Cave Science

The Transactions of the British Cave Research Association

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Volume 15 Number 2 August 1988

Sea-level Caves of Berry Head, Devon

Caves of Chiapas, Mexico

Aragonite in Daren Cilau

Cave Science

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CAVE SCIENCE Vol. 15, No. 2, August 1988
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Sea-level Related Caves on Berry Head, South Devon

C. J. PROCTOR

Abstract: Ancient marine erosion platforms on the Devonian limestone outcrop of Berry Head show that it has been a coastal headland, surrounded on three sides by the sea, since Tertiary or lower Pleistocene times. Apart from a few small wave-eroded sea caves, the known caves on Berry Head are exclusively phreatic in origin. They are partially controlled by Permo-Triassic extensional fractures and neptunean dykes, but the dominant influence on cave formation on Berry Head has been the hydrological controls dictated by the unusual coastal environment. Horizontal cave systems on the Head occur a few metres below the level of Pleistocene marine erosion platforms, showing that they formed during sea level still-stands, at the base of a shallow freshwater lens underlain by seawater. Deep rift systems formed at the lens base as the freshwater lens rose and fell during periods of changing sea level. The caves are tentatively dated by correlation with surface features. The evidence suggests that they formed when sea levels were high during interglacial periods. Cave development over at least three interglacials is proposed.

Berry Head lies at the eastern end of one of the largest outcrops of Devonian limestone in Devon. The headland is surrounded on three sides by the sea, and marks the southern extremity of Torbay (fig. 1). Quarrying on the north side of the Head has exposed a large number of cave entrances, and exploration since 1985 has revealed several hundred metres of phreatic caves (Proctor 1987), probably only a small proportion of the total cave development. These caves occupy a unique position in a block of limestone almost surrounded by the sea, and have an unusual morphology indicating that they formed at the base of a thin freshwater lens overlying a deep seawater aquifer, in a manner analogous to the Blue Holes of the Bahamas. The following is thought to be the first identification of such a process having operated in Britain.

GEOLOGY

The limestone outcrop of which Berry Head forms the eastern end stretches 7km to the west to the shores of the Dart estuary (fig. 1). The stratigraphy of the area has been described by Smythe (1973). The Brixham limestones were deposited through most of the middle Devonian, from early Eifelian times, and deposition finally ceased in Frasnian times (early upper Devonian). The limestone sequence consists of three main units. The lowermost unit, thin crinoidal limestones interbedded with red shales, is not exposed on Berry Head, but outcrops on the coast to the south. The middle unit is a thin-bedded crinoidal limestone. The uppermost unit is composed of poorly bedded crinoidal limestones which are laterally replaced by massive

Figure 1 Location map and geology

stromatoporoid - coral reef limestones on Berry Head itself.

The limestone has suffered extensive Hercynian deformation. Berry Head lies within an east-west trending syncline which brings the base of the uppermost (reef) limestone down to below sea level. Thus the main mass of the headland is composed of massive reef limestones (at least above present day sea level). To the north and south, middle limestones outcrop on the flanks of the syncline at Shoalstone and Durl Head, just outside the area of this study (fig. 1). The upper limestone on Berry Head shows tight small scale folding and well developed cleavages in places. These structures have not been mapped since they appear to have relatively little influence on cave development. Over most of the headland the limestones dip to the south at 10-30° but locally much steeper dips are present.

On Berry Head the limestone is cut by numerous "neptunean dykes" occupying WSW-ENE trending tension fractures , which generally show a steep dip (60°+) to the south. The dyke fill is red Permo-Triassic sandstone (usually calcite cemented) with blocky calcite veins, often showing evidence of several phases of infill. A further set of north-south trending vertical fractures, sometimes showing a downthrow on the east side, may also contain a similar fill. The dyke fill dates these features to the Permo-Triassic (Richter 1966), and they may be attributed to a period of extensional tectonics connected to the formation of the English Channel. The dykes have been examined in detail at Shoalstone Beach, just west of Berry Head by Richter (1966). He showed that at Shoalstone of two generations of dykes are present, an older calcite-cemented set, and a younger set which may be cemented by calcite or quartz. No such analysis of dyke petrography has been done on Berry Head. Neptunean dykes have considerably influenced cave formation on the headland, and a study of variations in dyke petrography would be particularly valuable in assessing their effect on cave development.

There are extensive outcrops of Permo-Triassic desert sediments on the floor of Torbay to the north of Berry Head, and small residual outcrops on the south side. These outcrops lie well below the top of the headland, suggesting that it was a ridge in Permo-Triassic times. The eastern end of the outcrop is now defined by a major Tertiary fault which has downfaulted the continuation of the ridge to the east (Laming 1982). Tertiary and later erosion has probably merely exhumed the limestone ridge from beneath a cover of later sediments, with little modification apart from the cutting of marine erosion platforms on its top and flanks.

Neptunean dyke in the roof of The Cavern: the dyke consists of a wide vuggy calcite vein flanked by narrower veins of sandstone (visible at top centre and lower right). Dyke width is approximately 0.8m.

SURFACE GEOMORPHOLOGY

As mentioned above, the gross morphology of the headland was probably determined in Permo-Triassic times, when the limestone outcrop formed a steep-sided ridge towering above the desert plain to the east (Laming 1982, p 163). Berry Head, being composed of massive reef limestones, would have been particularly resistant to erosion, and so formed the easternmost extension of the ridge.

Berry Head from the south: the +57m marine erosion platform forms the flat top of the headland, and the minor +3m platform can be seen as a ledge just above sea level near the end of the head.

There is no evidence of fluvial erosion on Berry Head itself, and it is probable that marine erosion was the major process involved in the exhumation of the ridge to form the present coastal headland. In detail the geomorphology of Berry Head is dominated by a series of marine erosion platforms and cliffs formed by wave erosion at sea level during former sea level still-stands (figs. 1 & 2). These platforms fall into two groups differing greatly in scale.

Major platforms

The top of the headland is formed by a platform at an altitude of approximately +57m O.D. (see appendix for survey methods). This platform (clearly visible on the 1:25000 OS map) cuts across the folded Devonian limestones and, at its west end, outliers of upper Devonian slates. It extends as a 1-2km wide strip for 5km along the south coast of Torbay west of Berry Head, and is backed by hills rising to an altitude of over +120m O.D. The platform has been dissected by several valleys west of Berry Head, but where it is well preserved, it varies in altitude between +55 and +58m O.D. on the seaward side, sloping up to around +61m O.D. on the landward side. This morphology identifies the feature as a marine erosion platform. A submerged cliff-line off the end of Berry Head (shown on Admiralty charts) with its base at around -40m O.D. backs another platform which is similar in scale (Donovan and Stride 1975). The association of this platform with the submerged cliff shows that it too is a marine erosion platform. These platforms dwarf the small erosion platforms attributable to short sea level still-stands during the Pleistocene ice ages: they must have been formed during still-stands of correspondingly longer duration. Since sea level is known to have fluctuated almost continuously during the middle and upper Pleistocene, these features are thought to be lower Pleistocene or Tertiary in age.

Minor platforms

Much smaller marine erosion platforms have been cut into the cliffs of Berry Head. These platforms have a number of features in common. In form they are benches generally only a few metres wide, but laterally traceable for considerable distances along the coastline. They are essentially horizontal features, cutting across the geological structure, but may vary in altitude by up to 5m, usually sloping up from the seaward to the landward side. These are features characteristic of marine erosion platforms. Four platforms have been identified (figs. 1& 2); see the appendix for survey methods.

The lowest, forming a bench (visible on the Admiralty chart) off the end of Berry Head at about -15m O.D., is the largest of the minor platforms. Off the end of the headland it is about 50m wide, but to the north and south it reaches a width of over 100m. The lower limit of this platform is at -16m O.D.; the upper limit is more difficult to ascertain due to a cover of recent sediments, but may be as high as -10m O.D. The other three platforms are above sea level. Just above high tide mark is a narrow (generally 5 to 15m wide) but prominent platform visible in numerous places all round the headland (fig. 1). The seaward edge of this platform is usually at a height of +3 to +3.5m O.D. (but varies between +2.5 and +5m O.D.) and it may slope up to just over +6m O.D. on the landward side. Five metres higher is another platform with a raised beach (containing abundant Ostrea and other molluscs) resting on it. The seaward limit of this platform lies at an altitude of between +8.5 and +9m O.D.; its upper limit cannot be ascertained due to the sediment cover. The platform and its associated beach is well exposed only on the north side of Berry Head, particularly between NGR SX 939 568 and SX 942 568 (fig. 1). The highest of the minor platforms is poorly exposed, and is seen clearly only on the east side of Oxley Head at NGR SX 942 562 (fig. 1). Here it can be seen as a ledge mantled by scree deposits, cutting across folded limestones at an altitude of +28m O.D. The ledge is halfway up a cliff face, discouraging close examination, but it appears to vary little in altitude. Elsewhere around Berry Head the cliffs at this altitude are largely buried beneath scree deposits, and the platform cannot be definitely identified. These platforms are referred to below by the average altitudes of their seaward sides, which is normally fairly constant (hence, as the -15m, +3m, +8.5m, and +28m platforms).

As mentioned above, a raised beach rests on the +8.5m platform. Raised beaches are known at a similar altitude to the Berry Head example in many places in southwest Britain: in Torbay raised beaches are exposed in several localities resting on marine erosion platforms at altitudes between

Raised beach resting on the +8.5m marine erosion platform on the north coast of Berry Head (NGR SX 9415 5674), comprising limestone cobbles and abundant fossil Ostrea in a matrix of shelly sand.

Figure 2 Diagrammatic profile of marine erosion platforms on Berry Head.

+8.5 and +10m O.D. Beaches of at least two different ages are present, as demonstrated by the presence at some localities of two beaches, one resting upon the other, for instance, on the north side of Torbay at Hopes Nose, NGR SX 948 634 (Bowen et al. 1985). The Berry Head beach is partly covered by quarry spoil and it is not possible to see whether two beaches are present. Bowen et al. (1985) have shown by amino acid geochronology of molluscs in these beaches that they are referrable to stages 5 and 7 of the deep sea oxygen isotope record (Shackleton 1977). They argue that beaches of a third intermediate age are present, though it is dubious whether their method is sufficiently precise to be sure of this. Unfortunately the Berry Head beach falls within this "intermediate" group, and it is uncertain whether it dates from isotope stage 5 or 7. Bowen et al. consider on tectonic grounds that the platforms on which the beaches rest are not much older than the beaches. This is probably correct: the narrow altitude range of the platforms implies they have not had time to be significantly affected by differential uplift or subsidence. This implies the +8.5m platform on Berry Head dates from one of the short sea level still-stands of the middle and upper Pleistocene ice ages. The other minor platforms are similar in scale, and are still well preserved, so cannot be very old. This suggests that they are similar in origin.

Discussion

Two major preglacial platforms are present at altitudes of -40 and +57m O.D., demonstrating that Berry Head has been a coastal headland since at least the lower Pleistocene, but more probably since Tertiary times. Smaller platforms on the sides of the Head at altitudes of -15m, +3m, +8.5m and +28m O.D. were cut during short still-stands in the rapidly fluctuating sea levels of the middle and upper Pleistocene ice ages.

The age of the headland is of considerable significance in considering the origin of the caves: either they are extremely old, for which there is no evidence, or they developed in a coastal situation and can be expected to have been heavily influenced by the sea and changes in its level. The geomorphology of the caves demonstrates that the latter interpretation is correct.

GEOMORPHOLOGY OF THE CAVES

Over 50 caves, varying in length from 3 metres to the 215m long Corbridge-Cavern system are known on Berry Head. Most of the caves lie within the disused Berry Head Quarry or on the adjacent coastline (fig. 3). High grade surveys (Proctor 1987) have been prepared of the caves in this area of the headland and it is upon these caves that this study is based. (See appendix for survey methods).

Shaky Caves, a vertical system on a N-S fracture, which has been breached by quarrying.

Morphology

The locations of the caves discussed below are shown in fig. 3. Apart from a few small sea caves, the caves in and around Berry Head Quarry all show clear evidence of formation by phreatic solution. Irregular passage forms and passage networks (for instance the upper levels of Sweetwater Pot) that are typical of phreatic caves

Figure 3 Sketch map of Berry Head showing locating the Quarry Caves.
A - Sweetwater Pot
B - Corner Cave
C - Corbridge Resurgence Cave
D - Rift Cave.
E - Holes in the Wall
F - The Cavern
G - Corbridge Cave
H - Shaky Caves
I - Berry Head Cave
J - Hogberry Cave
K - Starfish Cave.
L - Cuttlefish Cave
M - Garfish Cave

The sump, Sweetwater Pot: a vertical rift in a N-S fracture. The sump is 15 metres deep.

are common (figs. 5 and 6). In addition all caves show such characteristic features of phreatic caves as blind roof pockets and irregular solution pitting on walls. Fine boxwork solution textures are present in some places, notably Sweetwater Pot and the North Wall in Corbridge Cave. A characteristic and unusual feature of the caves is that even quite large passages may suddenly pinch out to impenetrable fissures. No vadose passages are known: the only vadose features are the small tidal creeks incised into mud deposits in Corbridge Cave.

Several sea level phreatic caves (Garfish, Cuttlefish and Starfish Caves) show enlargement of their entrance zones by mechanical wave action to produce sea caves. In Garfish Cave the enlarged entrance passages lead into unmodified phreatic passages; Cuttlefish and Starfish Caves show phreatic solution textures preserved high up out of reach of wave erosion.

Figure 4 Cross sections of chambers found on a neptunean dyke, showing cave development initiated along calcite veins in the dyke. (A) The Cavern. (B) North Wall, Corbridge Cave.

Figure 5 Berry Head Cave, an isolated horizontal rift cave.

Figure 6 Sweetwater Pot, a complex cave comprising a deep vertical system formed on N-S fractures, connected to a small horizontal maze at +25m O.D.

The North Wall, Corbridge Cave, a large aven formed on a neptunean dyke. Solution of limestone adjacent to a calcite vein on the north (left hand) side of the dyke has left a massive undissolved vein of sandstone acting as a barrier to solution on the south side. The sandstone vein can be seen running from top centre to lower right.

The dominant geological controls on cave development are the Permo-Triassic N-S and WSW-ENE fractures. Passage development in N-S fractures is seen in caves right across the headland and most of the known vertical cave development is on these fractures (fig. 6). Of more interest, however, is the relationship between cave development and neptunean dykes occupying the WSW-ENE fractures. Neptunean dykes are numerous at the west end of Berry Head Quarry, and much of the cave development in this area is clustered around a large WSW-ENE dyke in the NW corner of the quarry. This structure has a fill of calcite-cemented red sandstone and blocky calcite veins occupying a fissure (or in places several parallel fissures) that may approach a metre in width. The dyke has a steep southerly dip varying between 45° and vertical, and cave development intimately associated with it can be examined over a distance of more than 100m. Far from the dyke being a barrier to cave development, the largest chambers in Berry Head Quarry have formed along it. The relationship between the structure of the dyke and cave development shows that passage formation has been initiated along the blocky calcite veins. The sandstone may remain as a barrier to solution, but has frequently been breached by collapse or by solution of the calcite cement. Thus in the Cavern, where the dyke has a large central calcite vein flanked by narrow veins of sandstone, solution has caused collapse of the whole dyke, and a chamber has formed by solution of the limestone on both sides of the dyke (fig. 4). In contrast, at the North Wall in Corbridge Cave, the dyke consists of massive sandstone with a calcite vein along the north side. Here, the North Wall aven was formed by solution of limestone adjacent to the calcite vein to the north of the dyke, leaving a massive unsupported hanging wall of sandstone on the south side of the aven (fig. 4). The occurrence of such massive cave development along this dyke is further discussed below. Clearly the relationships between neptunean dykes and cave development on Berry Head would be worthy of more detailed study, particularly the effects of variations in dyke lithology. Other geological structures (bedding and Hercynian folding) have exerted a minor and purely local influence on cave development, and will not be discussed in this paper.

The phreatic caves on Berry Head can be divided into two morphological types (see fig. 3 for cave locations).

(1) Horizontal systems of passages and chambers,

Corbridge Cave, looking down from the base of the North Wall aven into the end of the horizontal Mudfloored Chamber.

Figure 7 Cross sections of horizontal chambers showing variations in size and morphology. (A) First Chamber, Corbridge Cave. (B) Mudfloored Chamber, Corbridge Cave. (C) The Cavern. (D) Corner Cave.

which cut across the geological structures and may run for a considerable distance at the same level. Passages are generally small tubes and rift passages, often aligned along N-S fractures, and sometimes forming networks. Such horizontal passages and networks are present in many caves across the headland, but are particularly well developed in Berry Head Cave (fig. 5), the upper levels of Sweetwater Pot (fig. 6), Hogberry Cave and Garfish Cave. Chambers may be low and wide, as in Corbridge Cave, or narrower, as in Corner Cave and the Cavern (fig. 7). Most of the chambers are formed along the large neptunean dyke at the NW corner of the quarry.

(2) Deep vertical systems of rifts and inclined tubes, formed in vertical N-S fractures. These are restricted to the western part of the quarry. Sweetwater Pot (fig. 6) is the deepest, with a vertical range of at least 43m: other examples are the Cavern Connection passages in Corbridge Cave, and the Holes in the Wall. A related feature is the North Wall in Corbridge Cave, a large aven developed on a neptunean dyke (fig. 4).

Both types of passage may be present in the same cave, and the known vertical caves all connect to horizontal passages and networks. As mentioned above, the horizontal caves cut across the geological structure, showing that they must be the product of other controls.

Cave and erosion platform elevations

An extended elevation of the quarry caves is given in figure 8. The surveyed caves extend over a vertical range of 43m (from -14m O.D. to +29m O.D.) but horizontal cave development is almost entirely restricted to three very distinct altitude ranges: -2 to +2.5m O.D.; +5 to +9m O.D.; and +22 to +26m O.D.

Horizontal cave development between -2 and +2.5m O.D. is best seen along the north coast of the head, examples being Garfish Cave and Cuttlefish Cave. Cave development at this level is also seen in Corbridge Cave and Corbridge Resurgence Cave, but at both of these sites the original passages have been modified by collapse and silting. The major development at +5 to +9m O.D. is the wide, low horizontal chambers of Corbridge Cave. These show evidence of a complex origin, with several low chambers a metre or so apart in altitude (these chambers overlap one another, proving the altitude difference is not merely the product of collapse). In places extensive roof collapse has occurred (notably in Corbridge Cave first chamber) but solutional textures on the walls and in uncollapsed alcoves suggest that the collapsed chambers are no more than a metre or two above the original solution cavities. Horizontal passages and networks at the +22 to +26m O.D. level are widespread in caves right across the headland. Comparing these levels of horizontal cave development with the altitudes of the middle and upper Pleistocene marine erosion platforms (fig. 8) they are clearly related, with

Hogberry Cave: a horizontal rift passage on a N-S fracture.

major horizontal cave development occurring just below each platform (table 1).

This relationship between cave development and the marine erosion platforms can be further investigated by plotting a graph of altitude against the area of cave development. This was done using the following method. The extent of open cave passage at one metre altitude increments (estimated by reference to extended elevations and survey notes) was traced from the plan survey for each cave. By laying the tracings on graph paper the area of open passage at each altitude increment could be found by counting squares. No attempt was made to correct for possible upward migration of chambers through collapse (since this has been fairly minor in scale) but where sea level caves have been enlarged by wave action (in Garfish, Cuttlefish and Starfish Caves) the original passage size was estimated from the extent of remaining solutional features. Graphs of altitude against areas of cave development were plotted for individual caves (fig. 9) and as a cumulative graph of altitude against the total

Altitude of marine erosion platforms	Altitude of associated horizontal caves
+3 m O.D.	-2 to +2.5 m O.D.
+8.5 m O.D.	+5 to +9 m O.D.
+28 m O.D.	+22 to +26 m O.D.

Table 1 Correlation of marine erosion platforms and horizontal caves.

Figure 8 Extended elevations of the Berry Head Quarry Caves, showing the occurrence of extensive horizontal passages and large chambers just below the altitudes of marine erosion platforms. Key as in Figure 3.

area of known cave development in the quarry and adjacent coast (fig. 10).

The altitude/area graph for the total known cave development (fig. 10) shows three major peaks in area of cave development at altitude of -3 to +3m O.D.; +5 to +9m O.D.; and +22 to +25m O.D. This corresponds with the altitude distribution of the major horizontal cave development described above, confirming that major cave development occurs a few metres below each marine erosion platform (fig. 10 and table 1).

Examining the graph (fig. 10) in more detail, the major -3 to +3m O.D. peak contains two smaller peaks in area of cave development, at -1m and +2m O.D. Reference to the altitude/area graphs for individual caves (fig. 9) shows that the -1m O.D. peak represents cave development in the uncollapsed Garfish, Cuttlefish and Starfish Caves, whereas the +2m O.D. peak represents cave development in Corbridge Cave and Corbridge Resurgence Cave. Both the latter caves have been modified by collapse and silting. The lowest levels of Corbridge Cave contain deposits of collapse debris and mud at least 2 to 3m thick (as shown by the depth of tidal creeks incised into the deposits), which together with extensive phreatic pocketing of the walls at around 0m O.D., suggests that these passages formed at an altitude of around 0m O.D. Thus the altitude of maximum phreatic cave development within the -3 to +3m O.D. range lies at -1 to 0m O.D., 3 to 4m below the base of the +3m O.D. marine erosion platform.

The cave development between +5 and +9m O.D. is more complex. The altitude/area graph (fig. 10) shows two peaks at +6 and +8m O.D., corresponding to the two major chambers of Corbridge Cave, which lie at slightly different levels. The higher of these chambers (first chamber) is floored by massive collapsed slabs between 1.5 and 2m thick, suggesting that it actually formed at the same altitude as the other chambers, at around +6m O.D. However, as noted above, uncollapsed horizontal cave development is also visible at the higher level (+8 to +9m O.D.), in one place directly overlying a chamber at +6m O.D. Thus, although the major phreatic cave development in the +5 to +9m O.D. range occurs at around +6m O.D., 2.5m below the base of the +8.5m O.D. marine erosion platform, there is also evidence of horizontal cave development at around +8 to +9m O.D. This complexity of cave development may be related to the presence in Torbay of raised beaches of at least two ages within the +8.5 to +10m O.D. altitude range.

