

1479/3

INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS

KARST COMMISSION

FIELD EXCURSION, BURREN, CO. CLARE, IRELAND

23 May 1979

David Drew (Trinity College Dublin)

7260

A. ITINERARY

1. Bunratty to Ennis

The flat, ill-drained area around Bunratty forms a part of the lowlands of the Shannon estuary.

The route northwards to Ennis follows the valley of the Lower Fergus River. The Fergus derives much of its water from springs draining both the upland Burren and the lowland limestones. The river passes through a series of lakes in which extensive carbonate deposition occurs - thus the hardness of the river water varies along its course.

2. Ennis to Corrofin

The limestone between Ennis and Corrofin is largely blanketed by a thick cover of glacial drift, particularly drumlines. Drainage is primarily on the surface due to the relatively impermeable drift, however in some instances streams have developed underground courses through small limestone hills. The town of Corrofin is located on the southern margin of the Burren on the shores of Lough Inchiquin - a shallow lake in a glacially eroded hollow.

3. Corrofin to Kilfenora

This section of the route roughly parallels the contact between the limestones of the Burren to the north and the impermeable Namurian rocks to the south. The Upper Fergus River occupies a shallow valley to the south of the road as is greatly augmented in this section by a series of large springs draining c. 100 km² of the Burren. The largest of these springs is at Elmvale (G.R. 26.92) with a mean discharge of c. 3m³/sec. There is evidence to suggest that the development of this area as a major discharge zone for groundwater is a relatively recent phenomena. To the north of the road is the gentle dip slope of the Burren, in this area overlain by thin, patchy glacial drift.

4. Kilfenora to Lisdoonvarna

The underlying rock consists of Namurian shales overlying the limestone in this part of the route. A series of down-dip (consequent) streams drain the plateau flowing northeast to southwest and fossil evidence from the limestone areas of the Burren suggests that such a pattern of dip-slope streams once extended over the whole area. Closed depressions (dolina) up to 10m in diameter are common where the shale cover is thin indicating that subjacent karstification is occurring in the area.

St Brendan's Well (1) is an example of an overflow spring from the limestone developed at the contact between limestone and shale. The stream from this spring has excavated an embayment into the shales as it flows southwards, exposing the limestone and thus allowing the spring to migrate down-dip.

5. Lisdoonvarna to Coolagh R. Sink

To the north of Lisdoonvarna lies the hill of Slieve Elva, the highest point on the Burren at 349m a.s.l. The top 150m of the hill is composed of Namurian shales and gritstones on which a radial drainage pattern has developed. All the streams sink underground at the junction with the limestone. The Coolagh River (2) is an example of such a sinking stream. The sink is in a small limestone inlier completely surrounded by shale. The associated cave system - a youthful dendritic network of vadose passages - has been explored for 6 km. The water from these caves emerges at Poulsallagh (Stop 4). Southwest from the sink the dry valley continues via a series of fossil stream sinks to terminate near the coast.

6. Coolagh River Valley

The route follows a portion of the now almost dry valley of the Coolagh River downstream of the sink. In places the valley has decayed to uvala-like closed depressions with the valley floor formed in limestone and the valley sides in the overlying shales.

The walk from Schoolhouse Bridge (3) to Ballynalackan Castle

incorporates a typical section of the dry valley, including fossil sinks that pre-date the last glaciation of the region.

7. The Coast (Poulsallagh)

The coast of the Burren region exhibits fine examples of marine karren, especially well developed where (as at Poulsallagh (4)) the gentle dip of the rocks creates a wide littoral zone.

The bare limestone pavements inland show normal runoff and kamenitza karren forms. The inter-tidal zone is characterised by a sequence of distinctive karren forms (dominantly kamenitza and pinnacles) increasing in size seawards. Their dimensions seem to correlate with the biomass in each zone and they are probably largely formed by limestone solution by water made aggressive by respiration of living organisms.

Four zones are recognised :

Inshore	Verrucaria Zone
	Littorina Zone
	Barnacle Zone
	Mussel/Echnoid Zone

Low Tide.

The degree of development of the individual zones varies with local conditions of energy environment, geological structure and lithology along the coast.

8. Poulsallagh to Slieve Elva

The west coast of the Burren consists of a narrow coastal plain backed by the steep flank of the upland. Much of the drainage of the area emerges from drowned springs up to 0.5 km offshore, but more commonly within the intertidal zone.

The route continues inland up the Caher valley - the only perennial stream of the area. The great thickness of calcareous glacial drift allow the stream to maintain a surface course. The Caher River

has its source on the eastern flank of Slieve Elva hill. The road follows the shale - limestone boundary along which there are numerous stream sinks. The streams feed the rising at Killeany which is the source for an extensive local water supply scheme.

9. Cullaun V Cave

Cullaun V (5) is a typical example of a youthful (post glacial) cave characteristic of the western Burren. It is largely vadose in character and subject to violent changes in discharge. The modern caves are developed in the uppermost beds of the limestone and are strongly influenced by the regional dip of the strata and by the dominant north-south jointing.

10. Cullaun V to Kilcorney

Cullaun V cave is located on the flank of an outlier of shale - Poulacapple Hill. To the east is the 'High Burren' a limestone plateau some 200-300m in altitude. The High Burren has no perennial surface streams and groundwater seems to be highly localized in cave systems.

11. Kilcorney - Carran - Lough Aleenaun - Glensteade

Kilcorney (6) Meggah and Carran (7) are large closed depressions floored with up to 60m of alluvium and glacial drift. All contain seasonal lakes although they are c. 70m above the level of the regional water-table. This area of the Burren experiences severe water supply problems. There are numerous smaller closed depressions but the dominant landform is the plateau which is structural in origin. Large, gorge-like dry valleys dissect the surface and generally trend down dip (NE - SW).

12. Aillwee Hill

The 5km walk over Aillwee Hill (8) illustrates many of the characteristics of the High Burren. The old valley network, initiated on the former shale cover, has now decayed into a series of linear dolina with remnants of ancient fossil caves preserved in their sides. Extensive areas of limestone pavement and associated karren forms occur and lithology strongly

influences the micro-relief. Aillwee Hill shows evidence of settlement since early Bronze Age times, some of which appears to relate to very different environmental conditions to those prevailing today.

13. Aillwee Cave

The cave of Aillwee (9) is one of the few accessible pre-last glacial caves. It is developed in the strata immediately above a thick, impermeable shale band in the limestone. The cave contains important sediment sequences including varved clays. It is a fossil resurgence cave now perched some 100m above the present water-table.

14. Lowland Karst

The evening route passes through the lowland karst of Co. Galway. Much of the area is a flat limestone plain up to 35m a.s.l. and overlain by varying thicknesses of drift. Many of the rivers are dry for 4 - 6 months of the year, the waters resurging at the coast - as for example at Kinvara.

Turloughs (shallow basins with seasonal lakes) are common in this area, averaging 1km^2 in area. They appear to be glacio-karstic features though their relation to the regional water-table is not simple.

The Burren - Background Information

1. Introduction Topographically the Burren is a compact upland bounded to the north, west and east by abrupt scarps and fretted by large re-entrant valleys on its northern flank. A distinction is made between the 'High Burren' of the east, underlain wholly by limestones, and the western area in which younger, non-calcareous rocks outcrop in some areas. The Burren is some 430km^2 in area and has the form of a plateau sloping gently down to the south and southwest. Isolated peaks rise to c. 300m a.s.l. above the general plateau surface at 200 - 250m. To the east of the Burren and between it and the Devonian rocks of the Slieve Aughty mountains lies the flat limestone expanse of the Gort-Kinvara lowland, close to sea-level. This area is also karstified.

2. Geology

The Burren is developed in the upper (Visean) beds of the Carboniferous limestone. Two stages, the Asbian (lower) and Brigantian (upper) comprise the greater part of the sequence exposed.

In the western Burren the Asbian is subdivided into bedded and massive units - the former forming the characteristic stepped terraces and the massive unit giving steep, regular slopes or cliffs. Thin shale bands are present between the beds of limestone.

