
Mynydd Llangynidr

[SO12 14]–[SO15 15]

Highlights

Mynydd Llangynidr contains the finest array of collapse dolines and subsidence basins seen anywhere in Britain, and clearly demonstrates the surface geomorphic effects of interstratal karst.

Introduction

Mynydd Llangynidr is located on the summit of an escarpment overlooking the Usk Valley on the northern edge of the South Wales coalfield syncline. The escarpment is formed by the Carboniferous Limestone, but is capped by Namurian Basal Grit, and the moorland of the dip slope is pocked by a spectacular suite of collapse dolines and subsidence basins. These form a packed doline field 2 km wide near the crest of the escarpment, which is fringed by foundered masses of the Grit lying on the limestone of the scarp face (Figure 6.13). The site clearly demonstrates how subsurface, interstratal karst solution can induce collapse and therefore produce dolines and subsidence basins in the non-carbonate outcrop.

Thomas was the first to describe the geomorphic effects of the interstratal karst on the limestone and sandstone outcrops all along the northern rim of the South Wales coalfield (Thomas, 1954, 1963, 1973, 1974). The link between surface collapses and underlying cave systems was examined by Bull (1977) in the adjacent Mynydd Llangattwg, while Battiau-Queney (1980, 1986) recognized a buried palaeokarst exposed in quarries 4 km west of Llangynidr, and Smart and Christopher (1989) attribute some examples of large masses of foundered Millstone Grit to faulting.

Description

Mynydd Llangynidr is a bleak moorland rising to 550 m. To the north it is bounded by a steep scarp face overlooking the Usk Valley, and to the south an extensive dip slope extends towards Tredegar and the South Wales coalfield. Dinantian limestones, about 120 m thick and dipping 2–5° SSE, form the main escarpment. The dip slope is capped by the Basal Grit, a strong, coarse-grained sandstone forming the lowest unit of the Namurian Millstone Grit Series; the thickness of the Grit cover progressively increases from the escarpment edge to about 30 m where it gains a cover of Namurian shales.

The dip slope has a spectacular assemblage of dolines. Over 500 dolines are concentrated in an area of less than 10 km² (Figure 6.13). The largest of the dolines is 55 m wide and 17 m deep; an average diameter of 29 m (Thomas, 1974) is significantly greater than that of typical solutional dolines formed in limestone. Most have a roughly symmetrical, inverted conical cross-section. Thomas (1954) investigated 437 collapse dolines, across the whole of the South Wales interstratal karst belt, and found that nearly 75% of them have a depth:diameter ratio of 1:3. The remainder include both steep-sided, rocky dolines, and also broad and shallow depressions with saucer profiles. The doline sides have an average slope of about 30° on a veneer of Grit blocks and solifluction deposits; exposed rock walls form only part of the perimeters of about 30% of the dolines. The steeper funnel-like dolines dominate the Llangynidr interstratal karst, but there are also seven much larger subsidence basins. These are oval shaped, mostly no more than 5 m deep, and are up to 150 m across. One basin contains the lake of Garn Fawr, and the others have sediment floors pitted with smaller dolines. The northern edge of the escarpment, overlooking the Claisfer Valley, has an area of more than 12 ha of foundered Basal Grit on the edge of the limestone outcrop. Beyond this, collapsed and soliflucted Grit debris overlies the limestone in a zone about 200 m wide which is almost continuous along the edge of the solid outcrop of the limestone.