Cave development in the +22 to +25m O.D. range shows little modification by collapse, and the maximum cave development lies at around +24m O.D. (fig. 10), 4m below the +28m O.D. marine erosion platform. The altitude of maximum cave development actually varies slightly between different caves (fig. 9) and may lie between +23 and +25m O.D., 3 to 5m below the platform.

Taking the evidence for all three marine erosion platforms and associated levels of major

Figure 9 Graphs of altitude against area of cave development for the Berry Head Quarry Caves.

Figure 10 Graph of altitude against the total area of cave development in the Berry Head Quarry Caves, showing the relationship between the altitudes of marine erosion platforms and major cave development.

cave development discussed above, it is clear that the maximum phreatic cave development occurs in a narrow zone varying between 2 and 5m below the base of each platform.

Discussion

The correlation in altitude between marine erosion platforms and major horizontal cave development on Berry Head shows that they are related in origin. The caves formed at the same time as the marine erosion platforms, and they formed in a coastal headland surrounded on three sides by the sea.

The coastal environment in which they formed is similar to that of the Blue Holes of the Bahamas (Palmer and Williams 1984). The Berry Head caves have morphological similarities to the Blue Holes, which show the same features of extensive horizontal phreatic passage networks, and vertical phreatic systems developed in vertical fractures. Additional peculiar features characteristic of Blue Holes also seen at Berry Head are large passages and chambers which end with no possible continuation, and solutional features such as mazes, roof pockets and solution-pitted walls (Palmer and Heath 1985, Palmer 1986(a), Palmer 1986(b)).

These features and relationships suggest that the Berry Head caves formed in a similar phreatic environment to the Blue Holes, within or at the base of a freshwater lens underlain by seawater. The possible sites for the formation of horizontal phreatic caves associated with such a lens are the water table or the mixing zone at the base of the lens (Mylroie 1988). On Berry Head, the relationships between marine erosion platforms marking the former sea level and associated horizontal cave development can be clearly seen. The base of each marine erosion platform marks the lower limit of strong wave action during its formation (which lay at or below sea level) and thus provides a measure of the minimum altitude of the contemporaneous water table. Horizontal cave development associated with the platforms on Berry Head is at a maximum in a narrow altitude range of 1 to 2m, between 2 and 5m below the platforms, showing that solution and cave formation did not occur at the water table, but was greatest at least 2 to 5m below. This suggests that the horizontal systems formed at the base of a shallow freshwater lens a few metres thick. Their association with the marine erosion platforms shows that as in the Bahamian Blue Holes, the horizontal systems of caves developed during sea level still-stands.

Palmer and Heath (1985) have suggested that vertical cave systems in the Bahamas have formed by solution at the lens base as the freshwater lens rose and fell during periods of changing sea level. Vertical systems formed in this way should show marked variations in passage size with altitude, with larger caves at altitudes where a slow rate of sea level change allowed the lens base to remain for longer. Adjacent caves should show similar variations of passage size with altitude, since variations in the rate of sea level change would have affected them equally. The vertical rift systems on Berry Head show these features clearly. Graphs of altitude against area of cave development for the vertical caves (fig. 9) show a considerable variation in area of cave development with altitude (for instance in Sweetwater Pot, Rift Cave, the Holes in the Wall and Shaky Caves), with clear similarities between adjacent caves in several cases (as in Sweetwater Pot, Rift Cave and the Holes in the Wall, which all show an increased area of cave development at +17 to +18m O.D.). Thus the formation of the vertical systems can be attributed to solution at the lens base during periods of changing sea level.

The origin of the caves in the mixing zone at the base of a freshwater lens explains the occurrence of isolated caves and passages which close down to narrow fissures on Berry Head. Solution, and hence cave formation, occurred only where mixing took place, resulting in the formation of isolated cavities interconnected by a system of narrow fissures (Mylroie 1988). Only where cave formation is well advanced have large explorable systems developed. Over much of the headland the caves consist of isolated passages and small networks usually formed on N-S fractures, probably the result of small scale cave development at the base of a thin percolation fed lens. Much larger caves are associated with the large WSW-ENE trending neptunean dyke at the west end of the quarry, with major horizontal caves along the dyke, and deep vertical systems developed in vertical N-S fractures that intersect it. The largest chambers in the quarry caves are on this dyke, and their morphology shows that their formation was initiated along blocky calcite veins in the predominantly sandstone dyke. The presence of large caves formed on the dyke shows that because of the presence of calcite veins and open fissures along it, the dyke acted as a conduit rather than a barrier to water movement. It is probable that water flow along the dyke from inland was constantly recharging the freshwater lens in this area, resulting in greater mixing and the formation of large caves.

AGE OF THE CAVES AND ASSOCIATED MARINE EROSION PLATFORMS

Speleothem deposits, often associated with muds and other sediments, are widespread in the Berry Head caves, and a detailed examination of these deposits coupled with the application of speleothem dating techniques would yield much information of relevance in considering their age. However such specialised methods have yet to be applied to the caves, and it is necessary to rely on the evidence provided by their geomorphology. In attempting to use such evidence to date the caves, it is necessary to consider the two main morphological types (horizontal and vertical caves) separately, since they have somewhat different origins.

The horizontal caves are the more amenable to this approach. They formed during sea level still-stands of limited duration; thus caves at any one level formed over a limited period, and can in some cases be dated by correlation with marine erosion platforms and raised beaches. In contrast the vertical caves, formed during periods of changing sea level, can be expected to have had a much longer history, with renewed cave development with each new rise and fall in sea level, and different parts developing at different times. They will not be further discussed here beyond commenting that their formation can be expected to have spanned the period over which horizontal caves have formed on the headland.

Of the surface features which may be correlated with cave development on Berry Head, only the raised beaches have been dated, by amino acid geochronology (Bowen et al 1985). Their ages are discussed above: the evidence suggests that beaches of at least two different ages, referrable to oxygen isotope stages 5 and 7, are present resting on platforms between +8.5 and +10m O.D. in Torbay. The Berry Head beach is of indeterminate age and could date from either interglacial (isotope stage 5 or 7). The platforms on which these beaches lie are considered not to be much older than the beaches; claims that they are much older, based on the presence of older derived erratics incorporated into the beaches, are dubious. The other marine erosion platforms are more problematical, but leaving aside for the moment the dating of the +3m O.D. platform, it is possible to come to some very tentative conclusions about the +28m O.D. platform. It is generally accepted that during the last interglacial (isotope stage 5) the sea level reached a high point of not more than about +10m O.D., a conclusion supported by the evidence of raised beaches in southwest Britain. The raised beach evidence suggests that the isotope stage 7 interglacial sea level high may have reached about the same altitude. If so, then the +28m O.D. marine erosion platform must be the product of an older high sea level.

On the above evidence, it is possible to begin to construct a chronology of cave development on Berry Head over a period of at least three interglacials: this is summarised in table 2. It should be remembered that this is a preliminary model based on limited data, which will probably require future revision. The +28m O.D. marine erosion platform and associated horizontal caves at +22 to +26m O.D. are considered to predate the isotope stage 7 interglacial, and probably formed during an earlier interglacial. This implies an age of greater than 250,000 years for these caves; it is impossible at present to be more precise. The dated raised beaches show that the sea returned to about the same level (+8 to +10m O.D.) in the stage 5 and 7 interglacials. The associated caves between +5 and +9m O.D. most probably formed over these two interglacials, separated by a cold period with low sea levels. Cave formation at this level can thus be provisionally dated to two phases; from 245,000 to 186,000 years before present, and from 122,000 to 80,000 years before present (Bowen et al 1985). The cave development between -2 and +2.5m O.D. (and the +3m O.D. platform) cannot at present be dated: the platform shows no clear relationship to any dated sediments. Thus it cannot be incorporated into the chronology at this stage. Similarly the early history of the system cannot at present be speculated upon: the evidence of early sea level still-stands may have been masked by later cave development.

The above evidence suggests that the Berry Head caves formed during interglacial periods, at times of high sea level. During the intervening cold periods, low sea levels would have resulted in drainage of the caves. The extensive speleothem deposits, some of which extend below modern sea level, may have formed during cold periods in many cases. If caves formed during cold periods, they will now be very deeply submerged and probably inaccessible.

CONCLUSIONS

The phreatic caves of Berry Head formed in a coastal environment, on a headland surrounded on three sides by the sea. Their morphology and relationships to marine erosion platforms shows that they are fossil lens caves, formed by solution in the mixing zone at the base of a

Neptunean dyke at the entrance to Corner Cave. The sandstone dyke has been breached by solution of the calcite cement of the sandstone along joints, leaving pendants of eroded sandstone between the widened joints.

freshwater lens a few metres thick, and underlain by seawater. Sea level still-stands resulted in the formation of horizontal systems. Vertical caves were formed during periods of changing sea level, at the lens base as it rose and fell with the sea level. Many of the caves occur as isolated passages and networks, probably formed at the base of a lens fed by local percolation water. The major cave development associated with the neptunean dyke at the west end of the quarry is better explained as the result of enhanced mixing at the lens base due to an additional input of freshwater flowing along the dyke, suggesting that these caves also acted as a resurgence for percolation water from somewhat further inland.

The horizontal caves can be correlated with middle and upper Pleistocene marine erosion platforms showing that their formation was contemporaneous; the available evidence shows that the platforms and their associated caves formed during interglacial high sea level still-stands. Cave development over at least three interglacials is proposed (table 2), but the history of the system is certainly more complex than this.

Similar caves may be quite common in coastal limestones elsewhere in Britain, though at present only one possible site is being investigated, the submarine Doolin Green Holes in Western Ireland. The Green Holes are still being explored and it is as yet impossible to be sure of their origin, but Self (1988) has suggested that they were initiated by freshwater solution, and merely enlarged by later encroachment of seawater. This may explain some important differences between the Berry Head caves and the Green Holes; subhorizontal phreatic networks in the Green Holes appear to be bedding-controlled and dip gently to the south, unlike the Berry Head horizontal networks. Such differences underline the need for further work on coastal caves and their formation.

The correlation between horizontal caves and marine erosion platforms marking Pleistocene sea level still-stands suggests some more interesting possibilities for further work. Horizontal caves provide a potentially valuable tool in identifying Pleistocene sea level still-stands, since they are more durable than the easily destroyed marine erosion platforms. Furthermore, the close link between cave formation and the sea level means that the application of sediment mapping and speleothem dating techniques to the caves could be used to provide information not only about the history of cave development, but also about the history of Quaternary sea level variations in the area.

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APPENDIX: SURVEY METHODS

The study was based on surveys of the Berry Head Quarry Caves carried out between 1985 and 1987 (Proctor 1987). The Pleistocene marine erosion platforms were also surveyed to determine their altitudes. The instruments used were a Silva type 15T compass-clinometer and a 30 metre fibron tape. The cave entrances and two lower level marine erosion platforms (at +3 and +8.5m O.D.) were surveyed to BCRA grade 5, using sea level, corrected for tidal effects, as a datum. One long surface traverse was necessary, to survey the cave entrances in the west bay of the quarry. Here the grade 5 survey was supplemented by a levelling survey using an automatic level, to establish a datum point close to the cave entrances. The caves were surveyed to BCRA grade 5c, except for tidal sea caves, which were surveyed to grade 2-3 using the water level as a basis for altitude determination. Closed traverse errors on the surface surveys were below 1%, and on the underground surveys, 2%. Where the errors were greater, a resurvey was done. The closed traverse error for the 600m loop levelled to establish a datum in the west bay was 5mm. The marine erosion platform visible halfway up the cliff on Oxley Head (at +28m O.D.) was inaccessible and could not be surveyed using the normal methods. The height of the cliff top was fixed by a levelling survey (using the OS benchmark on Berry Head coastguard station as a datum) and the altitude of the platform found using photogrammetry. The altitude range of the major marine erosion platform forming the top of Berry Head was determined from the clifftop levelling survey mentioned above, and from the Ordnance Survey 1:25,000 and 1:2,500 maps. Features below sea level have been examined by diving but were not surveyed because precise altitudes were not required, and the Torbay Admiralty chart provided sufficiently detailed information.

Oxygen isotope stage and age (X1000 yrs)	Sea level (m O.D.)	Cave development
Pre stage 7 (>250)	~ +28	Horizontal caves between +22 and +26 m.
Stage 7 (186–245)	~ +8.5	Development of horizontal caves in +5 to +9 m altitude range: early development of Corbridge chambers.
Stage 5 (80–122)	~ +8.5	Renewed development of +5 to +9m caves: Corbridge Cave chambers reach their present extent.
Undated	~ +3	Horizontal caves between -2 and +2.5 m.

Table 2 Preliminary chronology for horizontal cave developments; ages after Bowen et al (1985).

ACCESS

Access to the caves should be arranged through the warden of Berry Head Country Park, Nigel Smallbones, at The Bungalow, Berry Head, Brixham, Devon (telephone 0803-882619).

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The Caves of Chiapas, Southern Mexico

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Abstract: The 35km of cave found prior to 1986 in Chiapas, the southernmost Mexican state, are reported. Locations and brief descriptions are given. The activities of the British-Mexico Expedition 1982-3 and the 12.6km of cave found is reported in more detail, with surveys and location maps.

Summario: Las 35km de cueva explorado precedentemente de 1986 en Chiapas, el mas meridional estado de Mexico, son reportado. Las localidades y descripcions cortos son explicado. Las actividads del Expedicion Britanico-Mexico 1982-3 y la 12.6km de cueva descubriado, es reportado mas especificado, con topografias, y mapas de localidades.

Chiapas is the southernmost state of the United States of Mexico. It borders the states of Oaxaca and Veracruz in the NW and Tabasco in the N. To the E the Rio Usumacinta forms its border with Guatemala. Its 74,000 sq. km present a wide variety of karst environments. (Fig. 1) Altitudes range from sea level to 2900m at Cerro Tzontehuiz 10km NE of San Cristobal de Las Casas, with a corresponding variation in climate and vegetation (Figs.2-5)

CLIMATE

In all areas rainfall is plentiful but in some areas it is markedly seasonal with December to February being the dryest period. Tables 1 & 2 and figure 5 contrast some of the variation in climate of the areas visited. Maximum rainfall of 5000mm occurs in the N in the Pichucalco-Teapa area and to the S where the Sierra Madre enters Guatemala. E of the Lagos de Montebello (La Trinitaria) at the mountainous border with Huehuetenango, Guatemala, about 5000mm occurs. In most of the rest of Chiapas rainfall is about 1500mm but the Central Valley of Chiapas, containing the Rio Grijalva (Rio Grande de Chiapas) is much warmer and dryer than the rest of Chiapas, with 800-1000mm, and has virtually no rain between November and April. However the Eastern slopes of the Chiapas Highlands are more humid with some rain in most months. Annual average temperatures range from 13°C in the San Cristobal area up to 25-30°C close to the Pacific Ocean.

VEGETATION

Five major vegetation zones can be distinguished, depending on altitude and rainfall. Details are in Table 3.

Pine-oak forest: corresponding to the Region of San Cristobal de las Casas, Amatenango and Teopisca at heights averaging 2000m. Largely forested with pines dominant at higher altitudes. Unwooded areas are occupied by meadows and maize fields. Eroded "terra rossa" is often observed.

Aerial view SE across doline containing Sima Escoria (SC7), San Cristobal. Entrance is below cliff centre right.

Figure 2

FIGURE 3.

Tropical deciduous forest: this zone is found in the Grijalva Valley, including the towns of Tuxla Gutierrez, Chiapa de Corzo and Ocozocoautla. The altitude is 5-700m and is subject to intense drought in Spring. The trees are deciduous or semi-deciduous. The area is extensively farmed.

Cloud forest: this is typified by the higher altitudes of Guatemala and the border areas near Lagos Montebello, La Trinitaria and in northern Chiapas in the Sierra Madre and near Pueblo Nuevo Solistahuacan.

FIGURE 4

FIGURE 5.

KEY TO FIGURE 4

Municipios of Central Chiapas

1	Jitolol	13	Larrainzar	26	Chanal
2	Bochil	14	Chenalho	27	Amatenango del Valle
3	El Bosque	15	Mitontic	28	Altamirano
4	Chalchihuitan	16	Tenejapa	29	Venustiano Carranza
5	Simojovel de Allende	17	Oxchuc	30	Nicolas Ruiz
6	Pantelho	18	Huistan	31	Las Rosas
7	Sitala	19	Acala	32	Comitan de Dominguez
8	Ocosingo	20	El Zapotal	33	Las Margaritas
9	Nuevo Usumacinta	21	Chiapilla	34	Nuevo Concordia
10	Soyalo	22	Zincatan	35	Tzimol
11	Ixtapa	23	Totolapa	36	Socoltenango
12	Chiapa de Corzo	24	Teopisca	37	La Independencia
25	San Cristobal de las Casas			38	La Trinitaria

TABLE 1

MONTHLY MEAN TEMPERATURES CENTRAL CHIAPAS (°C)

STATION	Alt. (m)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	MEAN
San Juan de Chamula	2300	12.0	12.7	13.7	14.4	14.6	15.0	14.7	14.5	14.7	13.5	12.7	11.9	13.7
San Cristobal de las Casas	2276	12.4	13.1	14.3	15.4	15.5	15.6	15.6	15.5	15.3	14.4	13.4	12.3	14.4
Chilil	2200	11.0	11.5	11.9	13.2	14.5	13.9	13.6	13.7	13.6	12.7	12.3	12.4	12.9
Huistan	1950	13.1	14.3	15.7	17.0	17.4	17.3	16.7	16.9	17.0	16.1	14.1	13.1	15.7
Amatenango	1850	14.3	15.0	16.3	17.9	18.4	18.9	18.1	18.1	17.9	16.9	15.6	14.5	16.8
Chenalho	1600	17.3	17.5	18.7	19.2	19.3	19.0	18.5	18.9	18.6	18.2	17.6	17.3	18.3
Comitan	1530	16.1	17.0	18.5	19.5	19.7	19.1	18.8	19.0	18.8	17.9	16.7	16.1	18.1
La Trinitaria	1530	17.6	17.5	19.6	20.6	21.1	20.7	19.7	20.3	20.0	19.6	18.5	17.6	19.4
Guaquitepec	1108	18.5	19.1	21.2	23.1	23.4	22.9	22.7	22.4	22.5	21.3	19.7	18.9	21.3
Ocosingo	908	21.5	21.8	23.2	25.1	26.0	25.3	24.8	25.0	25.3	24.4	22.4	21.5	23.9
Chiapilla	560	21.7	22.8	24.0	24.8	25.2	23.9	23.7	24.4	23.9	23.6	22.6	21.8	23.5
Tuxla Gutierrez	528	22.2	23.2	25.1	26.4	27.0	25.8	25.3	25.2	24.8	24.2	22.9	22.3	24.5
Acala	420	23.4	24.3	26.7	28.6	29.4	27.8	27.0	27.0	27.0	26.1	24.4	23.2	26.2

Data from: Servicio Meteorologico Nacional, Secretaria Recursos Hidraulicos and Comision Federal de Electricidad

TABLE 2

MONTHLY MEAN PRECIPITATION CENTRAL CHIAPAS (mm)

STATION	Alt. (m)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	MEAN TOTAL
San Juan de Chamula	2300	38.5	16.4	30.7	41.3	71.9	168.6	122.9	135.3	184.4	114.3	57.6	42.6	1024.4
San Cristobal de las Casas	2276	7.5	8.5	18.0	47.4	117.9	238.5	158.6	174.3	246.0	125.4	30.6	14.1	1186.8
Chilil	2200	27.4	24.6	42.4	27.7	165.1	214.2	176.5	150.1	194.4	131.6	69.1	29.8	1252.9
Huistan	1950	19.5	21.0	25.6	43.5	107.0	209.8	141.2	169.2	215.7	141.4	50.0	18.4	1162.2
Amatenango	1850	6.4	5.6	14.8	32.2	112.0	286.9	199.1	213.4	287.0	126.3	24.1	8.5	1316.3
Las Margaritas	1812	9.8	5.7	8.2	26.4	93.4	197.0	149.9	157.5	190.2	135.9	30.6	20.9	1025.6
Chenalho	1600	46.1	29.5	53.8	77.8	170.4	347.4	280.3	300.2	365.1	256.1	96.0	54.4	2077.3
Comitan	1530	8.0	7.9	12.3	32.5	116.1	211.3	131.2	114.7	228.4	123.5	23.1	8.5	1017.5
La Trinitaria	1530	6.8	11.1	10.3	28.7	91.3	194.6	122.6	133.1	206.1	126.7	33.7	17.6	982.4
Guaquitepec	1108	83.9	56.3	51.0	71.7	151.0	242.6	170.9	243.8	298.1	308.7	150.0	73.2	1901.3
Finca el Triumfo	1100	380.0	285.8	247.8	173.3	362.6	521.3	505.8	578.9	629.5	644.0	460.5	398.0	5187.7
La Pimienta	1089	82.4	45.5	32.2	42.9	92.5	324.8	378.2	325.1	398.9	304.1	120.3	74.6	2221.6
Ocosingo	908	42.0	33.9	46.4	69.4	149.8	253.0	228.0	210.6	325.2	248.2	84.9	44.8	1736.1
Chiapilla	560	3.1	1.3	7.2	22.5	96.5	247.5	192.7	193.7	267.7	142.5	12.4	5.1	1192.2
Tuxla Gutierrez	528	0.3	1.2	11.9	10.1	80.7	212.5	155.4	154.8	190.9	69.4	8.4	2.1	897.6
Acala	420	1.2	0.4	1.3	10.8	39.7	187.7	252.5	192.9	191.6	80.3	10.3	2.6	971.4

Tropical rain forest: the largest area surviving felling is in the most easterly part of Chiapas in the Selva Lacandona. Large Rivers such as the Rios Santa Domingo, Jatate, Lacatun and Lacanjah feed the Rio Usumacinta on the border of Guatemala. Tiny clearings occur round villages. Other important areas occur in the NW near the borders of Oaxaca and Veracruz.

