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GEOMORPHOLOGY AND EXPLORATION OF POULNAGREE, CO. CLARE, IRELAND

by

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Main Entrance Grid Ref: M 1215 0362.
Townland: Crumlin
Altitude: 235 m AOD
(245 m at Upper Poulnagree)
Estimated Length: 4515 m
Estimated Vertical Range: 130 m

ABSTRACT

Exploration in this cave between 1997 and 2000 has trebled its length. The discovery of a bypass to Sump 1 and a further 2 km of stream passage beyond the sumps is described. A tentative reconstruction of the geomorphic history of the cave suggests that it has had a long history, in that it was active prior to the glacial processes which truncated the overlying plateau at its southern end, producing the Oughtdarra basin and cliffs. Subsequent rejuvenation has begun to deepen the cave at its downstream end by headward erosion.

INTRODUCTION

The cave of Poulnagree is located on the west side of Knockauns Mountain in north west Co. Clare, Ireland (Figure 1). The main entrance to the cave is a pothole situated away from the edge of the shale cap of the mountain, though it receives water from a number of sinks along the shale edge. The cave was first entered in 1955, when the passage from the active sink of Upper Poulnagree (M 1213 0351) was followed for about 25 yards to the head of the pitch into the First Aven, though this was too tight to descend. The pothole entrance was explored the following day, but the explorers stopped at a narrow slot over an unstable pile of boulders where they deemed that the danger of continuing did not justify continuing as "The rift can only lead into [Upper] Poulnagree..." (Lloyd, 1956). The following year a further attempt was made and the cave was explored as far as Sump 1 and surveyed during 1956 and 1957.

Despite a number of unsuccessful attempts to dive Sump 1 during the 1970s, the only extensions made to the cave prior to 1997 were the discovery of the Trí Eagnai Mouncaí inlet by members of the Durham University Speleological Association (Walker, 1977) and an extension to the 1956 Tributary 2 Passage by cavers from Galway (Gibson, 1989).

In 1988, Julian Griffiths of Cambridge University Caving Club noted a tight mud-choked tube near the Inlet Sump at the bottom of the cave. This was dug sporadically by members of the UBSS between 1991 and 1997, finally regaining the streamway and reaching Sump 2 in April 1997 (Boycott and Mullan, 1998). Sump 3 was passed by divers in 1999, when the 2 km long Priory Streamway was first entered and explored. The end of this passage was reached the following year, ending this phase of exploration. At the time of writing only a few inlets are left to be completely explored.

DESCRIPTION OF THE CAVE

The cave as far as Sump 2 has been described in detailed previously (Collingridge and Witts, 1957; Tratman, 1968; Self, 1981 and Boycott and Mullan, 1998). These descriptions are not repeated here, save to note that the cave is strongly joint controlled and that the upper part of the passage contains many phreatic features. Other details of the passage form will be noted as appropriate in the discussion below to save repetition. The plan is given in Figure 2.

Sump 2 is approximately 8 m long and leads to 60 m of joint controlled streamway of which the first part is 3 - 4 m high canyon passage and the last third is an elliptical tube, 2 - 3 m diameter and at least half-full of water. Sump 3 follows (Figure 3); this is 70 m long and passes about eight airbells before returning to air-filled passage in the Priory Streamway.

The Priory Streamway is just over 2 km long. In general, it is a gently descending (on average 0.25° compared with just over 1° for the passage from the Second Aven to Sump 1) strongly joint controlled passage. It increases in size, to 10 - 15 m high and 2 - 3 m wide, after a significant inlet passage enters from the left 150 m downstream of Sump 3. There are many more formations than above Sump 1 and a number of minor boulder piles to negotiate. The form of the passage is generally a "keyhole" shape with a narrower canyon below a distinct phreatic tube (Figure 6). Shortly after the cave turns towards the south (Figure 2) the passage form changes, being wider at floor level rather than roof level, but it soon reverts to the previous shape and the canyon begins to narrow and deepen, forcing the explorer to follow the roof tube, a difficult process where the walls are covered with moonmilk, at Lacewing Inlet. The roof tube finally ends in a very pretty calcite and moonmilk cemented choke, named "Number 31". Close investigation of this choke found fine roots protruding through hairline cracks in the walls. The canyon here may be descended by a 10 m climb, followed by several shorter climbs through boulders, to rejoin the stream, which is flowing in a narrow rift. This can be followed for a further 20 - 30 m, at one point neck-deep in water, until it is finally blocked by boulders. At this point it is less than 0.5 m wide.

