differ in an easily observable manner.

Site Importance – County Geological Site
This is a good representative site for a significant part of Laois' geology and the contact between the bedrocks of two ages is not well displayed in many localities.

Management/promotion issues
The inclusion of this quarry as a County Geological Site has absolutely no implications for the normal permitted operation of the land around the quarry. It is hoped that the owner will continue to allow specialist research visits by geological groups by arrangement. It is not suited to general promotion as the quarry is on private land. Health and safety rules must be followed by any geologists visiting with the permission of the owner.

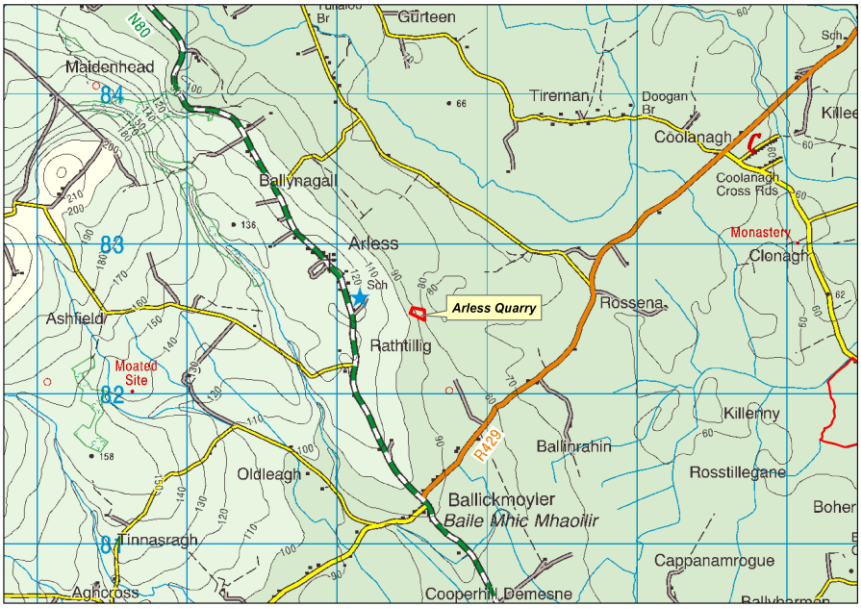
Arless Quarry, looking east.

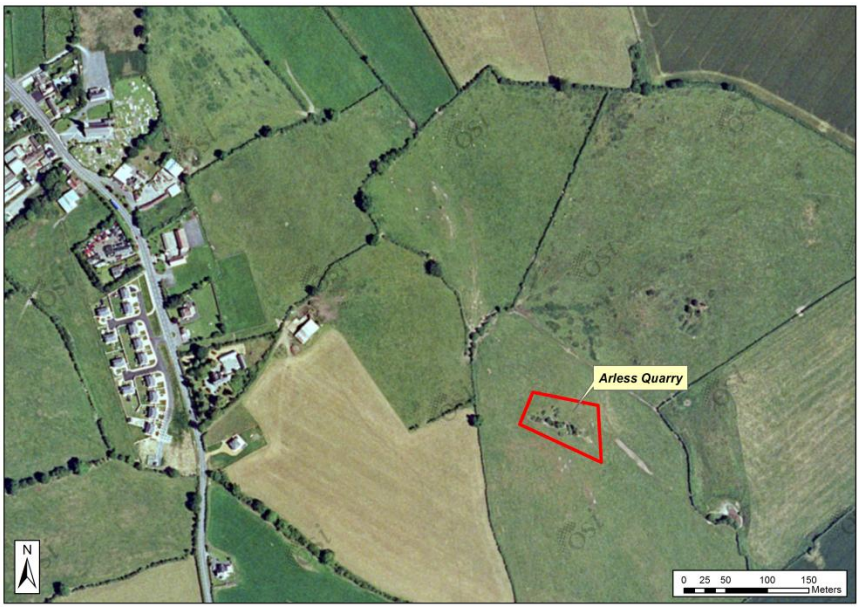


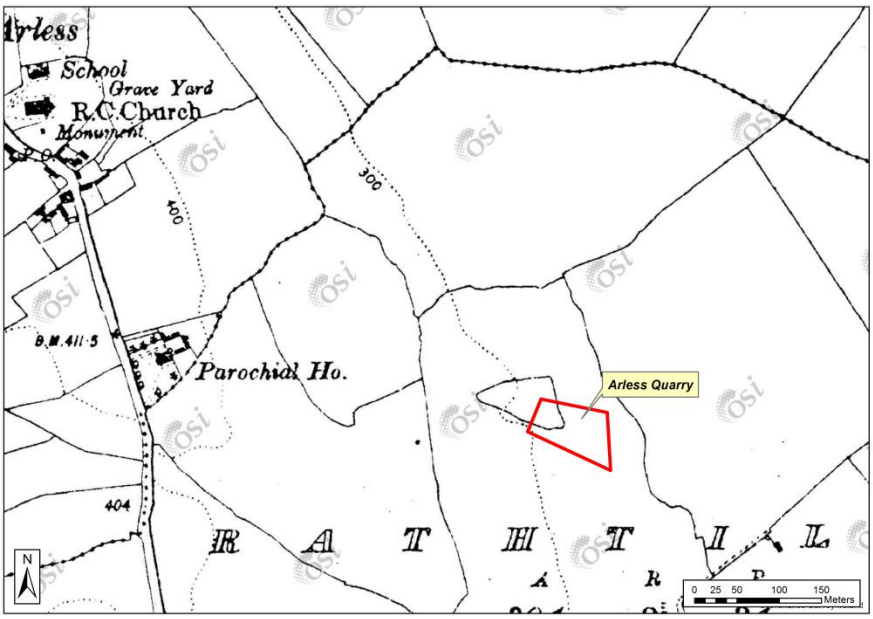
Looking northwards across the outcrop; the contrast between the black, massive shale and the underlying bedded limestone is clearly seen.

A view of the limited extent of bedrock outcrop at Arless Quarry.

Solutionally enlarged fissures in the limestone at the base of the exposure.


Gurteen
Maidenhead
Tirernan
Doogan Br
Coolanagh
Coolanagh Cross Rds
Monastery
Clonagh
Ballynagall
Arless
Arless Quarry
Rossena
Ashfield
Rathtillig
Moated Site
Killenny
Ballinrahin
R429
Oldleagh
Rosstillegane
Ballickmoyler
Baile Mhic Mhaoilir
Tinnasragh
Cappanamrogue
Aghcross
Cooperhill Demesne
84
83
82
81


Arless Quarry
N
0 25 50 100 150
Meters


Arless
School
Grave Yard
R.C.Church
Monument
B.M.411·5
Parochial Ho.
Arless Quarry
RATHTILL
N
0 25 50 100 150
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballyadams Quarry**
Other names used for site	
IGH THEME	**IGH8 Lower Carboniferous**
TOWNLAND(S)	**Ballyadams**
NEAREST TOWN/VILLAGE	**Athy**
SIX INCH MAP NUMBER	**19**
ITM CO-ORDINATES	**662179E 691626N**
1:50,000 O.S. SHEET NUMBER	**55 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
This site is a large working quarry.

Geological System/Age and Primary Rock Type
The quarry works a limestone formation named after this place – the Ballyadams Formation, which is of Holkerian to Asbian age within the Viséan Carboniferous Limestone succession.

Main Geological or Geomorphological Interest
This site is a good representative of the thick sequence of shelf limestones (formed in shallow marine seas) in the Stradbally district. The formation as a whole may be up to 700m thick and the height of the quarry face exposes a large section of this. Cyclical deposition is evident in the face, with several major discontinuities visible. These are clay wayboards marking a volcanic ash eruption which may have created a clay rich horizon or a 'fossil' soil. They may also be karstic surfaces where there is some karstic solution due to exposure or emergence above the sea water for a period.

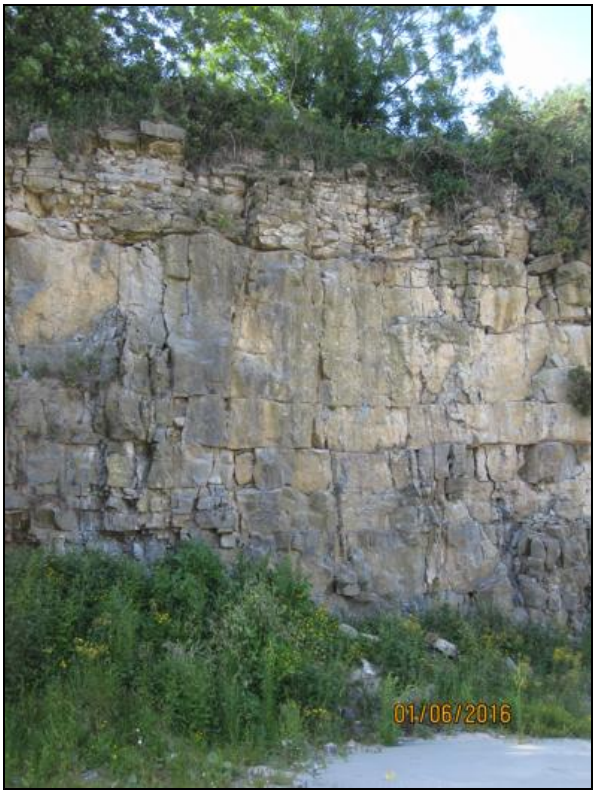
The quarry faces also show the lateral continuity of the limestone beds which are consistently developed over large areas, and in this region, are largely unbroken by faulting. There are also some very fossiliferous beds (mostly recorded in borehole cores), particularly brachiopod shells and corals.

Site Importance – County Geological Site; may be recommended for Geological NHA
This site may be considered for NHA status under the IGH8 Lower Carboniferous theme when all sites are reviewed on a national basis but it is certainly a robust County Geological Site as a representative site for the Carboniferous Limestone of the south east of the county.

Management/promotion issues
The working quarry is unsuitable for promotion without some a specific arrangement supported and agreed by the Roadstone management, as it is a potentially dangerous workplace environment.

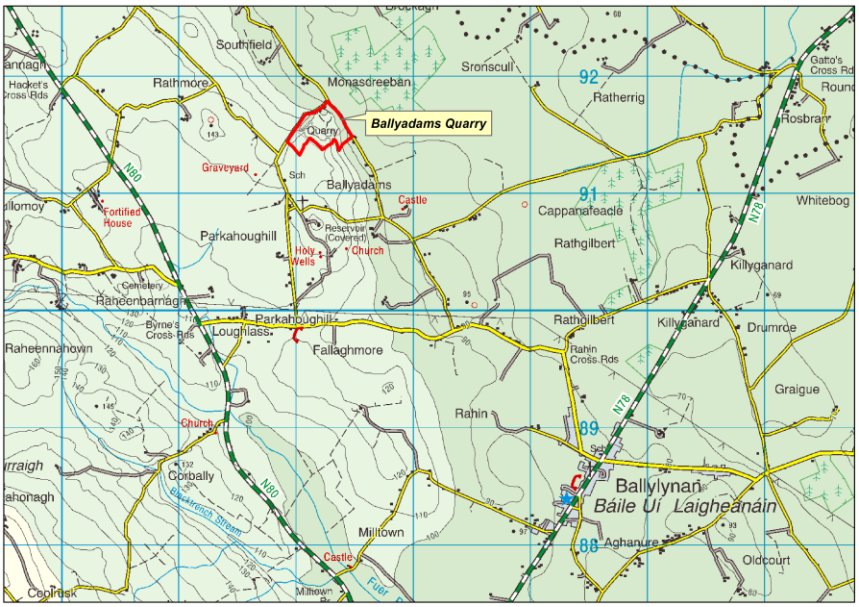
Panorama view of Ballyadams Quarry from the lower, northern side.

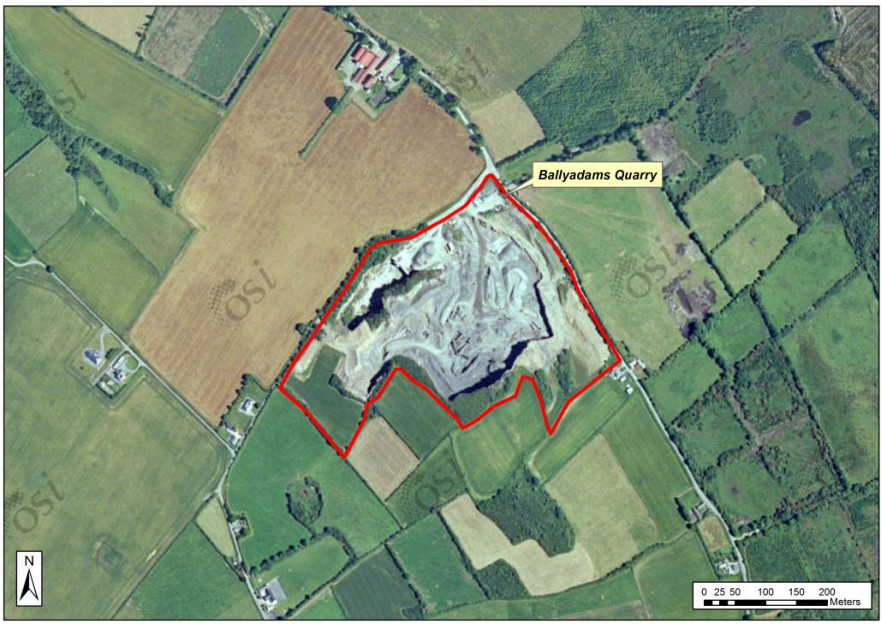
The main quarry faces shows several marked discontinuities which are clay wayboards representing periods of emergence or volcanic ash falls.

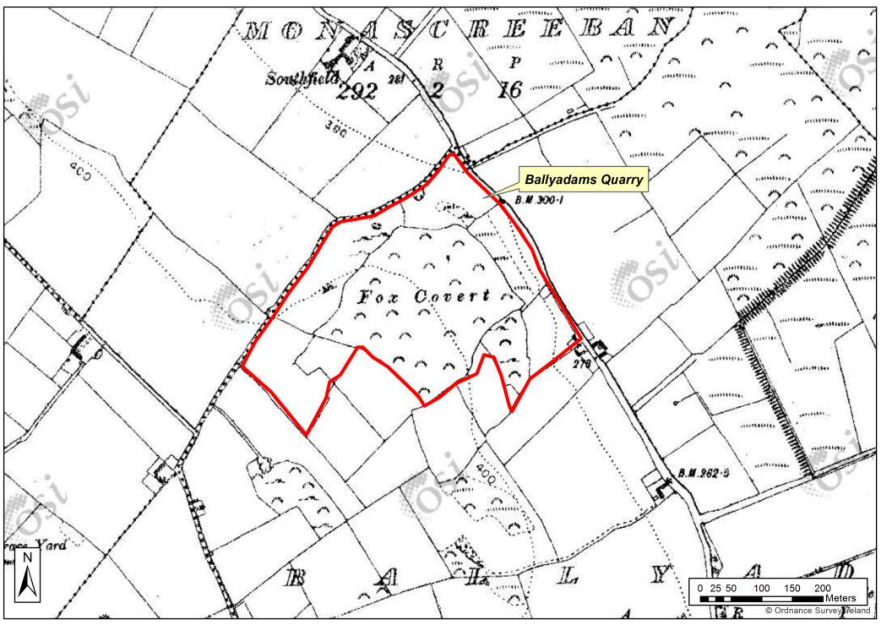


A clay wayboard is seen at the top of the massive beds, with thin beds above it, in an older section on the western quarry margin.

Panorama view of the quarry face from the quarry floor.


Ballyadams Quarry
Southfield
Rathmore
Monasdreeban
Sronscull
Ratherrig
Gatto's Cross Rd
Hacket's Cross Rds
Quarry
Graveyard
Sch
Ballyadams
Castle
Fortified House
Parkahoughill
Reservoir (Covered)
Church
Holy Wells
Cappanafeadle
Whitebog
Rathgilbert
Killyganard
Cemetery
Raheenbarnagh
Byrne's Cross Rds
Loughlass
Fallaghmore
Drumroe
Raheennahown
Rahin Cross Rds
Graigue
Rahin
Church
Corbally
Blackrock Stream
Ballylynan
Báile Uí Laigheánáin
Milltown
Aghanure
Oldcourt
Castle
Coolrusk
N80
N78
92
91
89
88


Ballyadams Quarry
N
0 25 50 100 150 200
Meters


MONASTEREBAN
Southfield
292
2
16
Ballyadams Quarry
B.M 300-1
Fox Covert
B.M 262-5
BALLYADAM
N
0 25 50 100 150 200
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE **Baunreagh Quarry**
Other names used for site
IGH THEME **IGH4 Cambrian-Sliurian**
TOWNLAND(S) **Baunreagh**
NEAREST TOWN/VILLAGE **Mountrath**
SIX INCH MAP NUMBER **11**
ITM CO-ORDINATES **628170E 702615N**
1:50,000 O.S. SHEET NUMBER **54** **GSI BEDROCK 1:100,000 SHEET NO.** **15**

Outline Site Description
Small roadside quarry in two sections, heavily overgrown with vegetation.

Geological System/Age and Primary Rock Type
The siltstone rocks exposed are of the Silurian Capard Formation, found throughout the Slieve Bloom inlier (inlier = older rocks surrounded by younger strata).

Main Geological or Geomorphological Interest
The rocks exposed are of the Silurian Capard Formation, which underlies all of Slieve Bloom. The nature of these rocks and their geological history means that they are very rarely exposed naturally, except in some river beds which can be very difficult to access. So the few man-made exposures are important additions to the understanding and mapping of the rocks, especially as they can provide a much more three dimensional picture of the nature of the rocks. This quarry provides one of the largest exposures available, although it is now much obscured by moss and grass and some saplings.

The rock is a generally uniform siltstone with a poorly developed ‘slaty’ cleavage, meaning it weathers and breaks into smallish pieces in natural circumstances and does not remain as a rock face. The breakdown of the rock into fragments helps soils form and exposures disappear. A horizontal trace across the quarry face is now obscured but was interpreted as a fault gouge – ground up paste of rock from the movements along a small fault.

The few fossils recovered from these siltstones rocks are of Wenlock age, within the Silurian Period. The occurrence of a particular ‘floating’ crinoid called *Actinocrinus wynnei* helps indicate that these were deposited in a deep water environment and they are very similar to same age rocks across Slieve Phelim, Knockshigowna, Slieve Arra, and other uplands of Silurian rocks in the south Midlands.

Site Importance – County Geological Site
Baunreagh Quarry is a good representative example of the Silurian rocks which are otherwise very poorly exposed within the large area where they outcrop in Slieve Bloom. It therefore deserves CGS status.

Management/promotion issues
The quarry has previously been the site of some dumping and small pockets of refuse remain on the floor of the quarry which has a coating of tarmacadam chippings from previous use as a road surfacing resource. The creation of a roadside drainage cut and a berm of material has stopped any vehicles pulling up beside the quarry and all of the floor and walls of the quarry are now heavily vegetated with moss, grass and tree saplings. The geological heritage would benefit greatly from a selected vegetation clearance project.

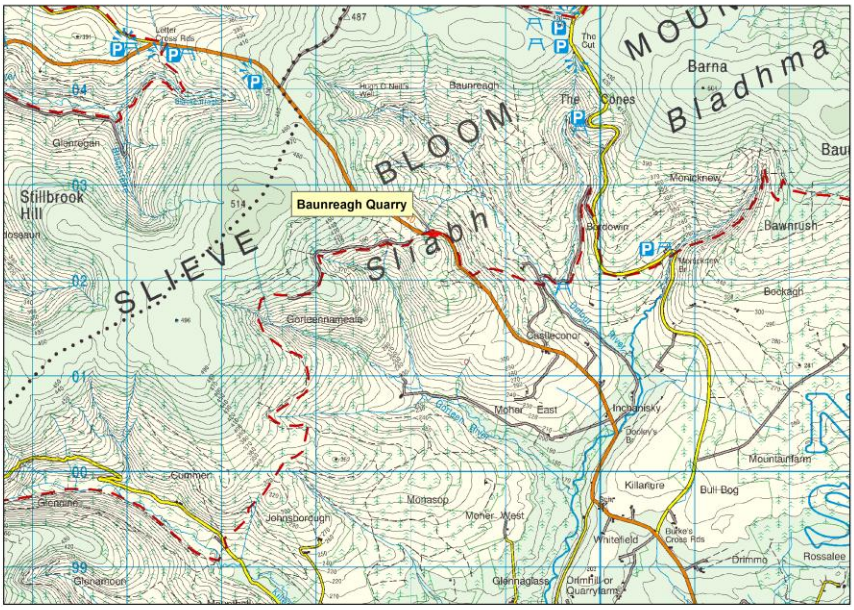
The highly vegetated face of the larger main quarry at Baunreagh.

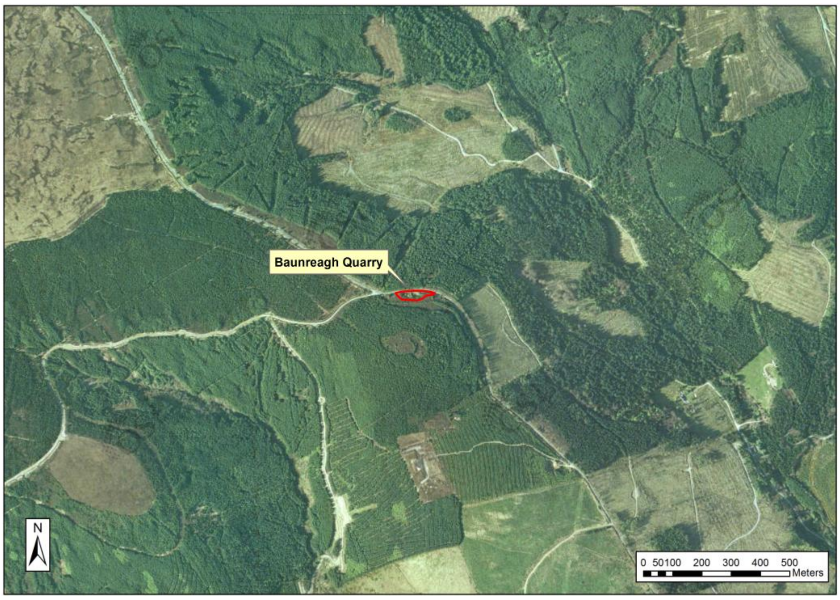
The main face is largely obscured by moss.

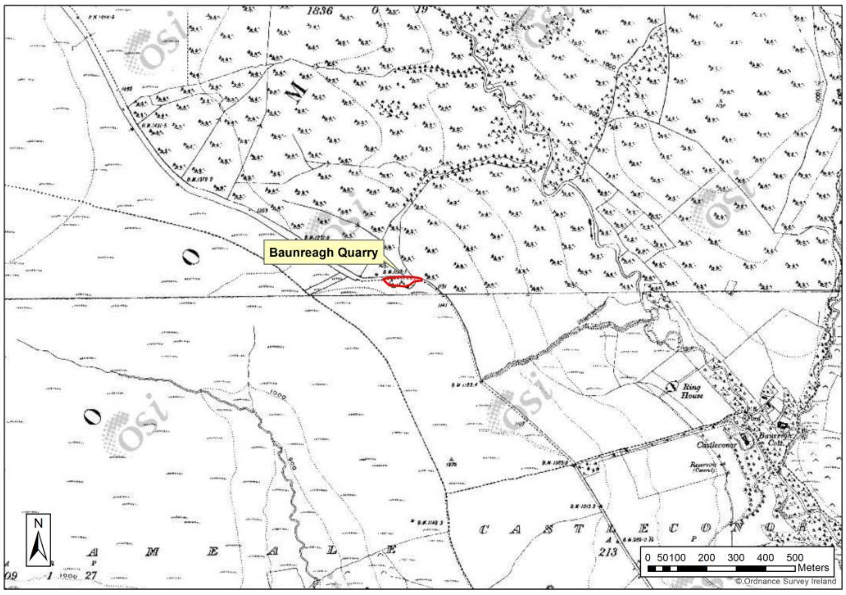
Baunreagh Quarry is easily missed when driving by.

The smaller quarry on the eastern side is small and similarly overgrown.

The higher face is not well exposed due to vegetation growth.


Baunreagh Quarry
SLIEVE
BLOOM
Sliabh
Bladhma
Stillbrook Hill
Barna
The Cones
Baunreagh
Monicknew
Bawnrush
Bockagh
Castleconor
Moher East
Moher West
Inchanisky
Mountainfarm
Killanure
Bull Bog
Whitefield
Glenregan
Glennamoon
Johnsborough
Glennaglass
Rossalee
Drimmo


Baunreagh Quarry
N
0 50100 200 300 400 500
Meters


Baunreagh Quarry
1836
Ring House
Castleconor
N
0 50100 200 300 400 500
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Carroll's Quarry**
Other names used for site	Knockacoller Quarry
IGH THEME	**IGH8 Lower Carboniferous**
TOWNLAND(S)	**Knockacoller**
NEAREST TOWN/VILLAGE	**Castletown**
SIX INCH MAP NUMBER	**16**
ITM CO-ORDINATES	**652950E 698200N**
1:50,000 O.S. SHEET NUMBER	**54, 55 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
A small but prominent, steep-sided limestone hill capped by the ruins of a Norman castle fortress, dating back to the early 12th century.

Geological System/Age and Primary Rock Type
Bedrock comprises Lower Carboniferous (Mississippian, Courceyan) fossil-rich Ballysteen Limestone Formation, deposited in open fully marine depositional conditions.

Main Geological or Geomorphological Interest
The Ballysteen Limestone Formation rocks are typically highly fossiliferous, dark grey, well bedded, muddy limestones, with bands of calcareous shales between the limestone beds. The strata dip gently 5°-15° south, and the quarry faces (east, south, west) exhibit excellent exposures of strata.

This site has hosted a quarry, on the southeast side of Bilberry Hill for at least 170 years. A quarry is illustrated on early on OSI six-inch maps dating from the mid-1800s. Early GSI one inch scale sheets (Sheet 127) from the late 1800's show that the site was recognised as an important fossil locality.

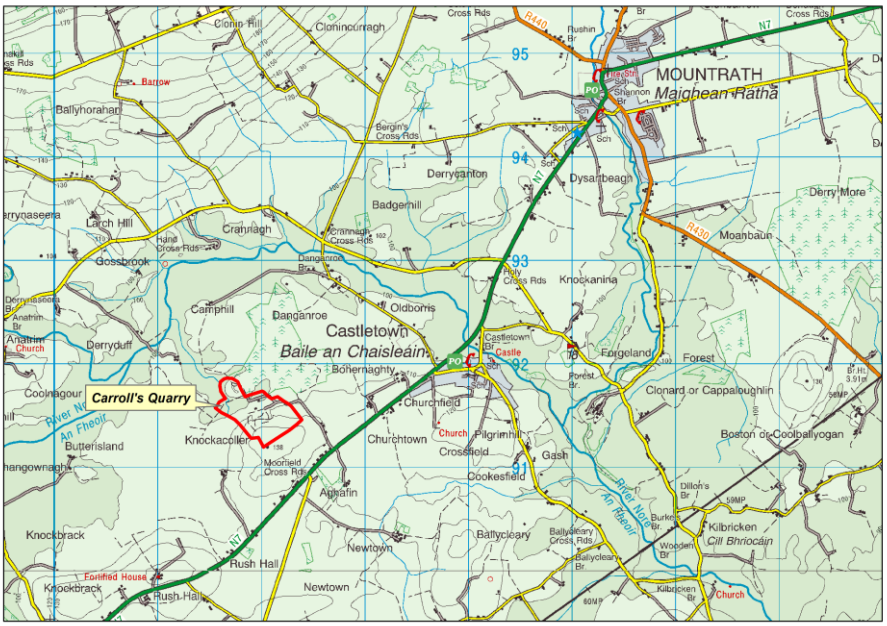
The quarry has produced stone for aggregates, chippings, railway ballast, lime dust, screenings, and drainage stone. Limestones of the Ballysteen Limestone Formation are worked for aggregate in several quarries in the region.

Site Importance – County Geological Site
This County Geological Site is an important representative site exhibiting fresh and extensive exposures of Ballysteen Limestone Formation. The site is adjacent to the NE quarter of Knockacoller Bog SAC (002233).

Management/promotion issues
As a working quarry, the listing as a County Geological Site has no implications for the normal operation of the quarry, subject to standard permissions and conditions under planning and environmental legislation. In the event of any future changes in quarrying operations, it would be desirable to consider retaining representative faces for geological purposes. As an operating quarry, the site is not suitable for any general promotion. Any correspondence can be made to the owner and operators Carroll Quarries, Knockacoller, Castletown, Co. Laois.

Limestone quarry faces at northwest part end of quarry.

South quarry face.


Carroll's Quarry
MOUNTRATH
Maigheann Rátha
Castletown
Baile an Chaisleáin
Knockacollier
Churchtown
Churchfield
Pilgrimhill
Crosfield
Gash
Cookesfield
Aghafin
Newtown
Rush Hall
Knockbrack
Ballycleary
Kilbricken
Cill Bhriocáin
Boston or Coolballyogan
Clonard or Cappaloughlin
Forgeland
Forest
Knockanina
Oldborris
Danganroe
Camphill
Derryduff
Coolnagour
Butterisland
Badgerhill
Derryganton
Dysartbeagh
Derry More
Moanbaun
Ballyhorahan
Larch Hill
Cranniagh
Gossbrook
Clonin Hill
Clonincurragh
Bilberry Hill
Moorfield Cross Roads
0 25 50 100 150 200 Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Castlecomer Borehole - Swan**
Other names used for site	Swan Artesian borehole
IGH THEME	**IGH16 Hydrogeology**
TOWNLAND(S)	**Moyadd**
NEAREST TOWN/VILLAGE	**Wolfhill**
SIX INCH MAP NUMBER	**31**
ITM CO-ORDINATES	**656310E 682460N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
An artesian borehole.

Geological System/Age and Primary Rock Type
The borehole is drilled through Upper Carboniferous (Pennsylvanian) bedrock of the Westphalian Coolbaun Formation shales into the fine-grained Swan Sandstone Formation. The catchment area of the Swan borehole lies at the northern end of the Castlecomer Plateau.

Main Geological or Geomorphological Interest
Located beside Swan Bridge, this artesian well consists of a pump house (elevation 170m OD) housing a borehole (Production Well LS 31/1) drilled to a depth of 39m, tapping a confined aquifer of Swan Sandstone, about 10m thick. The static water level (the level to which the confined aquifer water would normally level off) is around 174m OD.

An artesian well is one that is drilled into a confined groundwater aquifer, in this case sandstone overlain by low permeability shales. The confined aquifer is recharged by rainfall falling on the unconfined, outcropping portion of the sandstone aquifer around the perimeter of the Castlecomer plateau.

At least one major phase of folding around 300 million years ago (Variscan Orogeny) caused considerable fracturing in the underlying Clay Gall Sandstone Formation (lower) and Swan Sandstone Member (upper), but did not affect as severely the surrounding and overlying impermeable shales.

Carbon isotope dating of water from the well carried out in 1976 yielded an age of around 1,440 years, indicating that water moves very slowly through the aquifer.

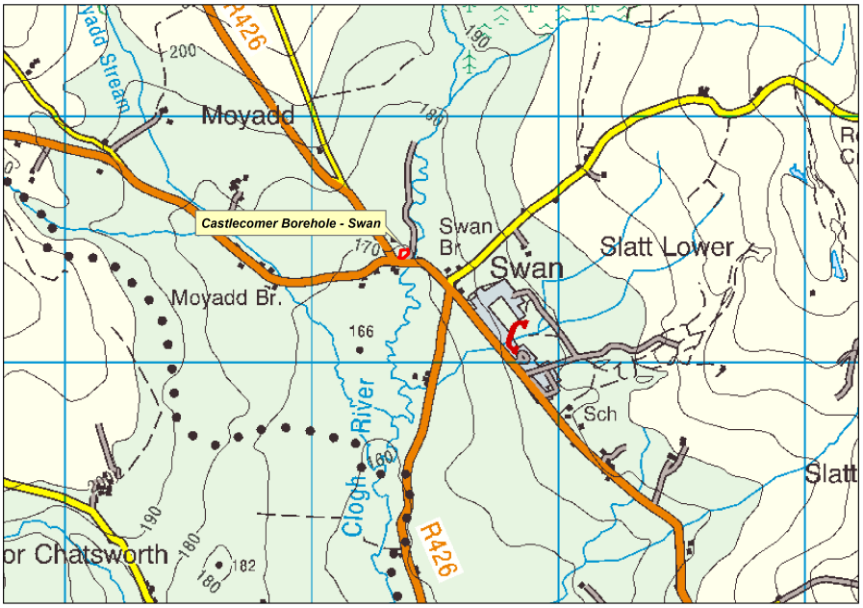
The well operates at a pumping rate of 916m^3 per day (8,400 gallons per hour) and provides an abstract rate of 590 m^3 per day (130,000 gallons per day).