There are two small caves on Mynydd Llangynidr (Figure 6.13). Ogof Cynnes is a cave with 900 m of rift passages formed in the top beds of the limestone beneath the Grit cover. The entrance passage has a roof of Basal Grit, and the complex of narrow rifts are plastered with mud and blocked by Grit boulder chokes; there are no large collapse chambers

in the cave. The cave passes beneath the floor of the entrance doline, and the passages end in chokes almost beneath adjacent dolines in the Grit (Glover, 1993). Ogof Fawr (Chartist Cave) is another small cave close to the upper boundary of the limestone; it also has a Grit roof at its entrance, and leads to rift passages and three spacious collapse chambers, which have no surface expression. Over 5 km of cave passages in Carno Adit Cave lie in the Dowlais Limestone, at a depth of about 100 m beneath the eastern edge of Llangynidr (Figure 6.13); they appear to be the downdip continuations of influent caves including Ogof Cynnes, but are only accessible from the drainage adit and are not directly related to the surface features (Gascoine, 1991; Bailey, 1992; Rogers, 1992).

Some of the dolines within the Basal Grit have small streams sinking within them, but the main surface drainage is to the south. Water also sinks at the Grit/limestone boundary, and underground drainage resurges at both Ffynnon Shon Sheffrey, in the Trefil valley (Figure 6.13), and Ffynnon Gisfaen in the Clydach Gorge, 6 km to the southeast (Gascoine, 1989).

Interpretation

The doline fields seen on Mynydd Llangynidr are interstratal karst landforms, where subsurface solution has induced deformation and collapse of the overlying cover rocks (Thomas, 1974). Interstratal karst occurs along much of the adjacent Lower Carboniferous outcrop, but is particularly well developed on Mynydd Llangynidr, where the dip slope gradient is very close to the regional dip, so that the cover of Basal Grit remains thin across a broad belt.

Where the Basal Grit is thinnest, along the northern margin of the interstratal karst belt, solutional erosion is at a maximum; groundwater recharge occurs through the thin and broken cover, and the high hydraulic gradient near the scarp crest maintains underground flow. In this zone of thin cover, solutional cavitation of the limestone causes collapse of the Grit which is transmitted directly to the surface, resulting in formation of the steep-sided collapse dolines (Figure 6.14). Processes in this zone are comparable to those observed in shafts beneath the Grit close to the Mellte Valley (Burke and Bird, 1966; Burke, 1967).

Further down the dip slope, the Grit cover is thicker, and lower fracture permeability at depth reduces the solutional activity. Collapses into solutional cavities within the limestone of this zone is generally confined to the lower beds in the Grit sequence. Repeated collapse expresses itself on the surface as a shallow basin caused by sagging of the uppermost beds (Figure 6.14). Thomas (1954) estimated that in one block covering 6 ha, the total volume of the dolines was 180 000 m³, equivalent to solutional removal of a continuous bed of limestone 3 m thick. Battiau-Queney (1980) suggested that the widespread rotting of the Basal Grit resulted from the solution of the silica under a deep regolith cover in the warmer climates of the Tertiary, and limestone solution only followed when uplift allowed circulation through the rotted zones; though the history of the solutional activity may remain open to debate, the dolines are clearly the result of cavity development within the limestone. The maze of rift passages in the top limestone beds in Ogof Cynnes, and the collapse chambers in Ogof Fawr, indicate the style of cavity development which ultimately will cause undermining and collapse of the Grit cover. Neither of these has developed to the point where collapse of the cover rocks can be seen underground as clearly as in Siambre Ddu (see below).

Along the northern edge of the escarpment, the limestone has undergone solutional erosion, and the Grit forms only a minor escarpment. There have been several phases of subsidence and collapse of the overlying Grit, which in places is so distorted that little of the original structure remains; these areas have been mapped as 'foundered Basal Grit' (Figure 6.14). However, some of these grit outliers, outside the Llangynidr karst, may be due to faulting, rather than solutional subsidence (Christopher and Smart, 1989). The age of the initial karstification may be estimated from measured solution rates and the extent of solutional lowering of the foundered Grit masses; maximum lowering has occurred outside the Llangynidr area and have implied ages of 10–15 Ma (Thomas, 1963), but these figures take no account of acidic waters from pyrite oxidation, climatic change and focusing of the drainage as the depressions evolve.

