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THE BALLINY DEPRESSION, Co. CLARE, IRELAND

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O.S. 1 : 10560, Clare Sheet 4 Td. Knockaunsmountain

ABSTRACT

The Balliny closed depression is formed along a N-S line of weakness and lies within an extensive limestone plateau on the north-west side of Slieve Elva. Prior to the last glacial advance the area had a thin shale covering and the depression served as the major sink for the region. During late glacial times the shales were removed and the sink became choked with sediments. The depression became a seasonal lake and overflowed directly to the sea.

The post-glacial cave Pollballiny has, in the lower part of its course, been captured by an older cave passage associated with this depression. The terminal choke of Pollballiny, whose position has been confirmed by radio-location, lies on the same N-S line of weakness as the depression. It is likely that the further parts of the cave turn north along this line before heading west to the sea.

INTRODUCTION

The Balliny closed depression has often been discussed in U.B.S.S. publications (Banfield and Ineson 1958, Collingridge 1969, Cassely 1977). The most recent of these gives a map showing its relations with the end of Pollballiny. The map is inaccurate and the depression seemed of such interest that one of the authors (O.C.L.) did a fresh surface survey and, with the help of an aerial photograph, has redrawn it (Fig. 30).

DESCRIPTION

The depression is situated mainly in the townland of Knockaunsmountain, lying north-east of that mountain and 1 km west of Slieve Elva. The surrounding area comprises a limestone plateau just north of the col between these two mountains. The floor of the depression is fairly flat and lies 10m below the level of the plateau. As a result one does not see the depression, when approaching it, until one is nearly there. The rocky walls facing the centre are sometimes steep and sometimes broken by four or five steps (Plates 6 and 7). There are no surface streams, since all the water from Slieve Elva and Knockauns sinks at the shale-limestone boundary, several hundred metres away. The one exception is the resurgence for Hawthorn Cave, which rises within the depression at B1d and sinks again within 30m to recontinue its underground course to Pollballiny.

The main part of the Balliny Depression, the western limb, is nearly 1 km long and runs in an almost straight course along the direction of the major jointing (198°) from the ruined fortress Liscoonera in the north nearly to the road in the south. The much shorter eastern limb, which contains the resurgence B1d, is aligned in a similar direction (190°). The

two limbs are joined near their southern ends to give the depression the form of a distorted letter H. These N-S lines of weakness show no appreciable displacement of the rocks on each side, though this is not easy to assess, so are best described as major joints.

The long westerly limb of the H is the more important and contains a number of wet depressions. South of the wall which runs east from Caher Beg there is a rushy marshy area and two dry swallets in a straight line with the easterly cliff margin. North of the wall are two further swallets on the same line, the Wet Sink and the Ferny Sink, both of which have clearly served to drain the area at one time. In the case of Ferny Sink there is a conspicuous drainage channel entering it from the north. 30m north of Ferny Sink, still on the same line, lies the entrance to the fossil cave B1c, about a quarter of the way up the cliff.

The short easterly limb of the H goes from B1d at its northerly end southwards for 71m. About 20m to the east of the drinking trough at B1d there is a V-shaped dry channel, perched about 4m above the floor of the depression, which clearly at one time drained two meandering dry valleys. One of these inlet valleys comes from the north-east, the Pollballiny drainage area, and the other from the south, the Polldubh area (Plate 8). A third drainage channel is to be found on the western side of the western limb, running west just north of Caher Beg, joining the road, running with it for 130m and then plunging down the mountain-side in a conspicuous gorge towards the sea, 200m below. This is clearly an outlet channel and, perched 8m above the floor of the depression, means that for part of its history the depression was a lake.

According to Collingridge (1969), the floor of the depression is covered by 60cms of brown loam overlying a deeper gravel of rounded shale fragments. The coarse nature of this gravel suggests that the lake was at most seasonal, if not flood only.

CAVES ASSOCIATED WITH THE DEPRESSION

The most northerly post-glacial cave on the shale margin that we need consider is Hawthorn Cave. The water from this cave resurges within the depression at B1d, sinks again and enters Pollballiny. Faunarooska Cave, which lies only a very short distance north of Hawthorn Cave, follows an independent course to the north-west which takes it well outside our area of interest. The drainage patterns are shown in Fig. 31.