Site Importance – County Geological Site
This is an important hydrogeological phenomenon of artesian well and confined aquifer behaviour in this part of County Laois and is a good example of an artesian well that serves a public water supply (GSI Well ID 2317NE W07). It is therefore a very important County Geological Site considering its value to the local Swan Water Supply Scheme. The aquifer is categorised as: Locally Important (Lm), generally moderately productive, fractured sandstone aquifer.

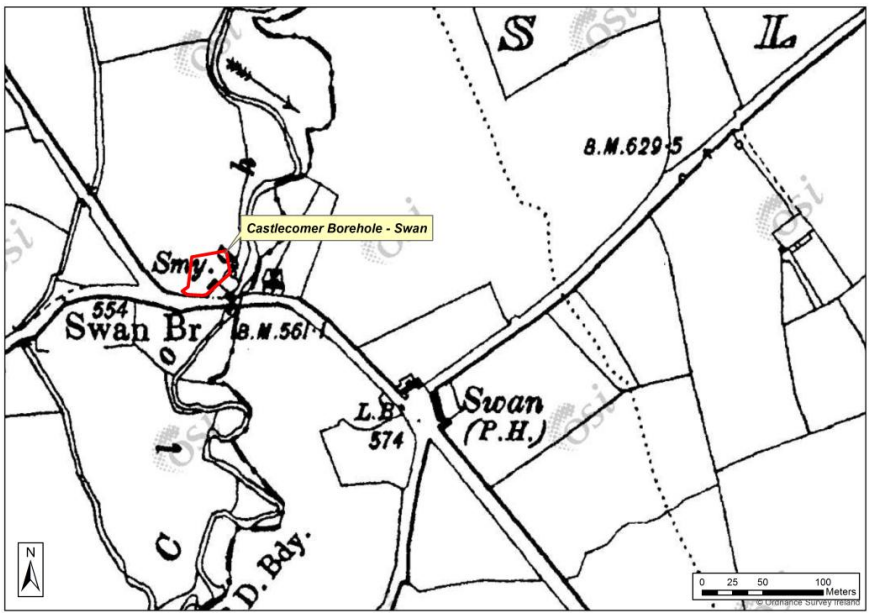
Management/promotion issues
The Swan Water Supply Scheme groundwater source is deemed to be relatively protected from contamination by its confined aquifer condition and its distance from the surface recharge area, located around 1km up-gradient to the north and northwest. Contamination at the recharge area would be unlikely to affect the source for many hundreds of years.

Pumphouse and works at Swan Public Water Supply Scheme. Clogh River to right near trees.

Swan Public Water Supply Scheme viewed from Swan Bridge.


R426
Moyadd Stream
200
Moyadd
190
180
Castlecomer Borehole - Swan
170
Swan Br
Swan
Slatt Lower
Moyadd Br.
166
Sch
Clogh River
160
Slatt
R426
or Chatsworth
190
180
180
182


Castlecomer Borehole - Swan
N
0 25 50 100
Meters


S
L
B.M.629·5
Castlecomer Borehole - Swan
Smy.
554
Swan Br
B.M.561·1
L.B.
574
Swan
(P.H.)
C
D. Bdy.
N
0 25 50 100
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clogh River**
Other names used for site	
IGH THEME	**IGH14 *Fluvial* and Lacustrine Geomorphology**
TOWNLAND(S)	**Moyadd, Slatt Lower, Aughatubbrid or Chatsworth,**
NEAREST TOWN/VILLAGE	**Swan**
SIX INCH MAP NUMBER	**31**
ITM CO-ORDINATES	**656270E 681270N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
A meandering river with braided channels.

Geological System/Age and Primary Rock Type
The river is a post-glacial landform, developing its present form in the past 10,000 years (Holocene). The river is underlain by Pennsylvanian (Carboniferous) age shallow marine shale and siltstone.

Main Geological or Geomorphological Interest
The feature exhibits well developed meanders and braided channels along an approximately 2.5km stretch of the river course on either side (north and south) of the Swan Bridge. The features occur as far as and south of the Laois-Kilkenny border.

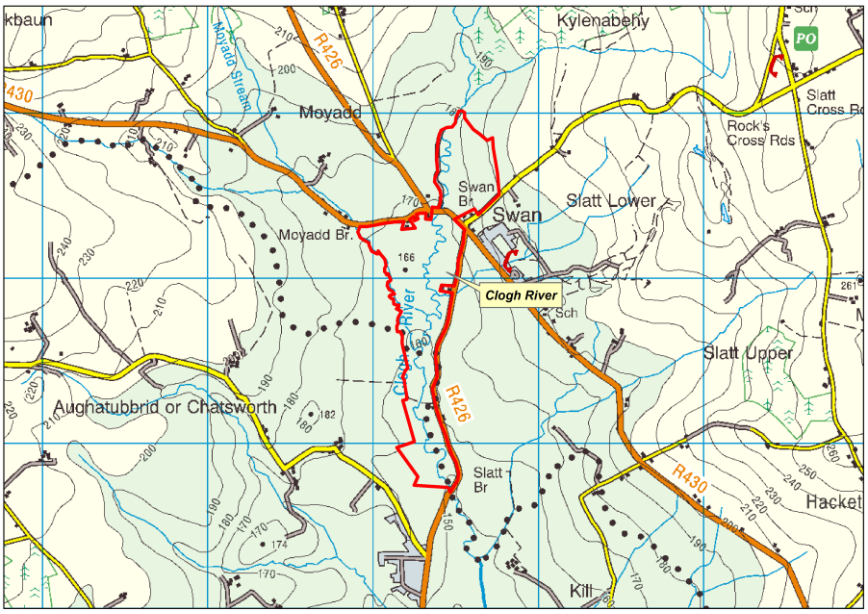
Site Importance – County Geological Site
This is an important County Geological Site in terms of fluvial geomorphology. The physical response of, and subsequent changes to, the river course as a result of flash and prolonged flooding events, will be of interest in the future.

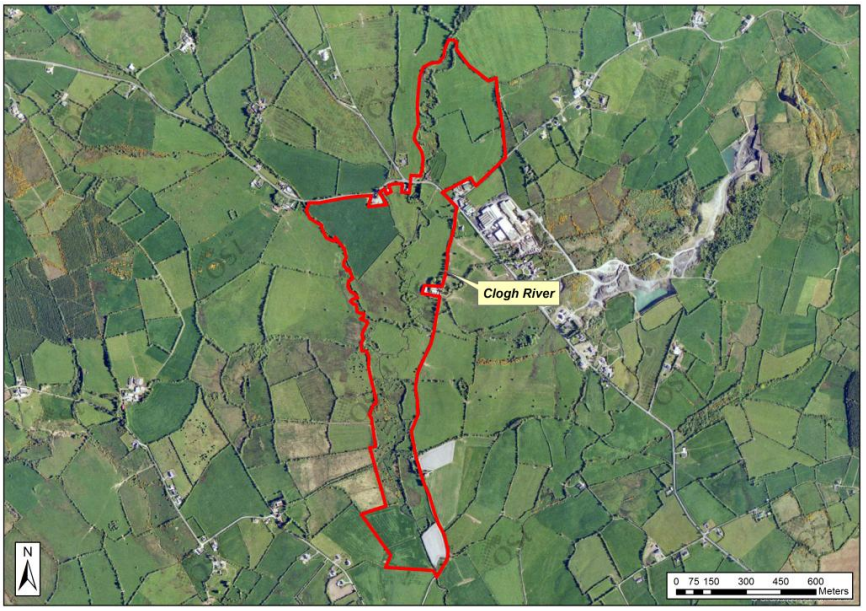
Management/promotion issues
The site traverses the Laois-Kilkenny county boundary, and is primarily bounded by private land. A limited number of narrow bridges afford a view of the site. However, as these locations are on busy public roads, the site is not deemed suitable for public promotion. The site may be of education and research interest, and interested groups should seek landowner permission to access the river course.

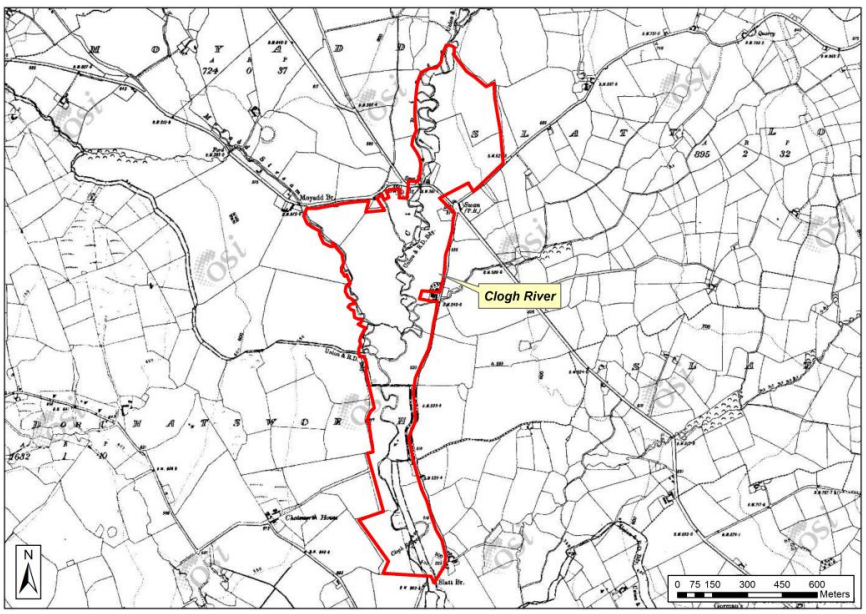
Point bar and cut bank in river channel, viewed looking downstream towards Slatt Bridge.

Close up of cut channel and point bar displayed in image above. Looking downstream, south.

Clogh River viewed from Slatt Bridge, looking northwest.


Kylenabehy
Moyadd Stream
R426
Moyadd
Swan Br
Swan
Slatt Lower
Rock's Cross Rds
Moyadd Br.
Clogh River
Sch
Slatt Upper
Aughatubbrid or Chatsworth
R426
Slatt Br
R430
Hacket
Kill


Clogh River
N
0 75 150 300 450 600
Meters


Clogh River
N
0 75 150 300 450 600
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clonaslee Eskers**
Other names used for site	The Clonaslee Esker, The Kinnitty-Clonaslee Eskers
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Clonlyon, Coolagh, Garryhedder, Castlecuffe**
NEAREST TOWN/VILLAGE	**Clonaslee**
SIX INCH MAP NUMBER	**2**
ITM CO-ORDINATES	**625300E 711500N (centre of main esker segment)**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

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

Geological System/Age and Primary Rock Type
The Clonaslee 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 during deglaciation, approximately 14,000 years ago.

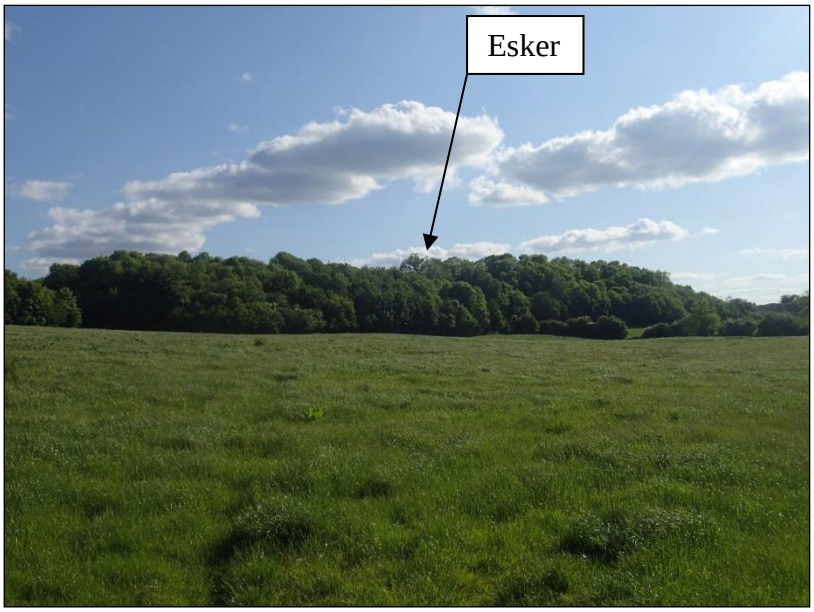
Main Geological or Geomorphological Interest
Where present the esker ridges are striking features, standing proud of the flat landscape of till (boulder clay) upon which it was deposited. Intact portions just north of the main R421 road west of Clonaslee, and within Coolagh Townland, are especially impressive. In both localities the esker is 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 feature is important in that it records faithfully the ice movement across this area of northwest Laois, 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 Garryhedder and Coolagh Townlands, flanking the esker, are probably part of associated ice marginal fans. The sands and gravels within the feature are comprised chiefly of limestone clasts, but with significant 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, and 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.

Management/promotion issues
This system comprises a well-defined landform sequence and should be listed as a County Geological Site. The eskers and their adjacent area across Derry Bog have been designated a pNHA and SAC (sitecode 000859) and all of this area, including the portion of Derry Bog, is proposed here as a County Geological Site. The esker ridge segments themselves, and the bog, are not worthy of pNHA status geologically or geomorphologically.

A signboard along the R421 road west of Clonaslee, where the features can be well seen, might help promote the features.

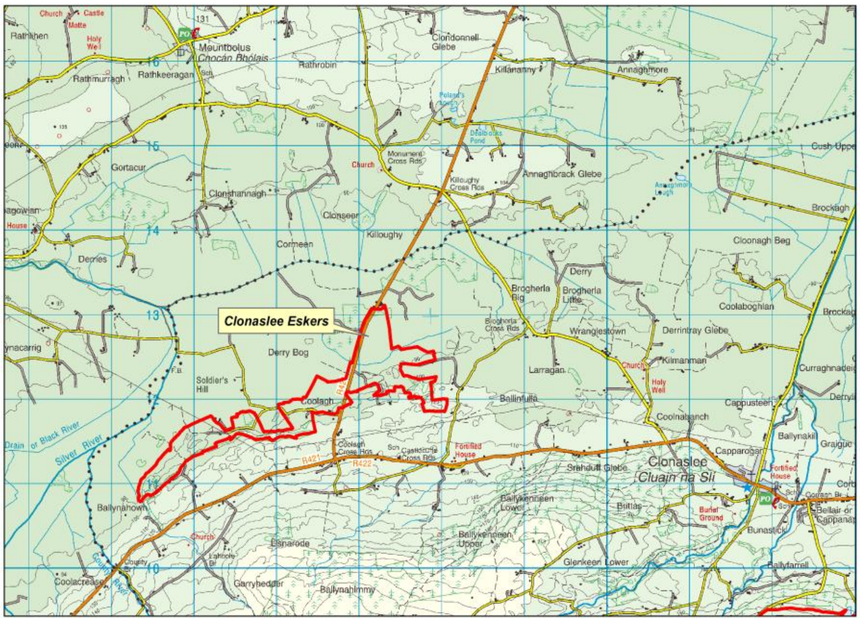


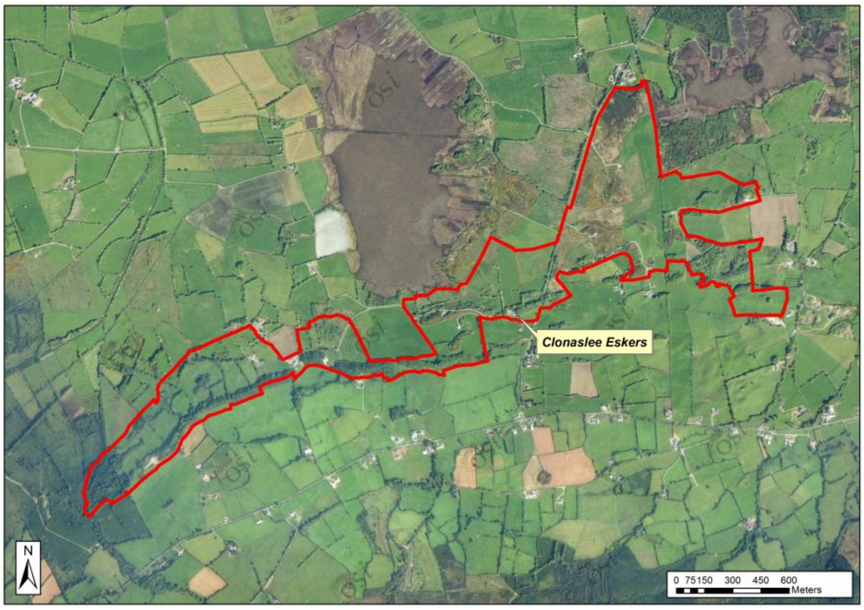
The main Clonaslee Esker, looking north, across Coolagh Townland.

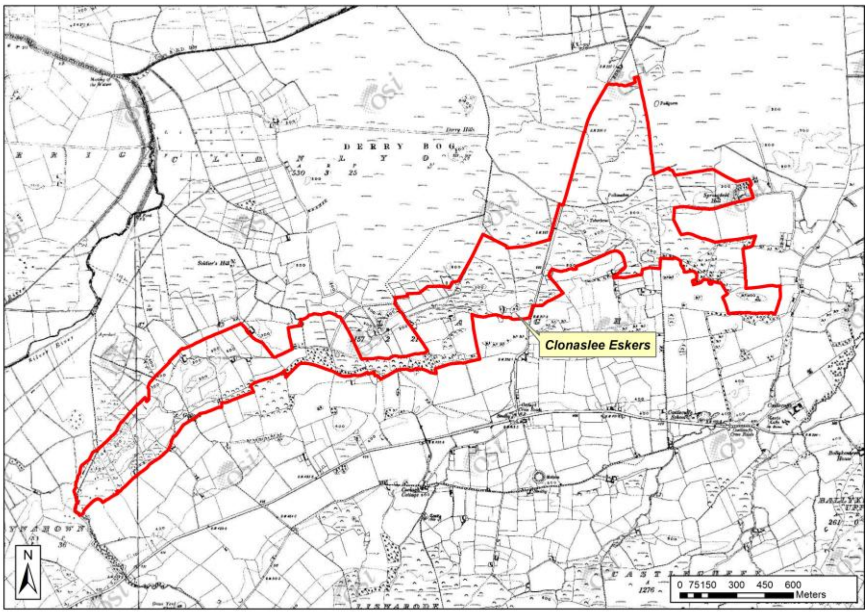
Looking north across haphazard esker topography and the flanking Derry Bog, in Coolagh.

Some of the hummocky terrain where the esker and fans meet, in Garryhedder.

An exposure into the main esker ridge in Coolagh.


Clonaslee Eskers
Mountbolus
Cnocán Bhólais
Rathrobin
Clondonnell Glebe
Killananny
Annaghmore
Rathmurragh
Rathkeeragan
Gortacur
Clonshannagh
Clonseer
Killoughy
Monument Cross Rds
Killoughy Cross Rds
Annaghbrack Glebe
Cush Upper
Brockagh
Cloonagh Beg
Cormeen
Derries
Derry
Brogherla Big
Brogherla Little
Coolaboghlan
Derry Bog
Soldier's Hill
Wranglestown
Derrintray Glebe
Larragan
Kilmanman
Curraghnadeir
Coolagh
Ballinfulla
Cappusteen
Coolnabanch
Ballynakill
Silver River
Drain or Black River
Clonaslee
Cluain na Slí
Capparogan
Srahduff Glebe
Fortified House
Ballynahown
Ballykenneen Lower
Ballykenneen Upper
Burial Ground
Bunastick
Glenkeen Lower
Coolacrease
Garrybedder
Ballynahimmy
Church
Holy Well
R421
R422


Clonaslee Eskers
N
0 75150 300 450 600
Meters


Clonaslee Eskers
DERRY BOG
N
0 75150 300 450 600
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clopook Cave**
Other names used for site	
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Clopook**
NEAREST TOWN/VILLAGE	**Stradbally**
SIX INCH MAP NUMBER	**19**
ITM CO-ORDINATES	**658300E 690770N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
A small cave is situated in the side of a possible relict karst tower.

Geological System/Age and Primary Rock Type
The cave is in Carboniferous Limestone rock, in the Clogrenan Formation which is the youngest part of the limestone sequence. The age of the cave is unknown but may be older than the immediate post glacial period of the last 10,000 years (Holocene).

Main Geological or Geomorphological Interest
This cave is neither long nor remarkable but is a relict of the broader landscape evolution of the Stradbally area. This is one of very few caves in Laois, despite the widespread bedrock of Carboniferous limestone. It is found on the flank of Clopook Hill, which is one of many hills in the area between Portlaoise and Stradbally that are widely believed to be tower hums. Hums is a term for remnant or degraded tower karst, of the type found today in China and SE Asia. The Ice Age would have removed most evidence of this, leaving only remnant hills such as Clopook Hill. The cave could date back to an interglacial period or even older. There is no active stream flow, so it formed under an entirely different hydrogeological regime and is now a 'fossil' or inactive cave. The shape of the open passage suggests that it was originally a large phreatic (i.e. water filled) cave passage, perhaps 5-10m wide. It is filled today, nearly to the roof, with earth and sediment. There is some potential for evidence preserved in this sedimentary infill that would give clues about the landscape that has disappeared from above.

Site Importance – County Geological Site
This site is one of only three caves known in Laois and is important as a County Geological Site for its association with a hum, and potential landscape development information.

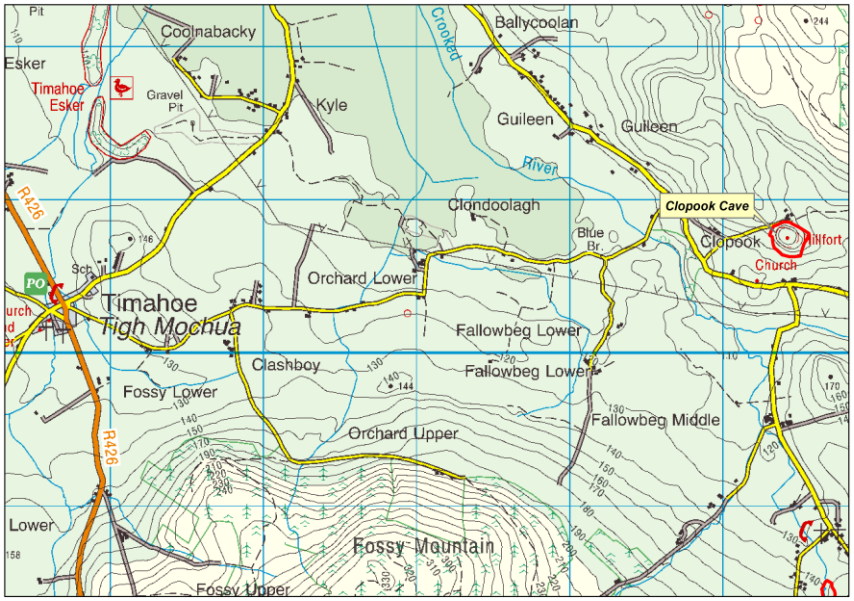
Management/promotion issues
The cave is on private farmland and should not be visited without the permission of the landowner. It is of no interest to sport cavers, being so short and inactive. It is not suited to promotion as it is low and muddy, without stalactites or stalagmites and is possibly home to some mammals.

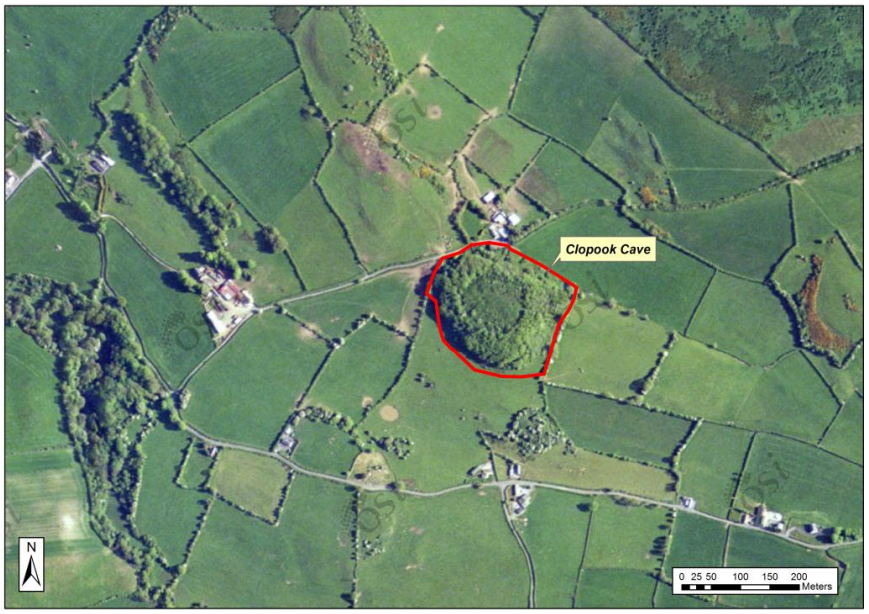
The entrance to Clopook Cave.

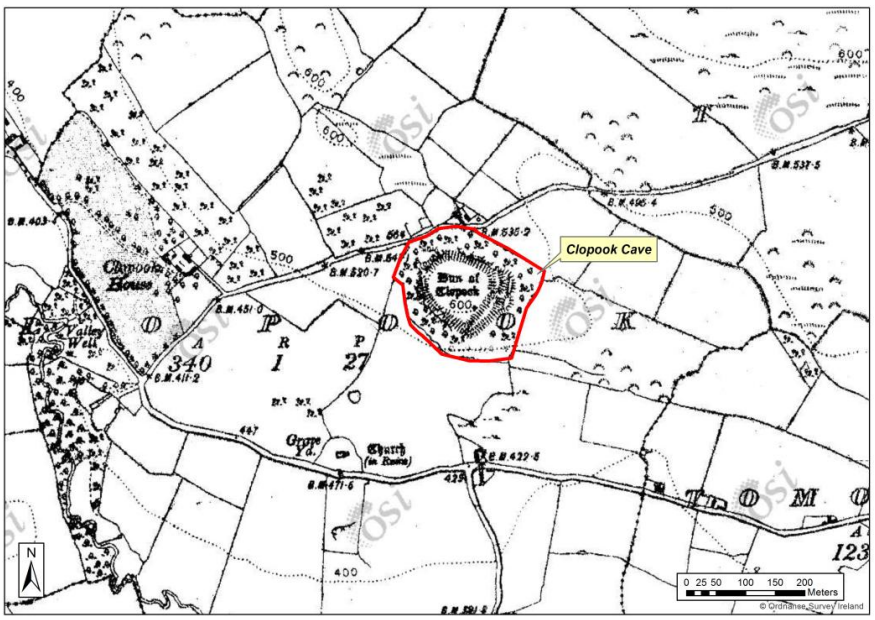
Animal burrows in the floor of the cave earth.

The entrance to Clopook Cave viewed from the inside looking out.

The limestone hill of Clopook, with the woods hiding the steep cliff or escarpment around the whole hill.

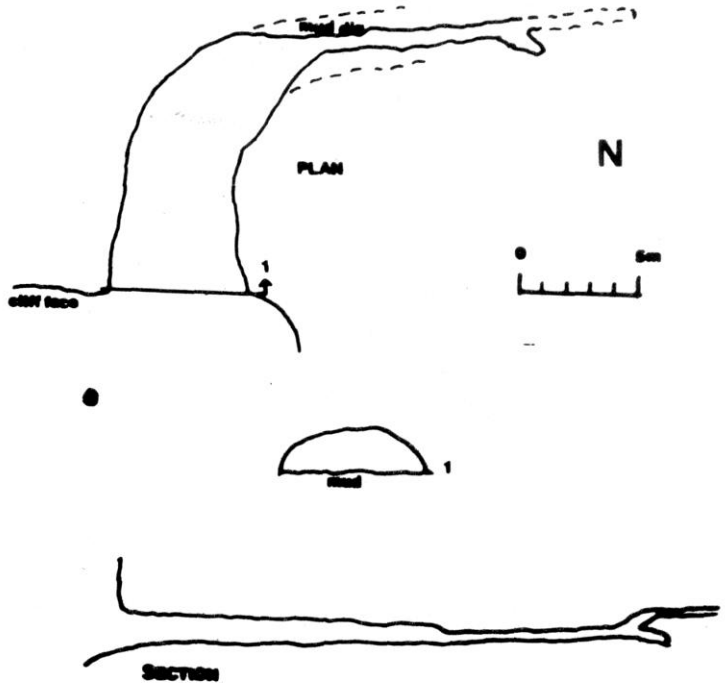

Clopook Cave
Timahoe
Tigh Mochua
Fossy Lower
Orchard Lower
Orchard Upper
Fallowbeg Lower
Fallowbeg Lower
Fallowbeg Middle
Clashboy
Clondoolagh
Guileen
Guileen
Ballycoolan
Kyle
Coolnabacky
Timahoe Esker
Gravel Pit
Clopook
Church
Fossy Mountain
Fossy Upper
Lower
R426
R426
Crooked
River
Blue Br.
Sch.
PO


Clopook Cave
N
0 25 50 100 150 200
Meters


Clopook Cave
Clopook House
Holy Well
Cairn (in Ruins)
N
0 25 50 100 150 200
Meters
© Ordnance Survey Ireland

Clopook Cave, Co. Laois.

Survey: J. Dowds, S. Dowds, S. Mossop.



Irish Speleology 23

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Darkin Well**
Other names used for site	Darken Well
IGH THEME	**IGH1 Karst, IGH16 Hydrogeology**
TOWNLAND(S)	**Straboe**
NEAREST TOWN/VILLAGE	**Portlaoise**
SIX INCH MAP NUMBER	**13**
ITM CO-ORDINATES	**649286E 702000N**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
This site comprises a significant spring rising within a fenced compound.

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 pure bedded Lower Carboniferous limestone of the Allenwood Formation, which is interpreted as being buried a few metres below the land surface at the site. The spring may be related to a fault, which passes through the site along a northeast-southwest plane.

Main Geological or Geomorphological Interest
Water which sinks at the Sluggory Cross Roads swallow hole, which is approximately 2.5 kilometres to the southeast of the Darkin Well, is reputed to emerge at the spring, though no karst dye tracing has ever been conducted. The supposition comes from the fact that the spring well became contaminated with silt in 1998 when the M7 Motorway works were working at Sluggory Cross Roads. The spring becomes very silty the day after heavy rainfall.

The spring is contained in a galvanised steel hut and was used as a water supply for a period of 2 months in 2007, but this was only as an emergency stopgap as it is considered too risky to use it continuously, given the flashy nature of the silt content in the emerging water. From estimates of water usage during this time, the spring overflow is considered to be approximately 80 m^3 per hour during high flow conditions. The spring has also been known to go dry in hot, dry periods.

Site Importance – County Geological Site
The site is of County Geological Site importance, as a complement to the Sluggory Cross Roads swallow hole site, and as part of a suite of karstic features within the limestone terrain surrounding Portlaoise Town.

Management/promotion issues
Given the wider issue of protecting groundwater quality, the site is managed by Laois County Council, but promoting it would not be advisable without active partnership of the Council and local landowners, especially those adjacent to the Sluggory Cross Roads swallow hole.

The Darkin Well compound, taken from the road at its entrance.

