# GHAR DALAM AND THE EURAFRICAN LAND BRIDGE.

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*With some additions by* SIR ARTHUR KEITH.

GHAR DALAM has been the scene of many investigations over a great number of years by different scientists and others whose object, however, has invariably been the salvage of animal or other remains, in which the cavern is particularly rich.

The investigation of which this paper is the issue was undertaken at the desire of Professor Zammitt, Rector of Malta University, to throw some light, if possible, on the many physical problems of the cave and its deposits and to endeavour to get them into some sort of order and perspective.

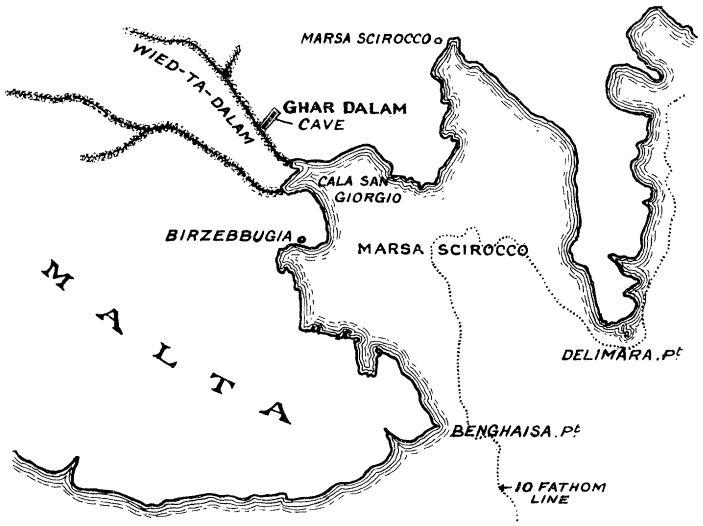



FIG. 4.—THE SOUTH-EASTERN PART OF MALTA, SHOWING POSITION OF CAVE AND MARSA SCIROCCO.

*Plan and Sections of Cavern.*

The first thing necessary for our own and further explorers' use was a plan and sections of the cavern. Only the front part of the cave, 270 feet in length, is dealt with here; beyond the limits shown in the drawing (Fig. 7) the cave branches backwards in several directions, following labyrinthine fissures in the rock. In these hinder branches falls of roof and other obstacles are such that extensive exploration of these portions are unlikely ever to be undertaken.

Cross-sections of the cave were proved by sinking further trenches and driving short headings under the overturned rocks as required. Cross-trenches Nos. 1 and 2 were continuations of the excavations made by Dr. G. Despott in 1916–18, and No. 3 a continuation of Dr. Ashby's trench made in 1914.

In all these cases the material met with between the bottom of the old trenches and rock floor was a dense layer of yellowish-blue plastic clay free from stones and containing no animal remains of any sort.

The rock bottom exposed was worn and uneven, but free from fissures or other irregularities. The rock consists of the upper layer of lower Coralline Limestone of the Malta series and is of what is termed locally " seconda," or second quality.

No previous excavations had been made outside the cave, the writer (G. S.) being the first to break ground there.

The upper trench immediately outside the entrance was sunk with the object of finding, if possible, the original sill of the cave (Figs. 6, 7). The upper 4 feet consisted of cave *débris* brought out by previous excavators, and the next $5\frac{1}{2}$ feet was a dense unstratified deposit of torba clay, apparently mixed with red soil, and altogether of a coarser description than the fine torba silt found in thin layers at corresponding levels inside the cave. No organic remains of any description were found in this layer. Immediately under this was a deposit of large angular stones and boulders, closely packed and wedged together, but with abundant animal remains intermingled. The remains were chiefly hippopotamus, with some elephant, but no sign was seen of stag or corresponding smaller mammal, with the exception of one vertebra unidentified. The trench, however, was more in the nature of a shaft, and the variety of the remains found cannot be taken as conclusive.

At a depth of 14 feet the work had to be abandoned, the dimensions and size of boulders being such as to preclude progress in the time available. The animal remains were fully mineralized and blackened, and apparently corresponded to those in the breccia deposit of the cave.

A further trench was dug on a lower level at a distance of 85 feet from the entrance with a view to picking up the stratification (Fig. 6). At a depth of 2 feet a foundation of a building with a torba beaten floor was uncovered, with numerous Roman or Punic potsherds in the *débris*. The level of this floor is about 11 feet above the Wied, so we may conclude that at least 2,000 years ago there was no question of flooding at this level. A layer about 5 feet thick of torba, free from earthy matter and containing no organic remains, covered the rock bottom, which was reached at a level of about 23 feet below the floor sill. This corresponds to the level of rock bottom in the cave, so we may infer that the bed of the cave and of the approach are more or less uniformly level, and that there is no rock sill to the cave proper. The heavy deposit of boulders met with in the trench under the overhanging entrance is no doubt the result of continual breaking away of the arch, and has served to retain the deposits within the cave. The configuration of the haunches of the entrance is such that there is

insufficient cover for the entrance itself ever to have been more than 20 or 30 feet in advance of the present line.

The rock bottom of the Wied was checked from the depth of an old well opposite, which showed a trickle of running water on the rock floor. This rock bottom is some 2 feet above sea-level and about 22 feet below the cave floor.