Savannah: dry grassland with isolated trees lies in the N of Chiapas on low ground, extending into Tabasco. It is also present in the Grijalva valley and on the Pacific coast. It is often extensively grazed by cattle (Sbordoni et al,1977).

GEOLOGY OF THE REGION

The Eastern parts of Mexico from the Texas border of the United States of America to Belize and Guatemala in the South contain great thicknesses of carbonate sediments. These rocks were mainly deposited in the Cretaceous period and contain most of the caves of Central America. Structurally the formations form bands extending NW-SE with the younger rocks being found as one moves to the NE. The oldest formations are a pre-Cambrian basement of basalt and granite corresponding approximately to the Sierra Madre. Towards the Guatemalan border it is covered by sedimentary Permian and Mesozoic rocks. The areas corresponding to the Grijalva Valley and the karst plateaux between San Cristobal and Comitan comprise a huge area of Cretaceous sediments. Further N a Miocene band is observed in the Selva Lacandona. In the eastern Selva Lacandona near the Rio Usumacinta the Cretaceous outcrops again, with low relief and related karst. Pliocene and Quaternary terrains on the border area stretch northward into the the alluvial plains of Tabasco. The alluvial plains between the Sierra Madre and the Pacific Ocean are Pleistocene and recent. The geological succession

TABLE 3

VEGETATION TYPES IN CHIAPAS

PINE-OAK FOREST
Pinus spp and Quercus spp dominant
Altitudes 1-2000m.

OAK FOREST
Quercus spp dominant usually with pinus spp
Altitudes up to 2800m.

PINE FOREST
Pinus spp dominant often Quercus spp. present.
Altitudes 300-4200m.

PLATEAU EDGE FOREST
Pinus spp and Quercus spp plus many of the species typically found in the high perennial tropical forest. Dense vegetation located on the sides of mountains or in sheltered valleys where mist is frequent.
Altitudes 800-2400m.

HIGH PERENNIAL TROPICAL FOREST
Dense vegetation dominated by tall trees, found in the warm humid regions of highest rainfall. Most species (75%) retain foliage throughout the year. Species include:
Terminalia amazonia (Canshan Sombrete)
Swietenia macrophylla (Caoba)
Brosimum alicastrum (Ramon, Capomo)
Vochysia guatemalensis (Palo de agua)
Andira galeottiana (Macayo)
Calophyllum brasilliense (Bari, Leche Maria)
Terminalia oblonga (Guayabo volador)
Pachira aquatica (Zapote de agua)
Dialium guianense (Guapaque)
Ficus spp (Amate)

DWARF SEASONAL FOREST
Vegetation less than 15m high found in the warmer drier areas most (75-100%) species lose their leaves in the 6-8 month dry season. Species include:
Bursera spp (Chupandia)
Lysiloma spp (Tepeguajes)
Jacaratia mexicana (Bonete)
Ipomoea spp (Cazahuates)
Pseudobombax palmeri (Amapola)
Erithryna spp (Colorin)
Ceiba spp (Pochote)
Cordia spp (Cueramo)

SAVANAH
Grassland with dispersed trees, often found in areas of poor drainage which are inundated in the rainy season.

Andropogon spp	Killinga spp
Paspalum spp	Cyperus spp
Imperata spp	Crescentya spp
Panicum spp	Curatella spp
Dichromena spp	Byrsonima spp

IRRIGATION AGRICULTURE
Lowland areas dominated by large irrigation schemes; often under sugar cane.

Cueva de la Cruz, Las Margaritas.
Speleothems in Babycham Chamber.

in the Tuxla Gutierrez region of Chiapas is shown in Figure 6 (Latham 1975). The Todos Santos Formation is a unit of Jurassic to Lower Cretaceous red sandstones and shales, deposited in a non-marine environment. They can be seen close to the Pan-American Highway (Hwy 190) between Cintalapa and the Tuxla airport near Ocozocuatla, 25km W of the state capital. Above these rocks is the Sierra Madre Limestone, 2400m of limestone of a variety of facies. This great thickness is folded and faulted to form the mountains of the Chiapas Massif with its highest points around San Cristobal de Las Casas. At Aguacero the limestone is thick but irregularly bedded and porous. It is abundantly fossiliferous and appears to be an extensive reef flat deposit. Around El Chorreadero (near km30 on the Tuxla-San Cristobal Hwy 190) the limestone is a fine-grained cream rock, thickly bedded and is considered to be of the back reef facies. Around the Rio Quinta area (between San Cristobal and Tenejapa) the limestone is of the lagoonal facies characterized by thin bedding and layers of chert nodules. The uppermost unit is a bed of highly jointed limestone about 80m thick, the Carretera Formation which forms the walls of the Rio Grijalva near the bridge at Chiapa de Corzo. The Cretaceous rocks are greatly faulted and tilted with dips of up to 80° often found adjacent to major faults. This faulting is very evident in the valley of the Rio Soledad, NE of Las Margaritas where Miocene marls and clays form the valley floor and the steeply dipping Sierra Madre limestones are faulted out at the western side of the valley. The limestones S of San Cristobal dip generally to the SW towards the Central Valley of Chiapas and the Rio Grijalva The steepest dips being adjacent to the sandstones and mudstones which form a topography of low hills and small tributary valleys of the Central Valley. The steeply dipping strata were prominant in the Pacific Highway within the cave Veshtucoc.

Tertiary volcanic activity has given the distinctive peaks near Venustiano Carranza and a series of andesitic rocks forming the NE edge of the San Cristobal depression and the high points near Cerro Tzontehuiz. The proximity of these is probably responsible for the large areas of dolomitisation found in the San Felipe Valley and other areas of San Cristobal. Tertiary? explosive vulcanism has also given rise to a series of ashes and tuffs which can be seen adjacent to Highway 195 near Soyalo and forms part of the catchment of Cueva de el Chorreadero. Volcanic activity still occurs in Chiapas as evidenced by the violent eruption in 1982 of El Chichon which deposited up to 50cm of ash in the area of San Cristobal.

KARST FEATURES OF THE CHIAPAS HIGHLANDS

The highest points around San Cristobal, above about 2000m, are partly tower karst at the scarp edges with large cliff-walled dolines on flatter ground. A few small areas of pinnacle karst occur above Carrizal (Fig 8). Lower down on the drier mountain slopes facing the Grijalva Valley, extensive areas of scrub covered limestone pavement are present on strata which dip up to 30 degrees. This limestone displays a wide variety of karren grooves. Close to the intrusive, tertiary, volcanic

KEY TO FIGURE 7

The area near Colonia Articulo 27, Las Margaritas (Contour interval 100m). 1) Sumidero Recuerdo, 2) Cueva de Snajchhawuc, 3) Cueva de San Nicholas, 4) Cueva Grande, 5) Nacimiento de Buenavista Pachan, 6) approx. location of Cueva de la Lima.

Figure 8.

rocks the impervious catchment or a cover of Terra Rossa, a red argillaceous deposit, gives a typical fluvio-karst with large river sinkholes or smaller mud-choked sinks. The underground flow of these rivers is chiefly dip controlled giving a radial pattern of flow from the highlands near San Cristobal. The streams flowing into the huge closed depression in which the town is sited, flow SW to the Municipio of El Zapotal close to the village of San Lucas. The huge river sinks of Sumidero Tenejapa probably flow NW towards Chenalho and from the Sumidero de Chenalho further NW to the Rio San Pablo. An even bigger sink on the Rio Yashanal at Yochib probably flows N to the western branch of the Chacte river (Boon et al,1974). The eastern highlands contain cockpit country on a vast scale. Closed depressions are often 2-3km in diameter and up to 400m deep, but dense tropical vegetation makes cave hunting very difficult. In some areas huge vertical pits such as El Suspiro, El Pozoron, Chen-Ven-Sil-Mut and Chen Ulish have been explored to boulder blockages or disappointingly short lengths of passage to syphons (Donovan 1975, Stock 1975; Thompson 1972). Several pits of this kind were also observed from the air in a region 20km NW of Comitan and in most of the highlands a scattering of smaller dolines have led to several pits 200m or more deep.

SUMMARY OF CAVE EXPLORATION

Between the years 1970 and 1978 the first organised exploration of the caves of the Chiapas Highlands was undertaken by Canadian cavers from McMaster University, Hamilton, Ontario. They recorded about 20km of cave at approximately 60 sites, recording their findings in The Canadian Caver. Most of the larger stream sinks in the vicinity of San Cristobal de Las Casas were explored but flowed for relatively short distances before encountering sumps. The volume of water in several of these systems is impressive even in the dry season ranging up to 10 m^3 sec^{-1} in Sumidero Yochib. As most of the river caves are formed mainly down dip, in general the longer the explorable cave the deeper the system. At the time of the 1982-3 expedition Cueva del Chorreodero was both the longest and deepest surveyed cave in Chiapas at 3284m long and 345m deep in a through trip. It is however likely that when the Hallucination Series in the Grutas de San Cristobal are re-entered and surveyed that this well decorated fossil system may become the deepest cave in Chiapas (Shawcross 1978). Table 4 lists the most important systems found prior to 1982, mainly by the Canadians. The majority of of caves they explored are described later in this article. (see also Table 5) In 1969 ,1973 and 1975 the Accademia Nazionale Dei Lincei sponsored expeditions to Chiapas and Huehuetenango (Guatemala) to investigate the cave biology of the region. Their reports, (Sbordoni & Argano 1972, Sbordoni et al 1973, Sbordoni et al 1977) describe 86 sites (not all caves) over a wide area of Chiapas. As the primary purpose of the Italian Expeditions was biological rather than spelaeological many of the caves visited were not fully explored and still remain to be investigated. These cave sites are included later in this article.

TABLE 4.

LONGEST & DEEPEST CAVES IN CHIAPAS UP TO 1982

Name	Length(m)	Depth(m)
Cueva del Choreodero	3284	345
Sumidero Yochib	3316	213
Grutas de San Cristobal	c.3000	c.300
Cueva Zapaluta (San Francisco	1930	88
Sumidero Chicja	1431	81
Sumidero de Tenejapa	1401	210
Cochol	1361	37
Cerro Hueco	? >1000	?
Sumidero Chenalho	c.1000	c.65
Joya Chen	874	83
Chen-Ven-Sil-Mut	522	139
Chenalho Resurgence	433	+69
Huistan Resurgence	430	+87
Sima de San Jose	360	70
Sima des Tres Cruces	c.300	c.52
Salida de Cruz Pilal	c.300	c.40
Cueva del Rio Hondo	? <300	?
Cueva de Aguacerro	186	+5
Sumidero de Hondonada	184	48
Okoltonil	c.100	?
Shaft Near Yochib, Tenejapa	-	213
C-en Ulis	-	134
El Suspiro	-	? c.105

Following the British Expedition a Dutch Expedition visited Chiapas and a summary of sites they visited is included here. The detail is contained in their report (Goutier,1986).

THE BRITISH MEXICO EXPEDITION 1982-83

The expedition consisted of 23 persons and a professional film crew of 8 people from Chameleon Film and Video Incorporated, Leeds. The party was in Chiapas during December and January but several people were out for shorter periods. Funding was by personal contribution, fund raising activities and donations from firms and organisations. Two vehicles were driven by an advance party from California to Mexico City, Veracruz and on to San Cristobal de Las Casas to meet the main party arriving by air. The vehicles were a Chevrolet 20 pick-up,bought by the expedition, and a Dodge panel van, owned by J.Morgan. A total of 21,000 miles was covered by these two vehicles including their return to the United States of America. The film crew had their own transport, a Ford Pick-up with a camper top. No major mechanical problems were encountered those experienced were mainly the result of poor quality gasoline, rough roads, dust and mud. Equipment was mainly supplied by individuals, bought from funds or donated by sponsors. Nearly 1000kg of equipment was shipped from Bradford to Veracruz by Schenkers International Shipping Agents who were our most important sponsors. The importation was aided by Schenkers Panamericano, Mexico and was forwarded to San Cristobal by truck.

From a base camp near the Hotel Molino Alborado, on the Periferico Sur of San Cristobal, small groups set out and explored in four main areas:

1) In the area of Colonia Articulo 27, S of Las Margaritas, about 80km from San Cristobal by road (Fig.2&7).

TABLE 5

LONGEST & DEEPEST CAVES IN CHIAPAS UP TO 1986

Name	Length m	Depth m
Cueva de Veshtucoc *	4930	+380
Sumidero Yochib	3316	213
Cueva del Chorreodero	3284	345
Grutas de San Cristobal	c.3000	c.300
Cueva Zapaluta (San Francisco)	1750	75
Sumidero de Tenejapa	c.1741	210
Sumidero Chicja	1431	81
Cochol	1361	37
Cerro Hueco	?<1000	?
Sumidero Chenalho	945	95
Joya Chen	874	83
Sumidero Recuerdo *	833	92
Cueva Borohuix *	700	135
Cueva Snajchawuck *	611	68
Sumidero San Nicholas *	575	138
Chen-Ven-Sil-Mut	522	139
Cueva de Dos Entradas *	500	25
Chenalho Resurgence	433	+69
Huistan Resurgence	430	+87
Sima de San Jose	360	70
Cueva de la Cruz *	315	89
Sima des Tres Cruces	c.300	c.52
Salida de Cruz Pilal	c.300	+42
Cueva de Rio Hondo	?<300	?
Shaft Near Yochib	-	213
Sima del Puerto *	-	139
C´en Ulis	-	134
Spaceman´s Pit *	-	125
El Suspiro	-	105

* Found by 1982-3 British Expedition

2) Close to San Cristobal at Zacualpa, Rio Salida del Tunnel, El Corralito, El Arcotete (Rio Quinta), Rancho Nuevo and the Ranch of Liebrevitz o´Shaunessy of the Olla Porida Restaurant.These areas were accessible on foot from the campsite but involved walks up to 12km) (Figs.8&9).

3) The area of San Lucas in the Municipio of El Zapotal, (15km by foot from San Cristobal but 80km by road) (Figs.2&9).

4) Minor explorations were carried out in other areas such as the Tuxla-Pichucalco Road (Hwy 195), The San Cristobal-Ocosingo Road and at Angel Albino Corzo in the Municipio of Trinitaria (Figs.2&4).

CAVES OF THE COLONIA ARTICULO 27 AREA

With limited time available, problems of getting access permission and the heavily forested nature of the area only a relatively superficial

knowledge of the hydrology was obtained (Figs.7&10). The ridge to the NE of Las Margaritas running SE past Colonia Articulo 27 forming the southern margin of the Rio Soledad Valley,is an asymmetric anticline. Oil well drilling is proceeding at the northern end. The eastern limb of the anticline is steeper, plunging up to 80 degrees before being faulted out on the W side of the Rio Soledad which runs on Miocene marls and shales.

Two obvious major sinks were visited and both yielded several hundred metres of impressive active passage ending in sumps. These are Sumidero Recuerdo, the flood sink of the Rio San Joaquin, which in the dry season terminates in a lake the Laguna Recuerdo. The other is the Cueva de San Nicolas which is the sink of the stream flowing through Colonia Articulo 27 from the Ejido de Xahac resurgence. These two swallets although not water traced are presumed to unite and possibly with another major sink reported but not visited near Santa Elena, feed the impressive rising El Nacimiento de Buena Vista Pachan, having flowed NE through the anticlinal ridge. At this resurgence a large river emerges from beneath boulders at the foot of a 70m cliff. The flow in early January was estimated at about $2m^3 sec^{-1}$. A huge cave entrance behind boulders immediately closes down to a clear blue lake that should be a major target for any future expedition with diving capability.

Closer to Colonia Articulo 27 a series of dry old phreatic cave systems was explored. Seven separate caves are presumed to have been part of one system now fragmented by roof collapse and stalagmite blockages. Many more caves undoubtedly remain in this area but digging would be necessary in most cases. All these fragments are exceptionally well decorated with flowstone formations and most contain fragments of pottery possibly used by the Mayas for ritual purposes.

Figure 11.

CAVE SYSTEMS OF THE SAN CRISTOBAL AREA

The town of San Cristobal de Las Casas, Chiapas has a population of approximately 35,000. It is situated in a huge closed depression 4km by 5 km (Figs.3&8) at an altitude of 2110m in the Chiapas Highlands. It lies 85km E of Tuxla Gutierez on the Pan America Highway (Hwy 190). All the streams flowing into the depression unite and flow to the SW of the town where they used to vanish into a series of partially blocked sinks the Sumideros de San Cristobal (Fig.11). Major flooding of the town during the rainy seasons led to the driving of a drainage tunnel 4.27km long from the sinks area to discharge near Carrizal (The Salida del Tunel). The highly polluted stream, $1-2m^3 sec^{-1}$ in the dry season, has cut a new course (Rio Salida del Tunel) 5km southwards towards the Grijalva Valley but sinks in several places on the plateaux at 1000m not far from the small village of Laguna Grande on the path between San Cristobal and San Lucas (Fig.8). The water is next seen at the resurgence of Ojo de Agua, at San Lucas (El Zapotal) feeding the Rio Blanco. Originally this rising was fed directly from the Sumideros de San Cristobal. Investigation of these sinks yielded disappointingly small amounts of foul cave. The closed depression of San Cristobal has usually been considered as a polje (Enjalbert, 1967). Early out-flow from this drainage basin could explain the existance of the very large well decorated cave of

Sumideros de San Cristobal. Aerial View SW towards the Periferico.

Las Grutas de San Cristobal at Rancho Nuevo 9km E of the town. This is now occupied by an underfit stream which can be followed to several constricted sumps. The cave consists essentially of one vast passage usually larger than 10m by 30m with breakdown areas. Two of these; Bosque de Piedra and Salon Kramsky are decorated by some of the finest large calcite formations in the world. The passages generally run down dip and the only tackle required is a 15m ladder into Salon Kramsky, (this can be bypassed underneath if the route is known well). Dip increases to the S and so the cave descends more steeply to reach a sump about 2.5km in at about -120m. The sump is probably not diveable being held up by a boulder and mud blockage. However it was found to be dry on one occasion and a small and mainly inexperienced party managed to get down several drops in a steeply descending passage reaching approximately -300m (Shawcross,1978). The depth potential of this system cannot be overstated. Starting at over 2,200m altitude and feeding towards Ojo de Agua at 600m, or ancient risings such as Cueva Borohuitz at 800m. The expeditions findings in this system was limited to the finding of another small sump upstream of the largest sump the Caracol del Diablo. A large muddy chamber reached by two short pitches under the righthand wall 100m before the main passage sump. This chamber, Salon Winge, contains two boulder-strewn sumps.

To the W of the town of San Cristobal is a narrow rim of pine and oak clad mountains reaching 2,300m. Dirt roads wind over them from near San Felipe, NW of the town past Zacualpa and the Salida del Tunel to Carrizal. There is another from near the airfield W of the city going to Corralito and San Antonia (Fig.8). Large dolines and rounded hills cover the highest land and dissected cave fragments abound. A few large open shafts such as El Suspiro (Thompson 1972) and Spaceman´s Pit choke in massive boulder piles. In some areas especially around the village of Zacualpa small streams sink into muddy shafts in mature oak woods. In almost all cases the initially roomy shafts show little horizontal development usually pinching out into into muddy chokes. Scum pot, Sima Escoria is an interesting exception. A small hole leading from the bottom of a large doline with 25m cliffs enters an unpleasantly tight, muddy, meandering, Yorkshire type of pot descending steeply down dip to 70m before becoming too tight.

CAVES OF SAN LUCAS, EL ZAPOTAL AREA

The limestone escarpment leading onto the Chiapas Highlands rises steeply from the low hills in the Central Valley of Chiapas. The limestone dips steeply towards the Rio Grijalva and at the foot of the slope numerous resurgences supply streams flowing SW to the Grijalva.

Near San Lucas two of the largest streams, the Rio Blanco and the Rio Trapeche (the lower part of the Rio Salado) unite to flow into the Rio Frio. The Rio Blanco rises from the boulder strewn Ojo de Agua in the village of San Lucas and is the rising for the polluted San Cristobal water. In contrast the Rio Salado flows from an idyllic, blue, tree-lined vauclusian pool which is more than 50m deep. In the dry season the water only flows about 80m before sinking in sand and gravel to re-emerge as the Rio Trapeche (Fig.9). NW of San Lucas is another large rising which feeds the Rio Frio, this massive spring, 1-2m^3 sec^{-1}, in the dry season possibly drains the area to the NW of San Cristobal, partly explored by the Dutch Expedition. Our team was unable to penetrate much further into the strongly watered boulder choke than George Tracey´s original exploration in ?1974, (Tracey, G., Letter to M. Shawcross) but a visit in lower water conditions could be worth while. Little cave is associated with any of these risings. Close to San Lucas is a huge drained vauclusian rising, the spectacular Cueva Borohuitz which speculation ascribes to the same waters that formed the Grutas de San Cristobal.

Further E near the town of Venustiano Carranza on its volcanic peak and Las Rosas are several other resurgences feeding the irrigation ditches of a large area of sugar cane plantations. The only stream investigated between Chiapilla and V. Carranza rises from a bouldery pool 200m N of the road and has no prospect of cave passage. Unusually for this region a major surface stream cascades spectacularly 100m down a cliff originating from the area of Aguacatenango.

The only cave of any length was discovered 0.5km NW of San Lucas. An obvious flood rising, Veshtucoc (literally in Tzeltal the "place where water flows in the rainy season"). This gave the expedition its most important find, 5km of well decorated, large and sporting stream cave over 300m in vertical extent and the longest cave in the State of Chiapas. It contains three free diveable sumps and ended at its upstream end in a huge breakdown chamber where the water emerges under boulders. In another branch a large static sump awaits the attention of cave divers. In 1984 the Speleo-Nederland Expedition revisited the cave and pushed upstream for a further 1.3km to an inlet sump (Goutier,1986).

