



## An Expedition to the Gilf Kebir and 'Uweinat, 1938

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# The GEOGRAPHICAL JOURNAL

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## AN EXPEDITION TO THE GILF KEBIR AND 'UWEINAT, 1938

*Evening Meeting of the Society, 23 January 1939*

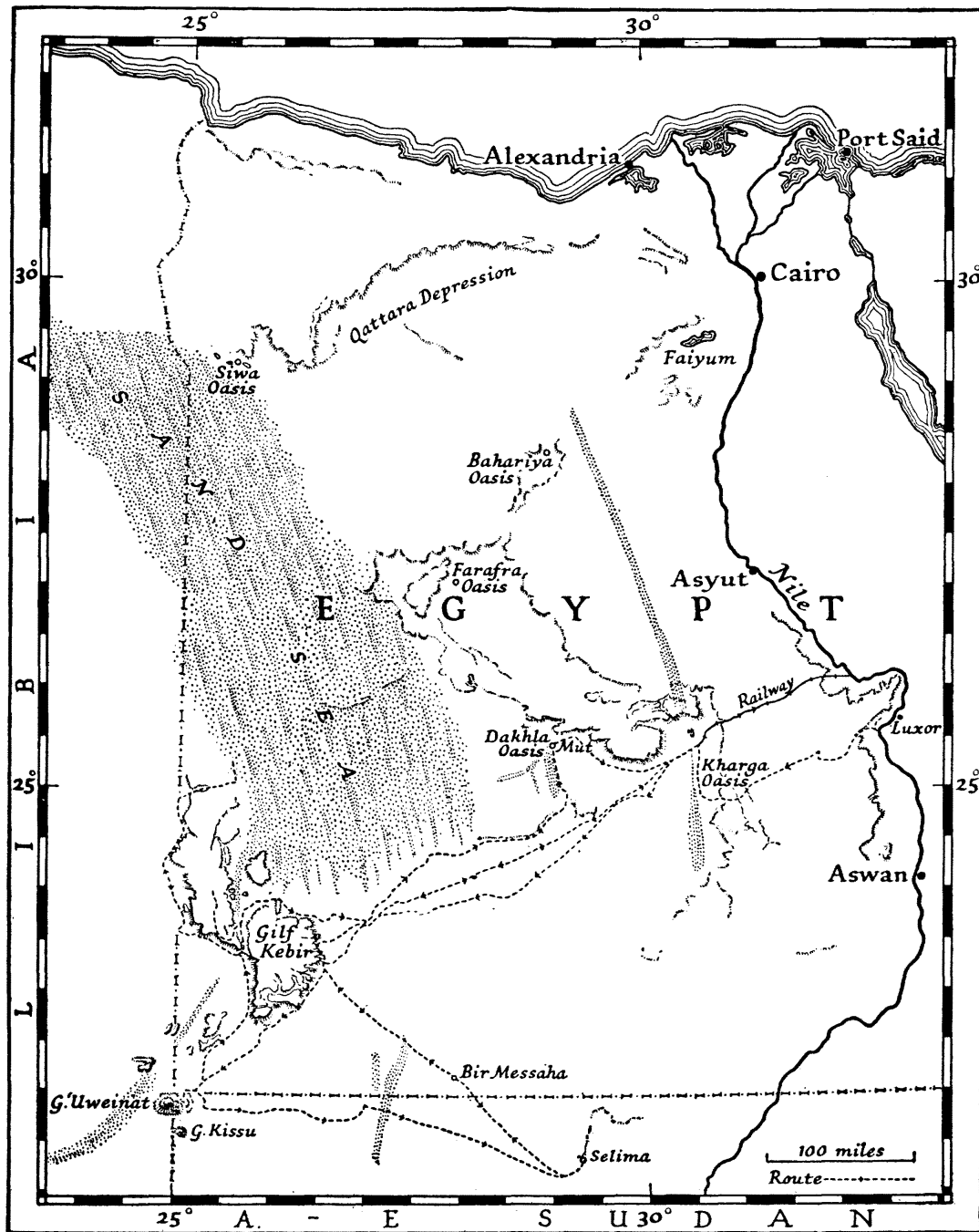
### I. NARRATIVE OF THE JOURNEY. By Major R. A. BAGNOLD

MY original object in instigating this expedition was to verify in the field, with the aid of a grant of money provided by the Royal Society, my previous experimental work on dunes and sand movement. The neighbourhood of the Gilf Kebir seemed an ideal spot for my purpose; not only is it generally held that sandstorms are more frequent in the west and south-west than elsewhere in Egypt, but this area I knew to lie on the type boundary between the vast seif-dune ranges of the Sand Sea in the north, and the barchan fields to the south and south-east, and to contain very interesting transition types.

In order that as much useful information as possible may be got out of an expedition to such a hardly accessible spot, it was clearly proper that specialists in other subjects should be included. Incidentally, by increasing the size of the party a considerable saving in the cost of transport could be effected. The Egypt Exploration Society took advantage of this opportunity, with the result that, through the generosity of the late Sir Robert Mond, I was joined by a party consisting of Mr. O. H. Myers, Mr. T. Gray, Dr. H. A. Winkler, a mechanic, and three Qufti excavators. For my part I was fortunate in having as my companion Mr. R. F. Peel, of King's College, Newcastle, to whom are due among other things the successful navigation of the expedition and the geographical results obtained. The expedition was thus a joint one consisting of the Egypt Exploration Society's party on the one hand, with two cars, and Peel and myself on the other, with but one car, each party being financially independent of the other.

The Gilf area is completely waterless, the nearest wells being at Bir Misaha (Messaha) and 'Uweinat, nearly 150 miles away; but with reasonable care the consumption of water can be made so small that a single initial supply can last a party for several weeks. As before, supplies of petrol and preserved food were sent in advance to Selima Oasis by camel from Wadi Halfa by the Shell

Company of the Sudan, and we are grateful to Mr. Purves, Governor of the Northern Province, and to Mr. A. C. Walker for their assistance in ensuring its safe arrival. The supplies included a number of new empty 4-gallon petrol containers for canning the excellent water of the oasis for our use at the Gilf.



*Sketch-map showing the routes to the Gilf Kebir*

The combined party left the E.E.S. camp at Armant near Luxor on 5 February 1938, and drove direct across the limestone plateau to Kharga Oasis, descending the cliffs of the depression by a new pass recently opened by the Egyptian Frontiers Administration. After a day spent in collecting

supplies of fresh food which Muhammad Wasfi Bey, the Governor, had kindly arranged for us, we set out for the south-west, following more or less my old route of 1932. This route, while by no means the best, lies for a long distance through a chain of ancient lakes or mud-pans of which the only remains now are strange groups of sitting sphinxes, or "mud-lions," occupying the bottoms of shallow depressions. This area is one nearly continuous neolithic <sup>1</sup> site, dotted everywhere with querns, grinders, implements, and the ashes of ancient hearths. It is now of course as barren as the rest of the sandstone plain, with not a vestige of vegetation.

On the second day the dark cliffs of the Gilf plateau appeared along the western horizon, headland after flat headland like some forbidding coast line. It was here, on the east side of the southern part of the Gilf, that we proposed to make our camp for the first month. A suitably sheltered spot was found underneath the 1000-foot cliffs, conveniently near to a likely neolithic site for Myers and his party and to a line of dunes for my own work. Myers and his three workmen were left marooned here with all our dumped stores while the rest of us went with all three cars to Selima, 250 miles away across the sand-sheet, to lay in further large supplies. Calling *en route* at Bir Misaha, dug by Mr. H. J. L. Beadnell for the Survey Department in 1927-28, we found that the report we had received in Cairo of its having become sanded up was unfounded, though the decay of the lowest timbers may at any time allow a small collapse of rock to make the well temporarily unusable. Both Peel and I were lowered to the bottom 220 feet below the surface, I for mere curiosity, and Peel to retrieve a light rope we had accidentally allowed to fall. In spite of the well lid being permanently shut down to keep out the drift sand, the air in the well, though hot and sulphurous, is perfectly good, as also is the water at the bottom, once the decayed wood and dead scorpions have been filtered out of it.

Returning to the Gilf dump, which Myers had in the meantime turned into a smart camp, we found that a remarkable change of outlook had taken place. The camp lay not as expected among the remains of early neolithic folk of perhaps five thousand years B.C., though such remains were there too, but was instead away back in the dim past of three hundred thousand years ago, in the midst of a large settlement of Acheulean man.

For the next few weeks, while I was mainly occupied with observations among the dunes, Myers and his party were at work on the past. Peel with my car and accompanied by Gray, and on windless days sometimes I alone, traced in turn the courses of each of the long winding gorges which penetrate westwards into the massif of the Gilf. These we found to contain much live vegetation (though no trees) and many ancient sites. For a long time the unexplored top seemed totally inaccessible except on foot. From El 'Aqaba in the north-west, southwards down the western coast, and northwards again along the eastern cliffs, including the outline of the walls of all the "creeks" and "fjords," we estimate a total cliff frontage of more than 2000 miles; yet so uniform is the structure of this extraordinary tableland

<sup>1</sup> It is at present impossible to distinguish between the late Upper Palaeolithic and Neolithic of Capsian origin in this area. Throughout this article "neolithic" has been used to designate the sites of this doubtful period where no pottery was found.

that we despaired of ever finding a way up possible for a car. On February 28 however Peel and I succeeded in finding a very tall sand-drift some miles north of our camp which yielded to us after four unsuccessful attempts to charge it at speed with our car empty. We found ourselves at the tip of a small peninsula connected to the mainland of the plateau by a narrow neck along which ran a well-beaten road marked at close intervals by ancient cairns. We had unwittingly hit upon a forgotten pass probably last used by the Stone Age people when the lifeless yellow plains below were green. On March 3 we went up again, and spent two days travelling over the plateau and across to the brink of the western cliffs.

A proper survey of the top was peculiarly difficult; for although the positions of the more important headlands had been fixed from below, from a distance, by Prince Kemal el Din on the east and by Clayton on the west, yet so flat is the land above that a few hundred yards away from the cliffs all landmarks visible from below disappear from view, and one is left with a flat horizon broken only by the domes, far away in the interior, of isolated unmapped basalt hills sticking up through the mirage. Indeed, unless one stands on their actual brink, the presence of the cliffs can only be inferred from the peculiar lack of whiteness in the hard sky of the horizon.

Upon the top the Gilf forces on one the complete illusion of a large cliff-girt island rising from mid-ocean: the endless succession of headlands all of even height, the cliffs beneath them falling sheer from the flatness of the tableland without preliminary drainage slope, the limitless plains 1000 feet below, so far down that their negligible yellow features fade away in the haze. Even more striking is the monotonous shouting of the wind that sweeps continually over the plateau and swirls away into space over the edge of the cliffs: nothing could better imitate the roar of breakers on a distant beach. Another odd fancy was the imagined presence of the old people. There was nothing between them and us. The place has the utter remoteness of another world. One felt suspended high above the desert below, itself many hundreds of miles from the nearest habitation. The plateau is a harsh barrenness of broken rock; over all its thousands of square miles we found but two or three tiny dells containing vegetation, yet a network of paths cross and recross it. Lines of stones are laid out in curious patterns as if by children playing at forts. Implements and flakes are everywhere; near the cliff edges the ground is literally strewn with them, some blackened by the sun, but others so fresh they might be yesterday's chippings. One expected at any moment to see the return of their makers, uncouth figures clambering up over the skyline of the cliffs hammer-stone in hand to resume their eternal rock-breaking.

On March 5 the rest of the party left for Kharga, 300 miles away, to bring out more fresh food and petrol. While they were away I spent a very pleasant eight days alone in the Gilf working up the results of my measurements and waiting for another sandstorm. Each evening the solitude was broken by loud and deep-throated talk coming from far up in the sky where, on their leisurely migration northwards to the African coast, flights of cranes circled and recircled while waiting for their laggard friends. Farther south, just east of 'Uweinat, we found flights of these great birds rallying daily some three hours earlier in the afternoon.