The uppermost stage of the limestone is the Brigantian, a coarse grained rock with much crinoidal debris. The rock weathers mechanically relatively easily to give a thicker soil and a more complete vegetation cover than the Asbian.

The limestones dip to the south-southwest at $1 - 5^\circ$ although in the eastern Burren folding is apparent - tightening to the east - and often monoclinial.

Two major joint sets (196° and $80^\circ - 90^\circ$) are developed throughout the region and provide the major guide for underground water flow.

Mineralisation has occurred to a limited extent especially where faults intersect joint lines.

The overlying rocks are the Namurian strata - shales grading upwards into sandstones, though including some calcareous horizons. The limestone - shale contact is not wholly conformable.

3. Geomorphic Evolution

It is virtually certain that at one time the whole of the Burren was overlain by Namurian strata. The development of landforms has been related to the progressive erosion of this cover to expose the older limestones beneath. A possible developmental sequence is illustrated in Figure 3. Initial erosion was concentrated in the Gort-Kinvara area - now a lowland. Removal of the Namurian rocks proceeded from northeast to southwest and thus karstic landforms are progressively better developed eastward from the present-day shale margin.

The initial removal of shale was by dip-slope streams flowing to the southwest. Eventually limestone was exposed in the bed of these streams and they sank underground. Progressive headwards retreat of the sinks then left the valleys completely dry. Gradually the fluvial network decayed and the centripital drainage pattern of dolina evolved. The very large closed depressions (e.g. Carran, Kilcorney) probably originated from inliers of limestone exposed in pre-glacial times.

The effects of the two major ice advances of the Pleistocene were to remove the remaining shale residuals from the High Burren and to deepen pre-existing valleys and dolina. Thus the Burren is not a true karst area as many of the landforms are relict fluvial or glacial features with a veneer of karstic landforms.

4. Vegetation and Soils

The soils of the Burren are largely azonal or intrazonal in character, often strongly reflecting the nature of their parent material.

The Namurian rocks are ill-drained and acidic and soils are strongly gleyed. Peat is widespread in these areas. Soils developed on the bare limestones are typical rendzinas 3-15cm in depth, though leaching is sufficiently effective to have rendered the upper portion of many profiles slightly acidic. Where glacial drift overlies the limestone shallow brown earth soils are developed, varying in form with topographic position.

The dominant vegetation of the Burren is plagioclimatic or immediately post-plagioclimax. The uplands are dominantly grasslands though corylus scrub has become widespread in areas no longer used for agriculture.

Remnants of the natural vegetation are still widespread and include unusual conjunctions of plant communities of diverse origins. Several species of Lusitanian flora are relatively common (e.g. *Crithmum maritimum*) as are several species of alpine-arctic flora (e.g. *Dryas octopetala*, *Gentiana werna*). Palynological evidence suggests that much of the Burren carried a woodland cover until Bronze Age times, and the peat bogs have certainly developed during this period.

5. Hydrology

The approximate catchments for the major springs draining the Burren are shown in Figure 5. The majority of the springs occur in the intertidal range on the coast or beneath the sea - presumably developed in relation to lower post-glacial sea levels. Exploitation of these springs for water supply is thus rendered difficult.

The two large inland springs are those at St Brendan's Well and Fergus River. Water tracing experiments suggest that in detail the hydrology of the area is complex, underground flow paths often uniting only very close to the springs.

Much of the groundwater flow is at shallow depth in discrete conduits and little evidence is forthcoming for the existence of a regional

water-table in the plateau areas.

Water supply problems are acute in the High Burren and until recently tiny seepages of water determined the location of farms and other settlements. Rainwater tanks fed by roof runoff or concrete aprons are widespread. Exploration for groundwater via conventional drilling methods have not been widespread or very successful. As in many upland karsts yields are unpredictable and the depth to water varies by as much as 70m within small areas. No attempt has been made to utilize the underground streams known to exist at shallow depth.

Precipitation in the area exceeds 1400mm annually but runoff is very rapid - springs exhibit the flashy hydrographs associated with surface streams and storativity in the limestone is probably less than 0.1. Some of the springs which are fed largely by percolation water do exhibit a considerable baseflow component and might be used for water supply. Only two sources of local water are presently used for piped water supply - a series of small springs near Ballyvaughan and the overflow spring at Killeany.

Vertical infiltration of groundwater is impeded by the shale horizons within the limestone and a concentration of lateral flow occurs at this level - as for example in the area around Aillwee Cave.

6. Man and the Burren (Emma Plunkett-Dillon, T.C.D.)

The Burren is characterised by the bare bleak nature of the landscape. Nevertheless, the evidence suggests that man has occupied this area for a considerable length of time and probably in fairly large numbers. This abundance of evidence has undoubtedly survived because the basic building material was ~~stone~~ slabs.

The earliest indication of man on the Burren comes from the

wedge-shaped megalithic tombs thought to have been built in the early Bronze Age. Their distribution over the high Burren suggests these people had a pastoral economy.

Another prominent feature of the landscape is the circular stone fort or caher. These were built as defensive enclosures for animals and humans. Dating is very difficult but it is possible they were first constructed as early as the third or fourth century A.D. They range from small animal enclosures, to family enclosures such as Caherconnell and Cahermacnaghten, to large defensive forts such as Caher Comaun.

After the successive invasions of Ireland, new architectural elements appeared in the Clare landscape. First there was the church. This resulted in the founding of monasteries such as the Cistercian Abbey of Corcomroe. Apart from the monasteries small churches were also built. Modern parish churches are placed on the site of many of the original churches but the rest are in complete ruin, for example, the church at Ucht Ma^á.

The Norman invasion introduced new square buildings. This is best typified by the square or round stone tower houses. A good example is to be found at Newtown, just south of Ballyvaughan. This invasion changed the whole of Gaelic society but Clare was isolated enough to retain many Gaelic customs and traditions. Thus people still built and used cahers in the thirteenth and fourteenth centuries. This probably accounts for their prominence in the landscape.

Aillwee hill is covered with an extensive network of stone walls some of which enclose very small fields. Many of these walls are extremely ruined but enough survive to suggest that the hill was used in a different way in the past. In addition to the boundaries there are several ruined cottages, small circular huts, long rectangular buildings, two cahers and three wedge-shaped tombs on the hill. The current practice of winter grazing within very few of the walls or the buildings,

This would imply one of two situations. Either there was a different agricultural system in use or else the environment was different.

The historical evidence suggests that a pastoral economy dominated Burren agriculture for at least the last three hundred years. On Aillwee cattle were grazed though sheep were present at the beginning of the nineteenth century. Herders lived on the hill to watch these animals. In the nineteenth century these herders lived in the cottages but prior to this small circular stone huts were used. The documentary evidence explains very few of the features on the hill. Only the larger fields, the houses and the huts can be placed. This infers that the other phenomena must be earlier than the seventeenth century.

There are two distinct patterns of walls not explained by the historical evidence. One system consists of long parallel walls with irregularly placed cross walls. These fields are an average 1.5 acre in size. The other system comprises of small roughly circular enclosures which are isolated or in groups. On average these fields are 0.5 acres in size, though many are smaller.

Many of the walls enclose drift hollows and there is evidence that a lot of these were cultivated by the herders of the last three hundred years. Unfortunately, many of the walls lie on bare limestone and cannot be explained in this way. The size of the enclosures suggests tillage occurred in these fields. However, as the historical evidence suggests, that the physical appearance of the Burren has not changed since the sixteenth century and as it would take at least a thousand years for a soil cover to disappear, these fields probably date to the first occupation of the area.

The long parallel fields could belong to this period also or to a later date. The existence of two cahers on the summit suggests these fields could be medieval. A system of strip grazing could have been practiced by the caher owners in order to use the land efficiently.

One caher is very small and its location on a ridge suggests

a purely defensive function. The other is much larger and square in shape. It is this aspect that indicates the building is medieval in date. There is a large, well built, rectangular building over the major source of water in the area. This could be interpreted as a mill. As it is very close to the caher it is possible the mill was controlled by the caher owners.