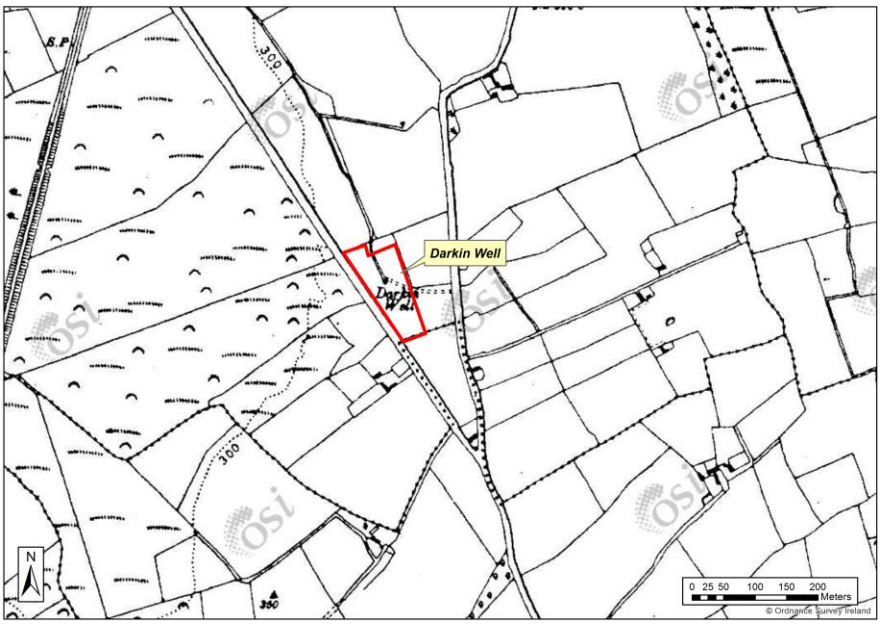
Looking northwards from the entrance to the spring hut.

The spring emerging at surface, flowing across a 90 degree weir.

A view inside the galvanised steel hut, where a gangway leads across the spring water.


Darkin Well
Shaen
Straboe
Church
Knocknagroagh
Rathnamanagh
Kylecionnhobert
Cooltoran
Triogue River
Ridge of Maryborough
Motte
Derrygarran
Ballydav
Clonreher
Rossleaghan
Borris Great
Castle
Kyle
Br
Ballytegan
Gorteen
R80
Bathéven
Sluggory
Cross Roads
R445
PORTLAOISE
Port Laoise
Borris Little
Kilminchy
Rathbrennan
Ballyroan
R425
Barrows
Clonroosk
Big
Prison
49MP
48MP
50MP
51MP


Darkin Well
N
0 25 50 100 150 200
Meters


Darkin Well
N
0 25 50 100 150 200
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Farnans Quarry**
Other names used for site	Drimsallagh quarry
IGH THEME	**IGH9 Upper Carboniferous and Permian** **IGH15 Economic Geology**
TOWNLAND(S)	**Farnans**
NEAREST TOWN/VILLAGE	**Swan**
SIX INCH MAP NUMBER	**31**
ITM CO-ORDINATES	**660435E 681780N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 15, 16**

Outline Site Description
A working quarry.

Geological System/Age and Primary Rock Type
The quarry extracts sandstone flags from the Coolbaun Coal Formation of Westphalian age.

Main Geological or Geomorphological Interest
This site is a working quarry, for paving slabs, building stone and cladding. The rock splits relatively easily into varied thicknesses and can remain in large slabs. Hand working of the past has been superseded by mechanical diggers, but the rock is readily lifted. It often displays ripple marks and other sedimentary features that give texture and variety to the slabs.

The site comprises only the workings for slabs. Immediately adjacent, and on the opposite side of the road are some quarries, operated by different owners, which have opened up more recently and where blasting has occurred. The rock is not visible in useful ways due to the different style of working, and these are not part of the site.

Site Importance – County Geological Site; may be recommended for Geological NHA
This is a good County Geological Site, but may be considered for an NHA in the future to represent the Upper Carboniferous Coolbaun Coal Formation, due to the relative scarcity of exposure of these coalfield rocks.

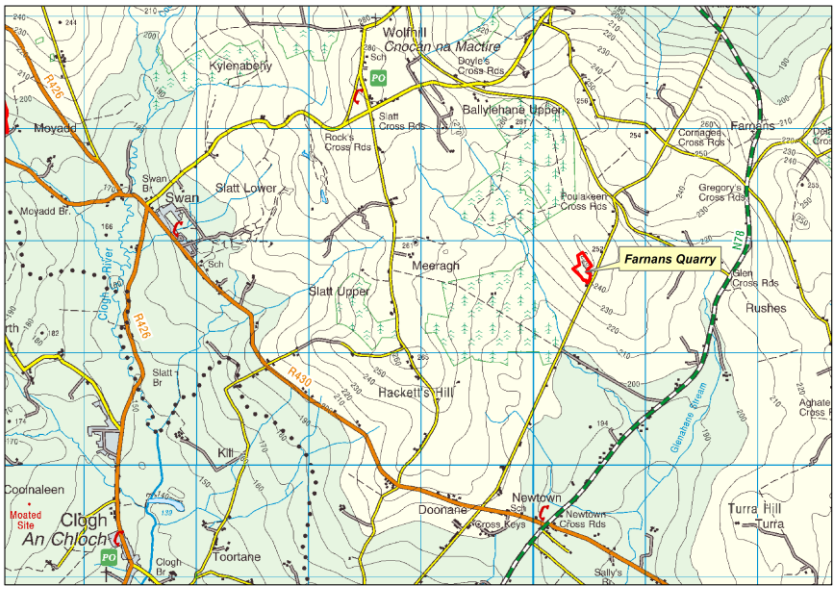
Management/promotion issues
The geological heritage interest relies on continued working of the quarry as a place to see the strata that it exposes and access for geologists is important. However, it is not suitable for promotion to the public as it is a private business and a working environment. Should the quarry cease to operate in the future, then some negotiated access to the site should be sought.

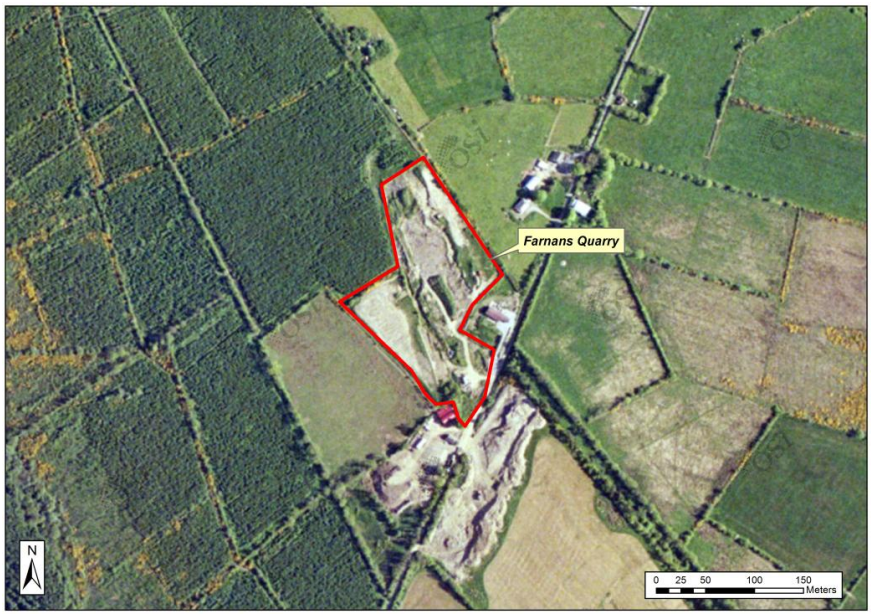
A view of Farnans Quarry.

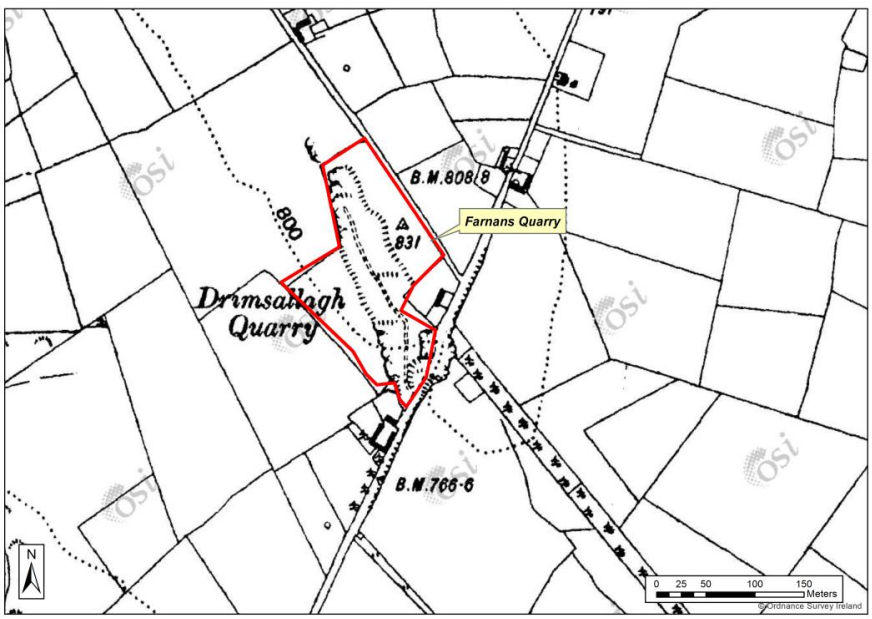
A view of Farnans Quarry, looking north.

A view of Farnans Quarry, looking south.

Very large slabs put aside in Farnans Quarry, beside the entrance.


Wolfhill
Gnocán na Mactire
Kylenaberry
Moyadd
Ballylehane Upper
Farnans
Slatt Lower
Swan
Moyadd Br.
Meeragh
Farnans Quarry
Slatt Upper
Rushes
Hackett's Hill
Kill
Coolnaleen
Clogh
An Chloch
Toortane
Doonane
Newtown
Turra Hill
Turra
R426
R430
N78


Farnans Quarry
N
0 25 50 100 150
Meters


B.M.808·8
Farnans Quarry
800
831
Drimsallagh
Quarry
B.M.766·6
N
0 25 50 100 150
Meters
©Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Flemings Fireclay Quarries**
Other names used for site	Lagan Brick Ltd
IGH THEME	**IGH9 Upper Carboniferous and Permian**
TOWNLAND(S)	**Slatt Lower**
NEAREST TOWN/VILLAGE	**Swan**
SIX INCH MAP NUMBER	**31**
ITM CO-ORDINATES	**657200E 682020N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 15, 16**

Outline Site Description
Extensive quarries worked for fireclay since 1935.

Geological System/Age and Primary Rock Type
The quarries at Swan work the strata around a Double Fireclay within the Coolbaun Coal Formation, part of the Westphalian (Coal Measures of historical usage, or Pennsylvanian in modern terminology) in the Carboniferous Period.

Main Geological or Geomorphological Interest
This series of quarries has been worked as Flemings Fireclays since 1935, but probably local working may have occurred previously. The Double Fireclays are the seat earths of coal seams although here there is no coal seam associated with them. They are interbedded with shales and mudstones. The Double Fireclay Member is widespread throughout the Leinster Coalfield and provided a marker horizon in the stratigraphy in boreholes and coal exploitation in the numerous mines that existed.

Present working is limited to one face and the most northerly section is flooded and largely inaccessible. The fireclay can be used to make refractory bricks but the general quarry output is used to make bricks, chimney liners and tiles etc as the demand requires.

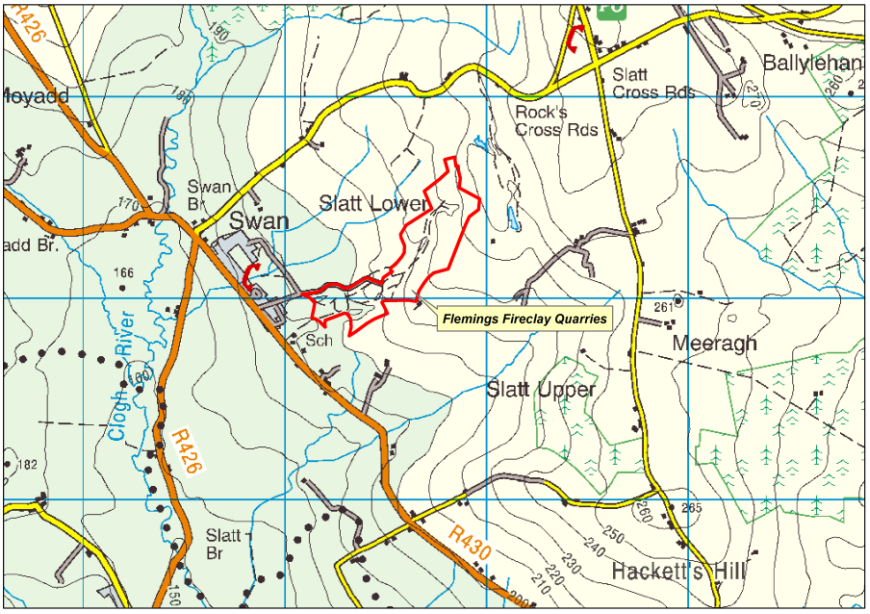
Site Importance – County Geological Site; may be recommended for Geological NHA
This is a site that is a good representative of part of the Westphalian succession of the Leinster coalfield, and as such may be considered as a candidate for NHA status.

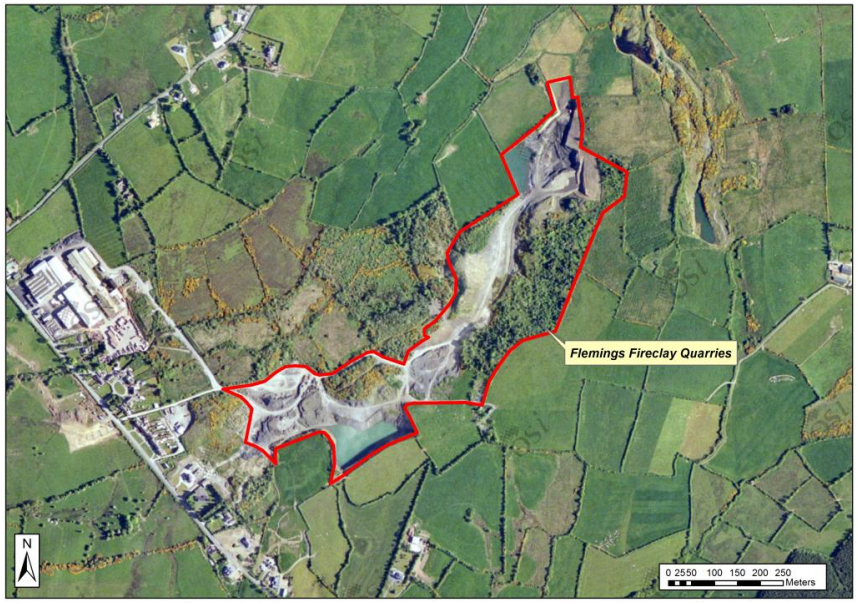
Management/promotion issues
The site is a working quarry and unsuitable for promotion, unless there was a specific arrangement with the owners and operators, Lagan Brick Ltd. Whilst faces are obscured by flooding, an upsurge in demand for products could see the water pumped out and working recommenced, so access for geologists could easily be restored in different parts of the quarry.

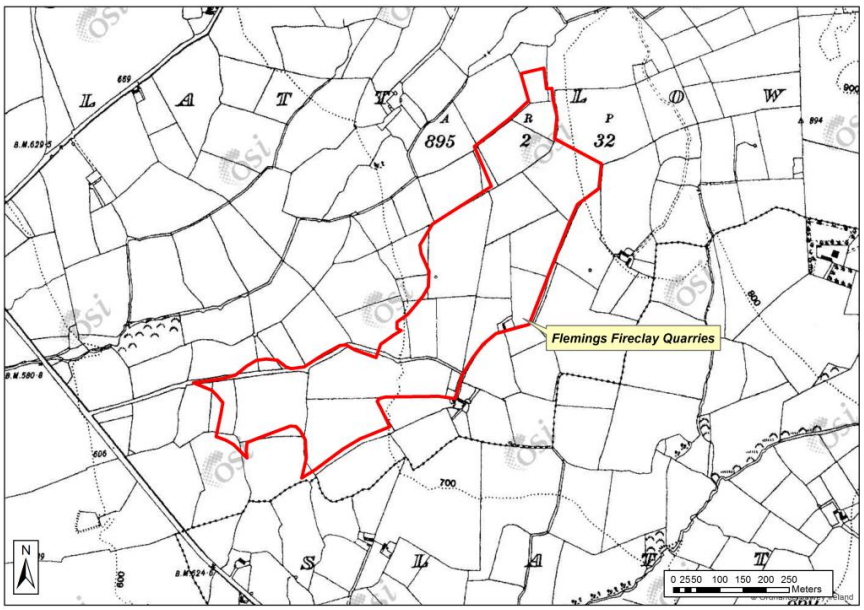
The main working face in the quarry in 2016, looking east.

The main working face in the quarry in 2016, looking southward.

The northern section of the site, with no pumping of water, and a face that is not being worked in 2016.


R426
Moyadd
Swan Br
Swan
Slatt Lower
Rock's Cross Rds
Slatt Cross Rds
Ballylehan
Flemings Fireclay Quarries
Sch
Meeragh
Slatt Upper
Clogh River
R426
Slatt Br
R430
Hackett's Hill


Flemings Fireclay Quarries
N
0 2550 100 150 200 250
Meters


LATT
LOW
895
2
32
Flemings Fireclay Quarries
N
SLATT
0 2550 100 150 200 250
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Glebe Quarry**
Other names used for site	
IGH THEME	**IGH10 Devonian, IGH15 Economic Geology**
TOWNLAND(S)	**Glebe**
NEAREST TOWN/VILLAGE	**Clonaslee**
SIX INCH MAP NUMBER	**6**
ITM CO-ORDINATES	**633000E 709245N**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
An intermittently worked flagstone quarry.

Geological System/Age and Primary Rock Type
The quarry exposes Devonian rocks of the Clonaslee Member, comprising the upper part of the Cadamstown Formation.

Main Geological or Geomorphological Interest
The Devonian rocks which cover the Silurian rocks of the Slieve Bloom inlier are surprisingly poorly exposed in the hills and only the stream gorges and valleys such as the Silver River provide linear and narrow exposures of them. Therefore a larger expanse of well exposed rocks in three dimensions within a quarry is a valuable addition to the total picture of the Devonian rocks in Slieve Bloom.

The rocks exposed are sandstones of a coarse grained and flaggy nature, which makes them easy to quarry and flagstones are very useful for paving, walling and building. In the scale of exposure seen in a quarry like this, it is possible to see broader sedimentary structures that suggest these sediments formed in a levelled landscape under ephemeral flooding conditions. Their total thickness is estimated at between 65 and 105m. There are some conglomerates and some mud lenses within the sandstones.

Historical maps and references suggest that quarrying of flagstones has been a feature of the higher ground above Clonaslee for centuries, with many small excavations shown on the maps now overgrown.

Site Importance – County Geological Site
As a representative site for an important, but poorly exposed part of the geology of Slieve Bloom this quarry deserves to be a County Geological Site.

Management/promotion issues
As a quarry it is not suitable for general promotion and is private land, so not accessible. If it is inactive or disused it would quickly become overgrown, so a modest degree of working would help keep faces accessible for any geological groups visiting with the landowner's permission in the future.

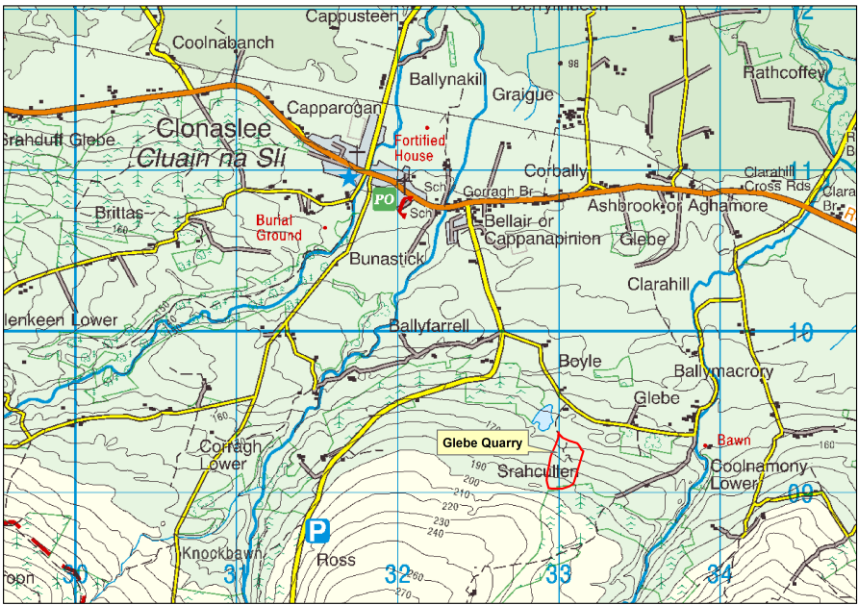
Panorama view of Glebe Quarry, looking towards the back face.

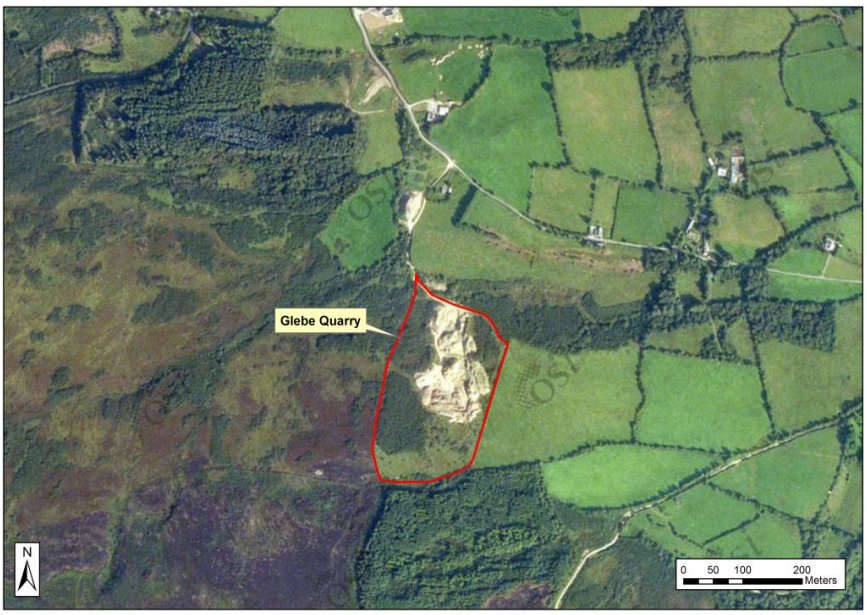
View into Glebe Quarry.

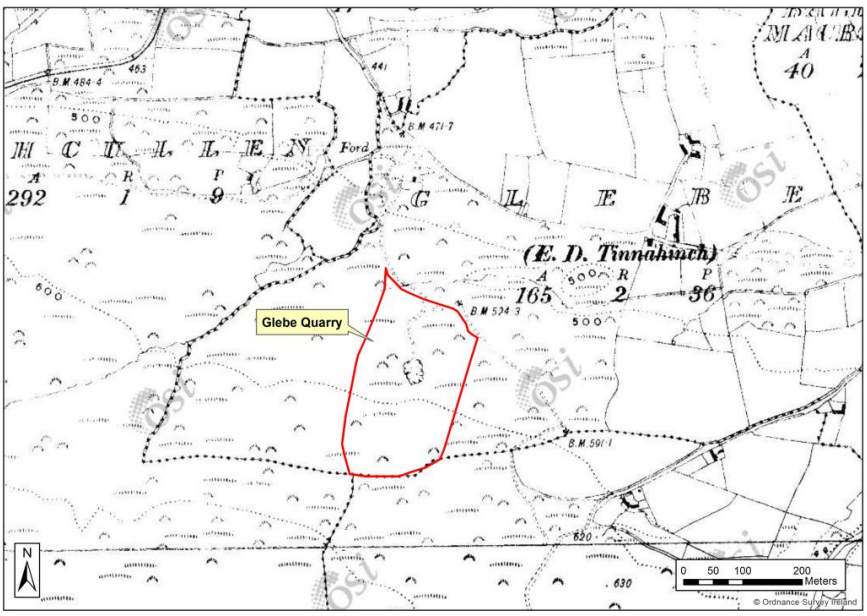
Inside Glebe Quarry.

Panorama view of Glebe Quarry, looking out from the back face.

A view of the back face of Glebe Quarry.


Cappusteen
Coolnabanch
Ballynakill
Graigue
Rathcoffey
Capparogan
Clonaslee
Cluain na Sli
Fortified House
Corbally
Clarahill Cross Rds
Britlas
Burial Ground
Gorragh Br
Ashbrook or Aghamore
Bellair or Cappanapinion
Glebe
Bunastick
Clarahill
Ballyfarrell
Boyle
Ballymacrory
Glebe
Glebe Quarry
Bawn
Srahcullen
Coolnamony Lower
Corragh Lower
Knockbawn
Ross
30
31
32
33
34
09
10


Glebe Quarry
N
0 50 100 200
Meters


Ford
(E. D. Tinnahinch)
165
2
36
Glebe Quarry
N
0 50 100 200
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Glenbarrow**
Other names used for site	
IGH THEME	**IGH10 Devonian, IGH7 Quaternary, IGH14 Fluvial and Lacustrine Geomorphology**
TOWNLAND(S)	**Glenbarrow, Tinnahinch**
NEAREST TOWN/VILLAGE	**Mountmellick**
SIX INCH MAP NUMBER	**7**
ITM CO-ORDINATES	**636250E 707933N (centre of valley)**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A long section in the bed and banks of the river in Glenbarrow.

Geological System/Age and Primary Rock Type
The primary rocks are Devonian sandstones, but there are also landslides in glacial till of Quaternary age.

Main Geological or Geomorphological Interest
This is a good section exposing a variety of sandstones and mudstones of Devonian age in the bed and banks of the gorge of the Glenbarrow River. Large exposures of sandstone beds are seen in the river bed, and in some sections waterfalls over particularly thick beds have produced cliffs with good sections through the strata.

On the northern bank there is a long section of exposures in glacial till, where landslides occur periodically which get removed by the river, thus creating further instability and further landslides. These tills have been studied previously, and are comprised of units of both basal tills and melt-out tills. They are dominated by limestone, but erratics of Galway granite have also been found within them.

Site Importance – County Geological Site
This is a good representative site in Laois to see the Devonian rocks of Slieve Bloom which are otherwise quite poorly exposed.

Management/promotion issues
There is a public path in the woods surrounding the river, which follows its course through the site, and has signposts as part of the excellent walking route infrastructure in Laois and Offaly. There is no significant mention of geology in the signboards and trail leaflets available, and this could be remedied.

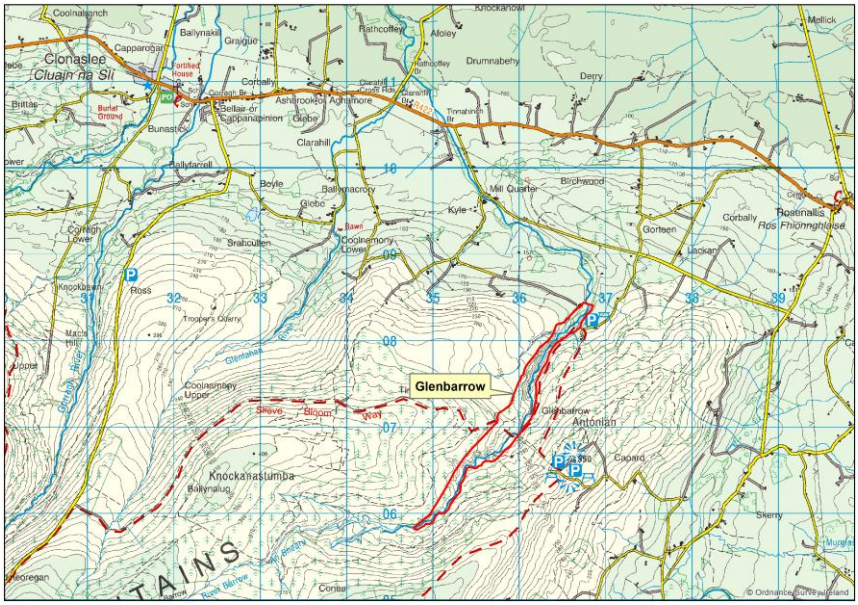
The waterfall in Glenbarrow, with mudstones exposed in the cliff beneath the thick sandstone bed which has caused the waterfall and plunge pool.

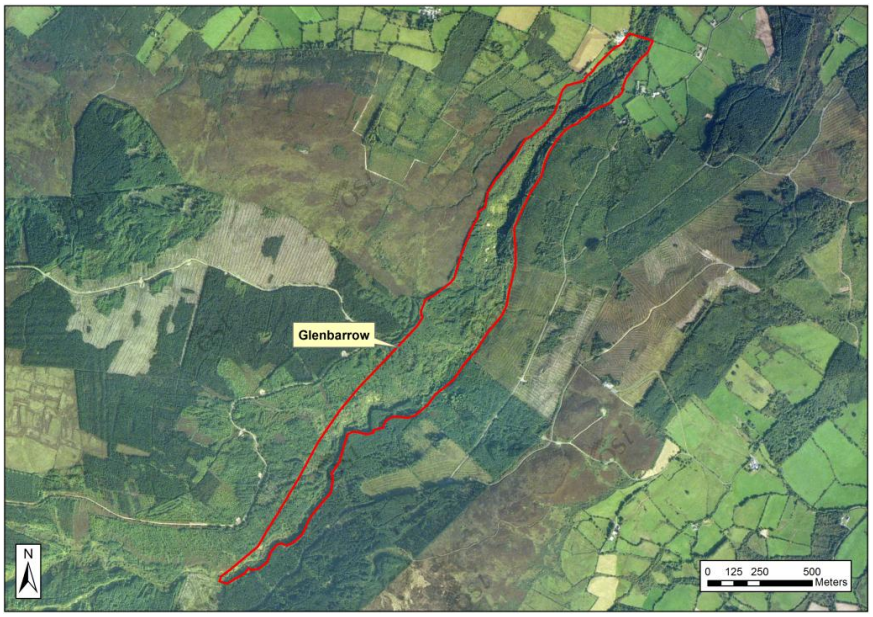
Cross bedding and channels are visible.

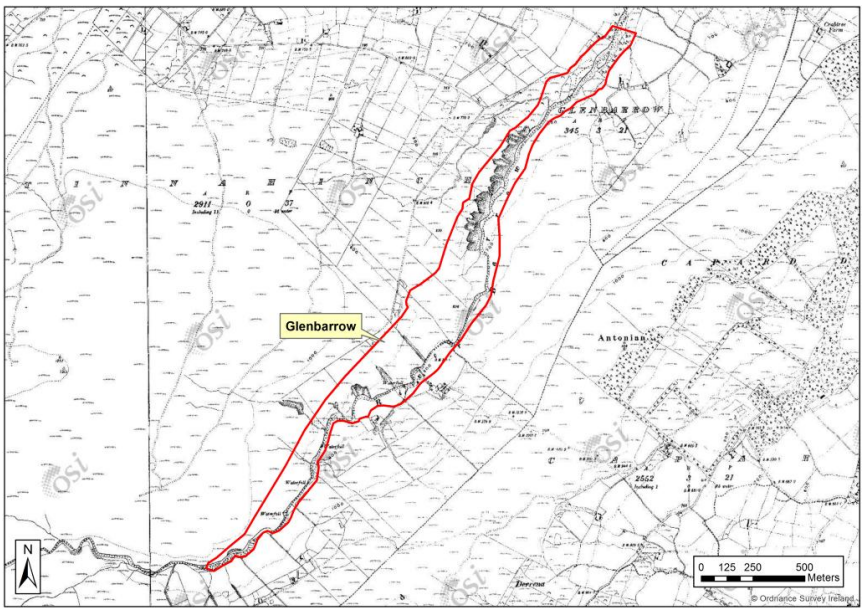
Large expanses of bedding planes are seen.

Glacial till with landslips on north bank.

Some signage at the car park.


