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FINAL REPORT

OF THE

MALTA EXPEDITION, 1963

R.N. Engineering College, Manadon, R.A.F.,

St. Mawgan, and Imperial College, London.

J.D. Woods,
Imperial College.

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REPORT ON SUBMERGED CAVES OF MALTA

Abstract

Underwater caves found by a joint expedition from the R.N. Engineering College, Manadon, R.A.F., St. Mawgan, and the Imperial College, London, are described and discussed. The diving techniques used in surveying a particularly large cave in Gozo are described.

CONTENTS

Appendices

2. Programme

The 1963 expedition set out to confirm the reports of underwater caves and to search for further examples. Selected caves were to be thoroughly examined and surveyed. They were to be classified for comparison with pleistocene sea-level data from other parts of the Mediterranean (Zeuner, 1945; Flemming, 1963), and assessed as sites for archaeological excavation.

1. Introduction

The Maltese archipelago consists of five islands; Malta, Gozo and Comino are inhabited, Cominetto and Filfla are little more than rocks, although sixteenth century maps do show a monastery on the latter. The axis of the archipelago lies from N.W. to S.E. and it appears to have rotated about this axis (Hyde, 1955) until today the N.E. coast is a series of shallow bays, while on the S.W. cliffs rise sheer out of the sea for hundreds of feet.

The Limestone of which the islands are formed varies from a hard coralline material to a soft sandy one, easily weathered by the atmosphere. In general the rock lies in undisturbed horizontal beds. Major faults cross the islands' axis to reach the sea in steep valleys, known locally as "Wieds". A good description of the geology of Malta is given by Hyde (1955), while Sir Harry Luke's book remains the best general description of the islands and their inhabitants.

Caves are well known in Malta and one, Ghar Dalaam, has become world famous for its fossil remains. This, however, is not a sea cave, being formed by a stream running into the Wied-Dalaam. But sea caves are to be found in abundance along the S.W. cliffs, both at and above sea level. Various reports from local spearfishermen had suggested that sea caves were also found below the present sea level.

There is, apparently, no description of Maltese sea caves in the literature. Shaw (1950-51) mentions them but concentrates on the solution ones.

3. Procedure

i) Preliminary Survey

Two members of the expedition made a helicopter flight along the S.W. coast from Hal Far to the Inland Sea, Gozo. The helicopter flew at 20 knots along the cliffs at about 200 feet above sea level (roughly half-way up the side of the larger cliffs).

This flight provided a convenient method of gaining a rapid estimate of the areas of maximum concentration of caves above sea level. A series of colour photographs taken during the flight have since proved invaluable in classifying the submerged caves found by the expedition.

ii) General Search

Each day the expedition diving boat (a sixty-foot M.F.V.) was anchored under the cliffs at a site selected by compromise between the conflicting claims of science and safety. A pair of divers then proceeded to search a section of the cliff starting opposite the M.F.V. and continuing until their air ran out. The sea's remarkable clarity allowed the divers to swim half-way between the surface and sea-bed and, from that depth, observe the entire submerged cliff from top to bottom. If the divers found a cave they would sketch it and measure the major dimensions.

This investigation usually occupied the remainder of the time before surfacing to the "surface cover" waiting in a small rowing dinghy. The limit of the first pair's search was noted by the surface cover and became the starting point for the next pair, and so on. Each diver was interrogated immediately he reboarded the M.F.V. and a report sheet (see appendix) was completed and signed. Experienced divers then made repeat dives to the most promising of the caves to make detailed sketches and measurements.

Frequently both dinghies were employed, allowing the search to continue simultaneously on opposite sides of the M.F.V. In this way, successive pairs of divers rapidly searched a considerable section of the coast on either side of the ship's anchorage.

This technique of search and check was followed whenever possible, but, inevitably, there were many occasions on which the procedure was modified to fit the circumstances. Occasionally, for instance, the check dives were made several days after the initial discovery, and some finds were never corroborated by independent divers through lack of time. On one occasion two divers using the electric tug discovered a large cave, but otherwise all searching was carried out without mechanical aids.

iii) Detailed Examination

Following our declared intention to make a thorough investigation of selected caves, we chose the large Gozo 'A' for detailed survey.

Unfortunately this ideal site is situated in a remote corner of the island group, four hours by sea from our base at Hal Far. However, we spent five days at Gozo 'A' surveying, photographing and exploring.