Most of the smaller buildings would appear to be either small huts used by the herders, lamb or kid shelters or turf stores. There are many small buildings in and around the caher. It seems likely that the caher was used by the herders for successive generations, to provide shelter and stores.

There are three basic soil types in the area - drift soils, rendzinas and peat. Today the drift soils are scattered over the hill in isolated patches. The evidence suggests that the drift cover was far more extensive than at present but that there was never a complete blanket of soil on the hill. This fact confirms that the small enclosures are quite likely to be Bronze Age in date but that the extensive network of long parallel fields is more likely to date to a period between five hundred and thirteen hundred A.D.

Physical and chemical analysis of the soils confirms that there has not been widespread cultivation on the hill in the last three hundred years.

Further support for the Bronze Age date of the small circular enclosures comes from the amount of evidence for Bronze Age activity in the area. Three wedge-shaped tombs are found on the south westerly flank. A magnificent gold collar, dated to this period, was found on a grike on the hill. The area is covered with small stone cairns which are probably burial cairns. A bronze age bracelet was found in one of the larger examples.

In conclusion the evidence appears to suggest a possible sequence of land use on the hill. It would seem the area was first occupied by Bronze Age farmers who grazed animals on most of the hill but who cultivated any suitable areas of drift soil. By the time the Caher dwellers took over the hill a lot of the drift would have been eroded and cultivation would have been severely limited. These people utilised the environment efficiently by operating a system of strip grazing. From the sixteenth century onwards grazing was the dominant agricultural practice. The herders had large fields for their animals though possibly smaller fields were built when sheep were on the hill. Cultivation would have been restricted to small pockets of residual drift soil.

It would appear that at one stage there was a different environment but there is some evidence of different method of using the landscape. As this upland is typical of the high Burren it is possible that this succession of practices and sequence of landscape change occurred throughout the area.

FIGURE 2 KEY MAP OF THE BURREN

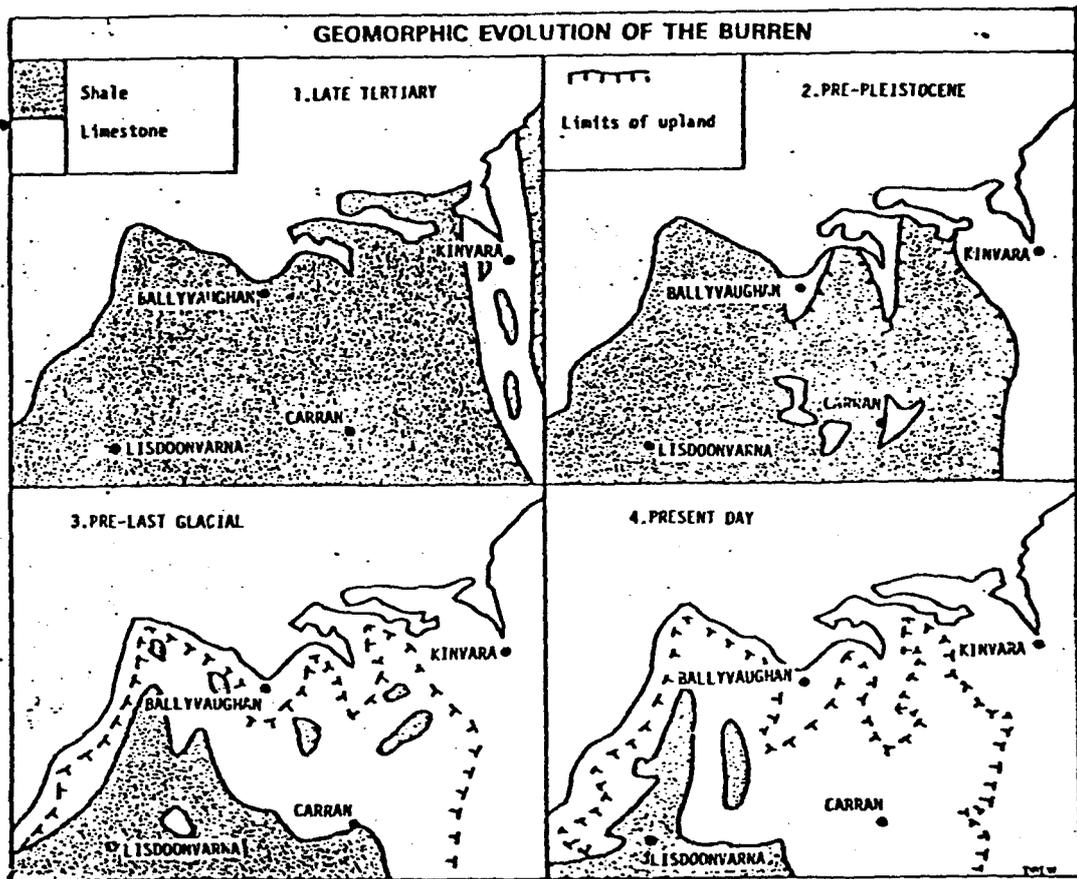
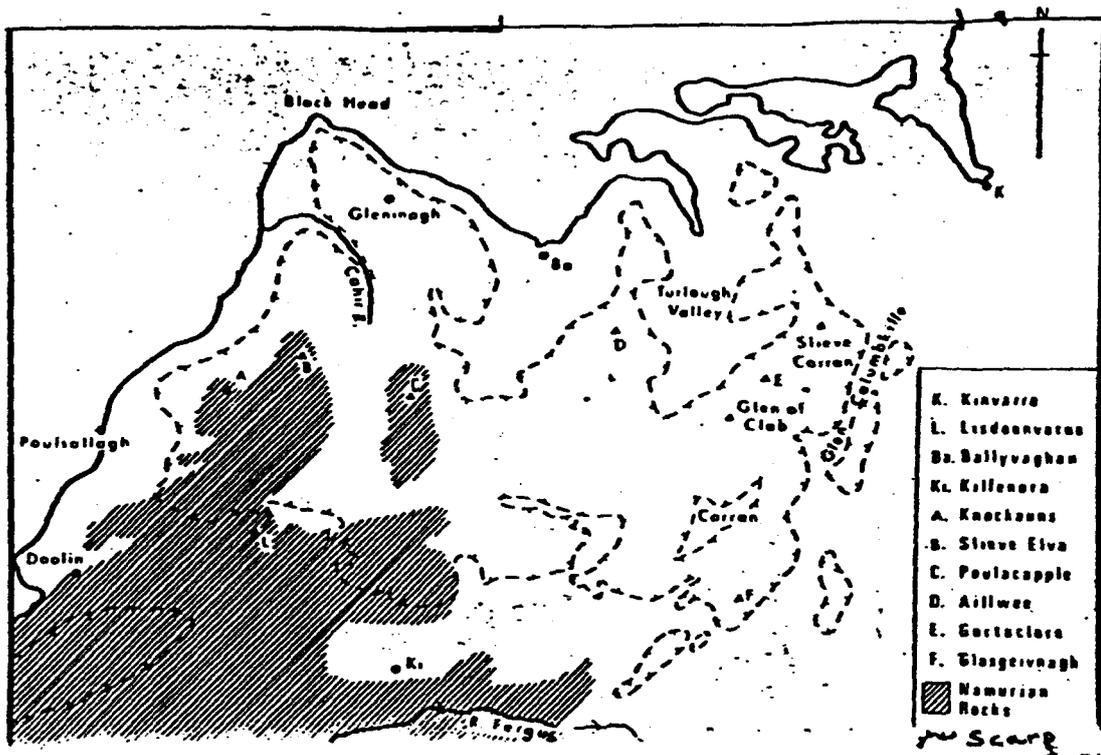
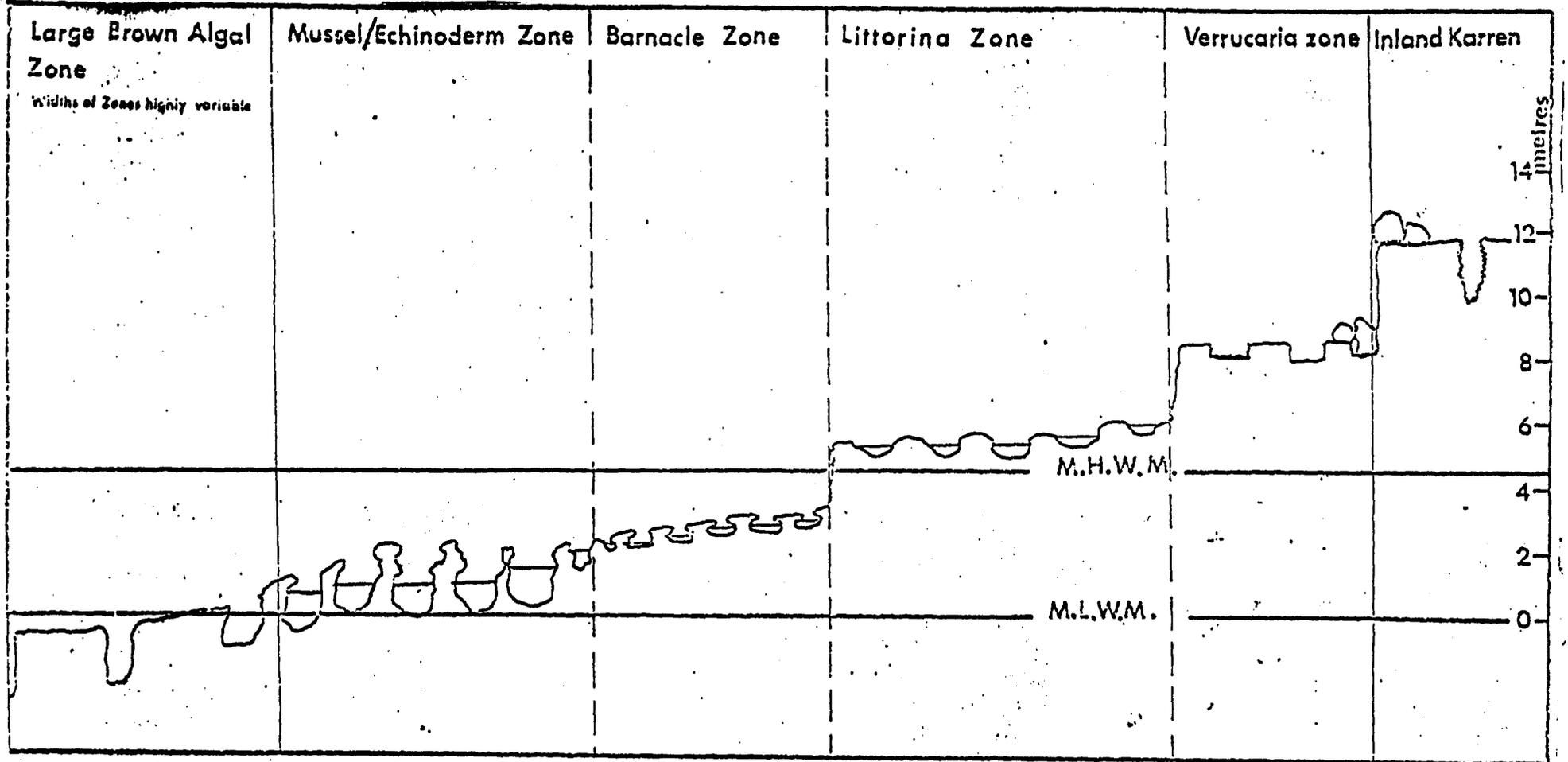