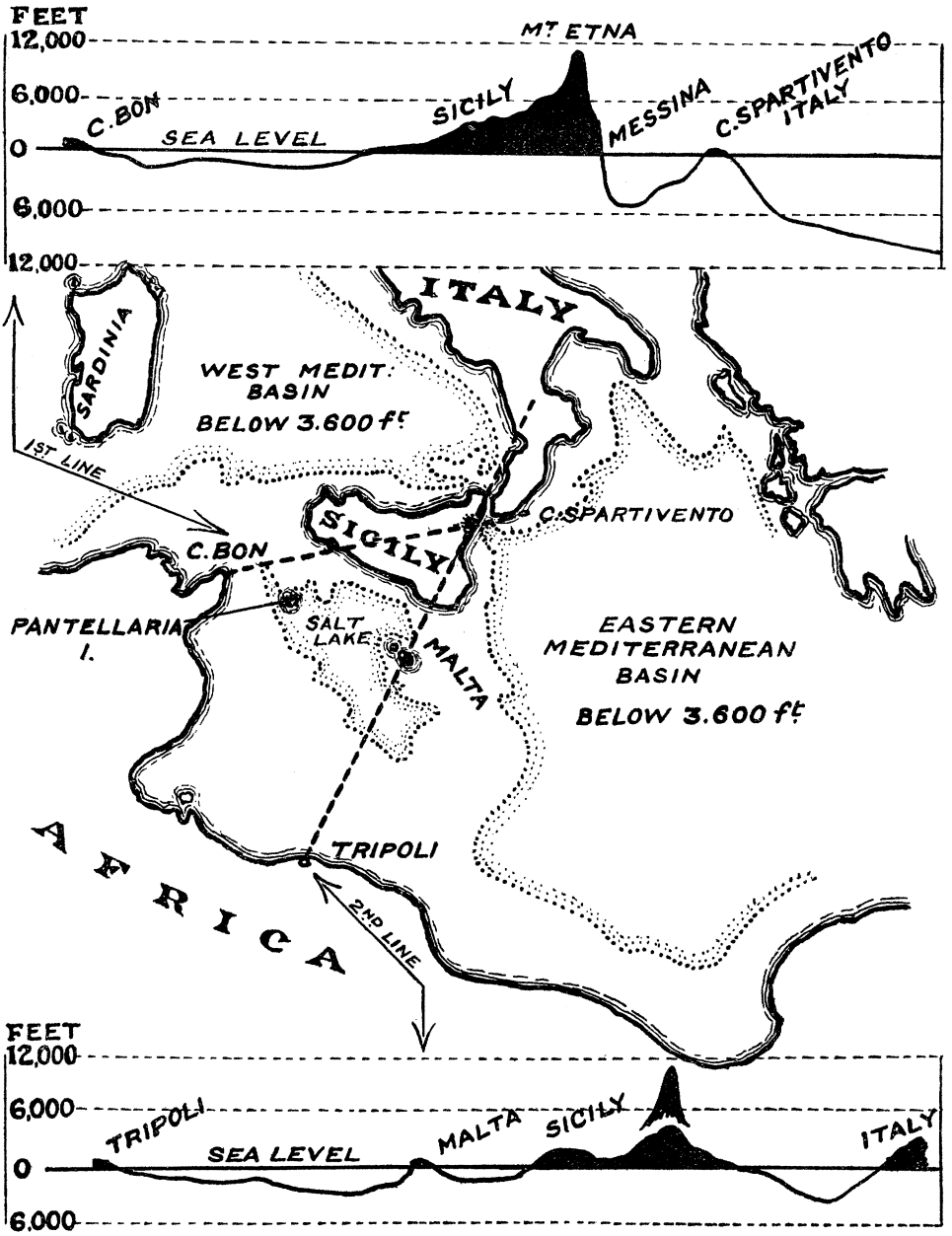



FIG. 5.—LAND BRIDGE WHICH COMES INTO BEING WITH AN ELEVATION OF 600 FATHOMS. SECTIONS ARE SHOWN OF THE PRESENT SEA FLOOR AND SHORES.

*Cave Deposits.*

The longitudinal section (Fig. 6) shows the extent to which the cave deposits have already been excavated, and an attempt has been made to co-ordinate the strata, taken as far as possible from the sample pillars left *in situ* and also shown on Fig. 7.

Taking into account the magnitude of the cave and the conditions under which the deposits were made, the strata are sufficiently uniform to permit of an attempt being made to group them.

