R. A. Hazelwood

PROCEEDINGS OF THE OXFORD UNIVERSITY CAVE CLUB

No. 6

PROCEEDINGS OF THE OXFORD UNIVERSITY CAVE CLUB

NO. 4 MAY 1966

CONTENTS :-

INTRODUCTION

I am delighted to be asked to write an introduction to this number of the Oxford University Cave Club's Journal. Since the O. U. Cave Club was formed a few years ago it has been very active, particularly during university vacations. Some of this work is recorded in the present Journal. Undergraduate clubs have the difficulty that hardly any of their members remain for more than three years and the officers are a continuously changing body of people. It is therefore to the credit of the O. U. C. C. that so much work has been accomplished.

The opening up of the Picos de Europa area in N. Spain has been largely due to the activities of the O. U. Cave Club. The original work, started there in 1961, has been followed up by subsequent expeditions both from Oxford and elsewhere. Some of the more recent work by M. J. Walker et al. is incorporated into this issue. The O. U. C. C. may justly claim that this part of Spain is "their ground," and it is to be hoped that the Club will make this area one of their long term projects. The University of Bristol Spelaeological Society's campaign of work in Co. Clare in Ireland shows what a normal university caving club can do in the way of a long term project; and this work by the U. B. S. S. is shortly to be integrated into a book - " The Caves of N. W. Clare " - dare I suggest that we look forward to a book - " Caves of N. Spain "?

Nearer home the O. U. Cave Club has interests in S. Wales, and in the local limestones of the Oxford region as Mr. Sanders' paper shows. I hope that the Club will feel able to embark on some long term projects here also. University caving clubs are particularly suited to the development of simple schemes demanding a large number of people using rather simple techniques. Observations on the calcium content of cave streams of limestone areas, measurements of the sizes and numbers of sinkholes in S. Wales, such are examples of the problems that might be tackled by an undergraduate caving club. It is to be hoped that, in addition to the fun of purely sporting caving, the O. U. Cave Club will continue to devote some of its time to investigating problems of real interest to science.

M. M. Sweeting
March 7th., 1966

CAVE DEVELOPMENT IN THE WESTERN CANTABRO-ASTURIC MOUNTAIN CHAIN (SPAIN)

Introduction.

Five years have passed since the first Oxford spelaeologists began investigations in the western part of the Cantabro-Asturic mountain chain, and it is convenient to publish some conclusions on cave development in the area. We may never understand all the parameters of cave solution by melt-waters from the deep winter snows which overlay the mountains for six months of each year, but we can define interesting relationships between features due to subterranean erosion and some surface physiographic erosional phenomena.

Whereas the eastern part of the Cantabro-Asturic chain has been well investigated by French (11) and Spanish (26, 29) cavers, especially in recent years, the caves of Asturias and León to the west had received less attention. In the eastern Cantabrians near Ramales (Santander) the deep Sima del Mortero has been explored to a depth of -453 metres, whilst the fall between entrance and resurgence is -695 m. .

In the neighbouring province of Vizcaya (see map 1) the Torca del Carlista system reaches a depth of -360 m. . These deep cave systems have attracted many French expeditions to the eastern area of the Cantabro-Asturic range over the past ten years, whilst the Grupo Espeleológico Vizcaíno has recorded 484 systems in Vizcaya alone(26).

The western mountains have been the preserve of British expeditions, except for a visit to the Picos de Europa (Asturias) by the Spéléo Club Languedocien that yielded 100 " cavités " (11), and an early visit by three French bio-speleologists (9) who mainly avoided the higher altitudes. Spanish spelaeologists, relying heavily on the 19th. century catalogue of G. Puig y Larraz (29), explored caves in the foothills of the Asturic mountains and recorded 195 cave entrances (21). Leonese cavers confined their activities to a few large caves in the Torío valley (15). Since 1961 seven English teams have visited the Picos de Europa, working at altitudes untouched by previous visitors;

1961 Oxford University Expedition to Northern Spain (6, 7*, 28*, 44, 47

1962 Oxford University Cave Club Summer Expedition to the Picos de Europa (25, 45)

1963 Oxford-Derbyshire Speleological Expedition to N. W. Spain (13, 32*, 43, 44)

1963 Manchester University Expedition to the Picos District of N. Spain (30)

1964 University of Nottingham Student Union Spelaeological Expedition 1964 Picos de Europa, N. W. Spain (10, 41*)

1965 Manchester University Speleological Society Expedition to the Picos de Europa

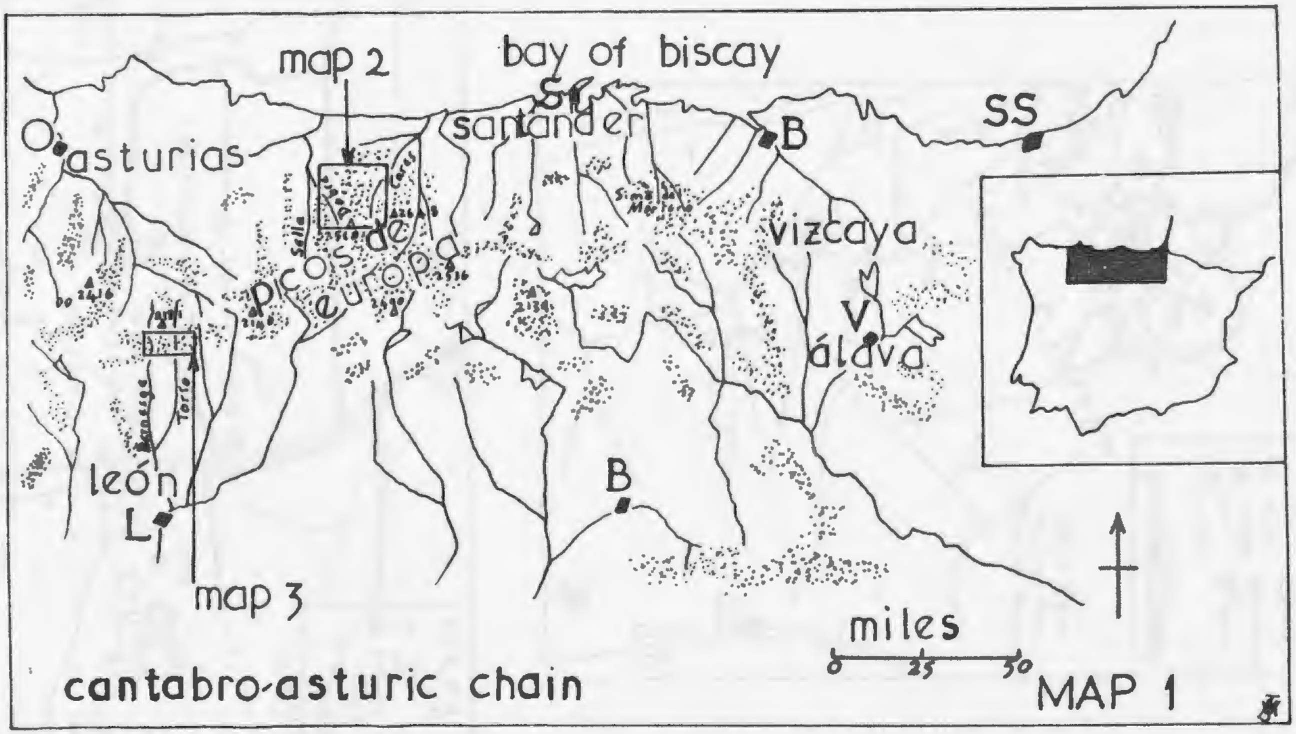
1965 British Speleological Expedition to the Cantabrian Mountains (5, 12, 31*)

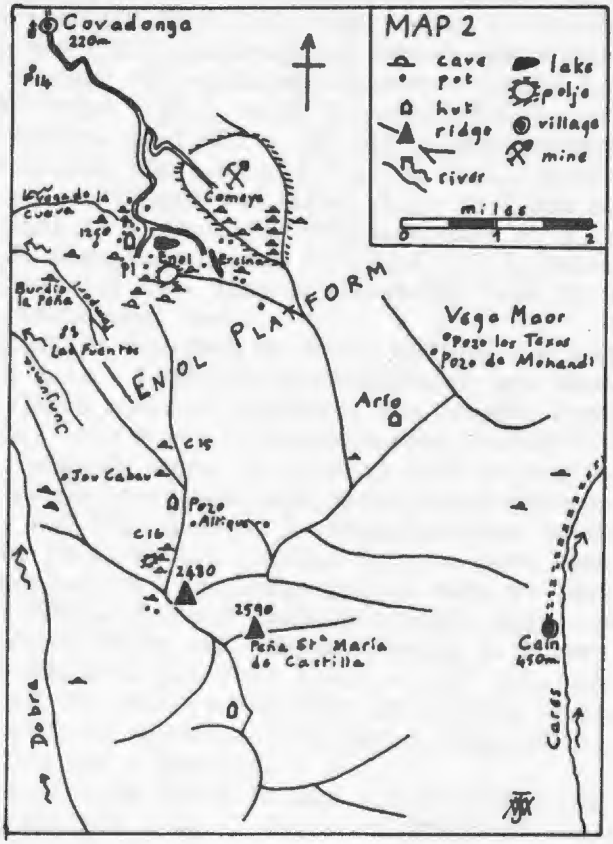
The more informative references have been asterisked. The last expedition in the list also worked in the Leonese caves around the Torío valley as well as in the Picos de Europa in Asturias.

Landforms.

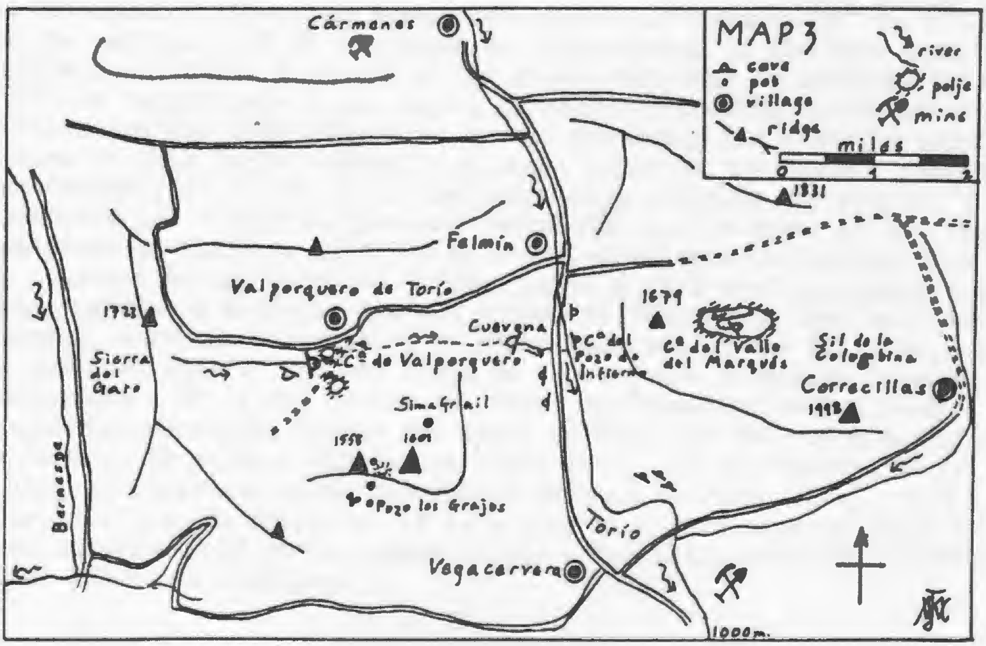
Accounts of the tectonics and stratigraphy of the western Cantabro-Asturic mountains have been given by many workers (thus 1, 2, 16, 17, 20, 33, 34, 36-39, 42). Here it suffices to state that scant traces remain of the Mesozoic peneplain that was dislocated by the folding that began in the Oligocene (17). Few traces also remain of the SE-NW direction of the ancient Hercynian orogeny, except for some mountains in León (42), and perhaps the NE-tending trench of the Río Cares in Asturias. Tertiary N-S compression has produced compartmentalised blocks parallel to the Biscay coast. One such block, the Sierra de Cuera, has probably deflected the course of the Cares to the ENE. Llopis attributes the platforms encountered at between 1,100 m. and 1,400 m. to a Miocene partial peneplanation. English spelaeologists have studied extensively the Enol platform in the western massif of the Picos de Europa. This is not a level platform, but slopes at an angle of 5° for 4.5 kms. up to the bases of the steep limestone pinnacles of the peaks. Everywhere the angle of dip of the massive Namurian limestone (caliza de montaña) is very acute, and often vertical. In spite of the considerable Mesozoic erosion (33, 42), Upper Carboniferous limestones (mainly Namurian) are still present from near sea-level to the summits of the peaks at about 2,600 m. .

Earlier studies have described in detail the effect of glaciations on the high mountains (7, 22, 33). Traces exist of the Würm and Riss


bay of biscay
map 2
O
asturias
S
santander
B
SS
vizcaya
V
álava
picos de europa
león
L
B
map 3
miles
0
25
50
cantabro-asturic chain
MAP 1



MAP 2
cave
pot
hut
ridge
river
lake
polje
village
mine
miles
0
1
2
Covadonga
220m
P14
Comeya
Vega de la cueva
Enol
Ercina
P1
ENOL PLATFORM
Vega Maor
Pozo los Texos
Pozo de Mohandi
Ario
C15
Pozo Altiquero
C16
2480
2590
Peña Stª María de Castilla
Cain
450m
Cares
Dobra



MAP 3
cave
pot
village
ridge
river
polje
mine
miles
0
1
2
Cármenes
Felmín
Valporquero de Torío
1723
1831
1679
Cuevona
Cª de Valporquero
Cª del Valle del Marqués
Correcillas
1998
Sima Grail
1558
1601
Pozo los Grajos
Torío
Vegacervera
Bernesga
1000m.

glaciations only. The Würm glaciers seem to have covered land between 1,400 m. and 2,200 m. above sea level, whilst the earlier Riss ice-cap reached down to 1,100 m. above sea level. Around the high peaks at c. 2,000 m. the glaciers have left their marks in the radial corries bitten out of the peaks (7), although no corrie lakes have been formed owing to drainage through well-jointed limestone. Instead, scree-sided dolines of the " jou " type (20) occur between 1,600 m. and 2,200 m. which were formed by nivation. At 1,100 m. in the western massif of the Picos de Europa there occurs the U-shaped Vega de Enol, terminating in a moraine above which are contained two lakes, Lago Enol and Lago de la Ercina. The Vega de Enol is a synclinal valley ending at a large transverse fault at which ice-plucking has occurred (7). Below the fault there is a polje about 1.5 kms. long known as the Vega de Comeya. This polje has a mainly structural basis.

