The Geological Heritage of Dun Laoghaire-Rathdown

An audit of County Geological Sites in Dun Laoghaire-Rathdown

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

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The Dun Laoghaire-Rathdown Geological Heritage Project was supported by

dlr Comhairle Contae County Council

An Chomhairle Oidhreachta The Heritage Council

GSI Suirbhéireacht Gheolaíochta Éireann Geological Survey of Ireland

This report is an action of the Dun Laoghaire-Rathdown Heritage Plan 2013 – 2019

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Report Summary

Dun Laoghaire-Rathdown is not widely known for its geological heritage, yet it has some very fine but underappreciated geological sites. The County Council's support for this audit is critical in raising the profile of geological heritage in Dun Laoghaire-Rathdown and for maximising its potential, amongst both the residents and the numerous visitors to the county.

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 Dun Laoghaire-Rathdown. It proposes them as County Geological Sites (CGS), for inclusion within the Dun Laoghaire-Rathdown County Development Plan (CDP). The audit provides a reliable study of sites to replace a provisional listing based on desk study which was adopted in a previous CDP.

County Geological Sites do not receive statutory protection like Natural Heritage Areas (NHA) but receive an effective protection from their inclusion in the planning system. However, some of the sites described in this report fall within existing pNHAs and SACs where the ecological interest is actually founded upon the underlying geodiversity. Others such as Dalkey Island also form part of Special Protection Areas (SPA) for birds. The commission of this audit and adoption of the sites within the County Development Plan ensure that Dun Laoghaire-Rathdown follows a now established and effective methodology for ensuring that geological heritage is not overlooked in the general absence of allocated resources for thematic progress at national level. It ensures that Dun Laoghaire-Rathdown remains at the forefront of geological conservation in Ireland.

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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 Dun Laoghaire-Rathdown County Council. It should also be made available via the County Council website for the people of Dun Laoghaire-Rathdown. A chapter of the report includes recommendations on how to best present and promote the geological heritage of Dun Laoghaire-Rathdown 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 or other publications on the geological heritage of Dun Laoghaire-Rathdown, if the funding can be found to produce them.

Dun Laoghaire-Rathdown in the context of Irish Geological Heritage

This report ensures Dun Laoghaire-Rathdown remains active at the forefront of geological heritage within Ireland, as more than half of the counties have now commissioned such an audit within the scope of the county-based Heritage Plan. 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.

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:

IGH THEMES

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

A fundamental approach is that only the minimum number of sites necessary to demonstrate the particular geological theme is selected. This means that the first criterion is to identify the best national representative example of each feature or major sequence, and

the second is to identify any unique or exceptional sites. The third criterion, identifying any sites of International importance, is nearly always covered by the other two.

Designation of geological NHAs will be by the GSI's partners in the Programme, the National Parks and Wildlife Service (NPWS). Once designated, any geological NHAs will be subject to normal statutory process within the Dun Laoghaire-Rathdown 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, along with any clear NHA selections.

Currently, in 2014, 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. No sites in Dun Laoghaire-Rathdown were so far considered to be of national importance nor been put forward as Natural Heritage Areas (NHA) to NPWS. Therefore, inclusion of all sites as County Geological Sites (CGS) in Dun Laoghaire-Rathdown'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 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.

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 Dun Laoghaire-Rathdown, with its urban dominance, there are none of these large landscape based sites.

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 Dun Laoghaire-Rathdown. A lack of awareness in the past, has led to the loss of important geological sites and local character throughout the country. In Dun Laoghaire-Rathdown a Landscape Characterisation Assessment of the non-urban south western half of the county was completed, which is summarised in the County Development Plan 2010-2016. This provides a tool for planners to help maintain the character of the County.

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, Murphystone Quarry is a working quarry included as a County Geological Site in Dun Laoghaire-Rathdown. 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, Dun Laoghaire-Rathdown's sites are not likely to require such an approach.

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.

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.burrenconnect.ie/geopark]. 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, but it is conceivable that Dun Laoghaire-Rathdown County Council could become a partner if there was ever an attempt to form a ‘Wicklow Mountains Geopark’.

Proposals and ideas for promotion of geological heritage in Dun Laoghaire-Rathdown

The clear and significant inclusion of an action on geological heritage in the first Dun Laoghaire-Rathdown Heritage Plan (2004-2008) was a most welcome and positive step, for a topic that is often undervalued and poorly known in the wider community. The audit is a direct fulfilment of the original action, 1.1.7, to identify sites of geological interest in the county.

The current Heritage Plan (2013-2019) is a pragmatic document for stringent economic circumstances, recognising the impossibility of planning a programme of actions, with massive uncertainty as to the availability of any funding to sustain those actions. It is therefore an aspirational plan, emphasising linkages with partners and listing some priority projects without a strict timeframe. Many are aimed at sustaining existing initiatives, developed through the former plan.

This section, therefore, examines the existing points in the plan and makes a few observations relating to geological heritage. It is not easy to provide specific suggestions as to how these may be implemented, supported or enhanced by the audit of geological heritage sites in the county, given the non-specific nature of many actions in the current plan.

One headline ambition is the communication of the story of our heritage. The audit helps fulfil this by making sure that information on geological heritage is included within the planning system. This helps to ensure that proposed developments and area plans can not overlook geological heritage for lack of awareness. The publication of the report, whilst aimed at planners, and as a tool for the Heritage Officer, will inevitably reach a wider audience. Through minor actions, such as adding guide leaflets about geology in Dun Laoghaire-Rathdown, to websites such as www.geoschol.com, or composing separate Dublin authority county leaflets on the back of the audit, greater communication should occur. A planned article for the magazine Earth Science Ireland will also promote the audit and the geological heritage itself. The exhibition on the geological heritage of the county, created by Matthew Parkes many years ago, could be reinvigorated and given some new exposure via different media. Alternatively a joint ‘Dublin’ exhibition could be created.

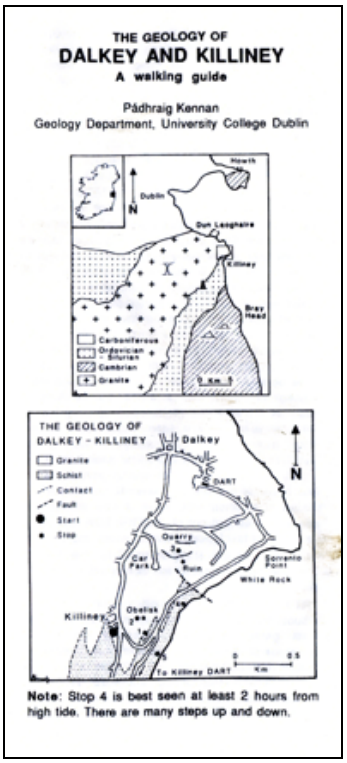
Under the headline topic of Caring for our heritage, the audit contributes by providing solid information which the planners and the Heritage Officer can use to incorporate sites into broader plans and strategic activity within the council.

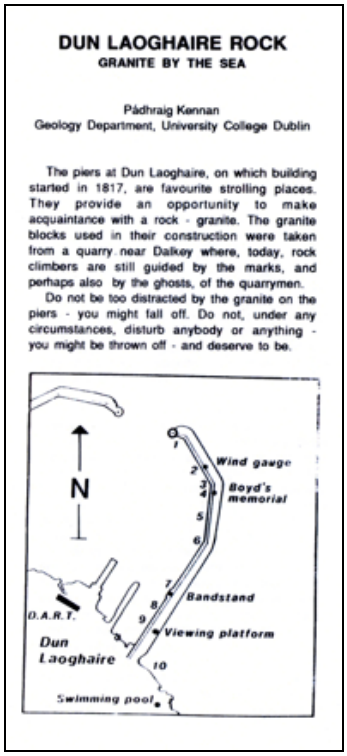
Increasing the level of community involvement is the third headline topic in the current plan. Whilst less obvious, the audit will contribute to this when locals become more aware of the outside interest in their particular site or heritage. An example that could be mentioned is the Ballycorus lead mines. Matthew Parkes, through involvement with the Mining Heritage Trust of Ireland, has had previous engagement with a small local group who wish to develop the appreciation of the lead mining and smelting heritage at Ballycorus. This audit may help them approach the Heritage Officer for guidance and assistance on a firmer footing than without it.

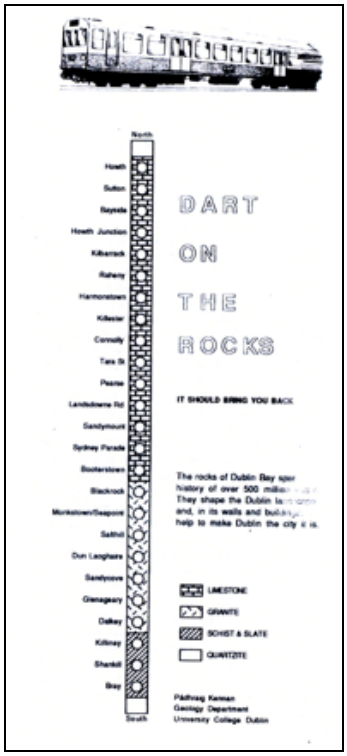
Specific ideas for projects

Leaflets

No existing leaflets on the geological heritage of Dun Laoghaire-Rathdown are known, except for some old Irish Geological Association (IGA) guides (available to download from www.geoschol.com). There is some scope for other and different leaflets. For example, a guide could be produced on geological heritage, copying the format of the excellent DLR Sculpture Trail, with a map and brief details of the geological heritage sites, and maybe other geological elements. Any leaflets produced could simply be made available as pdf downloads on the Council's website to avoid large costs of printing. However, a physical printed leaflet is more desirable.







Guides

There are few existing guides to the geology of Dun Laoghaire-Rathdown, apart from some GSI literature produced some time ago. The 1:100,000 map report for Sheet 16 covers Dun Laoghaire-Rathdown and is an essential resource. For general interest, *Wicklow in the Ice Age* is a useful resource. A more modern, excellent guide, *Wicklow in the grip of an ice age* is available from the Irish Quaternary Association and explains much background. An excellent practical field guide to Leinster's Geology by Chris Stillman and George Sevastopulo is still in print through Dunedin Academic Press.

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 Dun Laoghaire-Rathdown, in a**

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

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 Officer. It is most likely that a panel combining various heritage interests at a particular 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 panels is a fine art and the IGH Programme can offer input if signs are planned for key visitor localities.

It is suggested here that some very simple geology signs could be added to existing structures at Carrickgollogan. Existing signs about wildlife could be complemented by a simple sign explaining the geological structure linking Carrickgollogan to the Sugarloaf and Bray Head. It could be attached directly beneath the present sign. This would require support from the Dublin Mountains Partnership and Coillte who have erected the signboards in public car parks and strategic footpath locations.


A prime example of where a geology sign could add to the visitor experience, at the footpath below the summit of Carrickgollogan.

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 Dun Laoghaire-Rathdown County Council Offices, County Library branches or other venues. The model followed was that used for Carlow 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]. An earlier exhibition on the geological heritage of Dun Laoghaire-Rathdown was successful at the time, but will need an overhaul in light of the audit results.

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 recently launched 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.

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 Dun Laoghaire-Rathdown's geological heritage. It is anticipated by the authors of this report that they will contribute a summary article distilled from the audit report.

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 Dublin as a whole is already part of the available material (see Appendix 6). Working links to the Heritage section of Dun Laoghaire-Rathdown County 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 Dun Laoghaire-Rathdown geology and geomorphology will assist many users and researchers into the future. However, consideration should be given to making this a combined Dublin archive if it is desired, since the geology knows no administrative borders, but is linked throughout the four authority areas.

Commemorative plaques
The installation of a plaque at Killiney Beach in 2013 commemorating the work of Robert Mallet is a highly commendable event. Robert Mallet conducted an experiment in 1849 on the beach that demonstrated the movement of energy (from exploding a buried keg of gunpowder) travelled through the sand in waves. Later he did a comparable experiment recording the travel of energy through rock on Dalkey Island. He thus laid the foundations for seismology, and deserves to be much more widely known as an Irish geoscientist.

Perhaps there are other opportunities to celebrate Mallet and other Irish geoscientists through plaques or memorials? It should be noted that a council policy on the erection of memorials applies, so high standards of relevance need to be met.

A summary of the Geology of Dun Laoghaire-Rathdown

1) Paragraph summary

The landscape of Dun Laoghaire is dominated by one rock type – granite. This granite was intruded as a very large mass, into pre-existing rocks, and it then cooled slowly. The minerals quartz, feldspar and mica crystallising out together into the familiar rock, used in so many buildings throughout Dublin. Remnants of the older rocks the granite was injected into can be seen south of the granite mass. The injection of the granite locally metamorphosed these older rocks into schist. Contacts of granite and schist, like at Ballycorus and White Rock, have extra minerals that were mined for lead ore. The metamorphic schist is less resistant to erosion and forms lower ground around the hills of granite, but at Carrickgollogan is an older more resistant quartzite rock. This is a faulted remnant of a large fold structure, and is the same Cambrian rock as found on Bray Head and in the Great Sugar Loaf. North of the granite and faulted against it is Carboniferous Limestone deposited around 340 million years ago in a deep marine basin. Following erosion over several hundred million years, the last two million years have had most impact on the landscape in Dun Laoghaire-Rathdown with glaciers eroding the high ground leaving moulded bedrock hills, such as at Killiney Hill, and some deep valleys in the mountains, as well as blanketing much of the lower ground in the county with till.

AGE (Million Years Ago)	ERA	PERIOD	EVENTS IN DUN LAOGHAIRE-RATHDOWN	IF THIS TIMESCALE WERE A DAY LONG ...
2.6	Cenozoic	Quaternary	Several ice ages smothering Dun Laoghaire-Rathdown, followed in the last 10,000 years by the spread of vegetation, growth of bogs and arrival of humans. Moulding of bedrock in the Dublin mountains and around Killiney and Dalkey. Meltwater sculpts deep channels and deposits sands and gravels during deglaciation.	The ice ages would begin 38 seconds before midnight
66		*Tertiary*	*Erosion, weathering of rocks and denudation of land surface.* *No record of rocks of this age in Dun Laoghaire-Rathdown.*	The Tertiary period begins at 11.40 pm
145	Mezozoic	*Cretaceous*	*Erosion.* *No record of rocks of this age in Dun Laoghaire-Rathdown.*	11.15 pm
201		*Jurassic*	*Uplift and erosion.* *No record of rocks of this age in Dun Laoghaire-Rathdown.*	The age of the dinosaurs, starting at 10.55 pm
252		*Triassic*	*Desert conditions on land.*	10.42 pm
298	Palaeozoic	*Permian*	*No record of rocks of this age in Dun Laoghaire-Rathdown.*	10.30 pm
359		Carboniferous	Land became submerged, limestones with some shales and sandstones deposited in tropical seas across the area north of Dundrum and Blackrock. Limestones remaining today are mostly impure and bedded.	Inundation of land by sea around 10.10 pm
419		Devonian	Caledonian mountain building. Leinster Batholith Granite intruded, forming the Dublin Mountains.	Granite intruded into Dublin Mountains, at 9.52 pm
443		*Silurian*	*Shallow seas, following closure of the Iapetus Ocean.* *No record of rocks of this age in Dun Laoghaire-Rathdown.*	Starts at 9.42 pm
485		Ordovician	Slates, siltstones and volcanic rocks form across much of the southeastern portion of Dun Laoghaire-Rathdown.	Begins at 9.28 pm
541		Cambrian	Opening of the Iapetus Ocean. Greywackes and quartzites formed west of Shankill.	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

The Geological Timescale and Dun Laoghaire-Rathdown

2) Simple summary

The landscape of Dun Laoghaire is dominated by one rock type – granite. This granite was intruded as a very large mass, into pre-existing rocks, and it then cooled slowly. The minerals quartz, feldspar and mica crystallised out together into the familiar granite rock used in so many buildings throughout Dublin. The granite was intruded around 405 million years ago. The host for the granite is early Ordovician sedimentary rocks. These were formed as ancient sea floor rocks around 480 million years ago. They were uplifted into land as part of the Caledonian mountain building event at the end of the Silurian Period.

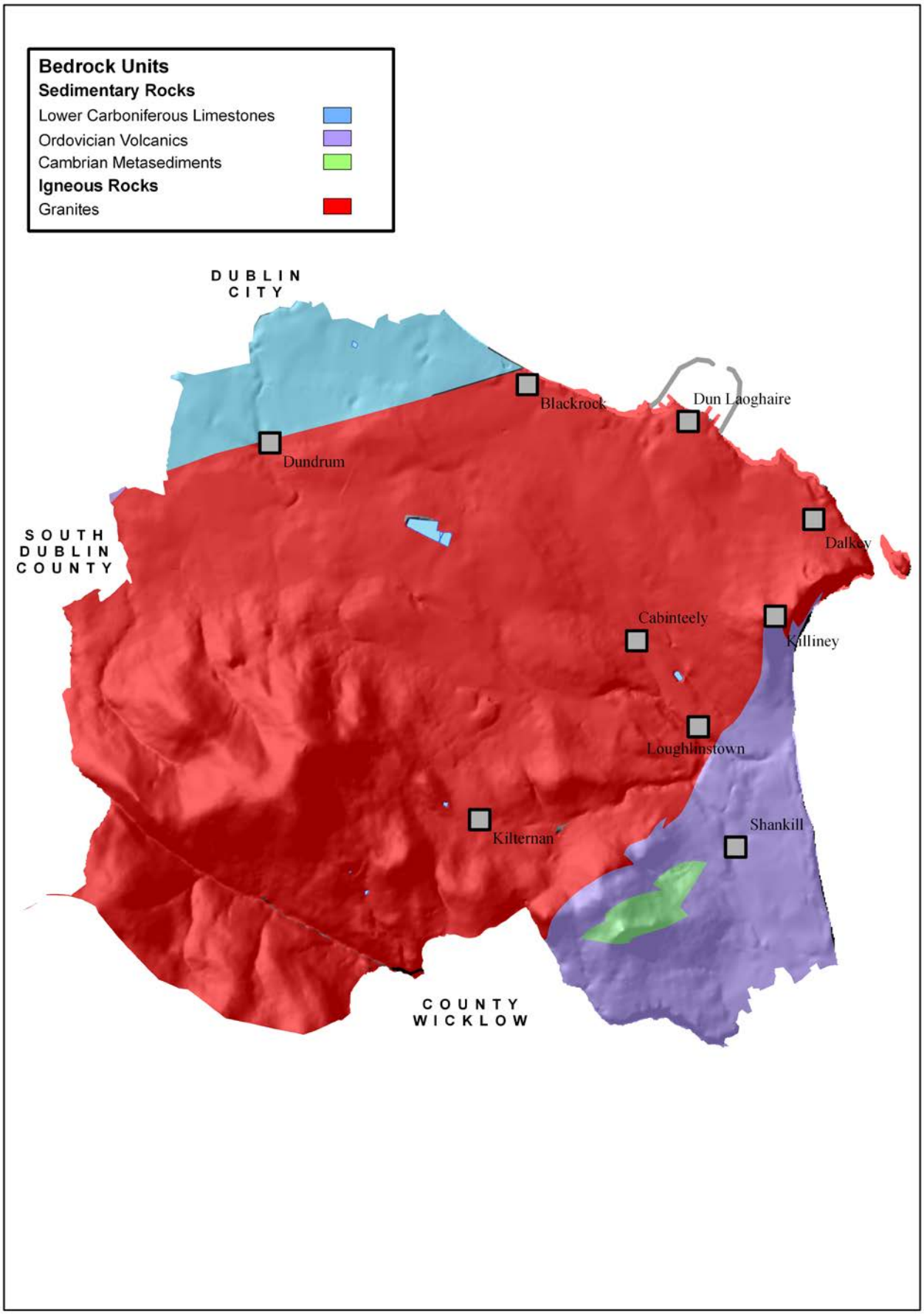
They were on the southern side of the Iapetus Ocean which separated two 'halves' of Ireland, and which drifted northwards to collide – forming mountains through the Appalachians, Ireland, Scotland and into Scandinavia. Shortly after, as a result of the collision of the continental masses, big volumes of granite were injected into them during the Devonian Period. The chain of three main granite bodies runs down through Wicklow and Carlow. Dun Laoghaire-Rathdown includes the northern end of the Leinster Granite chain. The injection of the granite locally metamorphosed these sedimentary rocks into schist.