The most important of the shale margin caves is Pollballiny. The Pollballiny catchment used to feed one of the inlet channels to the depression and now the water flows underground, following a very similar course. In its lower reaches the cave has intercepted an older system (probably associated with the original Polldubh drainage) and ends at a massive underground collapse beneath the western limb of the depression.

Polldubh and B2, both of which used to feed inlet channels to the depression, now drain down-dip to the south and are feeders to the Coolagh River by means of the resurgence B4. B5 also drains to B4. This

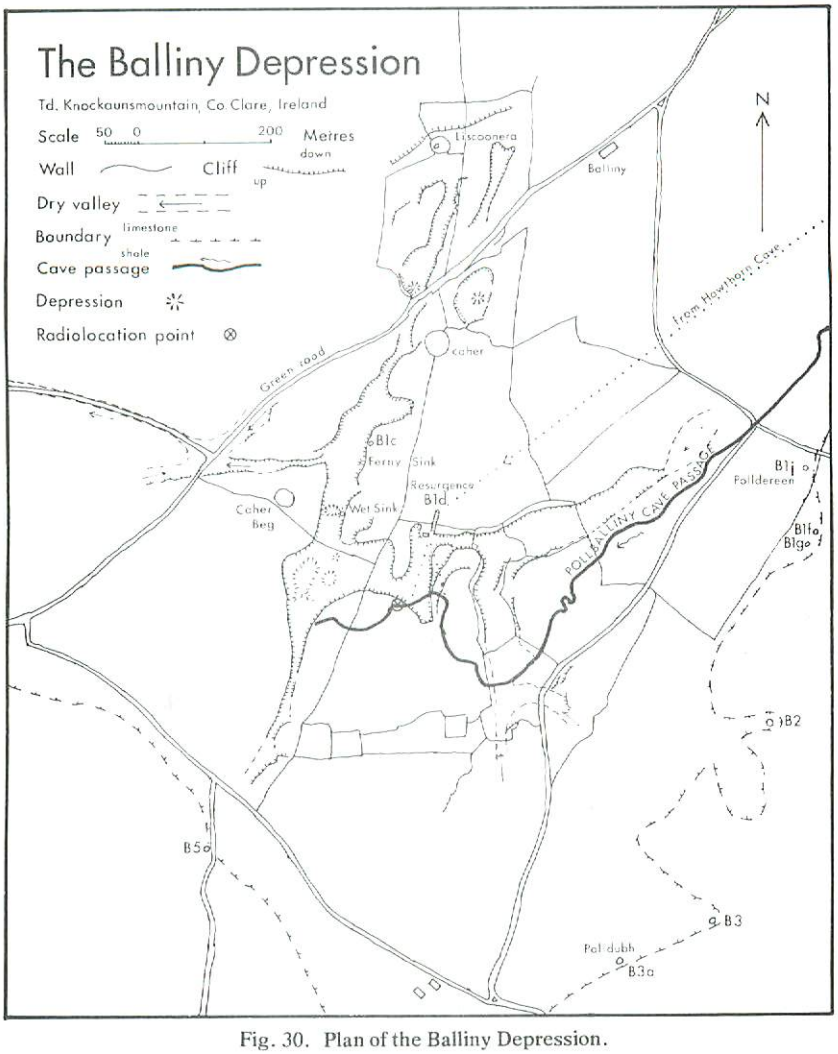

Fig. 30. Plan of the Balliny Depression.

represents an encroachment of the Coolagh River catchment once the shales had been removed from the Balliny platform, and the dominance of dip (south) over topography (sloping west) once the streams enter the limestone.

S5, the presumed submarine resurgence for Pollballiny and Faunarooska Cave, can only be observed under very favourable conditions. It lies offshore at about 10m below sea level. This suggests that it was formed during a period of lower sea levels and makes it a possible resurgence for the old Balliny Depression swallet.