By contrast to the Vega de Enol, most of the other valleys on the Enol platform have a V-shaped cross-section, and drain the platform to the NW. Only Cares and its tributary the Casaño, drain to the NE, suggesting that they might be superimposed features. The Dobra, Junjumia, Pomperi, and Redumaña begin at between 1400 m. and 2,000m. above sea level. The streams sometimes pass underground between adjacent " jou " type dolines, and they descend in steep ravines to the Enol platform. Here, grade is gentler, and pluvial dolines have been formed, some of which must have coalesced to form large poljes such as that of Las Reblagas. Towards the 1,000 m. contour grade increases again, and rejuvenation has caused deep gorges to be cut. Those streams that have taken an underground course across the Enol platform resurge near this contour. Considerable rejuvenation of the valleys has been attributed to post-glacial uplift amounting to +100 m. consequent to the melting of the 1,000 m. thick ice-sheet. (See Map 2 and Fig. 1)

The area of León shown in Map 3 presents a complex tectonic and stratigraphic picture (42). The most prominent feature is the canyon of the Río Torío which is known as the Hoces de Vegacervera. The walls of the canyon are mainly Namurian limestones which in many places seem to be unbedded. Devonian limestones dipping at between 70° to 90° occur at the northern end of the Hoces de Vegacervera. On the west side of the canyon most of the drainage of the Sierra del Gato is received by the Cueva de Valporquero (see fig. 2). Large dolines in which terrace cultivation has been undertaken by the peasantry lie over the upper series of this large system. In a small polje to the south a recent expedition (31) set up a base camp while studying the region. Various " jou " type dolines and associated shafts occur on the ridge to the south at 1,400 m. to 1,500 m. . Well-developed lapiaz was also seen, in contrast to the Picos de Europa. Lotze (22) mentions glaciations in León, but these probably did not extend to the region that has been studied. A recent observation of stone polygons in the Valle del Marqués on the east side of the the Hoces de Vegacervera testifies to periglacial conditions (31). The extent of recent rejuvenation of the Torío canyon is uncertain. Whilst the lower entrance of the Cueva de Valporquero, La Covona, is perched high above river level, on the other side of the valley at least one large resurgence cave is at river level. This is the Cueva del Pozo de Infierno. It is a very high rift cave in which a wide, deep and very cold stream sumps deeply after being followed upstream for about 300 m. in a dinghy.

Spelaeogenesis.

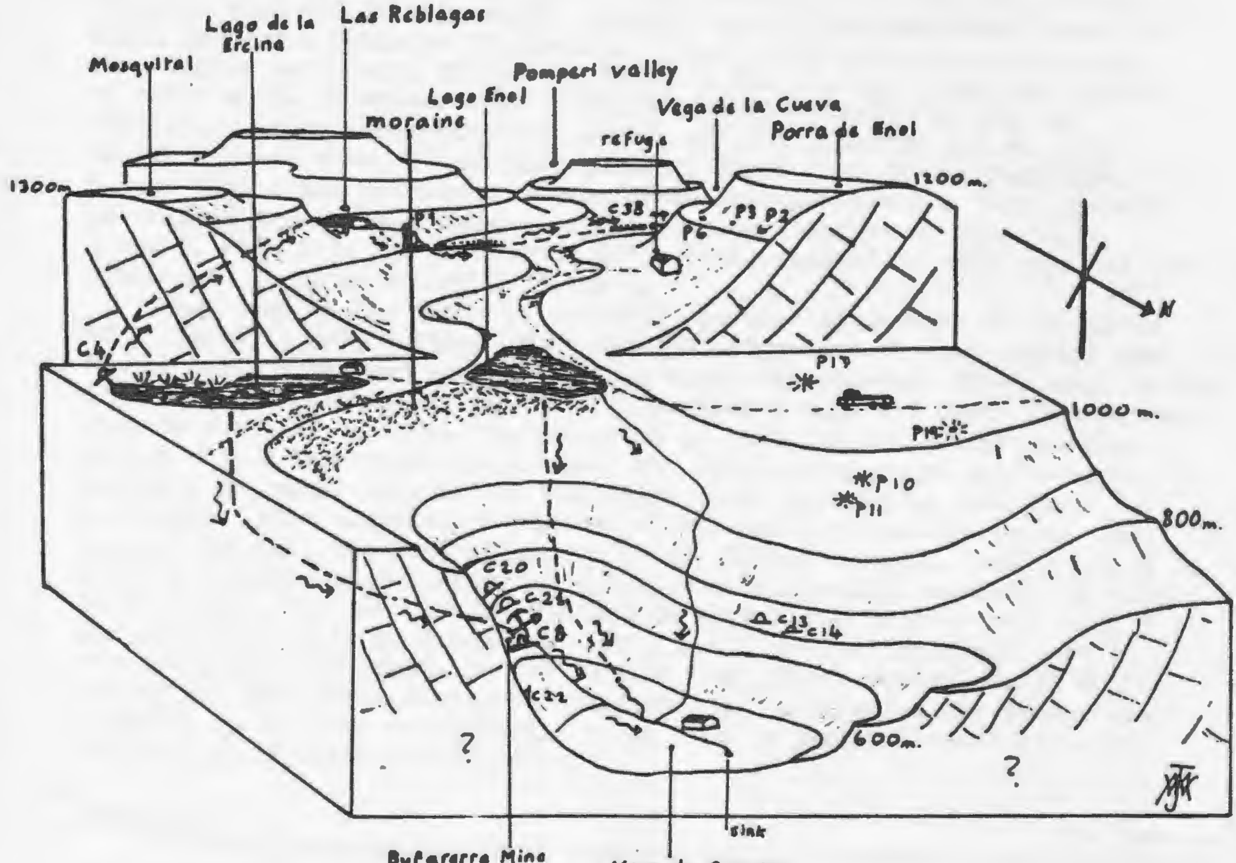
The Alpine orogeny in the Picos de Europa has removed any vestiges of earlier karst, apart from the fossil karst seen in geological sections. The Miocene partial peneplanation may have been responsible for the fossil caves of the Sierra de Cuera (20), but generally speaking, the features shown by the Asturic caves demand a Pleistocene spelaeogenesis (18, 19). Llopis studied the Cueva de Requeixu and concluded that there have been two " cycles " of cave formation, the second, at least, correlating with the uplift of the coastal terraces early in the Holocene. The initial "cycle" may well belong to the Riss-Würm interglacial. Similar chronologies have been proposed for Alpine cave systems by Corbel (3, 4) and Trimmel (40). Corbel has suggested that even such vast caverns as the Dachstein, Hölloch, and the Beatushöhle could have been formed entirely during the Pleistocene. This suggests a much younger spelaeogenesis for these caves than for British caves on Ingleborough whose formation has been correlated with erosion cycles of presumably far longer duration (35). At any rate, it has been claimed (46) that cave formation does not occur below ice sheets, thus limiting spelaeogenesis to ice-free periods. As at the Cueva de Requeixu, a two-stage formation has been proposed for the Cuevas de Fresnedo (14) which occur 700 m. above sea level in western Asturias, and were formed by successive down-cutting of the Río Sampedro. Interglacial and postglacial uplift seem to have been the mainspring behind cave formation in the Picos de Europa.

Throughout Asturias and León, tectonic structures have greatly influenced cave development, as has been noted in the Alps by Corbel (4). For example, a group of six shafts including the Pozo los Grajos, shown on Map 3, occur in relation to a minor fault.

Heterogeneity of the limestone is another factor influencing cave formation which has not as yet been adequately evaluated in the Cantabrians. Trimmel (40) noted that dolomitisation of limestone seems to have played a part in dictating cave location. The Cueva de Valporquero begins in a region of the Devonian limestone band (see Fig. 2) where dolomitisation is particularly pronounced, and the La Covona entrance lower down also occurs in dolomitised beds. Dolomitisation is also marked outside the entrance of the Cueva del Valle del Marqués on the eastern side of the Hoces de Vegacervera. Most of the caves of the León region are formed in Devonian limestones more closely jointed than the massive Namurian limestones.

As noted thirty years ago in the U. S. A. by Davis (8), steeply bedded limestones such as are everywhere met with in the Cantabro-Asturic chain frequently result in long, vadose cave passages with a marked preference for following the strike rather than the dip of the beds. These systems develop lateral extensions and networks only when they reach the water table. Two influent caves of this genus are the Cueva Orandi (P14, see Map 2), and the Cueva de Valporquero. An effluent cave which utilises two cross rifts is the Cueva del Vientó (C15, see Map 2). This cave shows networks of tubes at low levels where the water table is in close proximity. Some phreatic features have also been noticed in Pozo Palomero (P1, see Map 2 and Fig. 1) at low levels in the cave.

Nivation has been and still is important in the development of many vertical systems which often show traces of flooding in Spring such as might follow the melting of large snow banks. Some shafts have small eccentric entrances in dolines to one side of wide, domed potholes.



Drainage of the Vega de Enol. FIG. 1

Good examples of this type are seen in the region marked Las Fuentes in Map 2, and P17 (Fig. 1). The Pozo los Grajos pothole (Map 3) is another example, in León, which contains residual snow even in Summer. Permanent snow was not seen elsewhere in the Leonese region studied, although in the Picos de Europa small snow-fields remain throughout the year. The action of snow under pressure in such shafts may also be a component of spelaeogenesis. A large, domed chamber of unknown depth has been noticed in the Picos de Europa which is snow-filled. The snow enters via a small eccentric opening in the roof. A survey of this cave, C16, is given in (28). The deposits of argillaceous material at the bottom of P17, and the traces of flooding observed in this shaft, suggest that it may have been formed by rapid irregular episodes of flooding, which could occur if melt-waters from Winter snow-banks filled the shaft in the Spring. A standing column of water would be expected to dissolve a shaft radially as well as vertically, thus explaining the narrow, off-set openings and the wide shafts beneath them. A high back-pressure might lead to the formation of a dome behind the entrance, or even cause solution along a joint upwards as well as downwards. This may explain the development of Sima Grail (Map 3, Fig. 2). The phenomenon of "inverse erosion" of this type has been studied in Italy by Maucci (23, 24).

Many deep shafts occur in curiously perched situations on the sides of hills or in deep dolines. They must be attributed to their having been fed by meltwaters from snow-banks long since disappeared. Three small shafts above the mountain refuge in the Vega de Enol (Fig. 1) occur thus perched high on the side of a hill called Porra de Enol. As the valley was once filled with a tongue of the glacier, the position of these shafts might indicate the upper edge of the ice above which snow-banks would have collected. Other examples of perched shafts are the Pozo los Texos, the Pozo de Mohandi, the Pozo Altiquero (Map 2) and the Sima Grail (Map 3). These are much deeper shafts, often quite wide, leading sometimes to steep scree slopes. The scree maybe due either to collapse (of a domed roof ?) and/or to freeze-thaw. Frost-shattering has played an important part in the development of shafts in the Vega de Enol, where several small shafts are filled with frost-shattered boulders (47). Likewise the present-day entrance to the cave of El Burdio de la Peña is partly blocked by talus from the cliff which overhangs it.

Chronology. the Holocene and

The most important piece of evidence for the formation of caves during the Riss-Würm interglacial in the Picos de Europa is the reversed drainage of the Vega de Enol (see Fig. 1). Until thirty years ago, water from the Lago de la Ercina flowed down to the Bufarrera mine in the Vega de Comeya to the NE. Recently, the miners have been unable to rely on the lake as a reservoir for their ore-dressing operations, although they still receive water copiously from the Lago Enol. Dye tests (28) showed that underground connections exist between C4 at the southern end of the Lago de la Ercina and the Vega de la Cueva to the NW. Almost without a doubt, the Las Reblagas polje, the Pozo Palomero (P1) cave system, and C38 are connected with the devious new drainage of the lake to the NW. The Vega de la Cueva joins the Pomperi valley, itself a tributary of the Río Dobra. The result is that the water which until recently drained NE, now joins the main pattern of NW-tending valleys which cut across the Enol platform.

The reversal of the drainage of the Lago de la Ercina can only be explained by postulating increased rejuvenation and down-cutting of the NW-tending valleys in post-glacial times, since the lake itself is only a recent, glacial phenomenon. The absence of the tongue of the glacier which once filled the Vega de Enol has removed the impetus behind the rejuvenation of the NE drainage into the Vega de Comeya, and the rejuvenation of the Pomperi and Dobra valleys has thus overtaken that to the NE and so captured the water of the Lago de la Ercina. The Lago Enol, being at a very slightly lower altitude, although still behind the same moraine as its companion lake, has not yet been captured, although one may speculate that in time it will also cease to drain into the Comeya polje.

Since the postulated rejuvenation of the Pomperi valley must post-date the formation of the glacial lakes, the caves formed in connection with the reversal of the drainage of the Lago de la Ercina must be of very recent origin indeed. In short, Pozo Palomero, C4, and C38 must be dated within the recent Holocene period. It is likely that many of the shafts and caves near the Vega de Enol are of periglacial formation, as has been suggested above.