Glenbarrow
Clonaslee
Cluain na Sli
Ballynaslee
Graigue
Rathcoffey
Aloley
Drumnabehy
Derry
Corbally
Ashinrooka
Aghamore
Clarahill
Ballyfarrell
Boyle
Ballynacrory
Glebe
Mill Quarter
Birchwood
Kyle
Gorteen
Lackan
Rosenallis
Ros Fhionnghlaise
Coolnamony Lower
Srahcullen
Knockbawn
Ross
Trooper's Quarry
Coolnamony Upper
Shrove
Bloom
Knockanastumba
Ballynalug
Glenbarrow
Antonian
Capard
Skerry
TAINS
Ordnance Survey Ireland


Glenbarrow
N
0 125 250 500
Meters


Glenbarrow
Antonian
N
0 125 250 500
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Hollymount**
Other names used for site	
IGH THEME	**IGH3 Carboniferous to Pliocene Palaeontology, IGH12 Mesozoic and Cenozoic**
TOWNLAND(S)	**Hollymount**
NEAREST TOWN/VILLAGE	**Carlow**
SIX INCH MAP NUMBER	**32**
ITM CO-ORDINATES	**669467E 681900N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
A number of fields where a borehole was drilled in the early 1970s.

Geological System/Age and Primary Rock Type
The borehole was into Carboniferous Limestone bedrock, but samples from the borehole yielded pollen and spore material that are of Miocene-Pliocene (Neogene) age.

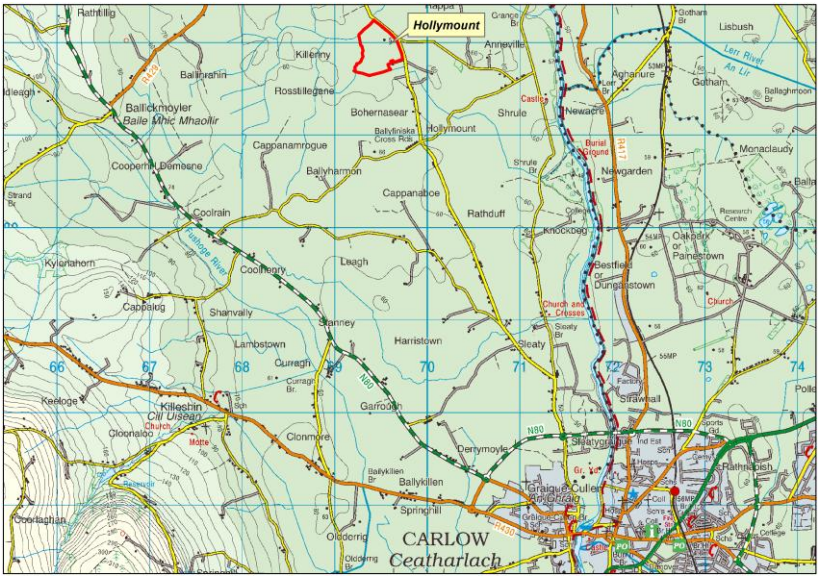
Main Geological or Geomorphological Interest
Samples from the site at Hollymount were extracted from a 46m deep borehole in a Carboniferous limestone region, and studied by a Trinity College Dublin student called Phyllis Burgess in 1973. Pollen and spore samples were located in a 36-44m deep part of the borehole. The assemblage is thought to represent woodland and heathland communities of plants of Miocene-Pliocene (Neogene) age. This deposit is covered by more recent till from the Ice Age. The extent or form of the Neogene deposit is unknown, but is assumed to be preserved in some kind of enclosed depression (doline) within the Carboniferous limestone. The borehole site location was selected based on three wells dug by the Land Commission that intersected clays at different depths. Disturbed samples from these wells indicated the presence of Tertiary clays, and the chosen drilling site was intended to gain a likely maximum depth. Geophysical survey also indicated this location (see map for precise locations).

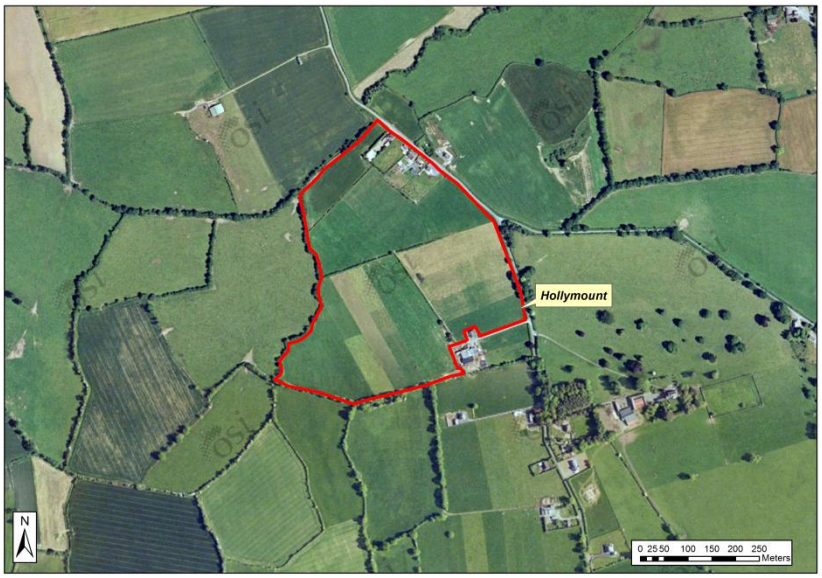
Site Importance – County Geological Site; may be recommended for Geological NHA
This site is a deposit of Miocene-Pliocene (Neogene) age, which is exceedingly rare in the country as a whole, and it may be recommended for geological NHA status in the future as work on the IGH3 or IGH12 themes is considered in a national framework.

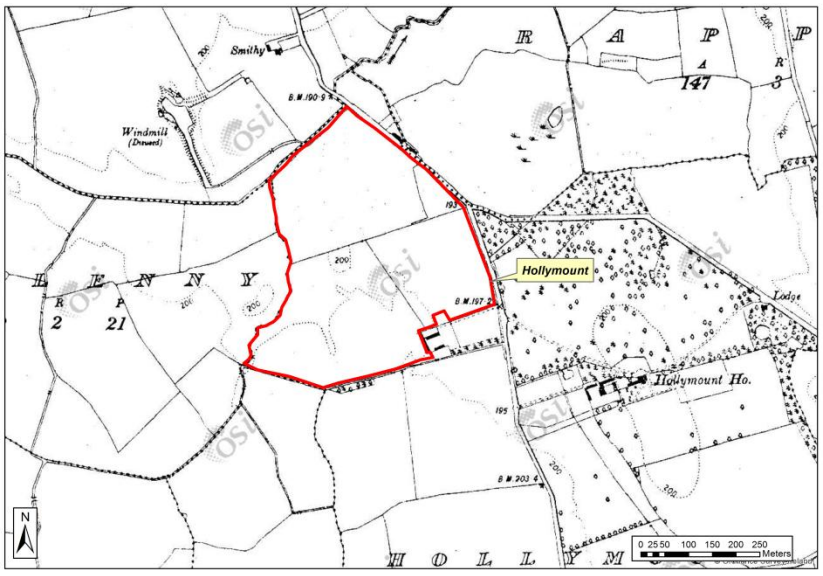
Management/promotion issues
The Hollymount site is unusual in that a single borehole does not really constitute a ‘site’ but the palaeontological importance and rarity of Hollymount is such that an area around where the borehole was drilled is considered as a site, to allow the possibility of repeating the borehole for research purposes or conducting other research to define or sample the geological interest.

The borehole was drilled on the far margin of the fields here.

An extract from the Geological Survey of Ireland drilling report that shows the location of the borehole, along with the three Land Commission wells that pointed to the presence of the Tertiary aged clays.


Hollymount
CARLOW
Ceatharlach


Hollymount
N
0 25 50 100 150 200 250
Meters


Hollymount
Hollymount Ho.
Windmill
(Disused)
Smithy
N
0 25 50 100 150 200 250
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Killeany Quarry**
Other names used for site	Kerwins Quarry
IGH THEME	**IGH8 Lower Carboniferous**
TOWNLAND(S)	**Killeany**
NEAREST TOWN/VILLAGE	**Abbeyleix**
SIX INCH MAP NUMBER	**23**
ITM CO-ORDINATES	**637200E 686200N (centre of quarry)**
1:50,000 O.S. SHEET NUMBER	**60 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A relatively small quarry cut into a small, but prominent, steep-sided limestone hill.

Geological System/Age and Primary Rock Type
Bedrock comprises Lower Carboniferous (Courceyan-Chadian) fossil-rich Waulsortian Limestone, deposited as a mudbank in open marine conditions.

Main Geological or Geomorphological Interest
The Waulsortian Limestone rocks are typically fossiliferous, pale grey, massive, unbedded wackestones, deposited below storm wave base in water more than 200m deep. The limestone in Killeany Quarry is heavily dolomitised, meaning dolomite has formed when magnesium ions replaced the calcium ions in the calcite within the rock. The dolomite is a brownish rock, with a sugary texture that weathers to fine sand.

The uppermost few metres of the quarry seem to have a well-developed layer of epikarst – enlarged fractures from dissolution of the limestone. Evidence of karstic cavities is also present in the lower part of the quarry. Folded beds can be seen in the northern face of the quarry.

This site has hosted a quarry since 2002 only, but a lime kiln has been present on the hill for over 100 years.

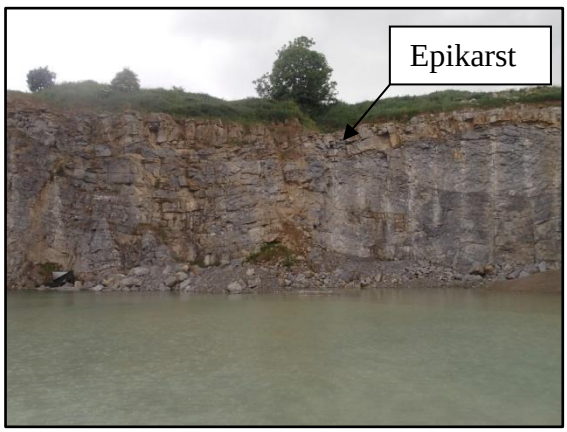
The quarry has produced stone for aggregates, chippings, railway ballast, lime dust, screenings, and drainage stone. Limestones of the Waulsortian Limestone are worked for aggregate in several quarries in the region.

Site Importance – County Geological Site
This County Geological Site is an important representative site exhibiting fresh and extensive exposures of Waulsortian Limestone.

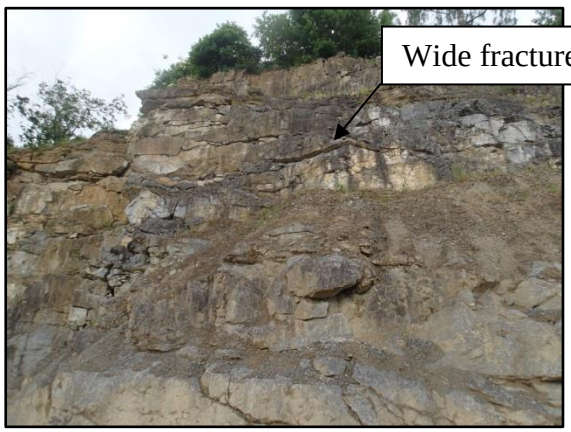
Management/promotion issues
As a working quarry, the listing as a County Geological Site has no implications for the normal operation of the quarry, subject to standard permissions and conditions under planning and environmental legislation. In the event of any future changes in quarrying operations, it would be desirable to consider retaining representative faces for geological purposes. As an operating quarry, the site is not suitable for any general promotion. Any correspondence can be made to the owner and operator Kerwin Quarries, Killeany, Kilbricken, Mountrath, County Laois.

The back face of Killeany Quarry.

A fold within steeply dipping beds in Killeany Quarry.

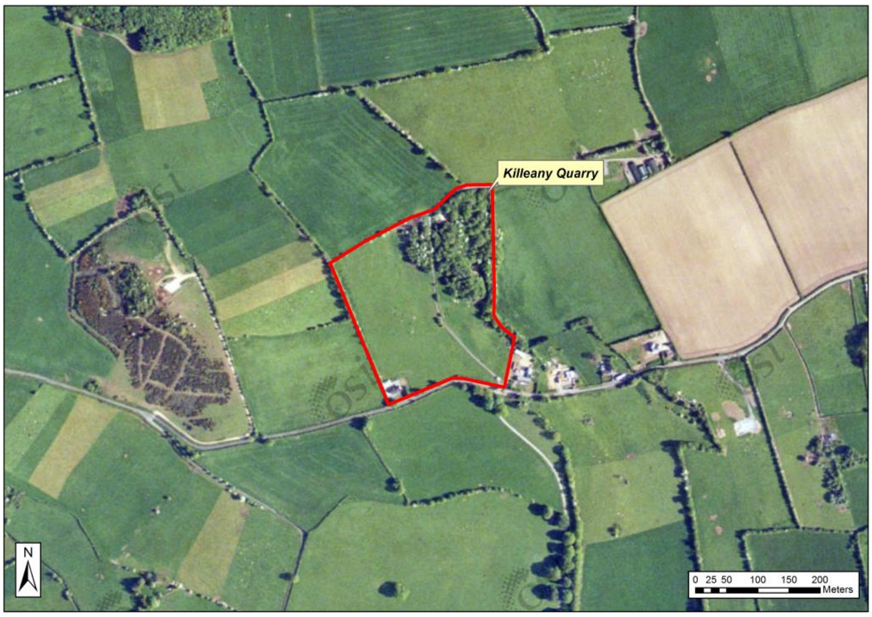


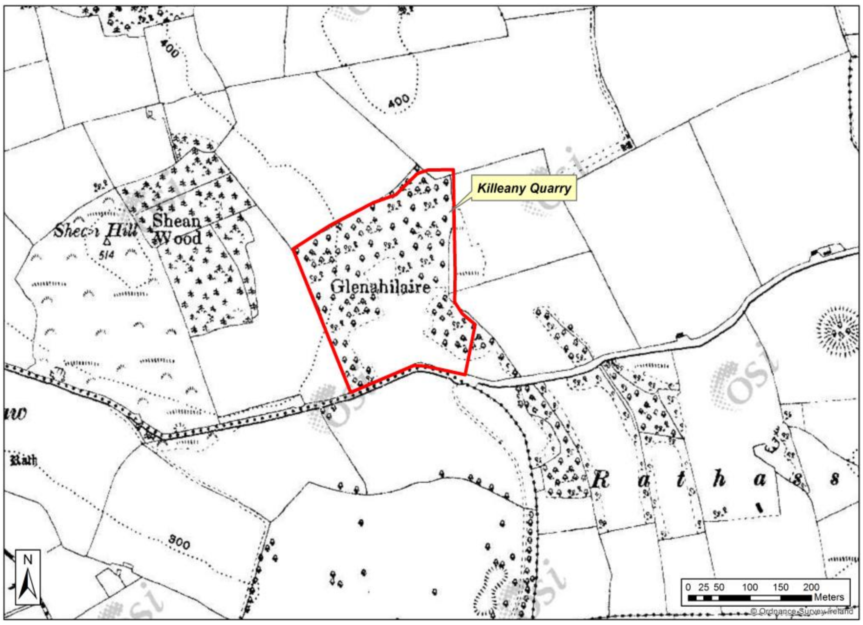
Epikarst in the uppermost portion of the exposed limestone.



Wide, dissolved fracutres and karstic cavities at depth within the rock face.


Killeany Quarry
Castletown
ABBEYLEIX
Mainistir Laoise
Killeany
Rathsaa
Aghaboe
River Nore
An Fheoir
Boston
Cuddagh
Kilbricken
Shanavolla
Tarbert
Doon
Boley
Boley Upper
Scotchill
Ballytarsna
Coolnacartan


Killeany Quarry
N
0 25 50 100 150 200
Meters


Killeany Quarry
Glenahilaire
Shean Wood
Shean Hill
514
400
400
300
Rath
R a t h a s s
N
0 25 50 100 150 200
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Killeshin Glen**
Other names used for site	
IGH THEME	**IGH3 Carboniferous to Pliocene Palaeontology, IGH9 Upper Carboniferous to Permian**
TOWNLAND(S)	**Coorlaghan, Keeloge**
NEAREST TOWN/VILLAGE	**Carlow**
SIX INCH MAP NUMBER	**32, 37**
ITM CO-ORDINATES	**666200E 676990N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
A long section of rocks exposed in a deep gorge-like valley.

Geological System/Age and Primary Rock Type
The rocks exposed in Killeshin Glen are Namurian and Westphalian in age, comprising the Killeshin Siltstone Formation, followed upwards by the Bregaun Flagstone Formation, the Moyadd Coal Formation and the Clay Gall Sandstone Formation.

Main Geological or Geomorphological Interest
At Killeshin Glen a near continuous stream section through the Namurian and Westphalian rocks of the Carboniferous is found. The Killeshin Siltstone Formation has two marine bands in it. The Reticuloceras gracile Marine Band is found in the stream behind the old church and graveyard in the village of Killeshin. The other is in the main section above the reservoir (which has an interesting history as a water supply for Carlow Town from 1894 -1987). The section upstream from the reservoir park includes the Gastrioceras cancellatum Marine Band in the upper part of the Killeshin Siltstone Formation, the Bregaun Flagstone Formation, the No. 1 Coal at the base of the Moyadd Coal Formation and the Clay Gall Sandstone Formation. Within the Moyadd Coal Formation another Marine Band can be found, long known as the Fleck Rock, which has flecks of black shale in a siltstone. Access to all of this section is extremely difficult without appropriate ‘expedition’ attitude.

Site Importance – County Geological Site; may be recommended for Geological NHA
This section is an important reference section for Namurian and Westphalian strata in the Leinster Coalfield, and is likely to be promoted as a geological NHA once suitable review of sites nationally is undertaken.

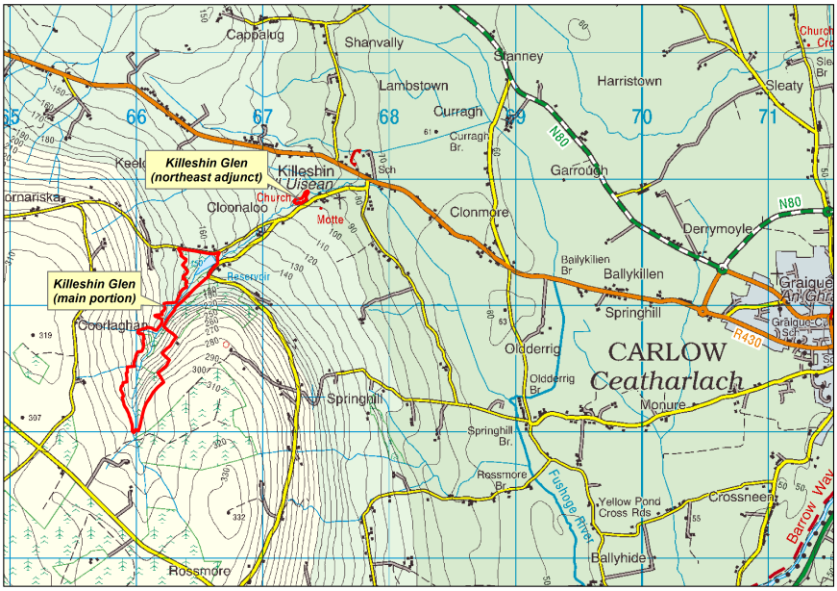
Management/promotion issues
The site is on forestry and private farmland and not suitable for general promotion. It is also very difficult to access due to deep vegetation even in summer when water levels are low in the stream. The stream is mostly within a deep and almost inaccessible gorge. The study of such a section is the protracted work of a highly committed geologist and is not undertaken on a casual basis. It remains as a good reference section for future study or re-appraisal with new tools or data, but it is not an inviting section.

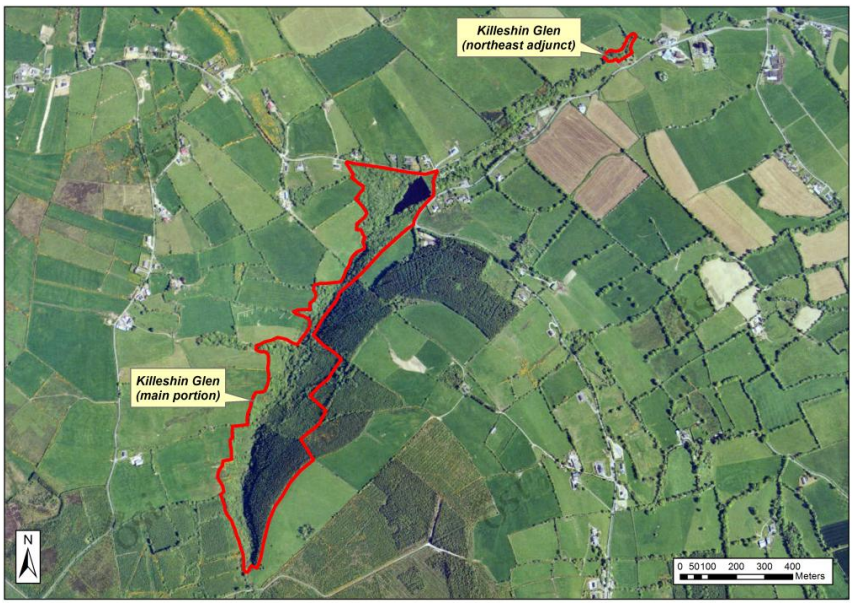
The deep ravine of Killeshin Glen is hidden when viewed from the plateau of the Castlecomer Coalfield, from the west.

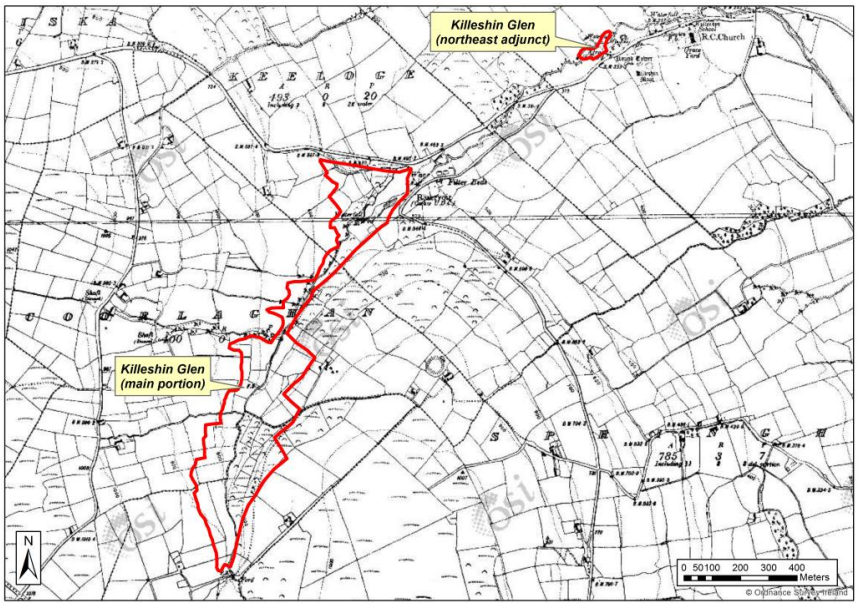
Most of the section is in a gorge.

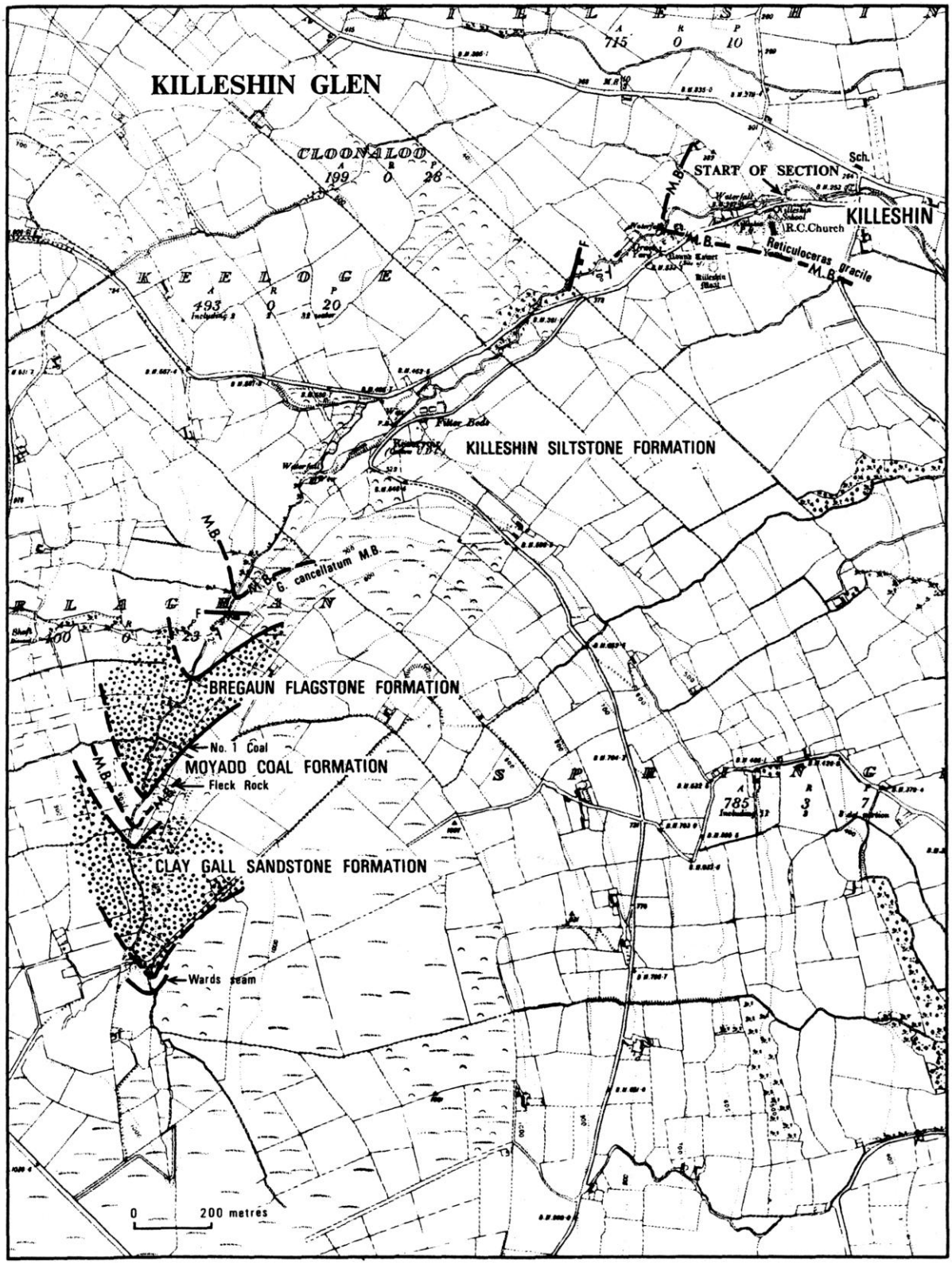
Waterfalls often occur where harder bands of rock create a barrier to erosion.

The Killeshin Glen section is in the ravine below the plantation forestry.


Killeshin Glen
(northeast adjunct)
Killeshin Glen
(main portion)
Cappaloig
Shanvally
Stanney
Harristown
Sleaty
Lambstown
Curragh
Curragh Br.
Killeshin
Uisean
Church
Motte
Cloonaloo
Clonmore
Garrough
Dernmoyle
Ballykillen Br
Ballykillen
Springhill
Coolaghan
Reservoir
Oldderrig
Oldderrig Br
CARLOW
Ceatharlach
Monure
Springhill Br.
Rossmore Br.
Fushoge River
Yellow Pond Cross Rds
Crossneens
Ballyhide
Rossmore
N80
R430
Barrow Way


Killeshin Glen
(northeast adjunct)
Killeshin Glen
(main portion)
N
0 50100 200 300 400
Meters


Killeshin Glen
(northeast adjunct)
Killeshin Glen
(main portion)
R.C.Church
N
0 50100 200 300 400
Meters



Map from Feehan, J. 2013. The Geology of Laois and Offaly. Offaly County Council.

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Kyle Spring**
Other names used for site	Toberading
IGH THEME	**IGH16 Hydrogeology**
TOWNLAND(S)	**Moyadd**
NEAREST TOWN/VILLAGE	**Wolfhill**
SIX INCH MAP NUMBER	**31**
ITM CO-ORDINATES	**656310E 682460N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
A natural freshwater spring that is a source of water for the local public water supply system.

Geological System/Age and Primary Rock Type
The spring issues from alluvial gravels underlain by the generally karstified Upper Carboniferous (Pennsylvanian) Ballyadams Limestone Formation. The gravels are alluvial, and Holocene in age, but also overlie glaciofluvial sands and gravels of Pleistocene age.

Main Geological or Geomorphological Interest
Located approximately 2.5km northeast of Timahoe, Kyle Spring is a high yielding spring issuing from a regionally important karstified limestone aquifer, overlain by a locally important gravel aquifer. The Ballyadams Limestone Formation is generally karstified, and therefore Kyle Spring can be classed as a karst spring. The relatively consistent flow rate and hydrochemistry however are more characteristic of a gravel spring than of a karst spring, suggesting that the groundwater flows up from the limestone, through the gravel, before emerging at the spring.

At an elevation of 9mOD, the spring operates at a pumping rate of 2,182m^3 per day (480,000 gallons per day) and provides an abstraction rate of 1,591m^3 per day (35,000 gallons per day). The spring-water is categorised as ‘hard’, falling within a range of 251-350 milligrams per litre $CaCO^3$.

Situated in a broad alluvial flat, Kyle Spring discharges eastwards into a small stream which runs into the Crooked River (Timogue River) about 1 km north of the spring. Kyle Spring is classed as a tepid spring. Water temperature values (recorded in 1983) were 11.45°C.

Site Importance – County Geological Site
This is a very important County Geological Site considering it is used as a public water supply, supplying Stradbally, Ballylynan and Timahoe. It is a high yielding spring issuing from a regionally important karstified limestone aquifer, overlain by a locally important gravel aquifer.

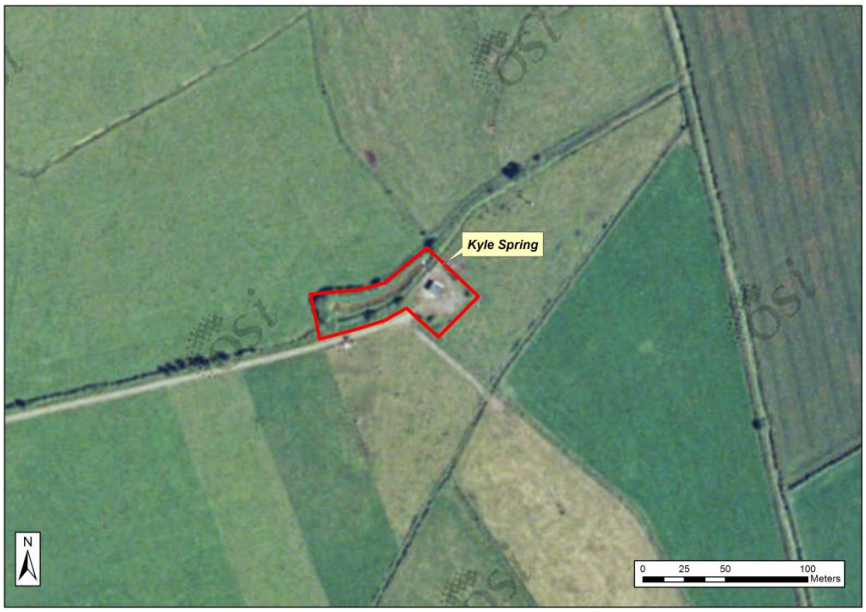
Management/promotion issues
The well is owned by Laois County Council (GSI Number 23/19SE W146). The spring and overflow area is fenced off. As a public water supply and a site accessed through private property, the site is not suitable for promotion. Kyle Spring has a Zone of Contribution of 4.75km^2. The Zone of Contribution is deemed ‘highly’ vulnerable to contamination.