A 200 lb. sinker was transported to the end of the cave with the aid of an air-filled kitbag, and anchored in the wave-notch, $3\frac{1}{2}$ metres from the innermost point. A green nylon line ($\frac{1}{2}$" circumference) was fastened to the sinker and stretched taut between it and a large boulder at the cave mouth, to make an axis line. The line was knotted at five ten-metre intervals, at each of which divers produced details of the cave's cross-section. A pair of divers would enter the cave and make their way to one of these markers, where their first task was to draw a rough sketch of the cross-section showing all prominent features. Each feature was numbered on their sketch, and then its depth and range (from the axis line) were measured with depth-gauge and radial nylon line, marked with fluorescent paint at one-metre intervals. The readings were noted on the formica board, a table having been drawn up for this purpose before the dive commenced. Usually a pair of divers were able to complete one such section in a single dive.

Five vertical sections, normal to the axis-line, and one horizontal plan showing the cave end in a semi-circle around the sinker, were constructed. These have since been used to reconstruct a three-dimensional block diagram of the cave, (see appendix),

but before the expedition left Gozo a preliminary sketch was produced and three pairs of divers entered the cave to verify and correct specific details included in it.

4. Results

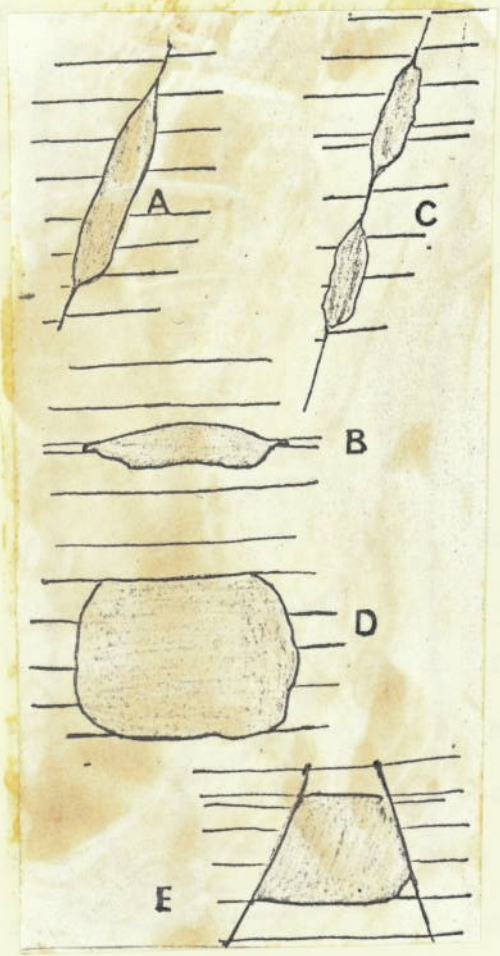
The caves found during the initial search are described in Table I and plotted on the map. A fairly detailed examination was made at Gozo 'A' and the Malta Complex I was also given some attention, but the remainder are divided into various categories describing their general shape and major dimensions. The helicopter photographs of surface caves provide a convenient catalogue of the shapes of cave entrances, which may be said to define cave types.

i) General Description of the Caves

The most instructive method of describing a cave is to consider it as a growing entity. One must search for the nucleus about which it grew and decide how its subsequent growth, fed by wave energy, was moulded to the limits imposed by the rock surrounding it. A cave submerged deeper than ten metres has lost the greater part of its energy supply, wave action can no longer reach it, and it dies. Although boulders crashing down from sea-level, where the cliff is still alive with turbulent water, may block its entrance, the cave remains inside as it was when first submerged. Marine organisms covering the roof and walls prevent even the slow process of solution, and a layer of marine sediment covers the floor.

The caves found under the sea in Malta and Gozo can be classified with the help of the above analysis. First, there are two

types which are essentially little more than minor enlargements of a fault (A) or a weak layer in the bedding (B). Although these may attain considerable size (up to four metres thick and ten or more metres long) they are essentially adolescents amongst caves. On some occasions we found that a fault contains two such caves along its length, and sometimes these would be joined behind to make a tunnel (C).



Larger caves tended towards a rectangular cross-section, with their roofs defined by the horizontal bedding and their sides bowing out in unrestrained growth (D) or pinned by further faults in the surrounding rock (E).