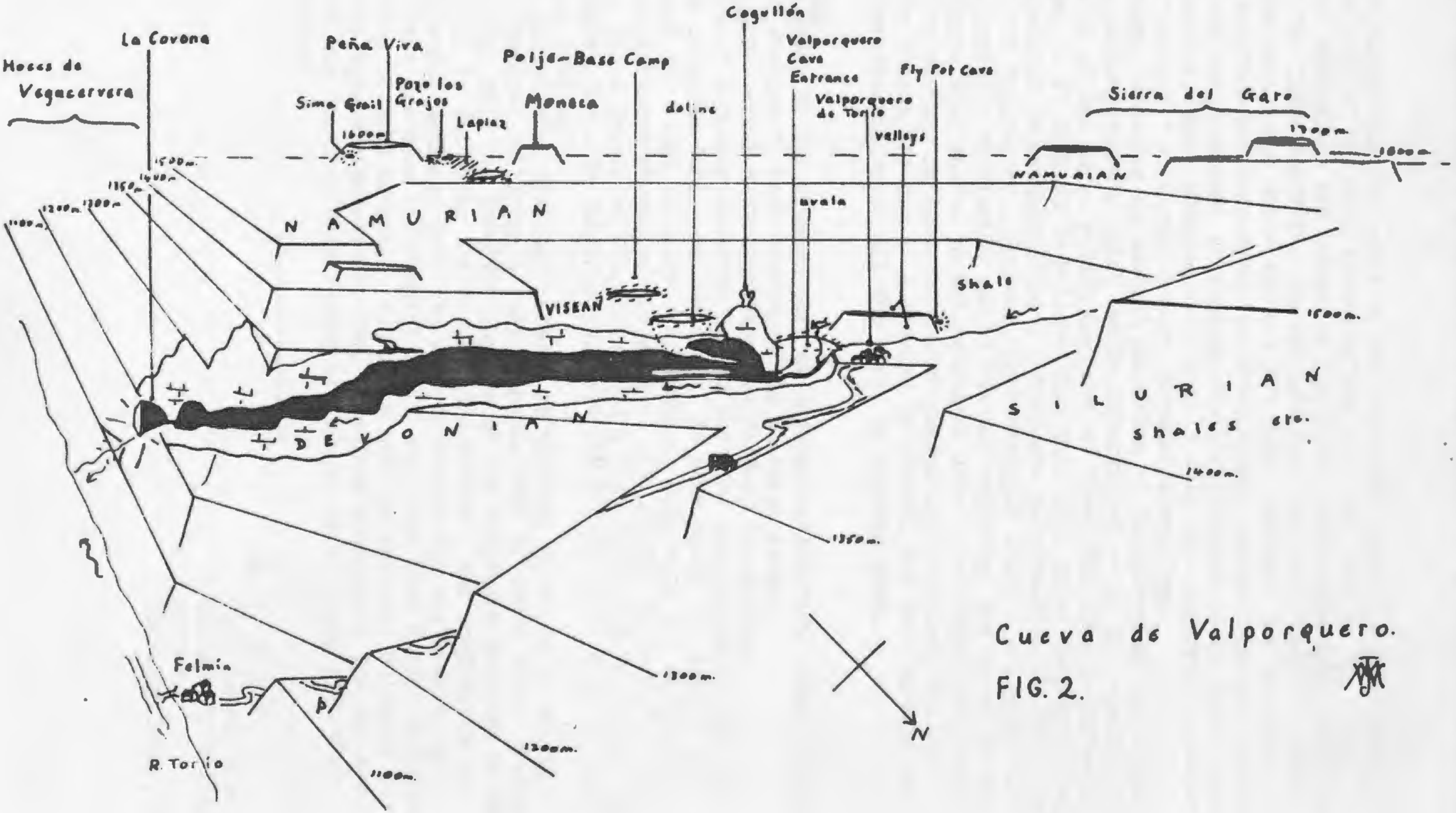
The Burdio de la Peña cave system (32) reflects the rejuvenation of the Pomperi valley in which it occurs. The cave is an effluent cave developed on several levels. An active, joint-controlled vadose passage leads into an upper series which shows stalactites encrusted in bergmilch and an infill of clay only today in the process of slow removal. These two principal levels are reminiscent of the Cueva de Requeixu (18) where Llopis described two cycles of erosion of the following type:

solution/stalagmitisation/ clastic deposition

Similar triphasic erosion has occurred in the Cueva del Buxu at Onau near Cangas de Onís (27, 32) where in the terminal chamber a calcite layer has developed on top of clay which has subsequently been partly removed and carried into a youthful lower series. Bergmilch has been seen in many small caves in the western massif of the Picos de Europa (28).

A curious feature of the Burdio de la Peña cave reoccurs in the Cueva de Valporquero. Each cave shows a large daylight effluent cavern, but this is not in direct communication with the main stream passage. The latter is reached only by means of small, high-level tubes involving difficult climbs. The stream passes between the well-developed main stream passage and the daylight effluent cavern via a sump. It would seem as if considerable infilling has occurred at some stage, blocking the sump and leading to the formation of the phreatic tubes, with a later removal of the infill. In fact, subsequent down-cutting of the Pomperi valley results in the main resurgence from the Burdio de la Peña cavern occurring a short way down the valley from the daylight effluent cavern from which egress has been blocked by talus fromthe overhanging cliff-face, although it is still subject to flooding via the sump. The lower rising is not passable. Down-cutting has also affected the P1 system, and partial exploration of a once active resurgence in the Vega de Enol has been made (45), perhaps corresponding to the part of the cave believed to approach the surface by the survey team (28).

The chronology of the caves in the Torío canyon is, by contrast, obscure. The La Covona effluent cave of the Valporquero system is perched some 80 m. above the valley floor, suggesting that either rapid rejuvenation of the canyon has occurred following a Pleistocene spelaeogenesis, following a chronology of the type discussed above, or that the cave was formed during the Miocene partial peneplanation, and the rejuvenation of the canyon has followed this. The latter explanation does not explain the failure of the cave passage to keep pace with a gentle rate of rejuvenation which should have led, theoretically at least, to a resurgence at river level. Also favouring a Pleistocene spelaeogenesis possibly is the presence of evidence for the two " cycles " of cave erosion of the triphasic type



Cueva de Valporquero.

FIG. 2.

mentioned above. One may point to the delicate, pendant stalactites of the upper part of the cave system on the one hand, and to the heavy, organ-loft formations and bosses of the lower active passages. Both this cave and the Cueva del Valle del Marqués have been the scene of clastic deposition on a large scale and not yet fully cleared. The two phases of stalagmitisation may correspond to interglacial and post-glacial activity, such as has been proposed to explain similar differences in Alpine caves (4). However, these phases could equally well have occurred in slower erosion " cycles " involving a more extended chronology.

Perhaps favouring an ancient formation of the Cueva de Valporquero -- assuming contemporaneity which may be unwarranted -- is the occurrence at river level of the large resurgence cave of Cueva del Pozo de Infierno (v. supra). It is hard to believe that this cave whose deep water sumps deeply upstream is consistent with a Holocene rejuvenation of -80 m. of the Hoces de Vegacervera. However, more detailed studies are required before a definite conclusion can be reached regarding the caves of the Torío canyon. Some shafts in the mountains above the canyon have been referred to earlier in connection with periglacial erosion, and are presumably recent. It may be a mistake to assume, and even more so to demand contemporaneity of all the caves in a given area.

Conclusion.

The caves of the western part of the Cantabro-Asturic chain show two " cycles of erosion ", each corresponding to three stages:

solutional erosion/stalagmitisation/clastic deposition.

One " cycle " probably occurred during the last interglacial, and the other has occurred during the Holocene. In many caves the second"cycle " has reached the stage of clastic deposition. Only very few caves still receive an influent stream of any size -- viz. Burdio de la Peña, Pozo Palomero, Cueva Orandi or P14, President's Pot, Cueva del Viento or C15, Cueva Dobros, Cueva de Valporquero. Most other cave receive at the most a seasonal inflow.

The pre-glacial drainage pattern of the Enol platform to the NW has been restored following a fall of base-level of about 100 m. during the Holocene. This has involved capture of the temporary drainage of the Vega de Enol to the NE by the rejuvenated valleys, and eradication of the periglacial drainage into the Vega de Comeya via the Lago de la Ercina. There are some caves which could only have been formed following the reversal of this drainage, and which must be entirely Holocene in their spelaeogenesis therefore. Some questions concerning the spelaeogenesis of the Cueva de Valporquero are posed, which require further investigation.

M. J. Walker
Weir Common Room
University College
Oxford.
February 20th., 1966

References.

1 Barrois, C. Mem. Soc. Géol. Nord. 2: 1 - 630 (1882) -

2 Birot, P. & Dresch, J. La Mediterranée et le Moyen Orient, I (1956)

3 Corbel, J. Rev. Géogr. Lyon 32: 43 - 56 (1957)

4 Corbel, J. Rev. Géogr. Lyon 32: 135 - 158 (1957)

5 Cowling, J. J. Craven Pothole Club 3 No. 5: 252 - 254 (1965)

6 Crompton, W. J. Proc. O. U. Cave Club 1: 5 - 15 (1962)

7 Crompton, W. J. Proc. British Spel. Assoc. 2: 39 - 47 (1964)

8 Davis, W. M. Bull. Geol. Soc. Amer. 41: 475 - 628 (1930)

9 Derouet, L., Dresco, E., and Negre, J. Speleon 5: 166 ff. (1954)

10 Dunford, J. A. The Speleologist 1 No. 2: 5 - 7 (1965)

11 ------------ " Echos des Explorations 1964" in Spelunca, Bulletin, 4ième S., 4 No. 4: 37 - 40 (1964)

12 Robertson, A. C. W. Proc. O. U. Cave Club 4: (1966)

13 Judson, D. M. J. Craven Pothole Club 3 No. 3: 131 - 137 (1963)

14 Julivert, M. Espeleología de Asturias, I (symp.): 51 - 74 (1955)

15 ------------ La Cueva de Valporquero , Publicación del Grupo Espeleólogo Leonés, 1956

16 Llopis Lladó, N. Trab. y Mem. del Lab. de Geol., Univ. de Oviedo Facultad de Ciencias 1: 2 - 51 (1951)

18 Llopis Lladó, N. Espeleología de Asturias, I (symp.): 75 - 101 (1955)

17 Llopis Lladó, N. Estud. Geográf. 15: 501 - 550 (1954)

19 Llopis Lladó, N. INQUA V Cong. Internac., Libro Guía de la Excursión No. 2, El Cuaternario de la Región Cantábrica pp. 43 - 55 (1957)

20 Llopis Lladó, N. Monograf. Geol. (Inst. de Geol. Aplic., Oviedo) 10 (1958)

21 Llopis Lladó, N., Fernández, J. M., and Julivert, M. Espeleología de Asturias, I (symp.): 3 - 37 (1955)

22 Lotze, F. Abhandl. d. Mathemat.-Naturwissensch. Klasse (Akad. d. Wissensch. u. d. Literatur) Jahrgang 1962 No. 2: 150 - 169 (1962)

23 Maucci, W. Boll. della Soc. Adriatica di Soc. Nat., Trieste 46: 1 - 60 (1951-1952)

24 Maucci, W. Atti del VII Cong. Naz. di Spel., Mem. III di Rass. Spel. Ital. e Soc. Spel. Ital. pp. 221 - 236 (1956)

25 Mills, K. J., & Walker, M. J. Proc. O. U. Cave Club 2: 5 - 11 (1963)

26 Nolte y Aramburu, E. Speleon 11: 53 - 159 (1960)

27 Obermaier, H., & de la Vega del Sella, Conde La Cueva del Buxu, Asturias (Junta p. Amplia. de Estud. e Invest. Cient., Com. de Invest. Paleontol. y Prehistór. 20, (1918))

28 ------------ Oxford University Expedition to Northern Spain 1961 Cave Res. Group of Gt. Brit. Publ. 14 (1965)

29 Puig y Larraz, G. Bol. de la Com. del Mapa Geol. de Esp. 21: 1 - 392 (1896)

30 ------------ Report of the tne Manchester University Expedition to the Picos District in Northern Spain (1963) (produced by members of the expedition, 1964)

31 ------------ Report of the 1965 British Speleological Expedition to the Cantabrian Mountains (produced by members of the expedition, 1966)

32 ------------ Report of the Oxford-Derbyshire Speleological Expedition to North-West Spain, 1963 (produced by members of the expedition, 1966)

33 Solé Sabarís, L. Geografía de España y Portugal, I, España Geografía Física pp. 287 - 310 (1952)
34 Suess, E. The Face of the Earth, II (1904)
35 Sweeting, M. M. Geograph. J. 115: 63 - 78 (1950)
36 Termier, P. Compt. Rend., Acad. Sci. (Paris) 166: 433 - 439 (1918)
37 Termier, P. Compt. Rend., Acad. Sci. (Paris) 166: 516 - 520 (1918)
38 Termier, P. Compt. Rend., Acad. Sci. (Paris) 166: 709 - 714 (1918)
39 Termier, P. Compt. Rend., Acad. Sci. (Paris) 166: 793 - 799 (1918)
40 Trimmel, H. Festschrift zur Hunderjahrfeier der Geographischen Gesellschaft in Wien 1856 - 1956 pp. 193 - 208 (1957)
41 ------------- University of Nottingham Spelaeological Expedition - Exploration '64 (produced by members of the University of Nottingham Student Union Spelaeological Expedition 1964 Picos de Europa, N. W. Spain) (1964)
42 Wagner, R. H. Bol. del Inst. Geol. y Mín. de Esp. 74: 1 - 159 (1963)
43 Walker, M. J. Proc. O. U. Cave Club 3: 9 - 15 (1963)
44 Walker, M. J. The Speleologist No. 3: 25 - 28 (1965)
45 Walker, M. J., Cowling, J., & Craven, S. A. J. Craven Pothole Club 3 No. 2: 66 - 70 (1962)
46 Warwick, G. T. Trans. Cave Res. Group of Gt. Brit. 4 No. 2: 125 - 160 (1956)
47 Wilcock, J. D. North. Cav. and Min. Res. Group Newsletters 1: 12 - 19 (1963)

SOME SOLUTIONAL FEATURES IN THE AREA AROUND OXFORD

Swallet holes and other solutional features occur on two different Jurassic limestones where these outcrop in the Oxford area.

Coral Rag

The first group of features to be described occurs at the junction of the Coral Rag (Upper Corallian) and the Kimmeridge Clay where the latter feathers out onto the underlying limestone.

Such conditions are met in the area between Forest Hill and Shotover, two hills immediately to the east of Oxford, and in the area further to the west on the other side of the Thames. Here,water from springs at the base of the Lower Greensand runs down the clay slopes of Cumnor Hurst and Pickett's Heath onto the Corallian plateau, promptly to disappear into fissures in the limestone. These fissures are known locally as " swilly " or " gulley " holes, and have been described by W. J. Arkell in his ' Geology of Oxford ' and referred to in ' British Caving '.

While it may be difficult for the speleologist to find as much enthusiasm for gulley holes as Arkell seems to manage, it cannot be denied that they show several points of interest. As he says, the quantity of water that manages to disappear down them after a sharp rainstorm is certainly visual testimony of the amount of solution that must have taken place underground. Accordingly, it seemed that further investigation was necessary.

Excavation of a gulley hole situated at NGR SP 483039 at 395' OD was undertaken by the O. U. Cave Club. The result has proved interesting.

The entrance to the hole lies at the bottom of a ditch. This has a permanent flow of water, nourished by a spring, that is of quite large proportions in wet weather. When first observed, the entrance consisted of two tubes, connected and running vertically downwards, which were filled to within three feet of the surface with mud and debris. The larger of the two tubes was 1' 6" in diameter. Removal of some of the surface soil showed that the entrance tubes are only two ofseveral running along a 'joint' whose axis is approximately N-S. The surface of the limestone at this point is smooth and unfragmented.

The mud has now been removed from the hole to a depth of some 15'. Most was of recent origin but there was evidence of an earlier fill in alcoves and tubes in the walls. Many pieces of wood in the lower portion of the debris were slightly calcited, while occasionally a piece was completely petrified. A few animal bones were found mostly of sheep.

