



South Wales RIGS Group Site Record

RIGS Description

SECTION A

General	South Wales
Site Name: Cefn Rhigos Drumlins	File Number: AH_73
RIGS Number: 784	Surveyed by: A Humpage
Grid Reference: SN 291460 206460	Date of Visit: October 2011
RIGS Category: Scientific, educational	Date Registered:
Earth Science Category: Geomorphological	
Site Nature: Mid elevation surface	Documentation prepared by: AJH
Unitary Authority: Rhondda Cynon Taff	Documentation last revised: 19 March 2012
OS 1:50,000 Sheet 160	Photographic Record: See images attached to this report
OS 1:25,000 Explorer Sheet 166	
BGS 1:50,000 Sheet 231 Merthyr Tydfil	
<p>RIGS Statement of Interest:</p> <p>An area approximately 2.5 km by 2km centred on Cefn Rhigos village has low relief elongate mounds with linear valley mires between them. This area is interpreted as a small scale drumlin field and complements the Hirwaun Drumlin SSSI 3km to the east. The identification of this area as drumlins indicates that the zone of drumlin formation in this area along the north crop of the South Wales coalfield may be larger than previously identified.</p> <p>At least five elongate streamlined drumlin ridges can be identified rising 5-10 metres above intervening valleys. The drumlins appear to be the classic “half-buried egg” shape in form with the more rounded end towards the east. This is the “upstream” end of the drumlin indicating ice movement from east to west towards the Neath valley. Some of the drumlin forms may be bedrock cored, whilst others may be within Till.</p> <p>The drumlin field may have been more extensive, extending southwards and eastwards, but coal mining and other industrial activity has resulted in significant modification of the landscape.</p>	

Geological setting/context:

Drumlins are oval-shaped hills, largely composed of glacial drift (till), formed beneath a glacier or ice sheet and aligned in the direction of ice flow. There are no strict definitions relating to their size but they tend to be up to a few kilometres long and up to 50 m in relief. They are widespread in formerly glaciated areas and are especially numerous in Canada, Ireland, Sweden and Finland. Drumlins are considered to be part of a family of related landforms including FLUTES, MEGA-SCALE GLACIAL LINEATIONS, and ROGEN MORAINE which are collectively referred to as SUBGLACIAL BEDFORMS. Their formation remains controversial (see below) but in spite of this they are extremely useful for reconstructing former ice sheets. The word drumlin is a derivation of a Gaelic word for a rounded hill.

Whilst there are many variations in shape, the 'classic' drumlin is a smooth, streamlined hill that resembles an egg half buried along its long-axis. They tend to exist as fields or swarms of landforms rather than as isolated individuals, with a typical swarm comprising tens to thousands of drumlins. Viewed en masse, drumlins within a swarm display a similar long-axis orientation and morphology to their neighbours, and are closely packed, usually within two to three times the dimensions of their drumlin length. The majority of drumlins in a swarm have their highest elevation and blunter end pointing in an upstream direction, with the more gently sloping and pointed end, or tail, facing down-ice. The upstream blunt end is called the stoss end and the downstream end called the lee. A common measure of their shape is the elongation ratio, which is the maximum drumlin length divided by maximum width. Typical elongation ratios are 2:1 to 7:1. Variations in drumlin shape include spindle-like forms, two-tailed forms resembling barchan dunes in plan view, and they also exist as perfect circular hills with an elongation ratio of 1:1. There is a whole branch of investigation, called drumlin morphometry, which uses measures of shape, size and spacing to try and develop or test theories for their formation.

The timing or synchronicity of drumlin formation within a field remains unknown. Some researchers deem drumlin formation as occurring close to ice margins and believe fields are built up incrementally as the margin retreats, whereas others believe that extensive patterns of drumlins may have formed approximately synchronously under wide swathes of an ice sheet. Drumlin patterns have been found to lie cross-cutting each other with some superimposed upon others. This demonstrates that older landforms can be persevered beneath ice flow and that more than one flow direction is recorded

The internal composition of drumlins reveals a perplexing array of different sediment types and structures. Some have rock cores surrounded by a concentric sheath of till, but they are mostly filled with unconsolidated sediments that are poorly sorted, and may contain silts, sands, gravel and boulders. They may however also be found with fluviially-sorted sediments at their core or in a lee-side position. Some interpret this as demonstrating that fluvial deposition was part of the drumlin formation process but others favour a two-stage process of fluviially-deposited material which was later shaped into a drumlin. Tectonic structures such as thrusts and folds have also been found and have been taken to imply the sediments have been deformed during the drumlinisation process.

Due to the inaccessibility of glacier beds nobody has been able to observe a drumlin actively forming and so it is perhaps no surprise that their formation remains something of a mystery. Part of the difficulty is that a good theory must be capable of explaining the full range of observed drumlins and other subglacial bedforms and their wide variation in shapes, scales and internal composition. There have been many hypotheses and theories that attempt to explain their formation. Menzies (1979) and Patterson and Hooke (1995) provide good overviews of the 'drumlin problem'. Put simply, drumlins may have formed by a successive build of sediment to create the hill (i.e. deposition or accretion) or pre-existing sediments may have been depleted in places leaving residual hills (i.e. erosion), or possibly a process that blurs these distinctions. Hypotheses have been proposed for all these cases but most common have been those involving some form of sediment accretion. These however, have difficulty explaining drumlins with cores of pre-existing fluvially-sorted sediments.