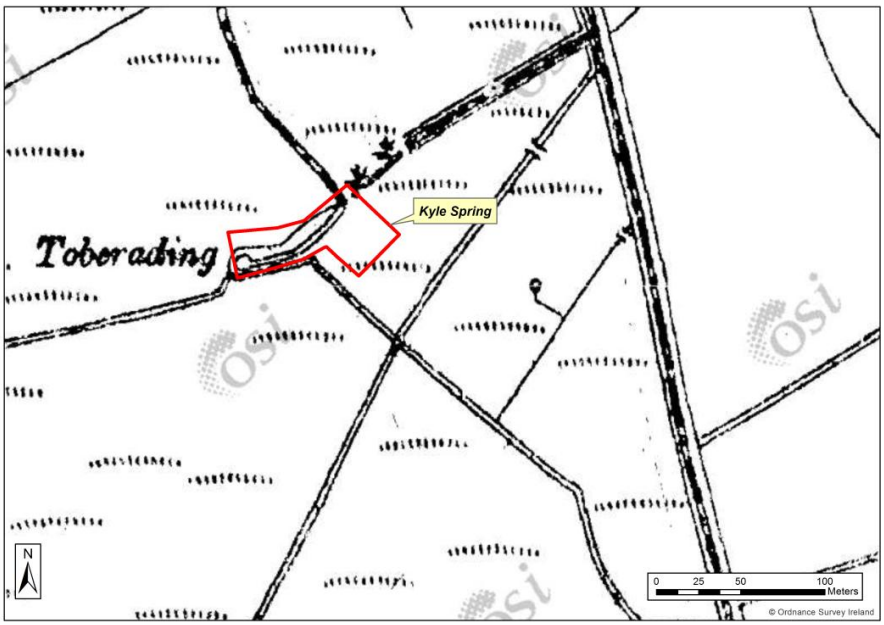
View of the spring and overflow, looking west towards Timahoe-Stradbally road.

Kyle Spring overflow (all fenced off).

Entrance gate to Kyle Spring pump house and works, looking east.


Brocknagh
123
Gravel Pit
Timahoe River
Honey Stream
Holy Well
Kyle Spring
Coolnabacky
Crooked
Esker
Timahoe Esker
Gravel Pit
Kyle
R426
Clondoolagh
Gravel Pit
Orchard Lower
PO
Timahoe
Tigh Mochua
Church
Round Tower
Fallowbeg


Kyle Spring
N
0 25 50 100
Meters


Kyle Spring
Toberading
N
0 25 50 100
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Lisduff Quarry**
Other names used for site	
IGH THEME	**IGH8 Lower Carboniferous**
TOWNLAND(S)	**Lisduff, Knockahaw**
NEAREST TOWN/VILLAGE	**Rathdowney**
SIX INCH MAP NUMBER	**27**
ITM CO-ORDINATES	**619400E 677600N**
1:50,000 O.S. SHEET NUMBER	**60 GSI BEDROCK 1:100,000 SHEET NO. 18**

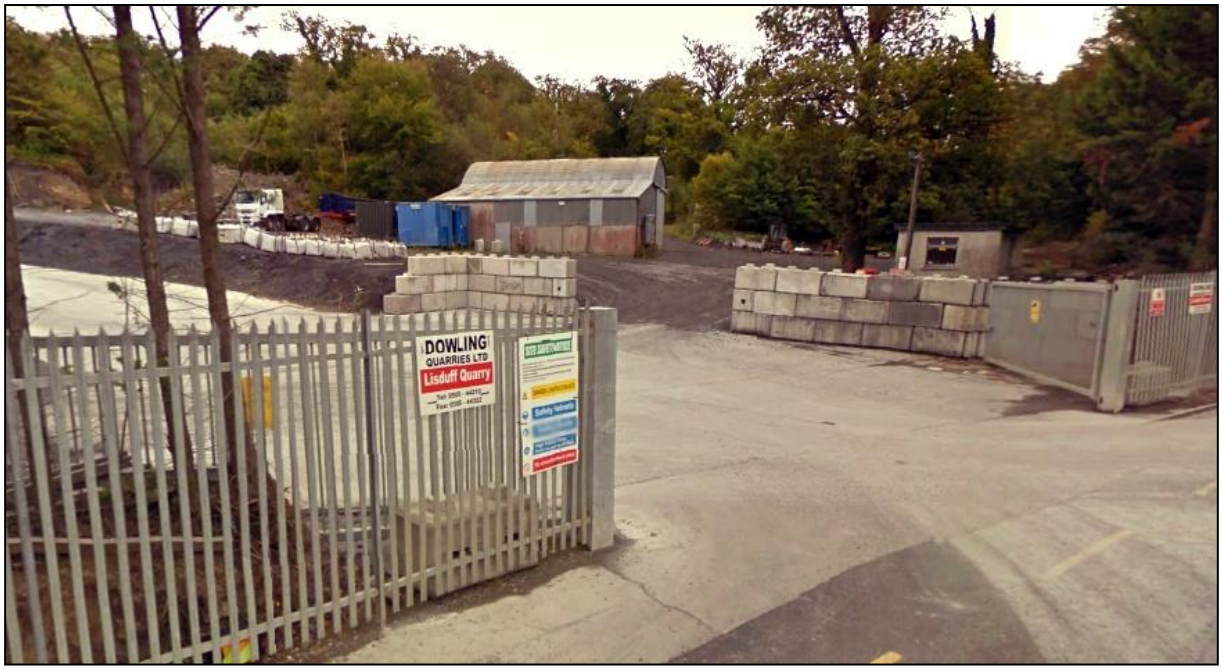
Outline Site Description
A large, active limestone quarry located 8km west of Rathdowney.

Geological System/Age and Primary Rock Type
Lisduff Oolite Member (Ballysteen Formation) bedrock comprising thick bedded, pale blue-grey, cross-bedded, well-jointed oolite of Lower Carboniferous (Mississippian) age.

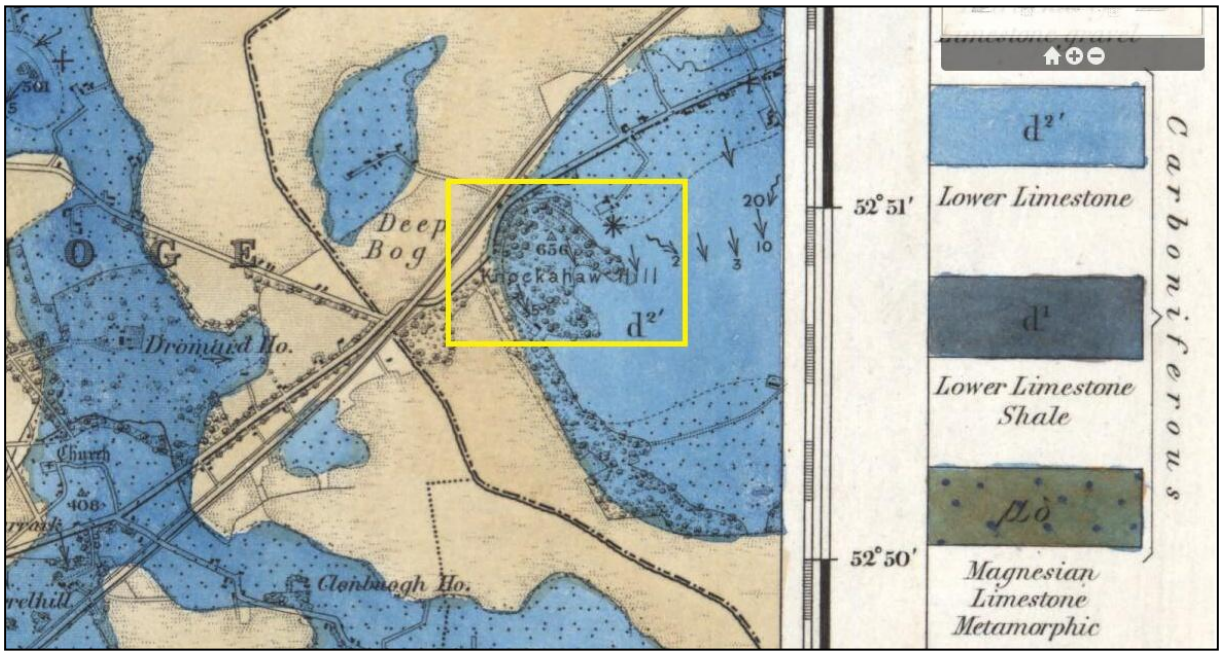
Main Geological or Geomorphological Interest
The site hosts clean and fresh quarry faces of Ballysteen Formation limestone. The strata dip gently 2°-10° south. Early GSI 1 inch scale sheets (Sheet 135) from the late 1800's show that the site, Knockahaw Hill, was recognised as an important fossil locality.

Site Importance – County Geological Site
This is an important County Geological Site, and is an important representative site with extensive exposures of Ballysteen Limestone Formation.

Management/promotion issues
The site is a large working quarry, producing lime for chemical uses, and some limestone for aggregates and other uses. No management issues arise, except if the quarry were to close; then maintaining access for geologists would be desirable. As a working quarry it is not suitable for promotion to general visitors other than at the instigation of the operators. Contact: Dowling Quarries Ltd, Lisduff Quarry, Errill, Rathdowney, Co. Laois (Telephone: 0505 44210).

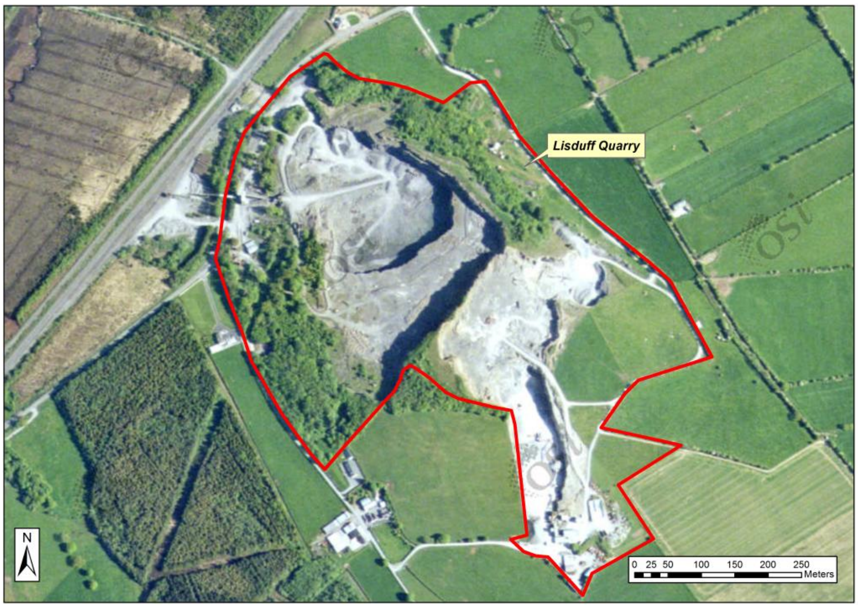


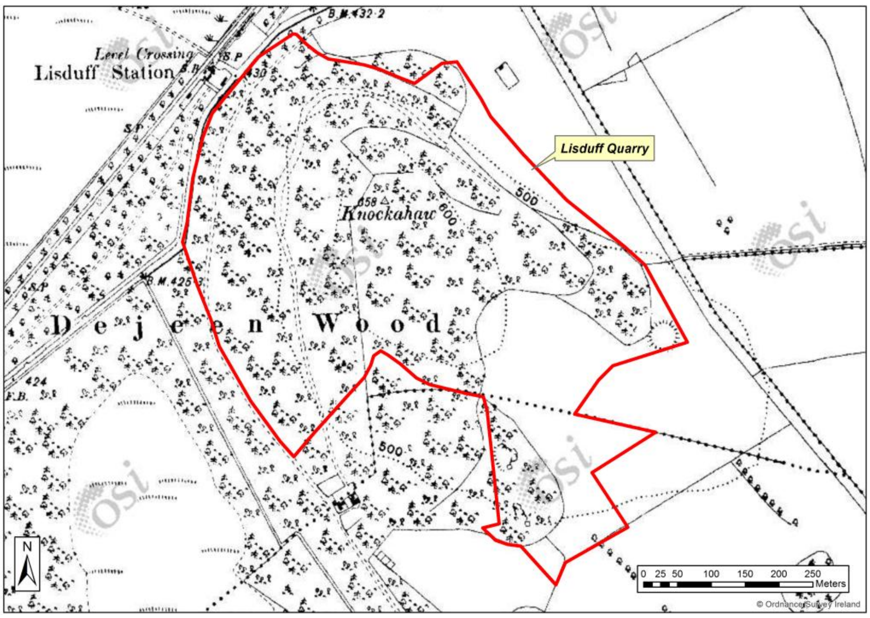
Entrance to Lisduff Quarry.



Knockahaw Hill on GSI Sheet 135 1-inch scale map, published 1860. Location of present-day quarry is at Knockahaw Hill.


Lisduff Quarry
Rathdowney
Ráth Domhnaigh
Erkina River
Uircín


Lisduff Quarry
N
0 25 50 100 150 200 250
Meters


Lisduff Quarry
Lisduff Station
Level Crossing
Knockahaw
Dejeen Wood
N
0 25 50 100 150 200 250
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Luggacurren Fireclay Pit**
Other names used for site	
IGH THEME	**IGH9 Upper Carboniferous and Permian**
TOWNLAND(S)	**Luggacurren**
NEAREST TOWN/VILLAGE	**Stradbally**
SIX INCH MAP NUMBER	**25**
ITM CO-ORDINATES	**658610E 687270N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
A farm borrow-pit.

Geological System/Age and Primary Rock Type
The site exposes Namurian rocks of part of the Killeshin Siltstone Formation.

Main Geological or Geomorphological Interest
Complementing the Luggacurren Stream section, this site is a farm borrow pit in the Killeshin Siltstone Formation, with a good fresh exposure. As the rock is shale, which fractures and decomposes very easily once exposed, natural exposures are almost non-existent, so small pits like this site are a valuable opportunity to see the character of the rock.

The shale is used for farm roads, as fill and occasionally used as a fireclay for mixing into the clay mix for making ceramic chimney liners.

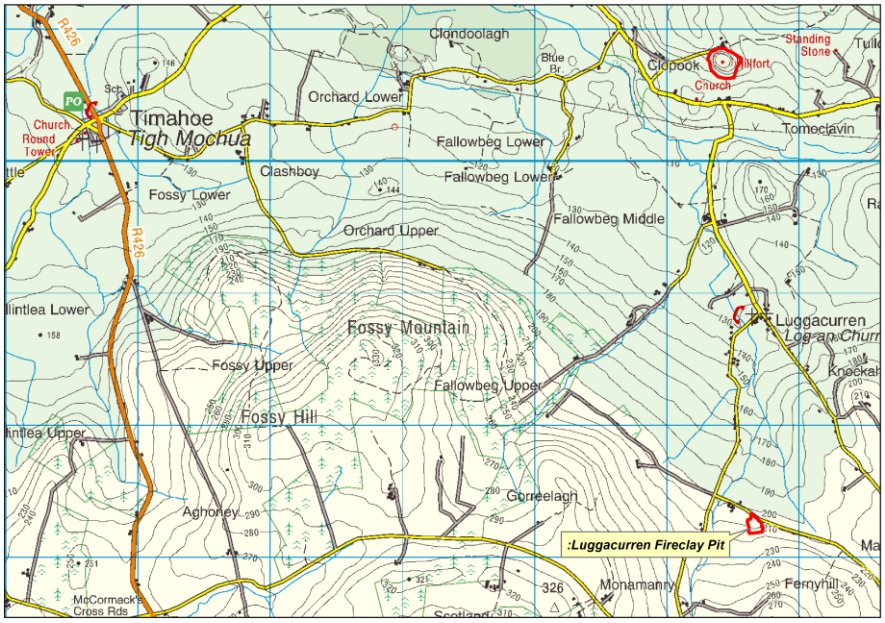
Site Importance – County Geological Site; may be recommended for Geological NHA
This is a small but good representative section of part of the Namurian rocks in the Leinster Coalfield and is a good County Geological Site, whilst it remains in occasional use, and does not become degraded and overgrown.

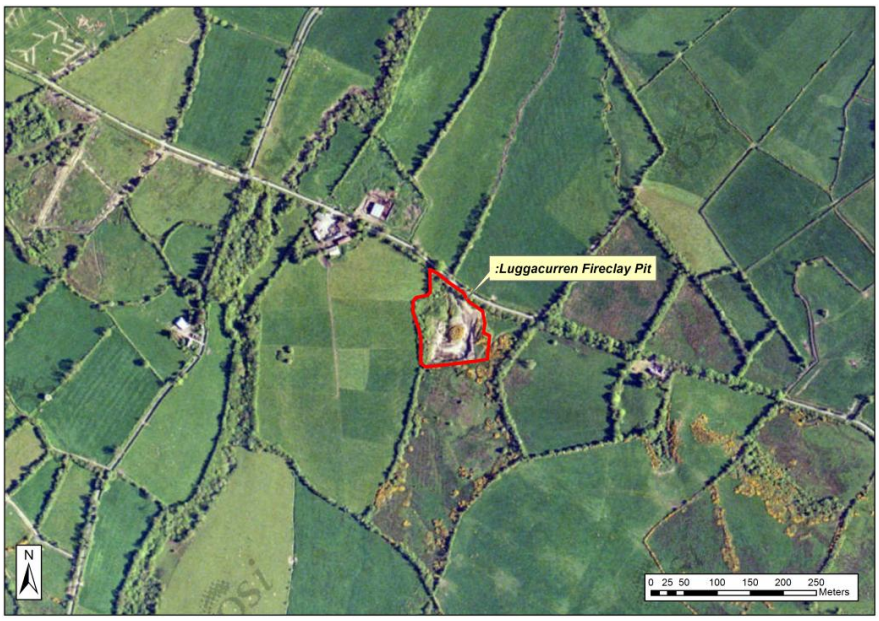
Management/promotion issues
The site is on private farmland and not suitable for general promotion.

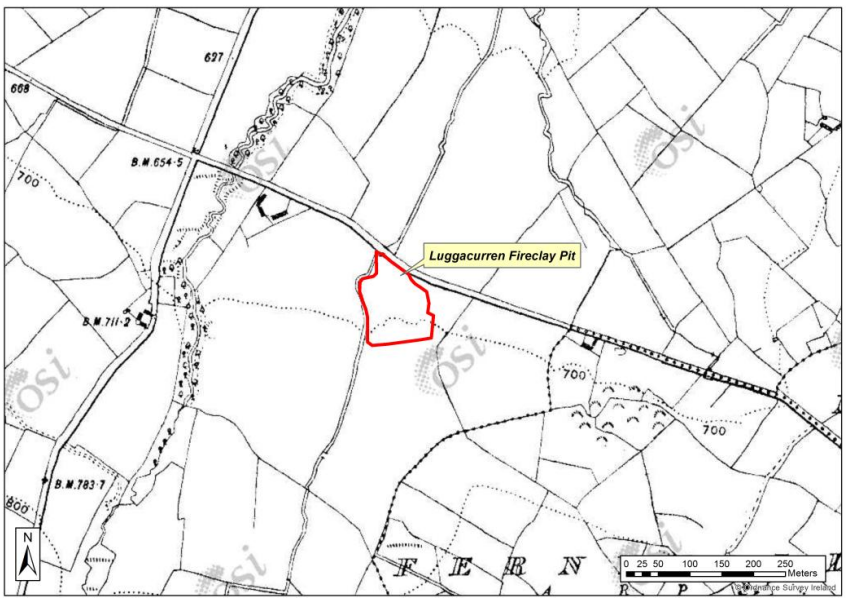
Luggacurren fireclay pit, looking eastward.

The entrance road into Luggacurren fireclay pit.

Luggacurren fireclay pit, looking west.


R426
Clondoolagh
Blue Br.
Standing Stone
Clogbook
Church
Orchard Lower
PO
Timahoe
Tigh Mochua
Church
Round Tower
Fallowbeg Lower
Tomeclavin
Clashboy
Fossy Lower
Orchard Upper
Fallowbeg Middle
Luggacurren
Fossy Mountain
Fossy Upper
Fallowbeg Upper
Fossy Hill
Gorreelagh
Aghoney
:Luggacurren Fireclay Pit
Monamanny
Fernyhill
McCormack's Cross Rds


:Luggacurren Fireclay Pit
N
0 25 50 100 150 200 250
Meters


627
668
700
B.M.654·5
Luggacurren Fireclay Pit
B.M.711·2
B.M.783·7
800
N
0 25 50 100 150 200 250
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Luggacurren Stream Section**
Other names used for site	The Crooked River
IGH THEME	**IGH3 Carboniferous to Pliocene Palaeontology, IGH9 Carboniferous and Permian**
TOWNLAND(S)	**Luggacurren**
NEAREST TOWN/VILLAGE	**Stradbally**
SIX INCH MAP NUMBER	**25**
ITM CO-ORDINATES	**658455E 688200N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
Two long stream sections with exposures in bed and banks of the Crooked River and a tributary, in a deep gorge.

Geological System/Age and Primary Rock Type
The site exposes Namurian rocks of the Luggacurren Shale Formation and the lower part of the Killeshin Siltstone Formation.

Main Geological or Geomorphological Interest
This section of rocks has been studied in detail by several geologists over the years since first surveyed in 1814, by Sir Richard Griffith. Most recently in the 1980s Ken Higgs, working for the Geological Survey of Ireland, established a detailed biostratigraphy based on goniatites and bivalve fossils, together with spores and pollen microfossils (palynomorphs). His fossil collections are housed in the Geological Survey of Ireland, along with some of the earlier collections. Higgs defined four members of the Luggacurren Shale Formation in the stream section, with only three of them exposed in the south eastern stream section.

Site Importance – County Geological Site; may be recommended for Geological NHA
This is a well-studied, reasonably exposed, good representative section of the Namurian rocks in the Leinster Coalfield and is likely to be proposed for NHA status when the IGH3 or IGH9 themes are fully assessed on a national basis.

Management/promotion issues
The site is on private farmland and not suitable for general promotion. It is also very difficult to access due to deep vegetation even in summer when water levels are low in the stream. The study of such a section is the protracted work of a highly committed geologist and is not undertaken on a casual basis. It remains as a good reference section for future study or re-appraisal with new tools or data, but it is not an inviting section.

Luggacurren stream exposures.

Luggacurren stream exposures.

Luggacurren stream exposures.

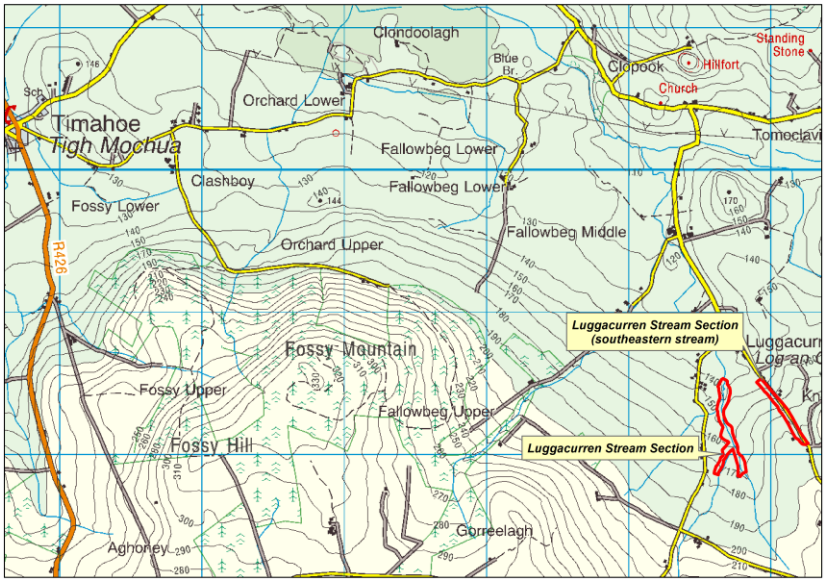
Luggacurren stream exposures.

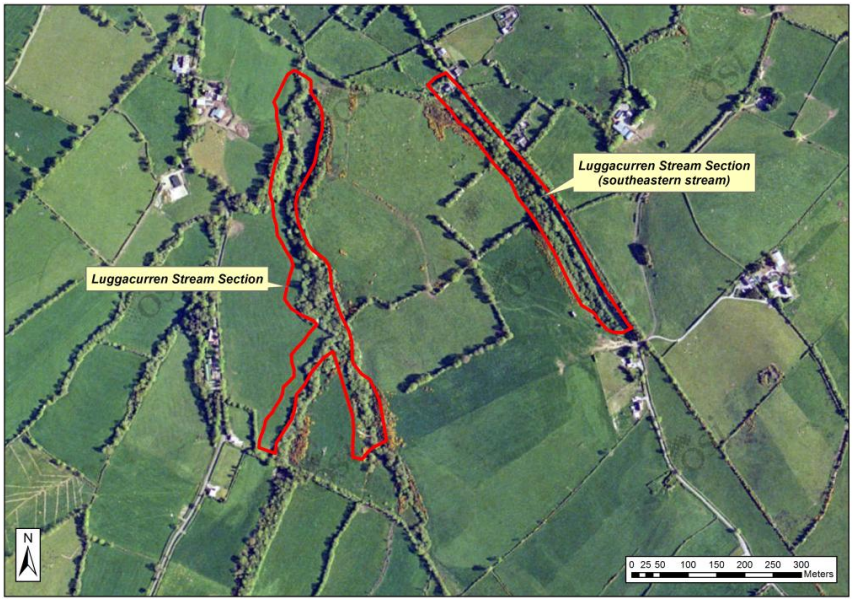
Luggacurren stream exposures.

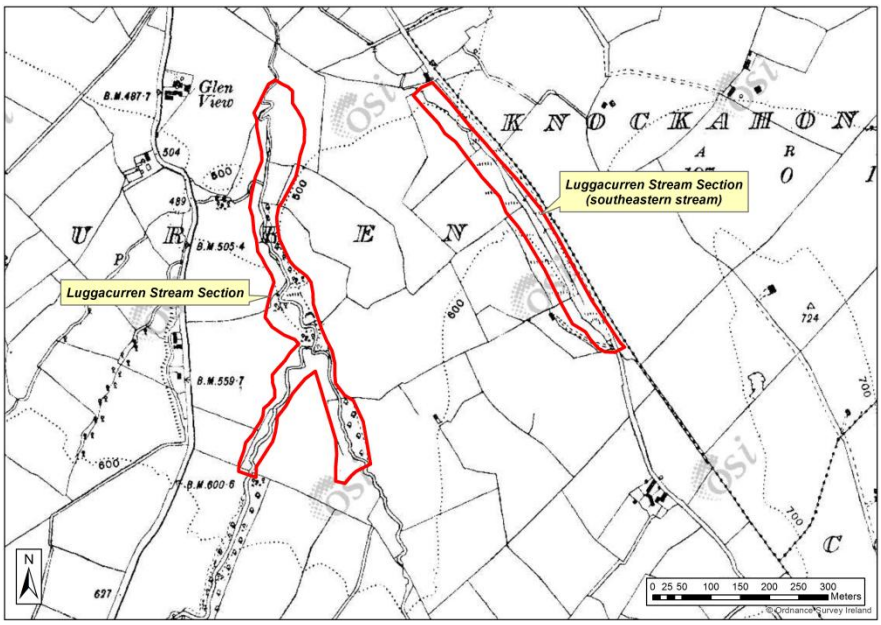
Luggacurren stream exposures.

Luggacurren stream exposures.

Luggacurren south eastern stream is in a gully to the left of this road.


Clondoolagh
Blue Br.
Clopook
Standing Stone
Hillfort
Church
Orchard Lower
Timahoe
Tigh Mochua
Fallowbeg Lower
Clashboy
Fallowbeg Lower
Fossy Lower
Fallowbeg Middle
Orchard Upper
R426
Luggacurren Stream Section (southeastern stream)
Fossy Mountain
Fossy Upper
Fallowbeg Upper
Fossy Hill
Luggacurren Stream Section
Gorreelagh
Aghoney


Luggacurren Stream Section (southeastern stream)
Luggacurren Stream Section
N
0 25 50 100 150 200 250 300
Meters


Glen View
B.M.487·7
KNOCKAHON
Luggacurren Stream Section (southeastern stream)
Luggacurren Stream Section
B.M.505·4
B.M.559·7
B.M.600·6
724
N
0 25 50 100 150 200 250 300
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**M7 Road Cut Derryvorrigan**
Other names used for site	
IGH THEME	**IGH8 Lower Carboniferous**
TOWNLAND(S)	**Derryvorrigan**
NEAREST TOWN/VILLAGE	**Borris-in-Ossory**
SIX INCH MAP NUMBER	**22**
ITM CO-ORDINATES	**626500E 686150N**
1:50,000 O.S. SHEET NUMBER	**60 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A 500m long road cut through limestone bedrock on the M7 Motorway.

Geological System/Age and Primary Rock Type
Bedrock is Lower Carboniferous (Mississippian) dark-coloured muddy limestone (Ballysteen Formation).

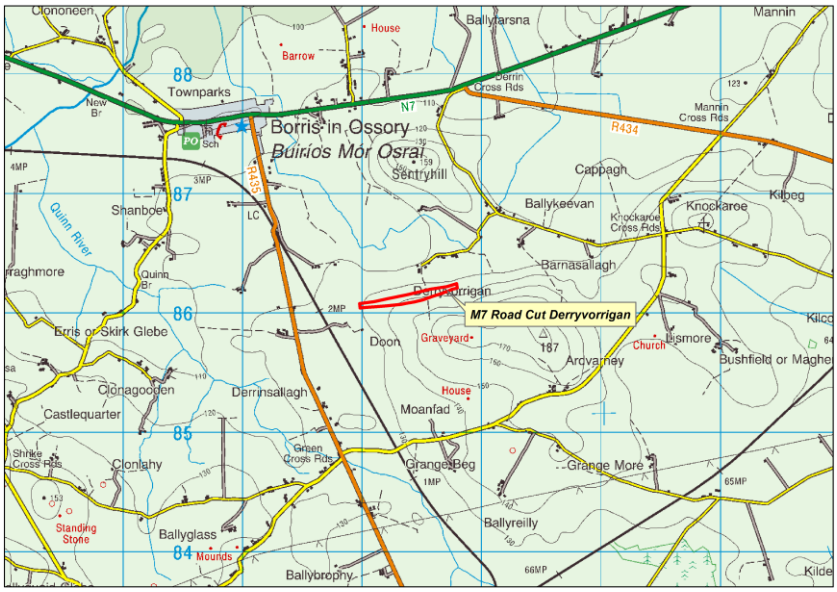
Main Geological or Geomorphological Interest
The limestones visible in the road cut exposures along this stretch of the M7 motorway provide a wonderful insight into the strata and structure of the bedrock in this region of County Laois.

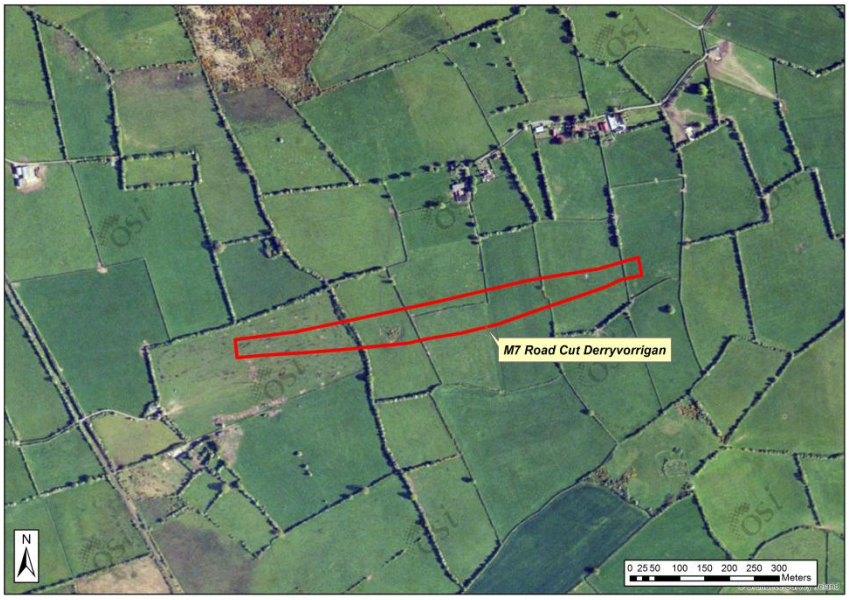
Site Importance – County Geological Site
This is a good representative section for the Ballysteen Formation, and it is of County Geological Site importance.