There are a number of inlets to this passage. The major ones are Crabeye Inlet, on the left about 150 m beyond Sump 3, and Lacewing Inlet some 150 - 200 m before "Number 31" and also on the left. Crabeye Inlet bifurcates upstream and is, in total, about 250 m in length. Both parts end in boulder chokes but only one now carries a small stream. There are some remarkable helictite formations (Figure 4). Lacewing Inlet starts, at the level of the roof tube, as a 5 m wide crawl over moonmilk-covered mud, and carrying a small stream. Passage width soon decreases to 3 m and, after 70 m, a "T" junction is reached. To the right a narrow ascending rift has been followed for 50 m to a boulder blockage. To the left the inlet continues as a 2 m wide hands-and-knees crawl in a mud floored stream. This has been followed for a total distance of approximately 400 m to a further junction. The left hand branch soon closes down but the right hand branch continues upstream over a moonmilk/mud floor at the same height and width as before. It has not been followed to a conclusion.

A third tributary, Moonmilk Inlet, enters from the right about 100 m below Crabeye Inlet and has been followed for nearly 40 m. At the junction, its floor hangs 2 m above the main stream and it ascends at a considerably steeper angle than the main passage. As its name suggests, is liberally decorated with moonmilk. A further inlet on the right, just before "Number 31", has been followed in a narrow rift for 50 m before pinching out. About half way along the rift it is possible to drop down into some bouldery chambers 2 - 3 m wide and 3 - 4 m high. None of the other inlets to the Priory Streamway have been investigated. They are generally 10 - 15 m up in the roof of the passage.