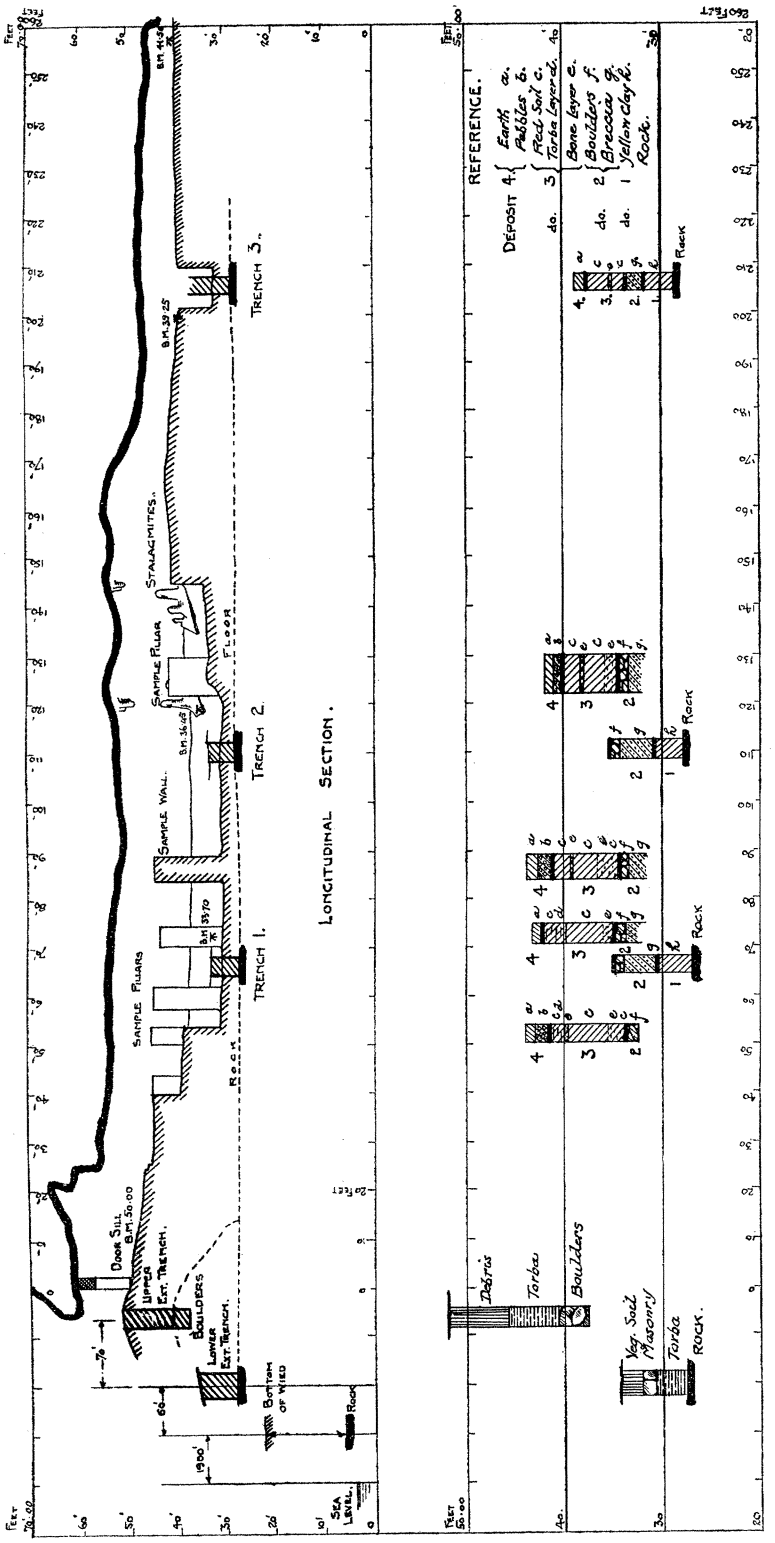
The rock floor of the cave was found to be practically level throughout, and the deposits, varying in thickness in different parts, may be summarized as follows:—

(1) Sterile layers of yellowish-blue clay, about 3 feet deep, which covered the whole rock floor as far as it has been excavated; it is a slightly stratified dense layer of plastic clay, entirely free from animal remains. It represents a long period of time when the cave was flooded with water heavily charged with silt. The deposit is singularly even and well-defined, and little change seems to have occurred in the physical conditions during its deposit, unless the slight stratification of the blue and yellow clays represent periodical modification in the flooded conditions. The upper skin of the clay deposit is hardened into a cake about 1 inch thick, forming a sufficiently hard floor for foothold for the animals which were afterwards to frequent it.

(2) *Bone Breccia*, including the overlying rounded boulder layer.

The breccia stratum, about 3 feet in depth, is at once the most interesting and, in a way, the most disappointing of the cave deposits. It is so dense and hard in places that only occasional fragments can be identified. Where it is free from stalagmitic infiltration the animal remains can be isolated more or less and present many curious features. In the first place, they are so numerous as to represent about 75 per cent. of the material of the stratum. They occur in utter disorder. The degree of mineralization differs; generally they are almost black in colour and intensely mineralized. The smaller pebbles which occur with them are of similar colour and weight. A large proportion of the bone fragments are rolled into pebble form, so much so that it is often difficult to decide off-hand which is bone and which is stone pebble. The remains, so far as they can be identified, are chiefly hippopotamus and elephant. The pebble-like rolling of the bones can only have been brought about by the action of water washing to and fro. Whether this occurred before or after mineralization is uncertain. They were rounded *in situ*, for the sides of the central trench in which they are contained are highly polished—just such a polish as we find in the best class of neolithic pottery, believed to have been effected with bone implements.

The bone layer marks a definite epoch quite different from the underlying and overlying deposits, and represents a long period when the cave was at least partly dried out and the climate genial, if not tropical, followed again by a prolonged period of flood or submergence. The breccia is covered by a boulder layer some 12 inches thick of large rounded pebbles and small boulders worn smooth, in the manner found




DEPOSITS IN RELATIVE POSITIONS.