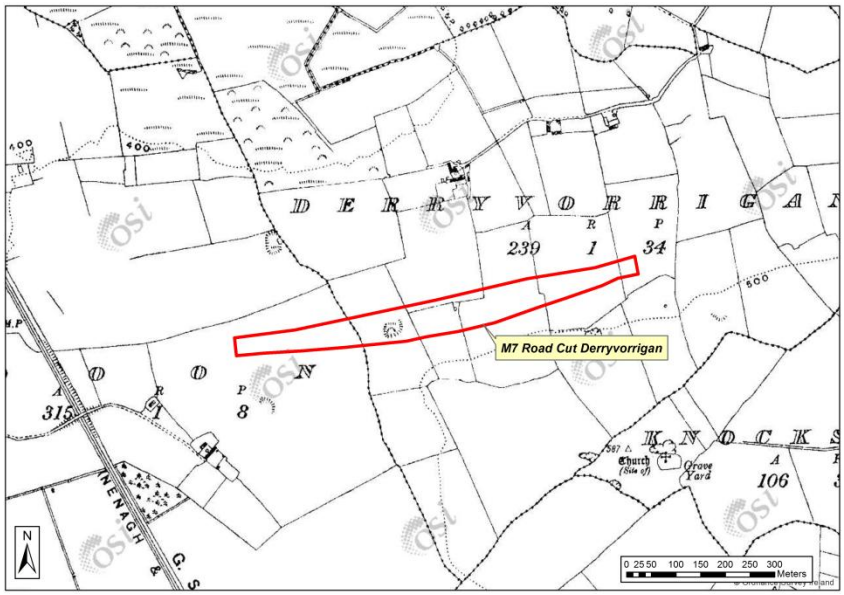
Management/promotion issues
The exposures are in road cutting on a long busy motorway, and are therefore not suitable for general promotion. The exposures provide hundreds of daily passing motorists with a rare ‘window’ into the limestone strata that underlie this part of County Laois, and much of the Irish countryside. Some localised management to keep the rock faces clear of vegetation would preserve this open ‘window’ into the limestone foundation in this region of County Laois.

M7 Road Cut viewed looking east, beside M7 Motorway road sign.

M7 Road Cut viewed looking east from top of southern embankment.


Clononeen
Ballyarsna
Mannin
House
Barrow
88
Townparks
New Br
Borris in Ossory
Buirios Mor Osrai
N7
Derrin Cross Rds
Mannin Cross Rds
R434
R433
Sentryhill
Cappagh
Kilbeg
Knockaroe
Ballykeevan
Knockaroe Cross Rds
Shanboe
87
LC
Quinn River
Barnasallagh
Quinn Br
Derryvorrigan
M7 Road Cut Derryvorrigan
86
Erris or Skirk Glebe
Doon
Graveyard
187
Church
Ardvarney
Bushfield or Maghe
Clonagooden
Derrinsallagh
House
Castlequarter
Moanfad
85
Shrike Cross Rds
Clonlahy
Green Cross Rds
Grange Beg
Grange More
Standing Stone
Ballyglass
Ballyreilly
84
Mounds
Ballybrophy
Kilde


M7 Road Cut Derryvorrigan
N
0 25 50 100 150 200 250 300
Meters


DERRYVORRIGAN
239 1 34
M7 Road Cut Derryvorrigan
DON
315 1 8
KNOCK
106
Church (Site of)
Grave Yard
INENAGH
N
0 25 50 100 150 200 250 300
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**M8 Road Cut Addergoole**
Other names used for site	
IGH THEME	**IGH8 Lower Carboniferous**
TOWNLAND(S)	**Addergoole**
NEAREST TOWN/VILLAGE	**Rathdowney**
SIX INCH MAP NUMBER	**28**
ITM CO-ORDINATES	**633950E 674850N (centre of road cut section)**
1:50,000 O.S. SHEET NUMBER	**60 GSI BEDROCK 1:100,000 SHEET NO. 18**

Outline Site Description
An 800m long road cut through limestone bedrock on the M8 Motorway.

Geological System/Age and Primary Rock Type
Bedrock is Lower Carboniferous (Mississippian) shaly limestone (Durrow Formation).

Main Geological or Geomorphological Interest
Approaching the road cut from the north, the strata are inclined (dip) to the south at an angle of around 30°. The bedrock is exposed along a continuous section on the west side of the motorway, and is almost continuous on the east side, with vegetation covering one northeastern section. Immediately south of this vegetated section the strata can be seen to adopt a more horizontal orientation. The transition from dipping to near horizontal is marked by an obvious south-dipping fault.

Towards the southern end of the road cut, where the motorway is traversed by a bridge (local Rathdowney to Cullahill road), the limestone strata are not as clearly visible and loose rubble dominates the section.

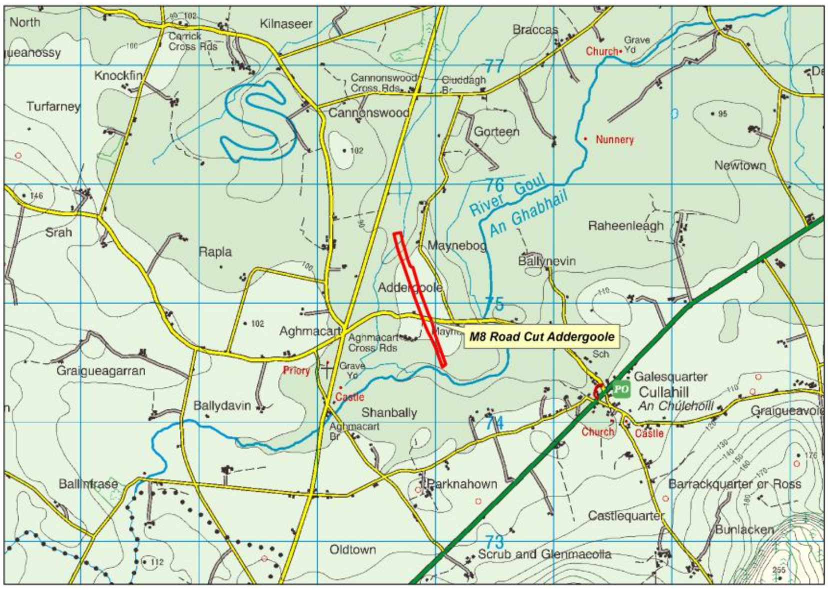
Site Importance – County Geological Site
This is a good representative section for the Durrow Formation, and it is of County Geological Site importance.

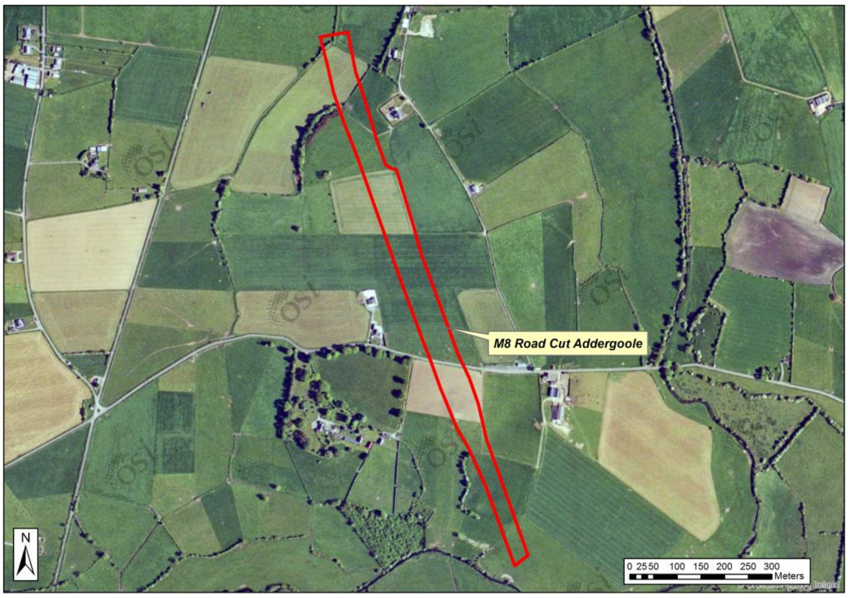
Management/promotion issues
The site is on a busy motorway, and is therefore not suitable for general promotion. However, the roadside exposures provide hundreds of daily passing motorists with a rare ‘window’ into the limestone strata that underlie this part of County Laois, and much of the Irish countryside. Over time, the rock faces will become covered with lichen, moss and other vegetation, obscuring the strata. Some localised management of this would preserve this open ‘window’ into the county’s limestone foundation, for example along the northern part of the section where strata are inclined.

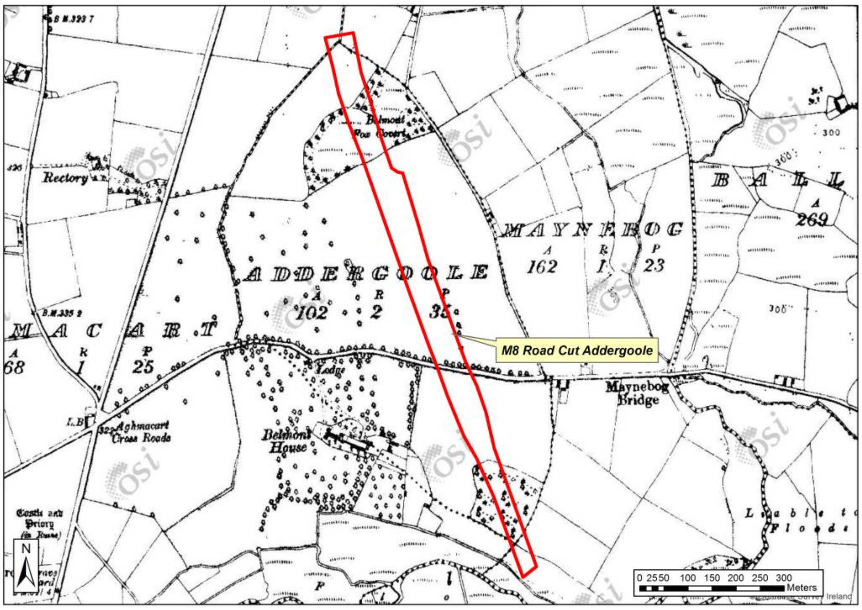
M8 Road cut viewed looking south from lay-by.

South-dipping limestone strata on the west side of M8 Road cut (northern part of road cut).

View looking south under bridge carrying local Rathdowney to Cullahill road over M8.


M8 Road Cut Addergoole


M8 Road Cut Addergoole
0 25 50 100 150 200 250 300
Meters


M8 Road Cut Addergoole
ADDERGOOLE
MAYNEBOG
Belmont House
Maynebog Bridge
Aghmacart Cross Roads
Rectory
0 25 50 100 150 200 250 300
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Modubeagh**
Other names used for site	Modubeagh Colliery
IGH THEME	**IGH16 Hydrogeology, IGH15 Economic Geology**
TOWNLAND(S)	**Modubeagh**
NEAREST TOWN/VILLAGE	**Wolfhill**
SIX INCH MAP NUMBER	**25**
NATIONAL GRID REFERENCE	**659500E 683900N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
Modubeagh is an abandoned coal mine site, largely overgrown but containing several extant surface features including the remains of mine buildings and a collapsed shaft.

Geological System/Age and Primary Rock Type
Bedrock at the site is part of the Carboniferous Pennsylvanian Coolbaun Formation but the underground mine exploited the Marine Band within the underlying Pennsylvanian Moyadd Coal Formation.

Main Geological or Geomorphological Interest
Modubeagh was noted for an unusual mine spring with a stepped structure, apparently sited at the southeastern corner of the field that bounds the site to the west. Old six-inch maps show a series of shafts running east-west along this field, crossing the field boundary at the southeastern corner. No trace remains of these shafts. A stream runs northeast along the field boundary here, its water turned red by mine drainage that enters the stream over 100 m upstream. A manhole in the centre of this field, 120 m northwest of the mine site boundary, is the only visible evidence for this apparent mine drainage system that may originally have emerged at the original site of the spring. Modubeagh mine was operated from the second half of the 19th century until 1925 by Wolfhill Collieries Ltd. The site is mainly of interest as an example of a largely 19th century coal mine site with several extant surface mine features including mine buildings, a reservoir and shafts. Buildings include the remains of housing for winding gear and a mine manager's house reduced to footprint level. The main shaft, marked by a 5m wide depression, is collapsed. It was one of the deepest in the coalfield, reaching a depth of 160 m.

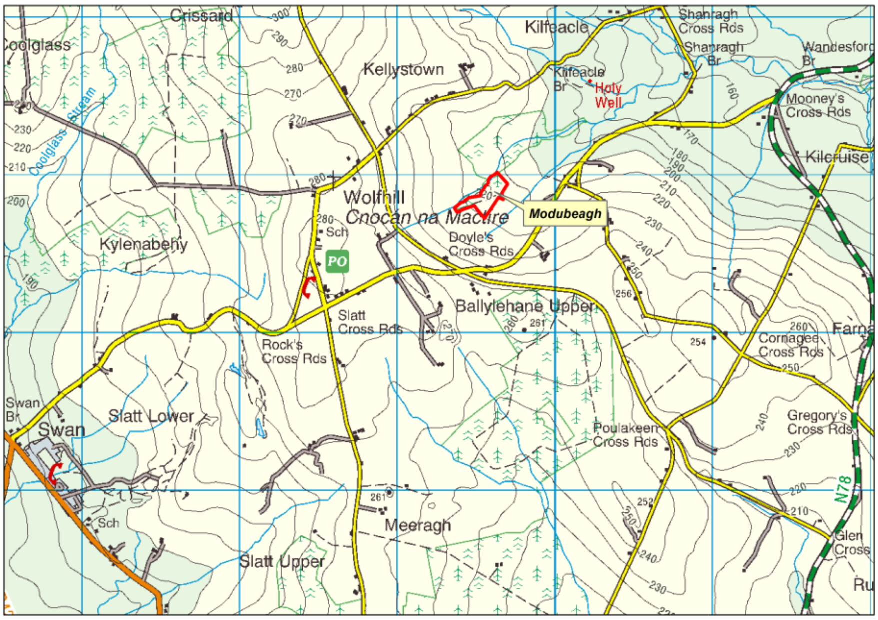
Site Importance – County Geological Site
There are not many surface traces of pre-20th century mining in the Leinster Coalfield, unlike the situation in the Slieve Ardagh coalfield to the southwest. Indeed, even many of the 20th century mines have little surface expression, the land having been reclaimed for farming and other uses. In this context, the Modubeagh site has considerable significance even if the extant surface features are largely overgrown.

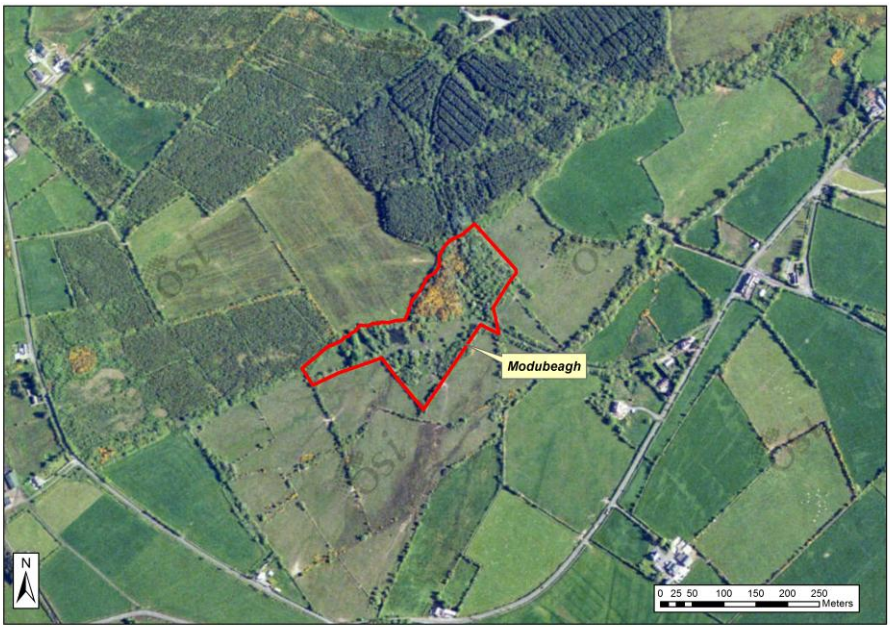
Management/promotion issues
The site, in its current overgrown state, is of interest mainly to students of mining history. The main shaft, although collapsed at the collar, is unfenced and constitutes a safety risk. The site is therefore not suitable for promotion to the general public.

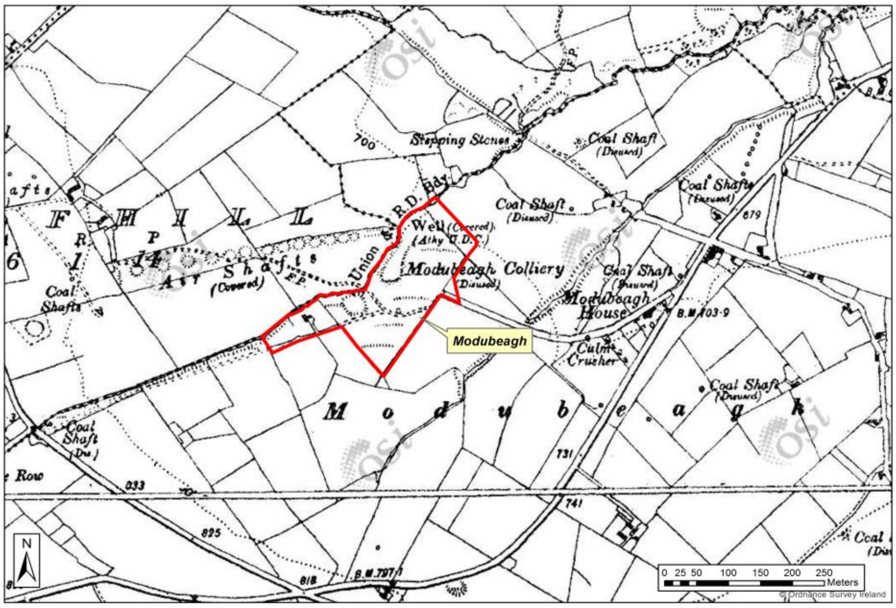
Remains of washing/screening plant at Modubeagh Mine.

Modubeagh Mine Reservoir.

Surface expression of Modubeagh Mine main shaft, c. 160 m deep.


Modubeagh
Wolfhill
Cnocán na Machaire
Kilfeacle
Kellystown
Crissard
Coolglass
Kylenabehy
Ballylehane Upper
Slatt Lower
Swan
Meeragh
Slatt Upper
Holy Well
Kilcruise
N78


Modubeagh
N
0 25 50 100 150 200 250
Meters


Modubeagh
Modubeagh Colliery
Modubeagh House
Stepping Stones
Coal Shaft
Culm Crusher
N
0 25 50 100 150 200 250
Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Moyadd Stream**
Other names used for site	
IGH THEME	**IGH9 Upper Carboniferous and Permian**
TOWNLAND(S)	**Moyadd, Knockbaun**
NEAREST TOWN/VILLAGE	**Swan**
SIX INCH MAP NUMBER	**25, 31**
ITM CO-ORDINATES	**655120E 683460N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 15,16**

Outline Site Description
A small river channel has exposed bedrock in the bed and banks for approximately 1km.

Geological System/Age and Primary Rock Type
The site is the type section for the Moyadd Coal Formation which spans the boundary between the Namurian and Westphalian (in traditional stratigraphical usage in western Europe).

Main Geological or Geomorphological Interest
This stream section has been logged in detail by Professor Ken Higgs in his work for the Geological Survey of Ireland and at University College Cork. The Moyadd Coal Formation is defined with this stream exposure defined as the type section. The lowest coal seams, No. 1 and No. 2 of the coalfield are found within the section separated by two marine bands. The marine bands are critical markers in the stratigraphy representing short lived inundations of the coal swamps with marine environments and their characteristic fossils. Goniatites (small coiled cephalopods) are the characteristic fossils of these marine bands.

Above the Moyadd Coal Formation, the succeeding younger Clay Gall Sandstone Formation and the Coolbaun Coal Formation are found in the stream, moving southwards. The section has provided samples for palynology (spores and pollen microfossils), but nearby boreholes and other sections have also been used for correlating and sampling other formations than just in the Moyadd Coal Formation.

Site Importance – County Geological Site; may be recommended for Geological NHA
The lack of exposure generally across the Leinster coalfield means that the extensive exposures in this stream section are an important County Geological Site, but may also be recommended for geological NHA status when reviewed in a national context.

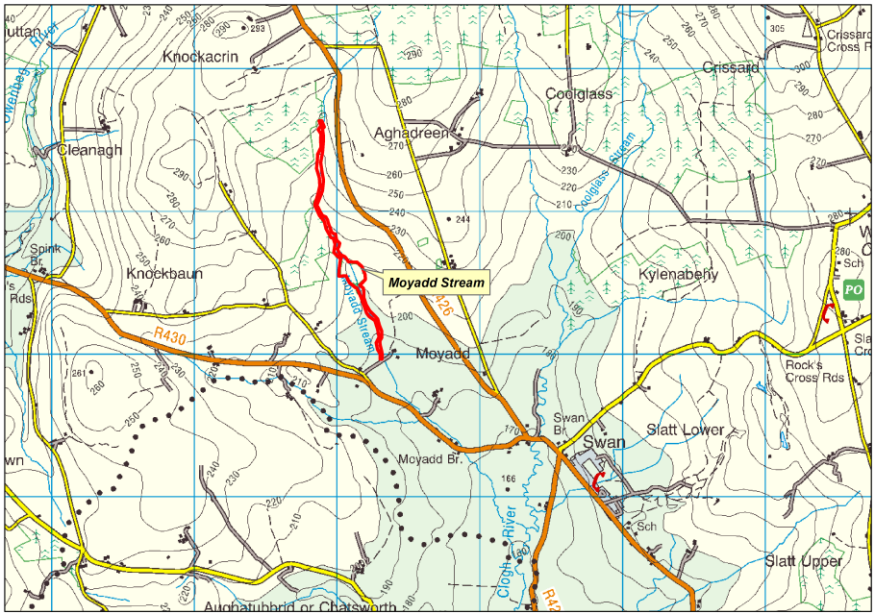
Management/promotion issues
The site is on private farmland and is unsuitable for promotion. It is also very vegetated and difficult to access without having the strong motivation of a field geologist to map or sample the bedrock.

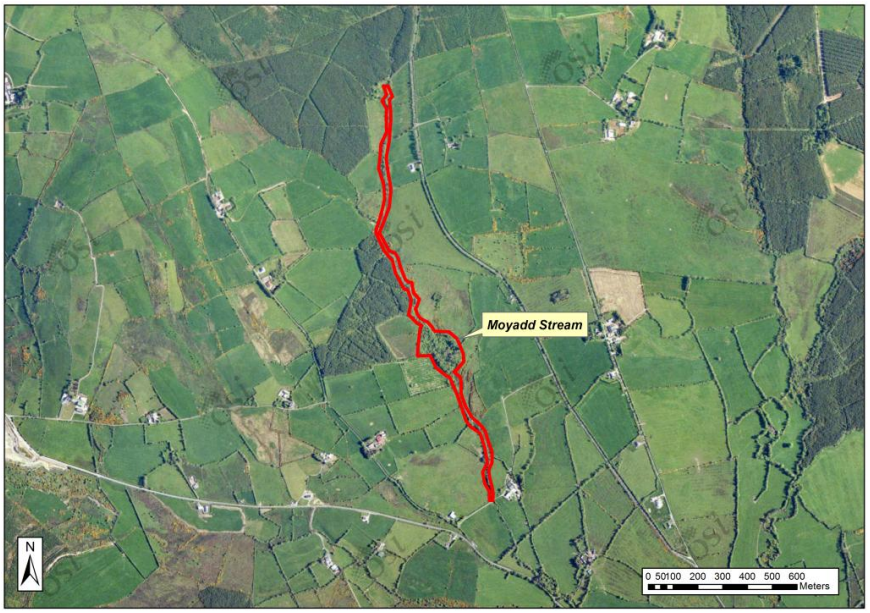
Panorama view of the Moyadd Stream site which runs along the edge of the forestry, flowing downstream to the left.

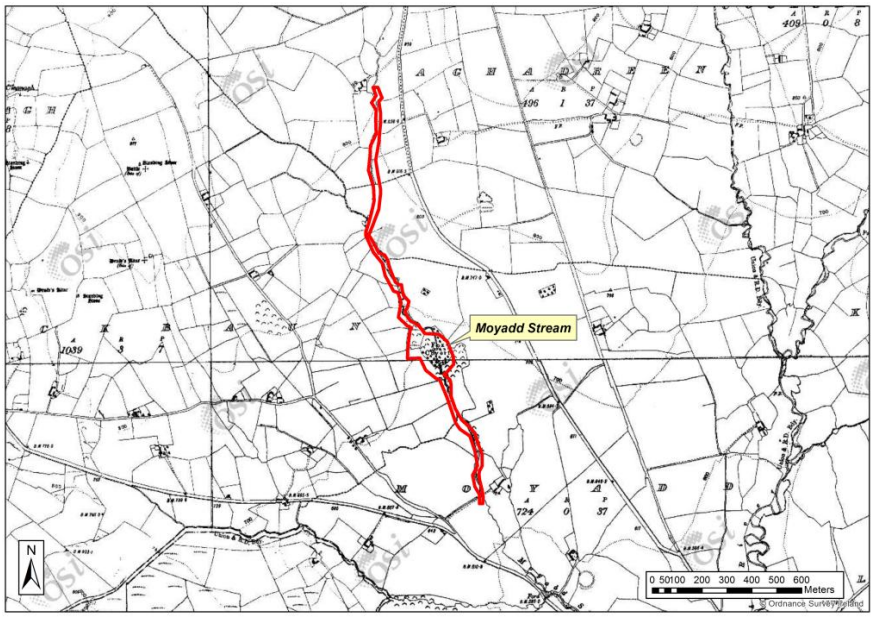
The stream bed and bank exposures are not extensive nor easy to access.

A typical example of the quality of exposure in the stream at Moyadd.

Disturbed ground, with many hollows and heaps, on the northern side in the middle of the site, may represent very old coal pits.


Knockacrin
Cleanagh
Aghadreen
Coolglass
Crissard
Knockbaun
Moyadd Stream
Moyadd
Kylenaberry
Rock's Cross Rds
Swan Br.
Swan
Slatt Lower
Moyadd Br.
Cloghoge River
Slatt Upper
R426
R430


Moyadd Stream
N
0 50100 200 300 400 500 600
Meters


Moyadd Stream
N
0 50100 200 300 400 500 600
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Old Rossmore**
Other names used for site	
IGH THEME	**IGH6 Minerals, IGH9 Upper Carboniferous and Permian, IGH15 Economic Geology**
TOWNLAND(S)	**Rossmore**
NEAREST TOWN/VILLAGE	**Bilboa**
SIX INCH MAP NUMBER	**37**
NATIONAL GRID REFERENCE	**666440E 673820N**
1:50,000 O.S. SHEET NUMBER	**61 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
Old Rossmore is a large abandoned coal mine and sandstone quarry comprising several large open pits, extensive waste heaps, derelict processing plant and outcrops of coal.

Geological System/Age and Primary Rock Type
The bedrock consists of sandstone, shale and coal of the Carboniferous Pennsylvanian (Westphalian) Moyadd Coal Formation and overlying Clay Gall Sandstone Formation.

Main Geological or Geomorphological Interest
Old Rossmore lies at the eastern edge of the Leinster Coalfield. Both the Moyadd Coal Formation and overlying Clay Gall Sandstone Formation are exposed within the two large quarries on the southern part of the site. A third large quarry to the north is flooded and no exposure of coal was visible during the site visit, while the large quarry to the south appears to have been exploited only for sandstone. A fifth pit, which appears on the 1:50,000 maps as a small lake, is present in the northern part of the old mine site – this area is not included in the Old Rossmore site defined for this audit as it contains no features of heritage interest. The western-most quarry (the Cheswell opencast) is actually located in County Carlow and is also outside the site boundary. Coal from the No. 2 seam or Marine band was mined in both the Cheswell quarry and the eastern quarry by opencast methods in the 1980s; subsequently sandstone was quarried. The Marine Band is 0.31 m thick and is the most widespread and economically important seam in the Leinster Coalfield. It is well exposed in both quarries, particularly in the eastern quarry. The coal, like all coal in the Leinster Coalfield, is anthracite, a high-grade coal with high calorific value. However, also like most coal seams in the coalfield, the Marine Band contains high concentrations of sulphur, evident in the fine-grained pyrite visible throughout the exposure. Coal was also mined here underground in the earlier part of the 20th century but few traces of underground mining remain.

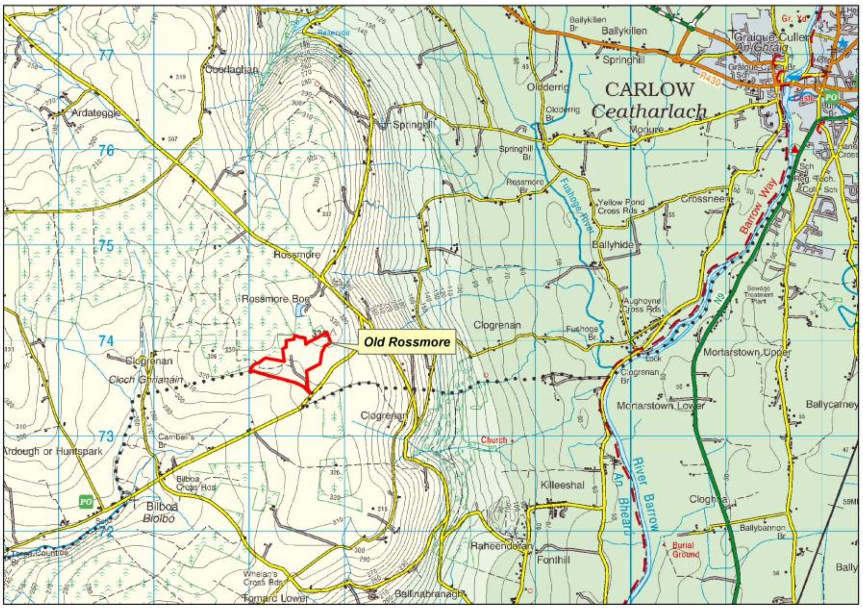
Site Importance – County Geological Site; recommended for Geological NHA
Good exposures of coal and coal-bearing strata are uncommon in the Leinster Coalfield, not least because so much mining took place underground. Old Rossmore is therefore of great significance in this context.

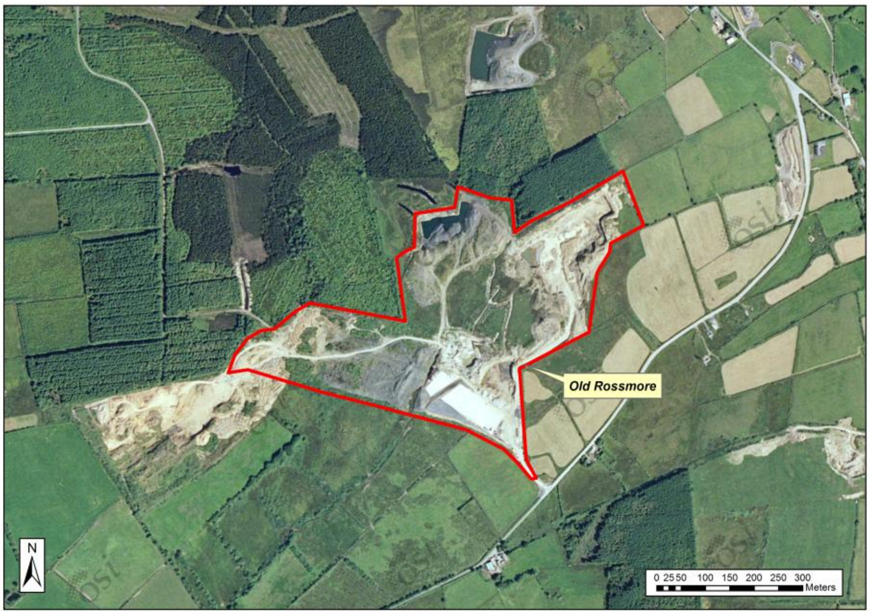
Management/promotion issues
The site is an abandoned mine site with significant safety concerns, including flooded quarries with steep, unfenced faces. Ongoing, very small-scale extraction has helped maintain exposure of the coal seam. It is of interest mainly to geologists and is not suitable for promotion to the general public in its current form.