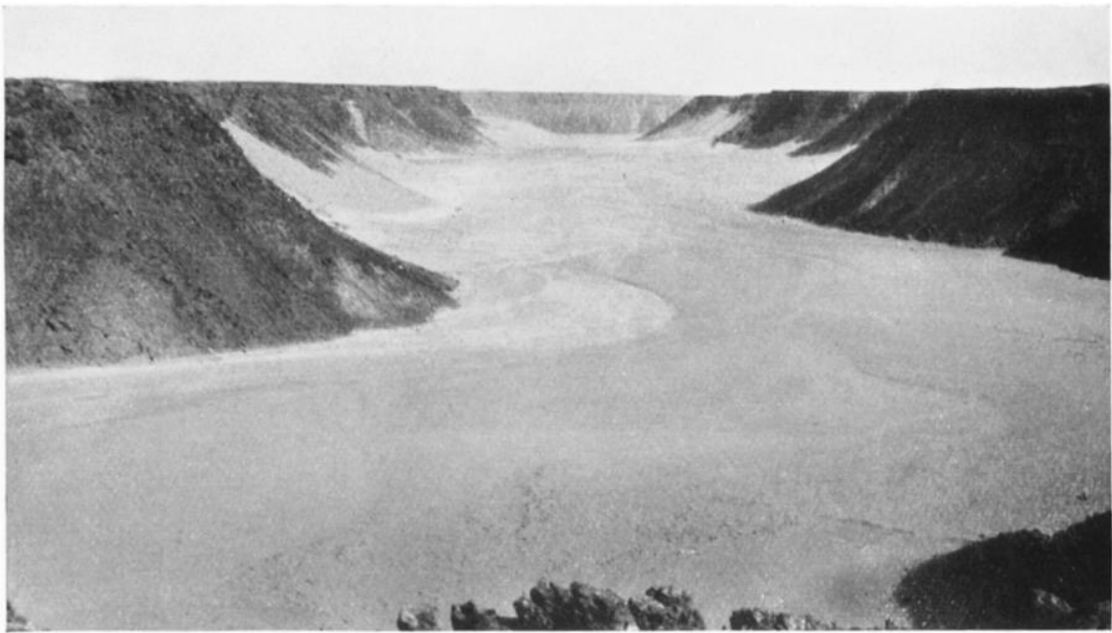
*Nubian sandstone country north-east of the Gilf Kebir*



*Ancient tracks on top of the Gilf*



*The Gilf cliffs*



*Wadi el Bakht near its head*



*Dune ranges, about 150 feet high, at the southern end of the Sand Sea*



*Cliffs behind the Base Camp. The detritus shows the stream beds of the last rains*

A heavy sandstorm came conveniently for me on March 6, and my anxiety lest our camp should be engulfed by the neighbouring dune was countered by the satisfaction of getting some really reliable measurements while the storm was at its height. It was accompanied by a great deal of hooting and booming on the part of our dune. Maybe the sand which blows over the Gilf is peculiarly prone to hooting—I will not call it singing, for the note is too low and pure—but we heard it on three occasions. One night when Peel and I were camped in El 'Aqaba in a narrow space between a big drift and a rock cliff it came on suddenly, breaking the silence of a still evening with a sound so loud we had to shout to one another to be heard. The whole valley vibrated with it for five minutes on end. Afterwards I imitated the noise quite easily, in a small way, by scrunching the butt-end of a whisky bottle in the sand.

The others returned on March 12 along a new route slightly farther south than any used by previous travellers, by which they avoided all the broken country and made very good going over fast sand-sheet all the way. We struck camp next day and moved south-west towards 'Uweinat, where Myers and Winkler proposed to spend a couple of weeks, the former looking for pottery and the latter for rock-engravings and paintings. On the way Peel noticed, and we all went and inspected, a large group of volcanic craters very similar to, but farther to the north-east than, those found by Clayton in 1931. We camped in the bed of Karkur Talh, at 'Uweinat, about 9 kilometres from its mouth, surrounded by the scores of rock-pictures which adorn the sandstone cliffs of the valley. The same evening Myers, Peel, and I left on a second journey to Selima for the remainder of our petrol. For the first 100 miles of the journey over the great plain we drove through site after site of ancient remains. Farther east, if they exist, the growing sand-sheet has covered them up. We also passed a large flight of cranes resting on the sand like a party of tourists on a beach. There were many single birds too, from other migrations.

As by far the best route to 'Uweinat from the Nile is *via* Selima, it may be useful to mention that the heavily used road marked out by the Sudan Government with petrol tins is by far the worst; it should be avoided at any rate for the 50 kilometres west of Selima. After experience of several routes I am convinced that the best is that found for us by Newbold in 1930, which strikes out due west after following the bones of the Arba'in track for not more than 12 kilometres.

Peel and I stayed a day or two at Karkur Talh, and then drove round to Karkur Murr at the south-east corner of the mountain. At the uppermost end of this valley upon the saddle dividing it from Karkur Talh and close to the foot of the great eastern bastion of the main massif I came upon a cave containing a new and interesting group of rock-paintings. The find releases this valley from the stigma of being the only source of water and grazing at 'Uweinat without its painted cave. Lower down, the water-holes which our party saw in 1930 are now much altered in appearance. There is far more water; in places it resembles a chain of moorland pools. While peering into the dark doorway of one of the deserted barrack huts built by the detachment of the Sudan Defence Force in 1934 I was all but knocked down by a very



fine specimen of wild sheep (*waddan*<sup>1</sup>) which came rushing out of the hut in alarm. As he trotted away I saw that his mane of chest hair reached to the ground, trailing between his forelegs. It has recently been said in Cairo that these animals were extinct at 'Uweinat, but we saw many. Indeed, at Karkur Talh the wild life was abundant, and *waddan*, gazelle, and foxes began after three days to take little notice of us. We then drove across to Gebel Kissu, where we spent an interesting day making what I take to be the first ascent of its main granite peak. The plain between the two mountains was full of gazelle, and by the state of the vegetation there must have been heavy rain not more than two years previously. The mountain plants on Kissu were all in full flower.

On March 19 Peel and I set out northwards from 'Uweinat, along the plain beneath the western cliffs of the southern Gilf, past El 'Aqaba and on up the side of the northern Gilf as far as the Cufra-Farafra camel route; thence, following it eastwards up the pass of El Gubba, to Clayton's former camp in the silica-glass area near the southern extremity of the Sand Sea, the dunes of which I had not seen for eight years. I wanted here to look at the particularly interesting transition forms taken by the dune ranges. The country, as everywhere in the Sand Sea, is dead flat. It consists, like the surface of the Gilf into which it merges towards the south, of black boulders of flint-hard silicified sandstone. In contrast with this harsh black floor the parallel ranges of pale dunes, rounded and filmy, seem very unsubstantial. At midday the lanes between them, 2 miles wide, are filled with mirage, through which the dune peaks 200 feet high rise like the sails of unending lines of yachts. Later the mirage goes; the peaks, now of deep gold, join up into continuous walls that run on and on, straight as rulers, side by side to a serrated horizon. The silica glass, a geological enigma, lies about in greenish-yellow lumps glittering in the sun. Some of it is opaque, but most of the fragments, especially the smaller ones, are completely transparent; they might be bits of gem-stone. Like the Gilf and its surroundings, this part of the Sand Sea is littered with palaeolithic and neolithic remains. The glass was much worked during the latter period.

After two days here we returned on our tracks westwards and southwards to the pass of El 'Aqaba, which had been agreed upon as a rendezvous with Myers's party for April 1. On the way we visited the painted caves found by Almásy in the western cliffs at his Wadi Sura (lat. 23° 33', long. 25° 16', about 3 kilometres south-east of the spot marked "rock pictures" on the Egyptian 1/500,000 map).

Having still some days in hand, we left a message at El 'Aqaba, as we had done at other places along our route in case we should become stranded with our one car and should need rescue, and drove up from the top of the pass (which enters a broad lane of lower level that cuts the plateau into two halves) on to the tableland of the northern Gilf, with the object of visiting the Wadi Abd el Malik, to look for the well which the old man Abd el Malik has assured Almásy was there. There being as usual in the Gilf no possible way down for cars from the plateau to the valleys within it, we had to climb down and walk. We walked a total of more than 30 miles along the soft sandy floor

<sup>1</sup> Erroneously called *mouflon* by some French and other writers.

of that wadi, during two stifling days when a *khamzin* wind was blowing from the south. The trees were green, and the xerophitic grasses and scrub were in full flower, but although we came upon the *heglig* trees mentioned by the old man, we failed to find any other evidences of the well. We were however rewarded by Peel's discovery of yet another painted cave.

While returning over the boulders of the plateau top the day before our pre-arranged meeting with Myers at El 'Aqaba, our car expired suddenly from a broken back axle-shaft. As with this disablement it could not even have been towed, there was no alternative but to abandon it and walk.<sup>1</sup> So, strapping a 2-gallon can of water on our backs together with some food, we set out on foot over the rocky cliffs to the rendezvous, which was fortunately not more than 25 miles distant. We had left the others but ten days before and only 140 miles away at 'Uweinat, but as none of them had ever been up the western side of the Gilf or seen the rendezvous, and as without transport there would have been no hope of walking to anywhere useful in this world, we were relieved at finding them waiting for us.

It was bitterly cold the night of our arrival. Myers had found an excellent camping-place in the side of a collapsed hill where there was good shelter from the wind and soft lying on beds of drifted sand beneath the huge blocks of fallen rock. Perhaps for me the most lasting memory of the expedition will be the finding of an artificial ledge in the dark recess of one of the caves, and on it a stone knife left behind untold centuries ago by the last occupier, just as we ourselves would empty our pockets before going to bed.

After collecting with one of the remaining cars all our gear from the wreck, we set out north-eastwards through the gap in the Gilf on an uneventful run to Dakhla Oasis and the Nile.

In conclusion, I should like here to thank, on behalf of Peel and myself, the Council of the R.G.S. for their grant of money for our side of the expedition and their loan of instruments; Oliver Myers for his active cooperation and the services both of his excellent mechanic, Hagob Palamoudian, and of his three cheerful Egyptian assistants; and to acknowledge with grateful memory the help and encouragement we all received from the late Sir Robert Mond.

## 2. THE SIR ROBERT MOND EXPEDITION OF THE EGYPT EXPLORATION SOCIETY. By O. H. MYERS

When Major Bagnold suggested that we might make a joint expedition into the western desert, he to study sand, and we to study archaeology, it so happened that the scheme coincided with some research upon which we were engaged connected with Saharan pottery. The proposal was put to Sir Robert Mond, who at once saw the importance of the research, and with his never-failing generosity financed this further archaeological venture. Many expeditions have collected material from this area, notably that of Mr. W. B. K. Shaw in 1935, but there were two outstanding differences

<sup>1</sup> The car has been recently located, repaired, and brought back by Muhammad Wasfi Bey. Since the exploits of Prince Kemal el Din, this expedition of his is probably the most difficult to be accomplished entirely by Egyptians.

between our own and those of our forerunners; we had certain specific objectives, and we proposed to excavate, albeit on a very small scale. We therefore brought with us two cars in order to carry workmen and archaeological impedimenta. Our part of the expedition was made up of myself, Mr. Terence S. Gray, M. Hagob Palamoudian (chauffeur-mechanic, who also aided us in every possible way), and three native workmen, a man and two boys, who carried out their duties excellently. For the second month Dr. Hans Winkler joined us to copy rock-drawings.

Before describing what we found it is necessary to state the problem posed us at Armant, which made it worth our while to undertake the expedition.

As long ago as 1929 we began finding on the surface of the desert edge certain sherds which did not seem to belong to any known Egyptian culture. It was not until 1934 that we began seriously to investigate the matter, and after considerable research discovered identical pottery from various places in the south-western and south-central Sahara. We were given every opportunity to study these by the Direction of the Musée de l'Homme in Paris. On the return of the expedition to Armant in the autumn of 1935 we tried to discover more about this curious intrusion of a Saharan culture in the Nile valley. For part of that season and the next our efforts were singularly unsuccessful, because we were trying to find either the cemeteries of these people or a settlement with some depth, and neither existed. Last season however we adopted a new technique of sieving the surface in all places where Saharan pottery was found and collecting all the sherds, flints, and other objects for statistical study.

By this new approach we rapidly achieved results. First, we were able to piece together complete and semi-complete pots which, as Mr. W. B. Emery pointed out, bear close resemblances to the early C-Group of Nubia, which may be dated to about the VIth Dynasty. At the same time it was possible to prove statistically that the Saharan sherds were related to a sealing-wax-red ware of Egypt made between the IIIrd and the VIth Dynasties. A few beads indicated the later date. A small expedition to the north as far as Farshut could find none of these sherds north of our concession, whereas one to the south as far as Edfu found examples all the way, and it seemed safe to assume that these people came in during the VIth Dynasty either from the west or the south, probably the latter. We set out with the idea of seeing if traces of this Saharan people (or of any other earlier invaders) could be found due west and of filling in some points in the huge gap between Armant and Gebel Silto (near Bilma, west of Tibesti), the nearest spot from which the same pottery had been recorded.

The results were extremely satisfactory. Identical pottery was found at 'Uweinat in the south, and none north of this. It seemed abundantly clear that the great stretch between 'Uweinat-Gilf Kebir on the one hand and Kharga-Dakhla on the other was already closed by desiccation at this date (*circa* 2500 B.C.). There is an area of dunes connecting the 'Uweinat area with that of Erdi and Ennedi, and this would be passable after sufficient rain as it would provide grazing. The area is well covered with ancient sites (not examined by us), and it is well known that tribes to-day can travel over dune areas after rain when other areas are impassable. It seems probable that the

'Uweinat group were an offshoot of the main emigration, and that they either stopped there or went across to the Nile *via* Bir Tirfawi and Sheb, where there is a large area only a few feet above the present water-table. The main route might have been *via* Erdi, Merga, Laqiya, Selima to Wadi Halfa, but more probably it passed farther south still, as Frobenius found C-Group pottery in Wadi Hawa. Through Wadi el Melik (not to be confused with Wadi Abd el Malik in the Gilf) to Ed Debba is an extremely likely route, for as late as the Meroitic period it was in constant use. Dr. Grabham has seen extensive Meroitic remains at the head of the wadi, including sandstone columns. This result therefore supported our hypothesis that the migration route was along the south. Indications were also found that this culture belonged to the most recent of the rock-drawings at 'Uweinat (those done in white only), but our small staff, and the fact that two-thirds of it were ill while we were at 'Uweinat, prevented our obtaining proof.