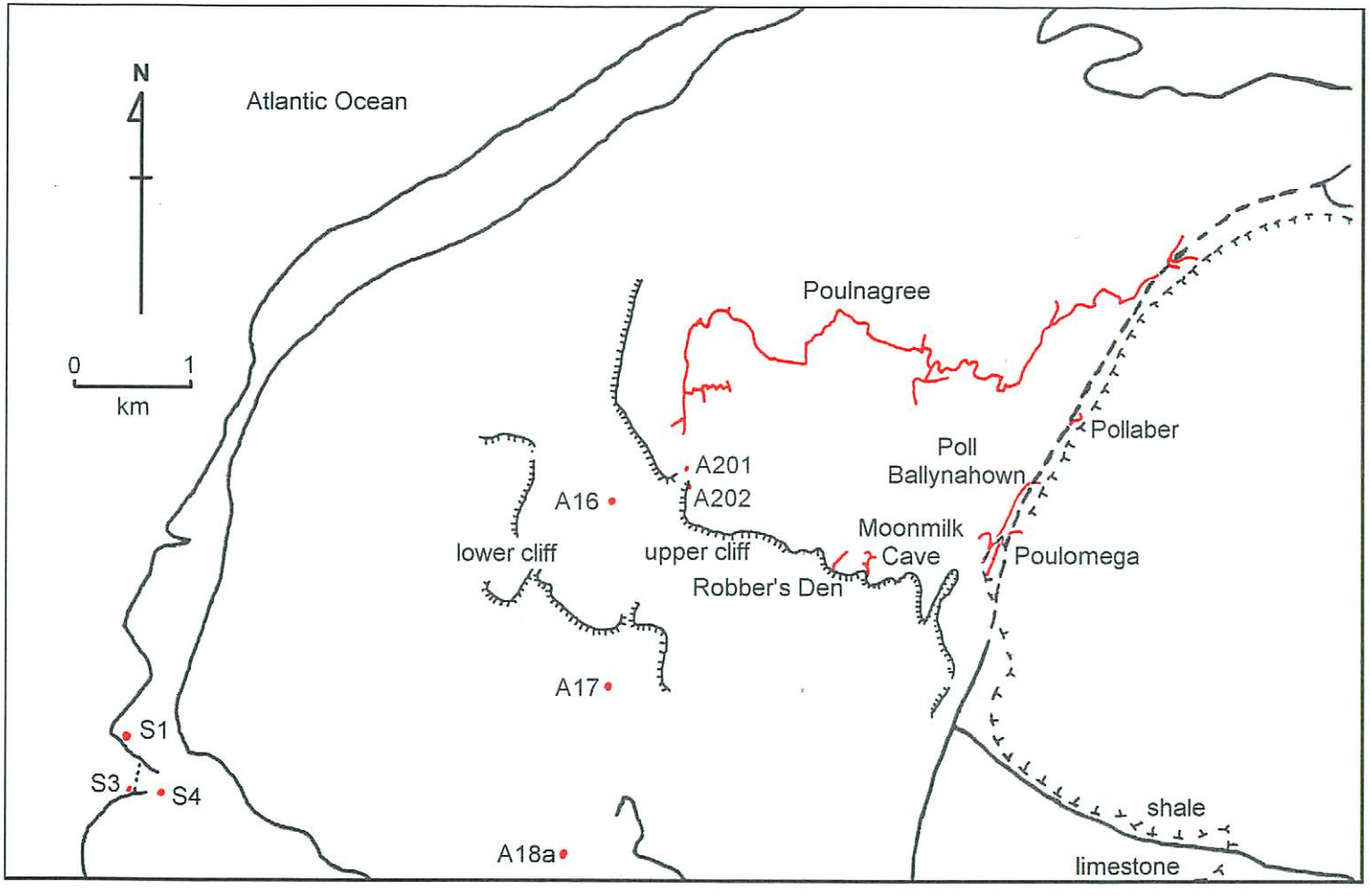

Figure 1. *Poulnagree and nearby caves in relation to surface features and the underlying geology. Cave passages shown in red.*