Cave floors tend to be obscured by a marine fill consisting of shells, broken coral and sand, with larger pebbles near the entrance and boulders outside. This fill often rises towards the back of the cave (particularly at Gozo 'A'), while we often found, at the mouth, a "sill" of, apparently, bed-rock (but, possibly, consolidated blown sand - no samples were collected).

Wave notches are not a prominent feature of the Malta coastline, frequently being obscured by the horizontal bedding. However, in one cave (Gozo 'A') a series of notches is preserved round the walls, but they disappear at its entrance. In this case there is clear evidence of recession of the coastline around the cave entrance, and the wave notches of lower sea levels have been erased from the cliff.

ii) Description of Gozo 'A'

The cave is situated on the coast opposite the "Inland Sea" of Gozo. The cliff rises only a few metres out of the sea to level off to a broad flat platform, but underwater it drops sheer to a 30 m. platform strewn with large boulders and broken by gullies. The platform ends about 30 m. from the cliff in a broad flat sandy plain starting at a depth of 35 m. and sloping fairly steeply out to sea. To the North, this plain comes right up to the foot of the cliff (at 35 m.).

The cave's cross-section is essentially rectangular with a horizontal roof defined by the bedding and near vertical walls. The floor is covered with a deep layer of sediment consisting of the usual sand and small shells, plus pieces of broken 'sea rose', a coral-like growth which grows to exceptional size on the roof of the cave (up to 30 cm. diameter). These apparently fall to the floor when they become too heavy for the sponge on which they grow, or are disturbed by passing fish. Several whole 'sea rose' lay intact

on the floor where they had fallen. The broken pieces give the floor a sharp, pricking nature that cuts the palm of a hand pressed onto it; this hand-pressure is sufficient to compact the material, which is so loosely packed that a 1 m. rod (of 1" conduit) pushed into the floor penetrated almost under its own weight.

Table II: Gozo 'A' Dimensions

Main Chamber		overall length 55 m.			
Section	Roof depth	Floor depth	Width	Notches	
				South	North
sinker	15	16½	10	16	16
10 m.	15	19	14	20	17
20 m.	15	21	16	20 16	20 18
30 m.	15	25	25	20 16	25
40 m.	16	30	42	29 24	25
51 m.	17	29½	55	29	29
Passage		depth: floor 20 roof 21½		width 4 length 6	
Inner chamber		depth: floor 20 roof 21½		diameter 10-12	
(All measurements in metres)					

The inner chamber differs considerably from the main chamber. Very little light reaches it, and there was no evidence of algae. However, the walls were covered by wormlike shells,

and large red shrimp-like creatures (about 6" long) peered at the intruding diver - their eyes glowing bright orange in the beam of his lamp. An attempt to capture one of these in a plastic bag failed when the diver's movements stirred up the extremely fine black floor covering. The only other living thing observed in the inner cave was a small black fish, some eight inches long, which was presumably, like us, a temporary visitor from outside.

At the cave's entrance the roof is very flat, coinciding with a bedding plane, but twenty-five metres into the cave it ends in a broad semi-circular notch, possibly wave-cut, to be replaced by another flat roof at 15 m.

Wave notches are cut very deep into the walls on both sides, and measurements show that one of them slopes uphill into the cave, as expected. The two most pronounced examples appear at twenty-nine metres (which rapidly becomes covered by the rising floor) and at twenty metres. This latter almost reaches the end of the cave on the south side, and on the north it is associated with the passage leading to the second chamber. The cave ends in a notch at sixteen metres, with the "fill" rising to its highest level of $16\frac{1}{2}$ m. in the south-east corner.

The Gozo 'A' cave must be one of the largest reported, and merits further study from a variety of aspects, discussed below.

5. Discussion

The underwater caves discovered by the expedition are undoubtedly only a small sample of the total number along the S.W. coasts of Malta and Gozo. Assuming those found are representative of the whole, one might estimate the total number to be several hundred along the forty kilometre coastline. Casual observations along the coast between Marsa Sirrocco and Grand Harbour reveal a number of caves at sea level, and there are, undoubtedly, many under the sea on that side of the island also, particularly on the reefs that lie offshore.