Remnants of the older rocks the granite was injected into can be seen south of the granite mass. Contacts of granite and schist, like at Ballycorus and White Rock, have extra minerals from late stages of the granite cooling, that were mined for lead ore. White Rock at Killiney is so named because the white granite against the darker metamorphosed schists was very visible to sailors. At Blackrock a rare breccia of granite was probably caused by an explosion of gas from the cooling magma.

The northern half of the county is formed of Carboniferous Limestone rocks deposited in a deep marine basin. These rocks were formed around 340 million years ago and are faulted against the older rocks along the base of the mountains. The limestone deposited in this basin is a muddy limestone with few fossils as it was generally a deeper water environment. This limestone underlies most of Dublin and is known as Calp limestone or 'the Calp'. It is well displayed in the Belgard Quarry in South Dublin but poorly exposed in Dun Laoghaire-Rathdown.

The Pleistocene Period or Ice Age began after 2 million years ago. Several cold periods interspersed with warm periods saw glaciers form in the Wicklow Mountains and meet with ice flowing across the lowlands of Dun Laoghaire-Rathdown. As a result, ice moulded the bedrock hills of the county area into the 'domed' hills seen today. The rock the ice ground down was deposited as till in thick blankets over much of the lower ground, as well as on the flanks of the mountains.

The ice sheet which covered Dun Laoghaire-Rathdown had a complex flow pattern which radiated out from the centre of the mountains in Wicklow, and met with ice from the Midlands which flowed southwards. None of the county area stuck up above the ice. Since the Ice Age, during the Holocene, the modern drainage pattern was superimposed on the deglacial channel network, resulting in some areas of haphazard drainage among the boulder clay and well expressed in places like Shankill. At this time peat also formed across much of the southern extreme of the Dublin Mountains. During this time also the coast as it is now began to take shape, and beaches were deposited between Killiney and the Wicklow county boundary.



A simplified geology map of Dun Laoghaire-Rathdown outlining the main geological units.

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 briefly looks at the specific record and nature of geological hazards in Dun Laoghaire-Rathdown and the relationship of the County Geological Sites to those hazards.

The difference between human timescales and geological timescales can be difficult to comprehend but, for many geological processes, there are periods of sudden activity encompassing major events, and then quiet periods in between. The sites in this audit represent evidence of past geological environments and processes, such as the building of high mountain chains, deep intrusion of massive granite bodies, volcanic eruption, glacier erosion of the land surface and so on. In Dun Laoghaire-Rathdown, no sites represent the active geomorphological or land-forming processes of today. In other counties, such sites are dynamic environments and can be subject to constant or intermittent, sometimes sudden, change.

Landslides and bog flows
The Geological Survey of Ireland has been compiling national data on landslides in the past decade. There were 40 events recorded in Dublin, but the data does not discriminate between the separate local authorities.
See 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 details of individual flood events in Dun Laoghaire-Rathdown. Many smaller floods occur in urban settings where rainfall exceeds the capacity of the local drains. Karstic flooding can occur when underground passages are unable to absorb high rainfall events. The Carboniferous limestone bedrock in Dun Laoghaire-Rathdown is not prone to karstification, and this is not an issue as in many counties.

Sea level rise, coastal erosion and sedimentation
Geological processes can operate at very different scales, some fast and some slow. Looking at things with a geological perspective means that inevitably sea level will rise and and fall relative to the land surface over time, but whether that happens in human life timescales is what raises concerns. Certainly, small changes to coastal situations, like building cliff defences or groynes for sedimentation traps can have very rapid effects, with impacts further along a coast when such changes are made.

Whether human influences on the environment, especially the atmospheric gas components such as carbon dioxide, are affecting climate and causing enhanced changes above natural ones is a different question. However, it is important that for any proposed development in the coastal zone, that different scenarios are considered and modelled, as change through time is a geological fact, not a possible effect.

Radon

Radioactive minerals and gases at higher concentrations can be carcinogenic. Radon 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 Radiological Protection Institute of Ireland was formerly responsible for this but has been merged with the EPA.

Glossary of geological terms

Geological term	Definition
Adit	a horizontal or only gently inclined mine tunnel dug to access coal or mineral ore, or to drain, ventilate or further develop a mine.
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.
Aplite	a fine to medium-grained igneous rock found as veins within coarser-grained plutonic igneous rocks.
Appinite	plutonic igneous rock formed from hydrous magma of mantle origin, dioritic in composition, i.e. rich in hornblende, also containing plagioclase feldspar and/or alkali feldspar, with or without quartz; typically associated with breccia pipes in Donegal
Basin	low areas in the Earth's crust, of tectonic origin, in which sediments have accumulated.
Batholith	large igneous intrusion (100 km² or more)
Beach	a landform along the coast of an ocean, sea, lake, or river which consists of loose particles, often composed of rock, such as sand, gravel, shingle, pebbles, or cobbles.
Bedrock	a general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.
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.
Braided River	a river that consists of a network of small channels separated by small and often temporary islands called braid bars.
Breccia	igneous or sedimentary rock comprising of large angular fragments within finer grained material.
Carbonate	a rock (or mineral), most commonly limestone (calcite) and dolomite.
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.
Dimension stone	stone that is quarried and cut to specific shapes and sizes
Dune	a mound or ridge of drifted sand, occurring along the sea coast or in deserts.
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.
Fan	a usually triangular deposit of sand and gravel deposited by a glacial stream, either under a lake or under air.
Floodplain	a flat or nearly flat land area adjacent to a stream or river that experiences occasional or periodic flooding.
Flute (glacial)	smooth gutter-like channels or furrows made by the abrasive underside of a glacier moving across a rock face.
Fluvial	pertaining to a river or stream.
Glacial	of or relating to the presence and activities of ice or glaciers.
Glacial striae	markings left on the surface of pebbles / boulders / bedrock by moving ice sheets.
Glaciofluvial	pertaining to the meltwater streams flowing from wasting glacier ice and especially to the deposits and landforms produced by such streams.
Glaciomarine	sediment, which originated in glaciated land areas and has been transported to the oceans by glaciers or icebergs.

Grading	a sorting effect with the coarsest material at the base of the bed and finest grained material at the top.
Granite	a coarsely crystalline intrusive igneous rock composed mostly of quartz and feldspar.
Grus	crumbled granite sand formed by weathering
Gully	a deep valley created by running water eroding sharply into bedrock or subsoil
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.
Interglacial	the time interval between glacial stages, or pertaining to this time
Irish Sea Till	clay-rich till found along the eastern seaboard of Ireland, and occurring as much as 12km inland, which was deposited by an ice stream which occupied the Irish Sea Basin during the last glaciation.
Joints	vertical fractures in rocks caused by earth movements but along which there has been no movement of the rocks on either side.
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.
Lodgement	process by which debris is released from the sliding base of a moving glacier/ice sheet and plastered or 'lodged' onto the glacier bed; also describes tills emplaced by this process (i.e. lodgement till).
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.
Microgranite	Medium-grained granite in which crystals are somewhat smaller than those typical of granite, indicating more rapid cooling of the magma
Misfit stream	a stream which is too small to have eroded the valley in which it flows, as is often the case with streams now flowing in meltwater channels.
Moraine	any glacially formed accumulation of unconsolidated debris, in glaciated regions, such as during an ice age.
Nunatak	an exposed, often rocky element of a ridge, mountain, or peak not covered with ice or snow poking up above an ice sheet or glacier.
Outcrop	part of a geologic formation or structure that appears at the surface of the Earth.
Outlier	area of younger bedrock completely surrounded by older bedrock
Peat hag	solitary banks of peat standing proud of surrounding areas of eroded and removed peat
Porphyritic	igneous rock texture with large crystals (phenocrysts) sitting within a fine grained groundmass, arising from a two stage cooling of magma
Raised Bogs	an area of acid, peaty soil, in which the centre is relatively higher than the margins.
Sandur	a plain formed of glacial sediments deposited by meltwater outwash at the terminus of a glacier
Schist	a metamorphic rock exhibiting a foliation defined by the preferred alignment of tabular minerals.
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.
Slate	is a fine-grained metamorphic rock produced from a sedimentary mudstone by pressure, imposing a cleavage along which the slate easily splits.

Spring	the point where an underground stream reaches the surface.
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.
Tor	a large, free-standing rock outcrop that rises abruptly from the surrounding smooth and gentle slopes of a rounded hill summit or ridge crest

Data sources on the geology of Dun Laoghaire-Rathdown

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 (DMS) is freely available to any person at the GSI Customer Centre, into which about half a million documents and maps have been scanned. This means that any user can visit the GSI Customer Centre themselves and search on screen for data of relevance to them. High quality colour and black and white print-outs can be made or data supplied on CD, or via USB keys etc. **Data is available free of charge**. It is planned to make this resource available online within the next few years, although many subsets are already available within existing online data sets.

Key datasets include:

1:100,000 Map Report Series

All historical, modern and other mapping has been compiled into very useful maps and reports that describe the geology of the entire country. Sheet 16 includes Dun Laoghaire-Rathdown.

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 112 and 121 cover Dun Laoghaire-Rathdown. 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 Customer Centre library and scanned on the DMS.

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

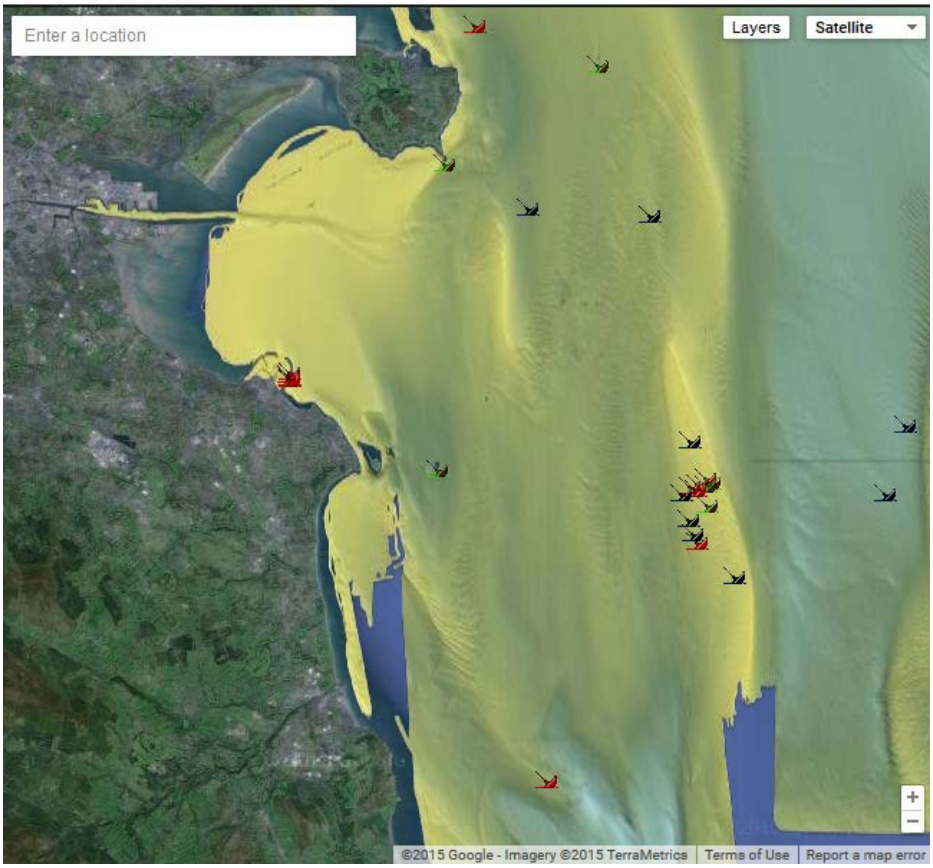
The MinLocs Database records all known mineral occurrences, however small, from GSI records, such as 19th century fieldsheets and Open File data.

Historic Mine Records
Abandonment plans and varied other material exists for the various mining ventures in the country as a whole, but there is nothing significant available for the White Rock mine or Malpas Mine. However, research on these mines has been published in the Journal of the Mining Heritage trust of Ireland.

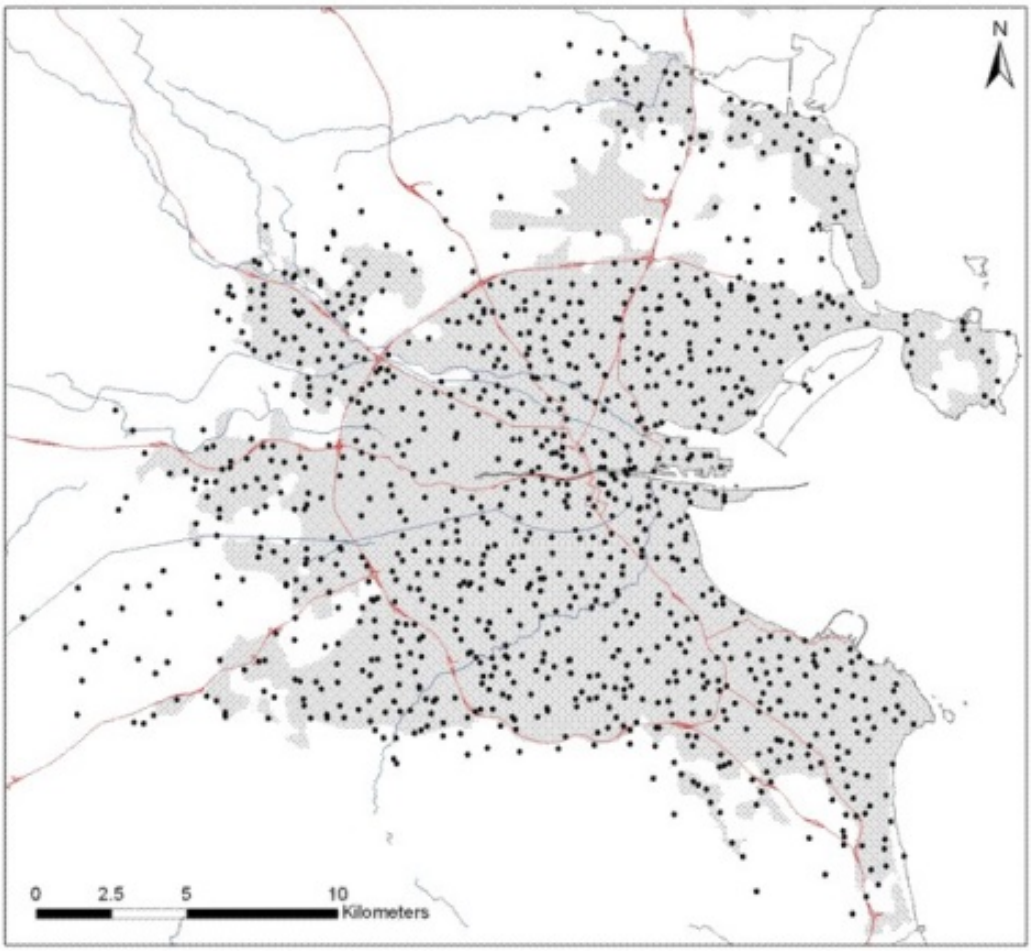
Subsoils Mapping
Since a Groundwater Protection Scheme has been completed (2012) for Dun Laoghaire-Rathdown by GSI, a modern map of the subsoil types and depths across Dun Laoghaire-Rathdown exists, as well as the previously completed bedrock mapping. This provides a significant resource in general terms as well as for groundwater protection. Customised output is possible. Furthermore, detailed compilation of glacial geology datasets will provide more data from late 2014 onwards.

Digital mapping of many different datasets is now available via an easy to use public viewer on the GSI website: www.gsi.ie

Infomar data
The Infomar Programme in the GSI is mapping the seabed in targeted areas of the inshore coast of Ireland. The graphic below shows offshore in Dublin Bay, with some of the many wrecks identified by the survey. Infomar data is freely available for analysis and further processing from the Infomar data via the GSI website.
http://www.gsi.ie/Programmes/INFOMAR+Marine+Survey/
See also www.informar.ie



Dublin SURGE Project (Soil Urban Geochemistry)
GSI has carried out a chemical survey of the topsoil around Dublin city and county in 2012. It involved taking and analysing samples of soil from areas that are publicly accessible (e.g. public parks and school grounds). The aim of the survey was to acquire important information about Dublin soils that will help to better manage the environment.
See https://www.gsi.ie/Surge.htm



Shortlist of Key Geological References
This reference list includes a few **key** papers, books and articles on the geology and geomorphology of Dun Laoghaire-Rathdown that are recommended as access points to Dun Laoghaire-Rathdown's fabulous geological heritage.

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Full Geological references
See Appendix 2 for the full reference list of all papers, books, articles and some unpublished reports etc relating to the geology and geomorphology of Dun Laoghaire-Rathdown that could be traced. Many are relevant to 'Dublin' and may not be specifically on Dun Laoghaire-Rathdown's geology.

Quaternary References
The references in Appendix 3 all cover the Quaternary, or Ice Age, geology of Dun Laoghaire-Rathdown. They are split into references specifically covering sites or features in Dun Laoghaire-Rathdown, and a section of national or regional papers which have some data from or on Dun Laoghaire-Rathdown, or just 'Dublin', included.

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. Tim Carey, the Heritage Officer of Dun Laoghaire-Rathdown 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

Acknowledgements

The authors would like to gratefully acknowledge the assistance of Tim Carey, Heritage Officer from Dun Laoghaire-Rathdown County Council in the development of this project. Funding from the Heritage Council and Dun Laoghaire-Rathdown 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. We also thank Mr Murphy of Murphystone for access to the quarry and very useful discussion and information. We thank the Walsh family of Walsh's Quarry, Ballyedmondduff for access to their quarry and very useful discussions. Mr Frank Lenihan is also thanked for past access to Ballybetagh Bog.