The hole descends vertically for about 9'. Below the entrance tubes there is a considerable widening. At the bottom of the vertical section it is just possible to squeeze under a rock bridge into a very small chamber. From this chamber a way leads off in a northerly direction, silted to within a few inches of the roof, which takes the stream. The total depth of the hole is about 15'.

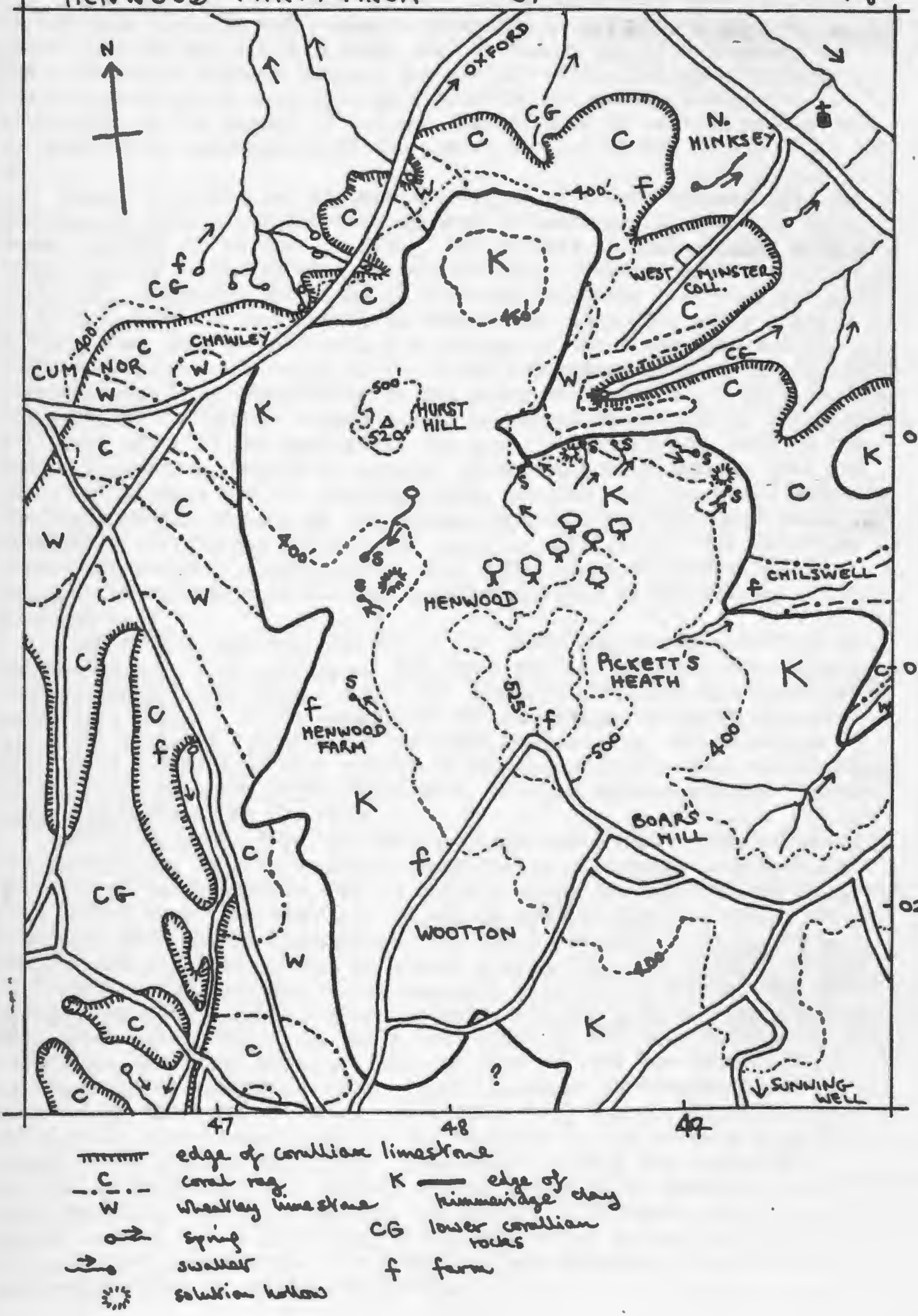
Apart from its gross structure, the most interesting feature of the hole is the way in which, in the walls, the structure of the reef limestone is revealed. The hard corals, pale cream in colour and crystalline, stand out frm the walls in relief where the interstitial filling has been etched out. Some fossils can be seen in the filling.

Further attempts to deepen the hole are unlikely to be successful. The indications are that the water table has been reached.

Arkell mentions a good example of a Coral Rag sinkhole near Forest Lodge, Shotover. This is situated in a copse 200 yds. south of the A 41 at NGR SP 5675 0726 at 340' OD and appears to be the only one in the area despite similar conditions further to the east. Likewise, the holes to be found between Cumnor Hurst and Pickett's Heath are developed in a very restricted area considering that conditions appear similar along the whole of the inner edge of the Corallian plateau.

The indications are that the answer to this anomaly probably lies in the nature of the limestone itself. This, as with most reef limestones, is of two distinct types: the actual reef masses with corals still in the position of growth, and a bedded detrital deposit laid down in the gaps between them. This latter stone is known separately as Wheatley limestone. The maximum extent of the reefs is seen at Cumnor, while eastwards the proportion of Wheatley stone increases twoards Wheatley where it reaches its maximum thickness. Development of discrete channels by solution appears to occur only in the coral masses of the reefs.

In the coral masses, the matrix is softer and more porous than the corals imbedded in it. It is clear that the water has been able to seep into this filling and after removing it, enlarge spaces between the coral heads in a manner analogous to joint enlargement in some bedded limestones. The Wheatley stone is porous throughout the whole mass, and, like the Oolite, seems to be subject to decalcification by water soaking through as if through a sponge without preferential enlargement of cracks, joints, HENWOOD FARM AREA SP fig 1



or cavities.

It is certain that many 'fossil' holes exist that have long been choked with clay. In wet weather, water has been onserved to sink in places where there is not the slightest surface indication of a solution channel, while there are several obvious depressions at the bottom of shallow valleys where water must once have sunk but has now been diverted. An indication of the amount of mud and debris which is carried underground is obtained by examination of the active swallet at NGR SP 476035 at 390' OD.

Local tradition has it that the corpse of a duck dropped into one of the Henwood Farm sinks later reappeared at Sunningwell, but this tale seems unlikely to be true. Firstly, the chances of such a bulky object being carried so far in what is undoubtedly a phreatic system are very small and, secondly, the sinks if they were anything like they are today would have been far too choked to permit its entry. The story seems nothing more than an interesting variation of the " shepherd and chaff " tale, recounted for so many of the sinks and resurgences of the Yorkshire Carboniferous. The destination of the water still remains a problem. The use of a dye or isotope tracer has to be vetoed on account of the possible pollution of wells and springs in the area. Other methods, such as the use of lycopodium, would, on account of the number of springs that are potential risings for the sinking water, involve very laborious sampling. The boggy nature of many of the springs makes percolation slow and presumably effectively filters the emerging water, while dye detectors become irreversibly stained after only a few hours of immersion. Pin-pointing of risings thus becomes a matter largely of intelligent guess work.

None of the solution hollows on the Coral Rag can be described as dolines in the usual meaning of the term. This is probably due to the thinness of the limestone (about 30') and to its generally unjointed character, explaining the absence of the assemblage of karst features one might be led to expect. The presence over much of the Corallian plateau of a tenacious clay means, in the majority of cases, the blocking of incipient solution pipes. Thus wide, shallow hollows and not funnel-shaped shakeholes are the rule.

Arkell suggests that the narrow, steep-sided valleys that dissect the plateau may be the result of the collapse of caverns developed at the base of the limestone, but it seems certain that the valleys were in fact formed by spring sapping. At NGR SP 488043, the long valley which runs down towards the Hinkseys is, for the first part of its course, shallow and dry with no sign of recent stream flow. On reaching the 350' contour however, the valley abruptly deepens and widens, the sides become precipitous, and a stream emerges from a bog on the valley floor. This seems likely to be the water that sinks in the hole that was excavated. The steep sides of this and like valleys are accounted for by the relative resistance of the hard limestone to erosional processes compared to the soft underlying Calcareous Grit (Lower Corallian), while their narrowness is due to the tendency of the sandy clay of the latter to be rapidly entrenched, thus concentrating the extension of the valley headwards. The sharply convex slopes to be observed above the steep side scarps are due to cambering. The result of cambering on a large scale can be seen on the neighbouring Witham and Beacon Hills, where the settling of a previously horizontal limestone bed into terraces down the slopes has been plotted by Arkell and others.

Cornbrash.

Another group of swallets occur at the junction of the Oxford Clay and the Cornbrash, under conditions very similar to those at Cumnor, about 3 miles NW of Oxford at North Leigh.

There are, however, several significant differences. Unlike the reef limestone at Cumnor, the Cornbrash is a very coarse, impure limestone, but which has the distinction of being very well jointed. Indeed in places it might almost be described as shattered. It is very much thinner than the Coral Rag at Cumnor, being at the maximum 10 - 15' thick. It is underlain by a bed of clay 2½' thick. The problem of interest is to understand how, in the formation of sinkholes, water has been able to penetrate this clay of the Wychwood beds, and through several other formations as well, down to the Oolite where, one presumes, it reaches the water table. The possibility of perched water tables seems ruled out, there being no spring line in the several places that the junction is exposed.

In contrast to the average Coral Rag sinkhole, those on the Cornbrash are rather more characteristic of the genus, the water sinking in well-defined and fairly steep-sided depressions. The flow of water, originating in a drain, that flows into one of the holes is quite impressive.

It is interesting to note, in reference to the map, how closely the line of sinkholes follows the edge of the clay but always a little way in, although it must be admitted that the boundary of the clay is very ill defined. Probably the best guide is the changing soil character, which is the reason for including field boundaries on the sketch map. Fields on the clay are smaller, sport ponds, and are generally laid down to permanent grass, while the lighter soil over the limestone downslope is devoted to cereal growing. The decreased necessity for drainage here due to the water sinking upslope allows fewer ditches and a larger field size. This situation is in interesting contrast to parts of the region to the North where heavy soils are usually of alluvial origin and restricted to the valley bottoms.

A clue to the formation of the swallets is seen in Breakspear's Quarry, East End, at the top of the steep hill that descends from the latter towards Ashford mill. Here, to quote " are exposed remarkable gulls in which vertical Cornbrash, Kellaways, and Northern Drift are let down into the Forest Marble apparently through slipping of the strata ". This conclusion needs qualification. Closer examination of the quarry reveals a small ' cave ' entrance in the east wall, about 3' 6" high, which narrows rapidly to a fissure and descends steeply a few feet in. This is clearly of solutional origin, and there are stalagmite flows on the walls. Examination of the Cornbrash exposed ten feet up the section shows a small channel running in at the base of the exposure, immediately above the clay bed. Clearly penetration of the clay has been effected in a region where it is thin, the two openings observed being part of a now dry sinkhole of the type seen still active at N. Leigh.

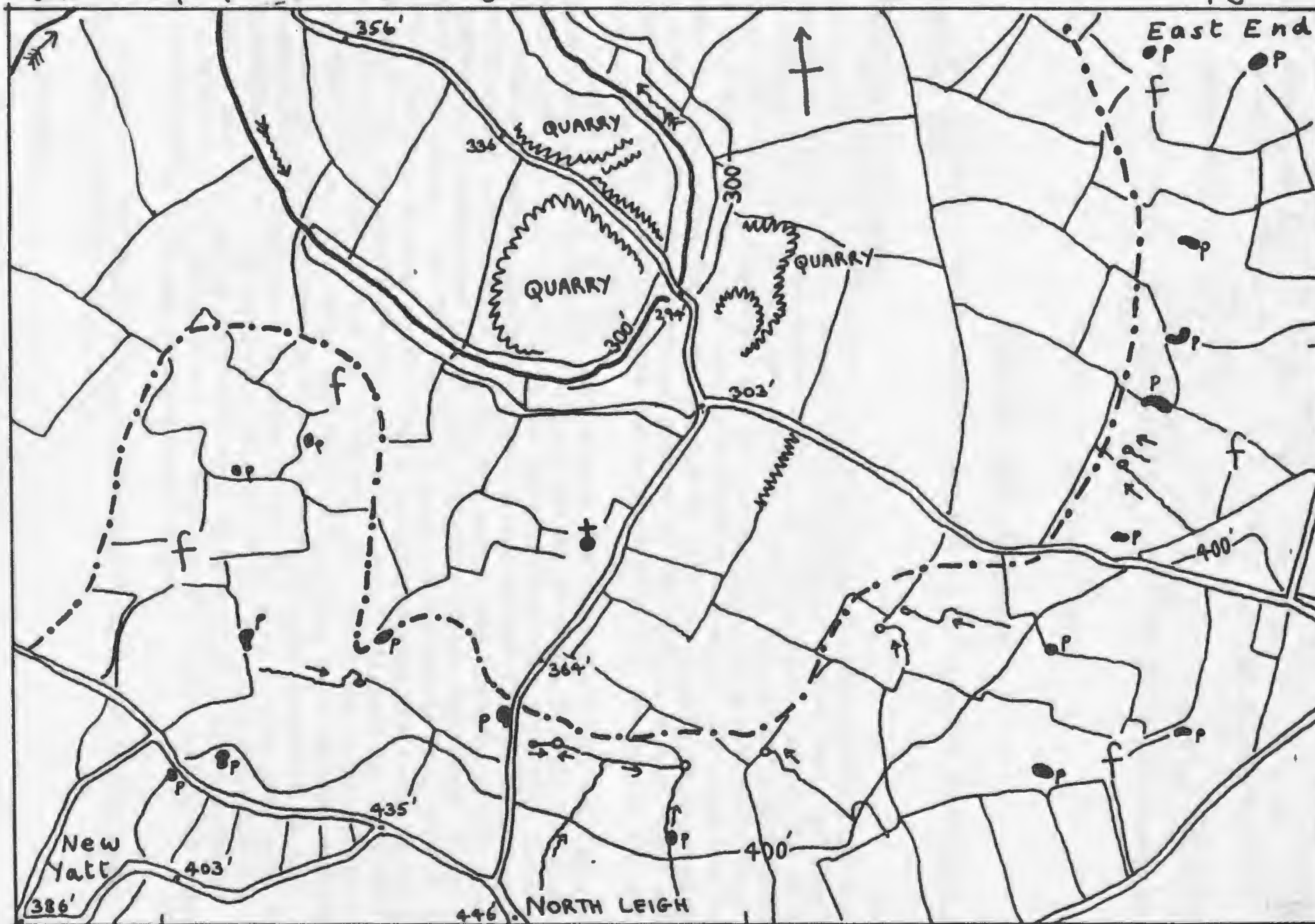
The destination of the water from these swallets is a mystery. Although the water is most likely to flow down dip, the clay cover to the South is continuous. Some rather more intensive work is about to be started by the Oxford Dept. of Geography under the direction of Miss Sweeting which should throw light on this interesting problem.