FIG. 6.—SECTION OF CAVE AND OF STRATA IN ITS FLOOR. THE POSITION OF TRENCHES AND FORMER EXCAVATIONS IS SHOWN.

on sea-beaches. The boulders were no doubt derived from the roof and walls of the cave under the action of frost.

(3) *Red Earth Layers.*

The total depth of these layers overlying the breccia is about 7 feet, and they consist chiefly of the red vegetable soil of the island, with alternating thin layers of "torba" clay in the upper portion.

The red soil is the product of disintegration of the Maltese rocks and must have been very plentiful at one time to support the tropical vegetation that no doubt existed when the elephant and hippopotamus roamed the country. "Torba" is a non-plastic earthy clay, of which extensive pleistocene deposits exist in the ground adjoining Marsa Scirocco.

About 3 feet down in the earth layer is a well-defined bone layer a few inches thick, the principal remains being stag. A substantial bone layer occurs also at the bottom of the earth deposits, also chiefly of stag remains.

Elephant and hippopotamus remains are found in the bottom part of the earth layer, partly intermingled with the lower boulder layer. These remains are said to be in a different state of mineralization to those in the breccia, but the writer is inclined to the view that they belong to the breccia deposit, being displaced by the violence of flooding, or have been deposited and bleached on the rocky ledges, to be afterwards intermixed with the later earth deposits.

With the exception of the bone and torba layers referred to, the whole of the earth layer is remarkably uniform in character, and was evidently deposited over long periods when the cave was flooded.

(4) *Surface Layer*, consisting of the superficial boulder layer, cave floor and pebble layer under it.

The superficial boulder layer which previous investigators found strewn on the surface to a depth of 2 or 3 feet, was composed of stones rounded by natural weathering. The valley outside is plentifully strewn with such stones, and it may be that the boulders in the cave were brought in by human agency, in the Bronze Age, or perhaps earlier. The plentiful potsherds in the cave show that it was inhabited for a considerable period, and it is more than likely that the inmates built themselves rough shelter walls round their separate pitches, both for privacy and for comfort. There is no evidence of flooding of the cave since Neolithic times. The cave floor contains on the surface Phœnician and Roman remains, with Bronze Age and Neolithic potsherds in plenty, and but little deeper down. In the pebble layer under it Neolithic potsherds are fairly plentiful, with occasional flint and stone implements. This pebble layer consists of small stones closely packed together, but not rounded in the same manner as the lower boulder deposit. The stones of the pebble layer may have fallen from the roof and sides of the cave under the action of frost or may have been set as flooring by the Neolithic inhabitants.