In the Gilf Kebir a similar pottery was found, though nothing exactly comparable with the Egyptian material; some of the sherds appear to be identical in decoration and shape with the large campaniform vases of Spain, which began there at 2500 B.C. In this respect it is worth noting another fact, that the first appearance of the Temehu Libyans in Egyptian history is in the reign of Pepy II, VIth Dynasty. Before describing briefly the other finds, it is worth summarizing the very important results of the above work.

At the First International Meeting for the Study of the Archaeology and Quaternary Geology of the Sahara, held in Paris in the last days of June 1938, the Armant material was submitted to the experts of the French Sahara, who agreed unanimously that it was Saharan. As a result we are now in a position to state that the C-Group people (and the Armant invaders) were of Saharan origin sharing a culture common to all that vast area (Weigall and Reisner both suggested a Libyan origin for the C-Group people), and that they entered Egypt about 2500 B.C.; that Saharan influences seem to have reached Spain at the same time; and that we may therefore assume a final exodus from the central Sahara at that date. A guess may be made as to the reason for this. Desiccation must have set in gradually, and even after modern weather conditions had become general food supplies would not all at once become exhausted. Much humus would remain and many more seeds would be lying dormant. The lake areas would only slowly dry up, and population by becoming nomadic could continue to exist for a considerable period in certain areas. However the first extensive period without any rain would make life impossible. A freak period of say seven years with no rain would make emigration essential. Perhaps this took place at about 2500 B.C. and the last pulse action of the Sahara was thereby caused, affecting cultures as remote as southern Europe and Nubia, and perhaps even farther. For the origin of this people we can perhaps look to the lake areas explored by M. Théodore Monod, where he found harpoons in quantity, hippopotamus bones, etc. The pottery, though little of it is basket-made, appears to have this process as the background of its decoration. Pottery is not naturally to be expected in a highly developed form from Badawin, but could well originate among marsh dwellers. The results are not only important for students of early European and Egyptian history but also for Saharanists, since cemeteries of

the early periods have yet to be found in that area and they will be able to derive much information from the extensive publications of Nubian C-Group graves.

Apart from pursuing the important primary aim of our research, we made such excavations and observations as we could on any archaeological material that came our way, though we did not touch any site without attempting something in the nature of scientific work.

Nearly three weeks were devoted to the clearance of an Acheulean surface site with instruments *in situ*. An area of 25 metres by 30 metres was completely cleared and all artefacts collected. Before moving any of the implements they were all marked with an arrow indicating magnetic north. It was soon clear that the majority of the instruments had not shifted and that the main winds had been steadily from the north since the instruments were left. Many interesting climatic and geological questions were raised by this site and neighbourhood, but they cannot be gone into until experts on these subjects have been consulted.

Throughout the entire area covered sites were found yielding instruments, ostrich shell, ostrich-shell beads, querns, and grinders. These might be either late Upper Palaeolithic or Neolithic of Capsian origin. In any case they preceded the general use of pottery in that area. One site was found between Kharga and Armant. It is clear that at this date communication was open across the whole area, and it seems probable that, when it dried, the people evacuated it in different directions, many probably clustering in the lake areas mentioned above and originating the pottery culture of the later period. Mr. R. F. Peel describes below a large number of these and other sites which he observed on the plateau of the Gilf and elsewhere.

The areas with pottery were those in which special circumstances prevailed and obviously at a period when existence in the vast part of the area was impossible. Apart from the sites at 'Uweinat, two were investigated in wadis in the east side of the Gilf. The wadis had been stopped by dunes, allowing lakes to collect, and it was here that a rather poor existence became possible for these people at this later date. The period is probably either contemporaneous with the Armant people or a little earlier. It is curious that they made no rock-drawings or paintings. Instruments were present in enormous quantities, mostly in quartzite, except for the microliths in quartz and chalcodony. Querns, grinders, ostrich-shell beads, and sherds were all plentiful; two or three examples of carved stone were found, two large spoons, and a phallic object. In each site, one or more squares were sieved and the entire material therefrom brought home for study, as well as the more important material from the site. No graves were found. Quantities of small rings of boulders and stones were found, the purpose of which was not discovered. These may have been dwellings, but some were perhaps used for exposing the dead, though the C-Group people did not have that custom. In some cases more than one level of implementiferous detritus was found.

At 'Uweinat we were able to show that the cultural material connected with the rock-drawings was still *in situ*, and a scientific excavation of a dozen of each type of site would, by statistical method, certainly tell us the connections of the different groups of artists with the different groups of implement and

pottery users. We could not go further with the research for reasons stated above. One splendid site found in Karkur Talh, with fine crystal blades and a spindle whorl, was left intact, as there was no time to work it properly and we had no wish to rob it of its most significant objects.

There is no place here to go into the details of the finds, which will be published fully later,<sup>1</sup> but one other result must be mentioned. Near the Acheulean site was a filled-in lake bottom with a neolithic site on the surface. Excavation showed layer after layer of alternating sand and mud representing the alternating wet and dry periods. Further excavation in similarly sheltered sites should give us the connections of the different cultures with these periods.

We are deeply indebted to Major Bagnold for the trouble he took in planning the navigation, transport, etc., of the expedition, and to Mr. Peel for making maps for us and giving other help. Also to Mr. Gray for giving his services to the expedition and for taking a most valuable series of photographs. Nor can reference be omitted to the splendid way in which M. Palamoudian helped us on every occasion in all departments as well as his own, nor to the exemplary behaviour of the Egyptians transported into the midst of the hated desert, who did their work and looked after our comfort with unfailing good-humour. I wish to express my personal thanks to the late Sir Robert Mond, who gave me this opportunity of exploring the innermost part of the desert on the edge of which we have worked for so long, and to Major Bagnold for allowing our expedition to join with his and therefore gain the help and advantage of his long experience in desert travel and navigation.

### 3. ARCHAEOLOGY. ADDITIONAL NOTES by R. F. PEEL and R. A. BAGNOLD

It is not in the province of the authors, neither of whom can claim expert knowledge of archaeology, to comment upon the important conclusions drawn by Mr. Myers from the work done by himself and his companions on the expedition. The very nature of the problems upon which the archaeologists were engaged however necessitated their concentrating attention upon a small number of selected sites. We, in the course of exploring and surveying the Gilf and its neighbourhood, wandered much farther afield, and had the opportunity of seeing a large number of sites which the experts could not visit. The following notes are intended to supplement Mr. Myers's account by giving a brief and necessarily non-technical description of these additional sites.

#### *Palaeolithic sites*

The palaeolithic sites discovered were few in number but widely scattered. The combined expedition discovered palaeoliths on the limestone plateau between the Nile and Kharga, lat. 25° 17', long. 32° 02'; on the edge of a large shallow depression some 60 miles east of 'Uweinat, lat. 21° 52', long. 26° 11'; and in large numbers at the Acheulean site near the Gilf base camp (*vide* Myers, *supra*, p. 290). In addition, Bagnold and Peel noted palaeoliths of similar types in one or two of the wadis near the Gilf base camp; on the

<sup>1</sup> Mond, Sir Robert, and Myers, O. H., 'Cemeteries of Armant II and a Saharan culture,' Egypt Exploration Society, London. (In preparation; due 1940.)

Gilf surface near the western cliffs, lat.  $23^{\circ} 18'$ , long.  $26^{\circ} 02'$ ; at the camp in the south of the Sand Sea, lat.  $25^{\circ} 17'$ , long.  $25^{\circ} 34'$ ; and in the upper part of Wadi Abd el Malik.<sup>1</sup>

The majority of these sites are grouped round areas of higher land, and none was found on the open sand-sheets. This distribution would appear to support Sandford's contentions of 1933<sup>2</sup>: "Palaeolithic implements are liable to occur almost anywhere in the Libyan desert, but there are certain wide areas where they are most unlikely to occur, from which indeed they appear to be completely absent. These areas are the sand-sheets . . ." And again: "As a rule height seems to have been favourable to Palaeolithic man . . . Ground that is high, or adjacent to some elevation, may reasonably be expected to bear implements." It must be pointed out however that nearly all our time was spent round the Gilf and 'Uweinat, and the sand-sheets were traversed at high speed with little opportunity of looking for implements.

#### *Later sites*

Far more frequent were sites later than Lower Palaeolithic. The most frequent objects they contain are flaked stone tools of a wide variety of types. Many also contain querns and grindstones, and ostrich-egg shell, sometimes decorated and worked into beads, is associated with a large proportion of such sites, particularly those out on the plains. Polished stone tools are rare, but a few were found by Myers, and one or two noted by the authors.

Sites of these types are exceedingly common. They exist over most of the area covered, but there was a concentration of quern sites in the more broken country, where eroded mud deposits frequently gave evidence of the former existence of lakes or marshes. At least a dozen such sites were seen at the feet of the scarps between Dakhla-Kharga and the Gilf. They were common also round 'Uweinat, but most abundant in the wadis and depressions round the Gilf. Myers has described later sites in two of the wadis (Wadi el Bakht and Wadi Ard el Akhdar) on the east of the Gilf, where there was also pottery. Sites without pottery were found in a large percentage of the wadis of the southern Gilf. More surprising was the discovery of similar sites in great profusion on the Gilf surface itself. At a large number of points on the plateau, particularly near its edges, and near the heads of wadis, the ground was literally covered with discarded flake tools and waste flakings. It would appear that the dwellers in the wadis periodically ascended to such points to flake implements out of suitable exposures of the upper silicified beds, and even occasionally out of basalt. Evidence of more lengthy occupation was found round many of the shallow depressions in the interior of the plateau, where querns and rubbers were numerous. Traces of mud in some of these depressions indicate that vegetation may have flourished after rains even on these now barren heights and allowed of temporary occupation.

Two sites near the western cliffs contained large numbers of microliths, and one coup-de-poing was found in this region.

<sup>1</sup> Neither Myers nor ourselves noticed a single Upper Palaeolithic implement throughout the trip, and it seems to be generally agreed that the Libyan desert was uninhabitable during this period.

<sup>2</sup> Sandford, K. S., "Past climate and early man in the southern Libyan desert," *Geogr. J.* 82 (1933) 219-22.



*Basalt hills on the surface of the Gilf*



*General view of crater A3*



*Stone circles on the surface of the southern Gilf*





*Wadi floor from the plateau, showing the stream beds*



*Eroded bed of former sand-drift lake at the head of Wadi Ard el Akhdar*



*The painted caves of Wadi Sura*

Sites with flaked stone tools were also found in fair numbers on the northern plateau, and a wide variety of implements in the upper part of Wadi Abd el Malik; lower down they were entirely lacking, probably on account of a later covering of water-borne deposit. Querns, flakes of many shapes, and one coup-de-poing were found, and one example of a beautifully worked implement of laurel-leaf shape, about 5 inches long.

Apart from artefacts, the Gilf surface showed some other features of interest. Stone circles, built of a single row of flat stones, and some 4–5 feet in diameter, were noted at three points. Similar circles were also found on the top of an isolated hill some 25 miles north-east of the southern Gilf. No obvious purpose could be assigned to these constructions. Still less explicable were certain irregular lines of stones laid out on the plateau surface. They may relate to the many well-defined tracks winding over the plateau, since in nearly all cases they are laid across the tracks as if to mark boundaries of some kind. The general impression gained is that the plateau was visited frequently, if not inhabited, up to neolithic times.

Implements of the types described were also found at intervals along the route north along the western side of the Gilf, and in the Sand Sea area to the north. The open ground of the "streets" between the dune lines abounded in flake tools and querns, and one palaeolith was found. Long curved blades of a type common among the dunes south-west of 'Uweinat were found on the flanks of the dune ridges. The silica glass had also been worked in many places, and a site containing glass and stone flakes was found in the heart of one dune ridge. It is noteworthy that remains other than palaeolithic were concentrated towards the dune ranges and away from the open rocky streets, and that herbage still grows in places after rain on these dunes, whereas there are no traces of any vegetation on the desert floor.

### *Rock-drawings and paintings*

The well-known rock-engravings and paintings of 'Uweinat were intensively studied by Dr. Winkler, and a full account of his work will be published elsewhere.<sup>1</sup> Dr. Winkler also visited the series of paintings discovered by McEuen and Shaw in 1935 in the southern Gilf.<sup>2</sup> At 'Uweinat Winkler found new sites in Karkur Talh, and Bagnold a fine series of paintings in abris at the head of Karkur Murr. Cattle and various groups of human figures were shown in dark-red and white. Subsequently the authors visited the remarkable caves in Wadi Sura, in the western Gilf, where Almásy in 1934 found what is probably the richest series of paintings known in the region.<sup>3</sup> Two large caves here contain paintings; the one cattle and archers, the other chiefly men of a variety of types and drawn in red, white, and, more rarely, yellow. Several distinct styles are represented, and a number of the groups are apparently engaged in social or religious occupations. Perhaps the most intriguing

<sup>1</sup> Winkler, H. A., 'Rock-drawings of southern Upper Egypt, II.' Egypt Exploration Society, London (in preparation).

<sup>2</sup> Shaw, W. B. K., "An expedition to the southern Libyan desert," *Geogr. J.* 87 (1936) 193–221.