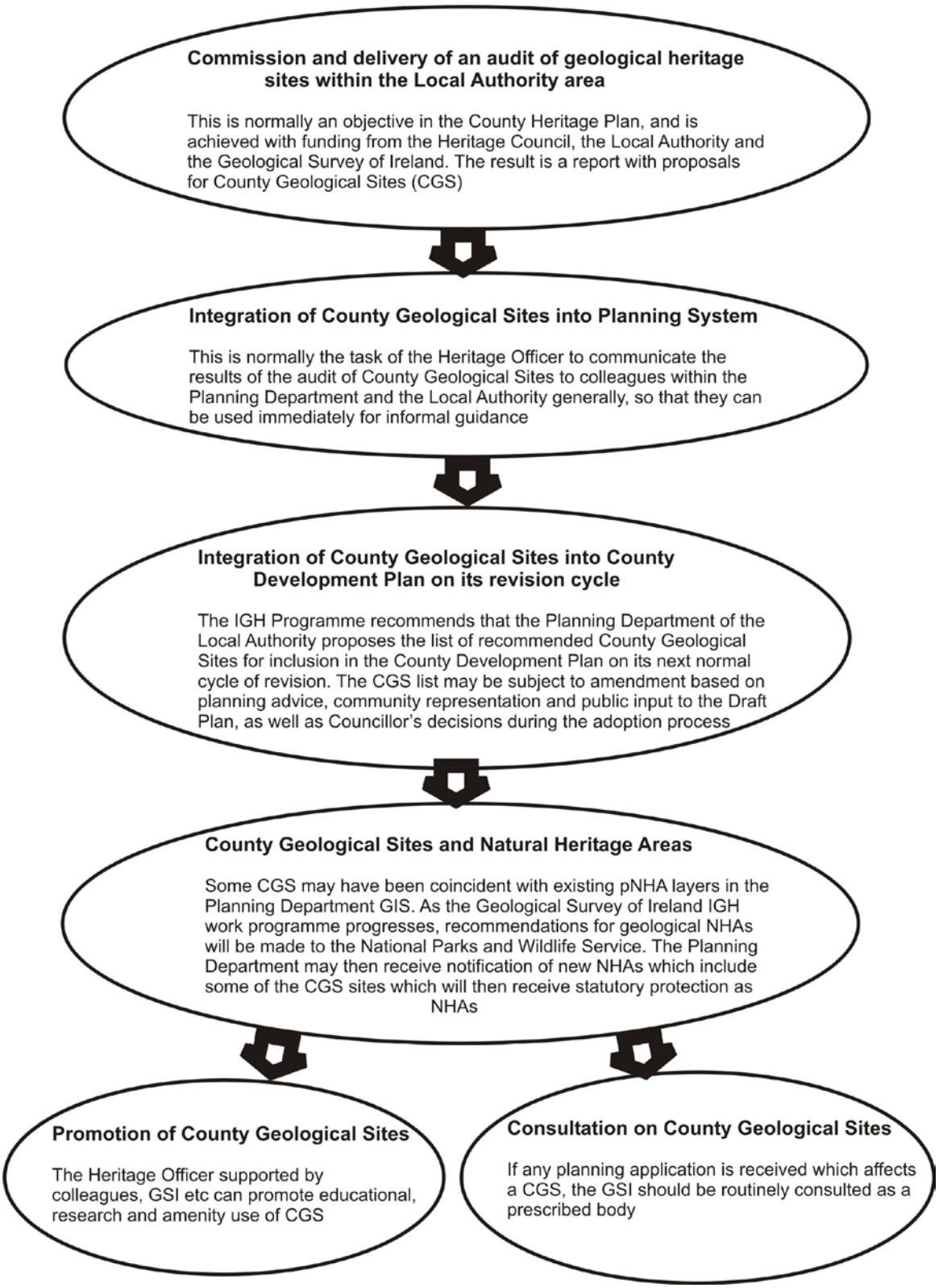
Appendix 1 – Geological heritage audits and the planning process

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

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

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

County Geological Sites - a step by step guide



Appendix 2 - Bibliography – Geology of Dun Laoghaire-Rathdown

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Appendix 3 - Bibliography – Dun Laoghaire-Rathdown Quaternary References

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Appendix 4 – Rejected sites

A range of sites had been previously flagged for consideration in the IGH Master Site List, and some were assessed as unsuitable for County Geological Site status in this audit. Similarly a range of additional sites were assessed in the audit, based on the authors' expert knowledge of Dun Laoghaire-Rathdown's geology and mining heritage. 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.

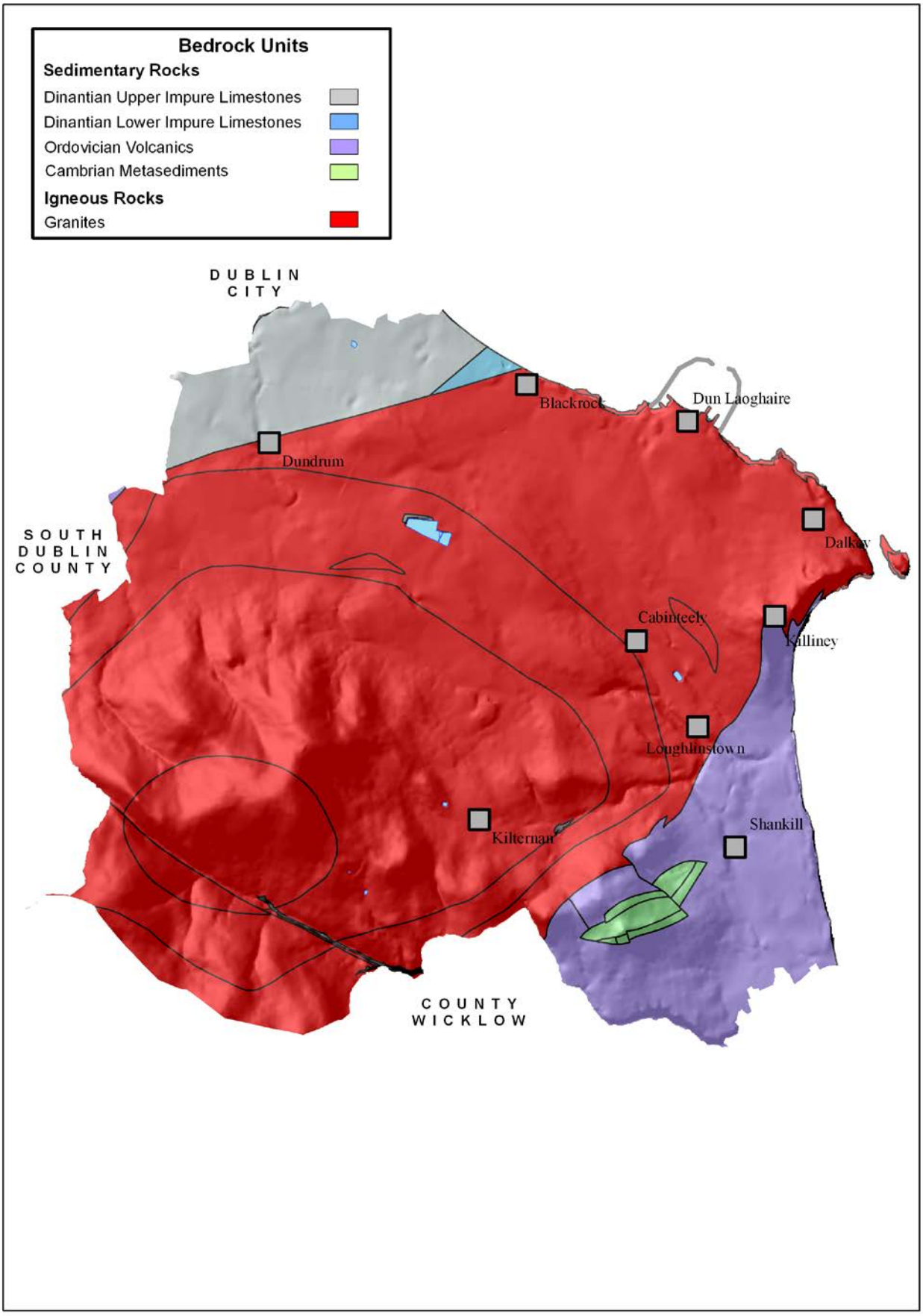
Walsh's Quarry, Ballyedmondduff
This is a small working quarry in the Dublin Granite that was visited and the County Geological Site audit project discussed with the Walsh Family who maintain a stone masonry business despite the infiltration of cheap Chinese granite into the market. Although there is some interest in the quarry representing a traditional geology based industry in the county, within the context of the IGH 15 Economic Geology theme, it is unsuitable for CGS status at present.



Left: The quarry overlooks Dun Laoghaire-Rathdown.
Right: the small quarry floor has overhanging or vertical sides.

Appendix 5

A detailed geological map of Dun Laoghaire-Rathdown



Appendix 6 - Geoschol leaflet on the geology of all of County Dublin

DUBLIN

AREA OF COUNTY: 921 square kilometres or 356 square miles

COUNTY TOWN: Dublin

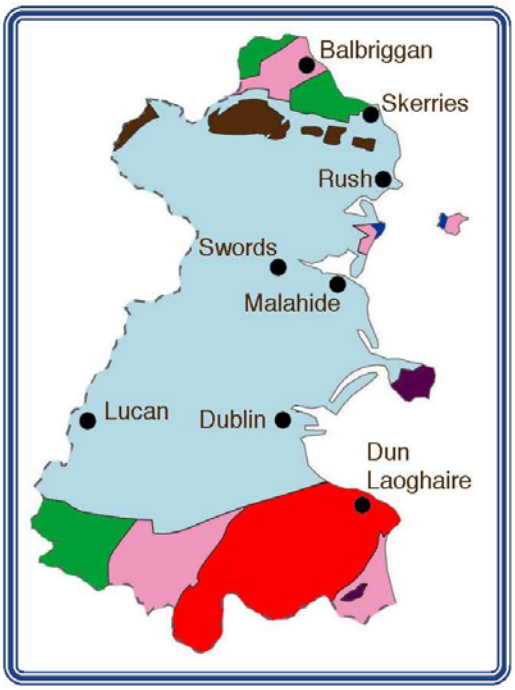
OTHER TOWNS: Balbriggan, Dun Laoghaire, Lucan, Malahide, Rush, Skerries, Swords

GEOLOGY HIGHLIGHTS: Howth Head quartzites, Granite mountains, volcanic rocks at Portrane and Lambay, Carboniferous limestone along north Dublin coast, Killiney metamorphic rocks and glacial deposits

AGE OF ROCKS: Cambrian to Carboniferous; Quaternary

Folded Carboniferous limestone at Loughshinney, north County Dublin

These limestones were folded into tight folds during a period of mountain-building when Africa collided with Europe.



Geological Map of County Dublin

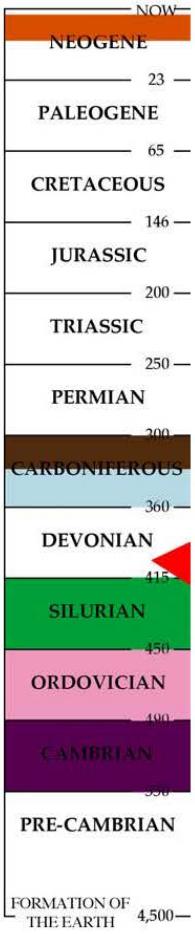
Purple: Cambrian; **Pink:** Ordovician & Silurian; **Green:** Silurian; **Dark blue:** Ordovician volcanic rocks; **Light blue:** Lower Carboniferous limestone; **Brown:** Upper Carboniferous shales; **Red:** Granite.

Geological history

The oldest rocks in Dublin occur on Howth Head where Cambrian shales and quartzites crop out. These were deposited in an ocean 500 million years ago [Ma] that separated two continents. It slowly closed so that during the Ordovician period (490-450 Ma) the crust was unstable and volcanoes began to erupt at what is now Portrane and Lambay producing a distinctive green flecky rock called Andesite. These rocks were deposited in a shallow ocean than contained many organisms including corals and trilobites. Later during the Devonian period (405 Ma) further disruption caused the granite of the Dublin mountains to be injected deep within the surface crust. As it did so it baked the rocks through which it moved and metamorphosed them into schist which can be seen at Killiney. The molten granite magma slowly cooled and formed the pale rocks that were once used as a building material in the city. Some muddy sediments were deposited in the Silurian sea, but any

Ordovician limestones form the cliffs at Portrane while a range of other rocks types are found on Lambay Island.

Devonian rocks have now been eroded away. During the Lower Carboniferous the area was covered by a warm shallow tropical seas where corals, crinoids, brachiopods, lived. Later rivers carried muds and sands that overlie the limestone in north Co. Dublin. During the Ice Age a glacier flowed down the Irish Sea and carried rocks from Scotland including a distinctive bluish microgranite from Ailsa Craig, and this ice met with ice flowing from the Irish Midlands. When it melted it deposited glacial till or boulder clay which is well-exposed along Killiney beach.



Geological timescale showing age of rocks in Dublin.

Dublin fossils

The oldest fossils from Dublin are those contained in the Cambrian slates and shales on Howth Head - there are no shells to be seen, instead only the traces and burrows preserved in the rocks. These are called trace fossils, and include *Pucksia machenri*. The Ordovician limestones at Portrane contain many fossil corals and brachiopods preserved in silica (glass) and geologists have extracted them by dissolving away the limestone that surrounds them. On the coast at Malahide and Portmarnock fossils of crinoids, brachiopods and bryozoans can be seen in the black Carboniferous limestones. In the mid-1800s a large number of skeletons of Giant Irish Deer (*Megaloceros giganteus*) which became extinct only 10,000 years ago were dug up from Ballybetagh Bog, close to Enniskerry, near the Wicklow border.

Mining and Building Stones

Lead mining in the 1700 and early 1800s took place in very small mines at Clontarf and Killiney. A well known mine at Ballycorus in south Dublin provided some lead, but soon ran

Christ Church Cathedral: Dublin's oldest stone building. Built in 1192 of black Calp Limestone quarried locally, imported cream-coloured Dundry Limestone and later roofed with green slates from Westmoreland, England.

out of ore. The lead smelter built on site was kept going by ore brought from Glendalough and other Wicklow mines. There was a big chimney built about 1.5 km away up a hill, to carry away toxic fumes. Some of the lead condensed on the inside of the tunnel and was collected every few months. The chimney has lost the brick top but is still a well known landmark.

Over 100 different stone types have been used for buildings in Dublin, but of these few have been quarried in the County. The most famous Dublin stone is Calp Limestone which is a black muddy limestone that was used for Christ Church Cathedral and the Old Library in Trinity College. Dalkey Quarry provided granite blocks for Dun Laoghaire pier, and many buildings used Leinster Granite from near Blessington or Limestone from Milverton near Skerries. The harbour at Dun Laoghaire is so big it shows up easily on satellite images. The rock to build it came from Dalkey Quarry and was carried down by a small railway. Dalkey and many smaller quarries also provided the granite building stone seen all over Dublin in larger houses and structures. Today many buildings are constructed of concrete or blocks which is produced from Carboniferous limestone quarried at Feltrim and Belgard near Clondalkin.

Geology museums and information

- Geological Museum, Trinity College, Dublin 2 (wysjcknp@tcd.ie); National Museum of Ireland (www.museum.ie); Geological Survey of Ireland (www.gsi.ie)

Suggested reading

- Patrick Wyse Jackson: *The Building Stones of Dublin* (1993) Country House.
- Patrick Wyse Jackson and others: *Field Guide to the Geology of some localities in County Dublin* (1993) TCD & ENFO.

Map adapted with permission from Geological Survey of Ireland 1:1,000,000 map 2003.
Image credits: Mike Simms 1; Matthew Parkes 3; Patrick Wyse Jackson 4.

Text by Patrick Wyse Jackson & Matthew Parkes

Section 2 - Site Reports

Site reports – general points

The following site reports are brief non-technical summaries of the proposed County Geological Sites for Dun Laoghaire-Rathdown. These have been specially prepared for this Report in order to make the information accessible to planners and others without geological training. For most 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. Further sites may become relevant as IGH Programme work develops.

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 one or two low resolution photographs exemplifying the site. **A CD accompanying this report will include further pictures of most sites at higher resolution, should they be required for a glossy booklet or leaflet for the general public**. 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.

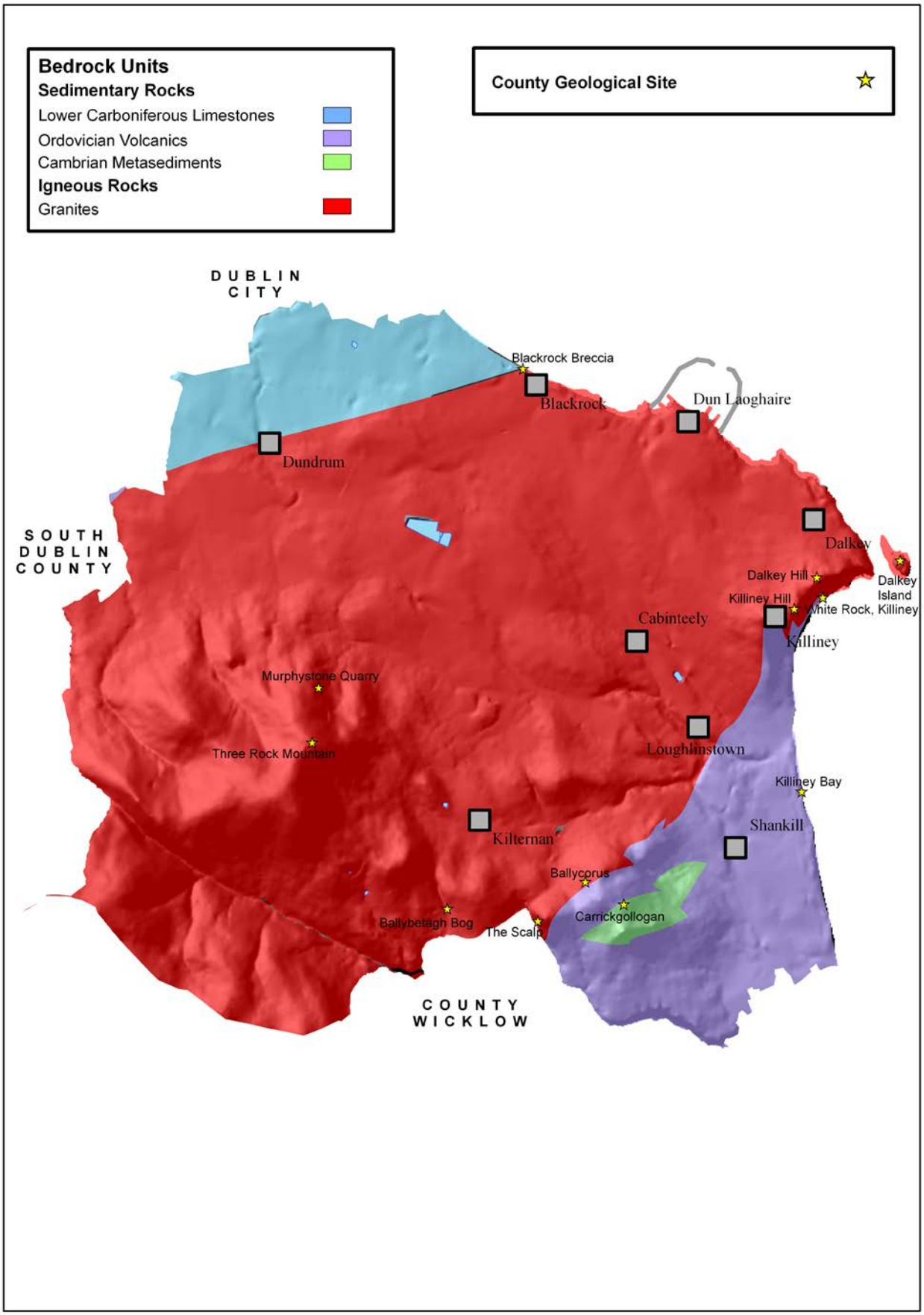
Irish Transverse Mercator (ITM) is the geographic projection co-ordinate system now in use for Ireland, and has been applied to all site localities in the site reports. It is the standard co-ordinate system for OSi maps, including the new Discovery map series, but a coordinate conversion tool is available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

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

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

In terms of any geological heritage site designation as NHA, due process of site reporting, boundary survey and very importantly, consultation with landowners where they can be readily identified, will take place before GSI finalises

recommendations with NPWS on the most important sites to be designated. Any landowner within areas or sites identified in this report with concerns over any aspect of this project is encouraged to contact Sarah Gatley, Head of the Heritage and Planning 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 Dun Laoghaire-Rathdown with site locations indicated.