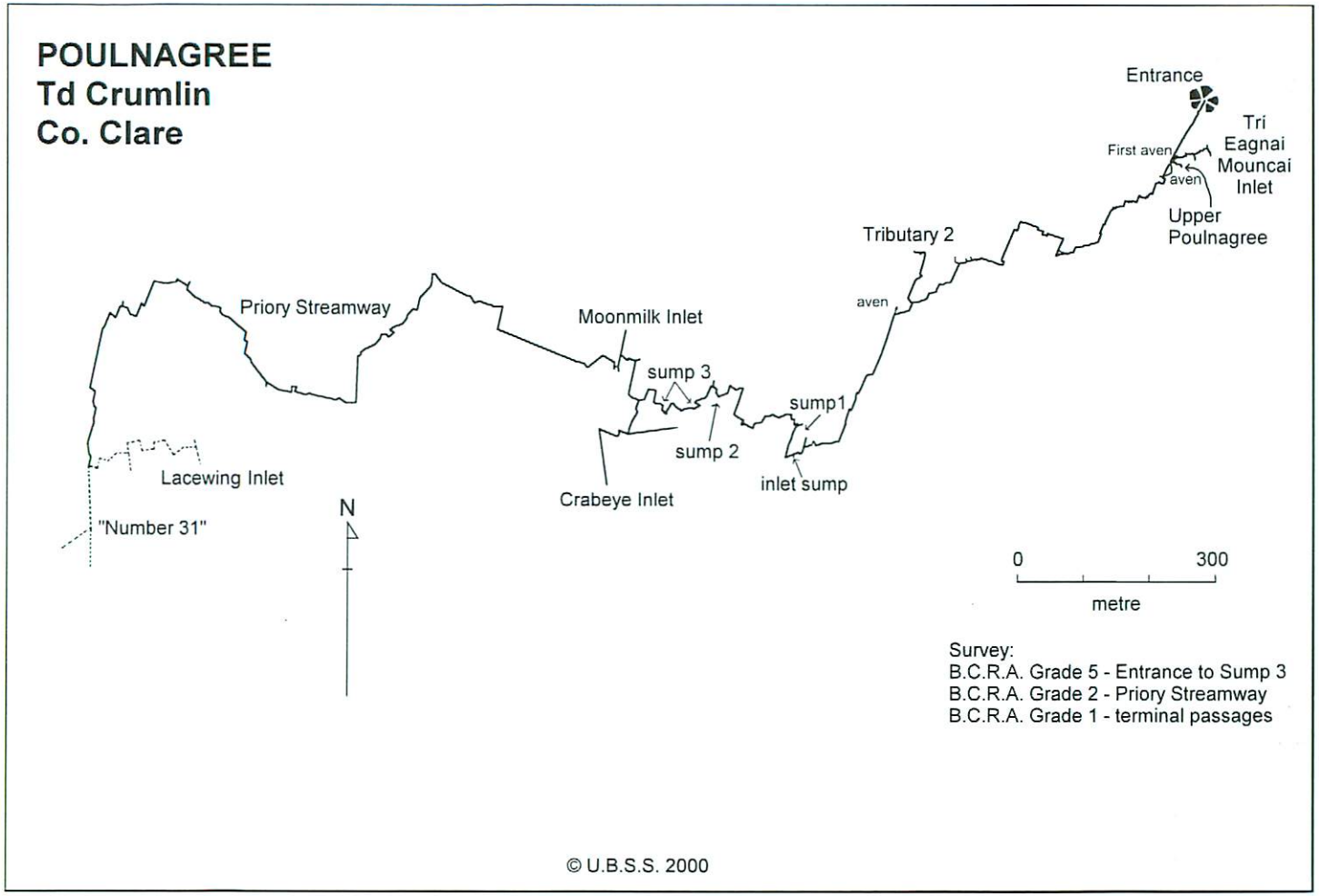

Figure 2. *Plan survey of Poulnagree.*

THE CAVE IN RELATION TO SURFACE FEATURES

Figure 1 shows Poulnagree and the other caves of the area in relation to surface features and to the basic geology of the area. It can be seen that the upstream ends are sinks intimately associated with the edge of the shale outcrop which caps Knockauns Mountain. The pothole entrance to the cave is formed in the side of a very shallow dry valley, here running south. This valley may be traced beyond the pothole where it turns westwards and meanders towards the coast. It peters out in a series of closed depressions at the edge of a section of limestone pavement.. In one of these depressions, at M 1205 0363, there is a relatively fresh collapse with waterworn rock visible a metre down. Intriguingly, this site is situated up-dip from Moonmilk Inlet. Following south and east from this area and back towards the green road, there is a further set of depressions which, when seen on an aerial photograph, clearly are orientated along the major, north-south, jointing.

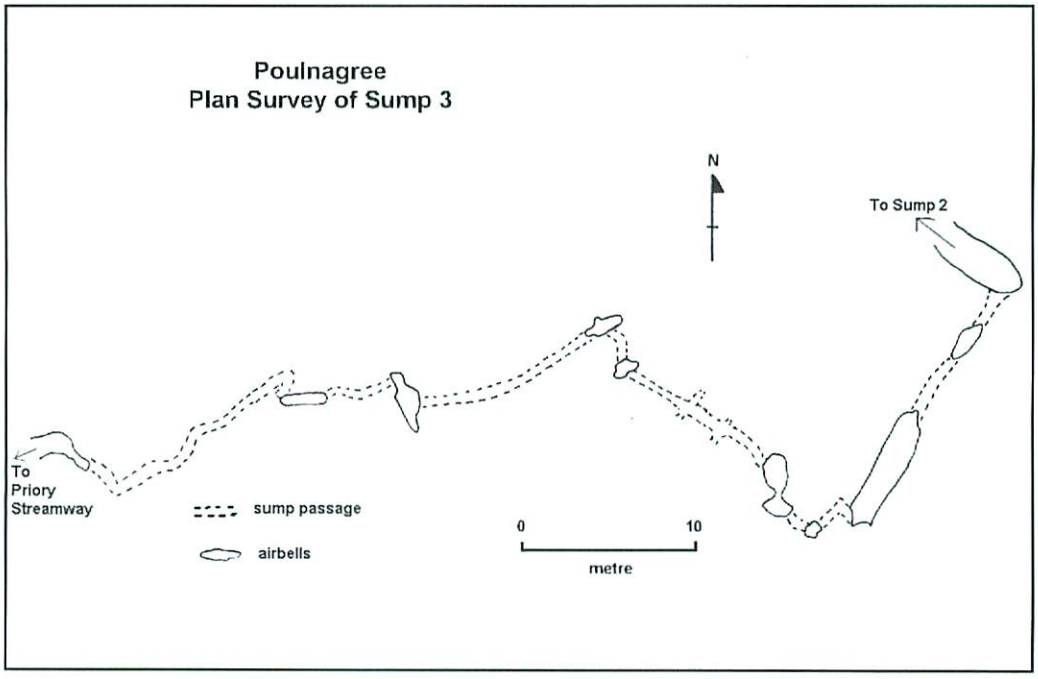

Figure 3. *Enlarged survey of Sump 3, Poulnagree (after Andrew Atkinson).*

The downstream limit of the cave lies very close to the Oughtdarra Upper Cliff. The final southwards trending section of the cave is subparallel to a substantial north-south feature which cuts through that cliff and forms the easiest route for walkers up or down the cliff in its western half. Two short sections of choked cave passage have been found on the eastern side of this feature. The higher, numbered A201, is a narrow phreatic rift choked with boulders and a fine grey clay. It is situated at M 1050 0276, at a height of approximately 150 m AOD. The lower, A202, is also a short section of rift, choked with boulders and with a loose boulder roof, at M 1047 0266 and approximately 130 m AOD. Both of these have been dug without reward.

Figure 4. *The "Crabeye" helictite in Crabeye Inlet*
Photo: S.B. Cottle & A. Atkinson.

The water from Poulnagree rises at Lackaniska Rising, A16 (M 1030 0262, 107 m AOD) (Self *et al*, 1980; Bunce, 1997). However, Self *et al* also note that water had been seen and heard higher up the hillside. In fact the water is first seen flowing through boulders at the foot of the cliff at M 1044 0269, 112 m AOD. This is just about the same level as the downstream explored end of the Priory Streamway which is probably no more than 100 m away. The water sinks again immediately, rises at A16, 5 m lower, and 150 m to the south-west, sinks after 200 m, rises again at A17 and sinks at A18a before finally reappearing at the rising S3 on the coast at Pollsallagh Bay due west of this point.