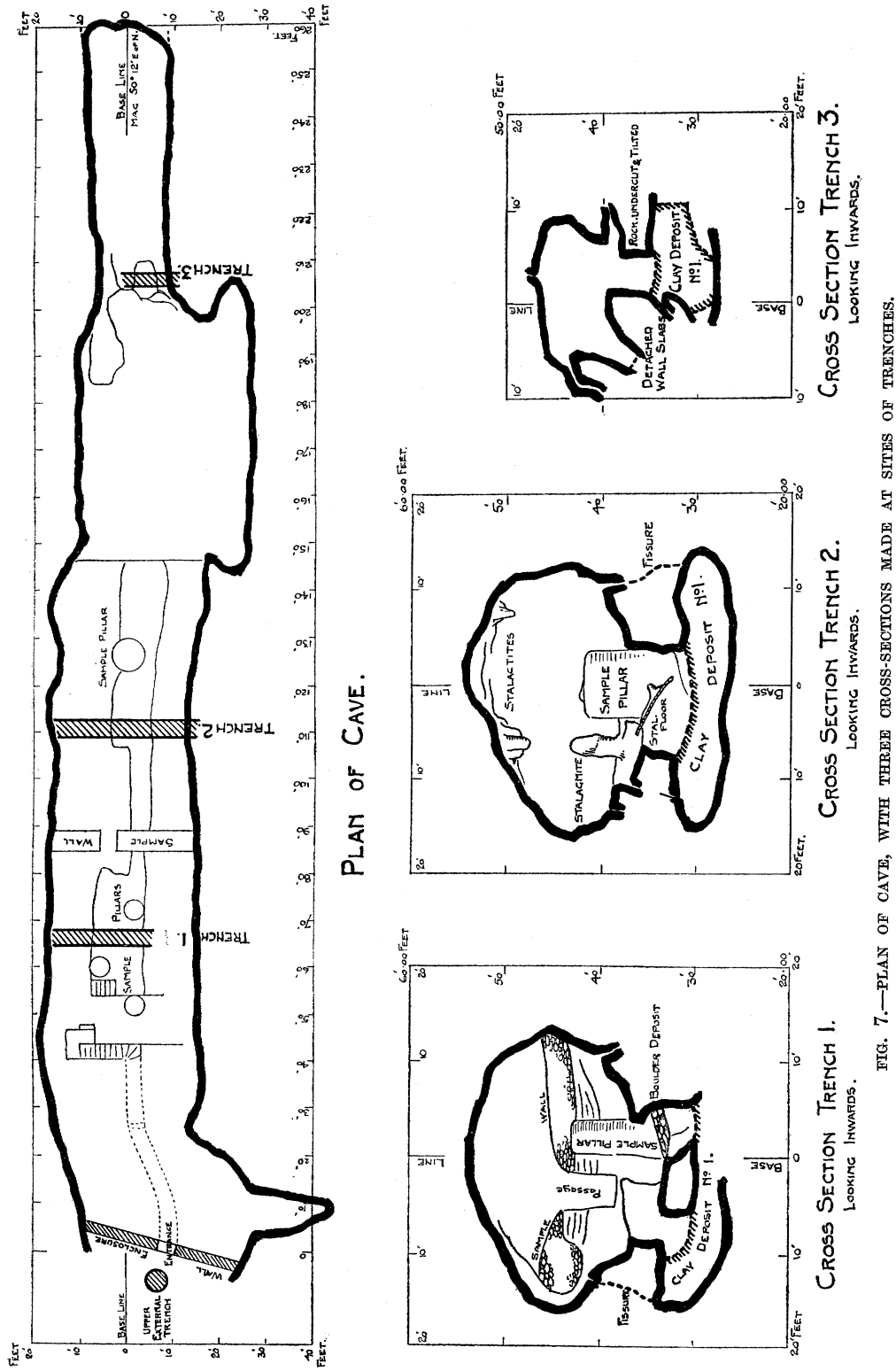



FIG. 7.—PLAN OF CAVE, WITH THREE CROSS-SECTIONS MADE AT SITES OF TRENCHES.

Neolithic potsherds have occasionally been reported from the middle part of the red earth layer. Mineralized remains of hippopotamus have, however, also been found with, and even over, such potsherds. The early excavators of the cave did not always leave precise records of where they had dug, and later evidence may be misleading on this point. The impression conveyed by a cross-section of the red earth is that it was uniformly deposited.

Before attempting to deal with the times at which these four strata have been formed it is necessary to consider the circumstances under which the cave came into existence. This in turn involves the formation of the surrounding land surface. No satisfactory explanation of the presence of the bone deposits is possible without a brief survey of the physical conditions obtaining in Malta in the pleistocene period.

*Eurafrican Land Bridge.*

It has long been accepted that, during recent geological times, Europe and Africa were connected by a land bridge between Sicily and Tunis, of which Malta now forms one of the few remaining links. The physiography of this bridge and its place in the chronological table is of the first importance, but no attempt seems to have been made to arrive at any definite conclusion. It may be well to remind the reader that it is 55 miles from Ghar Dalam to the nearest point of Sicily, 150 miles to the nearest point of Italy, 190 miles to the nearest point of Tripoli, and to reach the cave from Cape Bon in Tunis, the land journey being necessarily made by Sicily, 230 miles have to be traversed (*see* Fig. 5).

The following notes are put forward in the nature of a first suggestion towards the production of a working hypothesis.

*Period of Elevation.*

The basis of any study of the land bridge must of necessity be made on the soundings of the published Admiralty charts.

Whether the land rose or the sea fell is of minor importance as regards Malta, although it might be all-important in dealing with a large continental area where land elevation was not likely to be so uniform as a depression of sea-level would be. It is proposed to treat the difference in levels of the Mediterranean as being uniform, ignoring faults and change of dip. This sea may be roughly divided into two great basins east and west, each having stupendous depths of over 2,000 fathoms,[1] divided by relatively shallow water between Sicily and Africa.

Professor Hull mentions a possible elevation of 300 feet, but 300 fathoms, or 1,800 feet, would be necessary even to connect the two continents and leave some margin over. Professor James Geikie's estimate of 3,000 feet must be much nearer a true estimate.

[1] 12,000 feet (3,700 metres).

Only a minimum elevation of 600 fathoms will give a satisfactory explanation of all the land changes which have affected the whole Mediterranean basin, connecting Spain and Morocco; the Balearic Islands with Spain; Sardinia and Corsica with Italy; Tunis with Sicily and Italy; drain the Adriatic and the Ægean, except for some isolated lakes; and connect Cyprus with Asia Minor. The north coast of Africa, if raised 600 fathoms, would not be affected materially except at the land bridges to Sicily and Gibraltar. This elevation of 600 fathoms, or 3,600 feet, may be a little over the mark, but for the present argument it is proposed to adopt it. The higher land in Malta to-day is about 700 feet above sea-level, so that, if no allowance is made for subsequent denudation, the highest peak of land bridge would have been some 4,300 feet O.D., but the greater portion of the bridge would have been much lower. Ghar Dalam was situated on the shoulder of this ancient peak.

The Maltese rock series had its origin in Miocene marine formations, involving a steady elevation above the surrounding sea. Now one of the most striking physical features of Malta is the denudation of the eastern half of the island, where strata, having a total thickness of 400 feet, have been worn away. The limit of denudation is sharply defined and the division runs practically north and south. The possibility of direct glacial action must be dismissed, and everything points to marine agencies, modified, of course, by sub-aerial erosion over a long period of time. Professor Leith Adams, who did an immense amount of pioneer geological work in Malta, held this view about 1860, and was of opinion that denudation was the work of a secondary depression below sea-level. The erosion may have taken place as the plateau of land, the remains of which now forms Malta, rose gradually above the sea. The rock perhaps had a much less degree of hardness than to-day; it was open to the full force of storms from the eastern Mediterranean basin, and erosion being assisted by the gentle dip of the strata, we have a very satisfactory explanation of the present form and character of the eastern half of Malta. The present remaining high land in Malta would have been sheltered from the west by high ground extending west of Gozo, which no doubt has been greatly reduced in area, the cliffs standing some 400 feet above the sea. We are assuming, therefore, that Wied Dalam was fully formed during the early stages of the elevation of Malta, and it is probable that Ghar Dalam also was formed at the same time, ages before any of the present cave deposits were laid down. The rock floor of the Wied was lowered some 20 feet below the rock floor of cave probably at some subsequent period.