This unique concentration of submerged caves merits thorough study by geologists, biologists and archaeologists. The archipelago is very accessible, and offers the visitor good accommodation, excellent public transport, and a ready supply of small boats for diving. Compressed air and diving equipment are also readily available in Valletta. The National Museum and Royal University, both in Valletta, provide the visiting scientist with the usual facilities.

Three aspects of the caves are discussed below with reference to possible future work.

i) Human Occupation of the Caves

The majority of the caves would be dry if the sea were thirty metres lower, and several have convenient platforms at their entrances to provide easy access. They might indeed make useful shelters as Ghar Hassan did for the 16th Century Turk of Maltese legend (Shaw 1950, 1952).

There are various estimates for the date at which the sea may have been 30 m. lower. Fairbridge (quoted by King, 1963) suggests this might have been about 10,000 years ago. In applying this figure to Malta one must allow for local land movement, a convenient measure of which is provided by the prehistoric cart-tracks that have been submerged during the past 4,000 years at St. George's Bay and St. Paul's Bay (Hyde, 1955). Hyde agrees with the theory of island rotation about the N.W.-S.E. axis, and as the two sets of cart-tracks are submerged to similar levels although one is on the axis and the other at extreme range from it, one may eliminate land movement on this time-scale as being negligible.

If one assumes a date of 8,000 B.C., then it has to be admitted that there is very little evidence of human occupation in Malta at that time. A couple of teeth found in Ghar Dalaam have been offered as sufficient proof of an independent Maltese Neolithic culture, similar to that in Crete and other Mediterranean islands, but Trechmann (1938) puts the first human occupation as late as 4,000 B.C., when Gozo 'A' and many of the other caves would have already been partially immersed.

Having rejected the idea of independent human evolution on Malta since the breaching of the Sicilian land bridge (around 400,000 years ago ?), one must accept the population of the island group by people from across the sea. The first evidence for sea-going ships comes from Egypt vases of about 3,000 B.C. (Landstrom, 1961). These are too late for occupation of the caves.

The evidence, therefore, seems to suggest that human occupation of the caves was unlikely. However, it might still be worth excavating one of the caves in the hope of finding animal fossils (the Ghar Dalaam proves that the Fauna was very rich at this time). An air-lift (Dumas, 1962) would have to be used to remove the unconsolidated fill before excavation could be carried out as in dry caves, and the experience gained during such excavation might prove invaluable when similar work is undertaken at a more promising site on the European mainland.

ii) Physics and Ecology of the Caves

While there is a considerable literature on the physical properties of the sea in free water, the effect of cliffs and caves upon these properties has not been fully studied. It would be profitable to study the circulation of water and the variation of temperature, oxygen content, and plankton inside the larger caves. This data, combined with measurements of the variation of light intensity (and quality), would provide an invaluable background to an ecological study of the caves. Such ecological work has been carried out at Marseilles by Peres and Picard (1949) and more recently by Laborel and Vacalet (1958); while Riedel (Vienna) has observed deep sea fish in shallow submerged caves.

The work of these biologists could usefully be repeated in the Maltese caves, when even the untrained observer sees many

differences from the Marseilles caves (e.g. no precious coral). Again, the high concentration of caves, at all depths, available in Malta and Gozo enable the worker to place his observations on a better statistical footing.

iii) The Caves as Evidence of Low Pleistocene Sea Levels

The depth range of each cave is displayed in Table I along with the depths of such notches and benches as were considered reliable. As described above, the horizontal bedding obscures many of the notches - and introduces a multitude of "false notches" that certainly do not correspond to low sea levels. Similarly a weak layer of limestone may become eroded by sea action sufficiently rapidly for small sea caves to develop even though the sea level is changing relatively fast at that time.

Major features like benches are, however, more reliable, and these are plotted. The notches inside Gozo 'A' are also fairly reliable, although they may be higher than the corresponding notch outside, owing to the slope of the cave floor.

In general, therefore, owing to the local geology, little confidence may be placed in the correlation of the cave and notch depths with data from other parts of the Mediterranean.

6. Conclusion

This preliminary investigation of submerged caves around the Maltese archipelago has stimulated considerable interest in various aspects of marine science. Undoubtedly the area provides ideal sites for physical and biological studies, and it may be worthwhile carrying out a trial underwater excavation, more to gain experience of such work than in the hope of uncovering important fossils.