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Carrickgollogan**
Other names used for site	**'**Katty Gallagher', and variants thereof
IGH THEME	**IGH 4 Cambrian-Silurian**
TOWNLAND(S)	**Shankill**
NEAREST TOWN/VILLAGE	**Shankill**
SIX INCH MAP NUMBER	**26**
ITM CO-ORDINATES	**723055E 720550N**
1:50,000 O.S. SHEET NUMBER	**50, 56 GSI BEDROCK 1:100,000 SHEET NO: 16**

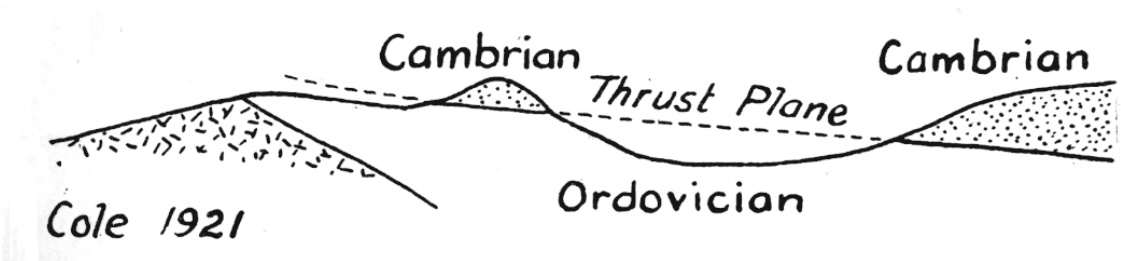
Outline Site Description
A small but prominent hill.

Geological System/Age and Primary Rock Type
The small hill of Carrickgollogan is composed of Cambrian quartzites of the same age as the Sugarloaf and Bray Head. The surrounding hill is composed of younger Ordovician rocks.

Main Geological or Geomorphological Interest
The small hill of Carrickgollogan is a geological anomaly in that the Cambrian quartzite rocks of the hill are much older than the Ordovician slate rocks on which they rest. Structurally they are upside down. The small hill is only a remnant of a very large recumbent (folded back on itself) fold structure that existed, most of it having been eroded away. The cross-sectional sketch below illustrates this. Geologically this hill is an inlier (older rocks surrounded entirely by younger rocks) but specifically because of its faulted origin it is termed a klippe. The site includes the hill itself and sufficient surrounding forest to show exposure of the slates on which the quartzite sits. There are good 360 degree views of the surrounding geology and landscape.

Site Importance - County Geological Site; may be recommended for Geological NHA
It is an unusual example of a klippe in a national context and may be recommended for geological NHA status, but certainly deserves to be a CGS.

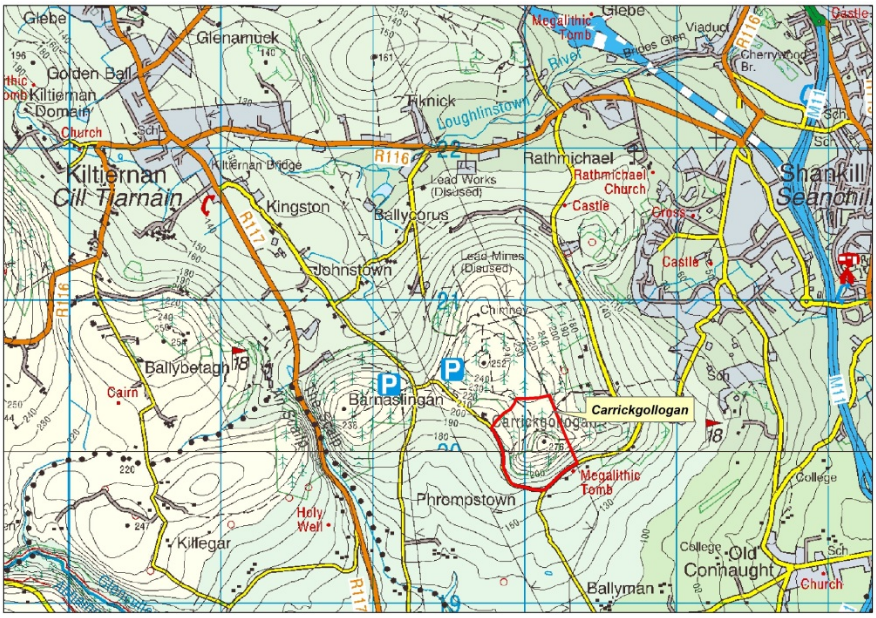
Management/promotion issues
The hill is on Coillte land and open for public access. A good variety of trails managed through the Dublin Mountains Partnership pass close by. A trailside sign about wildlife in the area, right at the foot of the small hill could be radically enhanced by addition of a panel explaining the geological structure with a simple cross-sectional diagram and possibly a map.

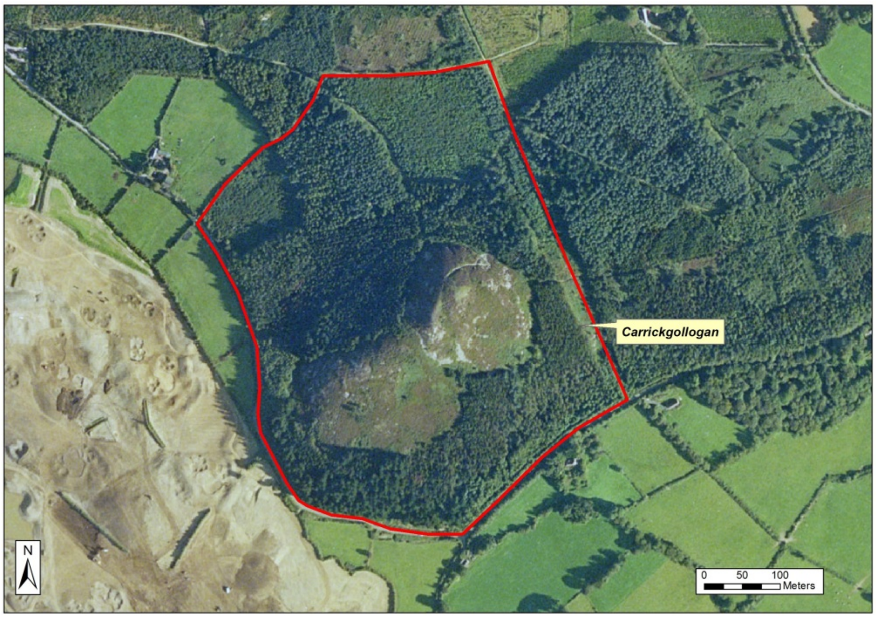


A very simple representation of how Carrickgollogan was emplaced by a major thrust fault, bringing Cambrian rocks up from the east onto younger Ordovician rocks, with subsequent erosion leaving the klippe of Carrickgollogan.

Carrickgollogan viewed from a trail from the Carrickgollogan woods car park.

Carrickgollogan – at the foot of the small hill of Cambrian quartzite rocks from the trail. An additional sign explaining the geological importance would enhance the visitor experience.


Glebe
Glenamuck
Golden Ball
Kiltiernan Domain
Church
Kiltiernan
Cill Tiarnáin
Kiltiernan Bridge
R116
R117
Kingston
Johnstown
Ballycorus
Lead Works (Disused)
Lead Mines (Disused)
Chimney
Ballybetagh
Cairn
Barnaslingan
Carrickgollogan
Megalithic Tomb
Phrompstown
Holy Well
Killegar
Rathmichael
Rathmichael Church
Castle
Cross
Shankill
Seanchill
Loughlinstown River
Cherrywood Br.
Viaduct
College
Old Connaught
Ballyman
Church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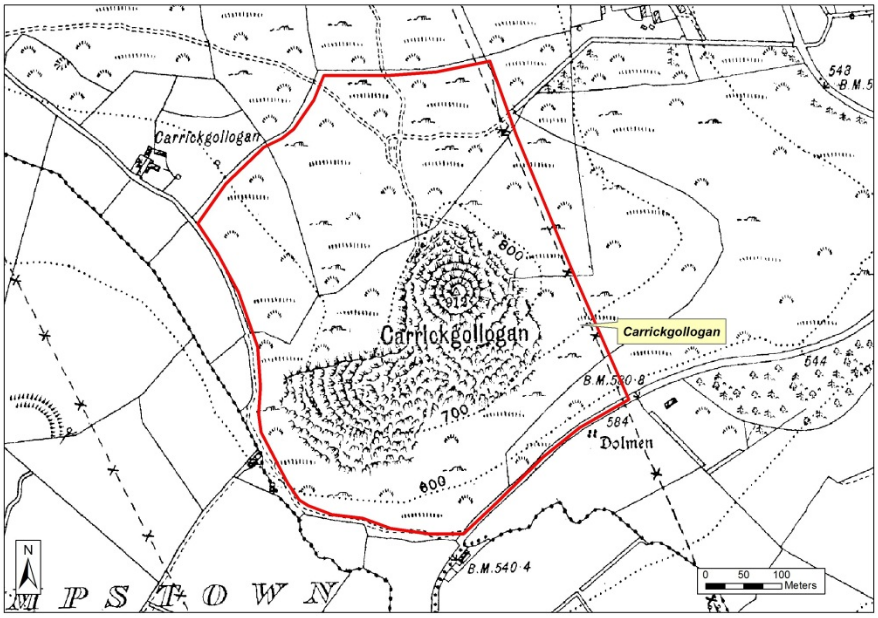
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DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballycorus**
OTHER NAME(S)	
IGH THEME	**IGH 6 Mineralogy, IGH15 Economic Geology**
TOWNLAND(S)	**Ballycorus**
NEAREST TOWN/VILLAGE	**Shankill**
SIX INCH MAP NUMBER	**26**
ITM CO-ORDINATES	**722400E 720930N (centre of site)**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO: 16**

Outline Site Description
Historic mine site, with opencast workings and smelter chimney and flue.

Geological System/Age and Primary Rock Type
The mineralisation at Ballycorus is probably of the same age as mineral veins at Glendalough and Glendasan, associated with the emplacement of the Leinster Granite about 405 million years ago. The main ore was galena.

Main Geological or Geomorphological Interest
The mine working at Ballycorus was actually short lived, but the associated smelter and shot towers (for making gunshot pellets) built on the strength of the development of the mine, were then sustained for decades by ore sourced from Wicklow. Although there were underground shafts on the mineral veins, there is none now visible. The main opencast scar is unvegetated due to metal toxicity to plants. The main ore was galena, but associated minerals recorded from here include barite, linarite, cerussite, silver, pyromorphite and quartz.

Of particular note here is the tall stone chimney, which originally had a brick top, and which is at the uphill end of a stone built flue around 1.6 km long. As the original fumes from the lead smelter in the valley were poisoning livestock and causing problems, the long flue and chimney were built to disperse the lead fumes and to condense more lead on the flue walls. Periodically the lead condensed on the walls could be scraped off and added to production.

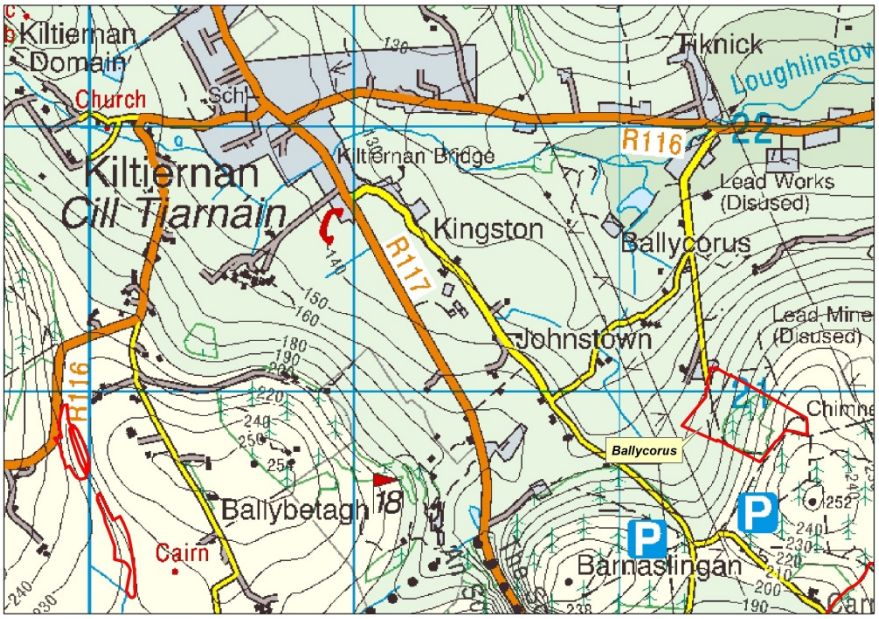
Site Importance - County Geological Site
The site is regularly used by geological groups for education, and is of great value as a geological heritage and local industrial heritage site in the county.

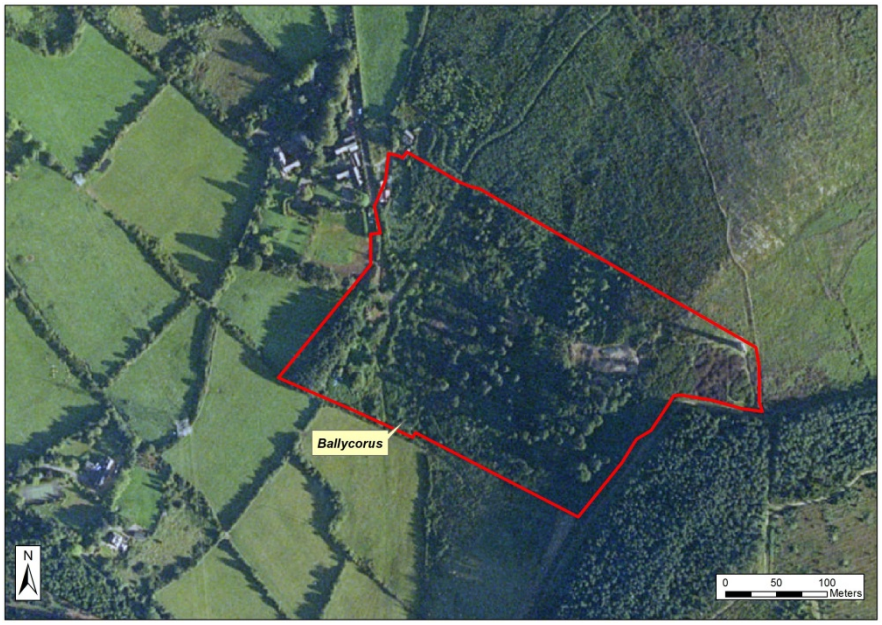
Management/promotion issues
The site includes the chimney and part of the flue, but the original leadworks and a separate complex of buildings with shot tower are not included. These are all on private property and are dwellings or business premises. They should ideally be preserved, but this is best addressed through other mechanisms than CGS, such as Architectural Conservation Areas. The main buildings are already listed in the Record of Protected Structures:
1-3 Ballycorus Cottages, Mine Hill Lane – No. 1814
Ledville Complex House – No. 1812
Flue – No. 1841
Lead Mine Complex – No. 1848
Complex house – No. 1849
Ballycorus Chimney and flue - No 1852

The area is well used by walkers, and forms part of the trails around Carrickgollogan and Barnaslingan Woods, but it is not clear if the mine site is within Coillte land or not.

A view of the main opencast working, looking downhill, towards the west.

The view up the workings with chimney in distance, and right, the chimney.


Kiltiernan Domain
Church
Sch
Kiltiernan
Cill Tiarnain
Kiltiernan Bridge
Kingston
Tiknick
Loughlinstown
R116
R117
Lead Works (Disused)
Ballycorus
Lead Mine (Disused)
Johnstown
Chimney
Ballybetagh
Cairn
Barnaslingan
P
P


Ballycorus
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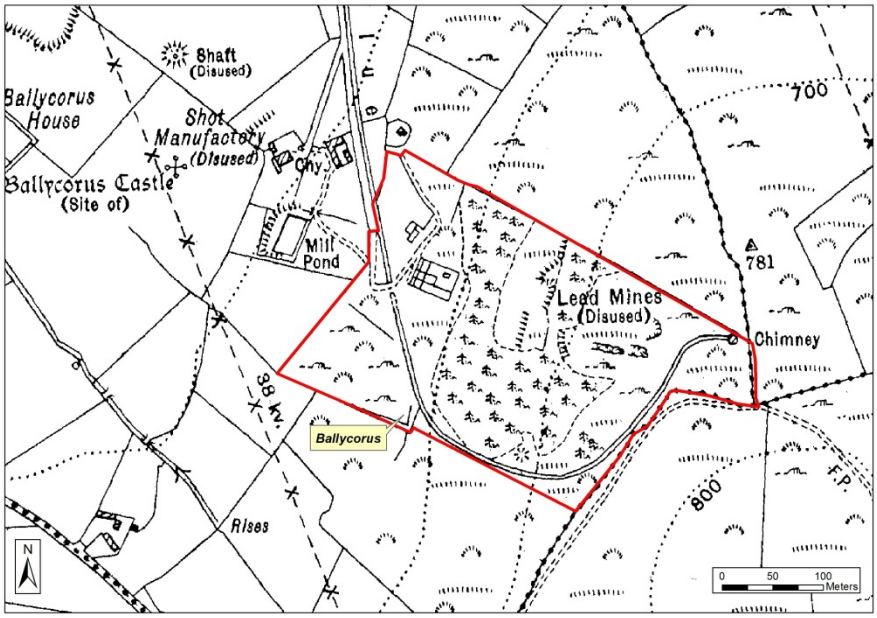

Shaft (Disused)
Ballycorus House
Shot Manufactory (Disused)
Chy
Ballycorus Castle (Site of)
Mill Pond
Lead Mines (Disused)
Chimney
781
700
800
38 kV
Ballycorus
Rises
N
0 50 100 Meters

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Killiney Hill**
Other names used for site	*Cnoc Chill Iníon Léinín*, Mount Mapas
IGH THEME	**IGH7 Quaternary; IGH 6 Mineralogy**
TOWNLAND(S)	**Scalpwilliam or Mount Mapas, Killiney**
NEAREST TOWN/VILLAGE	**Killiney**
SIX INCH MAP NUMBER	**23**
ITM CO-ORDINATES	**725957E 725576N (obelisk at summit of crag)**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
Killiney Hill is a coastal hill site, laid out as a public park. It is forested on its sides with a mixture of heathland and outcrop around the summit.