In the outflow channel from the Depression to the west there is a tank (at Clare 4, E 56.4, N 31.9 cm, and altitude 188m OD) containing running water, which is piped down the hill. This water is probably

surface seepage and not a resurgence for Pollballiny, as it lies only about 2m below the furthest known part of the cave streamway, 770m away.

The following caves all lie within the confines of the depression.

B1c is a small phreatic cave belonging to an earlier period. The cave is located about a quarter of the way up the cliff and runs east into the cliff for 11.1m Here it encounters a cross rift, rising towards the surface. Scalloping is not well marked but indicates a flow outwards, that is to the west.

B1d is the resurgence for Hawthorn Cave. The water rises in a conspicuous N-S rift, which is part of the Balliny Depression and runs in this for 30m before sinking. Some of the water is piped into a drinking trough and sinks again at once. The water reappears in the Scalloped Bedding Plane Bypass of Pollballiny. Upstream the resurgence has been pushed for 6m, where it is obstructed by chert.

Ferny Sink lies under a large rock and has been dug to 1.5m. The floor is of packed earth and boulders.

Wet Sink, at the foot of the cliff, has been dug to a depth of 2 metres. The south wall is solid and fluted.

Just east of the point where the green road crosses the main (west) line of weakness, at the northern end of the depression, there is another depression in a second line of weakness, perhaps associated with the eastern limb of the H. In its floor are four slump pits, one with visible canyon passage at the bottom.

DISCUSSION

The Balliny Depression has the appearance of an old abandoned swallow hole with well developed stream channels entering the depression from the east. The present day streams sink at the modern shale margin, several hundred metres away, so the depression must date from a time of more extensive shale cover, before the last glacial advance.

As with most structurally controlled features in Co. Clare, the two limbs of the depression are aligned within the limits 190-200°. The fractures in the rock which caused this alignment may be just very well developed joints, which is the traditional explanation for any features in north-west Clare on this orientation. Alternatively, they may be minor faults with little appreciable displacement of the rocks on either side. Though faults in Co. Clare are very rare, Pollcahermaan, a stream cave on the Knockavoarheen Ridge, follows the course of a minor fault (196°) not visible above ground. If a fault is present, the shales which at one time overlaid the depression would also have been fractured, facilitating water penetration. A major joint in the limestone would have a smaller effect on the overlying shales, so water penetration could only commence when the shale cover became quite thin. This makes a small difference to the date of inception of the depression, a fault aiding the development of a limestone 'window' within the shales.