<sup>3</sup> Almásy, Count L. E. de, 'Récentes explorations dans le Désert libyque.' Publ. spéc. Soc. géogr. Égypte, Cairo, 1936.

figures are those Almásy<sup>1</sup> styles "nageurs." The attitudes portrayed are certainly strikingly reminiscent of those of swimmers: a strange anomaly in this parched land. Unfortunately the walls and ceilings of these caves have scaled badly, and a large proportion of the paintings have been destroyed. Some have been deliberately defaced, possibly by inhabitants subsequent to the artists who resented or feared the art of their predecessors. It is to be hoped that here, and elsewhere, the remaining paintings will be thoroughly studied and recorded before they are lost for ever, and that the other associated remains on the cave floors will be carefully recorded before students interested only in art have trampled them down.

Later Peel found paintings in a small grotto in the eastern branch of Wadi Abd el Malik, some 12 miles above the junction of the two branches. Cattle only were depicted at this site and were so faint that they had to be moistened before they were clear enough to be photographed.

The Wadi Sura caves lie in the area of more massive sandstones akin to the Karkur Talh rocks, and tentatively identified as Palaeozoic. These rocks weather to give large smooth faces, ideal for painting on. The absence of this type of sandstone along the east of the Gilf may help to account for the lack of paintings in that region. In every case examined the paintings were on the walls or ceilings of caves or abris; the caves were themselves, or were near to, probable water sources; and the floors below often showed implements. At Karkur Talh, Karkur Murr, Wadi Sura, and Wadi Abd el Malik Bagnold found crude but distinctive microliths struck from small quartz pebbles, and at the last two ostrich-shell beads. On the floors of the Wadi Sura caves were also fragments of red ochre, and white and yellow clays which may have been the very pigments used by the artists.

#### *Tibu (Guraan) remains*

In Karkur Talh many traces were found of the Guraan who formerly used to visit the wadi. Most of these were probably left by the band of fugitives under Herri who fled here after the French occupation of the Ennedi-Tibesti highlands. Remains of three or four grass huts were found, and a large number of small stone shelters. Several large querns, baskets, ropes, water-skins, and woven mats were scattered round the dwellings, and two parts of camel-saddles were found. Pottery with a distinctive decoration was also present. A collection of these objects was brought back for study and publication elsewhere. A few traces of occupation were seen in Karkur Murr, and a number in Abd el Malik, where pottery was found with a decoration identical with that of the 'Uweinat examples. There was no evidence however that the Tibu had been in the region for a number of years.

*Appendix:* List of rock-painting sites in the Libyan desert (Egyptian and Anglo-Egyptian Sudan).

Rock-paintings (as distinct from engravings, etc.) have now been found at the following places:

(1) 'Uweinat: Karkur Talh. A large number of sites by Prince Kemal el Din, Hassanein Bey, Almásy, Winkler, and Myers.

<sup>1</sup> Almásy, *op. cit.*

- (2) 'Uweinat: Karkur Ibrahim. By Hassanein Bey.
- (3) 'Uweinat: Karkur Murr. By Bagnold.
- (4) 'Uweinat: 'Ain Dua. By Almásy.
- (5) Gebel Kissu. By Almásy.
- (6) Yerguehda Hill. By Bagnold.
- (7) Gilf: Wadi Sura. By Almásy.
- (8) Gilf: Magharat el Kantara. By McEuen and Shaw.
- (9) Gilf: Wadi Abd el Malik. By Peel.

#### 4. THE GILF KEBIR. By R. F. PEEL

The extensive sandstone plateau of the Gilf Kebir was discovered as recently as 1926 by Prince Kemal el Din during the course of his expedition to Sarra<sup>1</sup>; but he did no more than skirt its south-eastern scarps, fixing upon the map the positions of their major promontories. Bagnold<sup>2</sup> in 1930 followed the Prince's tracks to 'Uweinat, but again did not stop to penetrate the plateau. The western side remained unknown until 1931, when P. A. Clayton, of the Egypt Desert Surveys, accomplished a remarkable feat of high-speed surveying in sketching in the western cliffs as far north as lat. 23° 35' in a single day's journey from 'Uweinat.<sup>3</sup> In the following year the expedition of Sir Robert Clayton East Clayton and Count L. E. de Almásy advanced north of P. A. Clayton's turning-point in 1931, and spent some time in exploring and mapping the western side of the northern Gilf. During this expedition the wadis of Abd el Malik and Talh, containing live vegetation, were seen from an aeroplane reconnaissance, but attempts to reach them on foot failed.<sup>4</sup> Returning in 1933 with Wing-Commander H. W. G. J. Penderel, Almásy approached the Gilf from the east, and found that instead of being a continuous plateau it was divided into northern and southern sections by a narrow gap which afforded an easy through-route for cars. Passing through this gap (El 'Aqaba) Almásy returned to his attack on the northern wadis and explored extensively in the neighbourhood of Abd el Malik on foot, while Penderel pushed north along the eastern side.<sup>5</sup> Meanwhile however Clayton had been active in the region and had forestalled Almásy by penetrating into Abd el Malik by car, continuing his explorations round the north of the Gilf during 1933 and 1934, and fixing in the main outlines of the plateau in that region. Finally in 1935 W. B. K. Shaw reached the Gilf from the east, and passing through the gap spent some time in exploring the wadis in the extreme south of the plateau before proceeding on his way to El Fasher.<sup>6</sup>

No expedition from Egyptian territory had visited the Gilf since 1935, but new information had been collected about it by Almásy from an old Arab,

<sup>1</sup> Kemal el Din, Hussein, Prince, "L'exploration du Désert de Libye," *Géographie* 1928 (50) 171-183; 320-336.

<sup>2</sup> Bagnold, R. A., "Journeys in the Libyan desert, 1929 and 1930," *Geogr. J.* 78 (1931) 13-39; 524-35.

<sup>3</sup> Clayton, P. A., "The western side of the Gilf Kebir," *Geogr. J.* 81 (1933) 254-9.

<sup>4</sup> Clayton, P. A., *loc. cit.*

<sup>5</sup> Penderel, H. W. G. J., "The Gilf Kebir," *Geogr. J.* 83 (1934) 449-56. Also Berman, R., "Historic problems of the Libyan desert," *Geogr. J.* 83 (1934) 456-70.

<sup>6</sup> Shaw, W. B. K., "An expedition to the southern Libyan desert," *Geogr. J.* 87 (1936) 193-221.

Abd el Malik, after whom the largest of the northern wadis is named. This man, fugitive from Cufra after the Italian occupation of 1931, revealed that until recent times the Cufra Tibu had grazed their camels in the northern wadis after rains, and that he himself had continued this practice after discovering the wadis and capturing the Tibu camels. He also vouched for the existence of a well in Wadi Abd el Malik. A full account of his disclosures has been given by Almásy<sup>1</sup> and summarized by Bagnold in this *Journal*.<sup>2</sup>

As a result of these various expeditions the general nature and extent of the Gilf were known prior to our expedition, and its outlines were shown on the latest (1935) edition of the official 1 : 500,000 map in fair detail. Apart from the work of Clayton and Almásy in the north however little was known about the interior, and the southern plateau in particular remained virtually a blank space on the map, bordered by forbidding lines of hachured cliffs. Our attention was accordingly directed mainly to this area, and in the course of three weeks' work we were able to explore most of its wadis and, eventually, its surface, with results shown in the map accompanying this paper (following p. 376). Later, as Bagnold has related, we also visited the northern Gilf and were again able to add some details to the existing map.

#### *General description*

The plateau has a total extension in latitude of more than 150 miles, and a maximum breadth of some 50 miles. Its total area must be in the neighbourhood of 6000–7000 square miles, more than half that of Belgium. As Almásy discovered, it is divided into two parts by an erosional trough in lat. 23° 30', the southern plateau being much more homogeneous and clearly defined than the northern. Altitude observations are few, but such as exist show that the plateau surface is some 3500 feet above sea-level in the south, and drops to about 1500 feet in the north. The cliffs are also highest in the south, and decline steadily from about 1500 feet at the southern tip to zero in the extreme north, where the plateau merges into the plains underlying the Sand Sea. The surface is remarkably flat, and the dip so slight that to the eye the surface appears uniformly horizontal.

The plateau is dissected round its edges by numerous deep and gorge-like wadis. These have eaten their way back into it for considerable distances, especially in the northern Gilf, which is in parts merely a series of narrow tongues of plateau separating the deep and twisting wadis. Abd el Malik for example, has a total length of approximately 60 miles. The northern plateau is in fact to a large extent screened behind a maze of flat-topped hills, outliers of the plateau detached from it by wadi erosion. The smaller of these have been reduced by denudation to the isolated conical hills so characteristic of the Nubian sandstone country.

Apart from the well reputed to exist in Wadi Abd el Malik, for which we searched in vain, the whole region is absolutely waterless, and vegetation, apart from odd tufts of grass, had been found previously only in the three northern wadis of Abd el Malik, Talh, and Hamra. It seemed possible

<sup>1</sup> Almásy, Count L. E. de, 'Récentes explorations dans le Désert libyque.' This work gives a further account of all Almásy's expeditions.

<sup>2</sup> Bagnold, R. A., "The last of the Zerzura legend," *Geogr. J.* 89 (1937) 265–8.

however that similar live wadis might exist in the southern plateau, a factor which lent an added interest to our exploration.

*Exploration and survey*

The exploration and mapping of the southern plateau produced problems of some difficulty. It was originally hoped to map the plateau surface by plane-table, working between control points fixed astronomically. This idea proved impracticable on account of the distances involved and the featureless character of most of the surface. The wadis themselves are quite invisible from even a short distance. As these wadis were the most important features to map, it was therefore decided to work from below, and to run a series of traverses up the wadis and round the cliffs, closing on to points already shown on the map with reasonable accuracy. This method allowed us to explore a great deal of ground in a short period, but left the actual surface untouched. Eventually however we succeeded in getting a car up on to the plateau, and ran a zigzag traverse across it, tying in various wadi-heads *en route* as a check on the previous work. As a further check an astronomical fix was taken of a prominent hill on the plateau, and the various traverses were corrected on to this fixed point.

Owing to the long distances to be covered, traverses had to be made by car, with sun-compass and speedometer mileage, in the manner of normal desert navigation.<sup>1</sup> For this small-scale work however some minor defects in the method assumed considerable importance. In following a course over a day's run it is generally found sufficient to change the setting of the sun-compass every half-hour; the errors in the two quarters more or less cancel out. In small-scale work, particularly during the midday hours when the sun's azimuth is changing rapidly, one is seldom on the same course for long enough for this cancelling-out to occur. It was found advisable to change the compass setting every quarter-hour, and over the midday period almost continuously. By doing this errors of bearing were reduced to a negligible quantity, in spite of the rapid twists and turns of the wadis. Errors of distance were more serious. The over-size tyres fitted introduced a negative error throughout the expedition, but unfortunately this error did not remain constant. It appeared to vary with the load, the tyre pressure, the speed, and the nature of the surface traversed. A maximum error of 15 per cent. was recorded when running fast and light to Bir Misaha. Running slowly, and heavily laden, the average was 2-5 per cent., but it proved difficult to estimate the error in any particular instance. By reason of the checks employed however these errors were largely eliminated from the detailed survey. In all some 800 miles were covered in the course of this work. Detail was filled in round the traverse lines by visual sketching and compass intersections. Aneroid readings for altitude were taken at a number of points on the plateau and in the wadis, and the map drawn in the field on the scale of 1 : 250,000. A fair copy was taken off the original field-sheet directly on return to England and sent to the Egyptian Topographical Survey. With their concurrence, descriptive Arabic names have been given to the more

<sup>1</sup> For an account of the sun-compass and its use in desert navigation see Newbold, D., *Geogr. J.* 78 (1931) 526-30. Also 'Hints to travellers,' vol. 1, eleventh edition, pp. 145-9.

important features for easy reference to the places mentioned in this and other papers.

### Geology

The Gilf lies in the middle of the broad plain of Nubian rocks forming the central part of the Libyan desert, and is itself essentially a relict plateau cut out of the sandstones and pebble beds of the Nubian Series.<sup>1</sup> The bedding of this series is here apparently horizontal, but the gentle decline of the plateau surface towards the north and east indicates a low angle of dip in that direction. This dip becomes apparent to the eye in the series of east-west escarpments between the Gilf and Kharga.<sup>2</sup> From the surrounding plains the cliffs rise abruptly, giving excellent cliff sections in which individual beds can be traced for great distances. A typical section on the east of the Gilf, taken at the base camp, gave the succession shown in Fig. 1.

This sequence corresponds closely to that given by Sandford<sup>2</sup> for the

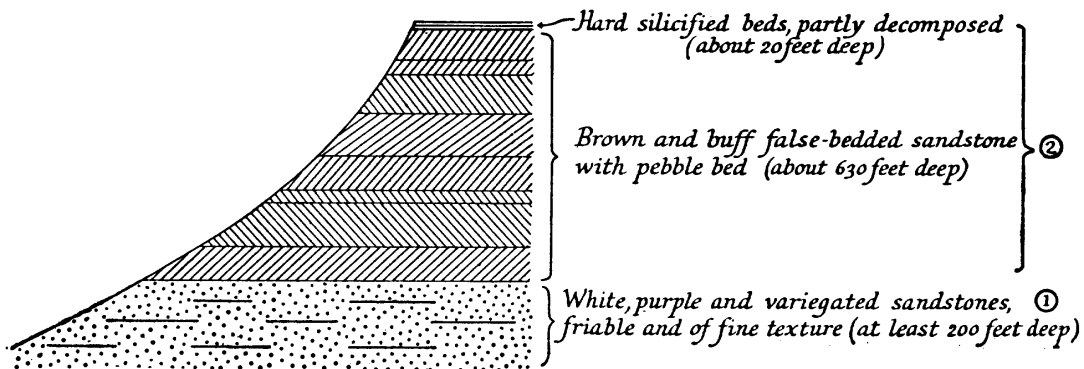


Fig. 1. Section of the Gilf cliffs

Nubian Series east of the Gilf, although no basal conglomerate or breccia such as he records was found between 2 and 1. Sandford has put forward the view that the lower part of the succession in the Gilf may be Palaeozoic in age.