Fig. 5 shows in outline the extent of the land bridge based on the 600-fathom contour. One of the striking features of this reconstruction is the great inland depression between Malta and Africa, extending some 200 miles long and from 40 to 100 miles wide. This depression (Fig. 5, salt lake) must have drained a great portion of the northern coast of Africa and southern slopes of Sicily, and was cut off from both east and west Mediterranean basins. It covers a large proportion of the whole area of the bridge. The western lip of the depression, between Sicily and Tunis, over

which the water contained in the depression would flow to the western Mediterranean basin, lies at a depth of 197 fathoms, and soundings westward indicate a tortuous channel leading into the western basin, as if at some time a great stream had flowed over this lip. It is 80 miles from Cape Bon in Tunis to Sicily. Unfortunately, the soundings at the eastern lip are not so numerous. This lip is between Malta and Tripoli, at a depth of about 250 fathoms. No additional soundings are available to show whether a stream overflowing this lip formed a channel into the eastern basin or whether the true lip was at a higher level seaward. When the eastern basin broke through into the depression, very substantial erosion of the sea bottom may have taken place. Had this erosion amounted to as much as 50 fathoms, making a contour of the original depression at the 200-fathom line, it would account for the normal overflow through the western lip and the formation of the western channel. In this case the depression would have been of substantially greater area than indicated on chart. In the absence of any such indication, however, we can only assume that the actual lip was at the 250-fathom line, so that this depth gives the limiting area of the lake enclosed in the depression.

During the elevation of the land bridge the depression must have been left filled with salt water. If the rainfall greatly exceeded the evaporation over a long period of time, causing a continual overflow, the salinity may have been reduced to vanishing point. With greater evaporation the salinity would be increased with a corresponding reduction in the area of the lake. A large area of land drained into this lake.

Ghar Dalam is situated in a deep, rocky valley discharging into a large land-locked harbour known as Marsa Scirocco, as shown on Fig. 2 in the preceding part of this communication. Before the present investigation was undertaken, Mr. C. Rizzo, an eminent Maltese geologist, had already formed the opinion that this harbour represented what is left of a large fresh-water lake. Certainly the configuration of the adjoining country and the large drainage area agree with this suggestion, and in considering the configuration of the land bridge it is difficult to put any other interpretation on it. The seaward side of this harbour and the sea bottom have undergone a considerable amount of change during recent times, and it is not possible to define the limits of this lake during the period of maximum elevation. It is certain, however, that it was much larger than at present. The level of this lake Scirocco would have been about 250 fathoms, or 1,500 feet above the level of the great "land-bridge" lake, and the distance between them would have been only 12 miles. The contour of the great "land-bridge" lake shows an estuary heading in the direction of Marsa Scirocco, and the inference is that the two were connected by a fresh-water stream of considerable volume flowing through a chain of smaller intervening lakes. Such a disposition of land, river and lake may throw light on the bone deposits in Ghar Dalam.

One of the characteristics of the bone deposits in the breccia is the preponderance of hippopotamus remains (*H. pentlandi*). The explanation accepted hitherto is that

the carcases were washed into the cave by floods in the adjoining valley—the Wied Dalam. This was first put forward by one of the earlier explorers of the cave and does not seem to have been challenged. If the suggestion made above as to the denudation of the eastern portion of Malta is well founded, Wied Dalam never had a greater watershed than at present. This watershed is quite inadequate to account for such violent flooding of the valley as would be necessary to drown and sweep away these animals, and there is nothing in the configuration of the valley to induce such an eddy as would cause the cave to trap the diverted floating carcases into the cavern. Circumstantial evidence has been adduced in the wear and undercutting of the cave sides, but these are much more likely to be due to marine action, as already suggested.

If we suppose that the animals whose remains abound in the cave were driven northward from Africa by some compelling instinct, and following or guided by watercourses or rivers, they would ultimately have found themselves on the shores of the great "land-bridge" lake. This obstruction to further progress northwards would necessarily have divided the stream of immigrants, one-half turning westwards towards Sicily and the other half eastwards towards Malta. Following the eastern shore of the "land-bridge" lake, perhaps the first, or at least the first important, fresh-water stream leading northward which they encountered would have been that from Marsa Scirocco, from whence it is but a step to Ghar Dalam. We may assume, therefore, that over a long period of time large herds of hippopotami frequented the lake Scirocco and its tributaries. Caves are not numerous in this area, Ghar Dalam being the only one of any size now above water in this region. To an enquiring race of immigrants the presence of the cave, probably with a flooded entrance, might soon have attracted numbers of hippopotami for the shelter it offered from a tropical sun. It might also have become the haunt to which, over a long period of time, these animals crept to die, or were pushed ashore by their companions when sick. The multitude of bones in the breccia deposit is so great that the only acceptable explanation is that the floor was paved with the trampled skeletons of animals over a very long period of time. Or is it possible that Palæolithic man in Malta, as at Solutré and Předmost, gathered the carcases of his prey at the site of their dwellings, or did they use the cave as a means of trapping their large game?