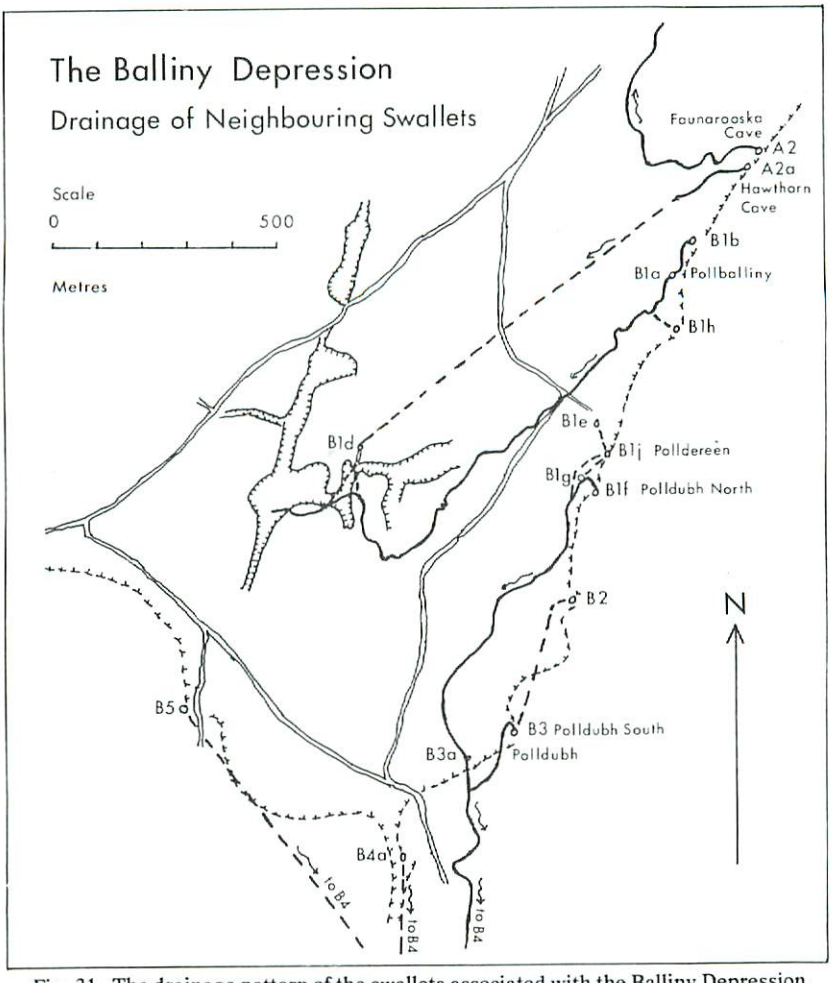

Fig. 31. The drainage pattern of the swallets associated with the Balliny Depression.

The importance of water on the formation of the Balliny Depression can be clearly seen in Fig. 30. The depression appears to be the focus of drainage for quite a large area, with particularly fine inlet channels entering from the east. These eastern channels are typical of sub-aerial stream courses, with V-shaped cross-sections and interlocking spurs. Interestingly, they orient very well with the current stream sinks: one heads towards Pollballiny, the other splits with the ends pointing to B2 and B3 (Polldubh). This may be coincidence, though one could infer that the surface drainage on the shales has not significantly altered since the depression was formed. (On the shale uplands of south Clare the post-glacial drainage has remained faithful to the pre-glacial pattern.) The inlet channel at the southern end of the depression, which points to B5, does not have the same profile as these others; its course is much straighter and it is flat-bottomed (Plate 7). This could be due to the joint or fault that it follows, so stream excavation may still be responsible.

Further north on the western limb there is an overflow channel running in a direct course down the hillside towards the sea. The depression, therefore, was formed by water during an earlier period of erosion. Since the floor of the depression is at an altitude lower than the overflow channel, the Balliny Depression was once a swallet.

The Balliny Depression lies in the middle of a limestone plateau, described by Collingridge (1969) as a remnant of the mid-Carboniferous peneplain. The (Lower Carboniferous) limestone was eroded into a generally flat and featureless surface before the (Upper Carboniferous) shales were laid down. The flat benches of limestone that skirt the shales wherever they form uplands are all fragments of this original erosion surface and seem to have been exhumed as a result of differential erosion of the relatively soft shales by the ice that covered the area during the Pleistocene. In the Balliny region it is thought that a thin shale cover was present during the last interglacial and that this was removed by the last advance of the Devensian ice cap. It seems likely that the Balliny Depression developed during this warm period, either as a limestone window within the shales or as a swallet at the (pre-last-glacial) shale margin. This does not exclude an even earlier origin.

If the Balliny Depression is a pre-last-glacial swallet, where then is the cave? One answer is in Pollballiny. Where Pollballiny first turns north it meets a much larger dry inlet passage, mainly obstructed by boulders (Cassely 1977). The post-glacial stream cave Pollballiny has been captured by this older cave passage and follows it north (with some undercutting) as far as the Scalloped Bedding Plane, where the cave resumes its south-westerly course. The modern stream course is the Scalloped Bedding Plane, while the older route was the Bedding Plane Bypass. This is in contradiction of Cassely, who thought that the older cave passage continued north into the Second Boulder Choke (Graham Mullan, who executed the cave survey, tells us that the Second Boulder Choke is merely a wall collapse, not a blocked passage). The stream rejoins the older route at the end of the Bypass and this combined passage is one of the largest in Co. Clare. The Choked Inlet, which enters this passage at roof level, seems to be a relatively late feature and is probably choked all the way up to the floor of the depression.