Along the western side of the Gilf a similar succession is to be seen, but in the region of Wadi Sura (lat.  $23^{\circ} 35'$ ) and for a short distance north sandstones of a different type outcrop in the lower part of the cliffs. These are of a darker brown, and more massive in structure, than the typical Nubian beds, and are essentially similar in appearance to the massive sandstones round Karkur Talh on the northern flanks of 'Uweinat. They have an apparent dip north-eastwards under the plateau, and may be referable to the earlier Palaeozoic sandstones of Sandford.<sup>3</sup>

### Structure: igneous rocks

No signs of disturbance in the horizontal bedding were seen in the outer cliffs of the plateau, although P. A. Clayton had recorded the presence of an

<sup>1</sup> Sandford, K. S., "Geological observations on the north-western frontiers of the Anglo-Egyptian Sudan and the adjoining parts of the Libyan desert," *Quart. J. geol. Soc.* 91 (1935) 342.

<sup>2</sup> Sandford, K. S., *ibid.*, pp. 345-6.

<sup>3</sup> Sandford, K. S., *ibid.*, pp. 334-54.

east-west anticlinal fold in the Abd el Malik region.<sup>1</sup> During the exploration of the wadis however signs of minor folding were noticed in the cliffs of Wadi Ras al Qibli, and immediately afterwards water-worn fragments of a heavy and dark igneous rock were picked up in the wadi bed. Higher up this wadi the source of these fragments was found in two rounded hills of basalt. On climbing on to the plateau surface a number of similar basalt hills became visible, standing out above the level surface in low rounded domes. During the next two weeks the central part of the plateau was traversed, and similar basalt hills were found to extend far to the north, and to link on to the two exposures already known in the extreme north-east. In all nearly fifty exposures were found and mapped, over a distance of about 50 miles. All were of similar type: isolated intrusions akin to volcanic necks, the largest being about  $\frac{3}{4}$  mile across. There were no surface traces of connection between them, and no traces of explosive action or of lava-flows. Many lay in a belt of low broken hills running down the centre of the plateau, and the surrounding rocks occasionally showed traces of contact metamorphism. In cases where wadis had cut back close to them the surrounding rocks were seen to be arched up round the intrusion, but no trace of this appeared on the surface. The age of these intrusions must remain doubtful pending detailed geological investigation, but their denuded appearance suggests that the present exposures may be merely the cores of the original structures. The intrusive rocks, all basalts, appear to remain fairly constant in type over the whole area, but details of the petrology will be published elsewhere when the specimens brought back have been analysed.

#### *Craters north-east of 'Uweinat*

At this point mention may be made of a second discovery in the realms of igneous geology. As Bagnold has related, on the run south from the Gilf to 'Uweinat our attention was caught by a group of low hills, some 5 miles off our course, which had every appearance of being volcanic craters similar to those found by P. A. Clayton in 1931, 25 miles farther south-west, and later investigated by Sandford.<sup>2</sup> Closer inspection confirmed this view. A row of seven craters rose from the level desert surface extending in line over about 5 miles, the mean bearing of the line being 115-295 mag. (Fig. 2). Camp was pitched at one of the largest of these craters, and in the limited time available notes were made of its outstanding features.

The crater was roughly circular in shape, measuring 1200 yards by 1000 yards (paced internal measurements). The walls consisted of baked and partially fused sandstone, thrust up vertically or even overturned outwards. They reached a height of about 100 feet. Inside the rim was a broad low dome of a heavy greenish igneous rock, in appearance like a diorite. The rim itself was broken by several gaps, and rainwater collecting in the crater had escaped through one of these. A second crater about a mile to the east was smaller, but with steeper and less broken walls. In the centre it contained a compound

<sup>1</sup> Clayton, P. A., *loc. cit.*

<sup>2</sup> Sandford, K. S., *loc. cit.*, pp. 358-66; "Volcanic craters in the Libyan desert," *Nature* 131 (1933) 46; "Extinct volcanoes and associated intrusions in the Libyan desert," *Trans. R. geol. Soc. Cornwall* 16 (1935) 331-58.



neck of basalt, which formed a low dome standing about 50 feet above the level of the plain. Again a stream bed led from the central hollow out through a gap in the rim at one point. The other craters of this group we had to leave unvisited, but from a distant view they appeared to be essentially similar to the two described. The surrounding plains were of rough sandstone with silicified bands, and littered with rock fragments, but in a hurried examination

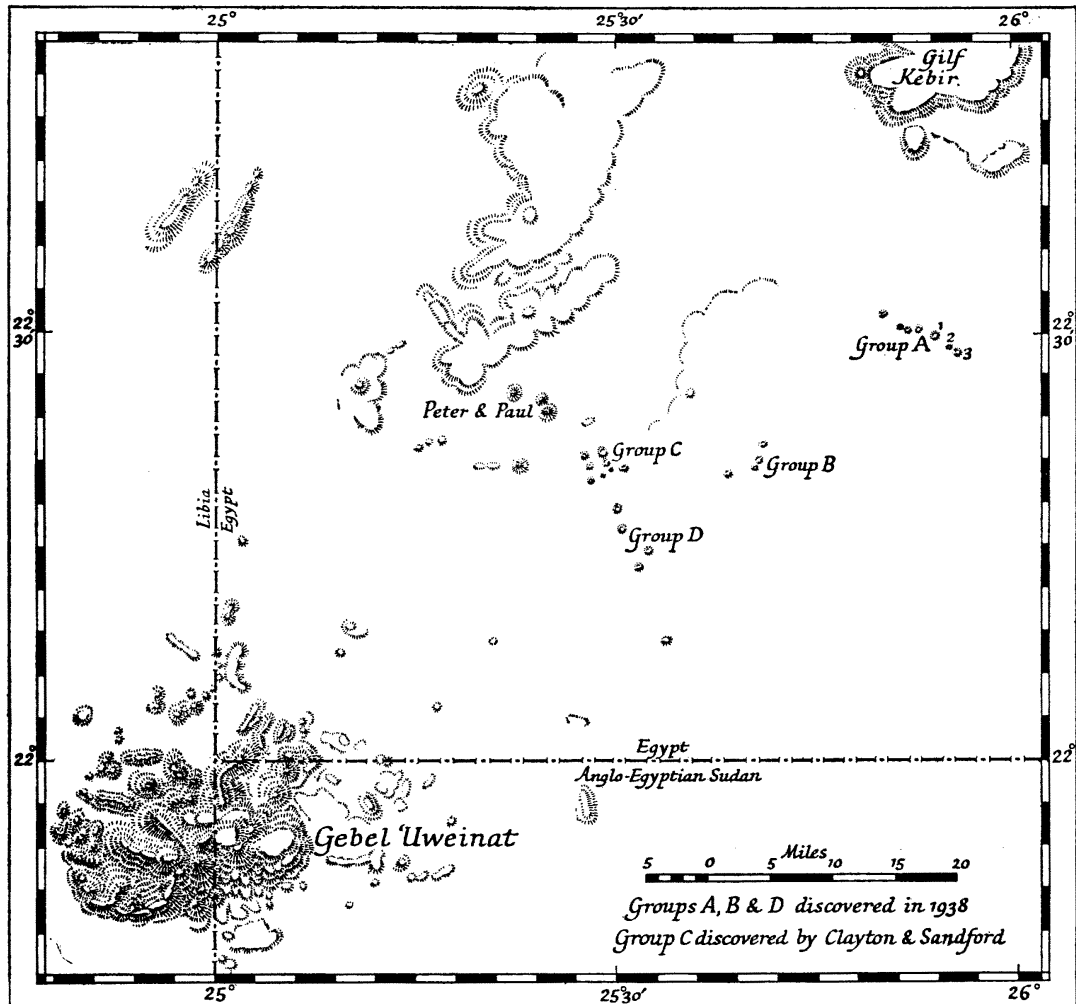


Fig. 2. Craters north-east of 'Uweinat

nothing was found which could be definitely identified as ejecta, and there were no traces of lava-flows (Fig. 3).

On the following day a second group of craters was discovered some 15 miles to the south-west, intermingled with isolated basalt domes of the Gilf type, and finally similar basalt hills a few miles to the south-east of Sandford's group of craters.

In general characteristics these craters appear to be of very similar type to those described by Sandford, and to form with them a single volcanic field. Igneous activity is indeed manifest over the whole of this area north-east of 'Uweinat, and upstanding walls of prismatic sandstone form a distinctive feature of the desert surface. The craters found, like those of Sandford, look remarkably fresh, but beyond the fact that they are post-Nubian

nothing can be said definitely about their age. Their relationship to the Gilf basalts would be worthy of future investigation.

### *Geomorphology*

Reference has already been made to the outstanding features of the Gilf: the levelness of surface, steep cliffs, and gorge-like wadis. Some additional details may be added which appear of significance in relation to its origin and past history.

The Gilf surface, although sloping gently to the north and east, is remarkable for its altogether unusual degree of flatness and lack of relief save for the

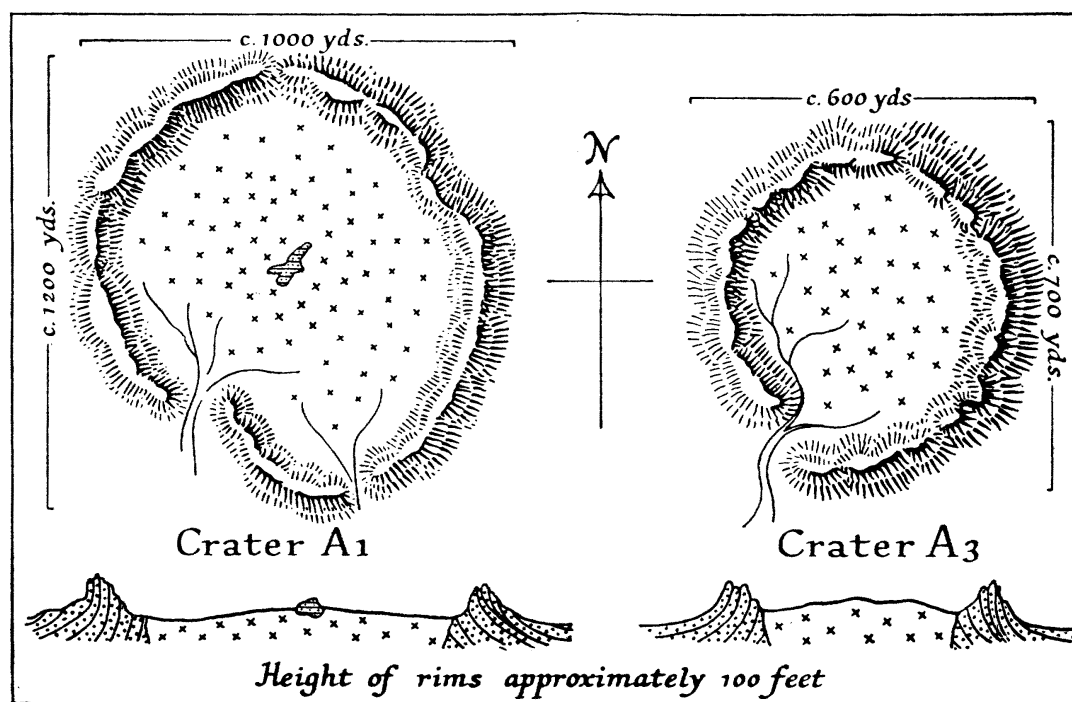


Fig. 3. Plan and section of 'Uweinat craters

basalt hills already noted. No traces of former drainage systems could be distinguished on it. This level surface is apparently continued in the smaller plateaux and flat-topped hills which partially surround the Gilf, those examined revealing an identical structure and rising, so far as could be judged by eye, to just about the same elevation. These features would suggest that the Gilf and its satellites represent surviving fragments of a former land-surface now dissected and largely destroyed by the subaerial denudation which has produced the present desert plains. The present cycle of denudation may have reached comparative maturity in certain areas of the central desert, as for example the Selima sand-sheet, where a level surface has been produced some 1500–2000 feet below the Gilf surface.<sup>1</sup>

The original extension and mode of origin of this last-named surface are matters on which nothing conclusive can be said until there is available much more evidence, both topographical and geological. In recent years the presence

<sup>1</sup> Sandford, K. S., "Geology and geomorphology of the southern Libyan desert," *Geogr. J.* 82 (1933) 211–35.

of extensive dissected peneplains has been recognized in East Africa<sup>1</sup> and South Africa.<sup>2</sup> The Gilf may represent a fragment of a comparable erosion surface of considerable antiquity: but it would be premature in the light of the existing evidence to make any definite claims as to its relationships or mode of origin. Sandford has suggested that it may be correlated with the Jef Jef plateau and many other elevated regions of Nubian sandstone between Tibesti and the Nile. He also suggests that "the southern Libyan desert is in fact a hole gouged out of a very old land surface, made of Mesozoic strata . . . probably reduced to subdued relief in early Tertiary times."<sup>3</sup> In another paper he summarizes this view: "The disposition of high and low ground has led me to suggest (1933) that at least two cycles of subaerial denudation may be recognized, but whether these may be coupled with East African peneplains is not clear."<sup>4</sup>

So far as the Gilf itself is concerned there is little manifest evidence of the actual mode of formation of the surface. It may be a peneplain of subaerial origin, as here inferred by Sandford, but the extreme flatness and lack of relief almost suggest a plain of marine erosion. The present termination of the marine Cretaceous is only some 150 miles to the north, and in a recent letter Sandford has stressed the possibility of marine denudation in Cretaceous or early Tertiary times being the essential factor in the problem. Nothing more than the statement of these various possibilities can be attempted at the present stage, but the problem would repay the attention of geomorphologists in the future.