FIGURE 3

FIGURE 4 IDEALISED SECTION OF COASTAL KARREN AT POULSALLAGE



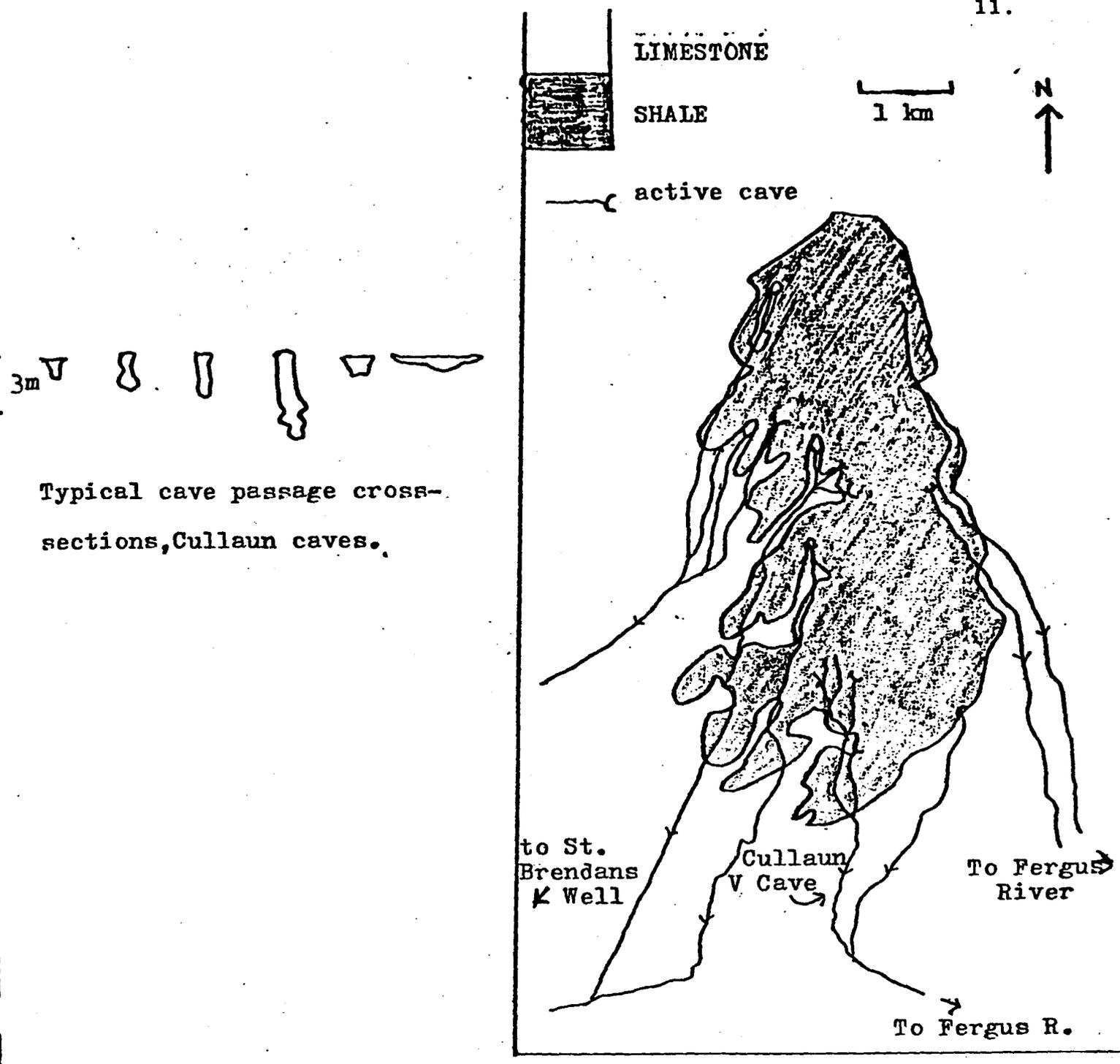
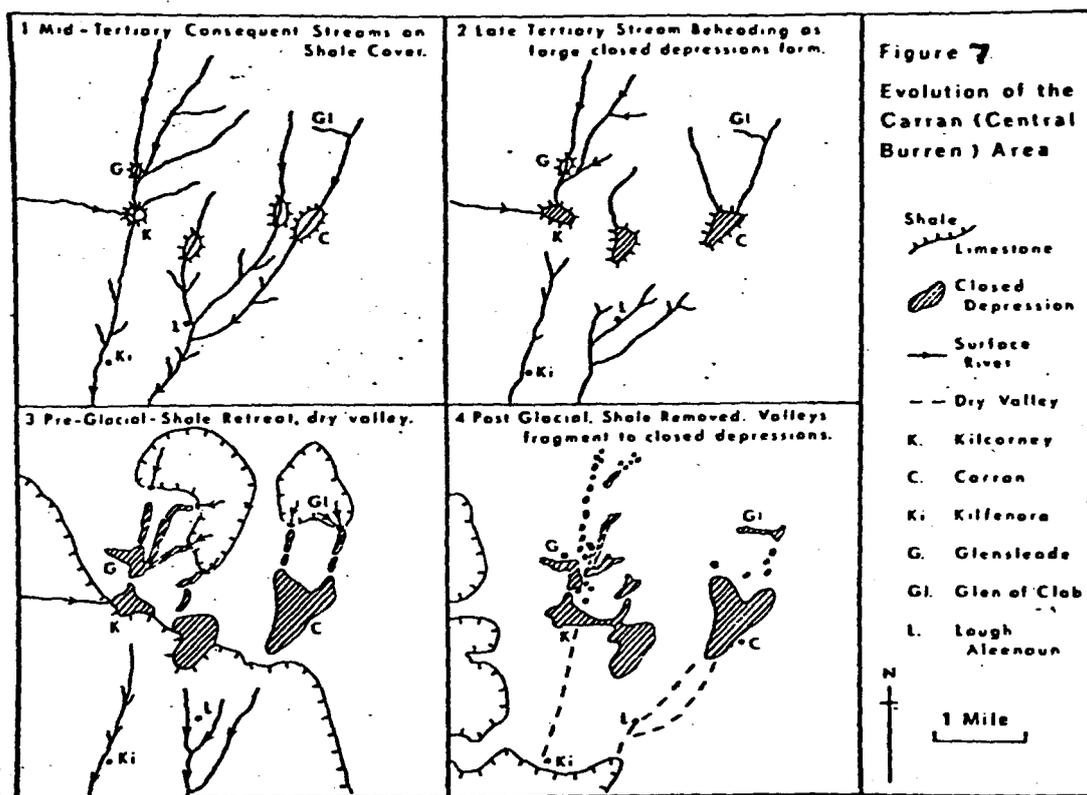
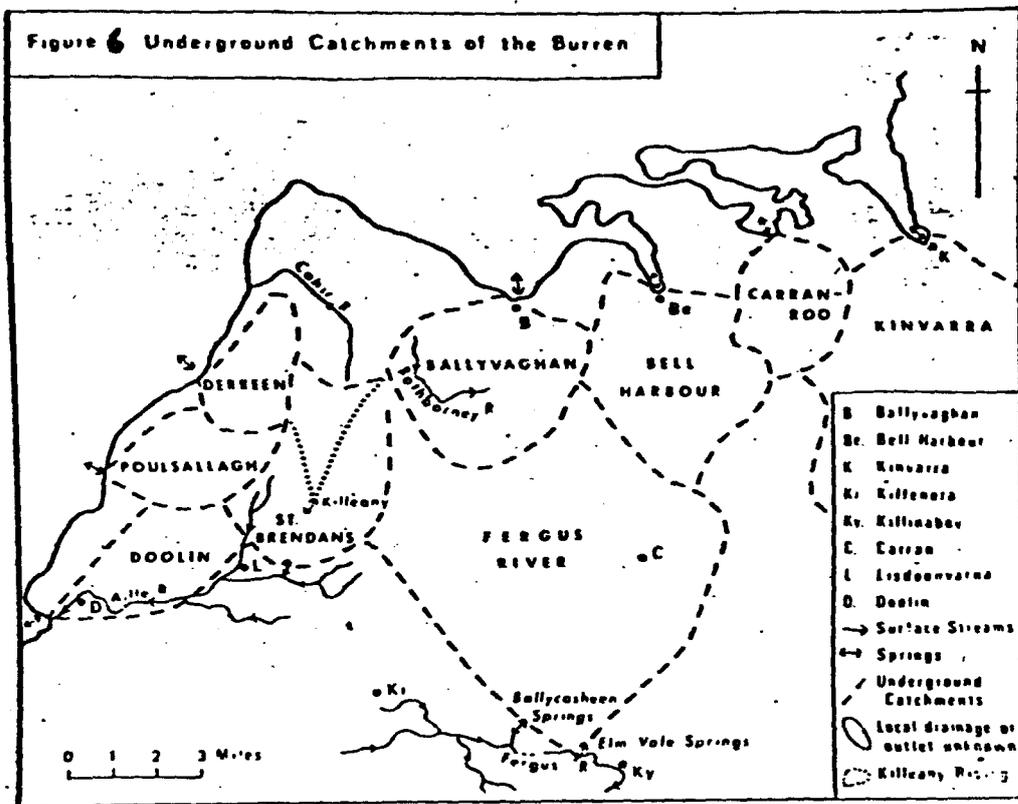


