composed of 5–7 mm granitic pebbles eroded from the hill itself. This surface is surrounded on either side by a light-coloured sand sheet. Because of their large size, the dark pebbles of the streak are less likely to move under the sand-moving winds. Consequently, the shape of the streak will change mainly in response to the shifting of the light-coloured sand on both sides. A similar setting was encountered by the senior author in the area of Ras el Abd in Sudan (see Section I).

Field investigation of dark streaks in the Uweinat area by the senior author indicates that the surface is also strewn with irregular chips of dark rock. These chips or flakes are usually a few centimetres in diameter. They appear to be fragments from the Gebel Uweinat rocks. Usually the dark-coloured chips cover smaller, lighter-coloured fragments and sand grains (Plate XXIVb). However, the colour of the larger fragments dominates, giving the area a dark colour in the field and in Earth-orbital photographs. These findings may help us better understand both light- and dark-coloured streaks on the surface of Mars.

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XII. FUTURE WORK IN THE SOUTHERN PART OF THE WESTERN DESERT

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SCIENTIFIC interest in the southern part of the Western Desert of Egypt goes beyond the study of the well-developed aeolian landforms. The part of this desert south of 24° north latitude is not well known and its potential has not been fully evaluated. For this reason our remarks will not be limited to the Gilf Kebir and Gebel Uweinat area, but will include the territory that is bordered by Lake Nasser to the east (Fig. 9).

It is clear that the southern segment of the Western Desert of Egypt received more rain in the past. Ancient lake boundaries, underground water close to the surface, and drainage patterns are physical evidence of this. Archaeological evidence indicates that the area was inhabited from 3000 to perhaps 200 000 years ago. Furthermore, during our expedition from Tarfawi West to the Gilf Kebir we encountered many areas where fertile, clayey soil was exposed or buried under a thin sheet of sand.

This indicates that there are some agricultural prospects in this part of Egypt; the prospects of good soil should be investigated along with groundwater resources. Also, there is the question of whether or not the underground water reservoir in the Western Desert oases is being replenished by the flow of water from the south or west. This question will not be resolved until the southern part of the Western Desert is more fully studied. In addition, areas of good soil in the eastern part may be utilized in crop-raising by the transport of fresh water from Lake Nasser via canals or, better, pipelines.

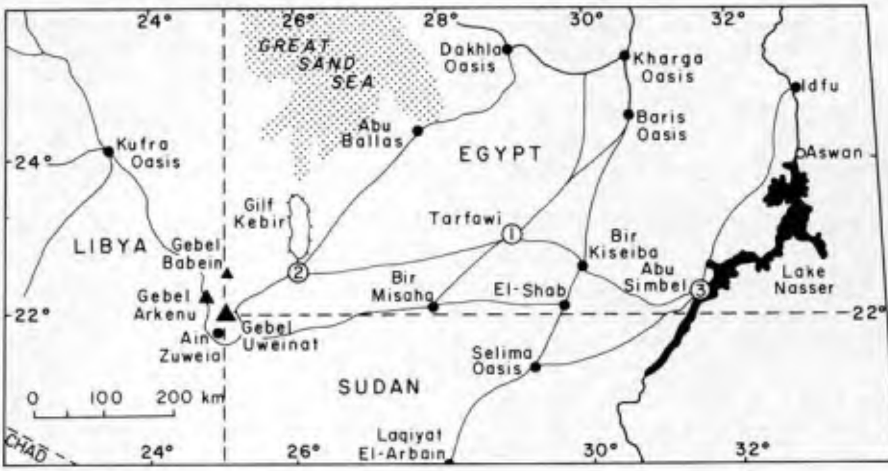

Fig. 9. Map of the southwestern desert of Egypt showing desert routes to neighbouring Libya and Sudan. Indicated are the proposed locations of a permanent camp at Tarfawi West (1), and seasonal camps at Gilf Kebir (2) to the west, and Abu Simbel (3) to the east

In addition to the agricultural potential, the area's mining potentials are encouraging. The iron ore which we sampled on our expedition about 150 km west of Bir Tarfawi turned out to be quite promising; as analysed in the laboratories of the Geological Survey of Egypt, the concentration of iron in the red type is 25 per cent and in the black ore is 58 per cent. Also some black ore is 68 per cent iron oxide and 22 per cent manganese oxide. This ore may be economical when the new railroad from Dakhla to the Nile Valley is built to transport the Abu Tartur phosphate ore.