On Mynydd Llangynidr, the pattern of collapse dolines may reflect the form of the irregular unconformable interface between the Basal Grit and the underlying limestone (Thomas, 1974). Solutional activity may have been concentrated to produce major caverns along the bases of depression within the plane of unconformity; many caves, including Ogof Cynnes, are developed at the unconformity. There is no clear relationship between the collapse dolines of Llangynidr and

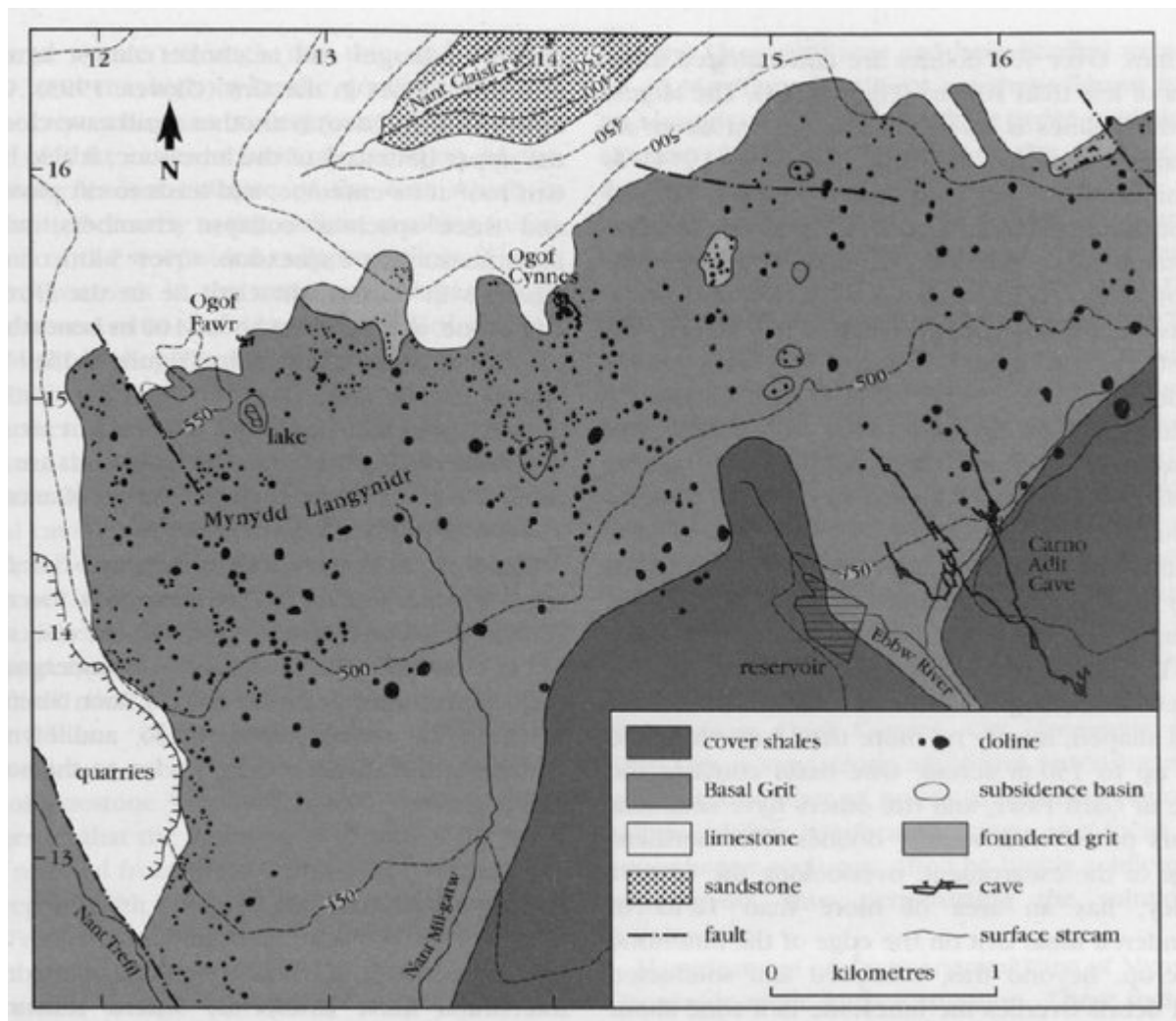
collapse features directly underground in the few known cave systems. On the adjacent Llangattwg plateau, direct links can be traced between the surface collapses and boulder chokes in Ogof Agen Allwedd (Bull, 1977), but similar links are absent from Ogof Cynnes. On Llangynidr, the Basal Grit is very strong and forms extensive roof spans at a number of points in this cave. Once a collapse doline has formed, it acts as a focus for groundwater recharge, often by highly acidic peat bog run-off, thus perpetuating the solutional development.