Cueva Grande, Las Margaritas.

CAVES FOUND BY THE 1982-83 EXPEDITION

The Las Margaritas Area (see Figs.7&10)

Cueva del Aguacate, Las Margaritas. L20
About 8km NE of Col. Articulo 27, near Santa Elena on the path to Cueva Grande. (Fig. 4) Small cave fragment, 20m x 10m by 10m high, massively encrusted with flowstone.

Cueva de las Aranas, Las Margaritas. L55,D7
Near Col. Articulo 27, (Figs.10&12) in the same shakehole as Cueva de Dos Entradas. Pitch of 7m leads to a well decorated chamber.

Cueva de Arcoton, Las Margaritas. L140,D12
Near Col. Articulo 27 (Figs.10&12) A short dry through trip, well decorated by dead stalagmite. Nearby entrance rapidly becomes too tight.

Cave, Las Margaritas. L8,D2
Oil Rig Site, NE of Zarragoza, 8km N of Las Margaritas. Entrance on extreme North perimeter of drilling site. Drop of 2m leads to a low wide bedding passage which chokes. Partly filled with rubbish.

Cueva de la Cruz (Rift Cave), Las Margaritas. L315,D89
Near Col. Articulo 27 (Figs.10&14).
Four possible entrances requiring 11, 18 or 35m of ladder. Descent of furthest S involves 11m pitch to a large mud floored chamber containing a large cross. To the N a climb up calcite passes beneath another entrance and leads down a steep boulder slope under a further entrance. A blind pitch here needs 55m of tackle. Continuing N one reaches another large and well decorated chamber with a stone wall and the final entrance pitch. Landowner in Las Margaritas should be consulted to avoid trouble! Many small rodent? bones found under one entrance. Bats found throughout.

Dos Entradas, Las Margaritas. L500,D25
Near Col. Articulo 27 (Figs.10&12). Two obvious entrances lead to a lengthy series of chambers with walls almost entirely covered by calcite. Ends in a stalagmite blockage. Three blind pits 8, 10, and 16m deep in the floor.

Cueva de la Cruz, Las Margaritas.
Speleothems in the North-Eastern cave passage.

Cueva Grande, Las Margaritas. L295,D89
8km E of Col. Articulo 27, 1.5km NE of Santa Elena (Figs. 4,7&16) Entrance is a huge pit, shown on the topographical map. In thick perennial forest and reached by small paths. Forested entrance collapse is 40m wide and deep. Tufa gours step down 50m to Salon Grande an impressive blind chamber with much stalagmite and a shallow pool. Another passage leads from the W end of the entrance to a 4m climb and a glistening crystal rimstone slope 40m long. From there a mud-floored passage leads 60m to a breakdown area and a complete choke at a depth of 80m.

Cueva de la Lima, Las Margaritas. L20,D20
NE Col. Articulo 27, approximately 1 3/4 hours (c.4km) walk through thick tropical forest to a hill top (Fig. 18). Entrance is a large recently collapsed chamber. It is possible to crawl under blocks at the sides. At the Western end a climb down over blocks leads to a squeeze into a rift passage with flowstone and a few helictites. Bridge down to final blockage. Many nasty looking spiders present.

El Nacimiento de Buena Vista Pachan, Las Margaritas. L60
An obvious large resurgence approximatly 1km E of Buena Vista Pachan in the valley of the Rio Soledad. Can be reached either from Las Margaritas; N via Zarragoza and the oil rig site and then E down valley to Buena Vista Pachan, or via Col. Articulo 27, Santa Elena and then 5km N (Figs.7&17). Presumed to be the rising for much of the water sinking in the Col. Articulo 27 area. River emerges from boulder blockage. Dry river bed above leads to an arched entrance topped by a 60m cliff. 16m down a boulder slope is a large blue sump pool. Narrow draughting rifts to the W of the entrance quickly close down. A ledge 15m up on the E wall was reached but a slot above in the roof needs bolting to.

Cueva des Ratones, Las Margaritas. L125,D17
Near Col. Articulo 27 (Figs.10&18). Entrance pitch of 12m into a well decorated chamber with well preserved pottery jars. Squeeze at N end leads to a muddy rift which becomes too tight. Contains rats.

Rift Cave, Las Margaritas.
c.f. Cueva de la Cruz.

FIGURE 17
EL NACIMIETO DE BUENA VISTA PACHAN. (LAS MARGARITAS)
British Mexico Exped., Survey Grade 5.
Length 60 m

Sumidero Recuerdo, Las Margaritas. L833,D92
Located about 3km NE of Col. Articulo 27 (Figs.7&19). The most obvious flood sink of the Rio San Joachin. Carefully crawl through rocks and timber to a 1m diameter tube. After 18m a 7m climb to a steeply inclined passage 6-10m wide and 5m high. Pass two pools (the fish ponds) to an impressive flowstone cascade entering from the left. A steep muddy slope (6m ladder) leads down to Salon Sulo, 30m by 10m and totally coated with white mud. Stream can now be followed down through canals to Salon Mike Farmer into Salon Stan Gee, well decorated and contains gour pools. A steep ramp leads to a sump. A high level passage from Salon Mike Farmer, chokes after 120m. Near the entrance is a steep ramp not fully explored. The cave contains considerable animal life including small fish, white crabs, caddis flies and ?pseudoscorpions.

FIGURE 19

Sumidero Recuerdo, Las Margaritas. View up the steeply sloping entrance ramp from the active streamway.

Cueva del Roble, Las Margaritas. L265,D82
Near Col. Articulo 27 (Figs.10&20). Steep entrance slope leads on the left to large interconnected chambers with another small entrance. To the right leads to pitches of 14, 7 and 21m into Salon Haway the Lads. This leads into a narrow mud choked fissure.

Sumidero San Nicholas, Las Margaritas. L575,D138
2-3km S of Col. Articulo 27, climb over gate to S of Track following obvious sound of river (Figs.7&21). Roomy entrance pitch 10m lands amongst trees and creepers. Stream sinks in boulders. The second pitch 16m is dry over flowstone, landing in a 3 by 4m chamber. Across a pool, under a showerbath leads into a rift and a very deep pool. Two short swims follow to a sling-assisted 3m drop into another swim. Traverse to left to avoid a sump. The third pitch of 13m follows and is very wet landing in a fine 10m diameter chamber. A fourth dry pitch of 18m follows shortly. This lands in another fine chamber Salon Long. A large passage 5m high and 10m wide leads after 40m to a final 29m pitch. Traverse down right-hand wall gives a drier hang. The pitch lands in Salon Longer which contains a final sump. As this is probably perched a silted up passage here may be worth digging. In all a fine sporting pot.

Cueva del Sapote, Las Margaritas. L45,D15
Near Col. Articulo 27 (Figs.10&32). An entrance 15m x 10m leads down a steep rubble slope to 20m of calcited passage. Final slope leads to a choked smelly chamber containing many bats.

Shaft R1, Las Margaritas. L40, D25
Oil Rig Site, NE of Zarragoza. Large entrance 20m by 8m. Climb down over boulders to the head of a sloping 20m pitch. Walking passage leads to a choke after 15m. Climb above pitch leads after 18m to a small blind but well decorated chamber. Contains many bats.

Shafts, Las Margaritas.
Oil Rig Site, NE of Zarragoza. Walk 0.5km down road taking a footpath on the right. Obvious entrances encountered by the path, all overgrown, all dry.

R2: Circular shaft 3m diameter, choked at foot after 11m. Tree roots reach shaft bottom, inhabited by a squirrel.

R3: Climb down from a small depression into a choked rift. Depth 6m.

R4: A 68m choked shaft 1m by 2m. Small ledge at -31m.

R5: Choked 4m drop.

R6: Choked 10m shaft.

R7: Choked 8m shaft.

R8: Free climb of 10m, duck into a blind chamber 5m x 3m.

Shafts, Las Margaritas.
Oil Rig Site, NE of Zarragoza. Obvious clearing 1km from drilling area on left of road opposite to where the footpath from R2 - R8 re-encounters the road.

R9: Shaft of 15m, probably choked but not fully descended.

R10: Rift 1m wide and 6m deep.

R11: Choked rift 3m deep.

R12: Choked 4m shaft.

Cueva de Snajchawuk, Las Margaritas. L611,D68
Ranch near village of Francisco Madero. Guide Jose Huerta. Follow track S of ranch and then follow fence line.(Figs.7,22&23). Entrance is a 30m shaft which may be bypassed via easy entrance to the E, this uses a ledge to descend. Four passages radiate off. Three close down rapidly, all contain dry-stone walls and cairns with wooden crosses and urns. Fourth passage descends a steep boulder slope into a large well decorated passage. Graffiti mentions "El Rio Subteraneo". A climb down over boulders leads to the river passage. This glutinously muddy walking passage is 100m long from sump to sump, and obviously sumps in wet weather. Streamway contains many bats. The water is said to resurge at a well near Col. Articulo 27, called El Ejido de Xahac ("Shack")(Fig.7)

CAVES OF THE SAN CRISTOBAL AREA

Libre's Ranch: Ranch owned by Leibrevitz Schiebel of the "Olla Porida Restaurant", San Cristobal, about 8km from the town.

Caves, San Cristobal.

No.1 L15: Swallet type sink in a depression to the S of the house. 15m to a squeeze. Full of spiders.

No.2 L10: Located 100m from no.1, large rock with two entrances. Goes 10m to a mud choked chamber.

No3 D2: Located 150m on a bearing of 240° magnetic from the house. Where water sinks. Dam stream to climb 2m to a sump.

No.4 L5: Located 100m S of cave no.3. Small oval hole 0.3 by 1m leads to 5m of rift passage, 0.5m wide blocked at each end. No prospects.

No.5 D10: Pothole located close to the top of the ridge 250m from the house, near boundary fence. 2m in from the entrance is a 10m decorated but mud choked shaft.

Area West of Periferico del Sud (San Cristobal de las Casas)

Birds Nest Pot, SC1, San Cristobal. D25
Located 100m W of El Suspiro, (Fig.8). Shaft of 12m leads to a steep mud slope followed by a 10m descent to a rocky choke. Dug for a further 5m; voice connection to a parallel shaft.

Cueva des Ratones, Las Margaritas. Delicate calcite columns near the entrance.

Cueva Snajawuk, Las Margaritas. Active lower series (El Rio Subteraneo) partly blocked by mud banks and containing large mud covered speleothems.

View east across San Cristobal.

Cave, SC36, San Cristobal.
Obvious entrance in prominent cliff above the Periferico del Sud. Bearing 280° from the Hotel Molino Alborado. Rock shelter needing climbing gear to visit it.

Sima Escoria, SC7, San Cristobal. L210.D70
Located under cliffs at the very Western end of a very large doline on the hills above Portal del Tunel (Figs.8,11&24). Squeeze under nasty boulders to 9m pitch. Tortuous rift passage, traversing often necessary, leads to a 4m pitch to a jammed boulder followed by a further 9m pitch. A larger section of tall passage is encountered but the exit is a tight bedding sloping steeply down dip to an impossible squeeze, through which a strong draught blows enticingly.

Shaft, SC10, San Cristobal. D4
Located between electricity pylons numbers 92 and 93 near Portal del Tunel. Climb of 3m leads to a large choked chamber.

Shaft, SC31b, San Cristobal. L30,D25
Located in a big depression about 1050m N of Salida del Tunel. Shaft with a small tributary passage encountered 5m down.

Shaft, SC35, San Cristobal. D5
Located about 550m N of Salida del Tunel. Shaft 5m deep and 6m in diameter blocked by mud.

Small Rock Shelters & Blind Pits, San Cristobal.
ocated on the path to a large valley with small spire karst to the N of El Suspiro. The path starts on the Periferico del Sud near El Portal del Tunel and goes via the SC7 doline (Figs.8&11).

a) L6: Cave at base of rocky scar 100m above Sumideros de San Cristobal 5 & 6.

b) Small rift cave with two entrances.

c)D10: pit on the side of the Sima Escoria (SC7) doline.

d) L6: From SC7 the track encounters another depression and then turns W over a small ridge. After 300m a is small cave containing a 10m high aven.

e) After a further 100m a series of small blocked sinks are seen to the N of the track. The deepest shaft is about 8m, none require tackle.

f) L10: The track forks after a further 50m; N leads 100m to a maize field where a rift cave is found in a cliff to the E side of the field.

Skuttle Pot, SC33, San Cristobal. D89
Take the track heading S-SE from the Sima Escoria, SC7 depression until an E-W track is encountered. Head N-NE through scrub for about 1km to a maize patch. The pot is in the NW corner (Figs.8&28). Entrance is 1m diameter through boulders. Belay to a bolt 2m down, rope protector needed at -10m. Rebelay after 35m. Next hang of 33m leads to a flat floor with three holes. One is too tight in a rift, largest

leads through a squeeze over boulders and leads down 12m to a crawl on mud beneath a tight fissure. Two very narrow squeezes lead to a 10m high rift only 0.2 to 0.3m wide. This rift with crystal formations becomes too tight after 15m. There is a slight draught at the end.

Sumideros de San Cristobal, San Cristobal.
Located to the W of San Cristobal where the Rios San Felipe and Amarillo unite (Fig.11).

1) L30, D30: Greasy climb through boulders leads to a narrow choked fissure with polished scalloped walls. Squeeze into cross joint and climb up into a small chamber which rejoins the original fissure. A squeeze almost blocked by flood debris leads to a further tight squeeze above a narrow continuation of the original fissure. Past another squeeze is a reasonably roomy pitch of about 8m, not descended.

2) L5: Climb down past gratings into a depression. At the SE corner dig out sand to squeeze into a sand-choked fissure.

3 & 3a) L30, D20: Three entrances close to dug channel, lead to several climbs down through boulders and through small chambers. Choked by rocks.

4) Sumidero Santa Rosa, where part of the river sinks just before the tunnel portal. Not accessible except in severe drought. Reputed to once be 5-8m in diameter and greater than 250m in length,but now sand-choked.

5 & 6) Sumideros San Nicholas and El Salvaje; S of the Periferico, beyond a flood relief channel is a cliff-lined quarry. Here a large cave is remembered as being closed by a rock slide.

7) This depression was the last overflow of all the sinks in the great floods of 1972.

El Suspiro, SC2, San Cristobal. D105
In the hills SW of San Cristobal (Fig.8). Free hang of 82m onto a mud and boulder pile at the foot of a huge shaft. Small climb down leads to a total blockage.

Cueva del Tunel, San Cristobal. L100
Access from the flood relief tunnel at San Cristobal. Manhole in tunnel roof 525m from entrance (Fig.8). Travel through tunnel by dinghy as water is very polluted. Rig rope across exit before embarking. Climb from boat through manhole into a large almost circular chamber 80m by 60m by 50m high. Rope is useful for entry.

Caves Near the San Antonia - Corralito Track (see fig.8)

Cave No.1, San Cristobal.
Obvious large entrance on skyline, seen from track. Not visited.

Cave No.2, San Cristobal. L22
Follow main track away from the Periferico to a sharp bend before the first fork. Obvious rift entrance 5m high by 1.5m wide to E. Ascends gradually for 6m to an eye-hole squeeze through to a chamber 5m by 15m by 11m high containing banks of flowstone.

Cave No.3, San Cristobal. L20
Entrance in large doline close to path and by a pinnacle. Small entrance drops into passage 3m wide. Floor of boulders and bones. After 5m an aven 10m high is encountered. Passage continues to branch. Left and right choke after 4m and 6m respectively.

Cave, SC35, San Cristobal. L15
Near to SC25 (Fig.8).

Sima del Puerto, SC34, San Cristobal. D139
Near the highest point of the track in a small depression 10m from the path (figs.8&25). A series of pitches in essentially one rift; p20, 4, 36, 7+5m to a large ledge. Last pitch is a broken 70m. Tiny stream sinks in boulders and silt.

Shaft No.1, San Cristobal. L7
Obvious stream sink in a large depression. Drop 3m into a steeply sloping rift. Squeeze under boulder to a wider part and a complete choke.

Shaft No.2, San Cristobal.
Near the top of a pinnacle in the centre of a depression close to Cave & Shaft No.3. Depth about 10m with a lower entrance. Not explored.

Shaft No.3, San Cristobal. D3
50m SW of Cave No.3, next to pinnacle. Climb 3m into a small chamber with a mud floor, slight draught but no obvious way on.

Shaft SC18, San Cristobal. D14
Near SC24.

Shaft SC19, San Cristobal. D65
By track leading into San Antonia, entrance found by digging by a tree. P25, 32 and 8m lead into a chamber with a large stalagmite boss. A narrow slot leads off.

Sima de Gabacho, SC24, San Cristobal. D95
(c.f.Shaft No.1 & Figs.8&26)

P4 and 9m lead to a traverse onto a loose pitch of 19m. Traverse over a blind pit to p22. A further p37 can be rebelayed at -7 and -11m. This leads to a calcite blockage.

Zacualpa Area (See figs.8&9)

Cave SC3, San Cristobal. L6
Huge doline E of Salida del Tunel track, also contains SC39 (Figs.8&9).
Rift cave with two tight entrances. In cliff on SW side of doline.

Cave SC9, San Cristobal.
Small cave to the S of the Salida del Tunel track (Fig.9).

Cave SC13, San Cristobal. L25, D10
Near the centre of Zacualpa (see fig.9). Single chamber 10m in diameter encrusted by dead stalagmite. Tight slot a lowest point on left was enlarged to a 6m pitch a small lower chamber. Crawls from there choke after short distances.

Cave SC14, San Cristobal. L15
In the bottom of a large but shallow doline containing a maize field, 1km E of Zacualpa (Fig.9). Isolated cave fragment located 6m up the W face of a large isolated rock. Consists of a small decorated chamber and crawls to two other entrances.

Cave SC15, San Cristobal. L12
See figure 9 for location. 5m rope required for descent to a boulder choked chamber. Hole on right becomes too tight. Above hole climb over boulders leads only 3m.

Cave SC16, San Cristobal. L8, D6
See figure 9 for location. Awkward crawl from small stream sink leads to a small chamber in boulders after 3m. Squeeze back towards the entrance leads down a wet thrutch to a full choke.

Cueva del Murcielago, SC20, San Cristobal. L125, D29
Located 2km NE of Zacualpa (figs.8,9&29). Horizontal cave with several entrances. Full of bats and guano.

Shaft SC5 (Cueva de la Cruz), San Cristobal. D24
Under cliff forming side of large shakehole complex in Zacualpa, marked by a cross. See figure 9 for location. Entrance shaft of 24m leads to a low passage choked by mud and an aven.

Shaft SC8, San Cristobal. D3
In a doline to the S of the Zacualpa-Salida del Tunel track (Fig.8). Small pot full of gnats.

Shaft SC17, San Cristobal. D22
See figure 9 for location. Shaft of 15m then down to mud chokes.

Sima Aere & Sima de la Cruz, SC11 & SC4, San Cristobal. L45, D61
(figs.9&30) Shaft SC11 of 58m leads into a low mud choked passage where another entrance SC4 enters as pitches of 19 and 24m.

Sima de Colibri, SC23, San Cristobal. D46
(figs.9&27) Three pitches of 16, 11 and 16m lead to a boulder and mud blockage, preventing access to a further 10m? pitch. Well decorated in parts, worth another visit.

Sima Mais, SC6, San Cristobal. D54
(figs.9&33) Sloping pitch 13m leads to 32m free hang. Descend rubble slope to a chamber with a rock bridge. Ends as a narrow muddy dog-leg choked by mud.

Sima de Zacualpa, SC12, San Cristobal. L30, D42
(figs.9&31) Entrance pitch of 10m belayed to trees is followed by a rubble slope to 4m pich onto jammed boulders. Rebelay for a further 13m pitch.

El Carrizal Area: Continue SE from Salida del Tunel

Cueva des Abejas, San Cristobal. L60
(fig.8) Impressive arched entrance, beware of wild bees nests. Climb down over calcited rocks and stalagmites. Lowest point is a mud choked fissure. Crawl on right leads into a continuation beyond a boulder fall. This ends in further collapse. Bats seen in cave.

Shaft SC22, San Cristobal. D11
Located 150m E of the pool at Carrizal (fig.8). Narrow fissure pitch of 8m chokes, climb over chockstone leads down 4m to a narrow immature rift in clean-washed limestone.

Shaft SC25, San Cristobal. D40
Located 25m SE of the pool at Carrizal (fig.8). Fine pitch of 32m leads to a calcited hole through which can be seen a final 1m diameter chamber.

Shaft SC27, San Cristobal. D35
Located 75m SE of the pool at Carrizal (fig.8). Entrance 2m by 1m leads to 20m free-hanging pitch. Choked with mud and rocks in a nice chamber 5m by 10m.

Shaft SC39, San Cristobal. D10
Sinkhole in the bottom of a very large doline E of the Zacualpa-Salida del Tunel track (fig.9). Single shaft blocked by boulders.

Rio Salida del Tunel

Caves?, San Cristobal.
Near to where river sinks totally in dry season. Several cave entrances seen, none explored (fig.8).

Cueva de Abono, SC26, San Cristobal. L40, D22
Near to where river usually sinks in dry season (fig.8). Hole which sometimes takes part of the highly polluted river. Climb of 5m leads to pitches of 7m, 5m, and 3m climb down into a low wet passage. Another shaft enters directly from the surface. A vist to this nauseous pot is not recommended.

Shaft SC37, San Cristobal. L15, D15
About 300m downstream from SC26, (fig.8).

Shaft SC40, San Cristobal. D18?
Located about 300m North of the final sink of the Rio Salida del Tunel, near to the track from SC28 (fig.8). Undescended shaft.

