WESTERN FRONTIERS OF LIBYA

K. S. SANDFORD

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I HAVE been invited to read before the Society a lecture which may be regarded as a sequel to "Libyan Frontiers." [1] I have the same objects in view, but wish to make clear at the outset that I have not travelled in western Libya, my interest in the region for several years has been primarily its geology.

A brief account of the twentieth-century history of Libya as a whole was given in "Libyan Frontiers," and the rest of that lecture was devoted to a view of the stage on which a campaign might be set. When it was read, the Italian Army possessed the initiative: when it was published—only a month later—the Army of the Nile was sweeping westward. By the time these notes are read probably the Eighth Army will have penetrated far in Libya. The lecture however is not harnessed to the fortunes of war: it is intended solely to describe in general terms Libya's frontier with the French empire in Africa and the country and communications adjacent to that frontier, as the paper which preceded it described the contact of Libya with the British sphere. The western marches seem to be little known in this country.

Issues in western Egypt were essentially military, but in western Libya they are confused by political considerations that affect not only Africa but Europe and the Atlantic. Clearly it is beyond the scope of this lecture to consider international politics, or politics of any sort, except in so far as they dominate the relative positions of Allies, Axis, and French Africa. The military problem, in its rudimentary state, is to seek and destroy the enemy, but the task may be helped or hindered by political expedience.

The main issues of this lecture are thus twofold: the nature of the country over which troops may operate, and the general plan of its communications. As the coastal zone of Tripolitania has already been described in the *Journal*,[2] these notes will be devoted rather to the interior. The western frontiers are with French territory throughout: French Equatorial Africa and West Africa in the extreme south-west, the Military Territories of Algeria (Sahara) in the west, Tunisia in the north-west. Italy occupied Libya during and after the war with Turkey in 1911–12, her troops entering Murzuch and Gat in 1914. Driven back to the coast during the war of 1914–18, the Italian Army only regained these two towns and the Fezzan in 1930.

Nature of the country.—There are striking differences between the geology and physical features of eastern and western Libya: the dividing line runs conveniently from the Gulf of Sirte at about El Agheila to the northern prolongation of the Tibesti massif known as Jebel Eghei. Eastern Libya is inseparable from the western desert of Egypt as a region of monotonous

[1] *Geogr. J.* 96 (1940) 377.

[2] See E. J. Russell, *Geogr. J.* 94 (1939) 273; also 96 (1940) 377.

plains and plateaux, featureless, bare, windswept, burdened by the Sand Sea which sprawls across the Egyptian frontier from the huge dune area that lies between Siwa and Gialo. In fact, the monotony of eastern Libya is perhaps even more marked than that of western Egypt because the western margin of the Eocene limestone plateau, with its patches of very rough going for motor vehicles, bends sharply northward under the Sand Sea. West of that feature the Nubian Sandstone and associated sands, sandstones, and pebble beds, stretch from the northern end of the Chad basin and the north-western Sudan to the northern limits of the Kufra–Tazerbo region, whence pebble beds indistinguishable from the Nubian Series continue to the line of oases from Giarabub to Marada. North of that line they are succeeded by the Miocene marls and limestones of Cyrenaica, which extend also as a narrow coastal belt westward along the Gulf of Sirte.

An enormous sand-dune area lies between Kufra, Tazerbo, and the prolongation of Tibesti (J. Eghei).

On the whole, western Egypt and eastern Libya afford tolerable going for motor vehicles, with bad patches of rocky and boulder-strewn ground and sand dunes. They are to be regarded in general as waterless, the scanty population being concentrated in a few widely separated oases (except in northern Cyrenaica). Western Libya, on the other hand, although it contains vast areas which are equally waterless and uninhabited, is, by comparison, to be considered as a well-watered region. It is supplied, especially along certain wadis and depressions, by thousands of wells and other sources of drinkable water. Native communications and the population are concentrated along these lines (except in the better-watered parts of Tripolitania), and the country is easier to traverse on this account than are the eastern plains.

Jebel Eghei recalls the 'Uweinat–Gilf Kebir country. In the south, adjoining the main block of Tibesti, are massive sandstones such as appear in Erdi and Ennedi (western Sudan), flanked on their western side by ancient gneisses, schists, granites, such as outcrop in and around 'Uweinat. The sandstones run northward in a narrowing ridge more than 3000 feet above sea-level, twice the altitude of the surrounding plains. On the east and north sandstones scarcely less massive and reaching similar altitudes are banked against those which are geologically older, the whole forming a succession of older and younger Palaeozoic, and finally Mesozoic, strata, for the greater part of continental origin.