Geological System/Age and Primary Rock Type
Roche moutonnées occur on bedrock of Late Caledonian (405 Ma) Leinster Granite but they are Quaternary in age, having been formed at the base of the ice sheet moving northwest to southeast during the maximum period of the last Ice Age.

Main Geological or Geomorphological Interest
This is potentially the best large scale example of a number of composite roche moutonnée ridges in Dun Laoghaire-Rathdown. Roche moutonnées are formed when a glacier or ice sheet passes over an area that contains a particularly resistant mass of rock (in this case the rock summit of Killiney Hill itself). The passage and force of the glacier ice over underlying bedrock results in asymmetric erosional forms, creating smooth, polished rock surfaces as a result of abrasion on the "stoss" (upstream) side of the rock, and jagged rock forms resulting from plucking on the "lee" (downstream) side. These erosional features are seen on a scale of less than a metre to several hundred metres on Killiney Hill. The hill itself is a very large roche moutonnée, and most of the individual outcrops on the hill are themselves much smaller roche moutonnées.

The Leinster Granite is very well exposed on Killiney Hill and abundant veins of aplite (very fine grained granite) and pegmatite (very coarse grained granite), formed as fissure fillings at a late stage in the intrusion history, can be observed. Some of the pegmatite veins contain, at their centre, crystals of killinite, identified as a variety of spodumene (Li $AlSi_2O_6$) in 1818 and named after Killiney. The mineral is in fact largely composed of fine mica that has pseudomorphed the original spodumene, so that the crystals observed have the outward form of spodumene but the composition of mica.

Site Importance – County Geological Site
This is one of the best examples of a composite roche moutonnées in the country. The occurrence of killinite, named after Killiney, adds interest to the site. The hill is already a proposed NHA (pNHA Site Code 001206, Dalkey Coastal Zone and Killiney Hill) for biodiversity reasons.

Management/promotion issues
This is an excellent site in terms of macro-scale Quaternary subglacial geomorphology. The feature forms the area of Killiney Hill Park. A signboard in the park, ideally just west of the obelisk overlooking many of the small-scale features, and detailing the importance and formation of the feature(s), and their various scales, might add to the interest for visitors. The geodiversity of the hill should also be highlighted in any promotion of the proposed NHA. The killinite occurrence locality should not be identified, however, lest the mineral become a target for collectors.

View across the southeastern side of the hill summit, with the bedrock smeared and etched by the base of the ice flowing over the locality during the last glaciation.

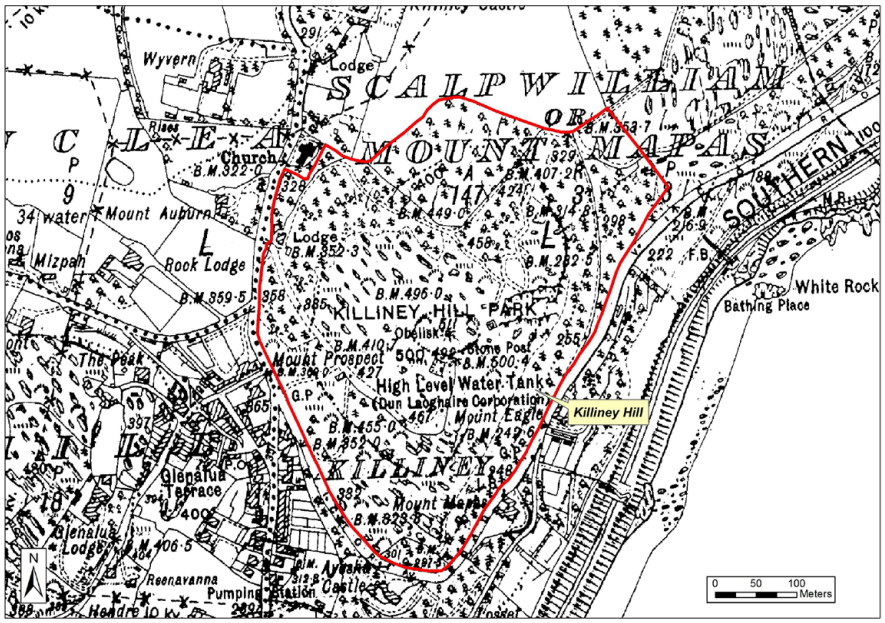
View southeastwards from the area just northwest of the obelisk, showing the dome-shaped roche moutonnée forms.

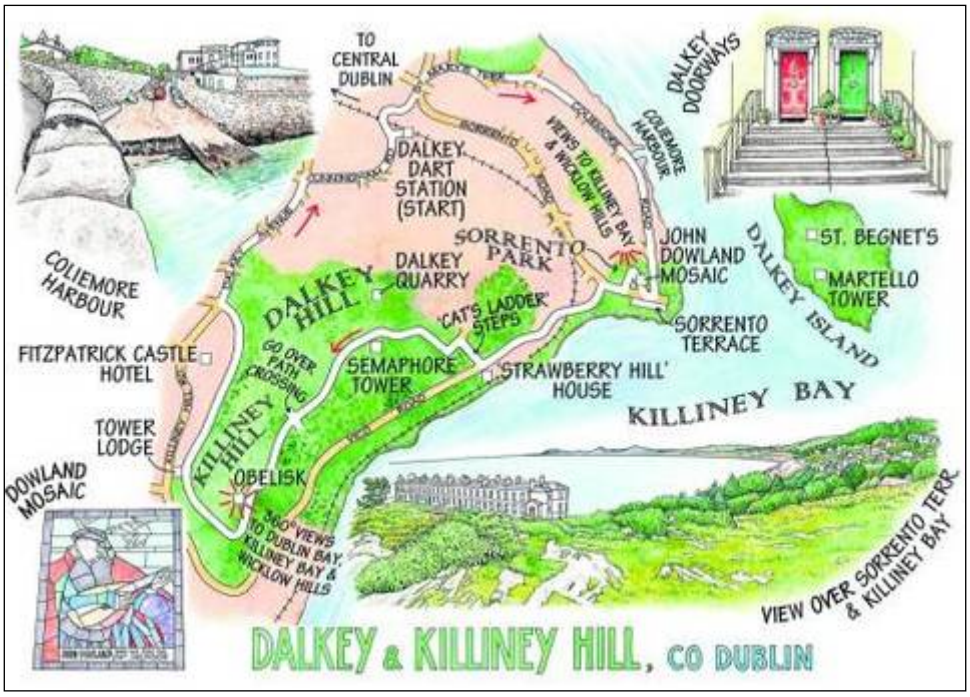
View northeast across some of the roche moutonnées.

Left: Killiney Hill, viewed from Killiney Beach to the south. Right: Killinite (long, thin broken green–white-coloured crystals at centre, below coin) in pegmatite on Killiney Hill.


Dalkey
Deilginis
PO
Castle
Maiden
Rock
Lamb
Island
Promontory
Fort
Church
Martello
Tower
Dalkey
Island
Oileán
Dheilgins
Dalkey Sound
R119
Dalkey
Hill
Sorrento
Point
R118
Killiney
Cill Inion Lenin
Killiney Hill
Kilbogget
Killiney
Bay
10MP
Br.Ht.
2.49m


Killiney Hill
N
0 50 100
Meters


Wyvern
Lodge
SCALP
MOUNTAINS
Church
Mount Auburn
Mizpah
Rock Lodge
KILLINEY HILL PARK
Obelisk
Mount Prospect
High Level Water Tank
(Dun Laoghaire Corporation)
Killiney Hill
Mount Eagle
KILLINEY
Glenalua
Terrace
Glenalua
Lodge
Reenavanna
Pumping Station
Castle
White Rock
Bathing Place
N
0 50 100
Meters



A promotional leaflet illustrating Killiney and Dalkey Hill, to accompany walks in the area.

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**White Rock, Killiney**
Other names used for site	
IGH THEME	**IGH 11 Igneous intrusions, IGH 6 Mineralogy**
TOWNLAND(S)	**Scalpwilliam or Mount Mapas**
NEAREST TOWN/VILLAGE	**Killiney**
SIX INCH MAP NUMBER	**23**
ITM CO-ORDINATES	**726444E 725770N (centre of outcrop)**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO: 16**

Outline Site Description
A coastal section of cliffs, at the northern end of the Killiney beach, including a small mine adit.

Geological System/Age and Primary Rock Type
The granite intrusion into Ordovician slates is of Devonian age, and was intruded approximately 405 million years ago. The country rock or host rock that the granite intruded is the Maulin Formation, part of the Ribband Group of early Ordovician age.

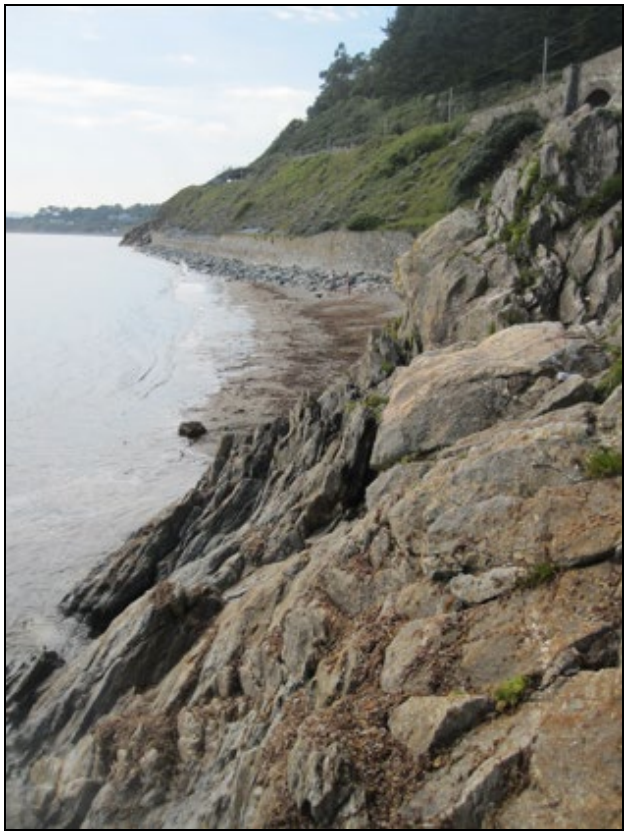
Main Geological or Geomorphological Interest
White Rock is so called because sailors noted a strong colour difference between the dark rocks on the southern side of the site, and the white or cream coloured granite exposures here. The site shows the margin of an intruded granite body into the older, dark coloured mud rocks, which have locally been metamorphosed to schists. The granite – schist junction is complex with intermixing, and veins of aplite (very fine grained granite) and pegmatite (very coarse grained granite) injected in both rock types form the late stages of cooling of the granite. The metamorphism of the mudrocks to produce schist has also resulted in the growth of some new minerals, including large needle like crystals of andalusite up to 20 mm long and 5 mm wide.

The interaction of seawater with minerals in the adit is reported to have formed deposits of the mineral phosgenite. This would be a rare occurrence.

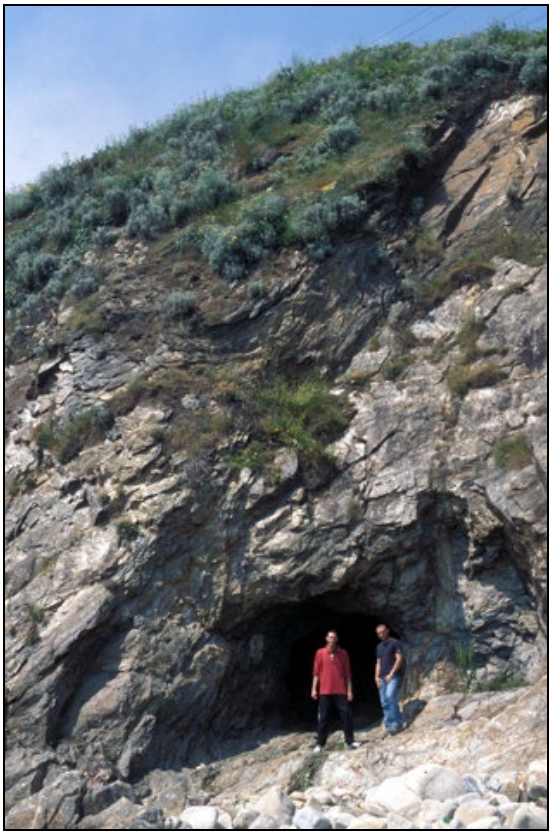
Site Importance - County Geological Site
This is a good educational site, widely used by third level student groups and is publicly accessible.

Management/promotion issues
There is good roadside parking on the Vico Road, above the site, with tarmac paths and a railway footbridge to allow access to the beach via steps. Care must be taken with tides by visitors but there is something to see even at high tides. The mine adit has a gate installed by the Exploration and Mining Division of the Department of Communications, Energy and Natural Resources. The concrete shelter building constructed for swimmers at the foot of the steps to access the beach could be used to mount an interpretation panel explaining the name of the place and the geological significance.

Overview of site from the northern end of the section.



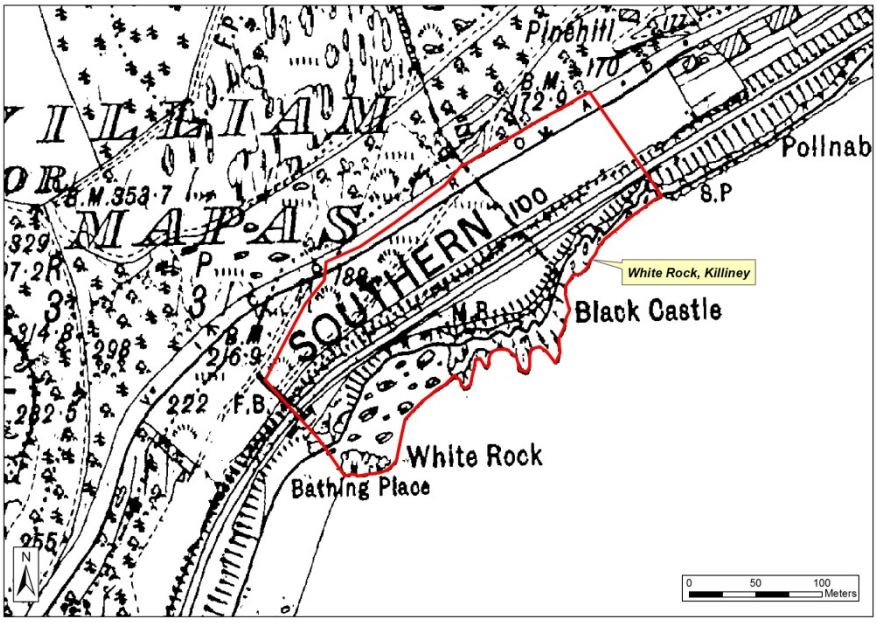
Schist and granite interfingered.



The mine adit is gated but is almost filled with mud and rock inside the entrance.


Dalkey
Deilginis
Maiden Rock
Lamb Island
Promontory Fort
Church
Martello Tower
Dalkey Island
Oileá Dheil
Dalkey Sound
Sorrento Point
R118
R119
Killiney
Cill Iníon Lemin
9MP
White Rock, Killiney
Killiney Bay
10MP


White Rock, Killiney
N
0 50 100 Meters


Pinehill
Pollnab
White Rock, Killiney
Black Castle
White Rock
Bathing Place
N
0 50 100 Meters

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballybetagh Bog**
OTHER NAME(S)	
IGH THEME	**IGH 7 Quaternary**
TOWNLAND(S)	**Ballybetagh**
NEAREST TOWN/VILLAGE	**Shankill**
SIX INCH MAP NUMBER	**26**
ITM CO-ORDINATES	**720050E 720475N (centre of central portion of bog)**
1:50,000 O.S. SHEET NUMBER	**50, 56 GSI BEDROCK 1:100,000 SHEET NO: 16**

Outline Site Description
Three sections of bog within the same narrow valley.

Geological System/Age and Primary Rock Type
The bogs at Ballybetagh are post-glacial to recent in age, covering around 12,500 years.

Main Geological or Geomorphological Interest
Ballybetagh Bog, comprising three distinct areas of 'fen' or 'marsh', is internationally renowned as a classical site of Irish Quaternary studies and as a significant locality for the study of the extinct Giant Irish Deer (*Megaloceros giganteus*). The long history of research on the Giant Irish Deer and its environment at this site, is due to the relative abundance of skeletal remains, as first excavated for a Famine relief project in 1847. Bones of Giant Irish Deer from the site have been dated at 10,600 BP.

The bogs lie at the head of the glaciofluvially-incised Glencullen Valley, just over 1 km west of the Scalp, and each is approximately 300m by 140m in area. The narrow valley floor, which was cut by a glacial meltwater (spillway), holds a relatively thick sequence of late glacial lake deposits and overlying fen (peat) growth. This provides a key international 'late-glacial to recent' stratigraphical section that is of major importance for the European chronology of the period.

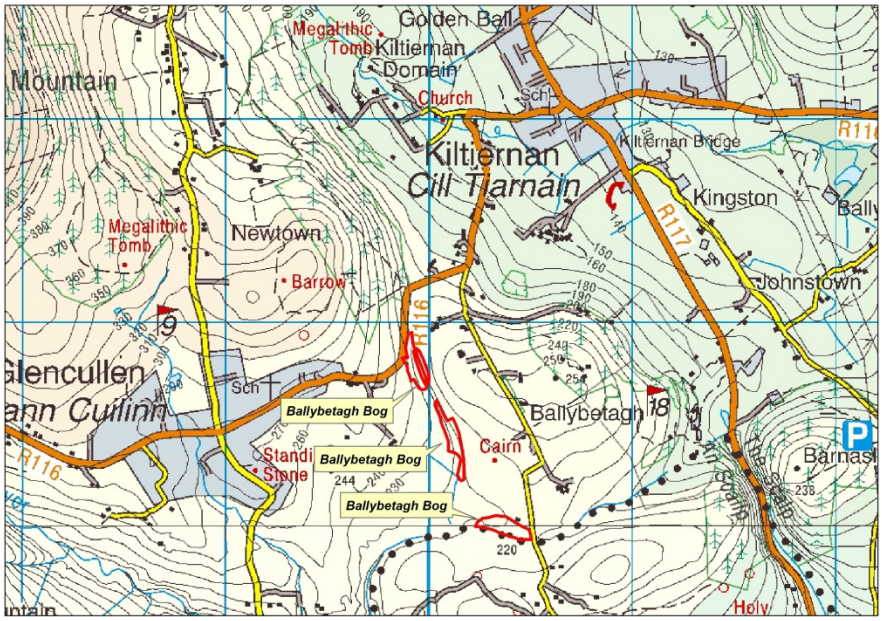
Accelerator-mass spectrometer (AMS) ages indicate that the late glacial sediments cover the period from 12,540 to 10,070 years BP. The pollen and macrofossil plant records have been tied into absolute dating techniques and show that post glacial vegetation of Ireland began about 12,600 years BP.