Spaceman's Pit, SC28, San Cristobal. D125
(Figs.8&34) Spectacular shaft concealed in a small wood. Belay to a tree on the S side, p77m. Rebelay is possible at two bolts on small ledges at -43m and -50m. Pitch ends on rubble cone in a large chamber. Contains some large formations including a tiered gour formation about 10m high where a small stream enters. A climb down through mud and boulders at the lowest point chokes.

Rancho la Lagunita, Laguna Grande & Santa Cruz.

Shaft, SC 29, San Cristobal. L10, D11
First shakehole S of Lake at Rancho la Lagunita. (Fig.8) At the bottom of a 5m deep shakehole a 5m pitch from a bolt leads past boulders to end in a miserable muddy crawl under a boulder to a choke.

Shaft SC 30, San Cristobal. L25, D38
Second shakehole S of Lake at Rancho la Lagunita (Fig.8). Entrance shaft of 28m leads to upstream and downstream passages 3m high and 1.5m wide. Both choke.

Shaft SC 31, San Cristobal. D6
SW of SC 29 at Rancho la Lagunita (Fig.8). Choked pit.

Cueva del Loma, San Cristobal. L20, D22
In a closed depression one valley E of the track from Rancho la Lagunita to Santa Cruz (La Garrapata). Follow track down the steepest part of the descent then turn left uphill on the first major track to join from the E. After 1km a closed grassy depression 0.5km in diameter is reached which contains an obvious stream sink (Fig.8). A series of short climbs separated by crawls and squeezes leads to a draughting bedding and a 8 inch squeeze. Very promising.

Caves, Laguna Grande, San Cristobal.
S of the village of Santa Cruz. Several small caves and pits not explored.c.f. Goutier 1986.

Cueva Pacni, San Cristobal. L25
Near track from Laguna Grande to San Lucas. To W of last field before the steep descent to San Lucas. Low walled entrance under small cliff. Mainly crawling over mud to where a trickle enters. Possibly used as a water supply. c.f.Cueva del Paco, Goutier 1986.

Cave, El Zapotal. L15
At the N side of the track from Santa Cruz to San Lucas at an altitude of about 900m. A fissure in scrubland close to where the San Lucas path turns S to descend steeply. Small stream sink blocked by rocks. (Possibly cave 44 in Goutier,1986).

Caves of El Zapotal Area.

Cueva Borohuix (Cave of jaguar mountain), El Zapotal. L700, D135
Behind a prominent hill with an electricity pylon 1km E of San Lucas (Figs.8&35). Large drained vauclusian rising. Arched entrance 40m by 15m leads to steeply descending tiers of large gour terraces. Main chamber is 55m below entrance and measures nearly 100m in diameter. Two passages lead off. Right is a short crawl to a small chamber from where a nasty 60m descent through boulders is possible. Left consists of 240m of mainly horizontal passage. The cave is regarded by many local people to have mystical significance. A small shrine guards its entrance.

Cueva del Cascada, (El Chorro), El Zapotal. L10
At the bottom of a waterfall on the Rio Blanco about 3km N of San Lucas.

Ojo del Agua, El Zapotal. L297, D+42
Located at the N end of the village of San Lucas where the Rio Blanco rises (Figs.8&36). The water sinking at the Sumideros de San Cristobal and the water of the Rio Salido del Tunnel resurges at a large partly dammed pool through a large pile of boulders. Wet crawl through boulders enters a small chamber which gives rise to a series of constricted rift passages, ending in narrow squeezes or at water. A roof fissure has been climbed to +40m where it becomes too tight. Worth another look in drought (c.f. Goutier 1986).

Nacimiento del Rio Frio, El Zapotal.
Major rising about 3km W of San Lucasat the foot of the escarpment. River joins with the Rio Blanco to flow to the Rio Grijalva. Powerful flow of water out of gaps in boulders has repulsed all prospective explorers.

Nacimiento del Rio Salado, El Zapotal. L66, D+12
A large vauclusian rising in an idyllic setting gives rise to the Rio Salado which sinks in gravel in the dry season only 200m away. It re-emerges as the Rio Trapeche (Figs.8&37). The only cave associated with the rising is a small preatic fragment reached by swimming. This cave contains many bats and is implicated as the origin of histoplasmosis. Entry is not recommended. No prospects.

Veshtucoc, (The place where water emerges in the rainy season), El Zapotal. L4.9km, D+380
(Figs.8,38,39,&40) The entrance is situated at the head of a prominent area of light coloured rock slabs about 2km to the

FIGURE 35.

FIGURE 36.

NW and 200m higher than San Lucas. Moderate climbing reaches a small vegetated cliff where a cross marks the entrance. A 6m rope climb leads to water, 6m swim leads to a duck. Climb out of small pool into a passage which proceeds 8m wide over and through gour pools, 20m swim to the sand-floored Pacific Highway. A stream of about 100 l sec^{-1} is encountered emerging from boulders and vanishing down a tiny hole. This stream is constantly met in the rest of the cave. Blockage of the hole will completely sump the entrance duck. The passage continues 10m wide through a stooping section to a boulder strewn enlargment. Climb boulders on the true right past alarmingly tilted stalagmites, up to 10m high. A pitch is encountered back to a short length of streamway. Bolt on the true right wall needs 20m of tackle but it is shorter and easier to use a rope tether round muddy boulders further along a broad ledge. A very muddy descent. Leave the stream and ascend over sand initially on the true left but traverse towards the true right towards the rocks at the top of the slope. This passage enlargement is Salon Schenker. Descend to the stream at the end of the chamber where a very low airspace leads through to a smaller, 4m square passage. Leave the stream at an area of sandbanks and climb to a higher level cross-passage. Underneath is a small stream which provide an alternative muddy squeeze onwards. Right leads to a draughty aven, not scaled whilst left is to a muddy chamber and on via short section of streamway. Climbing out of a boulder pile leads to a gloomy area of jagged black limestone. The stream is again met but leave it to climb around and over boulders following a large roof tube and back to another short section of streamway. Leave the water again by climbing up the true left wall on steep slabs to re-encounter it in a fine sporting canyon up to 3m wide and 20m high, with waterfalls and pools. A short length of wading leads to a large sump pool. A serious free-diveable siphon 4m long and 1m underwater. Do not dive towards the true right wall! Swim into a chamber and crawl through an eye hole to another short swim to a gravel beach at a passage junction. Left leads to the muddy boulder strewn very large Planta Baja ending at a very large deep sump pool. Right follows a fine ascending streamway. Leave the stream to climb to an obvious higher chamber. A series of chambers leads to the well decorated Salon Ben Dors which can also be reached in the streamway. An inclined pitch of 20m leads through a calcited constriction back to the most exciting stream way in the cave. Waterfall climbs and a short technical sling climb, the Aztec Twostep, leads to the monstrous boulder collapse of Moctezuma´s Revenge (= Montezuma). Here a narrow inlet enters at roof level, but the main water is lost under a huge mound of rock. Lack of time prevented a descent of 6m pitch through the boulders. The subsequent Dutch Expedition of 1984-5 (Goutier 1986), regained the streamway and found a further 1.3km of stream passage which gradually reduced in size to an inlet sump. The area between Salon Ben Dors and Planta Baja is highly faulted with a highly intricate series of boulder chambers and rifts. A second inlet to Salon Ben Dors is Rising Main which proceeds Northward to a high chamber, Surveyors´ End. Bolting reached 30m to a constriction where the way on could be seen on the opposite (true left) wall. The whole cave is a very exciting but serious undertaking.

Various Sites in Chiapas

Cave. El Bosque.
Finca Concepcion. Turn off Tuxla-Simojovel Road at the Carrisal sign. Contact Andres & Manuel Lopez. Told of a large cave with lots of formations. Not visited.

Cave, La Trinitaria. L15
By the E side of the Comitan-Venustiano Carranza road where it starts to descend steeply about 8km from Hwy 190. Obvious entrance by road-side under tufa cliff, leads to a 15m diameter chamber full of large dead stalagmite columns.

Cave, Soyalo. L31, D8
Near km 38 on the Tuxla-Pichucalco road (Hwy 195). Open fissure on W side of road. Rope climb of 8m leads to a meandering mud-floored rift. Ends in a mud choke. Contains many vampire bats.

Cave, OCR 3, Huistan. L60
San Cristobal-Ocosingo road a few kms before Chempil. Close to sign post to Col. Lopez Mateo. Sink to N of road in thick undergrowth. 24m of passage leads to a short drop where stream enters. Crawl passing two avens becomes low and wet. Water possibly goes to Prisoners Hole. Beware of hostile natives, enquire at Lopez Mateo.

Cave, OCR 6, Huistan. L5
San Cristobal-Ocosingo Road. Located 1.5km towards San Cristobal from OCR 7. Obvious triangular entrance used for road drainage on the S side.

Cave, OCR 7, Huistan. L15
San Cristobal-Ocosingo road. Located near Cholol, opposite house at the E end of the last major closed depression before

INLET
MOCTEZUMA'S REVENGE
ELEVATION - C
SURVEYORS END
SKATEAWAY
RISING MAIN
CLIMB UP 15M
WHISPER WHO DARES
KIWIS CONNECTION
ELEVATION - B
SULTANS OF SWIM
DANISH PASTRY PASSAGE
SUMP
PLANTA BAJA
4M SUMP
DIRE STRAITS
TELEGRAPH ROAD
SALON SCHENKERS
0.5M SUMP
G.G. GALLERY
ELEVATION - A
PITCH DOWN 20M
PACIFIC HIGHWAY
DUCK
ENTRANCE
MAG. NORTH JAN. 83.
Magnetic Variation 5° East in 1980 Annual Change in Minutes of Arc 5½° West
SCALE 80MTS
VESHTUCOC
CHIAPAS (EL ZAPOTAL)
SURVEY GRADE 5B
BRITISH MEXICO EXPEDITION 1982/83
LENGTH 3·6 KILOMETRES.
HEIGHT 288 METRES.
FIGURE 38
SEE FIGURE 39 Elevations A,B&C
AND FIGURE 40 DUTCH 84/85 EXT^N

FIG. 39 ELEVATIONS

Cueva Veshtucoc, El Zapotal.
Party about to pass the 4m Sump 1.

FIG. 40

CUEVA VESHTUCOC,

El Zapotal, Mexico

the hill down to El Corralito. Obvious entrance to at the S side of the road. Narrow rift 15m long by 0.5 by 6m high. There may be another cave in the house garden.

Caves, Chiapa del Corzo.
On a boat trip down the Sumidero Canyon several caves were seen in the canyon walls. At river level boats visited two partly submerged fragments Cueva de Lamon and Cueva del Colores. Climbing gear would be necessary to reach the better prospects (Fig.2 & c.f. Goutier 1986).

Prisoners´ Hole, OCR 4, Huistan. L185,D55
Located in a field near the San Cristobal-Ocosingo road, S of the turning to Colonia Lopez Mateo, where permission should be sought (Fig.41). Entrance is a small hole under a small tree into an 18m entrance shaft. This encounters a well-decorated passage containing a small stream. Upstream both two ways both

FIGURE 42.

become low. Downstream is 4m pitch. The passage becomes tall and narrow, traversing leads to a 10m pitch. A further short traverse leads to an 8m drop back to the stream. The fissure is too narrow to follow the water but a way on is obvious at roof level. Traversing and bolting appears to be feasible from the head of the 8m pitch. Not fully explored due to hostile natives.

Cueva de los Bancos, La Trinitaria. L60
Located in a scrubby patch of woodland approximately 1km N of Colonia Angel Albino Corzo. Ask El Presidente for a guide (Figs.2&42). Entrance p7 leads to a single chamber with funerary remains and about 300 human skulls. An archaeological site with no possibility of extension. Consult INAH at Tuxla before visiting

Cueva Draco, Tenejapa
Upstream inlet to Sumidero Tenejapa; From bottom of entrance doline a small stream enters from a low arched passage not fully explored due to limited airspace. L50+
Climb of 6m over upstream inlet reaches a flood rising. A low passage leads after 12m to a large chamber 30 x 10 by 20m high, a bedding of 25m leads through to a large sink cave 60m to daylight. Sink in river bed 100m upstream is inpenetrable possibly the water source of the low wet inlet described above. Length c.170m.

Mesbilja Resurgences, Ocosingo.
Turning off San Cristobal-Ocosingo Road at El Corralito (Km 51.5). Near house of Manuel Jolchi 1km on track is an impenetrable rising (0.5 m^3 sec^{-1}). 3km beyond the end of the track at Mesbilja is said to be a large rising but no cave. These risings produce a considerable river.

Shaft, OCR 1, San Cristobal. D12
By San Cristobal-Ocosingo Road Nr. km4.1 Shaft to choked chamber.

Shaft, OCR 5, Huistan. D75
By San Cristobal-Ocosingo road 0.5km W of Chempil. Fenced shaft by road, belay to large trees 55m free hang into a narrow chamber, choked by rocks.

Shaft, OCR8, Huistan. D10?
By San Cristobal-Ocosingo Road Near turning to Col. Lopez Mateo. Shaft not descended.

Shaft, OCR 2, San Cristobal. D20
Near the San Cristobal-Ocosingo road; N of Chilil on a right hand bend. Hidden by trees 70m across a small maize field. Sloping p11 leads to a free hanging p7 into a chamber. Hole in floor 5m deep is choked. Other depressions close by are choked.

CAVES REPORTED BY THE CANADIAN EXPEDITIONS; 1971 -1980

Cueva de Aguacero, Ocozocuatla. L186, D +5
Rio Venta area near L'Aguacera, 2km from Hwy 190 (Pratt,1975).

La Sima de la Angel Royo, Tenejapa. D46
Nr. Yochib (Lord,1974).

Cueva del Anticlino, Salto de Agua. L80
Agua Azul area, 1.55km North of Escuela Rural Lopez Mateos. Small, resurgence cave ends in sump (Miller,1979).

Cueva de el Arcotete, San Cristobal.L665
Rio Quinta Area. Entrance 2m square, leads to a chamber containing archaeological material (Pratt,1975).

Cascada de Mizola, Salto de Agua.
Ocosingo-Palenque Road, 2km from main road. Small resurgence cave near the 25m waterfall, swimming necessary. (Gascoyne,1976)

Cave, Ocozocuautla.
Pancho Villa, Turn from Hwy 190 at Pemex Station in Ocozocuatla, approx. 40km to Pancho Villa then 2km. Rock-shelter in sandstone (Pratt,1975).

Cave, Ixtapa.
Tuxla-San Cristobal Hwy 190, nr. junction with Hwy195. Crawl at road side leads to 10m square chamber (Gascoyne,1976).

Caves, Oxchuc.
San Cristobal-Ocosingo Road between Chilil and Huistan (Shawcross,1978).
1): Nr km21; short cave in doline E of road.
2): L40. At km 21.375; cave 50m W of road. Two small entrances.
3):At km 22.48 where track joins road 2 short caves.

Cave, Huistan. L30
San Cristobal-Ocosingo Road nr. km29.5. Entrance 5m above road to W. Contains a 20m high chamber (Shawcross,1977).

Caves, Oxchuc.
San Cristobal-Ocosingo Road. Caves reported near Oxchuc at km24.5 (Shawcross,1977).

Caves, Ocosingo
San Cristobal-Ocosingo Road. Caves reported near El Corralito, km56.5 (Shawcross,1977).

Caves, Ocosingo.
San Cristobal-Ocosingo Road. Nr Chital at km73.5. Three short caves (Shawcross,1977).

Cave, Ocosingo. L30
San Cristobal-Ocosingo Road, km73.8 (Shawcross,1977).

Caves, Huistan.L15,L15
San Cristobal-Ocosingo Road, 4km N of C'en Ven-Sil-Mut turning. In a small canyon called Yach'en. Two caves at river level (Gascoyne,1977).

C'en-c-ulel (Chenchulel), Tenejapa.
On the track between Yochib and Pocolum.. Small cave with a single chamber. Has religious significance. Some other pits about 20m deep in the area. Small sink in coffee plantation goes 30m to a squeeze (Lord,1974).

C'en Ulis (Chen Ulish), Tenejapa. D134
(= La Sima de las Golondrinas)
By the track from Yochib Plaza to Paraje Yochib. Blind pit, p116 on W side; E side is shallower with drops of 31m and 46m separated by a steep slope (Lord,1974; Stock,1975).

C'en Ven Sil Mut (Chentzilbilmut), Huistan. L522, D139
Single drop of 136m in a large shaft leads to stream with inlet and outlet sumps. Downstream probably goes to Huistan Resurgence but sump is rather "indefinite". Upstream a 6m climb needs a handline (Donovan & Stock,1975; Soul,1979).

Cerro Hueco, Tuxla Gutierrez. L<1000?
Near Tuxla zoo. Major rising and cave. The first 100m is dry but deep lakes separated by 1-2m waterfalls follow and characterise the main passage. This is mainly low up to 3m high. Ends with low airspace. There is a single oxbow and a low chamber. Risk of histoplasmosis (Thompson,1972; Enjalbert,1967).

Cueva de Chenalho (Chenalho Resurgence), Chenalho. L453, D+69
Water crosses road 1km of Chenalho village . Small entrance 6m up a steep slope. Single mainstream passage with pitches, climbs, pools and traverses to a duck and an inlet sump. Scaling of P6,P5,P6,C5,C3 present wet obstacles. Presumed resurgence of Sumidero Tenejapa (Gascoyne,1977).

Sumidero Chenalho (Chenalho Sink), Chenalho. L945, D95
From Chenalho cross bridge and follow track for 4km. Near its end walk down to col turn right on path through cornfield against a rocky wall. Very fierce streamway with traverses. Entrance series has pitches of 6,10 and 20m. Water goes to Rio San Pablo (Boon,1973; Boon,1974; Steele,1978; Stone,1975).

Sumidero Chicja, Tenejapa. L143, D81
At Chicja near Tenejapa. Consists of a 0.7km through trip and an essentially separate cave, Agua Caliente inlet near the top entrance, which goes 730m to a sump. Mainstream passage is almost straight 2-3m wide and mainly 20m high has pitches (P), climbs (C) and climbs down log jams (L). From top entrance; P4+C1, C1, C3, L5, C5, L2, P6, L6+2+4, P11, P18, P6 (Alleyn,1975; Boon,1977; Boon,1977a; Gascoyne,1976; Madil,1973; Shawcross,1975; Shawcross,1977).

Cueva del Chorreadero, Ixtapa. L3284, D345
In a ravine close to km35 between Tuxla and San Cristobal, by Hwy 190. Possibly the best sporting through trip in the world with pitches, swims and leaps into pools. A 40m and 16m rope should be taken through. It is possible to rig a 70m abseil down the canyon to the entrance if desired. Life jackets useful. More drops need rigging in low water conditions. Usually all but 6 pitches can be jumped (Gascoyne, 1977; Shawcross et al,1974; Thompson,1972).

Cochol (K'Ocho), Huistan. L1361,D37
Near Huistan 2km upstream of Joya Chen. Through trip involving 2 climbs (6m rope) and two limited airspace ducks. There are two side passages one with an inlet sump (Shawcross,1975; Tracey,1975).

Cueva Cruz Ch'en (c.f.Cueva de las tres Cruces), ?Tenejapa.

Salida de Cruz Pilal (Kurus Pilal), ?Sitala.Lc.300, Dc.40
Located to the W of Cancuc. Presumed rising for Sumidero Yochib. Easy passage with large stream ends in a stalactite blockage and a sump dived to about -30m (steep gravel slope, 1-1½m high, fair visibility) (Boon,1974a; Boon,1979; Dunn,1974).

Sima de los Cuervos, Ocosingo. Dc.80
San Cristobal-Ocosingo Road, Turn off at km74.3 near Chital where track leads to Buenos Aires, passing by pit. Single drop of about 65m (Shawcross,1977).

Hok'o tonil (Okoltonil), Tenejapa. Lc.100
Near Yochib, Side of the valley of the Rio Yashanal. Cave is a single passage penetrating the ridge (Lord,1974).

Cueva del Rio Hondo, Soyalo. L300
Pichucalco-Tuxla road (Hwy 195), Nr. km78.6. Main passage goes to sump with another entrance to right. Climb on left to chambers, crawl and slide to walking passage. Then 200m to rift and stream. Not fully explored? (Gascoyne,1977).

Sumidero de la Hondanado, Huistan. L184,D48
Short wet stream cave two handlines of 10m usefull. Near the entrance is a short high level passage. Downstream sump thought to enter inlet sump in Huistan Resurgence after about 200m (Stock,1975a; Thompson,1975).

Huistan Resurgence (Mapachero), Huistan. L430, D+87
Near Huistan. Walking and wading passage with an inlet about 370m upstream. The inlet water possibly comes from Chen-Ven-Sil-Mut and the Rio Huistan. The only obstacles are occasional log jams and a difficult 6m climb upstream of the inlet, passage leads to an upstream sump which probably leads to Sumidero de la Hondonado (Larson,1975).

Joyo-c´en (Joya Chen), Huistan. L874, D83
Abseil 20m into canyon. Narrow stream passage with climbs, swims and log jams ends in a deep narrow sump with snakes. Pitches of 3m and 6m. Water probably goes to upstream sump of Chen-Ven-Sil-Mut (Tracey,1975a).

Mesbilja Resurgence, Ocosingo.
San Cristobal-Ocosingo Road. Pass El Coralito turn off S at km 51.5. A resurgence is reported at Mesbilja (Shawcross, 1977). (c.f. earlier section).

El Pozoron, Comitan. D85
A few km from Comitan. Circular shaft 160m in diameter containing a lake (Thompson,1972).

Rio Quinta Caves, San Cristobal.
Rio Quinta Canyon, Near San Cristobal-Tenejapa road. Several small caves in canyon walls to left and right of road. About 2km upstream of El Arcotete (Gascoyne,1975).

? Resurgence, Ocosingo.
San Cristobal-Ocosingo Road. Obvious waterfall at km57.5 appears to be resurgence. c.f. Mesbilja Resurgence (Gascoyne,1976; Shawcross,1977).