F. E. Sanders
Exeter College,
Oxford

11 th. March, 1966

Sketch map of sinks at N. Leigh

fig 2



f FARM
SINKHOLE
POND
• SPRING
—•—•— APPROX. BOUNDARY OF OXFORD CLAY

Parish of N. Leigh
OXFORDSHIRE

References.

Arkell, W. J. The Geology of Oxford pp. 245 - 246 (1947)

Blake, J. H. G. S. Memoir The Water Supply of Berkshire p. 4 (1902)

Craven, S. A. J. Craven Pothole Club 3 No. 5: 234 - 235 (1965)

Hull, E., & Whitaker, H. G. S. Memoir Geology of parts of Oxon and Berks. (13) pp. 3 - 9 (1861)

Richardson, L., Arkell, W. J., & Dines, H. G. Geology of the Country around Witney (236) pp. 74 - 80 & 85 - 98 (1946)

Warwick, G. T. British Caving p. 179 Cullingford Ed., Routledge & Kegan Paul (1962)

ACCIDENTS AND INSURANCE

The following leading article appeared in the Guardian on Tuesday, December 7th., 1965 :

Cavern on the telephone.

Pot-holers are putting in a telephone line to the nearest farm from the top of Giant's Hole, one of the major caverns of the Peak; and hope to extend the line into the cavern itself, to reduce still further the delay in calling for help in case of accidents. It was from Giant's Hole that a woman was rescued a few weeks ago in circumstances of great difficulty; it took twenty hours to get her out. Clearly the sooner the alarm can be given in such cases, the less the risk of injuries causing death, during or after the slow and protracted process of extraction. Rescue teams are quick at getting communications established once they are there. The point is to get them there quickly.

Giant's Hole is not the only severe cavern in the Peak, and there are plenty more in the Yorkshire Pennines and the Mendips. Nor are falls and broken limbs the only hazard. Three times in Yorkshire this year fireman have been called to rescue cavers marooned by underground floods. Both rescue operations and quick communications cost money. The Derbyshire Cave Rescue Organisation reckons that it has used equipment worth about £600 in the last five or six years. The CRO nationally gets contributions from most of the caving clubs. In Derbyshire the county council started the local organisation off with £150 and contributes a small annual sum; but more may be needed to meet rescue costs if they go on rising. Are caving and climbing risks insurable ? If so, have clubs any system of getting their members insured ?

Luckily, caving accidents are very rarely fatal. According to the Mountain Rescue Committee's accident report for 1964 (just published in " Mountaineering ", the quarterly journal of the British Mountaineering Council) only six caving accidents were reported last year as against 147 accidents on the hills. There was only one fatal cave accident; a man was drowned while swimming in underground waters.

In reply to the Guardian leader, the following letter was published on Wednesday, December 15th., 1965 :

Caving insurance.

Sir,

is potholing insurable ? In Spain, yes. Here, climbers, skiers, and cavers in clubs of the Spanish Mountaineering Federation get third-party, accident, and medical insurance for 15s. a year. Next year, this is to be free of charge. Clubs outside the Federation, such as one caving club I belong to, must arrange insurance for their members. Even so, the annual subsciption is only 7s. 6d. .

The UK presents a sad contrast. It is surprising that the insurance profession will not enter this field, as there are very few serious cave accidents. Cheap policies are necessary since the poorer and worst-equipped clubs are the most accident-prone. Policies should cover all spelaeological activities, unofficial as well as club fixtures. At present, third-party insurance may be got, and some landowners (e.g. Mendip Water Board) insist on it. This does not help a rescue team, and could even hinder it.

To get cheap insurance, caving clubs need to cooperate much more closely. The two national associations, the Cave Research Group of Great Britain and the British Spelaeological Association, are unsatisfactory for this purpose. Regional caving associations, formed to control access rights to certain caves, fear the creation of one, strong, national association in which the thirty old clubs from caving areas would be outnumbered by 150 young clubs from the Midlands and the South-east. Ther regional associations would then be under pressure not to connive at the policies of the MWB and other landowners which effectively exclude many 'foreign' clubs. Lastly, the clubs themselves fear that their independence would be threatened if a national association could withdraw insurance cover from unruly cavers.

Cavers must think out just what they want and why. Then they should approach the insurance profession, and, if it should still refuse to help, there would be a strong case for Government-organised intervention. Until then, cavers will continue to rescue one another free of charge, knowing that few rescued potholers could foot the bill of a major rescue operation.

Yours etc.,
Michael Walker

Centro de Investigaciones Biológicas,
Madrid 6

On Thursday, December 23rd., 1965 , in the Guardian :

<u>Disunity among cave rescue teams.</u>

Sir,

Michael Walker belittles the main problem facing cave rescue teams in Britain today. The fact is that rescue teams are dependent almost completely on voluntary contributions for their funds and therefore remain in a precarious position financially. The injustice in the recognition of these teams.

If the life of an individual citizen in this country is endangered, it is the responsibility of the police force to preserve it. Yet the police openly admit that they have neither the technical facilities, know-how, nor the man-power to effect a cave rescue. Cave rescue teams, when called out, in fact do the work of the police. At present there are four main teams, responsible for the Mendips, South Wales, Derbyshire, and the Craven area respectively. They are in no way affiliated to one another.

The Government has offered these teams an annual grant to offset their enormous expenses, but only on the condition that they are linked, no matter how tenuously, into a national body. This, for extremely obscure reasons, the organisers of each team refuse to do. Until some serious rethinking has been done among the potholing fraternity, cave rescuers have little ground on which to grumble, since they are attacking, a situation which they themselves have allowed to be propagated.

Yours etc.,
Kevin Cowle

Fairfax Hall,
Leeds College of Education,
Leeds 6, Yorkshire

The correspondance was continued by another former O. U. C. C. member John Wilcock in the Guardian of Monday, January 8th., 1966 :

Linking cave-rescue organisations.

Sir,

Kevin Cowle, in commenting upon the remarks of Michael Walker, has omitted to mention that a proposal for linking of the existing cave rescue organisations into a loosely-knit national body was put before the fourth cave rescue conference held at Buxton in October, 1965, by the leader of the Maeshafn search, which received wide publicity in 1964.

This search, involving 750 personnel and estimated to have cost £ 22,000 , brought the attention of the Home Office to the generally unsatisfactory coordination between the police and the cave rescue teams in areas outside the popular caving regions. The county police information room had no information giving the standard conduct for a major cave rescue or search, as they have for such incidents as plane crashes and train crashes. This ommission has now been remedied and a new rescue organisation has been formed in North Wales. The same lack of communication would, however, still occur in some other regions if a cave accident had to be tackled.

The Home Office could cooperate to prevent this if the various cave rescue organisations in Yorkshire, Durham, Derbyshire, Somerset, Devon, South and North Wales consent to join up together in a national chain of communications, while retaining their regional autonomy. Potholers are individualists, and generally dislike organisation, but the forward thinkers may yet triumph.

Yours etc.,
John D. Wilcock

10, Beech Drive, Clough Hall,
Kidsgrove, Stoke-on-Trent,
Staffs.

Michael Walker, back in England, comments :

Kevin Cowle raises the argument that cave rescue teams do the work of the police. This is very dubious. Whilst I concede that Home Office funds for equipment and training costs of cave rescue teams are essential, I feel that total support by the government would reduce standards of safety training in cave clubs. I feel that cavers should recognise some liability to rescue teams in the event of a rescue team being called out on their behalf. Insurance is the only way to meet this liability. As a higher premium would follow a claim on your insurance company, there would be an incentive for clubs to demand higher standards of training than at present. Cavers who would not show to a cave-owner, warden, or national park warden, a card stating that they were affiliated to, say, a National Spelaeological Association, which would undertake insurance arrangements on behalf of individuals and affiliated clubs, ~~which~~ would be liable (1) to prosecution for trespass, (2) legal actions for rescue costs by a rescue team, in the event of their being involved in a rescue operation. Each card would carry a photo of the caver in whose name it would be made out.

This is where the difference between cave rescue teams on the one hand, and the police and the RAF Mountain Rescue on the other, is most marked. You can stop people going into caves easily -- indeed, it is done quite effectively in many caving areas at present. You cannot stop them from wandering onto the moors, hence the need for total government support in the RAF Mountain Rescue. But to stop a "yob" from attacking a helictite in GB Cavern is not the answer, if it sends him to a more dangerous Yorkshire pothole from which he has to be rescued at great expense. This is quite likely the outcome of present restrictions. My solution is for open access to <u>all</u> caves on production of a valid chit which everyone knows would mean that the bearer was fully insured, which would lead to higher training standards. It might be necessary for the government to arrange the insurance if the profession would not, but it would avoid the carefree attitude to safety training taken by many climbers, who " leave it all to Valley RAF Station ".

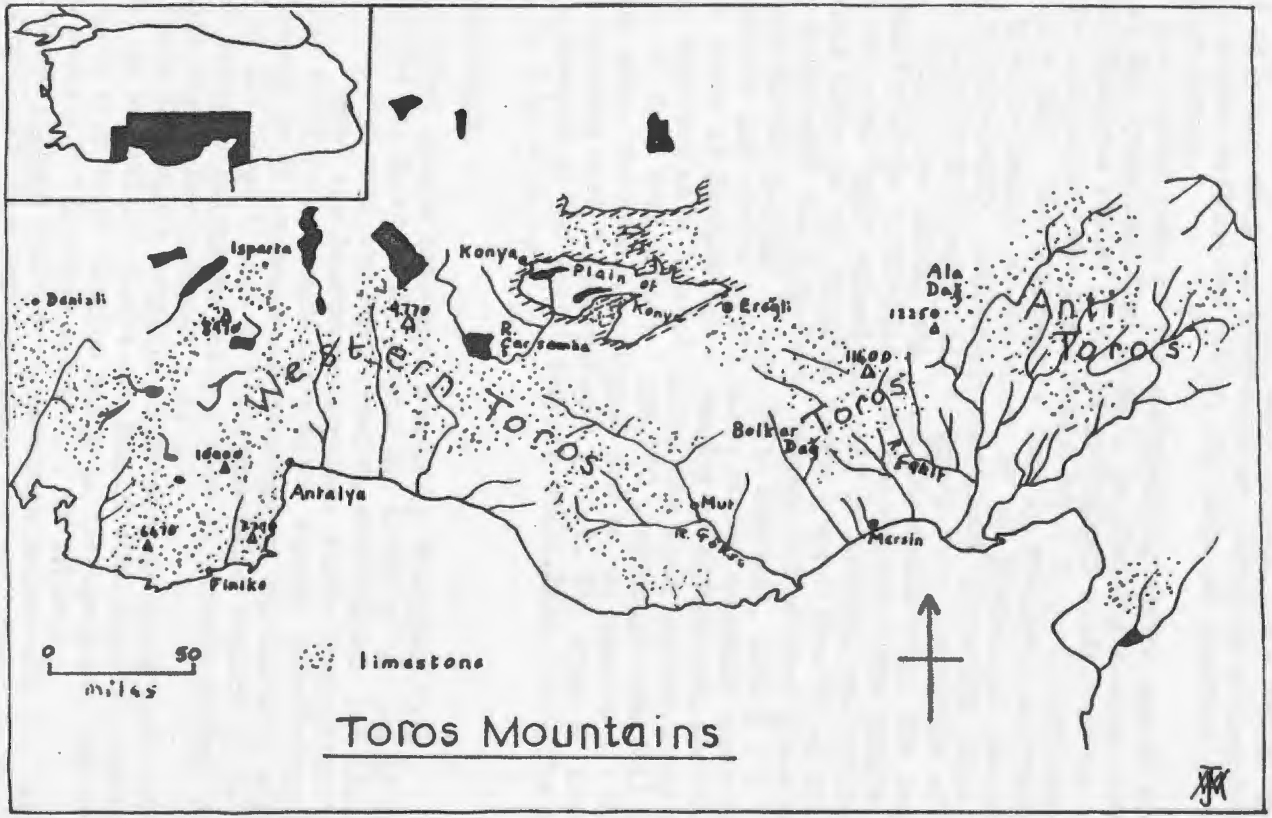
But perhaps too many people feel they would have to give up too much for such a system ever to be adopted.

CAVE LOCATION IN TURKEY

Most caves in Turkey occur in limestone, although caves in conglomerate have been recorded from the Plain of Konya (7, 9, 16), see map. However, the limestone spelaeology has been as little studied as the Turkish karst. Karstic landforms are mainly represented by the Toros mountain chain of southern Turkey, although smaller areas occur near Istanbul in the North-west, and near the Iraq frontier in the far South-east. Lindberg (17, 18, 19) investigated some caves in Palaeozoic limestones which outcrop around the Sea of Marmara and in the region of the Ereğli-Zonguldak coalfield to the north of it. These were mainly horizontal systems of limited extension. One of the longest, Yarim Bourgaz, occurs in European Turkey. It is a mere 600 m. long, and was first described forty years ago (14). Lindberg also undertook biospelaeological investigations in south-east Turkey and around Lake Van. One of these caves was 300 m. long, occurring at Şikefte in the canyon of the Gürölе-Suyu near Siirt. Most other caves were considerably shorter than this.

Although Lindberg states (17) that the Turkish anthropologist Dr. Kiliç Kökten claimed that there were in 1952 at least 10,000 caves in Turkey of which 585 had been explored, and although Lindberg also says that the spelaeologist in Turkey is confronted with an " embarras de choix ", he seems nevertheless to have explored only a handful of caves of quite small size. He neglected the Toros mountain chain where, in one small region around Antalya alone, the Turkish Historical Society had examined 512 out of 10,000 local caves for archaeological remains even before 1947 (16).

The limestone around the Plain of Konya is of little interest to sportive spelaeologists. This is an arid basin containing conical hills,


Isparta
Denizli
Konya
Plain of Konya
R. Carsamba
Ereğli
Ala Dağ
Anti Toros
Western Toros
Toros
Bolkar Dağ
Mut
Mersin
Antalya
Finike
0
50
miles
limestone
Toros Mountains

salt-marshes, and lakes. The hills were once thought due to volcanic action, but have recently been shown to be the result of hot springs (12). Palaeozoic limestones around its edge rise above the later Miocene limestones owing to thrusting, and where the two rocks meet there are interesting sinkholes which collect the run-off from the higher Permo-Carboniferous beds. The sinkholes are 200 - 300 m. in diameter and contain freshwater lakes between 130 - 180 m. deep (8, 12). Erinç (12) says that the sinkholes are formed on well-jointed limestones containing cave systems and tubes, but does not describe any cave systems in further detail.