*Period of Depression.*

The next and more difficult problem is to attempt to fix the various stages of depression of the land bridge in chronological order, so as to connect the cave deposits with the various movements.

We have assumed a maximum elevation of 3,600 feet followed by a corresponding subsidence, and the time taken for such subsidence, if orderly, we must presume to have been very great. We cannot say, if we confine our attention to the geological records of Malta alone, whether it was a regular progression or subject to periods of

stagnation or even re-elevation. The best we can hope for is a basis on which to assess the time of the various stages in the general depression.

Where Wied Dalam enters Marsa Scirocco there is a rocky promontory extending under the sea (Fig. 4). Situated on this promontory and laid out in a properly reticulated plan is a remarkable series of bell-shaped reservoirs cut in the rock. These tanks are some 10 feet deep and 10 feet in diameter and are at present situated for the most part with nearly their whole depth under sea-level, although some exist actually under the water and some above it.

The origin and purpose of these reservoirs is obscure, but the important point is that Professor Zammit assigns them definitely to Phœnician origin, say, 2,500 years ago. Now, it may be said with certainty that, for whatever purpose these tanks were made, whether for the storage of water, grain or olive oil, not only would it have been impossible at that date for them to be carved out under water, but the porosity of the rock is such that their contents would have been rapidly spoiled in such a situation. We may assume that they were used in connection with the trade of the Phœnicians, as an important settlement can be identified in the immediate vicinity, and Marsa Scirocco was probably used as a trading base. In such a case we might expect them to be as near the shore line as possible, and if we allow the whole depth of the tank clear of the water level and a margin of 15 feet over this to allow of any submerged tanks and give some working freedom, we have a depression of 25 feet recorded during the last 2,500 years, or 1 foot in 100 years. This fact is in itself a sufficiently remarkable one to warrant attention. The depression is rapid and probably still in progress. Search has been made for some check, and two cases have been found on the other side of the island which confirm the estimated rate of depression and show it to be an even one and not a tilt.

At the head of St. Paul's Bay is a small fort bearing the arms of Grand Master Perellos and dated 1716 (Fig. 2). The outer bastion wall is now partly submerged to the extent that the sea is level with the upper edge of the lowest course of masonry.

The second case is a similar fort at Cala San Marco, where identical conditions prevail, the sea also being about level with the top of the lowest masonry course. This fort is rather more exposed than that at St. Paul's Bay, and the sea has breached the bastion wall entirely, so much so that it is reasonable to say that, had it been originally built at the present relative level, it would long since have been swept away.

In both these cases it may be assumed that master builders, like the knights, would neither have run the risk of damage by sea nor have built a single course of masonry under water, with its attendant difficulties, if, as in both these cases, all trouble and risk could have been avoided by building on higher rock a few feet further back.

The estimated rate of depression of 1 foot in 100 years would fit these two cases very well, 1 foot representing the depth of masonry and the other for margin, which,

with a beach slope of about 7°, would place the building 15 feet back from the edge of the sea.

Sir Arthur Evans[1] has produced evidence that points on both the north and south coasts of Crete have sunk about 13 feet since the Roman period—13 feet in 2,000 years. At the western extremity of Crete, however, he found evidence of land elevation amounting to 16 feet in about 2,000 years. Such observations, while in keeping with the belief that Mediterranean shore lands have been sinking in historical times, also illustrates the fact that subsidence is not uniform.

*Old Sea Beaches.*

At the present time geologists are concentrating their attention on signs of former land submergences (or sea elevation), which are to be detected round the shores of the Mediterranean. The raised beaches, which are the sources of our evidence of past periods of submergence, are above the sea and are thus accessible for direct investigation. Prof. Ch. Depéret, whose observations and conclusions have been accepted by Prof. Sollas (*Proc. Geolog. Soc.*, Jan. 10th, 1923; *Nature*, 1923, vol. 111, p. 332), recognizes four periods of submergence, at least three of them lying within the Pleistocene period. The most recent, the Monastirian, is marked by raised beaches, which occur about 65 feet O.D. In one of the caves near Mentone this last period of submergence is represented by a raised beach 25 feet O.D., corresponding in level to the rock floor of Ghar Dalam. Over the raised beach at Mentone are cave deposits amounting to 33 feet in depth, the bottom stratum representing the period of Mousterian culture, the rest being the Aurignacian period. We must suppose that Malta shared in the general submergence of Mediterranean lands which occurred some time before or in an early part of the period of Mousterian culture, and that the floor of Ghar Dalam in this submergence was flooded by the sea. Still older periods of submergence are represented by the Tyrrhenian (100 feet) series of beaches; older still by the Millazzian at 194 feet, in which occur traces of early Mousterian culture as well as those of the Acheulean and Chellean periods. Higher still is the Sicilian series of beaches—330 feet. Were modern Malta to be submerged 330 feet below its present level the greater part of its land with its living things would disappear below the sea. The last-named series of beaches are believed to have been formed in the cold phase which occurred in the latter part of the Pliocene.