DISCUSSION

When looked at in plan view, this cave is seen to be strongly aligned along the jointing. This is confirmed by carrying out a polar analysis of passage direction and constructing a rose diagram (Figure 5). Allowing for survey distortion, such as legs measured partially across passages, this clearly demonstrates that the cave's direction is controlled mainly by the major, north-south, jointing with a secondary control by the minor, east-west joint set. The dip in this area is about 2° towards the south-west and the plan configuration of the cave also shows alternate dip and strike orientation.

The long profile of this cave is quite remarkable. The first 160 m, as far as the Second Aven, slopes downwards at close to 30°, while the final 100 m or so also slopes at about 20 - 25°. For the remainder of some 4 km of passage the average slope is no more than 1°. In almost horizontally bedded limestone this indicates an extremely strong control along a single horizon. This finding is in agreement with the conclusions of Judd and Mullan (1994), that such a control operates on all the caves from as far north as Pollapooka, south to the Oughtdarra cliffs. It would seem likely that this particular horizon can also be correlated with the *Productus Giganteus* marker bed of Tratman (1968, p 135) as this can be seen in the floor of the Second Aven. The steeper sections obviously have different origins. At the upstream end, the passage is simply cutting down to the level of the controlling horizon. At the downstream end the passage originated as a phreatic tube (see below) which was drained as the Oughtdarra cliffs were formed, initiating rejuvenation and downcutting in the lower canyon part of the passage. A similar

process of steepening and headward erosion can also be seen in both the Upper Poulnagree and Trí Eagnai Mouncaí inlets as they approach the First Aven at the upper end of the cave.

The formation of the cliffs and by extension the Oughtdarra basin was discussed briefly by Self *et al* (1980). They noted that while the basin has many glacial features; deposits of moraine are widespread and there is a marked glacial trough to the north-west; it is unlikely to be a glacial cirque as these are generally formed on north and east facing slopes, giving enhanced winter snow and ice accumulation and decreased summer melting. However, in the Burren such local accumulations of ice seems to have been relatively unimportant compared with the massive inflows of ice from the north-east (Farrington, 1965). The relatively low-lying Oughtdarra basin, cut into the south-western flank of Knockauns Mountain, seems more likely to be the result of sub-glacial plucking on the lee slope of the hillside beneath the main body of the ice. Simms (2000) agrees with this as does the present author who, furthermore, would suggest that the series of north-south oriented depressions on the flank of the hillside north of the cliffs were probably accentuated by the same process.

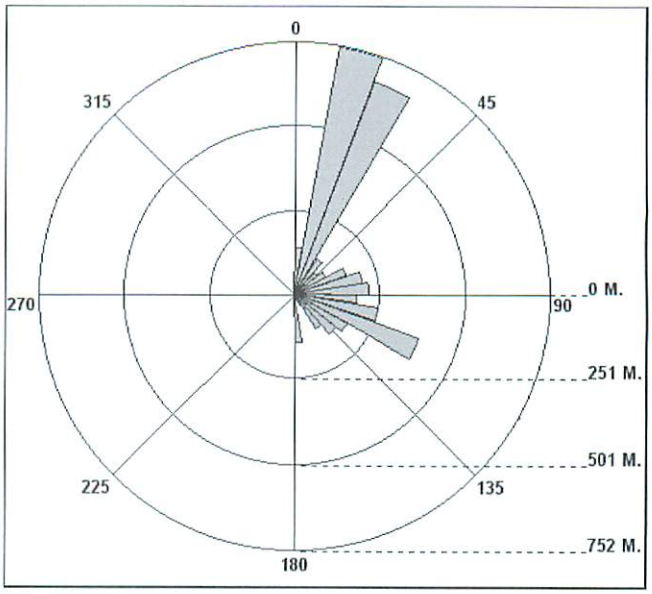

Figure 5. *Polar analysis of passage directions in Poulnagree. Each segment represents 10°.*

Self, *et al.,* also discussed the formation of the caves in the faces of the cliffs. However, their conclusions were based on observations of scalloping in Moonmilk Cave (M 1108 0241) which suggested water flow to the north. The scalloping in the near-entrance parts of this cave is poorly preserved and recent observations of much better preserved scalloping in the 1985 extension to this cave (Boycott and Wilson, 1986) clearly demonstrate water flow towards the entrance of the cave, i.e. to the south, thus removing the justification of their particular arguments. Indeed, the entrance passage to Moonmilk Cave also shows evidence of rejuvenation and steep downcutting in similar fashion to the downstream end of Poulnagree, implying that it too was truncated by glacial action and then briefly rejuvenated before final abandonment. The only flow in the cave now is of small seepages of percolation water. A less clear-cut example of this process may also be seen in Robbers' Den Cave (M 1097 0245). Through and Through Cave, on the other hand, is a classic paragenetic canyon above a bedding plane with anastomoses. It shows no sign of rejuvenation so must have been abandoned before the cliffs were excavated M.J. Simms, *pers. comm*).