Many features of the interstratal karst of Mynydd Llangynidr merit further attention. These include the effect of river rejuvenation and lowering water tables (Crowther, 1989), and examination of the nature, extent and age of some of the subsidence features, especially the foundered Grit masses north of the main outcrop.

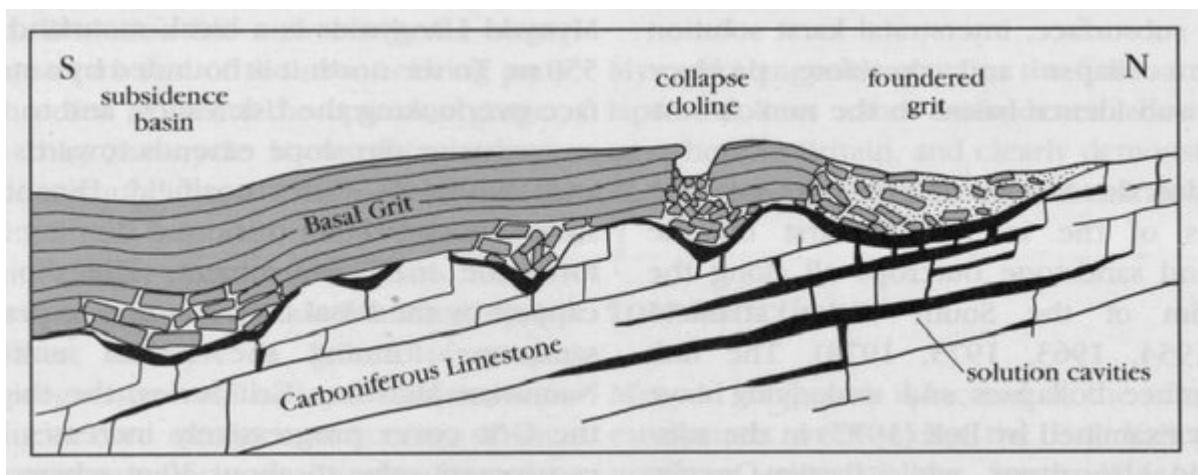
Conclusions

Mynydd Llangynidr is Britain's finest example of interstratal karst. Doline fields within the grit outcrops are a special feature of the karst on the gently dipping escarpments of South Wales, and Llangynidr has the densest, largest and most spectacular assemblage of dolines. Collapse dolines, broad shallow subsidence basins and large masses of foundered grit all occur within a small area.

References



(Figure 6.13) Geological map of the doline field on Mynydd Llangynidr (partly after Thomas, 1974: Ogof Carno from survey by Brynmawr Caving Club). The cover rocks are Namurian shales above the Basal Grit and Coal Measures. The sandstone beneath the limestone is Devonian. Much of the limestone outcrop is covered by soliflucted Grit blocks.



(Figure 6.14) Diagrammatic cross-section through the three types of surface depression formed in the Basal Grit due to solution of the limestone beneath (after Thomas, 1974).