Resurgence nr. Agua Azul, Salto de Agua.
4km from Palenque-Ocosingo road. Small caves seen at waterfalls. A rising reported 2-4km upstream of waterfalls (Gascoyne,1976).

Resurgence nr. Huistan, Huistan.
Not investigated (Soul,1979).

Resurgence nr. Cruz Pilal, ?Tila.
Clear water rising from rocks to the S of the Rio Cruz Pilal a few hundred metres from its rising (Boon,1979).

Grutas de San Cristobal, San Cristobal.
Rancho Nuevo, 8km S of San Cristobal on Hwy
Lc.3500,Dc.300
Large well decorated cave system. Entrance passages lit by electricity and open to the public. A higher entrance connects to the show cave. Main passages in excess of 10m by 30m are now occupied by small underfit streams which drop into three sumps. One off the show cave is very constricted. About 500m from the entrance is a sumped 1m by 2m clear-water sump reached by a 10m climb through boulders. The largest sump is in the Caracol del Diablo down a 20m shaft about 700m from the entrance. A series of large well decorated chambers the Bosque de Piedras lead to a chamber with three possible routes on. Above is a large collapse chamber Salon Murphy which may have a surface connection. Down leads through a confusing maze to Salon Kramsky, easier to reach through a higher level obvious passage to a 6m pitch and a pitch of 15m. From the well decorated Salon Kramsky the cave descends steeply down dip through a constricted section to a 10m deep muddy sump. This sump occasionally dries up and a muddy squeeze up through boulders leads to the Hallucination Series which continue rapidly down dip via pitches of 7,8,20,8,9 & 8m to an incompletely explored muddy end (Gascoyne,1976; 1977; Goutier,1986; Shawcross,1978a; Steele & Roy,1972; Thompson,1972).

Sumideros de San Cristobal, San Cristobal.
Just E of the Periferico de Sur near the Portal de Tunel. Several sinks of the Rio Amarillo were investigated prior to the driving of the drainage tunnel. Many are reputed to have been more extensive before being blocked by silt and rubbish. One sink was c.60m long ending in a deep canal and syphon. In one sink the large flow of water in a narrow fissure stopped exploration (Enjalbert, 1967; Thompson, 1972) (c.f. Sumidero 1 earlier in this article).

Cueva San Francisco, La Trinitaria. L1750,D75
(= Cueva de Zapaluta)
Near La Trinitaria N of Hwy190. Very large dry cave consisting mainly of one passage up to 12m high and 30m wide. Three constricted passages lead off to the deepest parts (Goutier,1986; Thompson,1972).

Sima de San Jose, Pichucalco. L360,D70
Near km 94 on Pichucalco-Tuxla Hwy195, Near Escuela San Jose. Entrance slope leads to p30, p20 follows immediately and drops into a chamber which was not fully explored. P10 leads to a streamway sumped upstream after 60m and downstream after 114m (Gascoyne,1979; Shawcross,1977).

Murphy´s Pit, San Cristobal. D73
Shaft on saddle 1 hr S of San Felipe (Anon,1975). Possibly El Suspiro.

Number 1 Shaft, San Cristobal. D89
El Coralito, on track to Campo Grande from the Periferico del Sur. Pitches of 13m,18m,23m to a squeeze then pitches of 9m and 20m to a flowstone blockage (Gascoyne,1975; 1976). (c.f. Sima de Gabacho, SC24).

Number 2 Shaft, (Frenchmen´s Hole), San Cristobal. D61
El Coralito, on track leading to Campo Grande from the Periferico del Sur. P23 & 35m to an impossible crack leading to another drop of about 50m. (Gascoyne,1975; 1976).

Shaft, Huistan. D13
San Cristobal-Ocosingo road, distinct hole near km45.2 on the S side of the road. Blocked shaft (Gascoyne,1976; Shawcros,1977).

Shaft, Tenejapa. D20
By side of Yochib road, 5km beyond summit at Cruz Ch´en, on SE side of road. Blocked shaft (Gascoyne,1977).

Shaft, Tenejapa. L122,D213
Turn SE off the Yochib road 4km from the summit at Cruz Ch´en, where there is a corrugated iron roofed hut. After a 20 minute walk a larger track is met running across the contours. Two shafts are near the junction. A free hang of 128m leads to a further drop of 46m into a chamber 40 by 160m containing a muddy lake. The water sinks in impenetrable cracks. The other shaft enters the roof and probably needs a minimum of 220m of rope (Gascoyne,1977).

Shafts, Oxchuc & Huistan.
By the side of San Cristobal-Ocosingo road.
All roadside pots from Rancho Nuevo to km13 were checked.
Near km12.5 on the S side of road is 20m choked shaft.
km13.00 on the S of the road is a narrow slanting rift 30m deep.
km13.25 Undescended pit in doline on N side.
km20+ Undescended large shaft 60m to S.
km21.03 Undescended sloping, narrow shaft in doline 50m to N. c. 25m deep.
km21.075 Blocked shaft 12m deep.
km21.165 Two undescended 10m pits one each side of the road.
km22.48 Shaft about 18m deep, to N side in a gulley. Another deep pit on the right of a track leading to a small Colonia (= settlement). Both undescended.
km22.68 Shaft 92m leads to easy slope to blockage (Gascoyne,1976; Shawcross,1978).

Shafts, Tenejapa.
Two hour walk uphill from C-en Ulis. Near Paraje Yochib, 1km S of school at Tzametal. Two shafts, one c.45m deep

Shafts, Las Margaritas. D150?
From plaza of Las Margaritas head N.E. towards Leva. 0.4km after kiloposts 19, turn left towards Soledad. Two shafts located each side of the track 8.5km from last kilopost. Undescended (Soileau,1978).

Sink, San Cristobal.
Rancho Nuevo, 2km SE of the Grutas de San Cristobal. 0.5km to the South of Hwy 190. Blocked by wood and debris (Gascoyne,1976).

Sink nr. Sumidero Chicja, Tenejapa.
Upstream of Sumidero Chicja the river can sink completely. (Shawcross,1975)

El Suspiro, San Cristobal. D105?
Located in mountains 4km W of San Cristobal. (Fig.8) Single drop in a bell-shaped shaft starting 25m in diameter. Two small choked fissures lead off. Reported as a 65m drop with a total depth of 80m. Suggest this should correctly be a 82m free drop to a total depth of 105m (Thompson,1972) (c.f. Murphy´s Pit).

Sumidero de Tenejapa, Tenejapa. L1401, D210
Obvious river sink in large depression 200m NW of town. Sporting pot with a large stream, pitches of 10, 3, 5, 5, 7, 3, 8, 7, & 16m (2 handlines of 15m also needed) leads to a low silty sump. The water probably goes to the Chenalho Resurgence (c.f. Cueva Draco earlier in this article) (Thompson,1972; Tracey,1973).

Sima de las Tres Cruces (Cueva Cruz Ch´en), Tenejapa.
c.300,D52
On the SE of the road between Tenejapa and Yochib, 5km beyond the summit at Cruz Ch´en. A 37m shaft as three pitches (the second is very loose). Drop of 12m leads to a dry passage which after 2-300m encounters a streamway. Downstream after 150m is a boulder choke. Upstream leads to large chambers and avens (Finn,1977; Gascoyne,1977).

Sumidero Yochib, Tenejapa. L1994, D213
Sink of Rio Yashanal in Yochib Plaza. A major river cave involving extreme hazard from fast-flowing water and susceptibility to flooding. The system consists of two separate routes diverging 300m in and at -30m. Great Expectations is a large abandoned passage with p23, 35, 15, +3, 10-15-18 and 5m ending at a muddy boulder choke. The river cave consists of 16 pitches from 12 to 35m. Complex rigging is required; this and numerous traverses to avoid the water preclude a meaningful guide to this steeply descending and often ferocious streamway. Consult original descriptions and Van Note (1978) as rigging guides. The streamway is 1.3km to a canal ending at a large sump at -206m. The inactive, well decorated part of the cave reaches a depth of 213m. The water is presumed to resurge at Cueva Cruz Pilal (Boon,1975; Boon et al,1974; Donovan,1975; Steele,1972, 1977 & 1986; Van Note,1978).

CAVES FOUND BY THE ITALIAN EXPEDITIONS; 1969, 1973 & 1975

From Sbordoni et al 1977

Cueva de Pasa Burro, 47, Berriozabal. L<50?
A resurgence providing water for Berriozabal. Entry is by a fossil passage to the streamway which was not explored due to the quantity of water.

Grutas de los Indios, 38, Cintalapa
Several small caves situated on the leftbank of the Rio Negro

Cueva de Venado, 39, Cintalapa
Small cave on the bank of the Rio Negro.

Cueva de la Mariposa, 40, Cintalapa.
Small cave on the bank of the Rio Negro.

Grutas de Llano Grande, 85, La Grandeza
In a small basin 1.5km N of the school at Llano Grande. The upper entrance 2m high opens into a well decorated series of caverns which encounter a 20m high canyon passage on the right. Whilst left is a large fossil branch.

Cave, 30, Ixtacomitan. L5
Small cave at the side of the road to Tapilula, near Malpaso about 400m from the Zocalo of Ixtacomitan.

Sotano de Malpaso, 31, Ixtacomitan. L75, D38
Situated 2.5km 50° mag. from the Zocalo of Ixtacomitan. A 30m diameter shaft of about 38m connects by a short (25m) horizontal passage to another shaft from the surface with pitches of 15 and 25m. A small stream is seen.

La Cueva, 32, Ocozocoautla.
At the extreme western end of the Lago de Malpaso, near where the Rio Encajonado enters

Cave, 34, Ocozocoautla
A small niche near the confluence of the Rio Venta and the Rio Negro (Encajonado)

Cueva de las Dos Bocas, 35, Ocozocoautla.
A small cave on the left bank of the Rio Encajonado, 20m upstream of the confluence of the Rio Venta and Rio Negro

Cueva del Perro de Agua, 36, Ocozocoautla.
A fine rising near the confluence of the Rio Negro and the Rio Venta. Almost completely filled by water. Above is a fossil passage which connects with the stream at various points. Possibly blocked by sediments after 150m

Cueva del Agua Purificado, 37, Ocozocoautla.
A cave with three entrances on the left bank of the Rio Negro. Passages up to 5m high with many stalactites and flowstone formations. A small stream flows out from a low unexplored passage.

Cueva del Sabin, 41, Ocozocoautla. L18,D7
Single chamber massively encrusted with calcite located near the Rancho del Sabin to the left of the road, close to km22, alongside the Lago de Malpaso.

Cueva de la Cotorra, 42, Ocozocoautla.
A large entrance on the Piedra Parada visible from Hwy190, it is 4km N of Ocozocoautla. An earth road leads to a small ranch about 0.5km from the cave. A large rock shelter.

Cueva del Encanto, 43, Ocozocoautla.
(= C.de l´Aguacero)
c.f. previous section.

Cueva del Camino de l´Aguacero, 44, Ocozocoautla, L6
A small cave close to the Pan American Highway (Hwy190) approx. 70m from C. de l´ Aguacero.

Sima del Tempisque No.1, 10, Ocozocoautla
Located on the Rancho of Mario Leon Tempisque, 13km W of Ocozocoautla. A sinkhole of 20m leads into a vast system containing a large watercourse, used as a water supply.

Sima del Tempisque No.2, 45, Ocozocoautla
Rancho El Tempisque; 100m from S. de Tempisque No.1 and probably the source of its stream.

Cueva del Muju, 46, Ocozocoautla
At Rancho las Pilitas close to Hwy 190, about 5km from Ocozocoautla. The 1.5m wide by 3m high entrance enters a large chamber 15m in diameter and 4-5m high. Crawl under concretions in a small passage. This enlarges and encounters a rich area of formations in a chamber of similar size to the entrance chamber, a 4m pot continues.

Sima del Ojito, 11, Ocozocoautla. D24
Situated in the forest close to Colonia Galeana about 30km S of Ocozocoatla. A 24m shaft to a deep mud fringed pool.

Cueva de Cerro Brujo, 16, Ocozocoautla.
(= Cueva de las Calaveras)
Turn off the Berriozabal-Ocozocoautla road about 11km from Berriozabal, on to an earth road passing through Colonia Guadalupe and El Moro after 32km Colonia Galeana is reached. Continue on foot 12km to the Cerro Brujo where the cave is concealed in thick scrub. It is found with difficulty just over 1km from Rancho de Cielito by turning back along the lane leading to Col. Galeana. The cave opens through three small entrances in steep wall in the forest into a large system massively decorated by calcite. A beautiful rimstone pool surrounded by columns is edged by many human remains and funerary offerings, much disturbed. The expedition reached a point down a rock slope where the floor leveled 40m from the entrance .Incompletely explored.

Cueva de Las Canicas, 17, Ocozocoautla. D85
Located on the Rancho del Cielito. A 20m drop to a talus slope which leads down about another of 30m to thickly calcited chamber. Several short branches open out but a longer one on the left leads to a small muddy chamber. From here a narrow passage leads to a tiny chamber with a stream, small rifts from here are said to be inaccessible.

Sumidero de Canada, 86, El Porvenir.
A short distance from the village of Canada in a large closed basin. The entrance is located to the left of an active sink. Entry is to a large chamber with many concretions. The lenticular chamber descends rapidly about 30m to the river. Not fully explored.

Cueva de Saclamanton No.1, 70, San Juan de Chamula. L12
Cave is 4km at 100° from S.J. de Chamula, use a local guide. Short cave ending in an aven of 10m.

Cueva de Saclamanton No.2, 71, San Juan de Chamula. L6
Single passage 150m from previous cave.

Cueva de Saclamanton No.3, 72, San Juan de Chamula. L6
Small cave found 300m at 70° from the tiny village of Saclamanton. Religious site.

Cueva del Azufre, 5, Tapijulapa, Tabasco. L<500
Found in the small valley, Arroyo del Solpho, Rancho de la Luz, 1.5km W of the Rio Oxolatan, about 3.5km S of Tapijulapa. The cave discharges a small sulphurous milky blue stream which flows to the Rio Oxolatan. There are several entrances and many oxbows. The passages are 2-3m wide interspersed with larger bat-infested chambers.

Grutas de Cocona, 4, Teapa, Tabasco. Lc.700
The cave is located about 3km NE of Teapa, near cocoa cultivations at base of steep-sided hill. A primitive show cave.
The accessible section is an overflow for a nearby rising but normally only a small stream runs through the cave. The cave contains good formations and large lakes. There is much guano present.

Cueva de la Frontera, 29, Teapa/Pichucalco, L30
At the bottom of a series of dolines 1km at 100° from El Azufre. It is an active resurgence, a stream of 100 l sec^{-1} being observed emerging from an immature cave largely full of water.

Cueva Tchabo Oet-oet, 50, Tila.
(= Cueva Chiquinchy)
Descend from the village of Tila to the S past the cemetary towards the Rio Puente; after approximately 2km the large entrance is seen 8m wide by 4m high. Descend on the left of the entrance chamber to a small stream which feeds the Rio Puente, upstream the water was 1.5m deep to a lake. Not fully explored.

Cueva de Nicolas Bravo, 51, Tila. L>1550
Found on a bearing of 115° from the village of Tilla in the Barrio of Francisco Madero. Cross a new bridge over the Rio Puente and turn left. The cave is at the base of a small rocky outcrop in a coffee plantation. The roomy entrance enters a sinuous corridor, after about 50m there is a fork. The main passage continues to a large clear syphon. The water from this pool flows down the S branch in a small wet passage rich in speleothems; this continues unexplored after 60m

Cueva del Barrio Francisco Madero No.1, 52, Tila L>40.
The cave is found in Tila, in the Barrio of Francisco Madero about 50m from the house of "Senor de Tila". The cave is presumed to be of considerable extent but was only explored for 40m.

Cueva del Barrio Francisco Madero No.2, 53,Tila
Found in the Barrio of F. Madero, Tila near the sports field. A 1.5 by 2.5m entrance. Probably only 6m long.

Cueva de Cepona, 9, Tuxla Gutierrez
Leave the town of Tuxla by the Via 7a Poniente, earth road leads to a stone quarry. Continue on foot for about 1km on a path in a small canyon, bearing 280° magnetic one comes to the 15m wide 6m high entrance in the right hand wall. Two linked parallel tunnels run about 150m. A short narrow twisting passage branches off near the end. The cave floor is dry and covered with ash and is reputedly a source of coal.

Cueva de la Ramillette, 8, Tuxla Gutierrez Lc.500
The cave is situated at 815m about 7km from the town in the direction 340° magnetic. The entrance is a window 3.5m above ground in a rocky wall. The Main passage 4-5m wide and 15m high runs NE for about 220m, a parallel passage is linked by transverse passages. There is a large chamber about 150m in, with moon milk covered walls and a dry guano covered floor.

Cueva de Cerro Hueco, 7, Tuxla Gutierrez
At the Balneario Cerro Hueco, c.f. Previous section.

Cueva del Campanario, 57, Jitol. L83
(= C. del Puente Redondo)
Found by the road which links the Pan American Highway to Pichucalco. About 2km from Jitol is a bridge on a bend above a ravine. The cave is about 50m on a bearing of 60° from the Puente Redondo. The water from and inpenetrable rising 4m deep, flows through the cave which is essentially a horizontal passage, with three entrances.

Cueva del Naciemiento del Rio Santa Domingo, 19, Bochil.
Leave the village of Bochil towards the Finca Santa Domingo. On reaching the bridge over the Rio Santa Domingo. A lane on the left borders the river and after about 0.5km the 10m high entrance is encountered which is connected to the underground course of the river.

Cueva de la Golondrina, 18, Bochil.
(= Cueva del Nasoch or C. de Santa Domingo)
A gully, El Nasoch, is encountered 4km from Bochil on the Simojovel road. Descend to a rocky area clearly visible from the road. The cave entrance is in thick vegetation and not easily found without a guide. Inside the narrow entrance the roof becomes steadily higher. 60m to the SE is a 7m pitch into a chamber 6-7m wide and 10m high. Continuing to the left one proceeds about 200m through a series of small richly decorated chambers. The branch ends in moonmilk. Returning to the drop, on the right, up and then down a muddy slope ends after about 150m. A 20m diam. chamber is hidden behind calcite curtains.

Grotta de la Finca S. Anïta No.1, Simojovel de Allende. L55,D15
The cave is approx. 100m N of km 30 on the unmetalled road to Simojovel, in a small depression in a coffee plantation. Walk down about 14m to the entrance into a curving descending chamber. A side pasage descends steeply past pools and was not fully explored. Risk of carbon dioxide.

Grotta de la Finca S. Anita No.2, Simojovel de Allende.
This cave is near the preceeding one about 30m from the road.

Cueva de Chanchaniptic, 56, Sitala, L550
(= Cueva de Sitala)
Essentially a through stream cave with a single passage.

Cueva de Chital No.1, 60, Ocosingo, L12
A small cavity on the right of the of the San Cristobal-Ocosingo road at Ranco Chital at the village of Chital c.14km from Ocosingo. A small joint cave.

Cueva de Chital No.2,61, Ocosingo, L30
Small cave found about 300m N of the previous one. A main passage with an unexplored oxbow.

Cueva de Cuxulja No.1, 62, Ocosingo.
Short cave found at km 69 by the side of the San Cristobal-Ocosingo Road.

Cueva de Cuxulja No.2, 63, Ocosingo. L8
Found about 100m S from the previous cave on the left of the road. A fragment of a larger cave.

Sumidero del Naranjo, 58, Soyalo. L12,D10
Leave the Bochil-Soyalo road about 9km from Soyalo. On the left is a track passable by vehicles in dry weather to Finca Carmen Navastic. The sumidero is 0.8km on 170°. Three separate entrances needing 10m of ladder, choked sink.

Cueva del Negro, 59, Soyalo. L150,D100
This is situated 1.2km at 180° from S. del Narango, Near Finca Carmen Navastic. A huge steeply sloping chamber 80m wide by 40m high entered by a steep slope needing about 8m of ladder. Full of speleothems including several large pillars.

Cueva del Chorreadero, 6, Chiapa de Corzo.
Balneario El Chorreadero, Chiapa de Corzo, c.f. previous section.

Cueva Roberto, 48, Chiapa de Corzo. L75
By Road (Hwy 190) between Tuxla and San Cristobal at km 27 near the turn to the Balneario de Chorreadero. A small grotto and a short blind passage.

Cueva del Panteon, 64, Altamirano L95
Lane running from Teopisca runs W & NW to the cemetery, the cave is about 2km beyond the cemetery in the same direction. A 12m wide imposing entrance directly enters a vast chamber about 80m in diam. The floor has a difference of 50m in level with imposing stalagmites and fallen rocks. The lowest point at the NW end reaches a series of small muddy chambers extensively covered by speleothems. They end at a narrow fissure beyond which the cave may continue.

Grutas de Rancho Nuevo, 20, San Cristobal de las Casas.
(= Grutas de San Cristobal)
c.f. previous references in this article

Sumidero de Casa Clark, 73, San Cristobal de las Casas.
Situated 1.3km to the N-NW of the house of Mr Samuel Clark, located near the northern limit of the San Cristobal basin.

La Cueva Encantada, 74, San Cristobal de las Casas. L42,D26
Situated 200m NW of the preceeding cave. Consists of a single, steeply sloping, gallery 5m in diameter.

Cueva de las Calaveras, 75, San Cristobal de las Casas.L8
A small cave 0.3km at 130° from the previous.

Cueva de la Planta No.1, 76, L40
Cueva de la Planta No.2, 77 L200
Cueva de la Planta No.3, 78, L150, San Cristobal de las Casas
In the Las Piedrecitas area close to the Rio Quinta on the San Cristobal-Tenejapa road. Several caves which have probably been previously explored by the Canadians (c.f. previous section, also Pratt 1975 & Gascoyne 1975).

Cueva de la Canada No.1, 79, San Cristobal de las Casas.
Situated near the Rio Quinta about 0.35kn N of the village of Quinta reported by Pratt (1975) (c.f. previous section).