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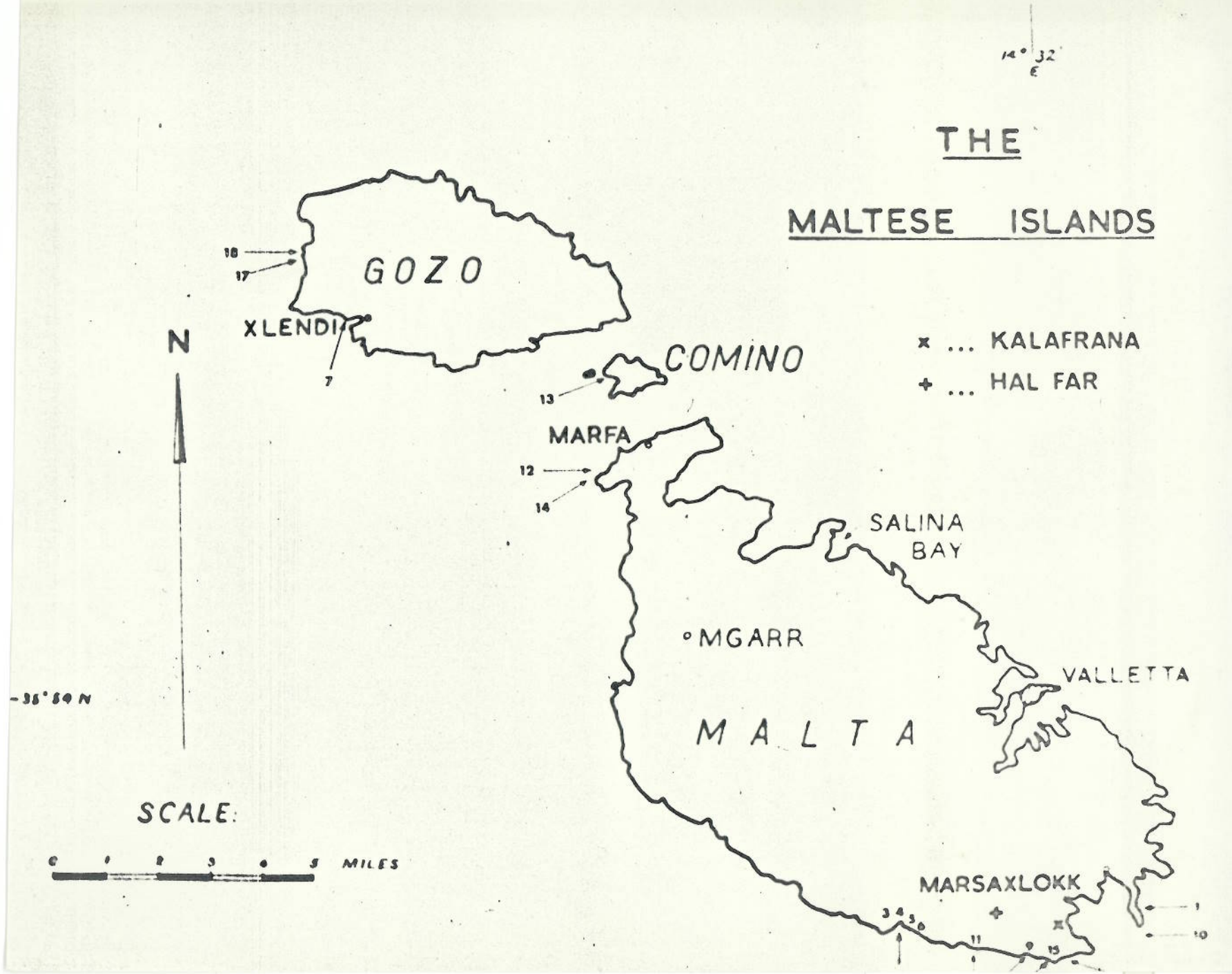
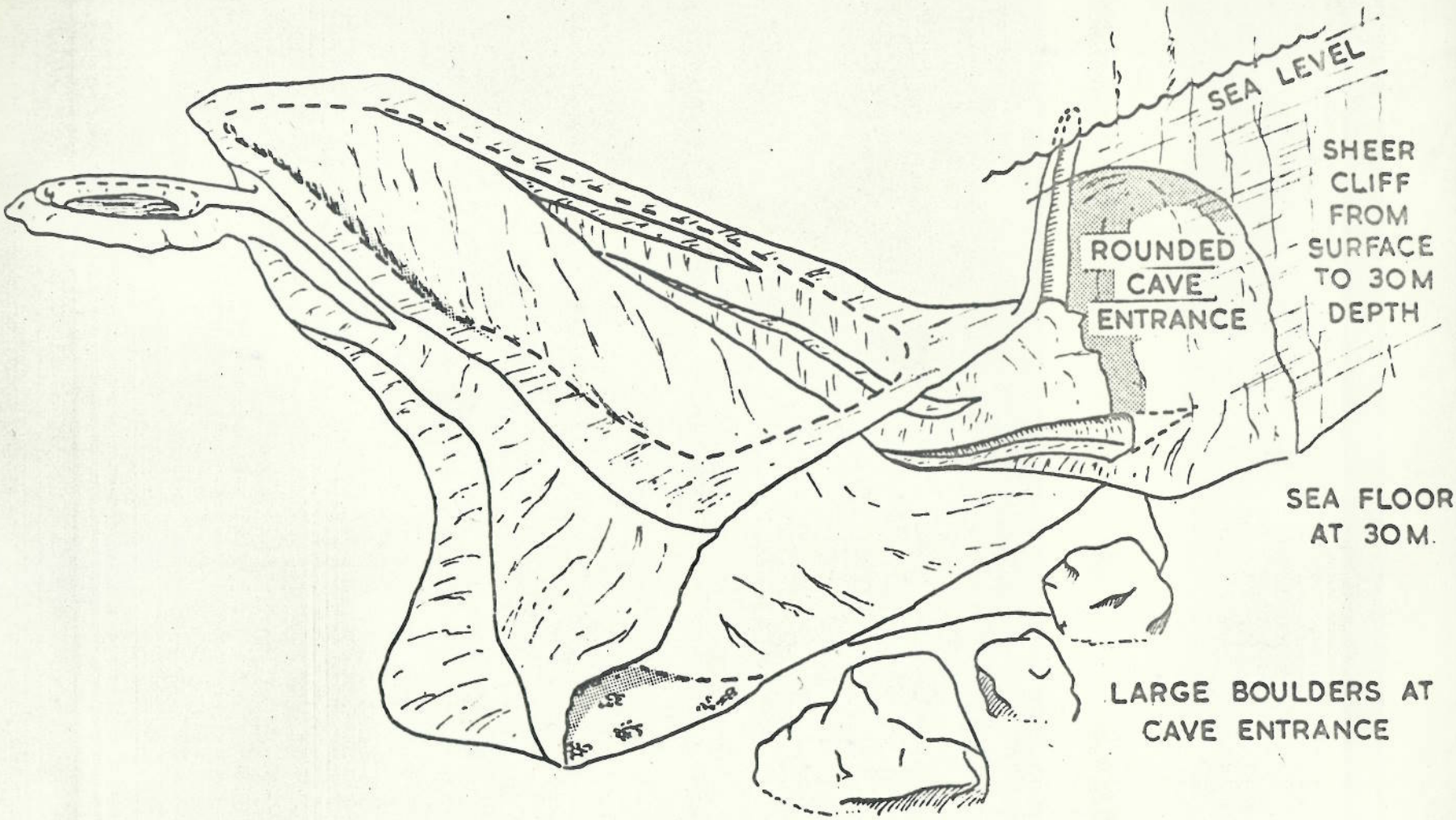