The phosphate layer of Dakhla extends along the southwest-trending scarps far beyond Abu Ballas (Fig. 9). Although the known layer is thin, measuring less than 60 cm, thick layers may occur. Also, kaolinized material is exposed along the base of cliffs on the western side of the Gilf Kebir plateau. Kaolin may be present there in economic amounts. More importantly, the lithologic setting is suitable for radioactive element concentrations in the Uweinat area; the conglomerate horizon above the Uweinat granite may carry the highest concentrations.

The southern part of the Western Desert of Egypt also has socio-political significance. The Darb el Arba'in is the natural road connection between Egypt and Sudan. Trade between Egypt and Sudan and between these two countries and Libya would be served by paving the desert roads (Fig. 9). Probably the best way to study the area fully would be to assemble a multidisciplinary group from all three nations. It is here proposed to study the Egyptian part first by the establishment of the three desert camps shown in Figure 9.

Surface mapping

The exploration of the southern part of the Western Desert of Egypt is hampered by the lack of adequate maps. The only maps that cover the whole region are at 1:1 000 000 scale. The southwestern corner is covered by 1:500 000 maps, and the Nasser Lake region and the oases are mapped at larger scales. To serve as base maps it would be most desirable to have contoured orthophotomaps at 1:50 000 scale. In the absence of mapping-quality photographs, mosaics should be made from digitally enhanced and colour corrected LANDSAT images at

1:250 000 scale. These LANDSAT base maps are required to compile the surface geology of the region by the Geological Survey of Egypt. Some emphasis should be placed on mapping sand dunes and dune bundles. Boundaries of sand sheets and the motion of sand dunes may be very important factors in considering the development potential of the desert. In addition, both structural and soil maps should be made. The structural maps would emphasize the hydrogeology and petroleum potentials and the soil maps would classify the exposed soils for agricultural utility.

Subsurface mapping

Aeromagnetic and gravity surveys are necessary to establish the depth and shape of the basement rocks beneath the sediments in the southern part of the Western Desert. This knowledge is essential to a full understanding of the underground water reservoir and its future. In addition, surveys of the natural γ-ray radiation should be made to locate areas of high concentrations of radioactive elements. An effort should also be made to compile all the subsurface geological data obtained by drilling wells by various organizations to decipher the near-surface stratigraphy. It may be necessary to pursue a modest drilling programme to fill any gaps and allow extrapolation of existing well data and complete the subsurface picture.

Fluvial history

The fluvial history of the southern part of the Western Desert of Egypt is most interesting; large lakes have given way to sun-scorched rock and sand. The Gilf Kebir plateau presents a special challenge in the study of fluvial landforms. The plateau surface is not dissected by a drainage pattern. However, the scarp of the plateau is deeply incised by valleys, particularly on the southeastern side. Perched high in some of these valleys are also dry lakes. Layers within these lakes have kept a record of past fluvial episodes, which may give clues to climatic change. The lake beds of Wadi Bakht and Wadi Ard el Akhdar are particularly interesting where lakes were formed as a result of natural damming. These localities warrant detailed study by a multidisciplinary group to shed some light on past, wetter conditions and thus on the climatic history of the region. This history would in turn expand our understanding of the changes in climate in all of North Africa.

Aeolian history

Unlike the fluvial history which has to be deciphered by digging in layers of ancient lakes, signs of aeolian history are still exposed on the surface. The southern Western Desert exhibits a great variety of aeolian landforms. In fact, it is believed that this region, because of its extreme aridity, may display more signs of wind erosion than any other part of the Sahara. In addition to the numerous sand sheets and a variety of sand dunes, it displays various wind-carved landforms. Particularly in the Uweinat region, the displayed features help in the interpretation of wind-blown patterns on Mars. Patterns created by the interaction of the wind with the circular mountains in the Uweinat region may be analogous to those formed as the wind bypasses circular craters on the surface of Mars. These features should be studied in more detail to allow more specific comparisons and to help us better to understand the aeolian regimes of both Earth and Mars.

Note: The spelling of place names in this series of papers is that of the authors and not necessarily that of the RGS.