Observations within Poulnagree show a distinct phreatic half-tube in the roof which may be followed all the way from the Second Aven, near its upstream end to "Number 31" almost at the downstream end. This phreatic phase was relatively prolonged, as indicated by the narrow oxbow passage approximately 300 m downstream of the Second Aven. Here the roof of the streamway is 1 m below the level of the roof of the oxbow but both passages show the same

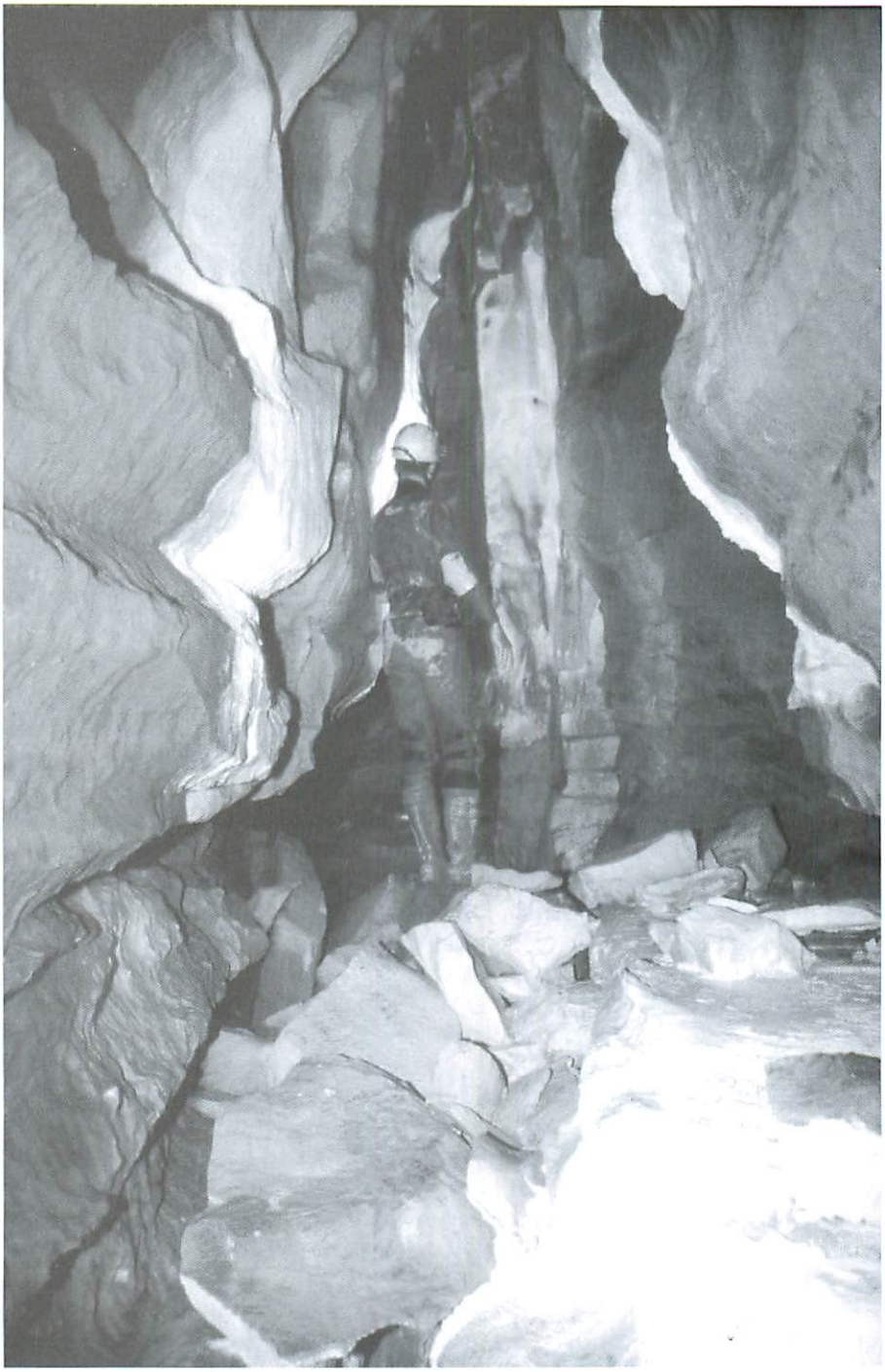

Figure 6. *The canyon passage of Priory Streamway*
Photo: S.B. Cottle & A. Atkinson.

phreatic features. Eventually, however, phreatic conditions gave way to vadose ones and, as noted by Tratman (1968, p 135), the walls and in places the roof are covered by large phreatic scallops with smaller vadose ones being found only at or just above stream level. In much of the cave above sump 1 the width of the canyon has remained constant as it cut down it, demonstrating a marked consistency in discharge rate over the vadose part of the life of the cave. Coincidentally this width also tends to be the same as the diameter of the roof tube.