FIGURE 5 UNDERGROUND DRAINAGE ON POULACAPPLE HILL - SHALE/
LIMESTONE CONTACT



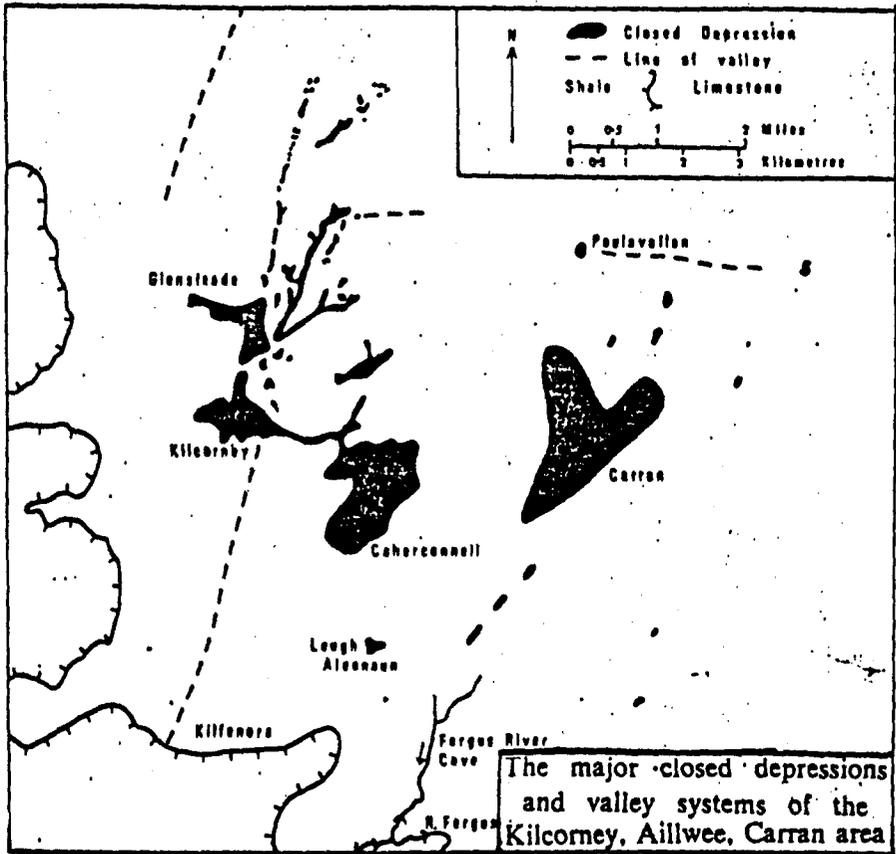