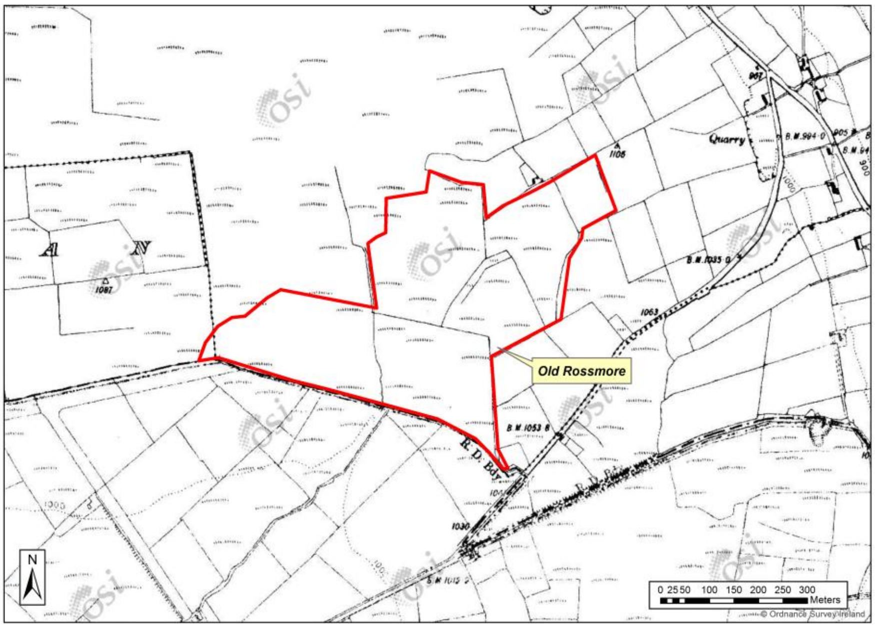
View from southwest of eastern quarry; coal exposures (dark grey) in background.

Marine Band coal seam (centre) with shale below and sandstone above.

Marine Band coal seam (close-up, A4 page for scale).


Old Rossmore
CARLOW
Ceatharlach


Old Rossmore
0 25 50 100 150 200 250 300 Meters


Old Rossmore
Quarry
0 25 50 100 150 200 250 300 Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Poulastore**
Other names used for site	Poulasthore, Poulastare
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Killone, Kilmurry, Ballythomas**
NEAREST TOWN/VILLAGE	**Stradbally**
SIX INCH MAP NUMBER	**14**
ITM CO-ORDINATES	**655211E 700974N**
1:50,000 O.S. SHEET NUMBER	**55 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
A cave situated in the top of Killone Hill.

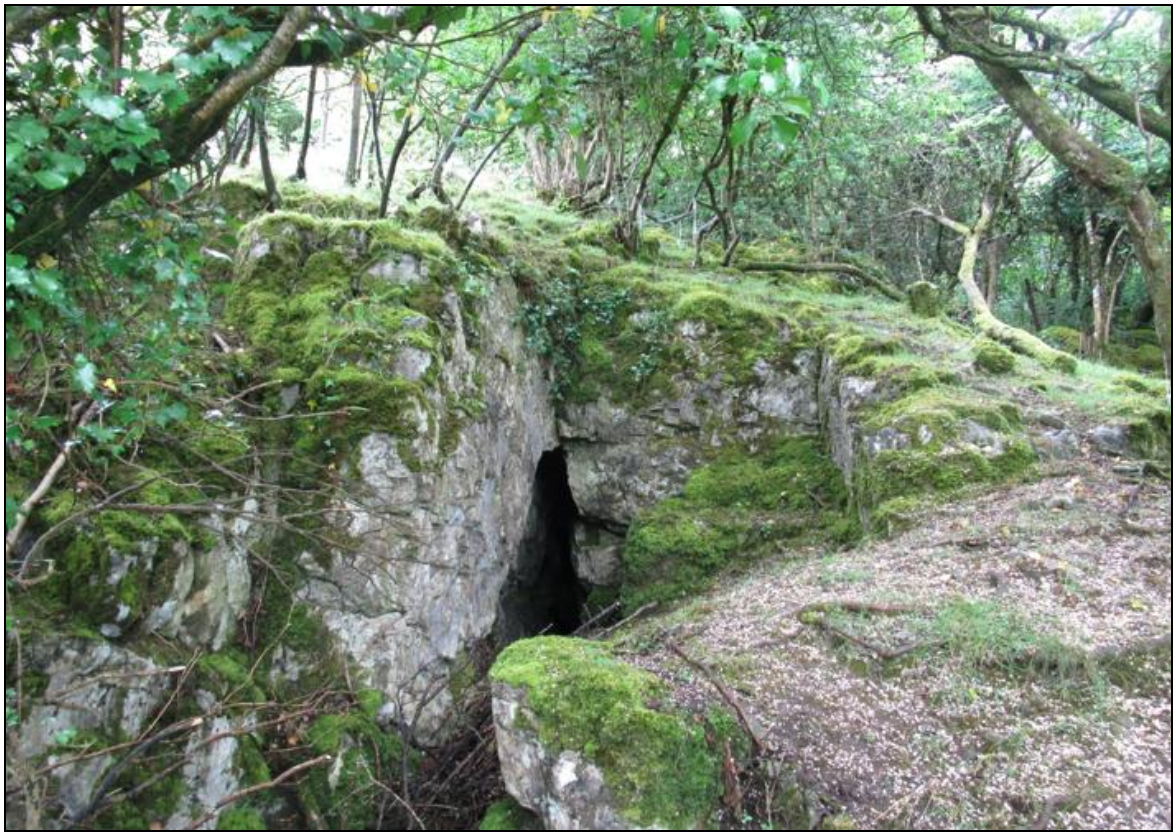
Geological System/Age and Primary Rock Type
The cave is in Carboniferous Limestone rock, in the Clogrenan Formation which is the youngest part of the limestone sequence. The age of the cave is unknown but may be older than the immediate post glacial period of the last 10,000 years (Holocene).

Main Geological or Geomorphological Interest
This is one of very few caves in Laois, despite the widespread bedrock of Carboniferous limestone. It is found almost at the top of Killone Hill, which is one on many hills in the area between Portlaoise and Stradbally that are widely believed to be tower hums. Hums is a term for remnant or degraded tower karst, of the type found today in China and SE Asia. The Ice Age would have removed most evidence of this, leaving only remnant hills such as Killone Hill. The cave could date back to an interglacial period or even older. There is no active stream flow, so it formed under an entirely different hydrogeological regime and is now a ‘fossil’ or inactive cave.

Early descriptions of this cave tend to strongly exaggerate the size and danger, but one from 1794 is interesting in describing “the most brilliant scene ever exhibited by nature, or described in fairy tale; the sides, roof and every pointed rock, are instantly covered with festoons and bouquets of pearls, diamonds, rubies, and every other precious stone, in full oriental splendour, caused by the drops of water issuing from the calcareous rocks; though there are no incrustations to be seen.” The phenomenon is one that cavers will have seen in some caves where the drops of water combine with certain algae to give bright silver and other glistening reflections to their head torches. A 1965 description by Jack Coleman in his book ‘The Caves of Ireland’ also describes “fungoid structures” in the deepest chamber.

Site Importance – County Geological Site
This cave merits inclusion as a County Geological Site in Laois, simply from its rarity. It may have importance as evidence of ancient landscapes but has not been studied.

Management/promotion issues
The cave is on private farmland and unsuitable for promotion and there should be no access without landowner permission. The cave also provides its own restriction on access as after about 10m the further reaches are only accessible through a very tight muddy squeeze. Only experienced cavers in recognised groups should consider seeking landowner permission.

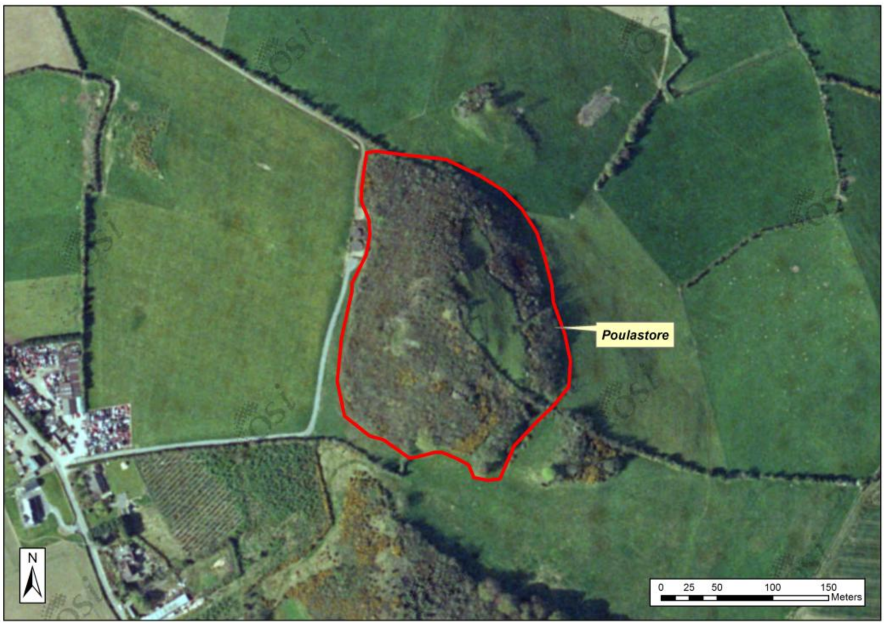


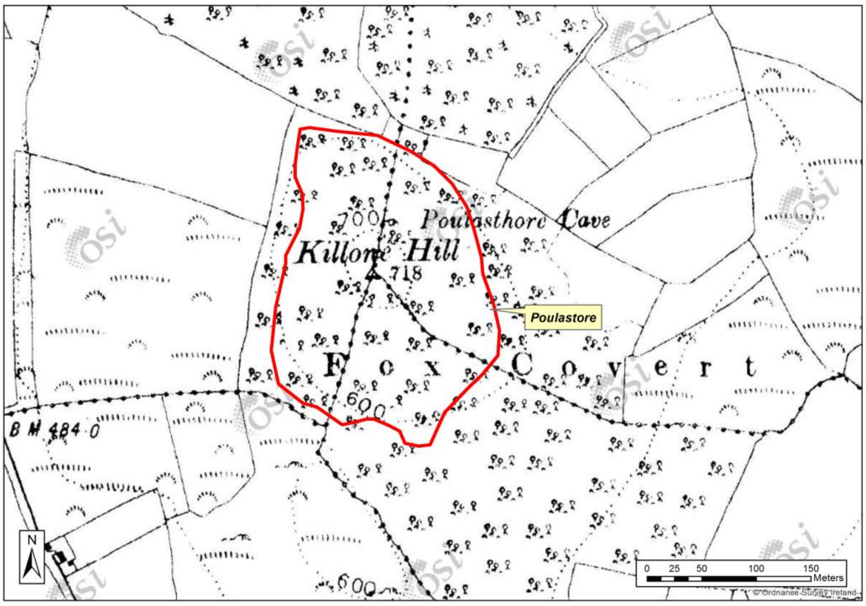
The entrance to Poulastore.

Killone Hill viewed from the north east side.

Gold coloured reflections from algae with water droplets.

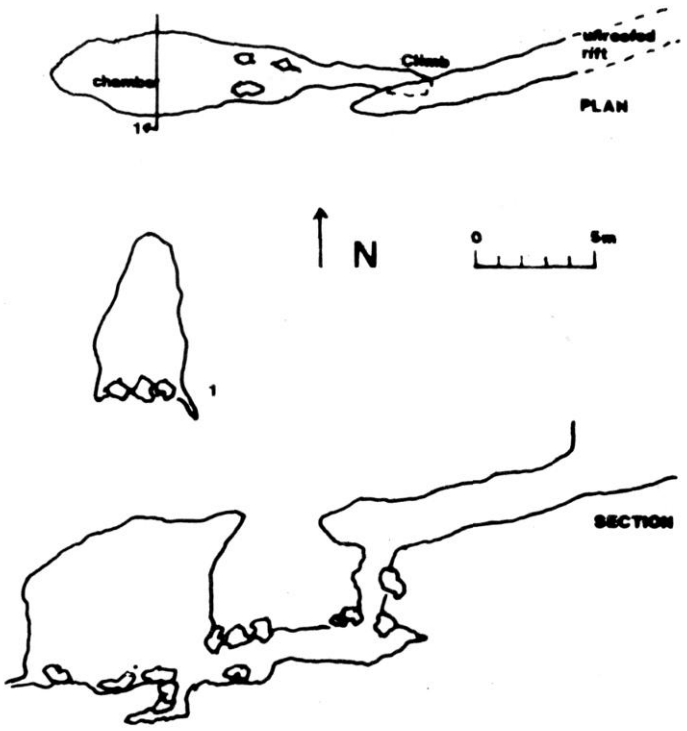

Poulastore
Greatheath
Barrows
Little Bog Lough
The Heath
An Fraoch Mór
Heathlodge
Killenny
Moated Site
Carrigeen
Ballythomas
Raheennahown South
Ballyduff Cross Rds
Killeen
Moyanna
Raheen
Raheenahoran
Kilpatrick Cross Rds
Kylespiddoge
Yellowpit Cross Rds
Kilrory
Ballinlough
Ballymaddock
Ballyrider
Bush Cross Rds
Ballynowlan
Ballyclider
Ballycarroll
Gravel Pit
Church
Kilteale
Ballymaddock Cross Rds
Budock Cross Rds
Aghnahily Bog
Park or Dunamase
Dunamase Castle
Deserted Settlement
Slievebaun
Rathmore
Barrow
Park Upper
Park Lower
Garrans Cross Rds
Aghnahily
Knocknambraher
Dysart
Newtown
Castle
Grange Upper
Grange Lower
Hewson Hill
Loughakeo
Graveyard
Coolnacarrick
Raheenduff
STRADBALLY
An tSráidbhaile
Steam Museum
Brockley Park
Kylebeg
Stradbally River
Church
M7
R445
N80
R427
51
53
54
55
56
57
58


Poulastore
N
0 25 50 100 150
Meters


Poulasthore Cave
Killone Hill
718
700
600
Poulastore
F o x C o v e r t
B M 484·0
N
0 25 50 100 150
Meters
© Ordnance Survey Ireland

Poulastore, Co. Laois

Survey: J. Dowds, S. Dowds, S. Mossop.



LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Rathleague Spring**
Other names used for site	Rathleague Warm Spring
IGH THEME	**IGH16 Hydrogeology**
TOWNLAND(S)	**Rathleague**
NEAREST TOWN/VILLAGE	**Portlaoise**
SIX INCH MAP NUMBER	**13**
ITM CO-ORDINATES	**648750E 696660N**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15, 16**

Outline Site Description
A natural spring situated under tree cover, 2km southeast of Portlaoise alongside the R425 road.

Geological System/Age and Primary Rock Type
The spring emerges at the surface through pure-bedded Dinantian (Lower Carboniferous/ Mississippian) Allenwood Formation limestone bedrock.

Main Geological or Geomorphological Interest
Rathleague Spring is a karst feature, and is one of several in this region southeast of Portlaoise. (Other local karst features include springs, sinking streams, enclosed depressions). The spring emerges at an elevation of 110 mOD. Rathleague spring is recorded by GSI as a 'Warm' Spring, and was recorded on the early GSI six inch sheets to have a temperature of 14°C. It is situated close to a mapped fault, which lies around 700m to the east. At this fault contact, the Allenwood Formation lies in close proximity to Clogrenan Formation limestones and younger Namurian shales (Luggacurren Shale Formation; Killeshin Siltstone Formation).

Site Importance – County Geological Site
This site is an important County Geological Site. The spring is situated in a Regionally Important Aquifer – Karstified aquifer. This is an important hydrogeological phenomenon of a warm spring in this part of County Laois, and is possibly the county's only warm spring. (Tepid springs have been identified elsewhere, e.g. Kyle Spring). A 1986 paper on the energy potential of groundwater in Ireland listed Rathleague Spring among 17 warm springs (with a temperature >13.5°C) in Leinster, with a water temperature value of 14.5°C recorded on May 10th 1982. Warm spring temperature values are considered 2.5°-7°C above normal.

Management/promotion issues
The well is listed by the GSI as Well Number 23/19SE W148. The spring remains hidden beneath well-established deciduous tree cover and lower vegetation (brambles, ivy). Its situation in close proximity to the R425 road is benefited by this cover. Otherwise fly-tipping could be a greater threat. General 'blown-in' litter was not identified. However, the site requires regular monitoring to ensure these problems and subsequent pollution of the spring does not become an issue. The site is not suitable for general promotion owing to the difficulty of access, proximity to the busy road, and the general undramatic nature of this apparently still, pond of water.

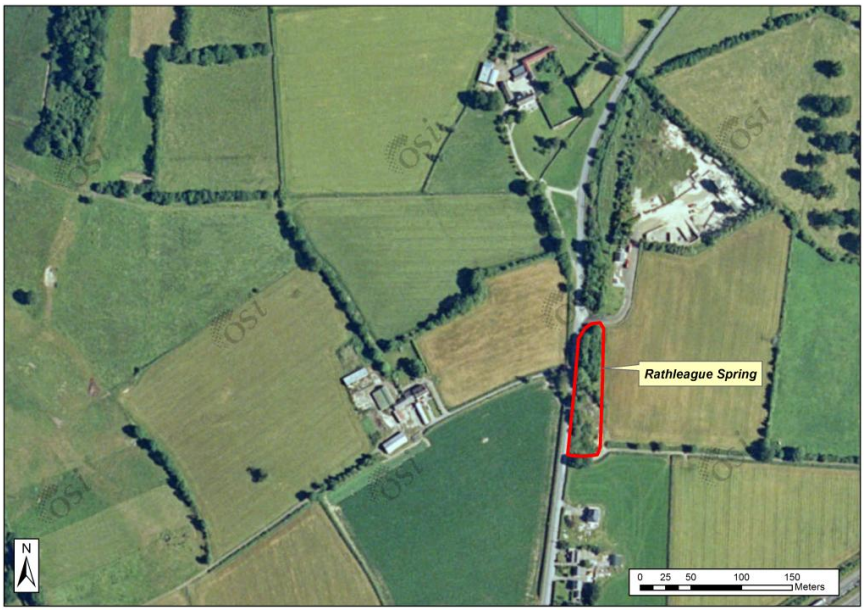
Location of Rathleague Spring hidden amid vegetation alongside R425. Looking northeast.

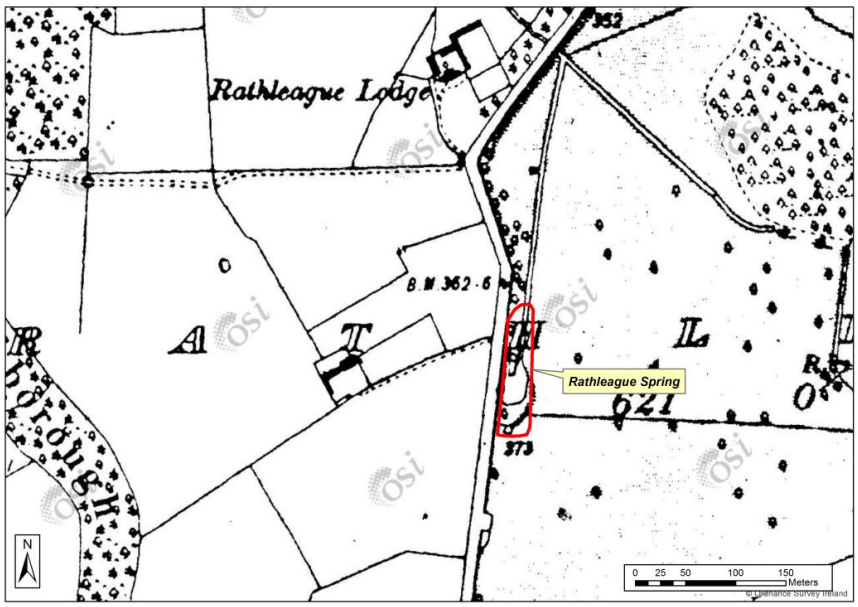
Entrance gate to *Kilsaran*. Spring to right of gate, beneath trees. Spring emerges and flows north (left) under entrance.

View of spring amid trees, brambles and other scrub. R425 to left. Looking north.

View of spring amid trees, ivy, brambles and other scrub. R425 to left. Looking northeast.


PORTLAOISE
Port Laoise
Borris Little
Kilminchy
Rathbrennan
Ballyclider
Aghnahi Bog
Barrows
Ballyroan
Prison
Fire Stn.
Beladd
Ballymooney
Clonroosk
Clonroosk Little
Kylekiproe
Summerhill or Aghnaharna
Ballymacken
Kylegrove
Knockmay
Clonminam
Downs
Derry
Currierspog
Mobrick
Rathleague Spring
Rathleague
Togher
Sheffield Cross Rds.
Cappoley
Hophall
M7
N8
R445
R425
R426


Rathleague Spring
N
0 25 50 100 150
Meters


Rathleague Lodge
B.M 362·6
Rathleague Spring
373
N
0 25 50 100 150
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ridge of Portlaoise**
Other names used for site	Portlaoise Esker, Ridge of Maryborough
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Rathleague, Downs, Borris Little, Meelick, Maryborough, Ballytegan, Gorteen, Cooltoran, Knocknagroagh**
NEAREST TOWN/VILLAGE	**Portlaoise**
SIX INCH MAP NUMBER	**13**
ITM CO-ORDINATES	**647290E 698630N (the Ridge Graveyard, on the feature in Portlaoise Town)**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
The Ridge of Portlaoise and its surrounding sands and gravels include a long, sinuous accumulation of sands and gravels deposited both under the ice sheet and at its margin as the ice withdrew northwards across central Laois at the end of the last Ice Age.

Geological System/Age and Primary Rock Type
The Ridge of Portlaoise is formed within an area dominated by bedrock of Lower Carboniferous limestones. The esker and flanking gravels themselves are Quaternary in age, having been deposited either under or at the edge of the northward-retreating ice sheet during deglaciation, approximately 14,000 years ago.

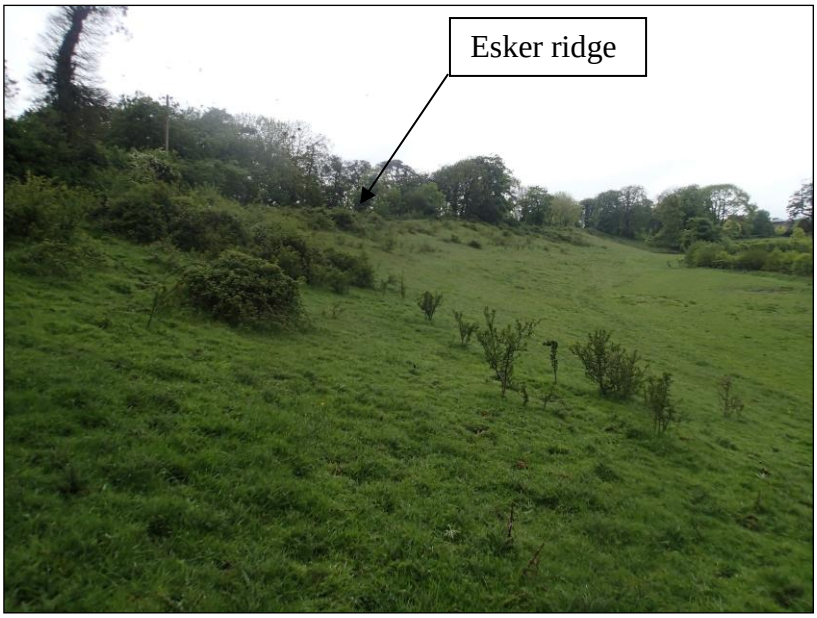
Main Geological or Geomorphological Interest
Where present the esker ridge is a striking feature, standing proud of the flat landscape of till (boulder clay) upon which it was deposited. Intact portions along Downs Road, southeast of the town, and within Portlaoise Town itself (particularly at the Ridge Graveyard), are especially impressive. In both localities the esker is comprised of a raised, steep-sided, elevated ridge of sands and gravels.

The esker feature is important in that it records faithfully the ice movement across this area of central Laois which is along its orientation, *i.e*. north to south. Associated sands and gravels in Downs, Cooltoran and Ballytegan Townlands, flanking the esker, are probably part of associated ice marginal fans. The sands and gravels within the feature are comprised chiefly of limestone clasts, but some sandstones are also present.

Site Importance – County Geological Site
What remains of the feature is still a high, striking example of a dry sand and gravel ridge, which stands proud of the surrounding landscape. This esker and the 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
This esker system comprises a well-defined landform sequence and should be listed as a County Geological Site. The esker ridge has been delisted as a pNHA (sitecode 000876) but all of this area is defined here as a County Geological Site, although the esker ridge segments themselves are not worthy of pNHA status geologically or geomorphologically.

Much of the feature has been destroyed by the development of Portlaoise to the south in recent years. It is important that the balance between development and conservation of this feature is examined in the future.

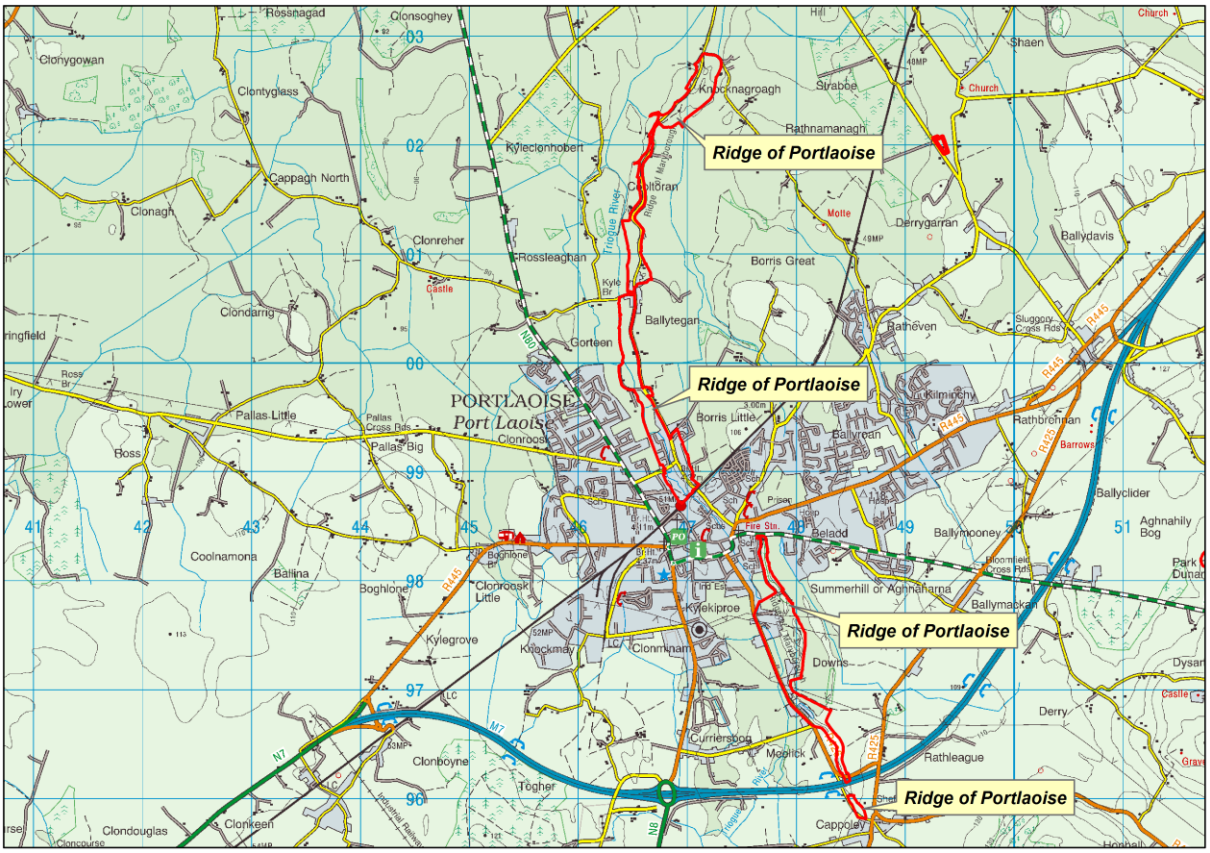


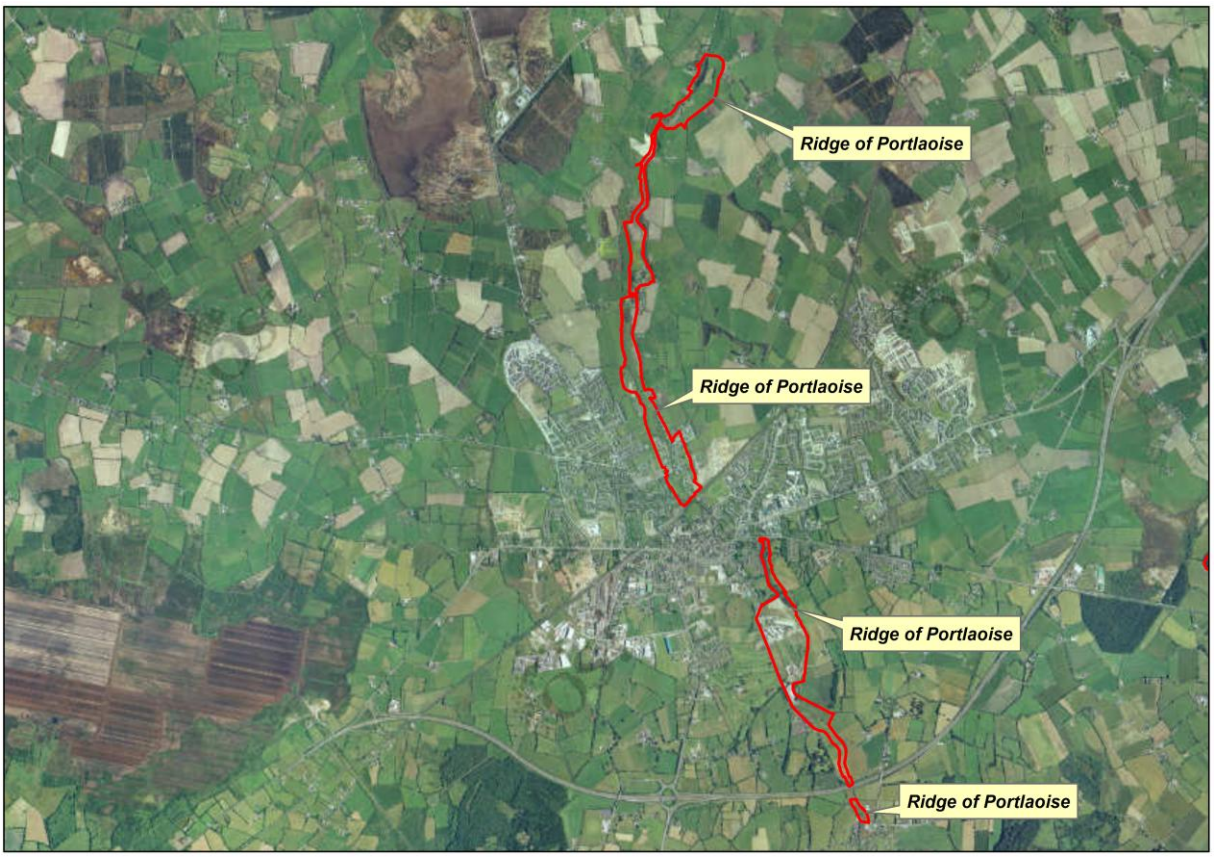
The Ridge of Portlaoise, looking north from the town boundary at Downs. Note the high, elevated nature of the ridge.