A tentative reconstruction of the history of Poulnagree can now be set out: The cave was initiated by water sinking on the north-western side of Knockauns Mountain, which dropped rapidly to the level of the *Productus giganteus* bed at which level it followed the jointing and less obviously the dip as it moved towards a now vanished resurgence somewhere south of the Oughtdarra cliffs. The gentle gradient taken by the cave allowed for an extensive phreatic phase, especially where flow was along the strike rather than down dip. A number of inlets enhanced the flow and formed their own tributary passages. Cave development probably ceased for much of the last glaciation, but recommenced following the retreat of the ice. By this time the Oughtdarra basin had been excavated and subsequent cave development was able to breach the previous base level, thanks to an increase in fissure openness brought about by the unloading of the ice overburden and the removal of the bedrock mass which previously extended south of the cliffs. In this regard it has been noted that the joints appear to be more open, and therefore more easily enlarged by solution, as the end of the cave is approached (Andrew Atkinson, *pers. comm.*). These processes have produced the steeply descending canyon at the downstream end of the cave. At the same time, the majority of streams feeding the cave were disrupted and most inlet passages are now dry (Tributary 2) or carry only calcite-rich misfit streams of percolation water which are depositing moonmilk (Lacewing Inlet, Moonmilk Inlet; Figure 7.) Other inlets to the cave are new developments which have yet to form substantial passages (Tributary 1, the roof inlets to the Priory Streamway). The only exception to this rule may be the stream which feeds the inlet sump close to Sump 1. It seems likely that this inlet may have originally formed the Sump 1 bypass passage, before finding a lower route through this sump. As, however, the sump and the upper end of the bypass passage are both choked with mud, no exploration has yet been carried out here.

As well as the well-known caves of Poll Ballynahown and Poulomega, there are a number of minor sinks along the shale margin south of Poulnagree, including two, Pollaber and Pollnagarsuin, which have been explored for about 100 m (Boycott and Wilson, 1986). These might well feed many of the inlets, especially those to the Priory Streamway, but carrying out dye traces to such a remote area would be logistically difficult.

The stream sinking in Poulomega has itself been dye traced to Lackaniska Rising and this result has been used in surmising that Poll Ballynahown also flows to this rising. At the time that this test was carried out, it was presumed that the route taken by Poulnagree closely followed the shale edge (see for example Figure 1 in Tratman, 1968) as do both of those caves. However, in the light of the new data on Pounagree, and of the fact that these two caves also seems to be controlled by the same horizon as Poulnagree, an interesting hydrological conundrum has arisen: The rising is due west of them, so if the water flows for any distance along the controlling bed, then it should intercept Moonmilk Cave, Robbers' Den or one of the smaller caves in the cliff, most of which are also situated at this horizon, and be redirected towards the cliff. If it flows at a level below the base of the cliff, what, then, has caused it to turn along the strike to Lackaniska, itself an immature feature, instead of simply rising at the same level but further east down the steepest available hydraulic gradient. Given that the log book entries on the tracing of Poulomega are somewhat confusing (Irish Diaries, 1968, 1969) and that a rising

has been reported at the base of the eastern end of the cliff (M 1122 0230) (Irish Diaries, 1957), down dip from the end of Poulomega, although this latter feature has not been re-located on the ground, this trace needs to be repeated.

NOTES ON THE SURVEY

Poulnagree was originally surveyed to C.R.G. Grade 4 in 1956/7 (approximately equivalent to the modern B.C.R.A. Grade 4 [Ellis, 1988]). The workers at this time did not have access to modern instruments, especially robust and accurate clinometers, and so although their plans were useful they collected very little elevation data. Consequently the cave as far as Sump 1 has now been resurveyed using modern techniques and instruments to B.C.R.A. Grade 5. The 1997 extension as far as Sump 2 was surveyed to this standard originally. To this has been added data for the Galway Pothole Club extension to the Second Tributary and for Upper Poulnagree and Trí Eagnai Mouncaí inlet, both to B.C.R.A. Grade 3.