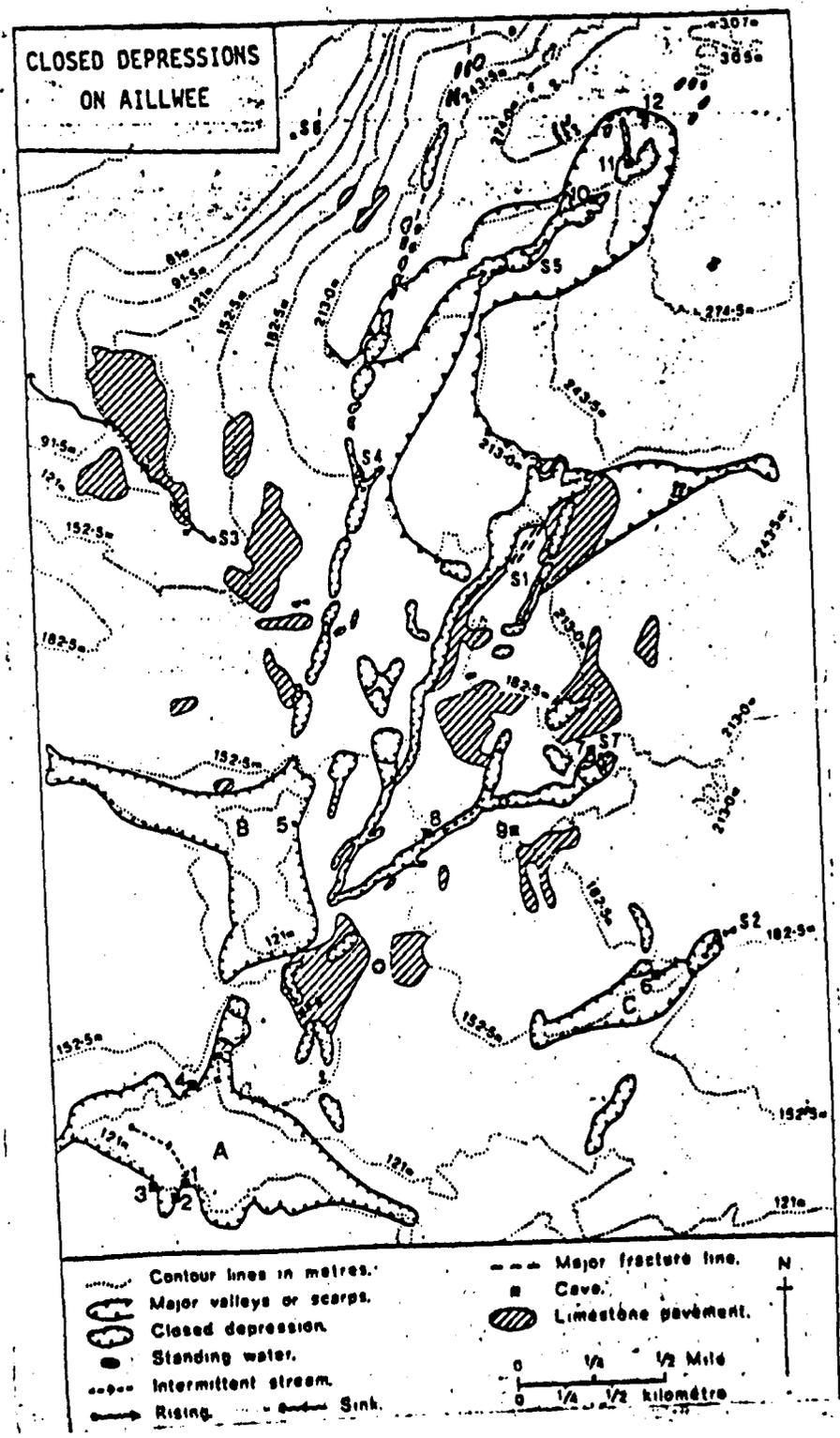


FIGURE 8



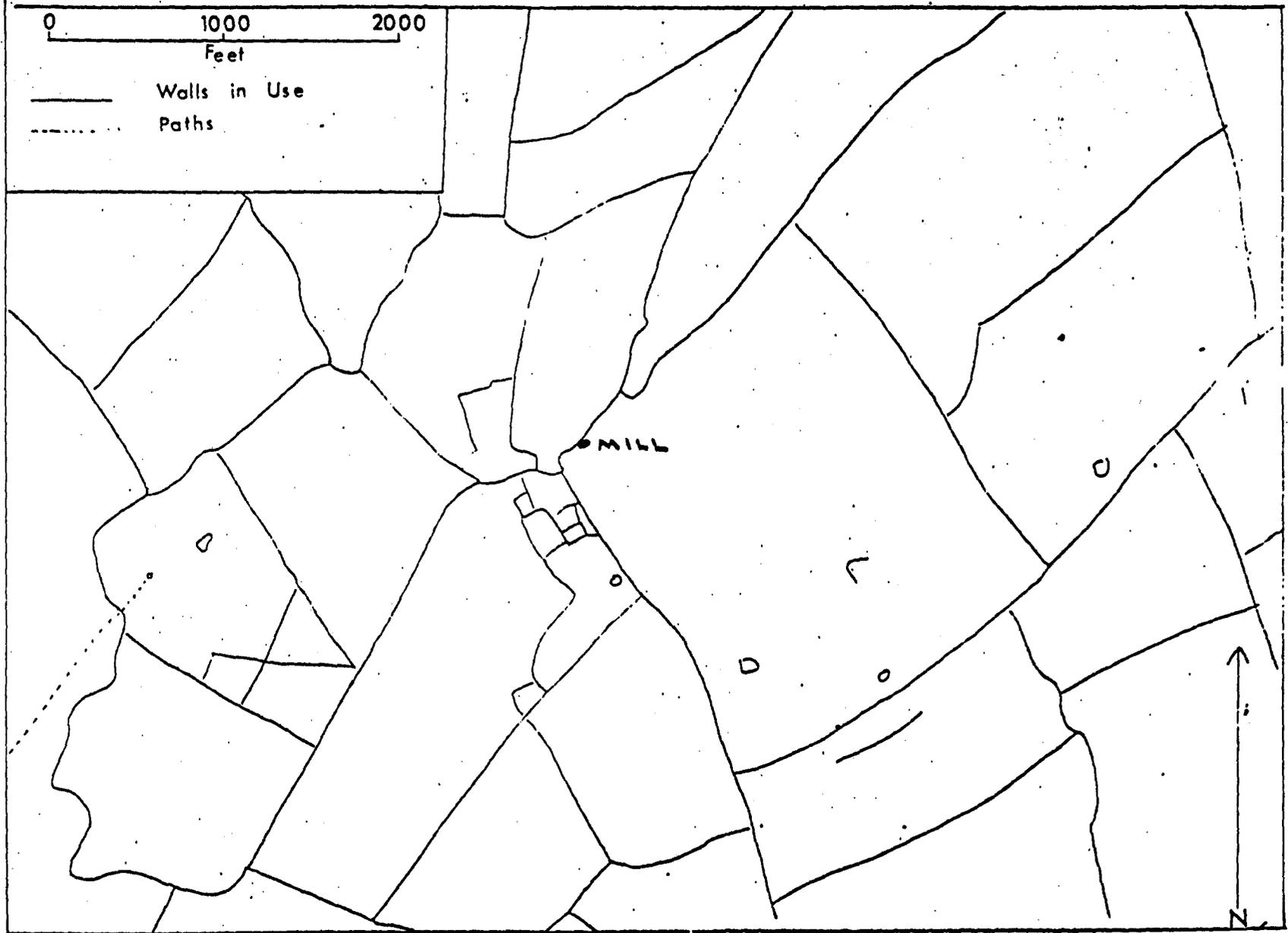
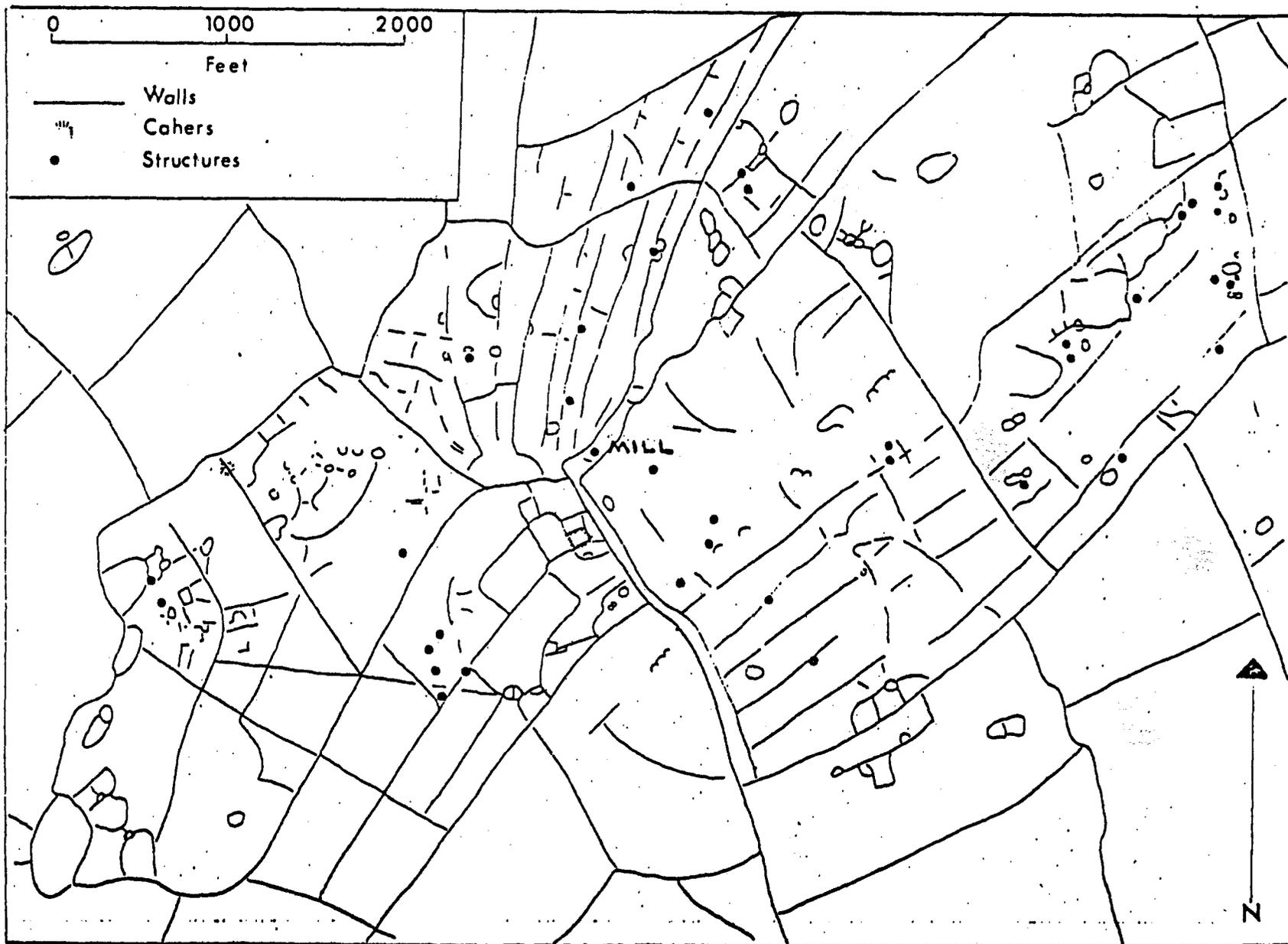