This great bastion separates the Kufra–Chad plains from a remarkable tract of country that runs from French West Africa north-eastward across a rugged ridge between Tibesti and the Ahaggar–Ajjar massifs to the Fezzan.[1] The surface consists primarily of sandstones and pebble beds encumbered by vast areas of wind-blown sand. One such sand-dune region lies between Tummo and Murzuch. On its western side, between In Ezzan and Gat and stretching westward to the Ahaggar–Ajjar, rise the Tassili escarpments, massive sandstones, many of them of the same geological age and type as

[1] See Conrad Kilian, *Geogr. J.* 86 (1935) 17. A general account of this country, from a geological point of view, together with a considerable list of references to literature, will be found in "Observations on the Geology of Northern Central Africa," *Quart. J. geol. Soc. Lond.* 93 (1937) 534.

those of J. Eghei, Tibesti, Erdi, Ennedi. The escarpments and their rugged plateaux run westward some 600 miles into the French Sahara, surrounding the huge mountain massif of the Ahaggar, which is crowned by now extinct volcanoes.

For the greater part the Tassili scarps and mountains are barren rock, but rainfall is abundant in some years, flushing the deep wadis which debouch into the surrounding plains and supporting a considerable vegetation in some of them. The wadi Tanezzuft, in which Gat is situated, is one of these, and recent Italian surveys have shown Gat to be well supplied with water. The physical features of this region, through which runs the Franco–Italian frontier, are very clear-cut. First, mainly on the French side, is the main Tassili plateau in which the Tanezzuft rises near the frontier south of Gat. The wadi runs northward to fade out near the junction of the scarp country with the plains, thus forming a deep trench between the Tassili and the next range of mountains, the Acacus Tadrart, on its east side. From this range numerous wadis drain eastward, all of them disappearing in a region of sand dunes, which also runs north and south. A third ridge follows, the Mesach (or Amsach) Mellet, likewise running north and south, rather narrow, giving rise to wadis which drain both west and east sides and disappear beneath sand dunes. All these ridges consist of Palaeozoic strata, most of them of marine rather than continental origin.

From the northern part of the Mesach Mellet a plateau of Nubian Sandstone, the Hamadet Murzuch, runs north-eastward to a point about midway between Sebha and Hun. In its western part broad drainage channels lie on its flanks, the wadi Bergiug on the south and the wadi Irauen on the north, and beyond, on both sides, lie the great basins, sand-dune areas (Edeien, plur. Idehan) of Murzuch on the south, and Ubari on the north. The two wadis are important features: they are joined by numerous wadis from the high ground between them and from the northern prolongation of the Mesach Mellet, and the Irauen in particular traverses a broad area of recent alluvial deposits, is vegetated, and provides an inhabited corridor between the mountainous country around Gat and the southern approaches to Tripolitania. Moreover eastward from Ubari (wadi el Agial, with nearly six hundred wells) and from Murzuch water is at or near the surface and maintains oases arranged in long lines between rocky ridge and sand dunes to points beyond Sebha (over three hundred wells) and Zuila. The region between Murzuch and Zuila: El Hofra, in which Traghen is situated, is especially well supplied with water: there are stated to be over one thousand wells.

The Edeien Murzuch is roughly circular in outline, with a diameter of about 175 miles: Italian maps show caravan routes only across its eastern part between Murzuch and the oases of the district of El Gatrun. The Edeien Ubari stretches westward into French territory; eastward, in Libya, it is broken by a broad area of rock-desert and tapers off to the east beyond Sebha. On its northern side in this region Palaeozoic strata come to the surface once more, forming rocky country. As in the wadi Irauen on the south side, so here are alluvial deposits, drainage channels, and oases between rock and sand: some of the oases are well watered and in the general area of the wadi esc Sciati (with over six hundred wells) to wadi Cneir there is considerable

vegetation. The small town of Brach is the centre of this district. Waterholes, salt pools, and the like occur in the eastern part of the Edeien Ubari, and it is crossed by numerous caravan routes. To the north and east the nature of the country changes radically.[1]

North of Brach the ubiquitous sands and sandstones of the south and east give place to limestones, with associated clays and sands, of marine origin and of Cretaceous and Eocene age. These occupy the whole of western Libya north of Brach and west of Marada, with a great promontory stretching southward in the central part of Libya almost as far as J. Eghei. The eastern plateaux consist of Eocene beds like those of western Egypt, the western limestones are Cretaceous and constitute the Hamada el Hamra, *i.e.* the country west of a line from Hun to Homs. The northern margin of Hamada el Hamra forms the Tripolitanian Jebel, a striking scarp, or series of scarps and hills, running from the coast at Homs due west into Tunisia. Tarhuna, Garian, Nalut, and other important centres are situated upon the scarps and adjacent uplands.