At the western edge of the accompanying sketch map of southern Turkey is the Aydin limestone massif, an imposing plateau raised 1,000 m. above the Menderes river. Detailed geological studies of the massif with maps were made before the First World War (21). It has been written of the area that " the drainage is largely swallowed and runs underground" (23). Near to Denizli to the north of the plateau are the petrifying springs of Hierapolis, well-known throughout historical time.

The rest of this paper will be given to a description of the Toros mountain chain (see sketch map) and its spelaeology. The mountain chain itself must be subdivided into the western Toros ranges, which describe an acute angle around the gulf of Antalya, and the Toros ((sometimes known as the Cicilian Toros) which runs NE of the river Göksu to merge with the Anti-Toros ranges. Whilst many place names give a clue to the geology (e.g. White Mountain, Ak Dağ) (1), very many mountains and rivers in all parts of the mountain chain have identical names as Turkish has a paucity of adjectives. Moreover, the available maps are at a limited scale, the best edition being the British M. D. R./3 series to 1 : 200,000 , although even this is not on general sale. One French geologist had to use maps to 1 : 800,000 which he declared were " incroyable " (10). The areas of limestone roughly indicated in the sketch map are taken from (5). The geological map in (24) is of no use.

The Western Toros.

The western ranges have been concisely described thus :
" Deep valleys lie between the ranges and drain to the sea at their southern ends, but some are obstructed further inland, and lakes are formed...... Most are freshwater expanses fed by intermittent torrents which course the bare mountain-sides after storms, this freshness is probably caused by the underground drainage of the lakes, a suggestion supported by the large bodies of limestone which swallow up whole streams at suitable points to deliver them as copious springs or from subterranean rivers lower down." (23).

The lakes themselves probably drain through their beds rather than into caves, as the valley floors are filled with alluvial deposits. However, there seem to be swallow holes in the limestone, and influent caves were described 120 years ago (13) as follows :
" The plains or yailahs which these mountain ranges wall in, vary in elevation from 2,000 to 6,000 feet above the sea. They have no outlets; the rivers which water them pass into caverns, and reappear in the low country near the sea." More recently Erinç (12) has written :
" Extensive surfaces of erosional nature at an average altitude of 2,000 m. are entrenched by deep valleys. All of these conditions contributed to maximum development of karst in this belt, where both small and large

karst features such as different kinds of lapiés, dolines, uvalas, poljes, blind valleys, ponors, resurgences, travertine terraces, caves, avens natural bridges, and subterranean river courses form the dominating element of the landscape. "

It may be recalled here that the Antalya region has been said to contain 10,000 caves (v. supra), although it may be wondered whether many of these are no more than rock-shelters, commonly described as " caves " by archaeologists.

Various morphologival studies which have been undertaken in the western Toros fail to mention cave systems, thus Binggeli (4) who studied the surface hydrology in the region of Suğla Gölü and the Carsamba river, and Louis (20) who studied polje formation near Suğla Gölü lake. The latter worker concluded that several poljes represent the floors of subsequently vanished valleys, and that secondary solution under local circumstances has imposed a pattern of sinking drainage towards their edges, resulting in lateral extension of the poljes. Other geomorphologists have studied the area (3).

The high mountains of the western Toros show compact Cretaceous and Tertiary limestones which are bedded at acute angles, dipping away from the axes of the chains. On the floors of the enclosed valleys conglomerate overlies the limestone. To the north more massive Permo-Carboniferous limestone outcrops away from the coastal strip around the Gulf of Antalya where metamorphosed rocks occur. Between these two different rocks there outcrops a Jurassic flysch facies (2, 10) cutting across the Buyuk Ak Dağ massif. A section in (5) shows this clearly.

The Toros.

The valley of the Göksü divides the western Toros from the Toros proper. The river has two major tributaries of the same name, each pursuing an underground course for short distances. The summits of the Cicilian Toros are Bolkar Dağ (10,630 ft.), Aydos (11,440 ft.), and Ala Dağ (12,250 ft.). Unlike the western Toros, this range is not fllded into parallel ridges. A section in (5) across Bolkar Dağ shows that it is an anticlinal block of Permo-Carboniferous limestone. Suess (25) has described it thus :

" ....the NW slope shows steeply upturned Eocene limestone, and probably Cretaceous also, while on the SE and S side of the range are very thick limestones of the first or second Mediterranean stage (we now know that these are in fact Permo-Carboniferous and not Miocene as Suess, following Schaffer, believed -- M. J. W.). These show fairly undisturbed bedding, dip for the most part gently away from the range, and are also, perhaps, slightly bent to form a flat anticline; at the same time they reach astonishing heights. On the east side of the Dumbelek-Dagh such almost horizontal limestones are met with at a height of 2,300 m. . This mighty girdle of unconformable limestones forms plateaux with a surface recalling that of the Karst; it is continued towards the SW and W far away into the valley fo the Calycadnus. "

Three authors (6, 12, 22) refer to the large cave through which the Çakit river flows for 500 m. at Yer-köprü before entering the 1400 m. deep canyon in which both the river and the Bagdad railway run south-eastwards to the coast. This cave is formed in an outcrop of Permo-Carboniferous limestone occurring amidst Cretaceous beds in the Ak Dağ massif to the NE of Bolkar Dağ (not to be confused with the Ak Dağ of the western Toros). The Cretaceous limestone which caps the Ak Dağ massif was thrust up in the Alpine orogeny, whereas Bolkar Dağ shows Palaeozoic beds up to the summit. Like Suess, Blanchard (6) and Furon (14) refer to caves, dolines, underground water reservoirs, and resurgences throughout the Toros irrespective of the age of the limestone. Many disused lead mines occur on the slopes of Bolkar Dağ; especially at Balyamadeni near Balya, the Ortakomuş mine near Anamur, and the lead and zinc deposits at Bulgarmadeni. Reports of a speleological expedition to the Toros in 1965 (11) are uninformative, although fuller information is being sought by the author.

News is also awaited of the findings of an expedition of speleologists from University College, London, in 1965. Some large resurgences in the western Toros were noted by British cavers in 1964 but not explored (private communication). It is hoped that the expedition which is to explore the caves fo the Toros this year, 1966, will clarify the position as to the scope of the speleology of the Toros

M. J. Walker
Oxford

February 20th., 1966

References.

1 Alagöz, C. Türk Coğrafya Dergisi 1 : 91 - 92 (1943)
2 Arkell, W. J. Jurassic Geology of the World, pp. 347 - 349 (1956)
3 Bilgin, T. Rev. Geogr. Inst. Univ. Istanbul (Ist. Ünivertesi Coğrafya Enstitüsi dergisi) 8 : 103 - 112 (1962)
4 Binggeli, V. Geograph. Helv. 14 : 248 - 255 (1959)
5 Birot, P. & Dresch, J. La Mediterranée et le Moyen Orient, II, pp. 139 - 153 (1956, Paris)
6 Blanchard, R. Asie Occidentale. Géographie Universelle, VIII, pp. 72 - 74 (1929)
7 Brewer, E. H. Nat. Geograph. Mag. 22 : 870 - 875 (1911)
8 Chaput, E. Mém. de l'Inst. Français d'Archaeol. de Stamboul 2 : 1 - 312 (1936)
9 dell'Occa, S., & Pavan, M. Rass. Spel. Ital. 8 ; 112 - 122 (1956)
10 de Planihol, X. Rev. de Géogr. Alp. 44 : 609 - 685 (1956)
11 ---------- Echos des Explorations 1965 Spelunca Bulletin 4th. ser. 5 No. 4 : 40 - 41 (1965)
12 Erinç, S. Rev. Geogr. Inst. Univ. Istanbul 6 : 1 - 14 (1960)
13 Forbes, E., & Spratt, T. A. B. Q. J. Geol. Soc. 2 : 8 - 12 (1846)
14 Furon, R. Mém. du Mus. Nat. d'Hist. Natur. (Paris), Série C, Sciences de la Terre 3 : 1 - 128 (1953)
15 Hovasse, R. Istanbul Ünivertesi Fen Facültesi. Mecmuasi 1st. ser. (1927) : 1 - 19 (1923 - 1931)
16 Kansu, S. A. Amer. J. Archaeol. 51 : 227 - 232 (1947)
17 Lindberg, K. Ann. de Spél. 7 : 55 - 66 (1952)
18 Lindberg, K. Ann. de Spél. 9 : 1 - 9 (1954)
19 Lindberg, K. Rass. Spel. Ital. 10 : 96 - 107 (1958)
20 Louis, H. Erdkunde 10 : 33 - 53 (1958)
21 Philippson, A. Reisen u. Forschungen im Westlichen Kleinasien, I - V 5 papers in Petermanns Mitteil. aus Perthes Geogr. Anst. 35 - 38 (1910 - 1913)
22 Philippson, A. Kleinasien. Handbuch der Regionalen Geologie V part 2 (1918)
23 ---------- Turkey I, pp. 140 - 151 (Naval Intell. Div., 1941)

24 ----------- Türkiye Atlasi (Istanbul, 1961)
25 Suess, E. The Face of the Earth III, pp. 317 - 318 (1904)

WALES 1965

The O. U. Cave Club has been active in South Wales during 1965.

PANT SYCHBANT

Ogof Fach, Cwm Cadlan, Penderyn

A fortnight of terrible weather endured by the authors in March, 1965, produced concrete results in the shape of the extension of this little-known cave in Pant Sychbant.

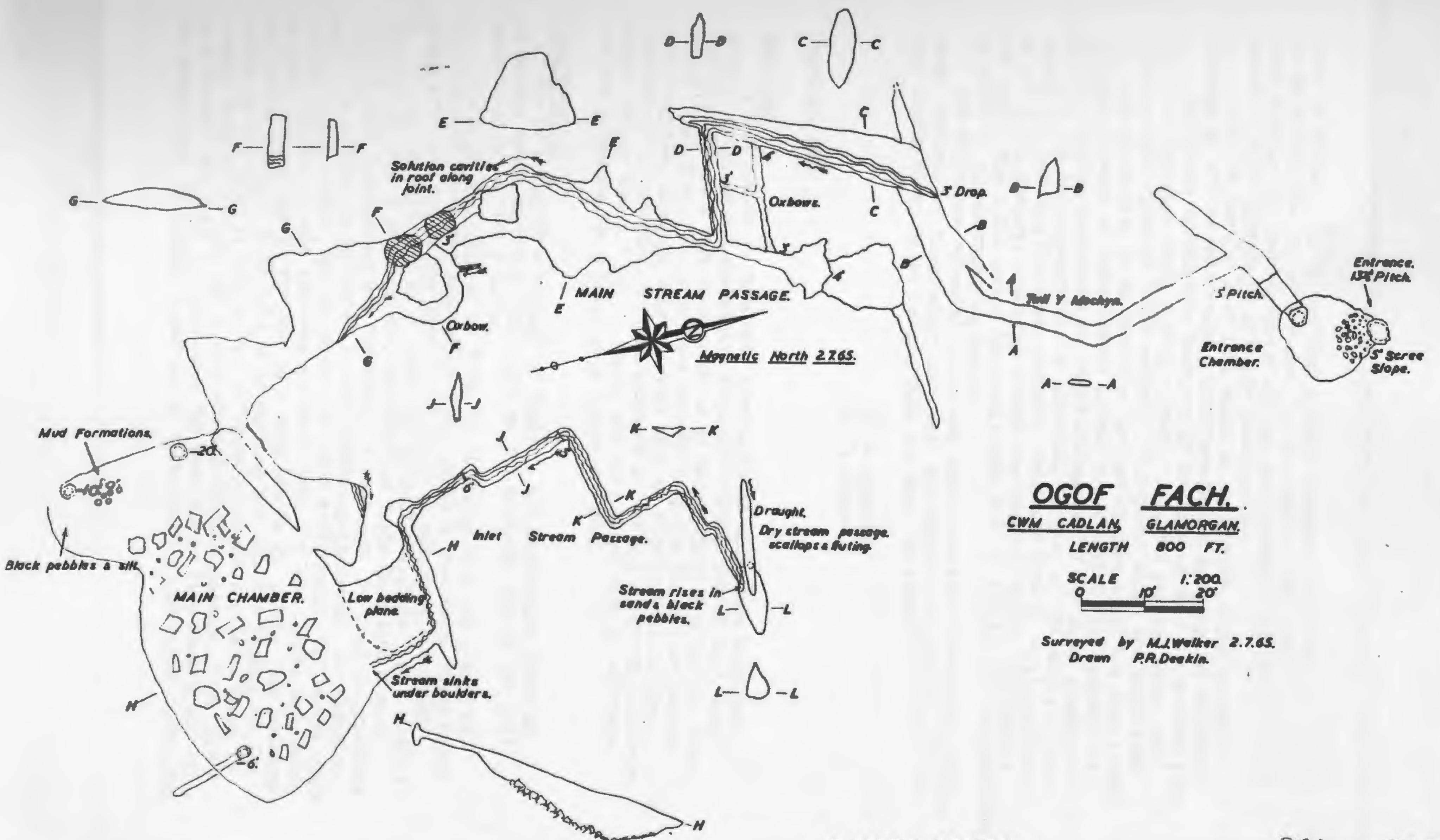
The cave is situated at N. G. R. SN 9707.0972, at a height of c. 975' OD. The entrance lies in the westerly of two adjacent shakeholes, the easterly taking a fairly large stream. The cave shows signs of having been entered initially by digging, and the farmer upon whose land the cave is situated, Mr. G. Davies, tells us that he remembers some local boys being active in the area in the early fifties. This story is confirmed by Mr. Melvyn Davies of the B. N. S. who says that the cave was probably first entered by the boys of Monmouth School led by Cullingford. He says also that Gordon Clissold dug in the cave in 1955.

When we first entered, a short entrance shaft led to a small chamber with a boulder floor, from which a squeeze to the left gave access to a 10' shaft. At the bottom of this the stream was met, which could be followed until it sank in boulders immediately under the entrance chamber. Traversing across the head of this shaft, a slide down to the right led to another chamber with a long, downward-sloping tube in the floor at the bottom of which could be heard faintly the noise of falling water. A half-hearted attempt to dig at the bottom of this tube was abandoned when it produced no quick result and we turned our attention to the entrance chamber. The whole entrance series is rather unstable.

By shifting some large boulders in the floor of the entrance chamber, access was gained via a very disconcerting squeeze to the head of a smooth, water-worn shaft down which we could just slip without dislodging several tons of unstable boulders jammed in it. The shaft opened out into a short rift, blocked at the end, which is, at the present moment, full of stones removed from the floor. Digging in the floor, we got into a downward-sloping bedding plane, also choked with stones. This was cleared and the debris deposited in the rift above.