Fig. 10A
Landscape Features
Used in the
Present Economy

3. 108
Human Features
the Study Area



PLAN OF AILLWEE CAVE

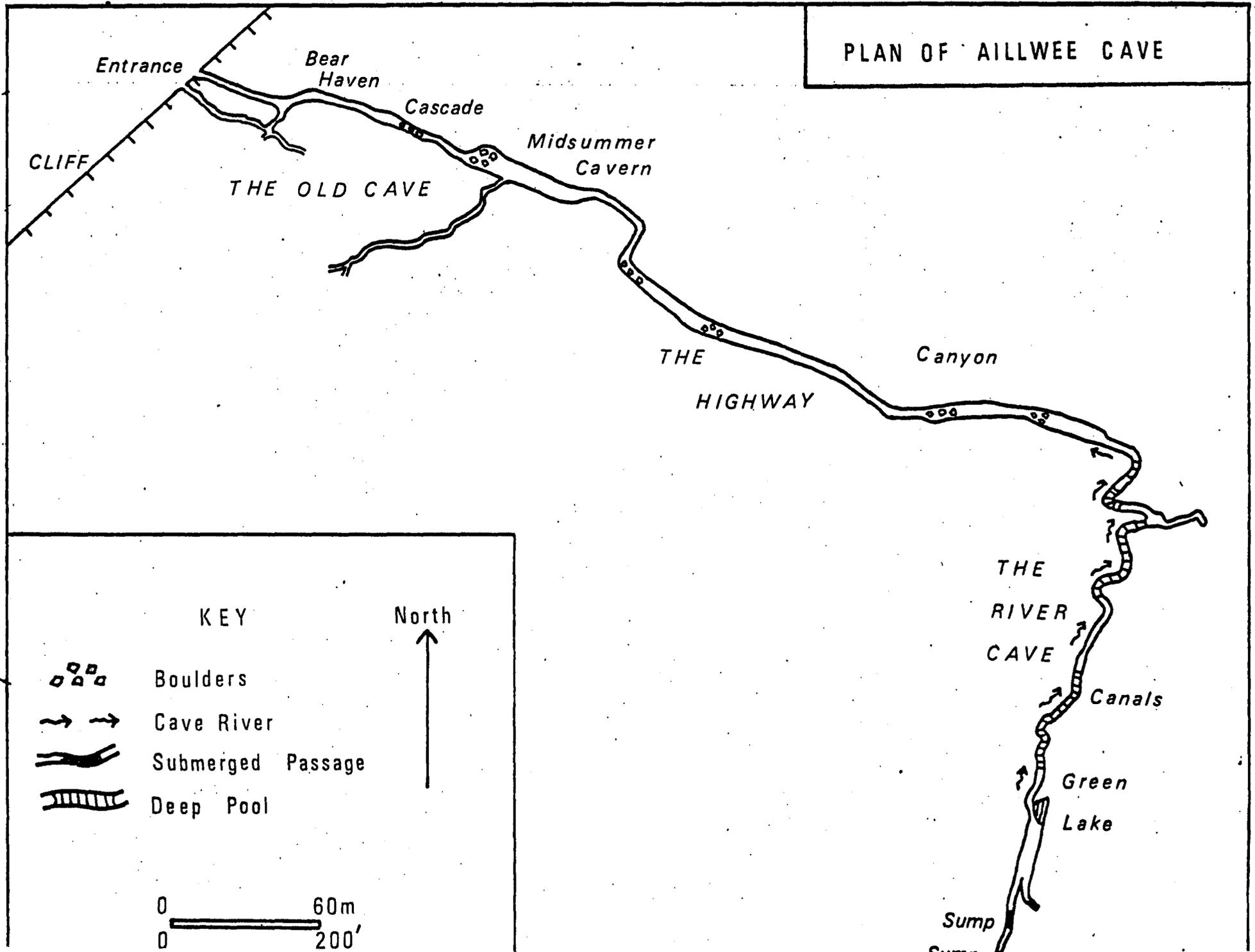
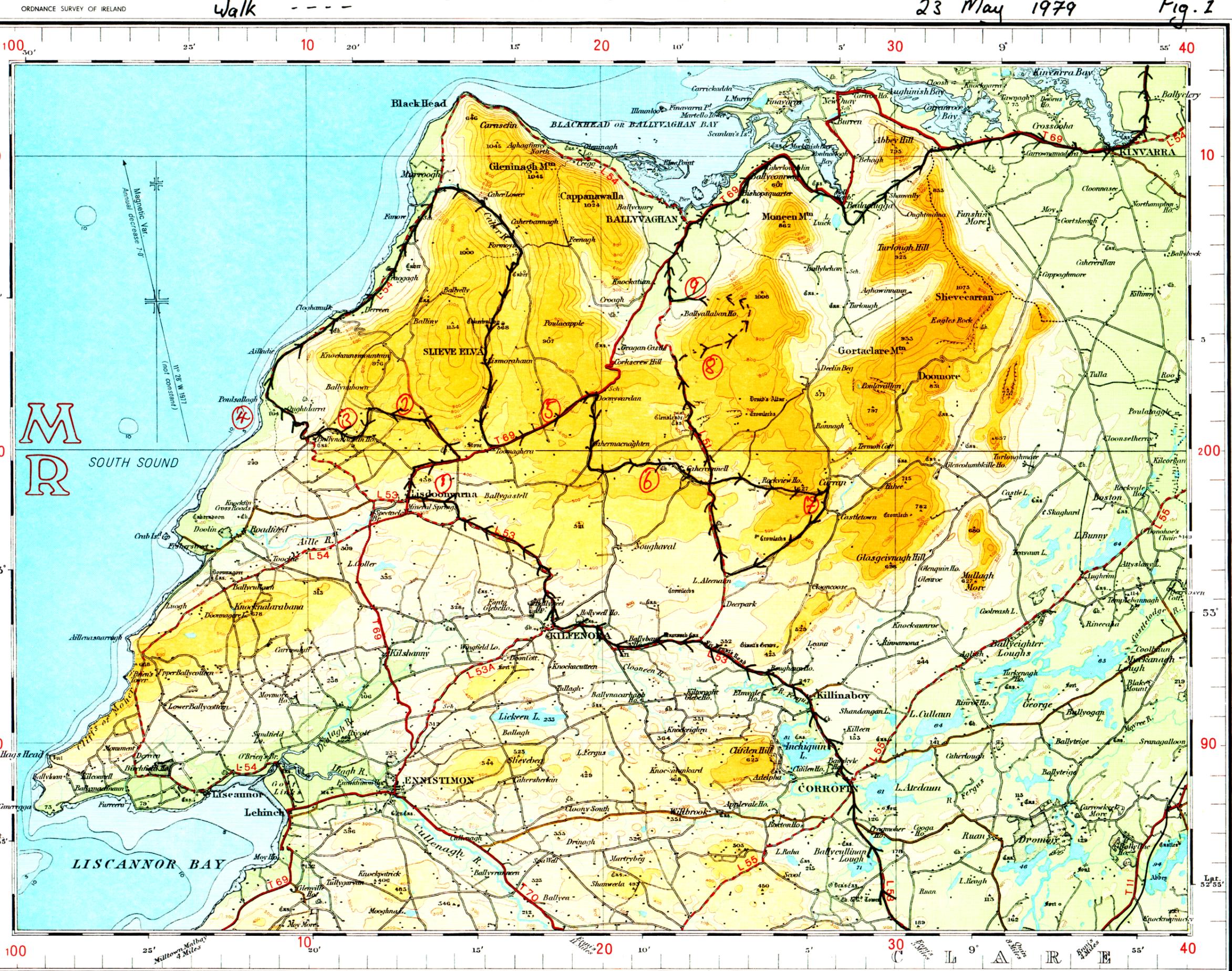