Crowning Cretaceous and Eocene plateaux alike in central Libya are the two huge volcanic regions of the Fezzan, the J. es Soda, traversed by roads from Tripoli and Hun, and the Harug el Asuad, stretching for nearly 200 miles southward from Zella and about 125 miles wide.

South of the Harug el Asuad are small and scattered lava sheets, small extinct volcanoes, and volcanic necks. They mark the region of Uau el Chebir and Uau en Namus. These two inhabited places are of some importance as they provide water between Tazerbo, Kufra, Tibesti, and the Fezzan. The region between them, the Harug el Asuad and Kufra, is of special interest in view of the remarkable operations of the Italian Army for the occupation of Kufra in 1931. A column was concentrated at Uau el Chebir, another travelled *via* Bu Hasciscia (Hashisha) on the eastern flank of the Harug, water being plentiful at both places: these two met at Tazerbo. A third column started from Agedabia (Jedabia) in the north and made direct for Kufra *via* Gialo, converging on the combined force from Tazerbo. Against such strength there could be little effective opposition from Kufra, but the operations were a milestone in the progress of desert warfare on account of the skilful combination of camel and mechanized units.[2]

There are other areas of lava in western Libya, notably in the Tripolitanian Jebel between Garian and Beni Ulid, the latter being situated in one of them.

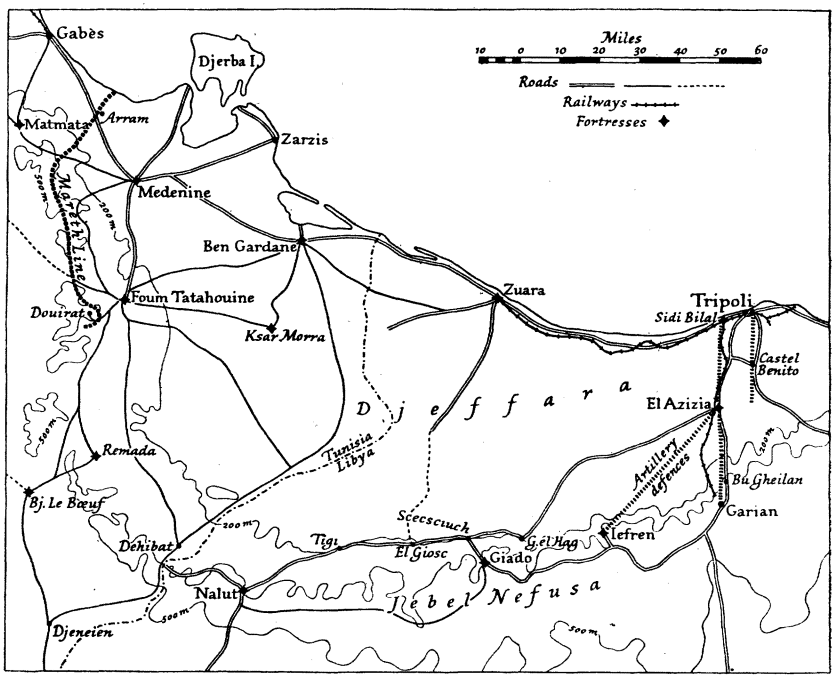
I will conclude these notes on the nature of the country by a more detailed review of the northern part of the western frontier zone.

[1] Technical papers on the Fezzan and Gat appear in 'Il Sahara Italiano,' a volume published by the R. Società Geografica Italiana, Rome, 1937. Useful summaries of the geology also are contained in "Osservazioni geografiche e geologiche compiute della Spedizione della Reale Accademia d'Italia nel Deserto Libico e nel Fezzan orientale (1931)," by A. Desio in Memorie geologiche e geografiche di Giotto Dainelli, Vol. III (1932) 111, and in " Riassunto sulla constituzione geologica del Fezzan," Instituto di Geologia, Paleontologia, e Geografia fisica della R. Università di Milano, Ser. G. Pub. No. 6 (1936) 319, by the same author. For Libya as a whole see especially Desio's recent paper "Le nostre conoscenze geologiche sulla Libia sino al 1938," *ibid.*, Pub. No. 10, 1939.

[2] A good account of this campaign is given by Bagnold in 'Libyan Sands,' London, 1935, pp. 241–51.