Observations of the nature of the bed of contemporary ice sheets have revealed that the forward motion of ice, can in part, be accomplished by deformation of the soft sedimentary bed. This has led to the deforming bed model of glacier flow, which has become the most widely accepted, but still unproven, mechanism for drumlin formation. If the sediments of the bed are weak they may deform as a result of the shear stress imparted by the overlying ice. If parts of this deforming till layer vary in relative strength, then the stronger stiffer portions will deform less and remain static, whilst the intervening weaker portions will deform more readily and become mobile. The relative strength is thought to be controlled by grain size, with coarse grained sediments (e.g. gravels) remaining strong as they do not allow a build up of pore water pressures, and fine grained sediments as easily deformable. So a till layer with spatially variable strength will have static or slow moving strong patches, around which the weaker more deformable till will flow. This can explain the cores of drumlins (strong patches; rock-cored, coarse-grained or with preserved fluvially-sorted sediments) surrounded by more easily deformed till which is responsible for the streamlining. It also explains the occurrence of folds and thrusts commonly observed in drumlins. In this deforming bed model of drumlin formation (Boulton, 1987) the position of each drumlin is controlled by sediment inhomogenities and the streamlined shape by deformation. As deformation continues, drumlins may be uprooted and become mobile.

An alternative to the above, is a model developed by Shaw, et. al. (1989) and colleagues that views drumlins and other subglacial bedforms to be the result of meltwater erosion and deposition as a consequence of large floods beneath the ice. In this meltwater model, regional scale outburst floods from the central regions of the ice sheet produce sheet flows of water, tens to hundreds of kilometres wide and deep enough to separate the ice from its bed. Turbulent water during the floodstage erodes giant drumlin-shaped scours in the base of the ice, which are then infilled with sediment as the flood wanes and as the ice presses down onto its bed. This is the cavity-fill drumlin and explains how fluvially-derived sediments may appear in drumlins. A related mechanism is also thought to operate whereby vortices in the flood water erode down into the till bed leaving intervening ridges of the original material, which are the second type of meltwater drumlins. These could therefore contain tills or almost any material, as the composition is unrelated to shaping event.

The difficulty in evaluating these theories arises from the fact that the deforming bed and meltwater models are each so comprehensive as to be able to predict the wide variety of observed drumlin characteristics. This makes it hard to use geomorphological observations to test between them. Also, both are still at the stage of qualitative theories rather than physically-based models. Deforming beds have been observed to exist and so have subglacial floods, the question remains as to which are capable of producing drumlin forms and over the widespread patterns for which they are observed. The answers must surely lie in numerical modelling to examine plausible mechanisms tested against large-scale drumlin patterns and internal structures.



Example of a typical classical drumlin form (not from RIGS site)

References:

Benn, D.I., and Evans, D.J.A. (1998). *Glaciers and Glaciation*. London: Arnold.

Boulton, G.S. (1987). A theory of drumlin formation by subglacial sediment deformation. In Menzies, J. and Rose, J. (eds), *Drumlin Symposium*. Balkema, Rotterdam, 25-80.

Clark, C.D., Hughes, A.L.C., Greenwood, S.L., Spagnolo, M., & Ng, F.S.L. (2009). Size and shape characteristics of drumlins, derived from a large sample, and associated scaling laws. *Quaternary Science Reviews.*, **28**, 677-692.

Menzies, J. (1979). A review of the literature on the formation and location of drumlins. *Earth Science Reviews*, **14**, 315-359.

Patterson, C.J. and Hooke, R. LeB. (1995). Physical environment of drumlin formation. *Journal of Glaciology*. **41**, 137, 30-38.

Shaw, J., Kvill, D. and Rains, B. (1989). Drumlins and catastrophic subglacial floods. *Sedimentary Geology*, **62**, 177-202.

SECTION B

PRACTICAL CONSIDERATIONS:

Please score Accessibility and Safety Red Amber or Green

Accessibility:



Comment: The site is accessible along the minor roads around Cefn Rhigos and there are a limited number of public rights of way.

Safety:



Comment: The site is mainly on agricultural land. Some boggy areas will be present

Conservation status:

The site is partially designated as Nant Fforch SINC within the Rhondda Cynon Taff LDP, otherwise there are no other known designations on this site.

OWNERSHIP/PLANNING CONTROL:

Owner/tenant: Unknown/ various

Planning Authority: Rhondda Cynon Taff

Planning status/constraints/opportunities:

There are no known planning constraints or opportunities

CONDITION, USE & MANAGEMENT:

Present use: Mainly agricultural grazing land.

Site condition: The site is predominantly grazing land divided into fields and is generally good.

Potential threats: Enlargement of Cefn Rhigos village or other developments may damage the drumlin forms. Extension northwards of any open cast mining activity will result in loss of the RIGS.

Site Management: Maintain current management practices.

SITE DEVELOPMENT:

Potential use (general): This site is of some interest to the general public, but it probably does not warrant any on-site interpretation initiative. Its importance lies in its possible origin with its significance (together with Hirwaun Drumlins SSSI) of ice movement dynamics in this area. It is of particular interest to Quaternary scientists and geomorphologists at the national level.

Potential use (educational): An accessible site that exhibits the form of drumlins. It may also be useful to study for the biological habitats in the wet areas between the drumlin forms.

Other comments:

Photographic Record

Insert photographs. Use separate sheet if required



Valley between drumlin forms (drumlin to right). View looking west just south of Cefn Rhigos village.