The surface of the Gilf, although in a sense structurally controlled, since the bedding is nearly horizontal, is certainly one of denudation, the folding round the igneous intrusions having no effect on its flatness. The basalt hills also evidently owe their present shapes to denudation. No reliable estimate of the thickness of Nubian strata missing from the Gilf surface can be made in view of the great distances involved and the very slight and variable angle of dip. A very rough calculation, assuming a constant dip for the Cretaceous from its outcrop to the north, would indicate a thickness to be measured in hundreds, rather than thousands of feet; a conclusion which would conform with Sandford's estimates of the thickness of the series as a whole.<sup>5</sup>

At present thick silicified beds form the surface over wide areas, and by their resistance to mechanical weathering form a protective capping to the plateau. These beds break up into spheroidal masses, which in turn exfoliate with expansion and contraction under the extreme temperature changes into splintered blocks and curved chips, giving a surface anything but pleasant to drive a car over. Over considerable areas however softer sandstones remain above the silicified beds, yielding a smooth surface of small rounded fragments of blackened sandstone. In a few areas the silicified beds have been cut through

<sup>1</sup> Wayland, E. J., "The peneplains of East Africa," *Geogr. J.* 82 (1933) 95; 83 (1934) 79. Willis, Bailey, "The peneplains of East Africa," *Geogr. J.* 82 (1933) 383-4.

<sup>2</sup> Maufe, H. B., *S. Afr. geogr. J.*, vol. 18, 1935.

<sup>3</sup> Sandford, K. S., *Geogr. J.* 82 (1933) 218.

<sup>4</sup> Sandford, K. S., *Quart. J. geol. Soc.* 91 (Sept. 1935) 326.

<sup>5</sup> Sandford, K. S., *ibid.*, pp. 352-4.

(or were locally undeveloped) and the softer underlying sandstones have been dissected into a mass of conical hills; but there is no system about the topography in those areas. Elsewhere the surface shows little trace of recent erosion. In places it is scored with shallow and superficial gullies, some of which lead into shallow closed depressions, but few into wadi-heads. Sand accumulations are completely lacking on the surface of the southern plateau (in the north a few of the great seif-dunes running down from the Sand Sea transgress on to the surface), although the presence of south-pointing sand-drifts in many of the wadis shows that a certain amount of sand does move over the plateau. Implements picked up on the plateau however show little of the sand polish typical of those found on the plains, and from the general circumstances it is unlikely that wind and sand-blast are effective agents of denudation. The greater part of the surface would appear to be undergoing effective attack only from very slow atmospheric weathering and lateral undercutting by retreat of the cliffs and headward recession of the wadis.

The wadis show several features of interest. In plan they follow an irregular radial pattern, the majority draining eastwards. The divide, if such a term may be used of a flat-topped plateau, lies near to the western cliffs, which are little dissected save in the extreme south, where, as Shaw<sup>1</sup> discovered, a few major wadis have cut back right through the plateau. Each wadi runs in a chain of straight lines, connected by abrupt bends; the smooth curves of a normal river valley are conspicuously absent. Tributaries join them at all angles. In cross-section they are typically flat-floored, the surface rising only gently to the base of the cliff walls, except where sand-drifts have accumulated. The cliff walls are invariably steep, showing an average slope of about 33 degrees. They become steeper towards the top, culminating in a vertical, or nearly vertical, lip where the silicified beds crop out. Their lower slopes are clothed in screes, but where not obscured the slopes clearly reflect the varying resistance of the different beds of the Nubian Series by rising in a series of steps. The protective effect of the capping of silicified beds is clearly reflected in the steepness of these cliffs, which appear to retreat by the undercutting of this layer.

It was hoped to make a series of detailed longitudinal and transverse profiles of typical wadis, but this proved impracticable. From the rather inadequate data of aneroid readings taken at intervals up two wadi beds, it has proved impossible to draw accurate profiles; the personal impression gained in passing up them is that the very gentle gradient does not steepen progressively and smoothly as in a normal river valley, but shows a sequence of steeper and flatter sections, being often steeper near the mouth than higher up. The wadis terminate in very steep and narrow gullies, or sheer cliffs, with a very pronounced break of slope at their base.

The mode of formation of these wadis presents an interesting problem. There can be no doubt that they are primarily the product of water erosion. The slope of their beds and concordance in level of their tributaries prove this, and additional evidence is afforded by the presence of very obvious stream beds in them. Viewed from above, the flat wadi floors are seen to be

<sup>1</sup> Shaw, W. B. K., *Geogr. J.* 87 (1936) 193-221.

scored with a multitude of drainage channels, deeply incised into the mantle of water-worn boulders and stones, sand, and mud which hides the solid rock. The latest stream channels have often cut meander terraces fringed with cliffs 6 or 8 feet high in the detritus laid down by their predecessors. The bulk of this erosion probably relates to an earlier period of much more frequent and copious rainfall, a conclusion supported by the fact that artefacts of neolithic age are occasionally to be found in the upper wadis apparently *in situ*; but many of the meander scars look very fresh and recent, and implements picked up in many cases show clear evidence of having been transported. Data on the rainfall of this area during historic times is of course scanty, but from the accounts of travellers who have visited it, and the native reports, heavy rainstorms are liable to occur about every seven to ten years. De Mascarel, a member of Kemal el Din's 1925-26 expedition, writes: "Ouenat n'est pas d'ailleurs complètement privé de précipitations atmosphériques intenses, ni même d'inondations, témoins les arbres flottés que nous avons trouvés dans les ravines de la plaine, à plusieurs kilometres au sud de la montagne, mais ces orages violents sont bien rares."

Kemal el Din himself, after quoting this statement, writes: "J'ai appris récemment que les pluies de l'automne 1927 . . . qui succédaient ici à une période de sécheresse de six années, ont été si abondantes que le bassin de réception dont il est question ci-dessus (contre les dunes, à 25 km. à l'ouest d'Ouenat) a été complètement inondé et que, des sayals qui le parsèment, il n'émergeait que la tête, ce qui suppose une profondeur d'eau dépassant par endroits 2 mètres."<sup>1</sup>

Sandford, in a paper summarizing the evidence of recent precipitation in the area, notes that there was good grass at 'Uweinat in 1923 when Hassanein Bey visited it, and heavy rainstorms occurred in the spring of 1934.<sup>2</sup>

Such heavy rainstorms would give an enormous concentration of water flowing down the wadis, and probably give rise to a mass transport of rock waste, sand, and mud akin to the sheet-flooding of American geologists.<sup>3</sup> Some such mechanism must be invoked to explain the accumulation of detrital material laid down round the mouths of even quite short and insignificant wadis. On reaching the plain the water would rapidly sink away and evaporate as it spread out over a wider area. While it appears clear that water erosion has been the main factor at work in the evolution of the wadis, the exact mode of that evolution is not so clear. The wadis present several curious features: their floors are flat; in many cases their width is out of all proportion to their length, and they grade into open bays; many contain alternating narrow gorge-like sections and broad, open basins; they run at peculiar angles, with tributary wadis occasionally pointing upstream; both in transverse profile and at their heads, the wadi beds end in abrupt cliffs; and there is little or no evidence of water flowing over the plateau surface to pour into the wadis. Most of these peculiarities may be summed up by saying that

<sup>1</sup> Kemal el Din, Prince, *op. cit.*, p. 328.

<sup>2</sup> Sandford, K. S., "Observations on the distribution of freshwater mollusca in the southern Libyan desert," *Quart. J. geol. Soc.* 92 (1936) 201-20.

<sup>3</sup> McGee, J. W., "Sheet-flood erosion," *Bull. geol. Soc. Amer.* 8 (1897); Blackwelder, E., *Bull. geol. Soc. Amer.* 39 (1928).

in the evolution of the wadis, lateral cutting seems to have been as important as vertical. Shaw's phrase puts the matter graphically: "It is as though an army of gigantic maggots, advancing from the east, had eaten their way into the plateau as into a flat cheese . . ." <sup>1</sup>

The problem of lateral cutting under arid conditions, especially with regard to the formation of desert plains, is one that has received much attention from American physiographers. J. L. Rich in a recent paper <sup>2</sup> has summarized the various views put forward, and advanced a theory to explain the retreat of scarps and the formation of rock plains in advance of them. He does not deal with the valleys cut in the scarps, so that his thesis is not strictly applicable to the matter in hand, although it would presumably cover the lateral retreat of the Gilf cliffs, which is in effect part of the same problem. His paper is useful however in summarizing the various erosion processes which are supposed to bring about lateral planation. Briefly these may be stated as: weathering of scarps and removal of the debris by occasional rain wash and wind deflation; lateral water erosion by sheet-floods; and lateral water erosion by heavily loaded streams, swinging widely in the lateral plain. Rich, while favouring the second of these agencies as the most effective, is willing to allow that all three might act together and their relative importance vary with local circumstances. In the Gilf all three may reasonably be invoked to explain the wadis. Wide lateral swinging by fully loaded streams after rainstorms might gradually carve out broad flat-bottomed valleys; while if Tibu accounts of the nature of the rainfall are even partially credited, some form of sheet-wash can readily be imagined covering the whole floor of even a broad wadi, and undercutting its sides. Several of the peculiarities enumerated however cannot be satisfactorily explained even by admitting all these processes. The essence of the problem seems to be to discover some agency which might gnaw away the cliffs from below in rather an irregular manner. In this connection a suggestion made to me by Bagnold seems worthy of consideration. At many points round the base of the cliffs partly obliterated cavities may be noticed. Almásy had no hesitation in identifying some of these in the Wadi Sura as intermittent springs. If rainfall on the plateau surface were to sink straight into the porous sandstones, and reappear near the base of the cliffs as copious springs, irregular undercutting and retreat of the cliffs would undoubtedly follow. This would help to explain the lack of drainage channels scoring the lips of the wadi cliffs and the plateau surface, the irregularity in the outline of the wadis, and the fact that they begin from abrupt cliffs. If this mechanism were allowed, recession of the cliffs and extension of the wadis would take place essentially by sapping and undercutting of the cliffs, the scree material produced being removed *en masse* by sheet-flooding after rains, and possibly by slow wind deflation in dry seasons.

As there had apparently been no rain at the Gilf for a very long period, it was naturally difficult to evolve any means of testing this hypothesis, which must remain purely tentative. Photographs taken from some 300 feet above a typical wadi floor strongly suggest however that, at the last major rains,

<sup>1</sup> Shaw, W. K. B., *op. cit.*, p. 195.

<sup>2</sup> Rich, J. L., "The origin and evolution of rock-fans and pediments," *Bull. geol. Soc. Amer.* 46 (1935) 999-1024.

water had seeped out from the base of the screes to form myriads of small meandering channels on the wadi floor.

A final feature of interest was noted in the wadis. In the upper parts of two of them thick deposits of mud, evidently the beds of ancient lakes, were found. In both cases these lay behind sand-drifts which had grown outwards so as to block the wadi. In the first (Wadi el Bakht), the old lake floor consisted of alternating thin sheets of mud and partly cemented sand with an upper capping of mud some 6 inches thick. Similar reddened and hard sand was found in many of the meander terraces in the wadi beds; probably iron oxides derived from the sandstones and basalts and washed into these sands during their transport are responsible for the alternations. In the lake floor in question little erosion was to be seen, but the sand-drift had evidently retreated, and a small mud cliff was outcropping from the sand face. A section along the wadi floor, kindly taken for me by Myers, gave the profile shown in Fig. 4.

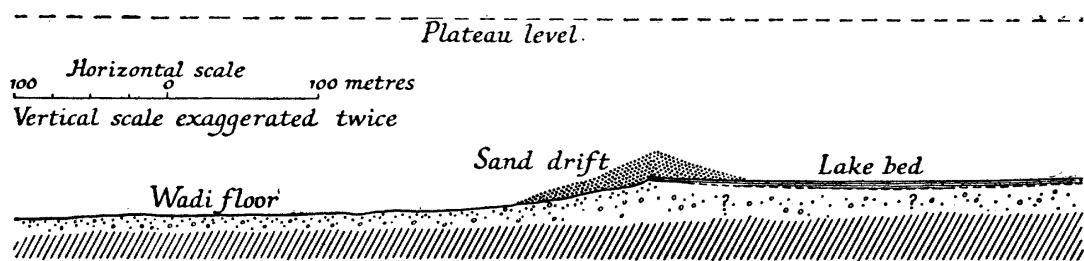


Fig. 4. Section of a wadi

From the evidence of the profile, and the entire absence of any other barrier, it appeared that the lake must have been held up by the sand alone, while vigorous erosion lowered the wadi bed below the obstruction. The lake bed, sand-drift, and to a lesser extent the wadi floor below were literally covered with stone artefacts, and Myers spent three days in working the site, with profitable results.