The Hamada el Hamra continues westward, south of Gadames, into Algeria, where it is termed the Hamada of Tinghert: it narrows here and is much dissected by watercourses which disappear under the sands of the Grand Erg Oriental (also known as the Zemoul el Akbar) on the north.

The northern sand area is a vital factor in the Tunisian–Tripolitanian defences: it lies along the whole western flank of the Hamada el Hamra, including the north-western prolongation of the plateau into eastern Tunisia. On the north the sands give place below sea-level to the Shotts, salt lakes, salt pans, treacherous mudflats, that lie between the Saharan plateau (Hamada) and the folded chains of the Tunisian Atlas. Sand and shott,



Tunisian–Tripolitanian defences

especially the easternmost or Shott Djerid, are regarded as considerable natural defences against the invasion of southern Tunisia. From the Italian point of view the possession of Gadames at the junction of Hamada and Erg is obviously desirable not only for reasons of internal security but as a southern outpost to the defences of the Tripolitanian Jebel and of the frontier near Nalut.

On the French side of the frontier, south of Tunisia, military measures have been concerned chiefly with internal security. The communications are the routes of the country, for the most part running north and south, some of them passing to ancient centres such as Gat and Gadames by long usage that takes no count of frontiers imposed by Europeans. Of forts there are several, but they may be regarded as survivals from the French pacification of the Sahara, centres of military administration situated on routes at places where

water is available. Two of them are within 100 miles of the frontier, Fort Charlet (Djanet) west of Gat and Fort Polignac in the Ajjar plateau-and-scarp country, but their positions are concerned with internal security. In the southern tip of Tunisia the frontier post of Fort Saint stands opposite Gadames near the edge of the sand dunes.

Strategy in the French Sahara seems to have relied on distance, so far as any threat from Libya might be concerned, and in this, as in south-eastern Libya, south-western Egypt, and the north-western Sudan, it may be regarded as camel-minded. Time, space, food, water, and surface controlled the movements of camel transport, but all these factors save surface seem to be disappearing in African warfare with the arrival of the self-contained petrol-driven and armoured columns of 1941.

North-east of the Zemoul el Akbar lies an interesting region. First comes the Dahar, dissected country from which the watercourses drain toward the sands and locally toward the Shott Djerid. On the eastern flank rise the remarkable hills, of Triassic to Cretaceous rocks, that are the key to the fortress defences of eastern Tunisia between the frontier, Foum Tatahouine and Matmata, the Mareth line. From the topographical point of view they are the last traces of the Tripolitanian Jebel, which on the Italian side is defended from the hills of Nalut.[1]

On the seaward side of the hills, and dominated by them, is the coastal plain (the Djeffara). Here lies the only route for the coastal road that leads eastward to Tripoli, westward to Sfax, Tunis, Bizerte, and into Algeria: it is dominated by the defences of both sides. The plain is narrow between Medenine and Gabès, but broadens again between Sfax and Sousse and eastward between Medenine and Zuara, tapering off till the Jebel reaches the sea at Homs.

Considerable areas of the coastal plain have been colonized and intensively cultivated by the French in Tunisia, especially around Sousse and Sfax, where there are olive plantations of great extent, and by the Italians. The Italians have also established colonies in the coastal plain on the west side of the Gulf of Sirte and in the adjacent higher ground of the Jebel. The Jebel is naturally sparsely vegetated on the limestone uplands; olives grow in the valleys and native cultivation was concentrated in them, the higher ground being given up to grazing. Italian colonization and irrigation has made considerable headway.[2]

Communications.—For purposes of this lecture we may consider communications to be of three classes: (1) Country passable by mechanical transport, irrespective of defined tracks; (2) the tracks and routes of the country, based on camel transport and used since very early times; (3) "autopiste,"

[1] G. L. Steer gives an interesting account of these defences in 'A date in the desert,' London, 1939.

[2] Compare a report of the early years such as "La Missione Franchetti in Tripolitania (Il Gebel)" (Società Italiana per lo Studio della Libia), 1914, with accounts given in the literature published by the Italians in the years immediately preceding the outbreak of the present war, also E. J. Russell, *Geogr. J.* 94 (1939) 272; and with a description of the mass migration of colonists from Italy, *e.g.* M. Moore, 'Fourth shore,' London, 1940.

i.e. routes artificially improved for the use of mechanical transport, for the most part based on native tracks, and motor roads specially designed as such, metalled and surfaced throughout their length or according to local needs.