Above ground, the northerly turning point of Pollballiny coincides with the crossing of an inlet channel to the depression, the one that leads from the Polldubh area. The obvious inference is swallet retreat of the pre-last-glacial Polldubh stream, swallet retreat being a very common feature of modern Co. Clare caves. Originally the Polldubh stream would have joined the other streams to sink at the main swallet in the western limb of the depression. As the streams cut down in their beds and reached the underlying limestone, the water developed new underground routes (which almost certainly fed into the already established cave from the original sink).

At the end of Pollballiny the cave enters an area of massive breakdown which coincides on the surface with the main line of weakness of the depression as well as the (tentative) inlet channel from B5. It seems highly probable that Pollballiny will turn north along this line of weak-

Plate 6. Balliny Depression from the south looking north. The line of bushes near the skyline to the right is next to Balliny Farmhouse.

Plate 7. Balliny Depression from the E-W wall looking south to the point from which Plate 6 was taken, a U-shaped depression on the skyline.

Plate 8. Meandering dry valley draining from the Polldubh area. The better quality grass in the channel was worth cutting for hay; a number of haycocks are seen.

Photographs by O. C. Lloyd.

ness and join the massive pre-glacial cave that must run west from the depression. When such factors as probable age, catchment area and gradient are considered this cave ought to be enormous.

As a postscript we ought to consider the possibility of entering this old cave from the surface. for a considerable period of time during the last cold phase the Balliny region was not covered by an ice cap but suffered what might loosely be called periglacial conditions. During this time there would be some shattering of the surface rocks by frost action, as well as considerable erosion by flood waters in the early summers when the winter snows melted. During this period the inlet channels cut down through the shales to the underlying limestone and perhaps some swallet retreat took place. After the passage of the ice cap, the shales had been mainly stripped from the plateau but new swallets had not yet properly developed at the new shale margin. The streams followed the courses already carved in the limestone, washing considerable quantities of sediment into the caves in the floor of their channels and in the floor of the depression. These entrances all became blocked and the depression turned into a lake. Also at this time the overflow channel developed. With the initiation of swallets at the new shale margin the floor of the depression was left dry and the cave beneath massively choked. Small soak-aways such as Wet Sink seem unlikely to be able to clear this obstruction, though the Pollballiny streamway is probably undermining the sediment plug at depth. This may cause the cave to open of its own accord, as seems to have happened at G.B. Cave, Doline III on the Mendips (Pete Smart, pers. comm.), though the time scale involved could be thousands of years.

RADIOLOCATION AND SURVEY

Pollballiny ends in a massive boulder choke. Cassely's map (1977, p. 272) shows this to lie under the southern end of the N-S weakness which forms the western limb of the Balliny Depression. It seemed worthwhile, therefore, to check the survey by radiolocation. This was done on 14.7.81. Transmission was made from a point 33m upstream of the first pitch. The null point was located on the surface and is marked in Fig. 30. It lies within 5m of the corresponding point on Cassely's map, which suggests a very fair degree of accuracy on the part of the cave surveyors. The depth below surface was 33.3m. At this point the roof of the cave would be about 10m above the floor and so about 23m below surface. The roof bed from here to the terminal boulder choke does not alter, so that at its surveyed end the roof of the cave may still be only about 20m below surface, even though the floor is 50m below surface. This is believed to have been the first cave radiolocation successfully carried out in Ireland.

ACKNOWLEDGEMENTS

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APPENDIX

The climate of the late Pleistocene

Though Ice Ages have occurred in the past, during Permo-Carboniferous times and on several occasions during the Precambrian, it is the Pleistocene period to which the familiar title 'The Ice Ages' came to be applied. In the popular imagination Ice Ages are seen as a time of climatic disaster, with woolly mammoths wandering aimlessly through endless snowdrifts and cave men sitting huddled beside their fires, trying to keep warm. This is not a true picture.

Quite early in the study of the Pleistocene, geographers came to recognise that there had been more than one period of glaciation. Four major cold periods were identified. The intervening periods, with a warmer climate, became known as interglacials. When viewed against the time scale of the whole Pleistocene (about 2 million years), the modern improvement in the climate since the last cold stage is just another interglacial. This modern interglacial, the Flandrian, has lasted 10,000 years.