FIGURE 11.

THE BURREN

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23 May 1979
Fig. 1



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SOUTH SOUND

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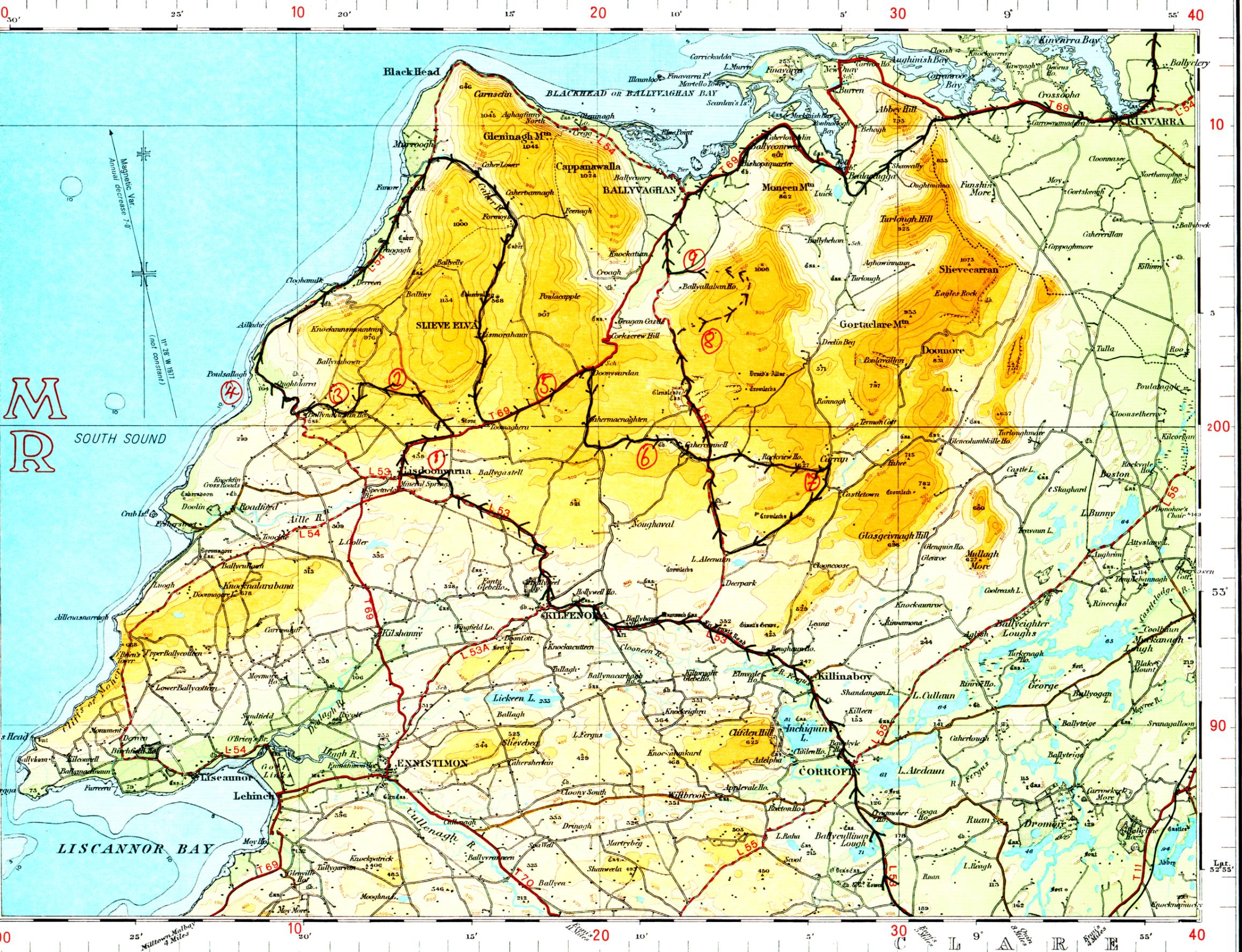
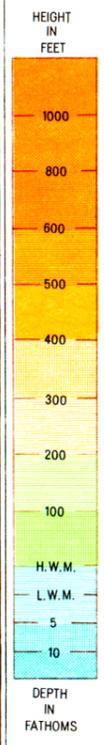
LISCANNOR BAY

100

- Trunk Roads T 69
- Link Roads L 55
- 3rd Class Roads L 54
- Other Roads L 53
- Footpaths L 55A
- Railways T 69
- Bridges L 54
- Youth Hostels L 55
- County Boundaries L 53
- Church or Chapel L 54
- Windmill L 55
- Lighthouse L 55A
- Contours L 53
- Submarine Contours L 54
- Woods L 55
- Station L 53
- Level Crossing L 54
- Power Station L 55
- Steam L 53

Scale of 1/2-Inch to One Mile = 126750
Altitudes are referred to Ordnance Survey Datum, which is a Low Water of Spring Tides observed in Dublin Bay on 8th April 1837, this datum being 8 218 feet below Mean Sea Level.
Published by the Director at the Ordnance Survey Office, Phoenix Park, Dublin.
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THE NATIONAL GRID
The Grid is divided into lettered Sub-Zones as shown by the diagram. A grid reference consists of the appropriate Sub-Zone letter, the Easting co-ordinate, and the Northing co-ordinate, of the position, given in that sequence.
EXAMPLE LISDOONVARNA R 13 98



ORDNANCE SURVEY OF IRELAND