The second lake bed was found at the head of Wadi Ard el Akhdar, farther south. The wadi presented many surprises; Shaw had explored the main wadi, but had not entered this narrow branch, which indeed gave every indication of petering out almost immediately. Instead of doing so however it continued as a narrow gorge for some 20 kilometres into the heart of the plateau, and terminated in a remarkable amphitheatre surrounded by rounded basalt hills. The wadi, at the point where it left this amphitheatre, was nearly blocked by a sand-drift similar to that in El Bakht, and in the basin beyond eroded mud deposits again indicated the former presence of a considerable lake or marsh. In this example the lake floor had been deeply eroded, probably by the cutting through of the sand barrier, and now formed isolated vertical-sided blocks of mud, rising 10 feet or so above the present surface. The floor of the depression again proved to be rich in archaeological sites, which were later worked in detail by Myers.

To sum up, it may be said that in the evolution of the Gilf erosion by running water appears to have played by far the most important rôle in shaping the topography. The general process seems to have been a steady retreat of the cliffs, both round the edges and in the wadis, with mass removal of detritus and perhaps lateral planing by sheet-wash. Erosion by wind and

sand has probably played but little part in the dissection of the plateau and the shaping of the wadis, though these have most likely been the main agents at work in the final scouring down of the plains, and perhaps in the degradation of isolated fragments of the plateau into conical hills and the elimination of the mounds of debris which form their penultimate stage.

Wind scour may also be the main factor responsible for one final and rather puzzling feature of the Gilf topography. In similar topography in Arizona, which furnishes most of the evidence used by Rich and other American writers in their theoretical discussions of desert planation, the desert scarps appear to be normally fringed by rock-fans or pediments, sloping gently upward from the plains to the foot of the scarps proper. There are no signs of such rock-fans, as distinct from detrital accumulations, round the Gilf cliffs: indeed, in many localities there is a perceptible descent towards the cliffs from the plain, and the mass of 'Uweinat appears to stand in a definite depression, as viewed from its eastern side. If these cliff-base hollows really exist, they must owe their origin to differential erosion, and several possible modes of formation may be suggested. On the one hand they may have been cut by water erosion of the streams issuing from the wadis and abrading the desert surface immediately below the cliffs before evaporating and sinking away. Certainly one would expect the action in the immediate zone of the cliffs to have been constructional, but wind may have carried away the detritus in between rains, and in the long run the combination of stream erosion and removal of the waste by wind may have led to a more rapid lowering of the surface here than out in the open plains. On the other hand wind action alone may have been responsible. Topographic factors may have concentrated wind scour along the base of the cliffs, and the resultant erosion may have been assisted by the growth of vegetation round the highlands, the roots breaking up the surface and facilitating the removal of fine particles by wind in the manner suggested by Ball as possibly contributory to the growth of the oases depressions.<sup>1</sup> Speculation on this subject is perhaps premature before the visual impression that such hollows exist has been confirmed by accurate measurement; but it is difficult to refrain from it in the face of the many unsolved problems of this strange land.

##### 5. ROCK-PICTURES AT 'UWEINAT. By DR. H. A WINKLER

The late Sir Robert Mond had generously enabled me to explore during the seasons of 1936-37 and 1937-38 the Upper Egyptian deserts east and west of the Nile. The aim of this exploration was the collection of rock-pictures, which are found near the wells, or in those wadis which attracted animals and men by their vegetation, and along the old migration and trade roads. The season of 1937-38 was devoted to the exploration of the western desert, the edge of the desert touching the Nile valley from Qena to Aswan, the roads from the Nile valley to the oasis depression, the oasis area (mainly the Gubari road between Kharga and Dakhla), and 'Uweinat. To explore 'Uweinat, famous for its rock-paintings, I joined the expedition of Major R. A. Bagnold and Mr. O. H. Myers during the last month of the season. On March 10 I

<sup>1</sup> Ball, J., "Problems of the Libyan desert," *Geogr. J.* 70 (1927) 34.



left Kharga with Myers and his party. I had done all my former explorations on camel-back or on foot. I had admired and loved the strength, patience, and steadiness of my camels. Now I bade them farewell, and enjoyed the power and the speed of cars running over the huge sheets of barren sand which my camels would have so disliked.

The rock-drawings of the Upper Egyptian deserts date from neolithic times to the present day. For the last five millennia the rock-drawings can here be connected with Arab, Coptic, Greek, or ancient Egyptian inscriptions and thereby dated. Within this period (in Roman times) the camel appears in the pictures. The earlier drawings are divided into two main groups: a period in which the artists knew and depicted cattle, and a pre-cattle period. Within these two periods five different peoples made rock-pictures, distinguished by their dress, weapons, crafts, style, and habitat. The most recent of these pre-dynastic groups is characterized by a type of papyrus boat frequently represented in their rock-pictures; they are the Early Nile-valley Dwellers, contemporary for the most part with the second Nagada (Gerzean) civilization. They are later than, and influenced by, a people who came across the Red Sea from somewhere in the east in straight wooden boats, probably dug-outs, with high vertical prows and sterns. These are the Eastern Invaders. Both peoples had to deal in the mountains with a race of cattle-breeders, wearing the Libyan sheath, probably the forefathers of those peoples who appear in historic times as speaking Hamitic languages. They are superior in this art to all the others. I have called them the Autochthonous Mountain Dwellers. They are found from the Red Sea hills to 'Uweinat and even farther west. In the oasis area near Dakhla another people has left us its rock-drawings, clever stone-workers, settled people, plant-cultivators, probably adoring a pregnant goddess. Pictures of pregnant women are characteristic in their rock-artistry. These are the Early Oasis Dwellers. They lived in connection with an archaic hunting people, who never depicted cattle and certainly did not know cattle in the earlier part of their long existence in these regions.<sup>1</sup>

At 'Uweinat an unusual number of rock-pictures proves first of all the importance of this pasture oasis. There are a few engravings of camels and human beings which by their lack of patination show that they are recent work. In all probability they have been made by the Tibu who still visit 'Uweinat, and whose huts, leather pots, and other remains we found. All the other engravings have a patina. There must be a considerable lapse of time between the modern engravings characterized by the camel, and the earlier ones characterized by cattle and giraffes. The absence of intermediate drawings suggests to me that these valleys had been abandoned at an early date by the people who made the cattle and giraffe drawings, that for many centuries nobody came here, and that finally only the camel enabled and induced men to visit and to rediscover these valleys.

The earlier pictures are engravings and paintings. In both, cattle are the main subject. The engravings appear in many degrees of patination, and the paintings in many shades from the faded and hardly visible to those in excellent preservation. Superimpositions occur amongst the engravings as well as

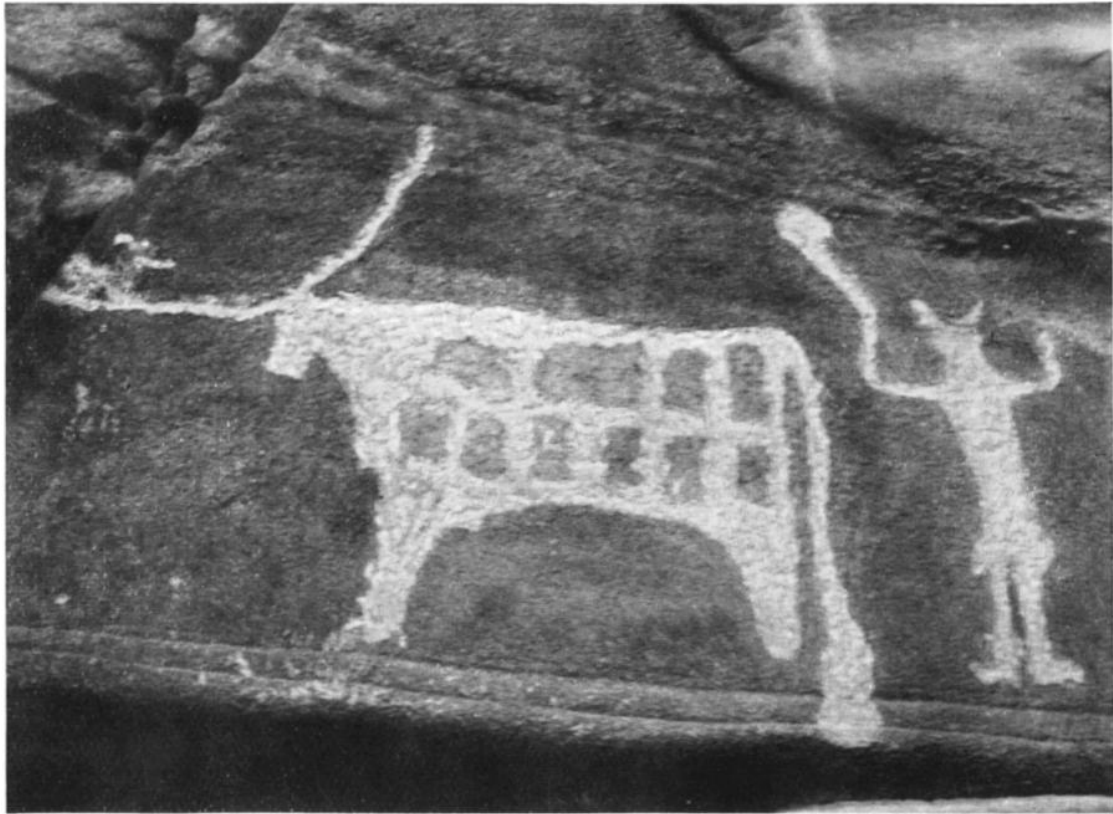
<sup>1</sup> See the author's reports, 'Rock-drawings of southern Upper Egypt, I and II.' London, Egypt Exploration Society, 1938-39 (vol. II in preparation).



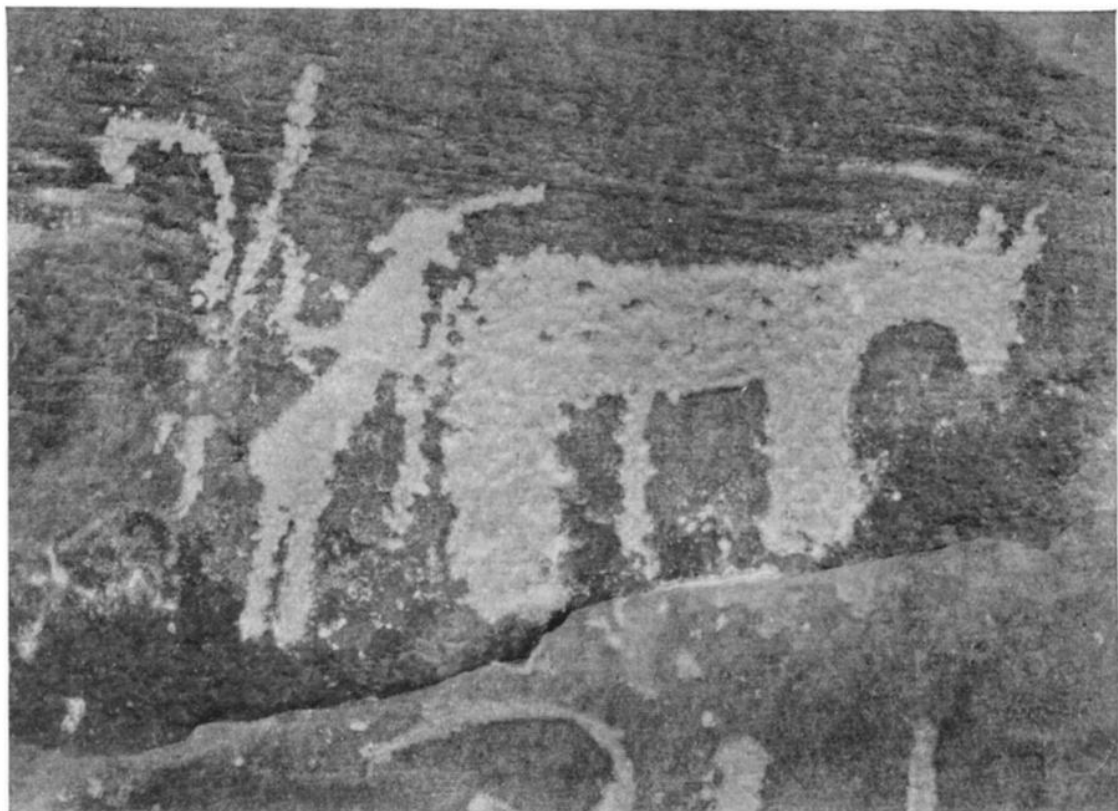
*'Uweinat (Site 72): men dancing, women in skirts*



*'Uweinat (Site 75): mottled cow with the udder between its hindlegs*



*'Uweinat (Site 73): mottled animal, man with club*



*'Uweinat (Site 74): unknown animal, man with hairdress and feather*

amongst the paintings. But there are no indications that distinct peoples lived here. Engravings and paintings seem all to be the records of one single people who lived here throughout a very long period.