14° 32' E
THE
MALTESE ISLANDS
GOZO
XLENDI
COMINO
MARFA
SALINA BAY
MGARR
VALLETTA
MALTA
MARSAXLOKK
N
35° 50' N
x ... KALAFRANA
+ ... HAL FAR
SCALE:
0 1 2 3 4 5 MILES


SEA LEVEL
SHEER CLIFF FROM SURFACE TO 30M DEPTH
ROUNDED CAVE ENTRANCE
SEA FLOOR AT 30M.
LARGE BOULDERS AT CAVE ENTRANCE

GOZO 'A' CAVE

	LOCATION	L	W
1	Qala Tawwalaiga	50	3
2.	Ghar Kirdua	8	1
3	Blue Grotto Bay	7	5
		5	2
4	..	10	8
5	..	...	...
6	..	5	2
		2	2
7	Xlendi Creek	35	6
8	Gozo 'C'	20	15
9	Malta Complex 1	10	6
10	Delimara Reef	15	15
11	I-Ghawejra	...	...
12	Marfa Reef	8	4
13	Comino	5	4
14	Marfa Reef	3	5
15	Wied-l-Miskta	...	...
16	..	5	6
17	Gozo 'B'	25	10
18	Gozo 'A'	55+15	55

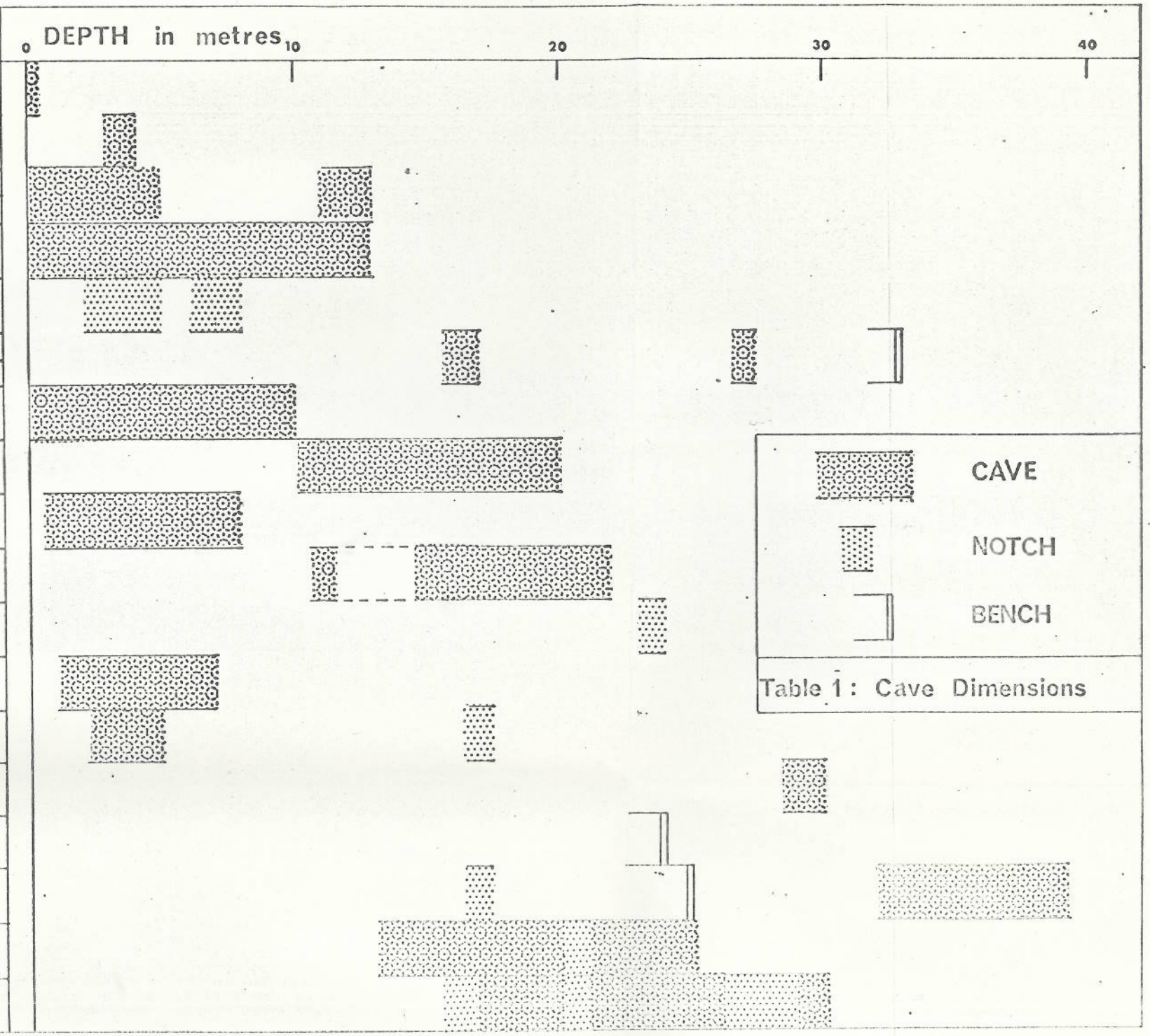


Table 1 : Cave Dimensions