Cueva de la Canada No.2, 80, San Cristobal de las Casas.
Situated on a bend of the Rio Quinta about 0.6km N-NE from the village of La Quinta. Two entrances connected by a straight passage of 30m long 10m wide and 4-5m high, many speleothems.

Cueva Oscura, 81, San Cristobal de las Casas. L60
Situated about 1hr (5km) from the road near Rancho San Nicolas, use a local guide. The cave is found on the side of a mountain at the bottom of a small valley. The cave is a single large chamber entered by two letterbox entrances. The 70m by 40m by 8m high chamber contains impressive columns and other speleothems.

Cueva Clara, 82, San Cristobal de las Casas. L125
4km from Finca San Nicolas on a peak on the left side of the Rio Quinta (or Fogonico?) Use a guide. Three large linked chambers upto 10m high with large stalagmites and many stalactites. It has 4 entrances including a p10 from the roof.

Cueva Nr. l´Arcotete, 83, San Cristobal de las Casas.
Two small caves reported at l´Arcotete. Leave the San Cristobal-Tenejapa road after 5km on a track to the right. A stream can then be followed to the natural arch of Arcotete. c.f. previous section.

Cueva del Coyote, 84, San Cristobal de las Casas.L130,D85
This fine cave is found to the S-SW of the Grutas de San Cristobal at Rancho Nueva. A guide is absolutely necessary. The cave is a single steeply sloping gallery up to 12m in diameter, with many speleothems.

Cueva del Rayo de San Felipe, 21, San Cristobal.
Near the village of San Felipe, 3.8km NW from San Cristobal on Hwy 190 there is turning onto an earth road which descends to the bottom of a deep valley. On the other side of the valley over bare limestone is the 2m by 4m wide entrance which leads to a 7m drop into the single chamber which has a maximum dimension of 30m.

Cueva de Tulanca No.1, 22, Amatenango.
About 2km from the Rancho de Tulanca, Amatenango. The 1.5m by 0.5m entrance opens into chamber about 15m long with a narrow 5m blind pit. All areas have many large dead formations. Funerary objects and human remains are scattered around.

Cueva de Monte Vidal 1, 66, Altamirano.
Located to the N-NE of the road from Altamirano running NE. Not far from Cueva de Los Chivos and is situated in a large forested shakehole. Another cave is close by. A guide is essential to locate these holes.

Cueva de Monte Vidal 2, Altamirano.
In the same doline as C. de Monte Vidal 1. unexplored.

Cueva de Rio Ticho, 14, Comitan
(= C. de la Toma de Agua) D62
Sinkhole 3km from Comitan which intercepts the stream used as the town´s water supply. Entrance is protected by masonry and the entrance shaft is strengthened. A 50m climb leads to a series of short pitches fitted with wooden ladders reaching a small muddy chamber at -60m where a small turbid stream enters a narrow passage not fully explored.

Cueva Chica de San.Agostin, 23, Comitan. D16
Near Km 52 on the Hwy 190 from San Cristobal to Comitan is a turning to the N is a track for Laguna Chamula. After 0.5km turn left and after 100m the obscure entrance is on flattish ground. This is on the Rancho de San Agostin about 400m from the Estacio Microndas de Laguna Chamula. A narrow pothole consisting of two pitches, p5 enters a small low chamber 7m in diam. from which p10 drops into a narrow chanber blocked by earth and small rocks.

Cueva Grande de San Agostin, 24, Comitan.
Follow the track from C. Chija de S.Agostin as far as a gully. The 20m diameter entrance is on the left wall. P15 lands on a debris cone 15m high. It is possible to climb down 5-6m between fallen rocks to a narrow passage with small concretions and small pools.

Cueva del Rayo de San Francisco, 26, Comitan. L18
The cave is near to Colonia San Francisco reached by an earth road running from Comitan. 4km W of the colonia are three small openings on the right of the track. Cave consists of two chambers about 2m in height containing many speleothems.

Cueva de las Florecillas, 27, Comitan
Two hours walking past the Cueva del Rayo de San Francisco one reaches a wide gully near Rancho Florecillas. Climb 15m down wide sinkhole into a chamber from which narrow passages branch off. Rifts in floor descend a further 15m.

Cueva de la Cruz Belen, 28, Comitan. L20
Turn left off Hwy 190 before Comitan at Finca Yerbabuena. Pass Rancho San Antonia Buenavista to Rancho San Antonia de

Padua after 4km. Cave is in a large karst valley near a cross. Entrance 2m wide by 1m high leads to a short slope into a chamber 13m in diameter and 4-5m high. Site for religious ceremonies.

Grutas de Zapaluta, 67,
(= Cueva de S.Francisco) La Trinitaria.
c.f. previous section

Cueva de Chinkultic No.1, 13, La Trinitaria.
Near the Mayan pyramid of Chinkultic close to the Lagos de Montebello, Comitan. Short dry horizontal cave, still used for religious ceremonies.

Cueva de Chinkultic No.2, La Trinitaria. L7,D4
Sinkhole close to C. de Chinkultic No.1 containing two short branches.

Cueva del Arco, 12, La Trinitaria. L200
From the Lagos de Montebello asphalt road, an earth road leads after a few hundred metres to San Rafael del Arco. River in small karst valley flows under natural arch and collapsed cave. Entrance is 200m downstream of arch about 20m above river bed. Abundant speleothems in a cave averaging 5-6m high. A small stream forms gours and muddy pools. There are two alternative entrances.

CAVES FOUND BY THE DUTCH EXPEDITION 1984-5. (After Goutier 1986)

1) Cueva Veshtucoc, El Zapotal.
Beyond Moctezuma's Revenge where the British Expedition stopped a boulder choke was descended for 28m to the river. At the end of this steeply ascending passage was a wide deep sump. A lot of surface debris occurs here and it is probably less than 100m from the surface near Santa Cruz (La Garrapata). (Figs.8,38,39 & 40)

2) Ojo de Agua, El Zapotal.
Wrongly named Cueva del Agua or El Chorro. c.f. Where the Rio Blanco resurges in San Lucas. Explored by the British Expedition. New fissure climbed to a height of 66m too narrow with calcite. (Figs.8&36)

3) El Chorro, El Zapotal.
(= C. del Cascada de Rio Blanco)
Explored by the British Expedition. Small cave with bats. Ends in two small inlets.

Surroundings of Santa Cruz (La Garrapata), El Zapotal. (Fig. 8)

4) Cave, El Zapotal.L25
In a small polje W of the path between San Lucas & Santa Cruz, Entrance 1m across is in a small group of trees.

5a) Cave, El Zapotal.L30 D8
In a series of dolines 0.5-0.7km W of Santa Cruz. Meandering passage choked by gravel.

5b) Cueva del Paco, El Zapotal, L20 D15
(= Cueva Pacni (c.f.))
Situated on the other side from 5a, small passage descending at an angle of 45° ending in two small meanders. Explored by the British Expedition.

44) Cave, El Zapotal. L15
Intermittant sink close to the track down to San Lucas from Santa Cruz. Explored by the British Expedition.

6) Sumidero, El Zapotal.
Sink, only active in rainy season, near Santa Cruz, 150m S from highest houses.

7) Sumidero, El Zapotal.
Choked sink, 150m NW from highest houses on the track to San Antonio.

8) Cave, El Zapotal.D8+
Sink near the track to San Antonio, 100m W of 7. Sink unexplored through lack of tackle.

Area around Paste-Elambo-Buena Vista, Zinacatan. (to the S of the HWY 190)

17) Cave, Zinacatan.L16
In a doline W of the Nachig-Elambo track ends in a boulder choke.

18) Shaft, Zinacatan,L11
Contains ladder and religious offerings.

19) Cave, Zinacatan.
Small hole to muddy slope, in doline not explored, location not defined.

20) Cave, Zinacatan. L12
Cliff with several openings, slightly ascending cave to small chamber containing offerings. Location not defined.

21) Cave, Zinacatan.L10
In the same cliff as 20

22) Shaft, Zinacatan, D2
In a doline S of Paste near the church.

24) Caves, Zinacatan.
On the Nachig-Elambo track about 1km N of Elambo. E of the road are two blind dolines, 24a, (lakes in wet weather). W of the track are two caves each L10.

25) Cave, Zinacatan.
At the bottom of a cliff 2.5km N of Elambo, continues unexplored but small.

26) Caves, Zinacatan.
Two dolines 0.3km N of 25, one is blind the other contains two small caves.

27) Cave, Zinacatan. D8
About 1.2km E of the fork in the track to Elambo or Paste; rocky shakehole, clay choked.

28) Caves, Zinacatan. L<10
About 200m SE of 27. Several holes at the bottom of a cliff.

Area 0.5km SE of Paste, Zinacatan.

29) ? Cave, Zinacatan.
Deep doline on private land unexplored.

31) Cave, Zinacatan. D3
In small doline ending in mud choke.

32) Cave, Zinacatan. L7,D5
Rocky doline 40m in diam. Shaft 0.5m in diam. ends in mud choke 3m down.

Area 4km S of Paste, Zinacatan

4) Sumidero, Zinacatan.
Narrow wet weather sink in maize field.

35) Sumidero, Zinacatan.
Wet weather sink, too small to enter.

36) Cave, Zinacatan. D10
Doline 15m diam. containing large wet weather sink, clay choked.

38) Sima Sin Luz, Zinacatan. D55
Intermittant active sink, at approx 92°44´47"W 16°39´3"N, steeply sloping shaft in boulders to a choked pool.

39) Shaft, Zinacatan. D7
Shaft at the bottom of a doline containing boulders and clay.

40) Shaft, Zinacatan. D28
Pothole 8m deep at the bottom of a 30m diam doline 20m deep. Clay choked in a large boulder choke.

41) Cave, Zinacatan. D12
Cave at the edge of a doline, too narrow.

Caves near the Laguna Grande-San Lucas path

42) Cave, San Cristobal de Las Casas.
Found just before Laguna Grande nr. Laguanita. Small entrance to labyrinth not fully explored.
43) Caves, San Cristobal de Las Casas.
About 15 short caves, the longest 15m. Just N of Santa Cruz.

45) Cueva de diez nil pesos, San Cristobal de las Casas. L30,D13
Sinkhole,2.5km W of Santa Cruz, clean-washed pot ending in a sump.

Caves on plateaux above Canon del Sumidero, Tuxla Gutierrez.

10) Cueva Penjamo, Tuxla Gutierrez. L240,D90
Cave at the bottom of a large vertical rocky doline, 20m deep. Coordinates 93°08´06"W 16°50´49"N. The cave is a large sloping, boulder strewn chamber ending in a 30m wall with no continuation above.

11) Sima Frans, Tuxla Gutierrez. D15
Shaft at the bottom of a large doline, too narrow.

12) Cueva Monte Cristo, Tuxla Gutierrez. L105, D10
Found at 93°06´56"W 16° 51´22"N. Nr. the village of Laguna. Rocky entrance 25m wide and 15m high to flat muddy floor, roof lowers to two branches at the end 1m high blocked with calcite.

Caves in the Canon Sumidero (Nr. The Embalso Malpaso) Ocozocoautla

13) Caves, Ocozocoautla
Several caves in a 40m high cliff, longest is 10m, full of bats.

14) Cave, Ocozocoautla. L30
Cave encountered by 75m test tunnel nr. dam, passage down sumped, upper passage ends in clay blockage.

15) Cueva de Canon del Sumidero, Ocozocoautla. L148
Located at approx. 93° 03´57"W 16° 49´28"N. Fossil system with many formations all passages choked by calcite.

Caves Nr. Oxchuc. San Cristobal-Ocosingo Rd.

47)Cave, Oxchuc. L66+
Nr. Rosario, water followed downstream, exploration terminated

through lack of permission.

78)Cueva San Francisco, La Trintaria, L1750
(=C. de Zapaluta)
c.f. Description earlier in this article

Frontera Comolapa area
On the E side of the Rio Grijalva, 0.5km from the Guatemalan border, Nr. Chamic.

48) Cueva Malpaso, Comalapa. L121
S of Chamic by the Rio Grijalva at 92°09´51"W 15°35´18"N. Complex cave with narrow passages, down probably sump, up are too narrow.

49) Cueva Nuevo Moreilla, Comalapa. L320 D48.
The cave is situated on the Comalapa-Motozintla road on the side of a mountain E of the Rio Grijalva (10mins walk). At 92°08´5"W 15°36´09"N. Two entrances the higher is 30m shaft. Two main passages, 5m high and wide are well decorated.

50) Cueva Tino, Comalapa. L95,D28
(= C. de Guerero).
The cave is a 45min. walk from the village of Guerero near the top of a hill, at 92°08´54"W 15°35´16"N. Climb 10m in a narrow sloping entrance, passage 10m high and wide leads to P20 into final chamber. No way on. Dry fossil cave.

51) La Gruta, Comalapa. L86
Very large entrance chamber at 92°07´55"W 15°35´46"N. At the end is a climb blocked by calcite. Said at one time to have been more extensive.

52) Cueva Puressa, Comalapa. L1032
Situated S of Guerero, W of the Rio Grijalva at 92°09´51"W 15°35´N. Mainly one horizontal active stream passage. At the end larger passages have many formations and a sump. There is a resurgence lower down from the entrance.

53) Cueva del Hombre de Platanos, Comalapa. L38
By the side of the Motozintla-Comalapa road at 92°08´24"W 15°37´17"N. An uninteresting system ending too narrow.

54) Sima Ojo de Agua, Comalapa.D62
Two parallel shafts nr. the village of Ojo de Agua 1 1/2hr. walk W of Chamic. Main shaft, P20+40 to blockage. Contains gours and other speleothems.

55) Shaft, Comalapa. D37
Pit nr. S. Ojo de Agua (54), on the path towards Comalapa. P37 ending in a choked meander.

56) Cueva Roblero, Comalapa. L50,D15
Cave alongside of the Ojo de Agua-Comalapa path. Mainly horizontal cave passage up to 12m wide, pit in floor choked by gravel.

Area between Motozintla & Comalapa

57) Cueva de Canada, Comalapa, L435,D35
Nr Canada. Complex cave with several levels.

58) Cave, Comalapa, L10
Nr. Canada. Small entrance, choked with mud.

59) Sima del Puerco Muerto, Comalapa. D52
Shaft nr. Bejucal de Ocampo, situated on the edge of a large doline by a toilet.P52 rebelayed at approx -25 lands on a mud bank in a 3m wide lake which winds off as deep foul water. Not fully explored due to dead pig and sewage water.

60) Cave, Comalapa. L10
Small cave S of Bejucal de Ocampo.

61) Cueva de Lingun, Comalapa, L194
Resurgence cave about 45min. walk N of Bejucal de Ocampo, under a W facing cliff. Water emerges from rocks 25m from entrance. Single active passage, stream emerges from a sump. Danger of coccidiomicosis.

62,63,63a) Tres Simas, Comalapa. D45
Nr. Bejucal de Ocampo. Three shafts joining in a chamber 30 x 20m at 28m pitch.

64) Shaft, Comalapa. D46
Nr. Bejucal de Ocampo. Blocked single shaft.

65) Sima el Canague, Comalapa. D66
Shaft in the bottom of a doline nr. Bejucal de Ocampo. P29,P13,P14 & P8 to an incompletely explored muddy meander. Unexplored passages go off at several levels. A major sink in wet weather.

66) Cave of the Fallen Key, Comalapa. D47
Nr. Bejucal de Ocampo. Single shaft, P32+15 to small lake in gravel and mud.

67) Shaft, Comalapa. D45
Hidden in bushes, about 15m above the road in Bejucal de Ocampo. Several parallel pitches of P26+15 to a 4m diam. mud choke.

68) Shaft, Comalapa. D5
Nr. Bejucal de Ocampo.

69) Shaft, Comalapa. D1
Silted up hole in large doline nr. Bejucal de Ocampo.

70) Shaft, Comalapa. D5
Nr. Bejucal de Ocampo. In bushes nr.Cueva de Lingun.

71) Shaft, Comalapa. D13
Nr. Cueva de Lingun in Bejucal de Ocampo.

72) Shaft, Comalapa. D8
Near to the school N of Bejucal de Ocampo.

72) Shaft, Comalapa. D2
Nr. to Bejucal de Ocampo.

74) Shaft, Comalapa. D10
Single blind shaft close to Bejucal de Ocampo.

75) Shaft, Comalapa. D22
Simple blind shaft nr. Bejucal de Ocampo.

76) Shaft, Comalapa. D34
Small entrance to P32 in a chamber, bedding across shaft top continues. Nr. Bejucal de Ocampo.

77) Shaft, Comalapa. L20,D48
Nr. Bejucal de Ocampo. Entrance p40 into chamber 8 x 4m square. Hole leads through to a muddy passage 2m wide.

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APPENDIX : MEDICAL ASPECTS OF CHIAPAN CAVING

A. Perou SRN

Six months before the departure date all members were asked to fill in a questionaire on their medical history. They were also advised to have their teeth checked and obtain vaccinations against cholera, typhoid, paratyphoid A & B, Poliomyelitis, yellow fever, tetanus and tuberculosis. To protect against infective hepatitis gamma globulin was recommended just prior to departure.

Three months befor departure two doses of rabies vaccine, 0.1ml intradermally, one month apart, were administered. All members were given individual first aid kits containing simple medications, dressings, pins and instructions for use.

Despite mosquitoes not being common in Chiapas antimalarial prophylaxis was started before departure and was continued, "Folaprim" was supplied but some members used "Daraprim". The medication was issued communally once per week. Many people rapidly succumbed to diarrhoea which eventually affected most. Some unfortunates suffered this for most of the time. Living conditions were far from sanitary although purified water was bought in San Cristobal. In the field "Puritabs" were used for water sterilisation (remember that the addition of vitamin C containing flavourings inhibits the effectiveness!). Appart from minor traumas such as one member being run over by a kamikaze bicyclist at the airstrip and cracked ribs after a wrestling match the group in general remained healthy. At the camp site hairy catterpillars caused nasty "burns" and ticks had to be removed on occasion.

On the 8th of January seven of the film crew and eight expedition members visited El Nacimiento del Rio Salado and spent between ten minutes and five hours in a dry ill ventillated chamber inhabited by bats. Nine to twelve days later most of these people became ill. The main symptoms, varying in severity were; fever, respiration difficulties, coughs, headaches and joint pains. Some showed haemoptysis, sore throats, and vomiting. All those x-rayed showed lung changes, and at least two had enlarged spleens. Diagnoses included sand fly fever (biting flies were a common pest in the Grijalva Valley), typhoid (due to positive blood tests caused by vaccination). Histoplasmosis however was generally agreed on later. Of the fifteen persons exposed seven were flown to Mexico City and were treated at the American-British Cowdrey Hospital and all subsequently flew home after between two and three weeks in patient treatment, which included the use of "Nizoral" (ketakanazole). Three people flew back to Britain and were treated at home. Two people recuperated under medical supervision in a good hotel at San Cristobal. Of the remaining three, one suffered mild pyrexia and general malaise for five days, one had an influenza type illness for on day and one was apparently unaffected. It is interesting to note that this latter group had all caved in Mexico previously.

The risk of histoplasmosis had been discussed in expedition planning meetings but the precautionary used of mask filters (less than 3 micrometre mesh) was considered impractical in hot strenuous caving conditions. The number and severity of infections in this expedition was without parallel and is possibly related to the length of time people never previously exposed to the fungus were working in the cave at El Nacimiento del Rio Salado. A brief visit might have resulted in mild symptoms which could not be diagnosed. Particulars from those affected have been recorded with great interest by the London School of Hygiene and Tropical Medicine who should be contacted for further information on preventative measures and treatment.

APPENDIX : EXPEDITION PERSONNEL

British Expedition 1982-3

Name	Caving Club
Dany Bradshaw	B.E.C. & C.D.G.
Robert Cork	B.E.C. & C.D.G.
Barry Davies	D.C.C.
Andrew Davidson	N.C.C.
Richard Ellis	N.C.C. & H.W.C.P.C.
Ruth Ellis	- - - - -
Stephen Foster	M.U.S.S.
David Gill	E.P.C.
Anthony Jarratt	B.E.C. & C.D.G.
Howard Limbert	N.C.C.
Debborah Limbert	N.C.C.
Carl Maxon	N.C.C.
Jeffrey Morgan	H.W.C.P.C.
John New	D.C.C.
David Newson	- - - - -
Mark Robson	N.C.C.
Gail Searby	M.U.S.S.
Laurens Smets	S.L.
John Thorpe	N.C.C.
Ian Watson	N.C.C. & C.D.G.
Terence Whitaker	N.C.C. & C.D.G.
Ian White	N.C.C.

Abreviations
B.E.C. Bristol Exploration Club
C.D.G. Cave Diving Group
D.C.C. Derbyshire Cave Club
E.P.C. Eldon Potholing Club
H.W.C.P.C. Happy Wanderers Caving & Potholing Club
M.U.S.S. Manchester University Spelaeological Society
N.C.C. Northern Cave Club
S.L. Speleo Limbourg (Holland)

FILM CREW

Name	Function
Gill Ediger	Logistic Manager
Christopher Gibbs	Sound Recordist
Christopher Lister	Producer
Guy Meauxsoone	2nd Cameraman
Alison Perou	Assistant & Nurse
Sidney Perou	Director & 1st Cameraman
Christina Scholler	Assistant
Stephen Woods	Assistant

APPENDIX : FORMALITIES & PERMISSIONS

For the benefit of future visitors it is worth recording the procedure for getting official permission for caving activities in Mexico. The ridgidity to which local authorities

require formal applications varies greatly from area to area.

1) Allowing plenty of time (6-9months) write to the state governor (in Tuxla Gutierrez for Chiapas). Aquaint him with your plans and ask for a general letter of introduction and permission to be shown to the presidentes of the municipios. This is vital for efficient travel and caving.

2) It is also worth writing in advance to the presidentes of the most important municipios in the area you wish to visit asking them for letters of introduction to village Jefes and Commisarios. This request can also be made again when you receive the governor´s letter and can also be made in person when you arrive, provided you allow a day or so for the office work.