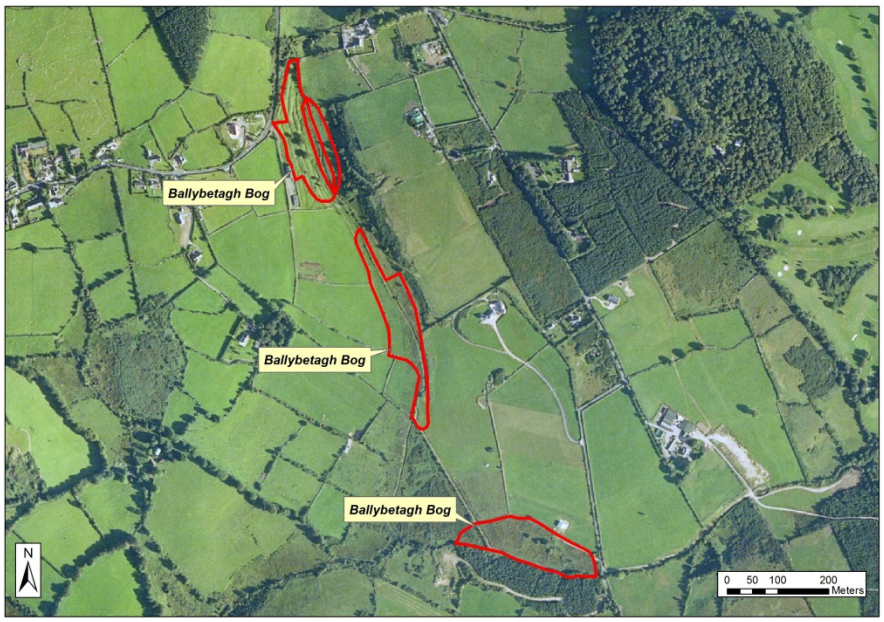
Site Importance - County Geological Site; recommended for Geological NHA
This is an important site that, despite some drainage in modern times, retains much scope for future research work and is not just a historical site with no potential for either new or baseline comparison studies. It has been recommended as a geological NHA to National Parks and Wildlife Service (NPWS) by the Geological Survey of Ireland (GSI). It is now a proposed Natural Heritage Area (pNHA – Site Code 1202).

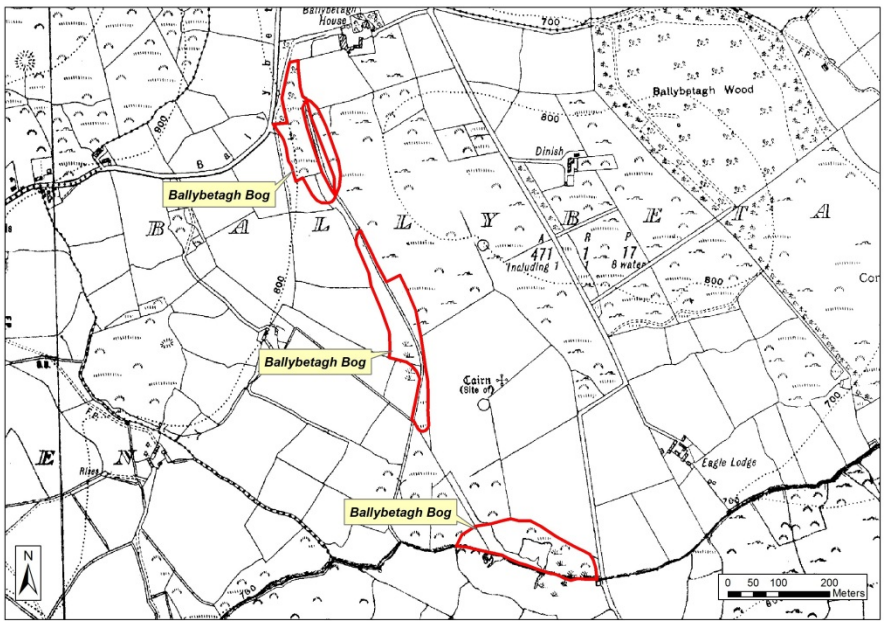
Management/promotion issues
The bog areas should not be further disturbed at surface by drainage or farming operations. The site is private farmland and there is no access without permission from the landowner.

The middle of the three bog areas is just right of centre in the image.

Looking northeast to the northern bog in a narrow valley.
Right: Looking north along the valley floor.


Golden Ball
Megalithic Tomb
Kiltiernan Domain
Church
Sch
Kiltiernan Bridge
Kiltiernan
Cill Tiarnáin
Kingston
R117
Johnstown
Megalithic Tomb
Newtown
Barrow
R116
Sch
Ballybetagh Bog
Standi Stone
Ballybetagh Bog
Cairn
Ballybetagh
Ballybetagh Bog
Holy


Ballybetagh Bog
Ballybetagh Bog
Ballybetagh Bog
N
0 50 100 200
Meters


Ballybetagh House
Ballybetagh Wood
Dinish
Ballybetagh Bog
Ballybetagh Bog
Cairn (Site of)
Eagle Lodge
Ballybetagh Bog
N
0 50 100 200
Meters

DUN LAOGHAIRE - RATHDOWN –
COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Dalkey Island**
Other names used for site	
IGH THEME	**IGH7 Quaternary, IGH 11 Igneous intrusions, IGH 16 Hydrogeology**
TOWNLAND(S)	**Dalkey Commons**
NEAREST TOWN/VILLAGE:	**Dalkey**
SIX INCH MAP NUMBER	**23**
ITM CO-ORDINATES	**727757E 726400N (centre of island)**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO: 16**

Outline Site Description
A small well on an island of extensively exposed granite.

Geological System/Age and Primary Rock Type
The bedrock is porphyritic microcline type 2 granite of the Northern Unit of the Leinster Granite (405 Ma), the northernmost of five plutons that comprise the Leinster Granite batholith.

Main Geological or Geomorphological Interest
The site is primarily listed for a 'scurvy well' on the island. Reports of the supposed benefits to sailors of the water in preventing scurvy cannot be relied upon. However, the occurrence of a well – a natural spring, rather than a dug well, on an island of granite is notable. This is because granite is typically a compact and massive rock with low porosity and permeability, such that groundwater is not to be expected to circulate within it. The well on Dalkey Island appears to be a consequence of the slightly saucer-shaped interior of the island, the surface of which dips gently towards the well near the landing place. A thin veneer of glacial sediment, primarily a granite cobble-rich till, within this saucer seems to be sufficient reservoir for rainfall on the island to sustain the small flow in the well.

In addition, excellent exposures of granite are abundant throughout the island, with prominent veins of aplite (very fine grained granite), pegmatite (very coarse grained granite) and white quartz cutting through the exposures. There are very spectacular roches moutonnées, formed by northwest-to-southeast ice movement across the island during the last ice age, while the veneer of glacial till underneath the grass covered basin on top of the island is also testament to the effects of ice movement. On the southwestern coast, unusual weathering features in the granite resemble the clints and grykes commonly observed in weathered limestone.

Site Importance - County Geological Site
The well is small but an interesting hydrogeological phenomenon. The island as a whole is worthy of designation as a CGS because of the spectacular exposures of granite and the effects of glacial action and weathering upon them.

Management/promotion issues
The entire island, as well as adjoining smaller islands, is the subject of a Dun Laoghaire-Rathdown County Council Conservation Plan 2014-2024 which encompasses geological heritage. The Plan was developed with extensive consultation with all interested parties. As a result, the island is now accessible to visitors via a licenced boat service from Coliemore Harbour.


The scurvy well is in a white-painted construction, near the landing place.

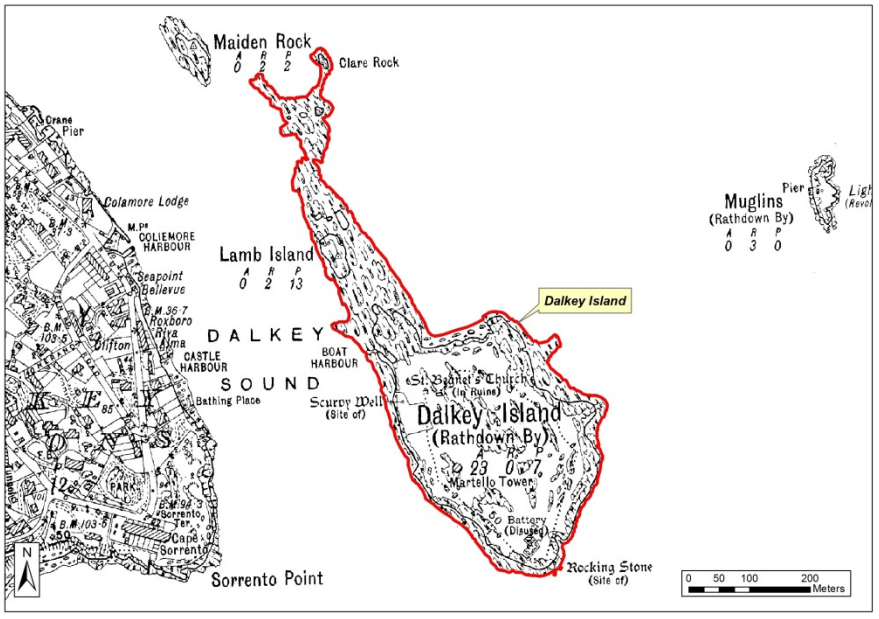
The scurvy well is fed by rainfall onto this saucer shaped basin on the top of the island.

The scurvy well is fed by rainfall seeping through this thin layer of gravelly granite till.


Left: The granite is cut by veins of quartz and also aplite.
Right: From the landing place the historical church and the Martello Tower are obvious and the thin glacial till is most apparent at the back of the beach.


Dalkey
Deilginis
PO
Maiden
Rock
Lamb
Island
Promontory
Fort
Dalkey
Church
Island
Martello
Tower
Oileá
Dheil
Dalkey Sound
Dalkey Island
Sorrento
Point
R118
R119
Killiney
Cill Iníon Léinín
9MP
Martello
Tower
Church
Killiney
Bay
10MP
bogget


Dalkey Island
N
0 50 100 200
Meters


Maiden Rock
Clare Rock
Crane
Pier
Colamore Lodge
COLIEMORE
HARBOUR
Lamb Island
Seapoint
Bellevue
Hoxboro
Rira
Rima
Clifton
DALKEY
SOUND
CASTLE
HARBOUR
BOAT
HARBOUR
Bathing Place
Scurvy Well
(Site of)
St. Begnet's Church
(In Ruins)
Dalkey Island
(Rathdown By)
Martello Tower
Battery
(Disused)
Rocking Stone
(Site of)
Sorrento Point
Muglins
(Rathdown By)
Pier
Dalkey Island
N
0 50 100 200
Meters

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Killiney Bay**
Other names used for site	Killiney section, Shanganagh Cliffs
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Killiney, Hackettsland, Shanganagh, Cork Little, Cork Great**
NEAREST TOWN/VILLAGE	**Killiney, Shankill (Dun Laoghaire-Rathdown) Bray (Wicklow)**
SIX INCH MAP NUMBER	**23, 26**
ITM CO-ORDINATES	**726080E 722465N (Corbawn Lane beach entrance)**
1:50,000 O.S. SHEET NUMBER	**50, 56 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
Along Killiney Bay, a 5km coastal section exposes a succession of several units of glacial till, separated in places by sand and gravel.

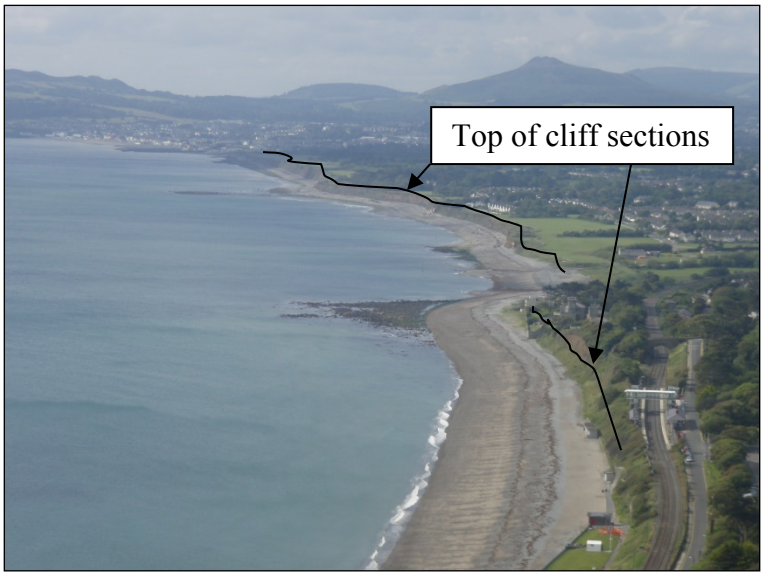
Geological System/Age and Primary Rock Type,
The till itself was deposited at the base of the last ice sheet to cover the area, during the late Quaternary Period, approximately 20,000 years ago. This till is deep in the locality but the sediments overlie slate and mica-schist bedrock of Ordovician age.

Main Geological or Geomorphological Interest
This sequence of sediments is one of the most renowned in Irish Quaternary literature and has been interpreted as 'glaciomarine' in origin (*i.e*. deposited under a floating ice sheet in the sea) by some academics. However, the general consensus is that the sediments are the product of a terrestrial ice sheet, interpreted as 'subglacial' tills deposited at the base of an ice sheet on land. Examining the sedimentology of the cliff shows that there are a number of till units stacked on top of each other. The tills include gravel beds, sand pockets and clay lenses, and are dominated by erratic limestone rocks. Large boulders of Leinster granite and limestone are also seen in the section and strewn across the beach. Small pebbles of a distinctive microgranite from Ailsa Craig in the Firth of Clyde can also be found.

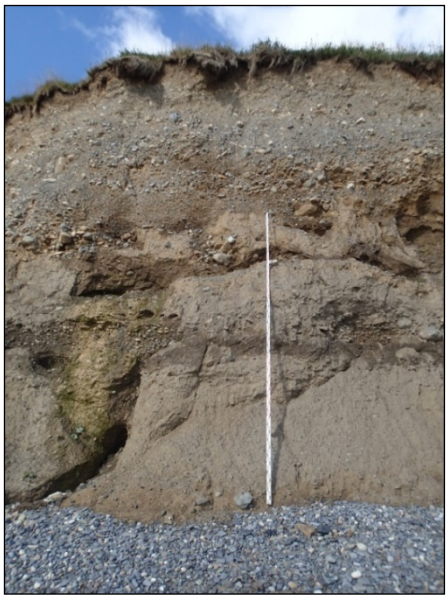
The southern portion of the section, between Bray and Shankill, hosts spectacular examples of clastic dykes, which are vertical beds of gravels set within consolidated, muddy till sediment, which result from expulsions of meltwater under a glacier. Micromorphological analysis of some of the sediment units at Killiney Bay has shown shear structures that can only have resulted from subglacial deposition.

Site Importance – County Geological Site; recommended for Geological NHA
This is a particularly impressive exposure of deep glacial tills, with several sedimentological characteristics well exposed. The site is effectively included within the existing proposed Dalkey Coastal Zone and Killiney Hill NHA.

Management/promotion issues
The site is accessible through public beach access and is therefore easily visited. The cliffs are prone to slumping, however, and care must be taken when close to the faces. The importance of the section could be highlighted in promotional material for the Dalkey Coastal Zone and Killiney Hill proposed NHA. Coastal erosion is a threat at Killiney Bay, as are the controlling measures such as erection of baffles and mesh-wire structures to stop recession of the cliffs. This now means many portions of the exposure at Killiney Bay are slumped, without the sea removing the slumped material, and the section is no longer continuously exposed. A commemorative plaque to Robert Mallet, the father of seismology, on a beach building is interesting, but could be supplemented by an explanatory signboard about his original experiments on Killiney Beach and on Dalkey Island.



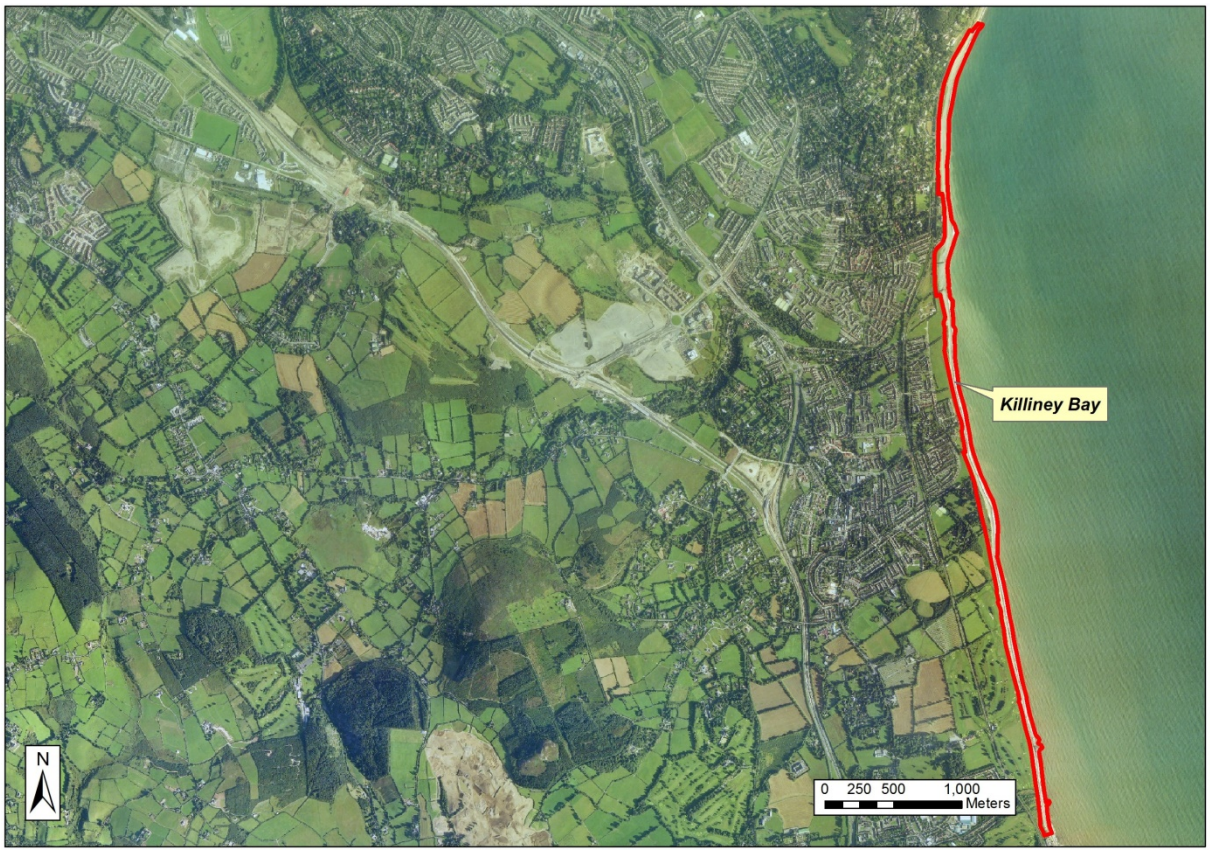
The section at Killiney Bay, looking south from the summit of Killiney Hill.