The stream passage through Sumps 2 and 3 have been surveyed using a diving compass read to the nearest 5° and a line tagged at 10 m intervals this is considered to be a B.C.R.A. Grade 2 survey. The remainder of the cave, the Priory Streamway and its inlets, has so far also been measured to no more than Grade 2 accuracy, supplemented by altitude data from an aneroid barometer. However, the good agreement between the configuration of the passages and certain surface features leads to a belief that it can be relied upon for the purposes of this paper.

All the data has been reduced using the shareware program "Compass" which was used to prepare the line survey and the polar analysis of passage directions. As no information on passage cross-section dimensions has been collected beyond sump 2, there is nothing to add to those shown on the 1998 edition of the cave survey (Boycott and Mullan, 1998) and so they have not been included in Figure 2, here.

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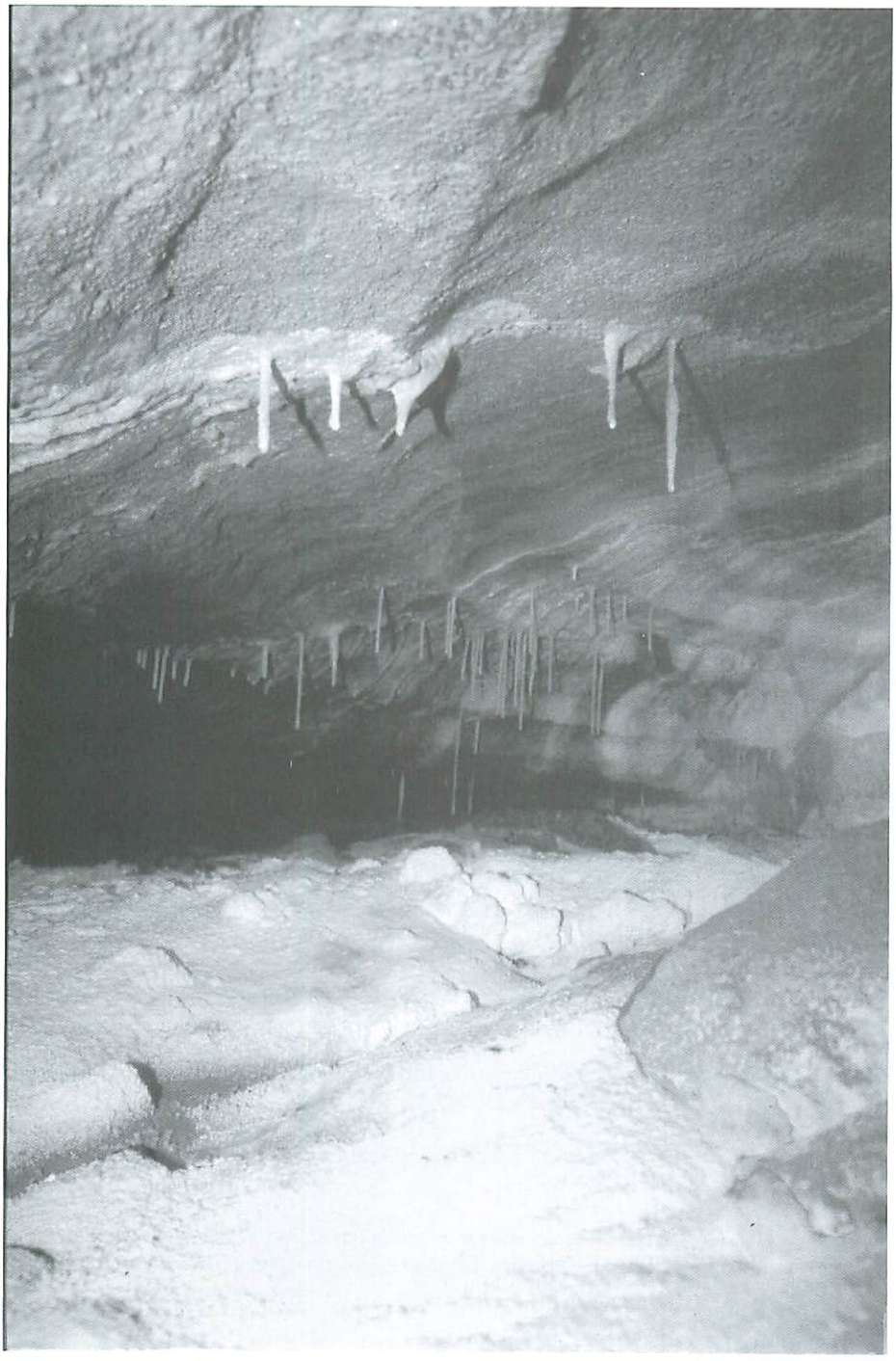

Figure 7. *The entrance to Lacewing Inlet, showing moonmilk covered floor*
Photo: S.B. Cottle & A. Atkinson.

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