At the bottom of the bedding plane was a jumble of large, unstable boulders, and it was at this point that we would have given up had it not been for the extremely loud rumble of water that we could hear through them after heavy rain. The bedding plane was named Twll y Mochyn after the unique character of the mud found there.

After very many false attempts, we broke through the boulders into a stream passage. As is the wont of those breaking into new caves we told ourselves that this was IT, another Agen Allwedd ! Alas for us, after a few right-angled bends, the stream sank into the floor, as did the roof. The next day, after some impotent scrabbling, we at last broke through this obstacle too, into a largish, low chamber. The floor of this chamber is of large boulders, and one has only to climb down through


OGOF FACH.
CWM CADLAN, GLAMORGAN.
LENGTH 800 FT.
SCALE 1:200.
0 10' 20'
Surveyed by M.J.Walker 2.7.65.
Drawn P.R.Deakin.
MAIN STREAM PASSAGE.
Magnetic North 2.7.65.
Entrance. 13½' Pitch.
5' Scree Slope.
Entrance Chamber.
5' Pitch.
3' Drop.
Oxbows.
Oxbow.
Solution cavities in roof along joint.
Mud Formations.
Black pebbles & silt.
MAIN CHAMBER.
Low bedding plane.
Stream sinks under boulders.
Inlet Stream Passage.
Stream rises in sand & black pebbles.
Draught.
Dry stream passage. scallops & fluting.

PRD 14-7-65

then to stream level to see what a nasty specimen of a choke it is. This is definitely the end of the cave for the moment. Just recently we have been digging in a bedding plane off the main chamber (not shown on the survey) which appears to continue indefinitely.

Worthy of mention also is a small but attractive inlet passage leading up off the main chamber which provides a sporting ten minutes.

One of the distinctive features of the cave is that the greater part of it is developed along a single shale band, the passage above this shows a high degree of joint control. Development along the shale band has also given rise to an extensive network of oxbows off the main stream passage. Several of these oxbows contain a stratified fill possibly of glacial origin. Quantities of eroded stalagmite in the upper reaches of the cave and large quantities of alluvium, in view of the nature of the stream now entering the cave, probably originate from an earlier period of the cave's history, deposited before the present, active development had begun. The whole system now totals some 800' in length and the extension is shown in the accompanying survey.

Our thanks are extended to Mr. and Mrs. G. Davies of Wern Las, Cadlan, whose kindness and hospitality have made the exploration possible, and to Paul Deakin of the Eldon Pothole Club who drew the survey.

F. E. Sanders
R. J. Cooper

December, 1965

Ogof Fawr

Several visits to this most impressive of sinks have been made. Unfortunately, on all occasions, inclement weather and/or dead sheep have not allowed a very close look to be taken. Since I wrote the above, I have learned that B. N. S. have re-opened an old dig and are making good progress, although this has been slow as they have encountered archaeological material. Thermal currents in the dig apparently indicate a cave rather than a ' pot '. Still, all that water must go somewhere and the prospects for a large cave system are good.

HEPSTE VALLEY

The following is a summary of findings and conclusions after an afternoon spent examining shakeholes on the southern edge of the grit capping of Gwaen Cefn y Garreg.

N.G.R. SN 9477.1172 at c. 1025' OD. A stream sink 100 yds. N of Tir Duweunydd farm, two shakeholes connected by a rock arch. These might repay attention but to dig them out would be an extensive operation.

N.G.R. SN 9478.1180 at c. 1050' OD. A small shakehole with a visible opening 100 yds. E of the above. The entrance leads down into a small chamber with interesting mud formations on the roof. The roof is gritstone while the chamber is developed in the underlying limestone, the division being clearly marked. The two rocks are quite conformable. Off to the right of this chamber, a hole that was not seen until the last minute led, after a little enlargement to the head of a very unsafe 25' pitch. Huge boulders all around appeared to be held in by nothing but mud. The landing at the bottom of the pitch is onto a heap of black gritstone boulders. There is a small aven to one side and a very short descending passage, both choked with debris. The pitch is remarkable for some rather fine fluting and for the occurrence, at regular intervals of a few feet, of perfectly horizontal bands of chert at an advanced stage of desilicification.

N.G.R.SN 9480.1195 at c. 1050' OD. East of the above and an active stream sink. It is a shakehole, half-filled with rubbish, where there has been a recent collapse of the face, but despite this, an opening can be seen under the debris and might repay further attention.

N.G.R. SN 9494.1207 at c. 1100' OD. On the other side of the mountain road to the above, near the gate. It is a larger shakehole than the others with a visible opening leading to a boulder-floored chamber once again developed immediately under the basal grit. Through holes in the rather unstable floor can be seen two openings, while a squeeze on the right leads to the head of an obviously unsafe pitch of about 25' depth. This was not though worth the risk involved in the descent.

Despite the repeated efforts of several clubs, notably B.N.S.S.S., only a small portion of the long underground course of the Hepste has been traversed. Inlet passages from sinks in the valley sides may provide a way in, although all sinks investigated to date have been hopelsssly choked.

It is hoped that after a little more work it will be possible to publish a rather more rigidly geomorphological account of some of the particular features of the Hepste and Cwm Cadlan-Pant Sychbant valleys.

F. E. Sanders

November, 1965

AN EXPERIMENT TO ESTIMATE THE ERRORS MADE IN TAKING COMPASS BEARINGS

The error made in taking a bearing between two points has a number of causes, aggravated under cave conditions, of which the most important are :

1) misplacing of the compass and sighting object
2) intention only to read to a certain accuracy
3) inability to read to an infinite accuracy
4) variations in the magnetic field.

The last of these is a systematic error and is not considered here, but the first three are random errors and are, as such, amenable to statistical analysis.

The quantity used to denote the likely error is called the standard deviation and is given the symbol o. If a large number, N, of readings are taken, and the error made in the i-th reading is e_i, then the square of the standard deviation (sometimes called the variance) is given by the equation

$$o^2 = \frac{1}{N}\sum_{i=1}^{N} e_i^2 \qquad (1)$$

The second type of error listed above, which will be called the tolerance error, is the error due to the coarseness of the scale used. For example, the error made if the scale is read to the nearest 5° may be anything up to $2\frac{1}{2}^{\circ}$ either way. The tolerance error is equally likely to be any value inside the tolerance but is certainly not going to be more than that tolerance. This case is easy to deal with and the standard deviation of the tolerance is calculable theoretically. If the scale is read to the nearest 5°, the standard deviation turns out to be 1.28°. In general, if the scale used is marked in divisions spaced at a distance a, then the standard deviation of the distribution of tolerance errors is a/3.46 .

The distributions of the first and third types of error, which will be called the position and reading errors respectively, are certainly nearly normal distributions, but it is unnecessary to attribute any particular form to them. The standard deviations of neither are calculable, so that an experimental determination of the total standard deviation must be devised that will distinguish between them. Fortunately, this distinction is facilitated by the very thing that makes it necessary.

The error made in measuring angles will be the sum of these three errors, assuming no variation in the magnetic field. In this case, the general theory of stochastic processes gives that the standard deviations add in the squares. That is to say, if the standard deviation of the position error, the tolerance error, and the reading error are o_p, o_t, & o_r respectively, then the standard deviation, o, of the total error is given by

$$o^2 = o_r^{\ 2} + o_p^{\ 2} + o_t^{\ 2}$$

Now o_r and o_t are independent of the distance, d, between the compass and the sighting object, but o_p, the error due to the misplacing of the compass and the sighting object, can be written as a/d where a is some quantity independent of d. Thus

$$o^2 = o_r^{\ 2} + o_t^{\ 2} + \frac{a^2}{d^2}$$

Since o_t can be calculated, if o is measured experimentally for two or more values of d, both o_r and a may be individually calculated.

Objections can be raised to the simple device of setting up a compass and sighting object, taking the bearing of the latter from the former many times, and evaluating o from equation (1) subsequently. Were this done the same reading would be recorded each time, and, taking the true value of the bearing as the average of all the readings, o would turn out to be zero. This does not point to the failure of equation (1) but rather to the fact that the errors in such a procedure are not random. Indeed they are not, each being just the same as the other.

Four points must be borne in mind when devising the experiment to measure o :

1) the reading recorded in any particular case may be biased by a memory of previous readings if the same or nearly the same angle is measured twice.

2) it should be certain that the tolerance error really is random in the way indicated above.

3) it should also be certain that the position error is random, neither this nor the last error will be random if the compass or the sighting object is not continually moved during the experiment.

4) equation (1) is true only after an infinite number of readings have been taken. An error is introduced because only a finite number of readings can be taken. If the true value of the reading is not known this error enters twice, as the true value has to be taken as the average of all the readings.

The experiment to be described here takes account of the fourth difficulty while overcoming the first three. Basically, it comprises measurement of the internal angles of an n-sided polygon with a compass and comparing their sum with the known result. The only drawback is that the number of readings that has to be taken to achieve a given accuracy increases by a factor of 2n.

If there are m polygons each with n sides, and the error in measuring the sum of the internal angles of the i-th polygon is e_i, then the standard deviation o is calculated from the formula

$$o^2 = \frac{1}{2nm} \sum_{i=1}^{m} e_i^2 \qquad (2)$$

The answer obtained for o will be accurate to within $100/\sqrt{2m}$ of the actual value (that value would be obtained if an infinite number of polygons were used). These two results are derived in the appendix.

Certain form should be observed during the experiment in order to ensure that reliable answers are obtained. Clearly, since o varies with the distance d, all the sides of the polygons should be the same to within a very few inches. The most suitable polygon to use is a regular pentagon, in the case of three and four-sided figures there would be noticeable similarities between the readings and this would detract from the reliability of the answers. Some order of reading the bearings should be used that introduces the maximum confusion into the memory of previous readings.

The method of working out the sum of the internal angles is important. Each angle should be evaluated separately as the difference between the forward and back bearings at each point, these angles then being summed. If a different method is used, much of the information from the experiment could be unwittingly thrown away. This method also minimises the effects of magnetic field variation.

The procedure is then as follows. First stake out a large number of pentagons with a given length of side and evaluate o for that value of d from equation (2). Then repeat this for at least one more value of d. From the formula

$$o^2 = o_t^2 + o_r^2 + \frac{a^2}{d^2} ,$$

o_r and a may easily be calculated. o_t is given by

$$o_t^2 = \frac{t^2}{12} ,$$

where t is the tolerance (e.g. 1° if readings are taken to the nearest degree.

APPENDIX

If the standard deviation on the error of a single reading is o and the standard deviation on the error of the sum of the internal angles of an n-sided polygon is o_t, then, as the sum of the internal angles is an algebraic sum of 2n separate readings,

$$o_t^2 = 2no^2 .$$

If the error on the sum of the internal angles of the i-th polygon is e_i, then

$$o_t^{\,2} = \underset{q \to \infty}{\mathrm{Lt}} \sum_{i=1}^{q} e_i^{\,2}/q \,,$$

so that

$$o^2 = \underset{q \to \infty}{\mathrm{Lt}} \frac{1}{2nq} \sum_{i=1}^{q} e_i^{\,2} \,.$$

Define o_{calc} and o_{tcalc} by the equations

$$o_{calc}^{\,2} = o_{tcalc}^{\,2} / 2n$$

and

$$o_{tcalc}^{\,2} = \sum_{i=1}^{m} e_i^{\,2} / m$$

Then

$$o_{calc}^{\,2} = \frac{1}{2nm} \sum_{i=1}^{m} e_i^{\,2}$$

Now the probability density of getting an error e_i for the i-th polygon is $P_e(e_i)$, where

$$P_e(e_i) = \frac{1}{\sqrt{2\pi}\, o_t} \cdot \exp\left(- e^2 / 2o_t^{\,2} \right) .$$

If $f_i = e_i^{\,2}$ and the distribution of the f_i goes as $Pf(f_i)$ then

$$P_f(f_i) = \frac{1}{\sqrt{2\pi}\, o_t \sqrt{f}} \cdot \exp\left(-f / 2o_t^{\,2} \right) .$$

It should be noticed here that it is not necessary to assume that either the position error or the reading error follows a normal distribution. The error on one reading follows a distribution that is certainly not Gaussian but the distribution of e_i is the convolution of ten such distributions which are all similar so that it is very close to a normal distribution.

The standard deviation of P_f may easily be calculated by the usual formula and it turns out to be $\sqrt{2}\, o_t^{\,2}$ ($= \sqrt{8}\, n o^2$). The standard deviation of the sum

$$\sum e_i^{\,2} \quad \left(= \sum f_i \right) \text{ is then clearly } \sqrt{8mn}\, o^2 \text{ so that the}$$

standard deviation of the distribution of the quantity $o_{calc}^{\,2}$ is $o^2 \sqrt{2/m}$. It is now easy to see that the standard deviation of the quantity o_{calc} is about $o / \sqrt{2m}$

The $o/\sqrt{2m}$ is the likely error that will be made in measuring o if m polygons are used.

H. I. Ralph,
St. John's College,
OXFORD

CLUB DIARY

During the two years since the publication of Proceedings No. 3, the O. U. Cave Club has spent, apart from the usual meets during term, several profitable vacations.

In 1964 the Summer Meet was held in Yorkshire; the first half was spent at the old Kendal Cave Club hut at Helwith Bridge, followed by a move to Bull Pot Farm on Casterton Fell. Graham Stevens had already surveyed part of Washfold Pot and several days were spent in an attempt to finish this. Unfortunately, wet weather at the time prevented descent of the 110' pitch, but the survey of the upper series was complete and a new rawlbolt fixed at the top of the pitch from which the ladder could be hung free of the water. Graham has since completed the survey.

While at Bull Pot Farm, a determined effort was made to pass the Northern Sump to try to link the cave with Casterton Pot. The level of the sump was lowered about 1' by digging away some of the silt and Tim Cooke, by free-diving, reached a bell about 10' in. Since then, a visit by a fully-equipped diver has proved the sump to be at least 50' long. A trip was made to the choke in Lancaster Hole Easter Cave as were sundry others to Easegill, Yordas, Calf Holes-Browgill and etc. which finished an enjoyable meet.

Other activities during that summer included a visit to Czechoslovakia (G. Stevens) and one to Ireland (R. Hazelwood, D. C. Robertson).

No official meets of the club were held at Christmas '64 or Easter '65 largely on account of preparations for the expedition that was to be held in the summer. Several training trips for the expedition were organised in Derbyshire and Yorkshire, including Giants Hole (twice), P 8, Marble Steps, and Nott's Hole, all being very well attended.

Francis Sanders spent much time with Ron Cooper and many others (as and when they could be persuaded to go) near Penderyn (S. Wales) where Ogof Fach was considerably lengthened.