The last cold stage, known as the Devensian, is thought to have begun about 70,000 years ago. The reason that we can no longer call this period 'The Last Ice Age' is that for most of the time the land was not covered by ice. Fossil pollen analysis, together with oxygen isotope ratios (temperature dependent) of oceanic fossils, shows that the climate has never been stable for very long. Interglacial periods have been broken by cold spells; cold stages have been punctuated by warm interstadials. The Devensian was a time of generally cooler climate, the preceeding Ipswichian interglacial a time of generally warmer climate.

The modern mean annual air temperature in the British Isles is about +10°C. If the (m.a.a.) temperature were to drop to +5°C, seasonally frozen ground would appear. At 0°C, permafrost would become established. Permafrost and glaciation do not go together. When the (m.a.a.) temperature drops below +3°C, the air becomes too cold to hold the water needed to provide snow, if ice masses are to build up. Glaciation only takes place when the (m.a.a.) temperature remains stable at about +3 to +5°C, the zone of heavy snowfall.

According to Mitchell (1977) the Devensian period in Ireland began with a steady drop in temperature to around 0°C. The climate then deteriorated further and ice wedges and other deep frost structures developed in the ground. By Middle Devensian times the climate had ameliorated and stabilised at about +5°C. There was probably heavy winter snowfall, but this was balanced by summer melting. The Late Devensian opens at about 26,000 years ago and ice masses gradually built up in Ireland, Scotland and Wales. Ice began to move south from the Irish midlands, the first advance bypassing Co. Clare. The ice then migrated further west and this second advance covered Co. Clare as far south as the Shannon estuary.

About 14,000 years ago a very dramatic rise in temperature took place, to a level at least as warm as that of today. This burst of heat was short-lived and the temperature began to fall again. About 11,000 years ago the temperature crash-dived to a very low level, perhaps -5°C. This final cold snap lasted about 1,000 years and gave way to the modern warm conditions.

The present climate is abnormally warm compared with the average for the Pleistocene period. Though many of the caves of north-west Clare are Flandrian (post-glacial) in age, in particular those associated with the modern shale margin, others are obviously much older. In the British Isles as a whole, most caves are older, having developed during the Pleistocene. Cave initiation is normally attributed to interglacial periods. What would have happened to a cave in Co. Clare during the Devensian cold stage? If the cave had formed during the preceeding Ipswichian interglacial, the very cold conditions of the Early Devensian would have halted its development. There would be very little precipitation and consequently little flowing water, even in summer.

The heavy snowfalls of the Middle Devensian changed all that. We know that there was no nett accumulation of snow during this period, so there must have been snowmelt floods in the early summers. These snowmelt streams should have been good for cave development, as they are for present day high alpine caves. Cold water is more corrosive than warm, as it can carry more carbon dioxide. In addition the summer floods would mean rapid water flow, with abrasion of the cave walls by sediments carried by the stream. New caves could develop under these conditions, too. The limiting factor is the high sediment load of the streams, as this would tend to block the caves whenever the stream flow slackened.

With the encroachment of the Late Devensian ice cap, snowmelt gave way to snow accumulation and the caves again ceased to be active. The Late Devensian warm interstadial seems too short to be responsible for much cave initiation. More likely the streams washed glacially derived sediments into the caves that were already there. The subsequent cold snap would again halt cave development, while further loosening the surface rocks. Since then the streams have retreated to swallets at the new, post-glacial shale margin.

The crucial question for cave initiation and development during the Middle Devensian is therefore: which is the dominant process, solution by snowmelt streams or infilling by stream-borne sediments? If solution is dominant, we have the possibility of caves formed during an Ice Age. What is now needed is some stalagmite dates (Uranium-Thorium disequilibrium) showing active stalagmite deposition. This will give us minimum ages for the caves.

The equivalent Irish terminology for the British Pleistocene names are as follows:

Flandrian	=	Littletonian
Devensian	=	Midlandian
Ipswichian	=	Last Interglacial

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