Left: Gravel beds resting on top of stiff, muddy glacial till sediment in the coastal section at Shanganagh Townland. Right: Looking south along the section from Corbawn Lane, with the huge recently installed 'rock armour' boulders set as coastal protection clearly seen.

Left: Looking north along the section towards Killiney Hill. Right: the plaque to Mallet on a building.


Killiney Bay
Killiney
Bay
Dalkey
Sorrento
Point
Killiney
Cill Iníon Léinín
Foxrock
Carraig an tSíomaigh
Cornelscourt
Cabinteely
Cabán tSíle
Carrickmines
Carraig Mhaighin
Ballybrack
An Baile Breac
Loughlinstown
Shankill
Seanchill
Rathmichael
Kingston
Ballycorus
Cherrywood
Cork Little
Willford
Ravenswell
Old
Connaught
Ballyman
Phrompstown
Killegar
BRAY
Bré
CHANNEL
Bhreatan
GEORGE'S
ST
20°
19


Killiney Bay
N
0 250 500 1,000
Meters

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**The Scalp**
Other names used for site	*An Scailp*, which means 'the chasm' or 'the cleft'
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Barnaslingan (Dun Laoghaire-Rathdown)** **Killegar (Wicklow)**
NEAREST TOWN/VILLAGE	**Kiltiernan (Dun Laoghaire-Rathdown)** **Enniskerry (Wicklow)**
SIX INCH MAP NUMBER	**26**
ITM CO-ORDINATES	**712552E 720214N (centre of channel)**
1:50,000 O.S. SHEET NUMBER	**50, 56 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
The Scalp comprises a deep channel that was formed by meltwater erosion on the southeastern flank of the Dublin Mountains. The channel is oriented generally north–south, and extends for a distance of approx. 700m.

Geological System/Age and Primary Rock Type,
The feature is formed in an area of bedrock outcrop and subcrop, and bedrock crops out along the majority of the channel sides, giving the feature its 'scalped' appearance. The feature was etched out by meltwater during deglaciation at the end of the last Ice Age, about 12,000 years ago.

The bedrock in the locality is dominated by granite, but the southernmost portion of the channel is etched into mica-schist.

Main Geological or Geomorphological Interest
The Scalp channel is up to 70m deep and has a U-shaped profile, typical of meltwater channels. The base of the channel is dry, although a drainage ditch has been dug along most of its length to channel excess surface water during heavy rainfall.

The Scalp is considered to have formed completely in the late-glacial Period. Initially the Scalp was a subglacial channel, formed under the ice, but later carried surface glacial outwash into Glacial Lake Enniskerry from an ice margin just to the north. The channel carried huge amounts of subglacial meltwater draining the ice sheet which covered the Irish Midlands close to its zone of convergence with Irish Sea Basin ice. This very high energy meltwater flow resulted in the Scalp's unusual depth and size.

Much of the sides of the channels are very steep, and littered with (often huge) boulders, some in quite precarious positions above the R117 road, which passes through the feature. This makes the site a popular mountain climbing destination. This also means many of the huge boulders have interesting names, such as 'Quartz Crag', 'Eugene's Pinnacle' and 'Rothery's Rocks'.

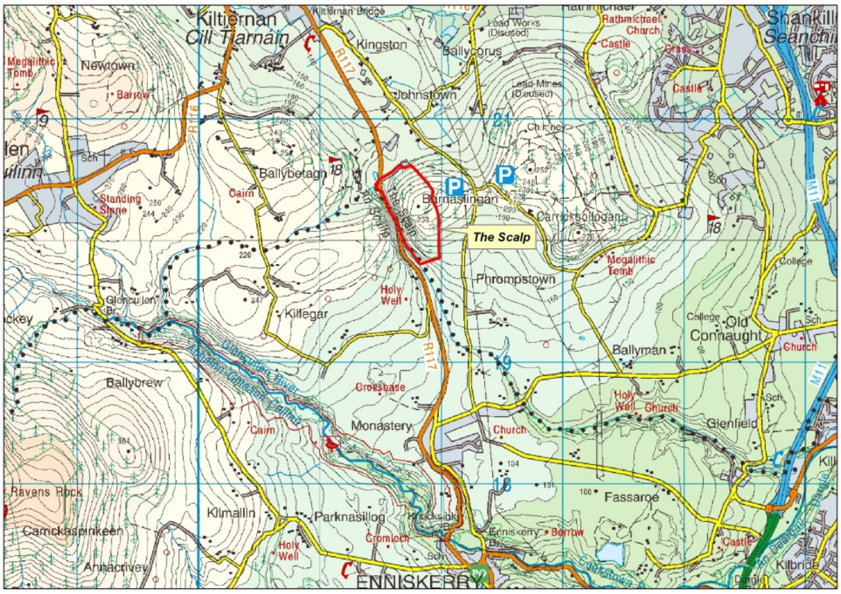
Site Importance – County Geological Site; may be recommended for Geological NHA
This is a site with good teaching potential on glacial meltwater erosion, as the feature is accessible, quite spectacular, and easily viewed from roads. The site is definitely of County Geological Site importance but may be considered to be of national importance.

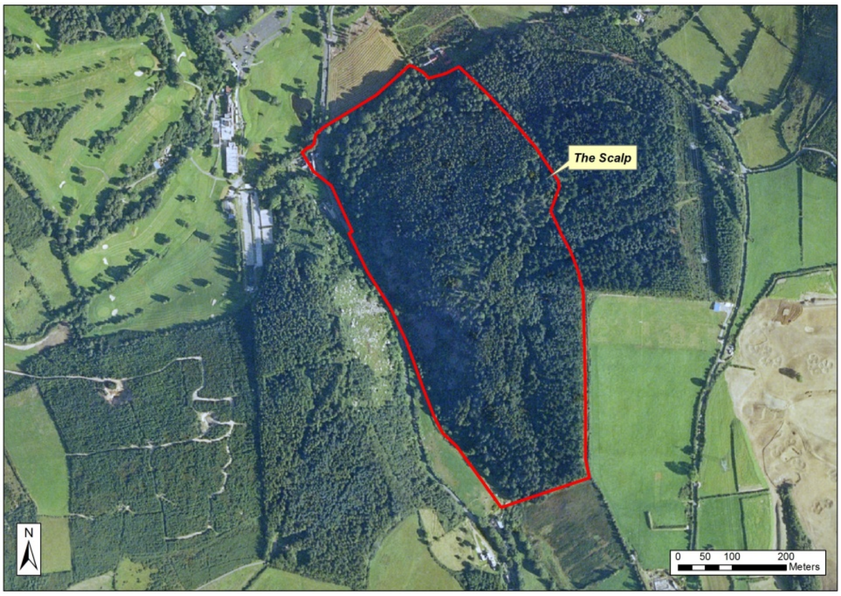
Management/promotion issues
The roadside location of the channel means it is easily accessible, although the flanks are located presumably in private ownership or in commonage. However, there is no parking nearby and it is difficult to stop safely on the road. A good impression of the feature can be had by driving through it on the R117 road, but the view from the Old Connaught to Enniskerry road, to the south, is better.

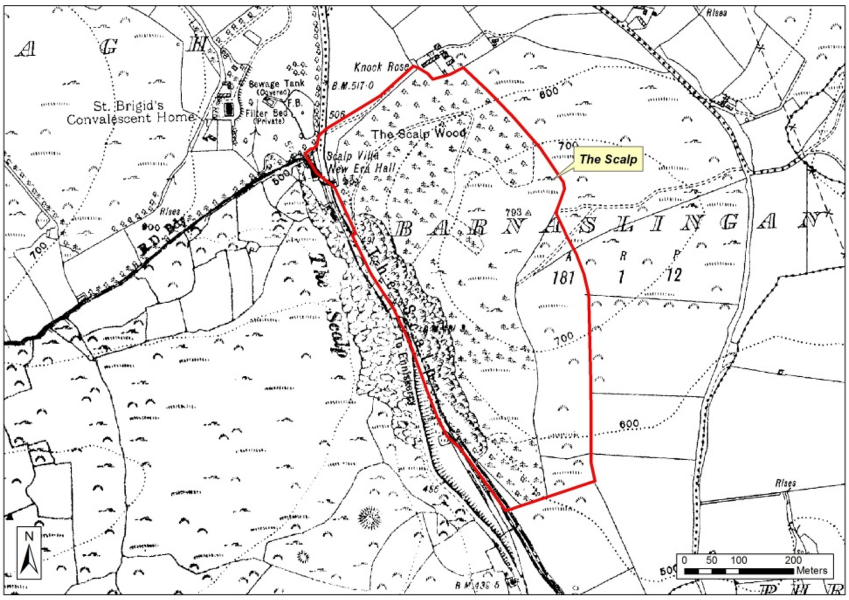
The Scalp, viewed from the south.

Left: Large boulders along the eastern flank of the Scalp.
Right: One of the huge boulders along the R117 road.

The Scalp, viewed from the north.


The Scalp
Kiltiernan
Cill Tiarnáin
Kingston
Ballycorus
Johnstown
Newtown
Barrow
Ballybetagh
Cairn
Standing Stone
Barnaslingan
Carrickgollogan
Phrompstown
Kilgefar
Holy Well
Ballyman
Old Connaught
Ballybrew
Crossbase
Monastery
Church
Glenfield
Fassaroe
Kilmalin
Parknasillog
Cromlech
Ravens Rock
Annacrivey
ENNISKERRY
Megalithic Tomb
Rathmichael Church
Castle
Shankill
College
R117
M11


The Scalp
N
0 50 100 200
Meters


The Scalp
Knock Rose
St. Brigid's
Convalescent Home
Sewage Tank
Filter Bed
The Scalp Wood
Scalp Villa
New Era Hall
B A R N A S L I N G A N
181
1
12
600
700
N
0 50 100 200
Meters

An old photograph of The Scalp from the late nineteenth century, which was used as a postcard from the locality (David Cotter Postcard Collection).

George Victor du Noyer's sketch of The Scalp, viewed from "near the Dargle".

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Three Rock Mountain**
Other names used for site	Two Rock Mountain, Fairy Castle
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	**Ticknock, Barnacullin, Ballyedmonduff, Ballybrack,**
NEAREST TOWN/VILLAGE	**Glencullen, Kiltiernan**
SIX INCH MAP NUMBER	**25, 26**
ITM CO-ORDINATES	**717750E 723300N (centre of feature)**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
A landmark mountain to the southwest of Dublin City, on which craggy stumps of granite stand proud of a mainly peat-covered granite mountain top.

Geological System/Age and Primary Rock Type
Devonian granite (porphyritic granite with large muscovite crystals ~80mm), severely weathered during Quaternary (Pleistocene) ice ages forming stumps/crags known as *tors*.

Main Geological or Geomorphological Interest
On the summit of Three Rock and Two Rock mountains, deeply etched and conspicuous crags of granite rock stand proud of the surrounding mainly peat covered mountain top. These protruding crags give the two mountains their names. From a distance, the rocky features resemble man-made structures. However, the granite outcrops are natural, formed by differential weathering of granite bedrock, and mass wasting and removal of the weathered material. Weathering along horizontal and near-vertical joints has created the characteristic granite *tor* shape, and these are the best examples in the Dublin and Wicklow Mountains. Studies of the tors of the Cairngorms (Scotland) conclude that the survival of tors with deeply etched surfaces and no, or limited, block removal requires a cover of largely non-erosive ice during each of the cold stages of the Pleistocene. Three Rock Mountain (488m) is capped by radio and television radio masts. The 536m high summit of Two Rock Mountain (Fairy Castle) is capped by a stone cairn and a Trig Point.

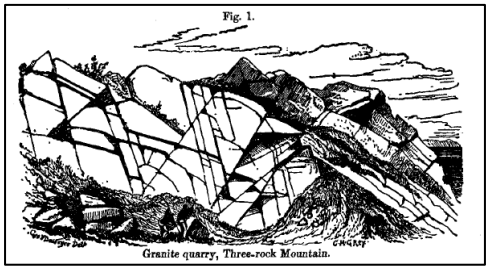


Illustration of granite outcrops on Three Rock Mountain (Figure 1, GSI Memoir Sheet 102/112, Page 28, 1875)

Site Importance - County Geological Site
This is an important County Geological Site, because the granite tors are landmark features and the best examples in the Dublin and Wicklow Mountains.

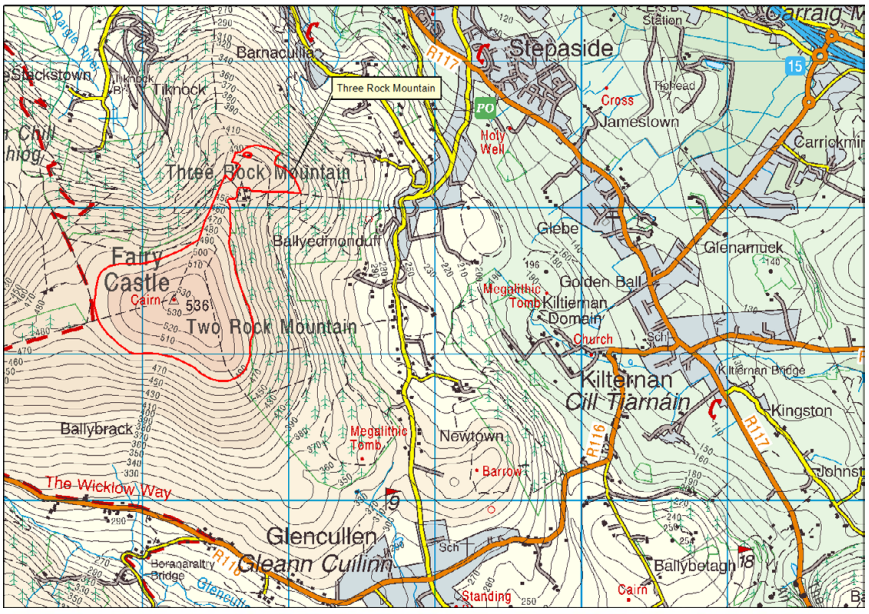
Management/promotion issues
Whilst the features are not under any immediate threat of damage, their sensitive situation in a popular hill-walking area demands attention. Littering and 'campfires' around the tors is an occurrence. Path development and improvement has been carried out using locally sourced granite sand and boulders. Coillte Outdoors and the Dublin Mountains Partnership have developed several looped walking routes on the site. Any future promotion of the site should relate the unique aspect of these features and their importance as features of Dublin's geological heritage.

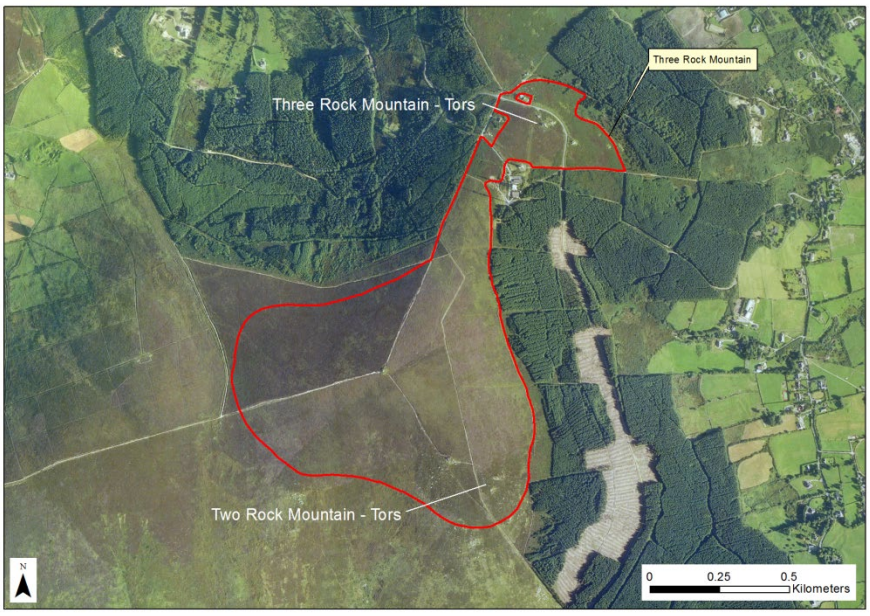
Granite tor on Three Rock Mountain looking south. In distant background: Bray Head (left); Little Sugar Loaf (right).

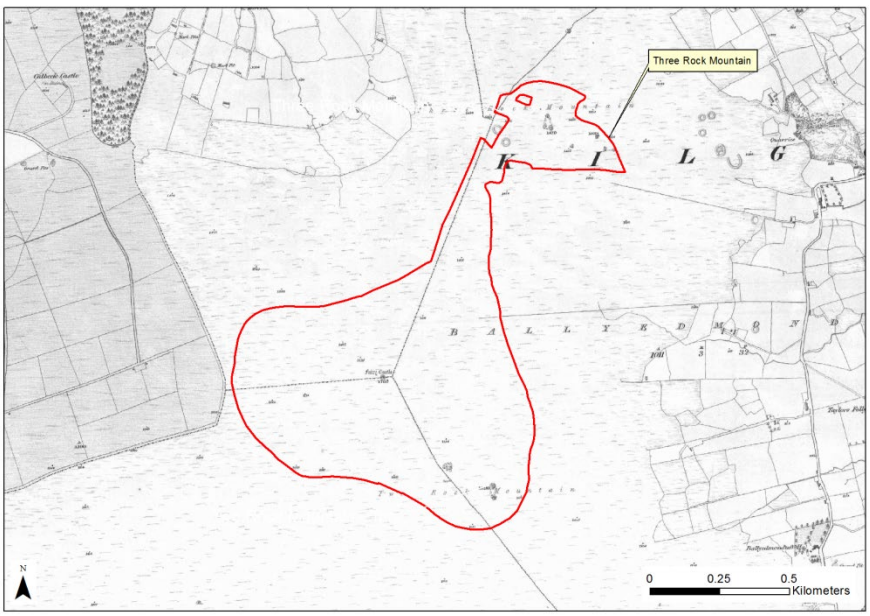
Two granite tors on Two Rock Mountain (near left and far right).

Stone cairn (archaeology) and Trig Point on Two Rock summit.

Horizontal joints on granite tor, Two Rock Mountain.