Of much more moment for students of pre-history are the periods of land elevation which raised bridges from the bottom of the sea and thus made possible an interchange of faunas and population between Africa and Europe. The land bridges and the beaches formed during the periods of elevation, with all their traces of man and beast, lie now hundreds of feet below the sea. We can get no help in the solution of our present problem from them, for they lie beyond our reach. We have, therefore, to fall back on caves situated on these old land bridges—such as Ghar Dalam—and

[1] *Nature*, 1923, vol. 112, p. 661.

by a study of the records yielded by the deposits of their floors see what light can be thrown on the periods of land elevation, and of the migration of man and beast.

*Rate of Subsidence.*

At the rate of 1 foot a century it would take 360,000 years to bring the land-bridge which has been outlined above to its present point of submergence. Even if we take the minimum amount of elevation—1,200 feet—needed to connect Malta to Africa via Sicily, and allow a subsidence at the rate of 2 feet a century, it would take 60,000 years to cut Malta adrift from an African union. At the same rate it would take 25,000 years to separate Malta from Sicily and Italy, for we must suppose that the European part of the land bridge has subsided 500 feet at least. And yet geologists and prehistorians talk in the most light-hearted way about the existence of a land bridge which united Africa and Europe and served as a highway for the migration of races and cultures in the Aurignacian period, the beginning of which cannot be placed earlier, on justifiable evidence, than 20,000 B.C. Either the relative changes in sea- and land-level take place much more rapidly than we believe at present, or the inter-continental land bridge, of which Malta is a mere fragment, must have disappeared at a much earlier date than has been supposed hitherto. Somehow Neanderthal man reached Malta. Did he come by the land bridge, or was he in these early times already a sailor ?

Those who have studied the fossil and animal remains of Malta and of other islands of the Mediterranean[1] find that, in the latter part of the Pliocene period, these islands must have been united to both Africa and Europe, for their fauna was similar to that of the adjacent lands. The subsidence of the land bridge and the separation which ensued towards the end of the Pliocene period must have isolated the islands of the Mediterranean for a period of long duration. The animals of the islands during this period evolved into distinctive species. Then, at one point in the Pleistocene, and apparently at one only, the Mediterranean islands again became linked to the continent, allowing forms such as the stag, the bear, wild goat, wild sheep and fox to reach Malta and other islands. It was the existence of this Pleistocene land connection, we may presume, which permitted Neanderthal man and other Pleistocene mammals to make their appearance in Malta.

The level of the rocky floor of Dalam cave and a consideration of the nature of the four strata deposited on it will help to throw some light on the Pleistocene land-bridge. The original floor of the cave is almost at the same height above the sea as the floor of the Grotte du Prince, one of the Grimaldi caves, on the shore of the Mediterranean at Mentone. On the floor of the Grimaldi cave are beach deposits 12 feet in thickness belonging to the Monastirian series, laid down by the sea during the long temperate phase which preceded the last or Würm glaciation. The deposits

[1] Dr. Forsyth Major, *Proc. Zool. Soc Lond.*, 1901, p. 628. Prof. M. Boule, *Les Grottes de Grimaldi*, vol. 1, 1906.

which occur over this old beach contain the culture and the fauna characteristic of the Mousterian period; then over the Mousterian strata lie deep deposits of the Aurignacian period. In Ghar Dalam we have a comparable series. The stratum of bone breccia and the layer of boulders over and in the breccia have the characters of a beach-deposit; the sides of the cave are polished; fossils and stones have been rolled. The 7 feet of red cave earth is clearly a later Pleistocene deposit which has never been exposed to tidal action, and is in every way comparable to the Mousterian and Aurignacian deposits at Grimaldi. If Neanderthal man was a contemporary in Malta of the same species in Europe, then it is just in the upper levels of the bone breccia and in the lower levels of the red cave earth we should find his remains. And it is just at this level they have been found.

Further evidence in support of the simultaneous movements of the opposite shore lines of Sicily and Tunis has been published lately by M. Allemand Martin (*C. R. Acad. des Sciences*, December 26th, 1923). At Cape Bon, as in Sicily, he found the Monastirian beach at the same level—63 feet O.D. The rolled bone breccia in Ghar Dalam represents the same deposit.

At the date these strata were formed in Ghar Dalam, Malta was already and had long been an island. If Neanderthal man reached Malta at this date, then it must have been by sea and not by land. If he came by land, then he came before the Mousterian period of culture or at a very early point in the development of this culture. There was certainly no land bridge uniting Europe and Africa in the later Palæolithic periods, and if migrations of men and of cultures did take place in these periods between Africa and Europe, as very likely they may have done, they spread by boat and not on foot.

The enigma of the antiquity and duration of the Pleistocene land bridge is rendered more intricate by the evidence of at least three periods of submergence during this geological period. During the Chellean period the level of the rock floor of Ghar Dalam was at least 60 feet below the level of the Mediterranean; in pre-Chellean times it was 100 feet lower still. During these periods the cave sank, but between them were others of land elevation in which the cave rose, but whether the rise which produced the land bridge was pre-Mousterian, pre-Chellean or at a still early inter-glacial period there is no evidence to permit us to reach a decision. I believe the land-bridge came into existence about the time Mousterian culture first appeared in South Europe (A. K.).

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