The summer of '65 was spent with members of the Eldon Pothole Club and many others (30 in all) in Spain (v. supra).

Christmas '65 saw another visit to Yorkshire. The weather was appallingly wet and activities were in consequence limited to "trog" trips down Lancaster Hole, Easegill, Bull Pot, etc. without any original work.

At the start of the Easter vacation, 1966, a small party spent a few days in Derbyshire going down Oxlow and Giants, followed by a splendid day in Penyghent Pot after a lightning dash to Yorkshire, as guests of the Eldon P. C.. Another Yorkshire trip is, at the time of writing, being planned for this Easter.

To return to term-time, Trinity '64 saw little activity, due as llways to the multitude of distractions provided by a summer in Oxford ! However, one visit to Stoke Lane Slocker was successful, although Sarah Cherry was surprised to find that the cave entailed diving a sump, while the writer lost his spectacles in the latter and had to return home for a spare pair. Indoors, Oliver Lloyd talked about new cave passages - how to find them and what to do if you have that good fortune.

Michaelmas '64 arrived with its usual crop of freshmen who were initiated into the delights of Swildons and Eastwater. Trips to G.B. and Ogof Ffynnon Ddu both succeeded despite permit difficulties, but Hillocks Mine did not attract sufficient interest to make the projected trip worthwhile. John Wilmut of the Chelsea S. S. talked on Triglav '64 and our president, Dr. Margery Sweeting, on American Caves and Caving Areas.

Hilary 1965 got off to a bad start with a trip to the Forest of Dean and a film show which were both cancelled. The general lack of interest that seemed to spring from this failure put a blight on the next two terms. While trips to Tunnel Cave and Porth yr Ogof went well, those planned to Mendip and'Aggy' suffered from weather and transport difficulties, both coming to a grinding halt. A talk by David St. Pierre of the S. W. Essex Technical College C. C. on their expedition to Norway and an uproarious A.G.M. served to compensate for the caving, poor despite the fact that a party succeeded in bottoming Primrose Pot in Eastwater, even though afterwards all avowed fervently that this trip was a'never again'.

Trinity '65, suffering from usual difficulties and from the legacy of the term before, had one trip to Oxlow and a talk by M. Schofield on Ogof y Dydd Byrraf, most of the members being occupied with preparations for the coming expedition.

In Michaelmas Term, a determined effort at the Freshman's Fair brought membership back to a reasonable figure. This gave rise to difficulties on the first trip with more novices than experienced members. Nevertheless two parties descended Swildons and Lamb Leer without mishap. Another double trip, St. Cuthberts and Eastwater Twin Verticals gave new members experience of the tighter type of cave. Two trips to S. Wales were well attended. Aggy was entered with much relief to escape the howling blizzard outside. Reg and Margaret Howard talked to new members on the Spanish Expedition and Mr. & Mrs. John Hooper of the D.S.S. gave an excellent talk on Bats and Bat Detection which was superbly illustrated.

Last term (Hilary '66) the A.G.M. was held at the Swan Hotel, Eynsham. Mike Wooding talked on Cave Diving and discussed the latest discoveries. Bill Maxwell of the C.S.S. gave an excellent history of the discovery and opening up of Agen Allwedd, all the more interesting to the freshmen who had visited it the previous term. A very successful Oxlow trip - exploring the new series - and trips to Stoke Lane Slocker and Ogof Fach completed the term.

The last two years have had their ups and downs but the club seems to have weathered them successfully.

R. A. Hazelwood

REPORT ON THE BRITISH SPELEOLOGICAL EXPEDITION TO THE CANTABRIAN MTS. SPAIN, SUMMER 1965

Several members of this club took part in the British Speleological Expedition to the Cantabrian Mountains during the long vacation of 1965, and we feel that a report of the findings of the Expedition should form part of the proceedings of the Club. For a fuller and more detailed account of this Expedition the reader should refer to the report due to be published by members later this year.

The Expedition was first planned in November 1964 and was intended to be quite small, not more than about ten members. We got into contact with a Spanish caving club based on León, the Grupo Espeleólogos de Peñalba, who appeared to be quite pleased at the prospect of a thorough exploration of their area. Partly on the strength of their reports, the Expedition grew to its eventual size of thirty. We were lucky in receiving large numbers of gifts of food and equipment from industry, but about three thousand feet of electron ladder had to be assembled.

On arrival at León, we were taken to the camp site prepared for us by the Spanish potholers, about twenty miles north of the City. This was situated in a polje whose floor was at 1,200 m. , surrounded on three sides by mountains and quite heavily afforested. The first few days were spent acclimatising to the extremely high daytime temperatures and arranging methods of exploration with the Spaniards. This had to be done in two ways: firstly, caves reported by the Spaniards had to be thoroughly investigated by us, and secondly, the surface had to be searched methodicall in the hope of finding new systems. The first provided many disappointments as most of the caves did not realise their full potential as reported by the Spaniards. I shall give a brief description of some of these.

<u>Sima Graíl</u>: 180' entrance pitch onto slope of rubble and guano. Below the slope a further pitch of 75' ends in an impassable floor of rubble. Above this pitch a rift continues upwards, but not to the surface. There are no horizontal passages.

<u>Sima el Solitario</u>: Near Sima Graíl, on the south side of Peña Cimera. Another shaft with a large entrance. Drops to 80' and then chokes.

<u>Pozo de los Grajos</u>: On the south side of the mountain Moneca. Shaft of 150' leading to snow. This is domed indicating that it could have been formed by a standing column of water. There are no horizontal passages. North of this there are three small shafts, depth 60', which connect at their bases.

<u>Cueva del Pozo de Infierno</u>: A resurgence cave in a large rift opening into the base of the Torío canyon. This extended almost horizontally into the side of the gorge and took a lot of very cold water. The rift was 60' high in places, with very deep water. Ended in a sump in which diving was attempted. Attempts to climb over the sump were made but these were abandoned.

Cueva del Valle del Marqués: This influent cave occurs in Devonian limestone in an enclosed valley on top of the mountains on the east side of the Torío gorge, above Rodillazo and Tabanedo. The entrance may take a large amount of water in the spring, but only pools remained in the summer. A large entrance rift leads via alternative passages into a rift at right angles. After a few hundred feet a stream is met flowing across a small chamber. Above this the rift could be climbed into a long boulder choke. Both above and below this choke a way might be forced with care, as chambers could be seen through the boulders.

Cueva de Valporquero: This is without doubt the finest system explored so far in the area, and part of it is being converted into a show cave. Below the public part there is an extended passage taking a stream which offers an extremely worthwhile trip. At present a survey is being drawn, and our estimate of the length as 1 - 1.5 Km. may be very inaccurate. The entrance lies in an uvala on the south side of the village of Valporquero de Torío. An influent stream enters the cave, which drains the Sierra del Gato about 3 Kms. to the west. A wide entrance leads into a largely dry upper series of well decorated passages. The stream sinks to reappear lower down the system. An inlet stream can be followed up through decorated chambers containing pools for some way. These are probably beneath the deep, conical doline to the east of the cave entrance and the curious forked rock formation above it, known as El Cogullón. The way down is through a narrow passage 300' high, called El Cañón, and then a climb down through boulders to the stream. After swimming through some deep pools, one reaches a high passage at the end of which the stream falls over a flowstone cascade of depth 70'. This is formed in a domed chamber about 300' high, with a flowstone floor. The stream passage is followed through more large chambers involving two 20' slides into deep pools. Finally the stream sumps in a large chamber. A thin M-shaped tube (in elevation) on one side of this chamber gives access to a daylight chamber out of which the stream emerges. The resurgence is about 200' above the Rio Torío.

Of the caves discovered by the Expedition members, only two are of any importance, and I shall describe only these.

Sil de la Colombina (Ghyrrt Cavern): This non-active cave is on the side of the Pico Polvoredo above Correcillas, the entrance being about two miles from the Cueva del Valle del Marqués described above. An entrance pitch of 110' leads into a large, curved chamber with a sloping rubble floor. This curves downwards and narrows until choking about 200' from and 100' below the foot of the pitch. A 40' pitch opposite the entrance pitch drops into a narrow rift which leads into a series of dry caverns, about 50' high, in which considerable clastic deposition has occurred. After two 25' pitches, the way on is through a hole blasted in a piece of stal into a very well decorated small chamber. After climbing down a steeply inclined bedding plane and a 50' pitch, the final chamber is reached. This is curved in shape, 100' long and about 75' high, with calcite walls and floor. Above the final pitch, a series of small passages was explored, but these led nowhere. The entrance to the cave occurs in a sloping limestone pavement, and it is hard to see how an active stream ever flowed in through the pitch. The entrance is in Devonian limestone.

Fly Pot: This is to the west of Cueva de Valporquero and was named after the very large number of flies found at the entrance. It consists of two 50' pitches and then a short passage following a small stream. This eventually choked in mud and rubble which cannot be dug.

After exhausting the possibilities of the Valporquero area in the first three weeks of the Expedition, there arose the question of what area should then be explored. There were two possibilities, either going to a completely new area and starting with no prior knowledge of the prospects, or returning to the district partially explored by previous expeditions. In the event, it was decided to do the latter, and the Expedition moved to a site near the town of Cangas de Onís, at the north of the Picos de Europa. Most of the caves found there were completely new, although there was one, reported on a previous expedition, which had to be investigated. This was called Jou Cabau, and had been reported as a very large diameter shaft over 150' deep, high in the mountains to the east of Cangas de Onís. This was found on inspection to consist of a cylindrical shaft, about 150' in diameter, between 175' and 200' deep, filled with 15' of snow at the bottom. The perimeter of the cylinder on one side was riddled with smaller shafts which were connected at their bases to the bottom of the main shaft. As these were on the uphill side, they probably took most of the surface water in times of heavy rainfall. On the opposite side of the cylinder, a small, well decorated passage led to a thin, but very tall, rift. This was descended in stages, using 175' of ladder, to a narrow stream passage at right angles to the rift. Upstream probably led back to the bottom of the main shaft, but the way was stopped by a difficult climb. Narrowing of the passage stopped any progress downstream. The total depth of the pot was estimated as 500'.

As found before in this area, the majority of caves consisted of vertical shafts which were found to be blocked at the bottom. Only two caves, apart from the Jou Cabau, were of any interest, Cotozia and Cueva Huelga. The upper series of both these caves had been explored previously and had been denuded of all their formations, which we presumed had been taken as decorations. The Expedition penetrated further than earlier parties.

Cotozia: West of the Sella gorge, near the village of Beleño. The entrance is a large hole in the side of a small cliff. There is a long daylight chamber, 20' high and about 75' long. On the left of this a very narrow squeeze, 10' long, leads to a series of dry chambers. These are full of very beautiful formations, certainly the best encountered by the Expedition. After three chambers, the way is blocked by a calcited mound of rubble. Two avens were climbed, but these were stopped in the same way. At the base of the rubble, the bones of a large bird were found. As it was impossible to move these without damaging them, only photographs can be used as a means of identification.

Cueva de la Huelga: The entrance is situated in an orchard near Nieda, east of Cangas de Onís. There was a small stream flowing into the cave, but debris high on the walls indicates that, in times of heavy rainfall, a considerable torrent may flow into the system. The upper series is complex and extensive and at one time may have contained a lot of formations. Two routes may be followed into the rest of the cave, one down a 50' pitch near the entrance over a large pool, the other a dry crawl in a series of sandy passages extending from the upper series. These both lead into a continuation of the main stream passage. This continues, with a number of blind side passages, into two large chambers. From the second of these, a winding passage leads into a bedding plane. At the bottom of this a small phreatic passage stops where the stream is met again. This disappears in a narrow sump, which would be difficult to dive. Nearer the entrance a dig in mud was attempted to locate the stream but this had to be abandoned due to lack of time.

This concludes the description of the caves explored, as the others met with do not merit attention in an article of this short length. Surveys of the following caves were made, and should be available when the Expedition report is published :- Cueva de Valporquero (as this was drawn up by the Spaniards, its accuracy may be open to some doubt), Sil de la Columbina (Ghyrrt Cavern), Fly Pot, Cotozia, and Cueva de la Huelga.

A conclusion on the success of the Expedition must also be left to the official report, but my personal opinion would be that the Expedition was made too large and too strong on the basis of reports by the Spaniards. As these reports proved to be very unreliable, the full potential of the Expedition was never realised in the caves that were found. The pre-Expedition organisation was good and, given some very extensive systems to explore, it could have been far more of a success than it was.

A. C. W. Robertson

EDITOR'S COMMENT

I feel very pleased to be able, at last, to issue No. 4 of the O. U. Cave Club ' Proceedings '. Although two years have passed since the last issue in May 1964, I feel that the contents of this issue should be adequate compensation for the long wait.

The papers and articles in this issue have been intended to record, in as interesting a way as possible, some of the things that members of the Club have done in the last two years. Michael Walker's paper on cave development in N. W. Spain is, as he says, a summary of the findings and conclusions of a number of expeditions which have taken place since 1961 in which members of the Club have participated. My short account of erosional features around Oxford tells of the not strictly speleological work that the Club has done on the limestones nearer home. Here I must acknowledge a suggestion by S. A. Craven of the Craven Pothole Club that the O. U. C. C. excavate one of the sinkholes near Henwood Farm, holes that have been christened by him ' Henwood Pots ', as it was this suggestion that opened our eyes to the possibility of research a little closer to Oxford than Mendip, our nearest caving area.

The paper on cave location in Turkey was written from data collected for a report to the committee of the expedition that later became the British Speleological Expedition to the Cantabrian Mts., 1965. Michael Walker has drawn my attention to the forthcoming bulletin of the Soc. Spél. de Paris which will contain an interesting account potholes and caves explored by that club in the Turkish Toros Mts. in 1965. A. C. W. Robertson's account of the Spanish Expedition follows, as does an account of some of the activities of the Club in S. Wales.

Hugh Ralph's paper on the calculation of likely errors in cave surveying will probably be useful to many, even if they, like me, find the mathematics very hard going ! This work was done in conjunction with Graham Stevens, a late member of the Club, who has recently produced a survey of Washfold Pot.

A leader and certain correspondance that appeared in the Guardian recently is reproduced by their kind permission, and Michael Walker has added a further comment.

Finally, for the sake of tradition, I have included a summary of O. U. C. C. meets, fortunes, and misfortunes during the last two years, written by Dick Hazelwood.

I am sorry to have had to abandon the previous format of the ' Proceedings ' and to have reverted to the cyclostyled quarto sheet that is the resort of so many these days, but it is simply a question of costs, and one flatters oneself that it is the content that really matters. A considerable saving by these means should allow continuation in the futu[re] of the old policy, ' an issue a year '.

F. E. Sanders