Three Rock Mountain
Three Rock Mountain
Two Rock Mountain
Fairy Castle
Cairn
536
Stepaside
Barnacullia
Tiknock
Jamestown
Carrickmines
Glebe
Ballyedmonduff
Golden Ball
Kiltiernan Domain
Church
Kiltiernan
Cill Tiarnáin
Kiltiernan Bridge
Kingston
Ballybrack
Megalithic Tomb
Newtown
Barrow
The Wicklow Way
Glencullen
Gleann Cuilinn
Bernanarilty Bridge
Ballybetagh
Cairn
Standing
Sch
PO
Holy Well
Cross
Thornhead
Station
R117
R116
15
18
19


Three Rock Mountain
Three Rock Mountain - Tors
Two Rock Mountain - Tors
N
0
0.25
0.5
Kilometers


Three Rock Mountain
K
I
L
G
N
0
0.25
0.5
Kilometers

DUN LAOGHAIRE - RATHDOWN –
COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Blackrock Breccia**
Other names used for site	
IGH THEME	**IGH 11 Igneous intrusions**
TOWNLAND(S)	**Intake**
NEAREST TOWN/VILLAGE	**Blackrock**
SIX INCH MAP NUMBER	**23**
ITM CO-ORDINATES	**721339E 729661N**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO: 16**

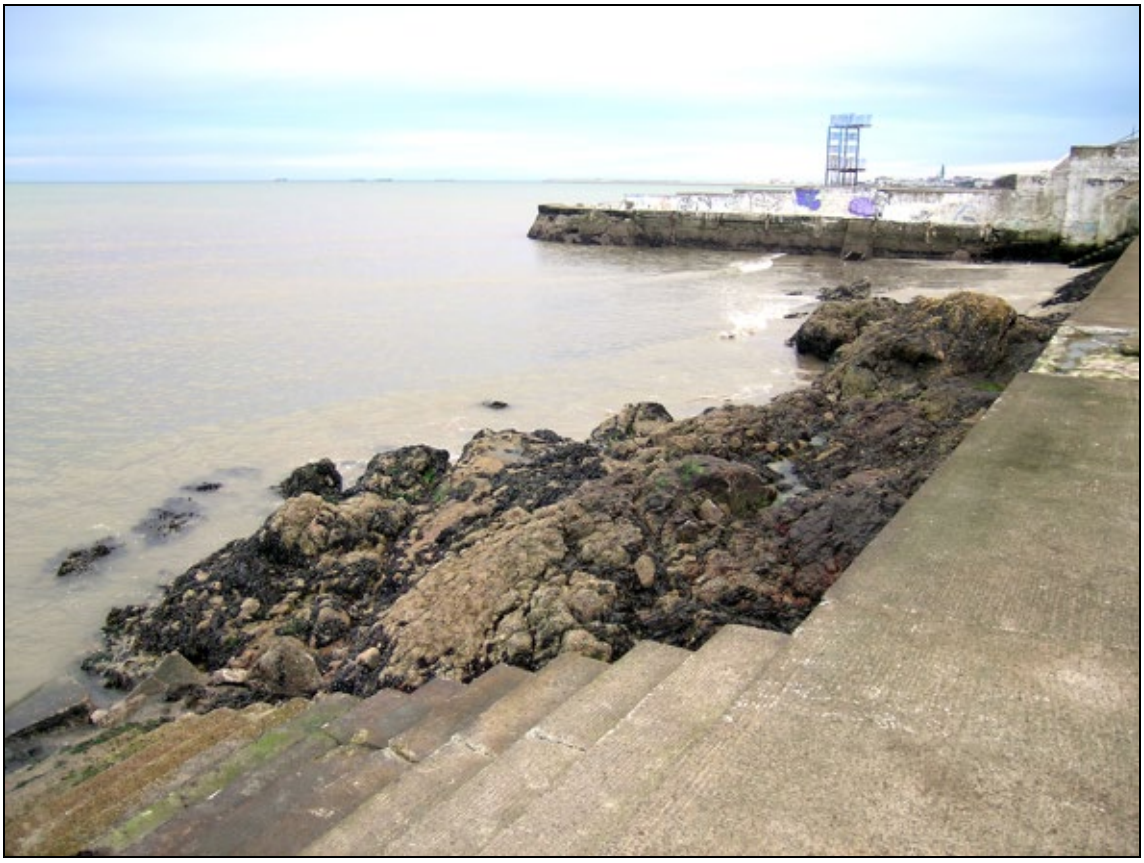
Outline Site Description
A small area of rocks exposed in the intertidal zone beside the coastal path, adjacent to Blackrock DART Station.

Geological System/Age and Primary Rock Type
The granite breccia is related to the intrusion of the Leinster Granite plutons in the Wicklow Mountains and the southern part of the Dublin area. It is probably of the same age of around 405 million years ago.

Main Geological or Geomorphological Interest
The small area (approximately 30m by 13m) of rock exposed in the intertidal zone is composed of a breccia – mostly angular fragments of granite set in a matrix of finely broken granite. No junction or boundary with another rock type is seen although exposures of granite are mapped to the south of the swimming baths beside the DART Station, and Carboniferous Limestone outcrops occur in the area. The rock is interpreted to be an explosion breccia – broken up by the upsurge of an explosive gas phase in the later stages of the intrusion of the granite.

Site Importance - County Geological Site; may be recommended for Geological NHA
As an unusual and relatively rare rock type, in Ireland at least, it merits CGS status, but may be considered for NHA designation when all sites in the Igneous intrusions theme are assessed together.

Management/promotion issues
The biggest risk to the site is the sea which is constantly attacking it. Eventual attrition will reduce the upstanding parts to a plane at low tide, but it may take some time. The benefit of the sea erosion is that it keeps surfaces polished and free of seaweed and barnacles so that the breccia is clearly visible.

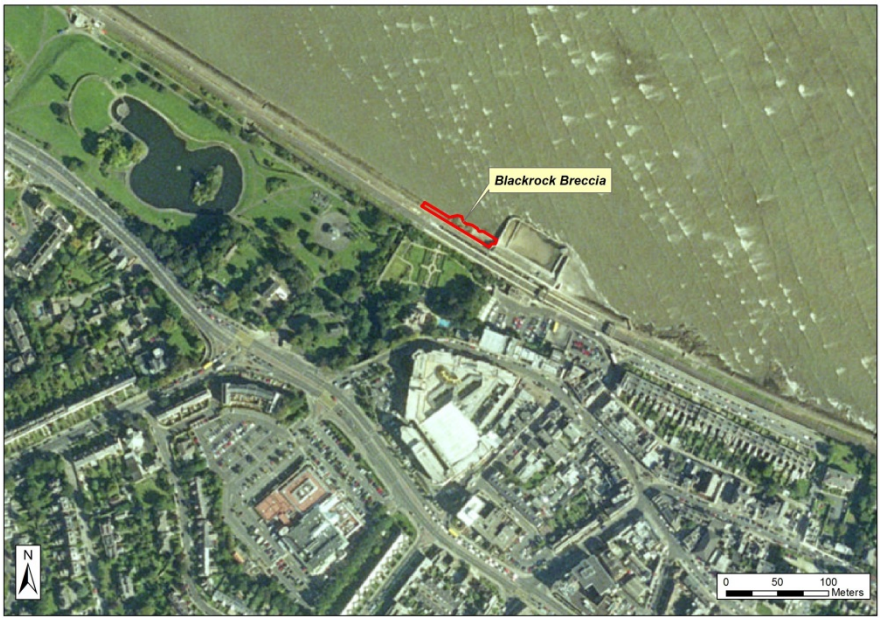


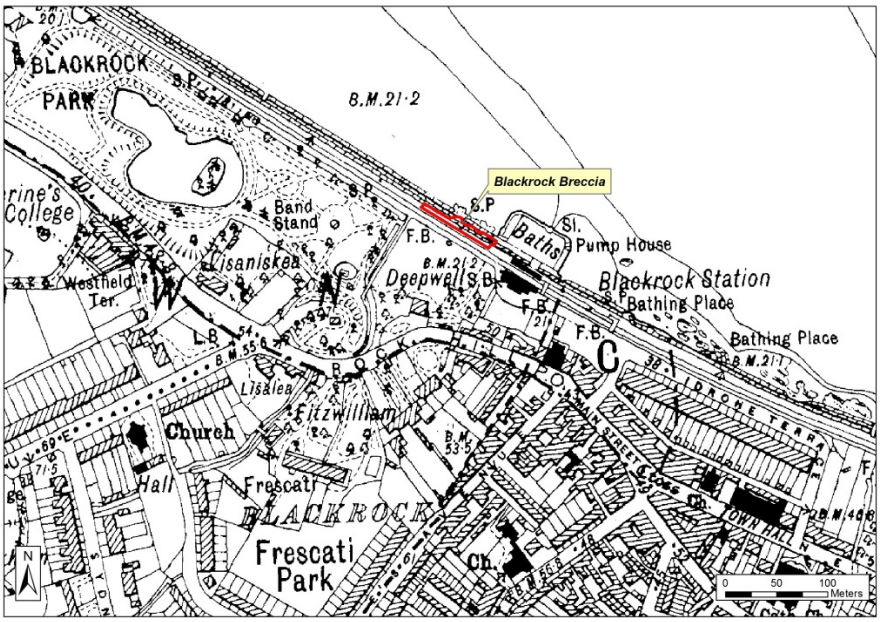
The Blackrock Breccia at low tide, with swimming baths in the background (2004).

The breccia close-up.

The Blackrock Breccia at high tide.


Merrion
Muirfin
3MP
Merrion Strand
21
22
23
30
Martello Tower
R118
Blackrock Breccia
4MP
Blackrock
An Charraig Dhubh
College
Sch
PO
N31
R113
R119
Monastery
Monkstown
Baile na Manach
Castle


Blackrock Breccia
N
0 50 100 Meters


BLACKROCK PARK
B.M.21·2
Blackrock Breccia
Band Stand
F.B.
Baths
Sl.
Pump House
Blackrock Station
Bathing Place
Deepwell S.B.
Westfield Ter.
Lisaniskea
Lisalea
Fitzwilliam
Church
Hall
Frescati
BLACKROCK
Frescati Park
Ch.
N
0 50 100 Meters

DUN LAOGHAIRE - RATHDOWN – COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Dalkey Hill**
Other names used for site	Dalkey Quarry
IGH THEME	**IGH 11 Igneous intrusions, IGH 15 Economic Geology**
TOWNLAND(S)	**Dalkey, Dalkey Commons**
NEAREST TOWN/VILLAGE	**Dalkey**
SIX INCH MAP NUMBER	**23**
ITM CO-ORDINATES	**726342E 726110N (centre of quarry)**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO: 16**

Outline Site Description
This is a large, disused granite quarry.

Geological System/Age and Primary Rock Type
The granite quarried here is part of the Northern Pluton of the Leinster Granite. It is approximately 405 million years old.

Main Geological or Geomorphological Interest
This large quarry is one of the best places to examine large faces and areas of the granite. The granite is part of the Northern Pluton (classified by geologists as Type 2p microcline phenocryst). This is the most northerly of three large plutons or batholiths that together comprise the Leinster Granite. It is approximately 405 million years old.

The granite was quarried in the early 1800's and the bulk of the rock went into local building use, but most notably for the construction of the major harbour piers of Dun Laoghaire. A railway system carried rock from the quarry down to the harbour on a route known today as the Metals, which while outside the quarry site, is an important component of the industrial heritage of this site. The ridge of rock dividing the lower floor of the quarry into two main sections was left as an inclined plane in order to carry rock on a series of truckways down the 4km or so to Dun Laoghaire harbour.

Small outcrops on the top of the hill behind the quarry walls are ice sculpted roches moutonnées.

Site Importance - County Geological Site
As a significant quarry in the history of Dublin, and the creation of the deep harbour of Dun Laoghaire (or Kingstown as it was called), it deserves the recognition of CGS.

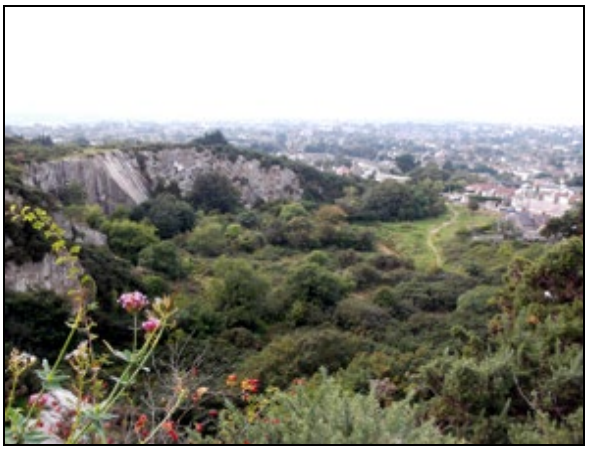
Management/promotion issues
The quarry and surrounding hill are largely open parkland managed by Dun Laoghaire-Rathdown County Council. There are some signboards at entrance points to the hill with interesting accounts of the quarrying and the Metals.

The quarry area is widely used by walkers and especially by rock climbers as it is possibly the best climbing venue in the country. The encroachment of gorse and other scrub vegetation on rock faces is a problem for access to some of the geology where faces are not regularly climbed.

An aerial photograph of the quarry, with two levels apparent and the central inclined ramp that supported the metals – the rails of a rail system for transporting rock to Dun Laoghaire.

A panorama view into the quarry from the top of the quarry. The inclined plane went down the central spur of rock visible in the centre.

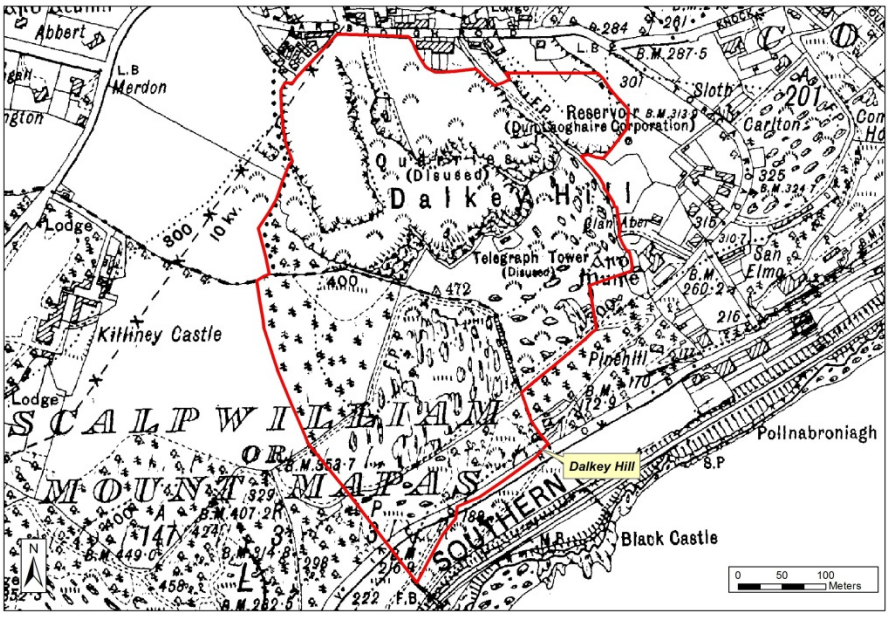
A view into the quarry from mid-level.



Looking into the quarry from the top.


Dalkey
Deilginis
PO
Maiden
Rock
Lamb
Island
Promontory
Fort
Church
Martello
Tower
Dalkey
Island
Oileá
Dheil
Dalkey Sound
Castle
Rail
Tunnel
Dalkey
Hill
R119
R118
Killiney
Cill Iníon Léinín
Sorrento
Point
9MP
Dalkey Hill
Obelisk
bogget
Martello
Tower
Church
10MP
Killiney
Bay


Dalkey Hill
N
0 50 100
Meters


Abbert
L.B
Merdon
Reservoir
(Dun Laoghaire Corporation)
Sloth
Carlton
Quarry
(Disused)
Dalkey Hill
Lodge
Telegraph Tower
(Disused)
San
Elmo
Killiney Castle
Lodge
SCALP WILLIAM
OR
MOUNT MAPAS
SOUTHERN
Pollnabroniagh
Dalkey Hill
Black Castle
N
0 50 100
Meters

DUN LAOGHAIRE - RATHDOWN –
COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Murphystone Quarry**
Other names used for site	Blue Light Quarry, Barnacullia Quarry
IGH THEME	**IGH 15 Economic Geology**
TOWNLAND(S)	**Barnacullia**
NEAREST TOWN/VILLAGE	**Stepaside**
SIX INCH MAP NUMBER	**25**
ITM CO-ORDINATES	**717862E 724235N (centre of quarry)**
1:50,000 O.S. SHEET NUMBER	**50 GSI BEDROCK 1:100,000 SHEET NO: 16**

Outline Site Description
A working granite quarry.

Geological System/Age and Primary Rock Type
The quarry is extracting granite from the northernmost of three plutons of the Leinster Granite. It was intruded approximately 405 million years ago.

Main Geological or Geomorphological Interest
There is a very long tradition of granite quarrying in the Barnacullia Townland, although other quarries have closed down and become abandoned and flooded. Murphystone is an active business supplying Dublin granite for multiple purposes. The granite is part of the Northern Pluton (classified by geologists as Type 3 muscovite porphyritic). It has large crystals of the mica mineral muscovite set in a equigranular matrix. This is the most northerly of three large plutons or batholiths that together comprise the Leinster Granite. It is approximately 405 million years old.

Site Importance - County Geological Site
As a well-managed active quarry it is a good example of the long tradition of quarrying in the area.

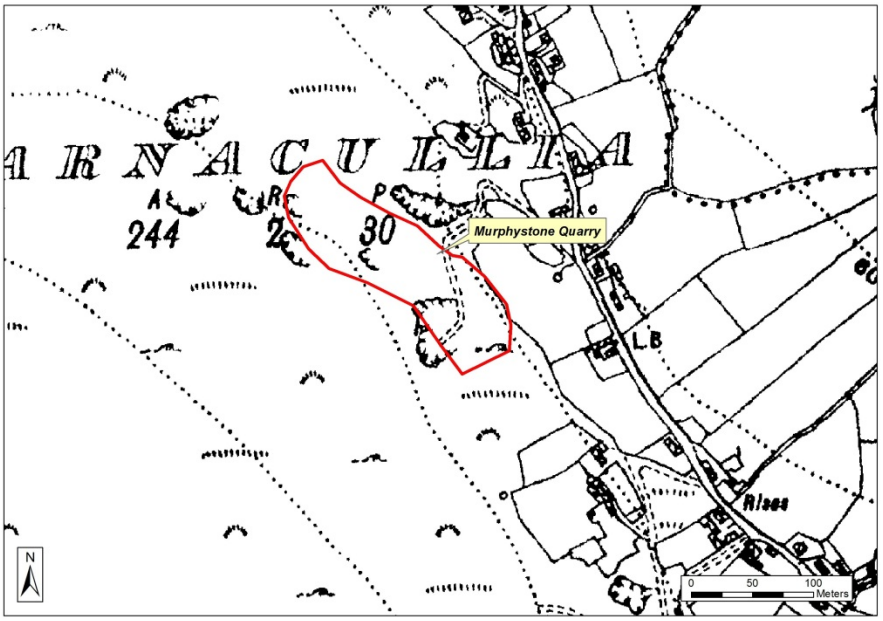
Management/promotion issues
As a working quarry, it is unsuitable for visits, but the management have an interest in the heritage and tradition of stone quarrying and stone working.

From the top of Murphystone granite quarry looking south east towards the workshop.

Murphystone granite quarry from the entrance.


Sandyford
Ath an Chaoimh
13
R117
Leopardstown
Hospital
Race Course
Castle
Sch
Newtown Little
Church & Cross
Kilgobbin
Castle
Ballyogan
S.B.C. Station
Murphystone Quarry
Barnacullia
Stepaside
An Chéim
Tiknock
PO
Cross
Jamestown
Holy


Murphystone Quarry
N
0 50 100 Meters


Murphystone Quarry
244
30
LB
N
0 50 100 Meters