Mature trees and semi-natural vegetation along the esker ridge in Downs.

The Ridge Cemetery in Portlaoise Town.

Some of the dug out esker adjacent to a retail park in Portlaoise.


Ridge of Portlaoise
Ridge of Portlaoise
Ridge of Portlaoise
Ridge of Portlaoise
PORTLAOISE
Port Laoise


Ridge of Portlaoise
Ridge of Portlaoise
Ridge of Portlaoise
Ridge of Portlaoise

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Rock of Cashel**
Other names used for site	
IGH THEME	**IGH3 Carboniferous to Pliocene Palaeontology, IGH8 Lower Carboniferous**
TOWNLAND(S)	**Cashel**
NEAREST TOWN/VILLAGE	**Portlaoise**
SIX INCH MAP NUMBER	**18**
ITM CO-ORDINATES	**647810E 692375N**
1:50,000 O.S. SHEET NUMBER	**54 GSI BEDROCK 1:100,000 SHEET NO. 15**

Outline Site Description
Disused quarry in a limestone hillock.

Geological System/Age and Primary Rock Type
The rock here is Carboniferous Limestone, part of the Clogrenan Formation, which is from the Brigantian Substage, the youngest part of the Viséan Stage.

Main Geological or Geomorphological Interest
This hillock has some natural exposures of rock, but the principal interest lies in two disused quarry faces, which display some of the character of the rock. The limestone was quarried by Laois County Council for use in making roads from 1906 to the 1950s. The faces show some beds full of productid brachiopods – effectively preserving the sea floor animal communities at the time of deposition of the limestone. Other fossils common here are crinoids, so call 'sea lilies', fragments of which can make up a large component of some limestone beds. There are some sedimentary features of the limestone beds which are interpreted as evidence of deposition by turbidity currents.

Site Importance – County Geological Site
This site was listed as an Area of Scientific Interest in the An Foras Forbartha Report of 1981. It is a good representative site for a particular formation within the Carboniferous Limestone stratigraphy in Laois.

Management/promotion issues
The Rock of Cashel is private farmland and is not suitable for promotion without negotiated arrangements in place with the landowner. The passing motorist can glimpse the quarry faces when driving south past the site. The site should not be confused with the more famous Rock of Cashel in Tipperary. The main section of quarry has had some infill on the southern side of the quarry floor with soil from elsewhere, but this has not obscured the faces at its current level.

The main section of quarry at the Rock of Cashel.

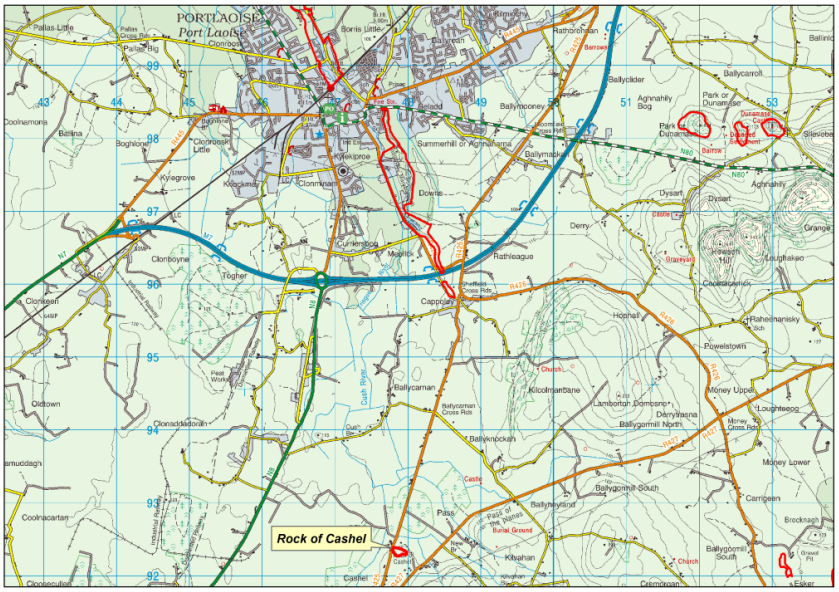
The smaller section of disused quarry at the Rock of Cashel.

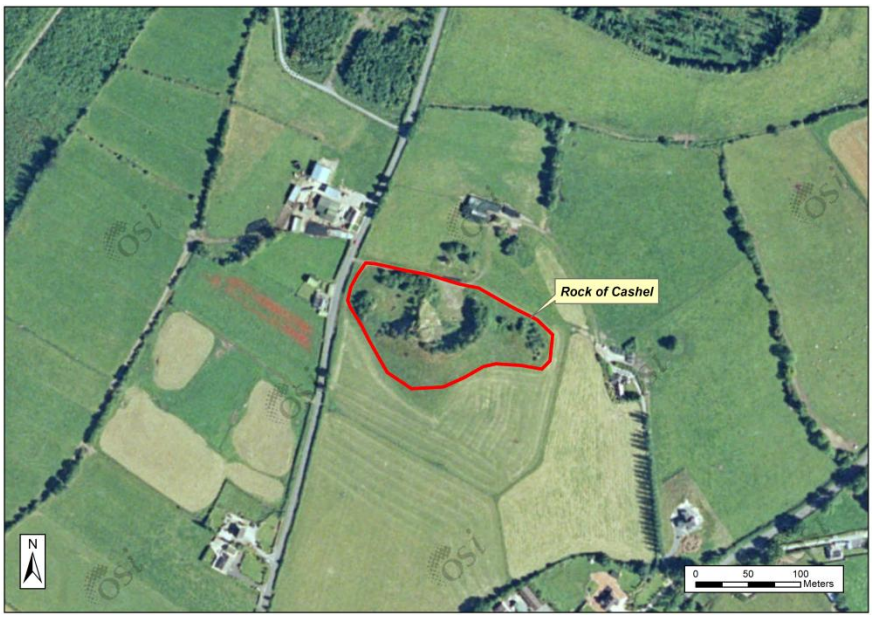
A bed surface with numerous productid brachiopod fossils. Each lump on this surface is one shell, approx. 7 or 8 cm wide.

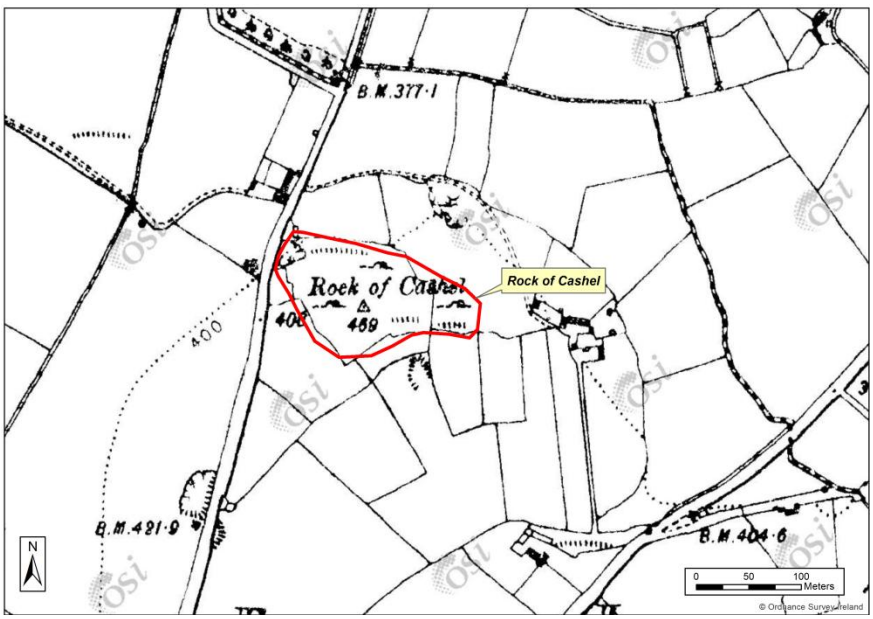
A palaokarstic surface in the quarry.

Soil fill on southern side of main quarry.

A view of the main quarry from the top of the hillock.


PORTLAOISE
Port Laoise
Rock of Cashel


Rock of Cashel
N
0 50 100 Meters


B.M.377·1
Rock of Cashel
Rock of Cashel
459
400
B.M.491·9
B.M.404·6
N
0 50 100 Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Rock of Dunamase**
Other names used for site	Dunamase Castle
IGH THEME	**IGH1 Karst, IGH8 Lower Carboniferous, IGH12 *Mesozoic* and Cenozoic**
TOWNLAND(S)	**Park or Dunamase**
NEAREST TOWN/VILLAGE	**Portlaoise**
SIX INCH MAP NUMBER	**13**
ITM CO-ORDINATES	**652950E 698200N**
1:50,000 O.S. SHEET NUMBER	**54, 55 GSI BEDROCK 1:100,000 SHEET NO. 19**

Outline Site Description
A small but prominent, steep-sided limestone hill, capped by the ruins of a Norman castle fortress dating back to the early 12th century.

Geological System/Age and Primary Rock Type
The hill comprises Carboniferous (Mississippian) cherty limestone bedrock (Clogrenan Formation). The steep, rocky slopes of the hill are a typical example of Tertiary karst limestone landforms in the county.

Main Geological or Geomorphological Interest
The Rock of Dunamase is one of a series of small, prominent limestone hills, erosional features known as 'hums' that rise abruptly above a plain. The hills are eroded from medium- to coarse-grained, blue-grey coloured limestones. The limestone beds are regularly cherty, examples of which can be seen in the beds exposed 20m-30m east of the Keep on the hill summit.

The hill is a fine example of a relict karst landform. The hill (and those of similar form in the region) may have formed as isolated ‘towers’ (possibly comparable to present-day karst landforms in south-east Asia). Subsequent physical erosion by the ice during the Pleistocene glaciations most would have smoothed off sharp peaks, formed the stubby hills found in this part of the county today.

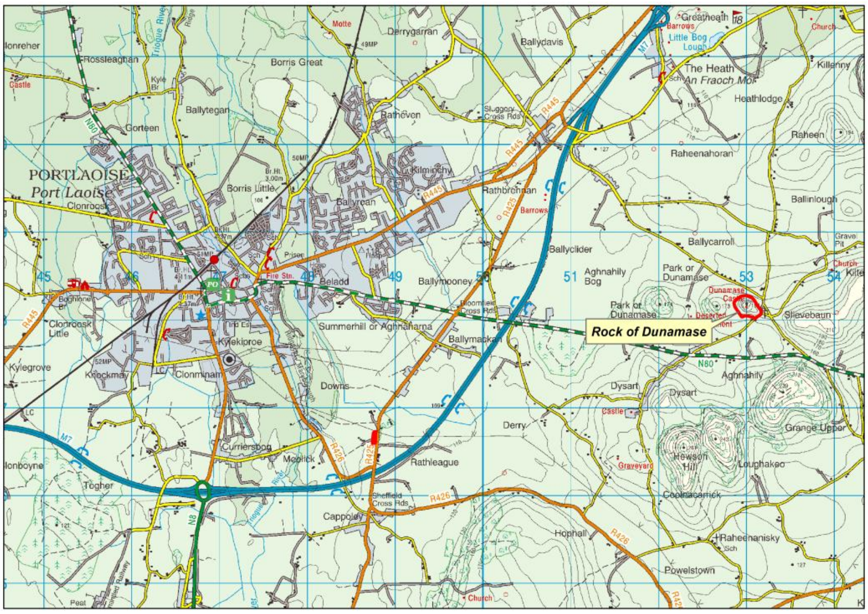
Site Importance – County Geological Site
The Rock of Dunamase is a representative site for the hills (hums) situated between Portlaoise and Stradbally, and is an important County Geological Site.

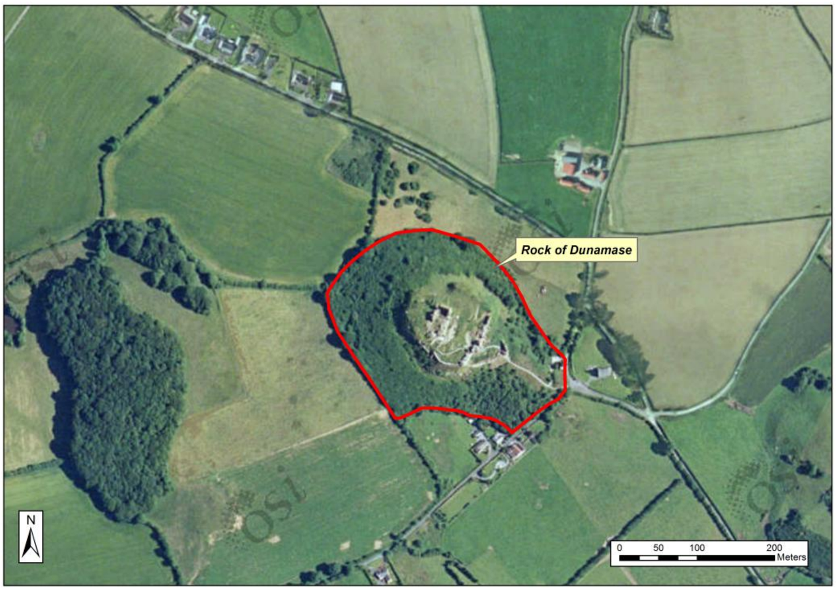
Management/promotion issues
The site and fortress ruins on the **Rock of Dunamase** are managed by the National Monument Service and are open to the public year round. A major conservation project on the masonary structures was completed in 2006. The strategic observational and defence advantages afforded by the natural limestone hum are evident in the presence of what was once a strongly fortified castle and ramparts. The site is an ideal location for visitors to be introduced to remnant landforms of the Tertiary, pre-Ice Age landscape of Ireland.

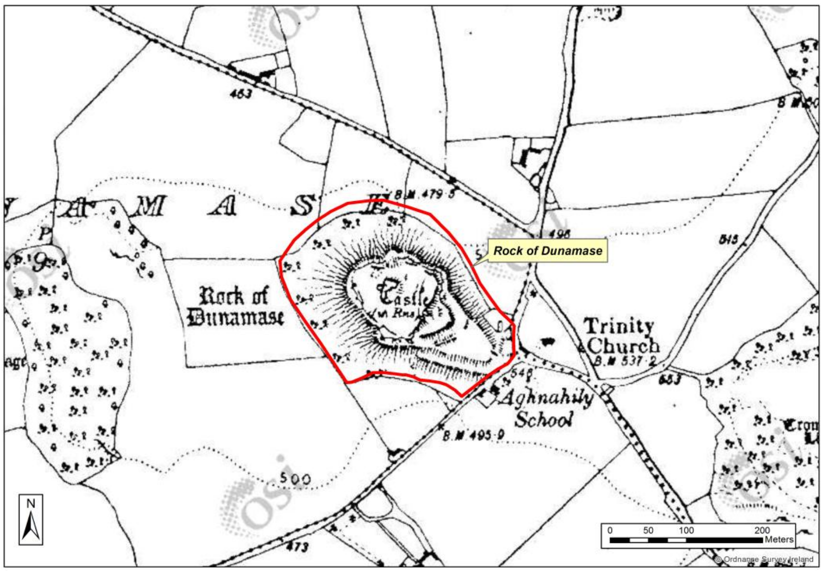
Southeast side of the Rock of Dunamase viewed from the approach road off N80.

Inclined limestone strata on near-vertical cliff on southeast side of the Rock.

Limestone (with cherty nodules) outcrops in the Lower Ward, east of the Keep (upper right).


PORTLAOISE
Port Laoise
Rock of Dunamase
Borris Great
Ballytegan
Gorteen
Rossleaguan
Borris Little
Kilminchy
Ballyroan
Rathbrennan
Ballycarroll
Ballyclider
Ballymooney
Aghnahily Bog
Park or Dunamase
Slievebaun
Summerhill or Aghnaharna
Ballymacken
Dysart
Aghnahily
Derry
Grange Upper
Hewson Hill
Loughakeo
Rathleague
Cappoley
Currenbog
Clonminam
Kyleklproe
Downs
Togher
Kylegrove
Knockmay
Clonrooskey Little
Hophall
Powelstown
Raheenanisky
Coolnacarrick
Raheen
Ballinlough
Heathlodge
Raheenahoran
The Heath
An Fraoch Mór
Greatheath
Little Bog Lough
Killanny
Ballydavis
Derrygarran
Rathevan
Sluggory Cross Rds
M7
N80
R445
R425
R426
Motte
Castle
Church
Barrows
Graveyard


Rock of Dunamase
N
0 50 100 200 Meters


Rock of Dunamase
Rock of Dunamase
Castle
Trinity Church
B.M 537·2
Aghnahily School
B.M 495·9
B.M 479·5
500
N
0 50 100 200 Meters
© Ordnance Survey Ireland

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Sluggory Cross Roads**
Other names used for site	The Sluggies, Sluggory Swallow Hole
IGH THEME	**IGH1 Karst, IGH16 Hydrogeology**
TOWNLAND(S)	**Ballydavis, Rathbrennan**
NEAREST TOWN/VILLAGE	**Portlaoise**
SIX INCH MAP NUMBER	**13**
ITM CO-ORDINATES	**650725E 700018N**
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 (swallow hole) in karstic limestone, northeast of Portlaoise.

Geological System/Age and Primary Rock Type
The sinkhole, drainage and cave development are probably all post-glacial in age, formed over the last 11,000 years. The karstified pure bedded limestone of the Allenwood Formation is of Lower Carboniferous age.

Main Geological or Geomorphological Interest
The site includes two individual stream sinks and the enclosed depression containing them. Two small streams flowing northeastward sink first (during high stream flow only) on the southwestern side of the enclosed depression and then (continuously) at the northern end. There is probably a significant cave beneath the site, though no entrance has currently been found.

The entire sinkhole gets filled with water in times of heavy or prolonged rain and wells up within the base of the enclosed depression.

Site Importance – County Geological Site
This is one of a small number of active karst sites in the limestone district around Portlaoise and is of County Geological Site importance.

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 of agricultural or road spills, or runoff. It is on private land and is not suitable for promotion. The site can be viewed from the Regional R445 public roadway, as a deep hollow filled with trees and channels entering it with flowing water, even in dry conditions.

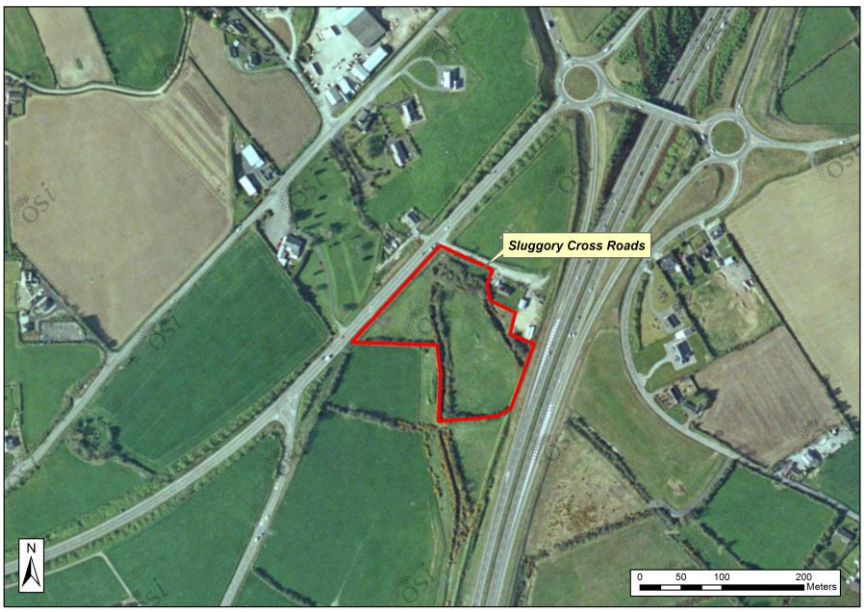
The view from the R445 road across the enclosed depression hosting the swallow holes.

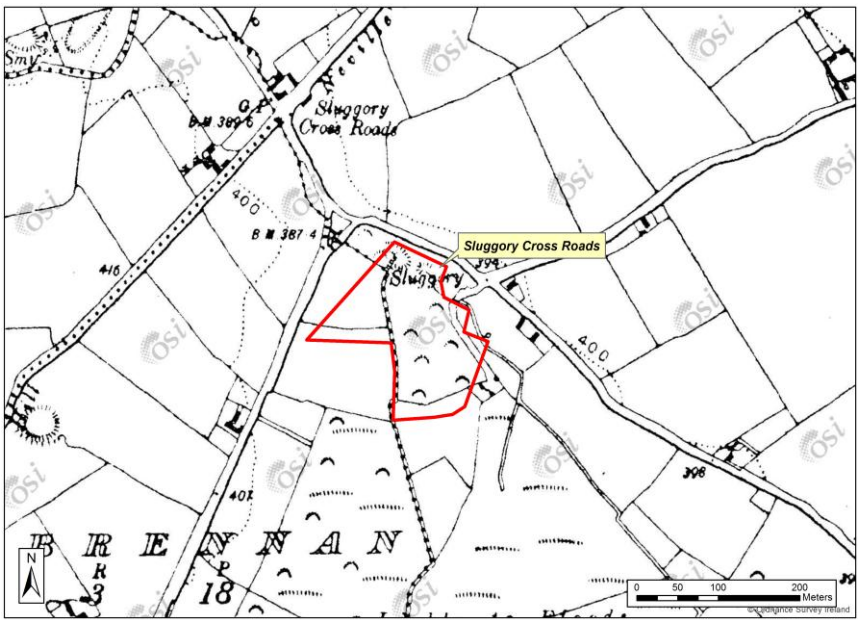
Looking eastwards across the enclosed depression.

The stream sinking at the base of the depression.

The steep, tree-lined sides of the enclosed depression.


Sluggory Cross Roads
PORTLAOISE
Port Laoise
Borris Great
Borris Little
Ballytegan
Gorteen
Rossleaghan
Derrygarran
Ballydavis
Rathéven
Kilminchy
Rathbrennan
Ballyrean
Beladd
Ballymooney
Summerhill or Aghnaharna
Ballymackan
Kylekiproe
Clonminam
Downs
Clonrooskl Little
Ballyclider
Barrows
N80
R445
R425


Sluggory Cross Roads
N
0 50 100 200
Meters


Sluggory Cross Roads
Sluggory Cross Roads
Sluggory
B R E N A N
N
0 50 100 200
Meters

LAOIS - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Timahoe Esker**
Other names used for site	
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Esker, Cloonnabacky**
NEAREST TOWN/VILLAGE	**Timahoe**
SIX INCH MAP NUMBER	**18**
ITM CO-ORDINATES	**653825E 691815N (centre of largest segment)**
1:50,000 O.S. SHEET NUMBER	**55 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
The Timahoe Esker includes a number of high, sinuous ridge segments, which all form part of the same esker system, deposited both under the ice sheet and at its margin as the ice withdrew northwestwards across east Laois at the end of the last Ice Age.

Geological System/Age and Primary Rock Type
The Timahoe Esker is formed within an area dominated by bedrock of Lower Carboniferous limestones. The esker itself is Quaternary in age, having been deposited either under or at the edge of the northwestward-retreating ice sheet during deglaciation, approximately 14,000 years ago.

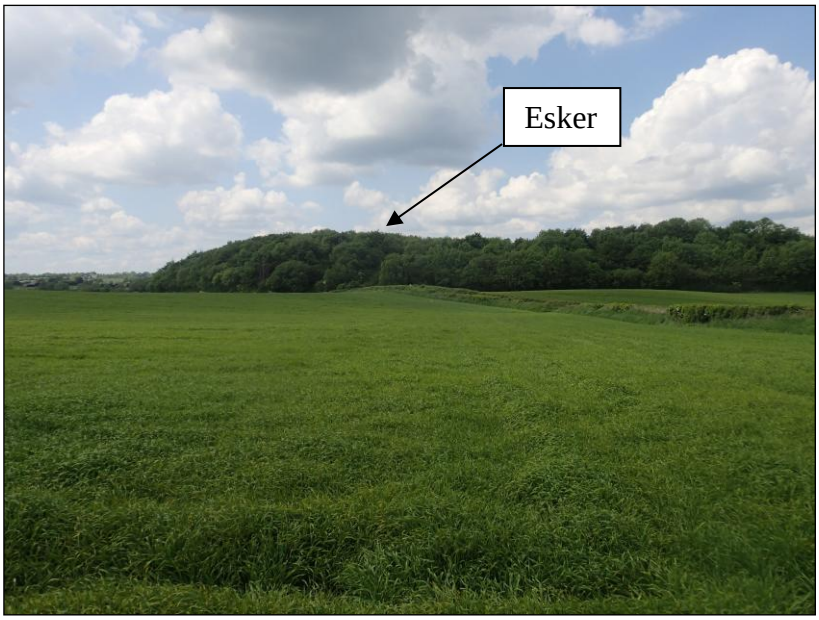
Main Geological or Geomorphological Interest
Where present the esker ridge is a striking feature, standing proud of the flat landscape of till (boulder clay) and sands and gravels within which it was deposited. Only three relatively intact portions remain, and although much of the feature has been quarried out in recent years, they are especially impressive. In all three localities the esker is comprised of a raised, elevated ridge of sands and gravels blanketed by broadleaf forestry.

The esker feature is important in that it records faithfully the ice movement across this area of east Laois which is along its orientation, *i.e*. northwest to southeast. Associated sands and gravels in Esker and Cloonabacky Townlands, as well as in Timahoe Townland itself, flank the esker and are probably part of an associated ice marginal fan. The sands and gravels within the esker feature itself are comprised chiefly of limestone clasts.

Site Importance – County Geological Site
What segments remain of the feature are still high, striking examples of a dry sand and gravel ridge, standing proud of the surrounding landscape. This esker and the 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
This system comprises a well-defined landform sequence and should be listed as a County Geological Site. Though four segments of the esker have been designated a pNHA (sitecode 000421), only three here are proposed for a County Geological Site as the fourth has been quarried out.

Furthermore, the three remaining esker segments themselves are not deemed worthy of pNHA status geologically or geomorphologically. A walking trail across one of the beads, and a signboard detailing the ecology of the feature, is an important local amenity resource. A new signboard (the existing one is faded beyond reading) including data on the ice sheet history in the locality would prove worthwhile.

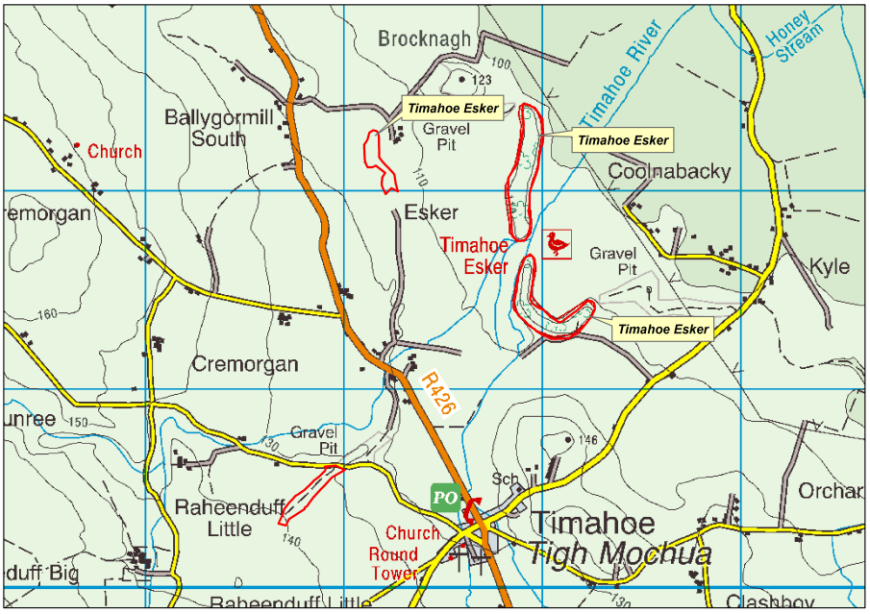


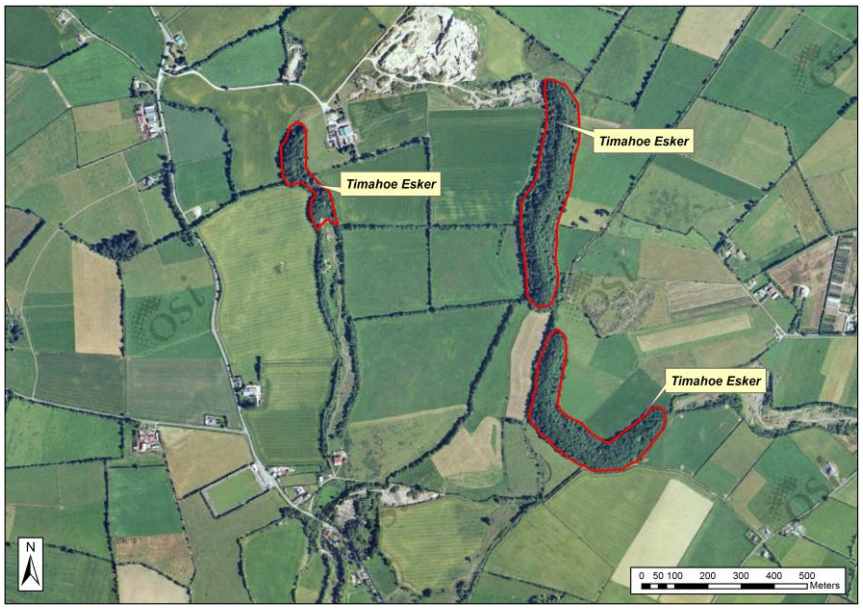
The Timahoe Esker, looking north. Note the high, elevated nature of the ridge.

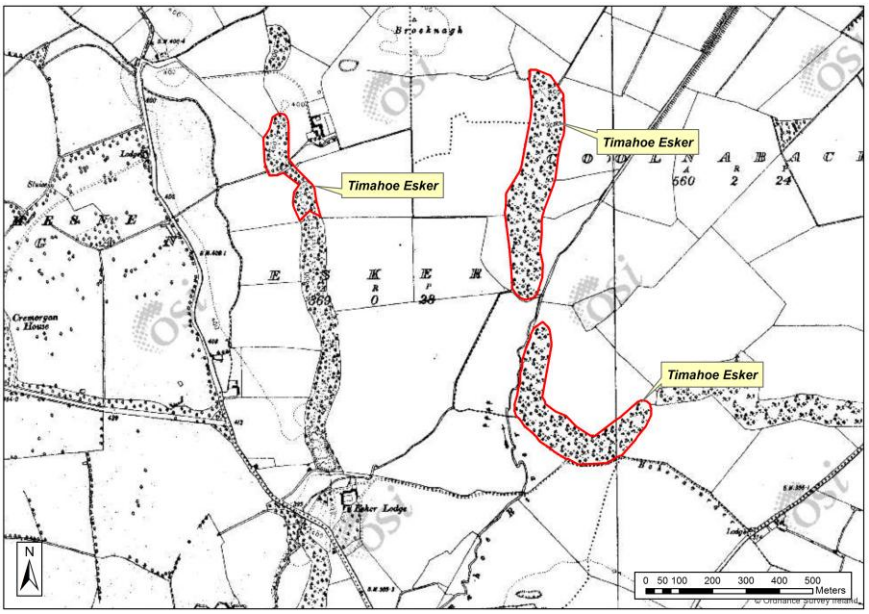
Looking northwards across the walking trail on top of the Timahoe Esker.

One of the quarried out esker segments, southeast of Timahoe Village.

The faded signboard along the Timahoe Esker walking trail.


Brocknagh
Timahoe River
Honey Stream
Timahoe Esker
Gravel Pit
Timahoe Esker
Church
Ballygormill South
Coolnabacky
Esker
Timahoe Esker
Gravel Pit
Kyle
Timahoe Esker
Cremorgan
R426
Gravel Pit
Raheenduff Little
PO
Church
Round Tower
Timahoe
Tigh Mochua
Orchar
Clashboy


Timahoe Esker
Timahoe Esker
Timahoe Esker
N
0 50 100 200 300 400 500
Meters


Timahoe Esker
Timahoe Esker
Timahoe Esker
N
0 50 100 200 300 400 500
Meters