These peoples were cattle-breeders. They are the same people who are found also in the deserts closer to the Nile valley and are there intermingled and interconnected with other predynastic peoples. The examination of the rock-drawings of these Autochthonous Mountain Dwellers in the eastern desert leads to the suggestion that they are some sort of early Hamites. Everywhere they appear connected with cattle. They knew the giraffe in 'Uweinat, as even their latest pictures prove. In the eastern desert they knew also the elephant. Cattle were hunted by them in the eastern desert; in 'Uweinat it seems only to be domesticated. Mottling—a result of domestication—is represented with much care. Necklaces, amulets, and horn ornaments indicate the love of and possibly the cult significance of cattle. Large and full udders show that the breeder appreciated the milk. The usual position of the udder between the hindlegs tells us that the people used to milk their cows from behind. Twice huts are depicted, and pots hang down from the roof. They are painted white inside, certainly to represent milk.

Hunting was less important. These people had, and represented here and elsewhere, a kind of greyhound. Barbary sheep, ostriches, and giraffes were caught in traps. Ostriches were tamed: one drawing shows a child playing with an ostrich. Straight and bent sticks with or without knobs were the main weapon, but bows and arrows also occur. Shields are frequent.

Men are depicted with large strips over the genital parts, probably the Libyan sheath. Strings at the chest and waist, fringes below the knees, sandals, bracelets, armlets, and anklets show current fashions in men's dress. On several occasions their legs are spotted, probably representing paint. Several human beings wear animals' hides. Women are simply dressed; several times they are shown wearing short skirts.

The dating of the Autochthonous Mountain Dwellers is obtained by their relations to predynastic rock-drawings in the desert nearer to the Nile valley, but they cover a long period. They appear in early predynastic times, well before 3200 B.C., and continue until late into dynastic times.

In comparison with rock-pictures of the other groups those of the Autochthonous Mountain Dwellers are distinguished by their fine art. They possessed a definite style, which I have called the style of balanced exaggeration. It is based on an exact observation of the proportions and curves of the human body. The shoulders are drawn broader and more raised and the waists thinner than in nature; the buttocks are accentuated, sometimes contrasting effectively with the thin waists. The legs are often heavier and longer than in nature. This style is found everywhere among Autochthonous Mountain Dwellers, and at 'Uweinat and in the western Gilf we possess one of the richest provinces of their art. It is interesting to see how this very distinct style occurs all around the habitat of these early pastoral people. It is found in the rock-paintings of eastern Spain, in Minoan Crete, on the Greek geometric art, and traces of it in early dynastic Egypt. We find it in recently discovered rock-paintings in eastern Africa and again in the south of the continent in the Bushman art. Further research will establish how far peoples

themselves migrated carrying with them their art, or how far only the style had been handed from nation to nation as a convincing conception of human beauty. It is noticeable that at the borders of the distribution of this style the Egyptian as well as the Cretan art arose. It may be audacious to connect the early eastern Spanish paintings (I prefer the opinion that they are of neolithic age) with these Saharan pictures, and these with early dynastic monuments, with Minoan Crete, and with the geometric style of Greece; and to extend this connecting line to some as yet undated East African paintings, and to the pictures of the Bushmen, which are to a large extent certainly not more than a few centuries old. Nevertheless the style is unique and so definite that we must consider such connecting lines, distant though they may seem. From this point of view the rock-pictures of 'Uweinat become important. They may illuminate not only some local problems of a certain early period but problems comprising the whole continent of Africa and of southern Europe, and covering the millennia from neolithic until present times.

There is still much to be done. 'Uweinat still holds many paintings which no eye has seen since the last of the ancient cattle-breeders left. Major Bagnold and Mr. Peel visited the rock-painting sites in the western Gilf and discovered new ones. The pictures there are identical in subject and style with those of 'Uweinat. They confirm and enlarge our knowledge of the ethnology of these cattle-breeders and provide splendid examples of their art. Pottery and implements also shed some light on the problems. One day it will be possible to establish clear relations between pictures on the rocks and the remains on and underneath the ground. We shall then know more about the periods within the long history of these cattle-breeders in the Sahara and about the trends of their migrations. And we shall then probably know how far the tribes themselves travelled, and how far their style spread.

#### 6. SAND MOVEMENT AND DUNES. By R. A. BAGNOLD

My main object being to confirm my experiments made in a small wind-tunnel in which wind speeds could only be measured up to a height of 6 inches above the surface, I hoped for as many good sandstorms as possible during which to repeat the measurements in the open. Both the area and the time of year were chosen with that in view. As it turned out, that spring was a very abnormal one both in the southern desert and in the Mediterranean. I was only able to make observations during two real but not very violent storms. Neither occasion was at all enjoyable. The wind was bitterly cold, and the effort of setting up and adjusting a delicate liquid gauge to measure the wind speeds at ten different places at the same time in a stabbing sand-blast, not to mention taking continuous readings with it for an hour or so, is not one to be repeated with overmuch enthusiasm. For all that, the results obtained were highly satisfactory; the connection between the quantity of sand in movement over a dune surface and the velocity of the wind, given in the *Journal* for May 1937 as the result of small-scale experiments in London, appear to be confirmed in the open desert in a remarkable way.

Experiments were carried out on the granular structure of "liquid" sand and of firm wind-bedded sand, and interesting results were obtained which

point to a simple connection between the sand structure (mode of deposition) and its ability to absorb and to hold moisture; this in turn was corroborated by a comparative examination of the structure of dune sand, in which grasses had succeeded in taking root, and of sand nearby which was barren.

Observations were also made on the size-grading of the grains on the surfaces of dunes which were seen to be growing, and of those which were seen to be falling, in confirmation of the results obtained experimentally in London and published in *Proceedings* of the Royal Society, November 1937. Finally, by observation in the rare areas where both seif and barchan dunes exist in close proximity, it has been possible to obtain several lines of evidence pointing to the conditions determining which type will develop in a given spot.

Some details of the above results have already been published (*Proceedings* of the Royal Society A.167, pp. 282-92, August 1938, and in *Nature* 142 (1938) 403). It is hoped to embody other results and conclusions in book form shortly.

#### 7. TRANSPORT, NAVIGATION, SUPPLIES. By R. A. BAGNOLD

The cars used were 30-h.p. Ford V8, 1937 models. Two of them had the standard American factory-built pressed-steel "pickup" body, and the third (mine) had an open light wood body which was specially built in Cairo. The front and rear springs of all the cars were strengthened by the addition of extra leaves, and the cars were fitted with the big 13 × 900 "airwheels."

They carried about 1 ton each when fully loaded, which they were on many occasions and for long distances. The mileage done per car during the expedition was about 5000. Petrol consumption across country, not following any previously beaten track whatever, was 10 miles per gallon (150 kilometres per case of 8 gallons was a useful figure for reckoning). The oil consumption was negligible. The water began to boil on one or two occasions on hot days with a following wind, but this was in no way serious.

Our only mechanical breakdowns consisted of the breaking of three rear axles (those on both Myers's cars also broke during the return journey from Kharga) and two carbon shafts after reaching the Nile valley. The springs held up astonishingly, considering the overloading and the rough country the cars were taken over. The ignition timing mechanism did however require much adjustment, and needed considerable experience, which was fortunately possessed by our mechanic, in diagnosing its ills. Otherwise the chassis gave no trouble.

The failure of the transmission was our own fault, due to overloading the cars. My previous experience with former models of Fords had been that the chassis could be overloaded to any extent if one did not mind risking the fracture of external and easily repairable parts such as springs and chassis frames. But the chassis of the V8 has now been made so strong that the elements of rebellion have, so to speak, been driven underground. The failure was due to the combination of a very powerful engine, overloading, and exceedingly bad going over boulders. I imagine that over the same country and with the same overloading no trouble would have occurred if the engines had been exchanged for ones of lower horsepower. Alternatively 1-ton lorries, with the big engines retained, might be suitable.

The factory-built bodies however gave rise to a serious difficulty. The driving-cab is totally enclosed and is of pressed steel. A magnetic compass is almost useless inside it, being completely screened from the earth's field of influence. Neither can a sun-compass be fitted in any position accessible both to the sun and to the eye. We had therefore to rely for navigation on my open wood-bodied car. As this was the one which was abandoned, we had to fit the sun-compass to the back of one of the other cars for the return journey. The result was that the navigator, who had to sit behind near the compass, was perched up on top of the freight and unable to read off the speedometer the distance run. This was overcome to some extent by the driver signalling with his horn the appearance of every tenth kilometre on the speedometer.

The carrying capacity of the cars and the range of action of a small party equipped with them can be judged from the following. On the return run after drawing supplies from Selima each car carried 140 gallons of petrol, enough for 1400 miles; 36 gallons of water, enough, at 4 pints per head, for two people for thirty-six days; 400 lb. of food, enough for two people for sixty days. Allowing some reduction of this load for the carriage of camp equipment, etc., it is quite feasible for a party of six or eight in three cars to visit this fascinating area and to stay there for a whole season entirely independent of all supplies including water, save for monthly trips with two cars to Dakhla or Kharga.

Water was stored in bulk in new 4-gallon petrol tins, packed in pairs in light wood boxes, in just the same way as petrol is carried on all desert expeditions in Egypt. These tins were soldered up. Two-gallon petrol tins were also used, as on former expeditions. Both types of container began to rust slightly inside after a few weeks, but this was not serious. At the end of the first month we emptied all the tins and rinsed them out with paraffin wax of high melting-point which had been brought almost to the boil. The thin film of wax over the inner surface of the tins completely prevented further rusting, and, except in one unaccountable case, did not in any way flavour the water. This scheme is strongly to be recommended, though an investigation is needed to ascertain why a nauseating waxy taste appeared in the one case.

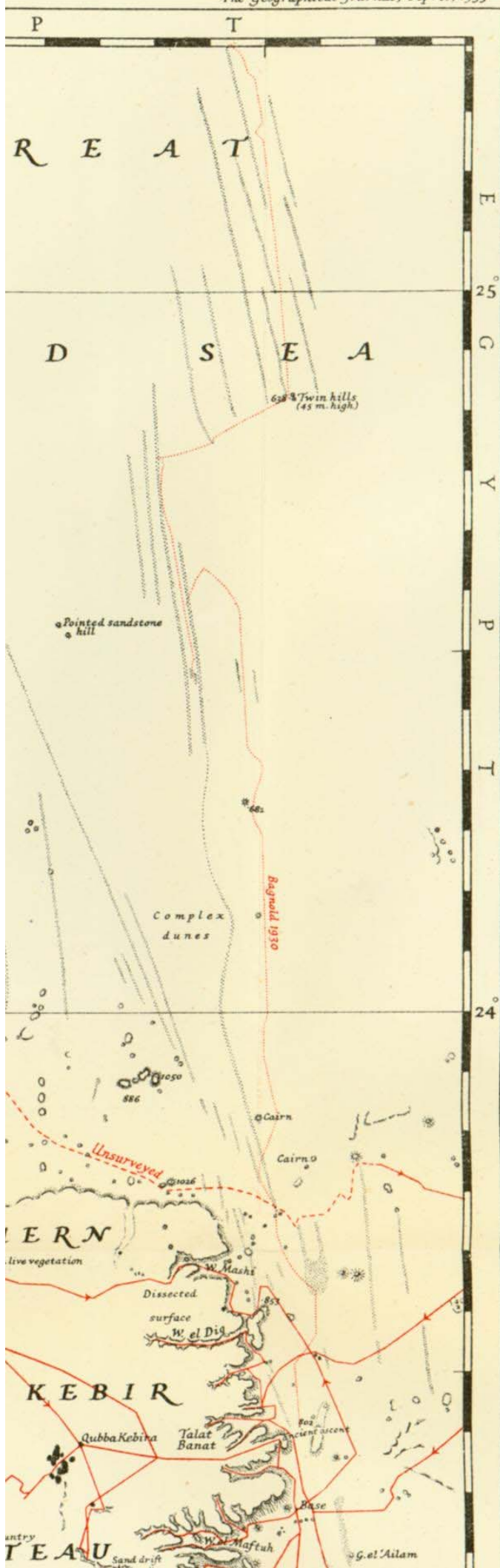
It may be of interest to record that we examined a dump of water left at an isolated hill—in permanent shade—near the Italian border west of the Gilf by Almásy in 1933. The water was soldered up in 4-gallon tins (unwaxed). We took one of the tins, replacing it by one of our new ones, and lived on the 1933 vintage for several days without any ill effects. The initial red rust inside had turned in course of time to a black sludge, but as this had settled on the bottom we were able to syphon off the clear water above. It was tasteless and perfectly good.

## DISCUSSION

Before the papers the PRESIDENT (Field-Marshal Sir PHILIP CHETWODE) said: I wish, before calling upon Major Bagnold, to say to you what I said to the Council this afternoon. Several months ago you did me the honour of asking me to become your President. Almost the day afterwards the Government asked me to go to Spain to do my best with the Commission to effect the release of some of the prisoners from both sides in that terrible conflict. I could not









SOUTH-WEST  
**THE GILF KEBIR**  
 To accompany the paper by  
 H. G. O'NEILL

Scale  
 5 0 5 10  
 10 0 10  
 Kilometers  
 Miles  
 Car traverse.  
 Exposures of  
 Height