3) Write to the Instituto Nacional de Antropologia e Historia (INAH), Centro Regional de Chiapas, 2°, Poniente Norte 465, Tuxla Gutierrez, Chiapas. Inform the director of your plans assuring him that you will inform INAH of any archaeological sites in the caves you may find. Also ask for a list of protected archaeological sites, where access is restricted. You can be arrested for accidently straying into these archaeological zones.

4) When your plans are well advanced write to the following informing them of your expedition; The British Embassy, Mexico City, The Department of Tourism in Mexico City and Tuxla Gutierrez and the Mexican Consulate in London.

5) Write to El Director, Centro Coordinador Indiginista Tzeltal-Tzotzil, in San Cristobal de Las Casas asking for their permission to visit Tzeltal and Tzotzil villages. Ask specifically for permission to photograph and visit the caves. It is worth asking their help in providing an interpreter if you have specific visits to be made in Chamulan territory.

6) Its worth getting a visa to visit the United States of America, just in case!

7) Two months before departure write to the Mexican Consulate in London for applications for tourist cards. Then send the completed applications back with your passport (recorded delivery). The purpose of your visit should be stated as "tourism" and nothing else. The cards are normally issued for 90 days. If you want to stay longer than this ask for the number of days you require in a separate covering letter; renewal is awkward in Mexico.

8) On arrival in your caving area, despite the temptations of "new caverns measureless to man" it is essential to go to the capital of the municipio see the presidente and present your letter of introduction from the State Governor and ask for a general letter of permission addressed to the village chiefs or commisarios. In the unlikely event of your already having these (paragraph 2 above), it is still worth visiting the presidente to thank him and acquaint him with your plans.

9) Despite having all the necessary permits it is still absolutely essential to visit the local chief before attempting to wander about. In Tzeltal or Tzotzil villages this is the time to try to arrive with an interpreter; this is vital in Chamulan villages where the villagers are often pugnaciously suspicious of foreigners. You may have to wait while a village meeting is called and you may have to address the gathering.

10) Unless you are fortunate enough or rich enough to have shipping agents it is almost impossible for individuals to ship equipment into Mexico with any certainty of its arrival. Temporary importation permits require a great deal of paperwork both in Mexico City and the port of arrival. It appears to be difficult to obtain a permit for temporary importation for more than 90 days. Usually a bond or guarantee of payment, is required, in case the equipment is not re-exported. There apparently is a time-consuming procedure for applying for a waiver of this bond.

11) It is probably best for a small expedition to bring equipment as personal baggage the remainder being brought from the U.S.A. by car or small truck. At the frontier insist that you are tourists and the equipment is personal sports gear. Remember to remove manufacturers´ packing material and stuff new ropes into bags.

12) It is not possible to take cars hired in the U.S.A. into Mexico and unless you can borrow a vehicle you will have to buy one. The "owner" stated on the registration document must accompany the vehicle unless legal permission for the driver to take the vehicle into Mexico is made out and witnessed, in front of a public notary.

13)Vehicle insurance, compulsory in Mexico, is readily obtained over the counter from insurance offices in any U.S.A. border town.

14) Documents for the temporary importation of the vehicle need to be completed at the Mexican immigration and customs offices at the border crossing. There is some difficulty in getting a permit for more than 90days.This is noted on the drivers tourist card. If you overstay a fine will be levied. Surrender the documents on your departure back to the U.S.A. On return a different driver will have no problem getting out of the country but if the original driver has had his tourist card marked "con vehiculo" he may have trouble getting out of the country.

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Aragonite in Ogof Daren Cilau

A KENDALL

Abstract: A number of samples have been collected from the main sites of formations in the 1984 extensions in Ogof Daren Cilau and their carbonate structures determined. Aragonite has been found to be present at all localities sampled.

Following the discovery of the first extensions in Ogof Daren Cilau, in 1984, questions were asked about the composition of the radiating crystalline speleothems, usually called helictites though some are really anthodites, found in Urchin Oxbow and at other sites. Both Tarrant (1985) and Gardner & Smart (in press) have suggested thate they may be aragonite, the less common polymorph of calcite. Samples were collected in March 1988 from near the White Company (locations are shown on the cave survey extracts). It was not felt necessary to collect from the Antlers area as the small anthodites here have the same crystal form as those found in the White Company area.

The White Company "helictites" and the anthodites in Urchin Oxbow, are mainly small, 1-4cm long, radiating branches of tightly packed crystals which appear to be recently formed and still actively growing. Some project straight from the limestone walls of the cave, whilst others are growing on older, more massive calcite formations e.g. in the White Company. The samples from Urchin Oxbow and the White Company area are made up of clear, colourless, acicular crystals, with good orthorhombic terminations. These are about 3mm long and clearly visible in sample 1, and although very fine can be seen under the microscope in samples 2 - 5. The crystals from Man in the Roof are also clear and colourless needles, in this case about 5mm long, but appear brown due to a fine coating of mud. A sample collected from Leonie Jaynes Playpen by Peter Bolt has also been analysed. This is part of a small group of greenish speleothems only recently dicovered.

Of each sample, about 5g (i.e. one small anthodite cluster) was analysed with Leitmeir & Feigl's solution which tests the reaction to a mixture of manganese sulphate and silver sulphate. This goes black in the presence of aragonite, the orthorhombic form of $CaCO_3$, in about 5 minutes but goes only grey in the presence of calcite, the trigonal form. Six of the samples gave a positive result. These were anthodites from the White Company and Urchin Oxbox, a small rosette of crystals from the Man in the Roof and a small piece of loose flowstone from Urchin Oxbow. Two of the samples (4 & 5) have also been analysed using X-ray diffraction (N.M.W. X-ray nos. 323, & 324). This shows that, unlike some stalagmites and flowstone from the Mendips (Donovan 1943), which are banded intergrowths of calcite and aragonite, these are entirely aragonite.

A small piece of broken straw from Urchin Oxbow proved to be calcite corresponding with a possible two phase deposition for some of the formations in this cave.

Although aragonite has not been previously been scientifically confirmed in any Welsh caves, O'Reilly et al (1969, p. 40) noted its presence without comment, and it would seem from this brief study that it is fairly widespread in Daren Cilau. Aragonite is probably present in other Welsh caves, especially in the Mynydd Llangattwg area, but has either not been recognised, or not recorded. Anthodites have, in fact, rarely been noted in British caves. Further study of other

Figure 1 Ogof Daren Cilau, Mynydd Llangattwg (after Gardener, in Gardener & Smart in press)

Figure 2 Sample localities in Agua Colorado Series

Figure 3 Sample locality in Leonie Jaynes Playpen

caves in the area is needed to determine it's distribution. Many factors, including termperature, Ca/Mg ratio, amounts of dissolved lead, strontium, and sulphate ions are known to promote aragonite growth (Murray 1954; Fyfe & Bischoff 1965; White, 1976; Hill & Forti, 1986). An examination of the geological environment around these anthodites in Daren Cilau may help in determining which of these factors are important in promoting aragonite precipitation.

The reminaing parts of the samples have been donated to the National Museum of Wales, N.M.W. 88.23 G.M 1-8.

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APPENDIX:- SAMPLES & LOCALITIES

ARAGONITE

1. Helicitic needles, roof 10m south of White Company, Epocalypse Way.
2. Anthodite fibres 8m south of White Company, Epocalypse Way.
3. Flowstone (loose), North side of Urchin Oxbow 18m from Epocalypse Way.
4. Anthodite, Urchin Oxbow 16m from Epocalypse Way. (N.M.W. X-ray No. 323).
5. Anthodite, Urchin Oxbow 16m from Epocalypse Way. (N.M.W. X-ray No. 324).
6. Small rosette of crystals, Man In the Roof Passage approx 40m south of Rabbit Rift.
7. Anthodite, Leonie Jaynes Playpen, Agua Colorado Series.

CALCITE

8. Straw (loose) Urchin Oxbow 20m from Epocalypse Way.

The White Company area, Ogof Daren Cilau (photo: C. Howes)

Anthodites in Urchin Oxbow, Ogof Daren Cilau (photo: C. Howes)

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Many thanks to Clive Gardener and Peter Bolt for their help in obtaining samples, Dr. R.J. King and Mr. M.P. Lambert of the N.M.W. for their help with the analyses, and Dr. T.D. Ford for his useful comments.

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Forum

Readers are invited to offer review articles, comments on previously published papers and discussions of general interest for publication in the Forum section of Cave Science.

MALARIA IN CAVE-ROOSTING PERUVIAN BATS

Jane M WILSON, Mary E STYLES and Alison J DENHAM

Limestones in caves in the Tingo Maria valley in the Peruvian Amazonica are not very extensive. Most passages have become blocked by calcite for, within this region of high rainfall (1300 mm annually), deposition of calcite goes on at a very rapid rate. Since the caves are so small, many have no Dark Zone and they are of little interest to the sporting caver. However, they contain much to attract ecologists. Endangered echo-locating Oilbirds (Steatornis caripensis) roost in some, and these import food for a wealth of guanobious invertebrates.

Two species of cave roosting, insectivorous bats are common in the Tingo Maria caves. These are 5cm long sheath-tailed bats, Peropteryx macrotis and 10cm Carollia perspicillata Phyllostomatid bats. Peropteryx macrotis roost singly, that is usually more than 60cm from the next individual. They are most frequently found in the Entrance Zones of caves, and never beyond the limit of light penetration. Carollia perspicillata roost in colonies much deeper in.

One of the most extensive caves in the Tingo Maria area, La Cueva del Nido de Guacamayo (Macaw's Nest Cave), comprised just 238m of passage. It is situated at about 690m above sea level, overlooking the Rio Monzon within the Cueva de las Lechusas (Oilbird) Nature Reserve in the Bella Durmiente limestone massif. Surveys and details of the ecology of this cave have been published elsewhere (University of Southampton 1982; Wilson 1983). About fifty Carollia leaf-nosed bats were found roosting within La Cueva del Nido de Guacamayo around the limit of light penetration into the cave.

Beneath the Carollia roost was a pool of stagnant water 80cm deep. Larvae and pupae of Aedes mosquitoes were found in abundance in the water and adult Aedes were resting on the cave walls near the bat roost. These mosquitoes seemed to be spending their entire life cycle in the cave: the adult females take blood from the Carollia bats and the larvae feed in the guano-enriched water below the roost. If this Aedes mosquito population never needs to leave the cave, the males (which never bite and are normally sustained by nectar) would be unable to feed.

Fieldwork

Four individual Carollia and eight Peropteryx bats roosting in La Cueva del Nido de Guacamayo were captured and their ectoparasites removed. Carollia perspicillata was host to Strebla curvata, and Peropteryx macrotis to Trichobius longipilus ectoparasites. Both parasites were flies of the family Streblidae.

Blood samples were taken from each bat by cardiac puncture or by piercing a vein on the leading edge of the wing. Thin blood smears were made using a BDH blood film maker; these smears were air dried, fixed in methanol, dried again and sealed in a polythene box with silica as a desiccant. The slides were Gram stained on return to the UK by which time some slides had grown mouldy.

The blood smears revealed several life stages of haemosporidian protozoan parasites. Unfortunately the parasites infecting three of the Peropteryx were in too poor a condition to be identified beyond doubt but those infecting all four Carollia resembled Polychromophilus "bat malaria" (R S Bray, pers. comm., 1983). The material collected was insufficient to make a more precise identification than this.

Only one or two parasites were seen per slide, indicating that the intensity of haemosporidia infecting the Peropteryx bats was very low. Less than half of the Peropteryx macrotis were infected.

All four Carollia were infected with haemosporidia. These were Polychromophylus-like parasites which were present in greater numbers than noted in the Peropteryx bats. In Carollia less than one red blood cell in 100 contained parasites (ie a parasitaemia of less than one per cent). The fact that all Carollia bats examined were infected implies that there was ample opportunity for transmission to occur in such a close community. It is likely that the Aedes mosquitoes present in the cave were acting as the vector for these Polychromophylus-like parasites.

Neither bat species appeared to be suffering any ill-effects from their parasites. The parasites discovered in these Peruvian bats are almost certainly undescribed species, Polychromophilus-like haemosporidia being exceedinly rare in bats from the American continent although they are well known in Old World bats (Garnham 1973). These parasites are among the hundred or so species of malaria-like organisms which infect mammals; they are akin to the five malaria species which cause disease in man. Fortunately these parasites are very host specific so bat malarias are not infective to man nor can human malarias infect bats.

Bats and bat ectoparasites are held at the British Museum (Natural History), London SW7 5BD; duplicate bat specimens and the Aedes have been deposited at the Natural History Museum in Lima: Museo de Historia Natural "Javier Prado", Av. Arenales 1256, Lima 14.

This work was carried out during the 1982 Southampton University Peru Expedition which was partially funded by the W.A. Cadbury Charitable Trust and the Gilchrist Educational Trust. The laboratory work was carried out at the Southampton Medical School Pathology Dept. British Drug Houses (Poole) kindly donated the blood film spatulae, and Chance Propper microscope slides. We are indebted to J E Hill and Tony Hutson of the British Museum, London, for promptly identifying the bats and insects respectively and to Drs R S Bray (Imperial College, London) and J R Baker (ITE Culture Centre of Algae and Protozoa, Cambridge) for looking at the parasites.

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RIPPLED SPELEOTHEMS

Trevor D FORD

Horizontally rippled flowstone is a common feature of many caves throughout the world, doubtless observed by many speleologists, but so far I have failed to find an explanation for the phenomenon. The ripples usually have a wave-length of around a centimetre though I have seen examples ranging from 8-15 mm. Individual ripples can often be followed for several metres horizontally or they may interdigitate with others within a few centimetres. Whilst they are most obvious on flowstone, ripples may also be found on stalactites and stalagmites with comparable wave-lengths. They occur on slopes around 45° most frequently, but on stalactites they are on vertical surfaces, whilst ripples also occur on nearly horizontal surfaces. Ripples may develop lipped forms which grade into micro-gours or even into small rimstone pools. The micro-gour form of ripples may develop on nearly vertical surfaces, whilst other similar surfaces nearby fail to show anything more than ripples separated by narrow flat shelves. Equally, flowstone on surfaces or similar nature in some caves fails to develop ripples at all!

Rippled surfaces comparable with those on flowstone also develop on many icicles and ice-encrusted surfaces (check your house roof this winter) though not on all; wave-lengths are generally around one centimetre, but can be more variable. I have also seen rippled surfaces on soft earthy limonite stalagmites in an old coal mine working, rather poorly developed on a squashy mud flow in a cave, and, with small microgours, on the stalactitic lime deposit common on concrete walls and bridges. Regularly rippled surfaces with microgours have been reported from Turkey and Italy.

The origin of the ripples and the consistency of the wave-length of around one centimetre both require explanation and a search of caving literature has failed to reveal one! In his brief comment on the phenomenon, White (1976, p 287) also said he knew of no explanation as yet. The nearest I have found is that for micro-gours by Martel (1894) (cited by Hill & Forti, 1986) which invokes the increased turbulence as water flows over the lip causing greater loss of CO_2 and hence precipitation of calcite, though he said nothing about wave-length or periodicity. Hill & Forti also noted Varnedoe's (1965) suggestion of a shift from laminar to turbulent flow being a factor. These hypotheses may offer an explanation for the growth of the lip on gours and micro-gours but they do not explain the initiation of periodicity of either these or the ripples on speleothems.

I have heard the above explanation of rippled flowstone put forward verbally several times - that micro-turbulence causes increased loss of CO_2 and this precipitation of $CaCO_3$, and it may well be true, but the "explanation" does not go far

Ogof Dydd Byraf - rippled flowstone on a wall with numerous microgours (a Nature Conservancy Council photograph).

Treak Cliff Cavern, Castleton, Derbyshire, with ripples on stalactites, columns, wall flowstone and on the sloping bank below (photo by T.D. Ford).

Thrutch Cave, Isle of Portland, showing ripples on stalactites and curtains, and, less well-developed, on the stalagmite boss and floor (photo T.D. Ford).

enough. Why is there this regular one-centimetre wave-length? The initiation of the ripples on flowstone has been "explained" to me as due to the effect of inherent irregularities in the bedrock surface beneath the flowstone (See also White, 1976). But why should these be consistently spaced at one centimetre? And how could such an explanation apply in pendant stalactites or in stalagmites? Speleothem surfaces with ripples range from vertical to nearly horizontal so slope inclination seems to have little significance. The rate of water flow over the surface, and hence of supply of $CaCO_3$ in solution, may have some significance though it is difficult to see how it could be measured; I have observed flows fast enough to be clearly visible at say several mm per second, in contrast with no visible sign of movement. White (1976) commented that a critical limit to surface adhesion of a water film might be important.

Thin sectioning of speleothem samples perpendicular to the ripples shows that they are commonly formed of fibrous calcite crystals in bundles normal to the surface. In this observation there may be something to be learnt from the growth of icicles. A review of recent studies of icicle growth by Walker (1988), largely based on the work of Knight (1980), Geer (1981) and on papers published in Japanese by Maeno & Takahasi (1984), has shown that there are indeed many parallels between stalactite and icicle growth but the former is largely a chemical process involving loss of CO_2 whereas the latter is a physical process involving temperature changes. In particular the horizontal ribs (ripples) on icicles commonly have a one-centimetre wave-length, and do not migrate down the length of an icicle (nor do ripples apparently migrate on flowstone), but the water-film over ripples is thinner and allows heat to be lost more rapidly there leading to more solid ice on ribs in contrast to "spongy" ice in hollows. By analogy, in the ripples on flowstone the slight outward divergence of crystallites on ripples may allow them to grow wider there giving more "solid" calcite in contrast with convergent and thus interfering calcite crystallites in hollows. Loss of CO_2 will also be greater on ripple edges, and growth will be maintained. This offers at least a partial explanation of the presence of ripples but not of wave-length or initiation.

Windy Dig, Isle of Portland, showing ripples on stalactites and on flowstone curtains on the right wall (photo T.D. Ford)

My observations also fail to explain whether or not ripples develop lips and become micro-gours. I have seen forms either with or without micro-gours on closely similar near vertical surfaces in different caves. I have not yet seen micro-gours on icicles or on limonitic mud flowstone, but perhaps more observant readers than I have done so.

One cannot help wondering if the serrated edges on many stalactite curtains are related phenomenon, as the spacing of the saw teeth is often around one centimetre as well. The saw teeth sometimes support small triangular micro-gours.

So, as far as I can tell, a common form of speleothem has not yet been scientifically explained. I can offer no more than my observations and a few thoughts; therefore it is up to some budding speleo-physicist to produce some answers. Good luck!

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CARLSBAD & LECHUGUILLA CAVES, NEW MEXICO

Any reader who, prompted by Trevor Ford's note in the last issue of Cave Science Forum, is pursuing thoughts on the role of gypsum in the genesis of Carlsbad Cavern should also be aware of Lechuguilla Cave. This quite remarkable system lies only a few kilometres from Carlsbad and has recently been explored to over 34 km of passages, reaching a depth of 457m. The story of its exploration and survey is told in the October 1988 issue of the NSS News, and though this does not enter into any geological debate, the photographs and descriptions are thought-provoking indeed. The scale of the gypsum deposits in Lechuguilla is nothing less than fanstastic, perhaps dominated by huge numbers of crystal chandeliers - sparkling white gypsum crystal clusters up to 6m long growing from the cave ceilings.

Tony Waltham

Research Funds and Grants

THE JEFF JEFFERSON RESEARCH FUND

The British Cave Research Association has established the Jeff Jefferson Research Fund to promote research into all aspects of speleology in Britain and abroad. Initially, a total of £500 per year will be made available. The aims of the scheme are primarily:

a) to assist in the purchase of consumable items such as water-tracing dyes, sample holders or chemical reagents without which it would be impossible to carry out or complete a research project.
b) To provide funds for travel in association with fieldwork or to visit laboratories which could provide essential facilities.
c) To provide financial support for the preparation of scientific reports. This could cover, for example, the costs of photographic processing, cartographic materials or computing time.
d) To stimulate new research which the BCRA Research Committee considers could contribute significantly to emerging areas of speleology.

The award scheme will not support the salaries of the research worker(s) or assistants, attendance at conferences in Britain or abroad, nor the purchase of personal caving clothing, equipment or vehicles. The applicant(s) must be the principal investigator(s), and must be members of the BCRA in order to qualify. Grants may be made to individuals or small groups, who need not be employed in universities, polytechnics or research establishments. Information and applications for Research Awards should be made on a form available from S.A.Moore, 27 Parc Gwelfor, Dyserth, Clwyd LL18 6LN.

GHAR PARAU FOUNDATION EXPEDITION AWARDS

An award, or awards, with a maximum of around £1000 available annually, to overseas caving expeditions originating from within the United Kingdom. Grants are normally given to those expeditions with an emphasis on a scientific approach and/or exploration in remote or little known areas. Application forms are available from the GPF Secretary, David Judson, Rowlands House, Summerseat, Bury, Lancs BL9 5NF. Closing date 1st February.

SPORTS COUNCIL GRANT-AID IN SUPPORT OF CAVING EXPEDITIONS ABROAD

Grants are given annually to all types of caving expeditions going overseas from the U.K. (including cave diving), for the purpose of furthering cave exploration, survey, photography and training. Application forms and advice sheets are obtainable from the GPF Secretary, David Judson, Rowlands House, Summerseat, Bury, Lancs BL9 5NF and must be returned to him for both GPF and Sports Council Awards not later than 1st February each year for the succeeding period, April to March.

Expedition organisers living in Wales, Scotland or Northern Ireland, or from caving clubs based in these regions should contact their own regional Sports Council directly in the first instance (N.B. the closing date for Sports Council for Wales Awards applications is 31st December).

THE E.K.TRATMAN AWARD

An annual award, currently £25, made for the most stimulating contribution towards speleological literature published within the United Kingdom during the past 12 months. Suggestions are always welcome to members of the GPF Awards Committee, or its Secretary, David Judson, not later than 1st February each year.