So far as the first class is concerned it is probably true to say that modern mechanical transport, skilfully driven and well maintained, can operate fairly freely over most of Libya, irrespective of roads, with exceptions which would include the following: the sand-burdened areas, where mechanized movement is in fact often possible but liable to be slow and fraught with difficulty; the broken highlands of the south-west and to some extent in the volcanic uplands of the centre, though even in the highlands the wadis are negotiable; ravined, boulder-strewn, and cut-up country, salt-pans, wet clay, sand and salt-marsh, and the like.

The scale on which cross-country travelling is possible in Libya could not be better illustrated than by the astonishing patrols of the Long-range Desert Group, led by officers well known in this Society, and it is to be expected that one day a full account of their accomplishments will be forthcoming. The best account so far available in this country seems to be that of *The Times* of 14 February 1941.[1] In the winter campaign of 1940–41 their main sphere of operations was in the vast emptiness that lies between the highlands of Cyrenaica and Kufra, and within it they came and went very much as they pleased. In the far south contact was made with the Free French forces operating from the Chad Territories and Tibesti. Combined operations led to the fall of the Italian garrison in Kufra. 'Uweinat, so long an outpost, the scene of one of the actions of the Long-range Desert Group, passes out of the picture.

Perhaps the most astonishing feat was the raid on Murzuch, Traghen, and their neighbourhood. A glance at the map will show the distances involved from any base—and at that time Kufra was in enemy hands. Two further points should be borne in mind about this raid. It produced the anomaly of Frenchmen immobilized on one side of the frontier—since most of French Africa adhered to the Vichy government—while their warring compatriots from Equatorial Africa raided northward with the British on the other side of the frontier. The raid brought Allied troops and vehicles, albeit in modest numbers, to the "autopista" road system that leads to the heart of Tripolitania.

The second-class tracks and routes of the country do not call for much comment here. A glance at detailed maps of the western half of Libya shows the country to be criss-crossed with such tracks, and with obvious exceptions it is a reasonable supposition that light mechanical transport can cover most surfaces that can be traversed by loaded camels. From the Gulf of Sirte to Tibesti, from Brach and Murzuch to Tazerbo, Kufra, and beyond the Italians have found, and mapped, many such routes suitable without improvement to their military vehicles. In the western Fezzan routes of this class seem to be fewer, but at least three lead from the Ubari–Gat motor road westward to the frontier.

In the region of the Tunisian frontier there is an interesting contrast

[1] See *Geogr. J.* 97 (1941) 396. While this lecture was in proof a good account, with map, has appeared in 'Destruction of an army,' H.M. Stationery Office, December 1941.

between French and Italian road policy imposed by considerations of defence and the nature of the ground. On the Italian side, where the ground is high, a motor road runs near the edge of the Hamada el Hamra, at the heads of the valleys that drain to the sand dunes of the Zemoul el Akbar, from Gadames to Nalut, thence eastward along the Jebel to the main road system radiating from Tripoli. On the French side Medenine is the most easterly main road centre, whence a southerly branch goes no farther than Foum Tatahouine and an easterly road goes through Ben Gardane to the frontier. From Foum Tatahouine there radiate southward and eastward tracks suitable for motor vehicles, all of them joining at widely separated points a frontier patrol track which runs from Ben Gardane southward along the length of the eastern frontier of Tunisia, skirting the sand-dune area, crossing the wadis that descend from the western face of the Hamada el Hamra, and so passing west of Gadames to the Hamada of Tinghert and the Saharan communications.

The third group of communications may be taken to include all routes primarily intended or maintained for motor traffic, and upon them Italy has spent lavishly of her engineering skill, financial, material, and labour resources. These excellent roads have proved her undoing both in East and North Africa, since they have provided unrivalled means of rapid advance for Imperial and allied troops. In Libya we may recognize two systems: the Cyrenaican which serves the coast and highlands, and the Tripolitanian which serves not only coast and highlands but the western frontier and the Fezzan. The two systems are joined by the road between sea and desert along the coast of the Gulf of Sirte, thus providing in effect a coastal road: the Littoranea, from the French to the Egyptian frontier. From Zuara through Tripoli to Homs there is also the railway, with a branch southward as far as Garian. Coastal Libya lacks nothing in west–east communications.

It must be borne in mind that very extensive territories lie to the south of coastal Tripolitania over which the Italians have driven their roads, and the southern system may be regarded as an adjunct of the Tripolitanian network rendered necessary in large measure by the reoccupation of the Fezzan in 1930. They are, then, roads to ensure internal security and development, but their plan is doubly interesting at the present time. The following brief account of them is based on information published up to the time of Italy's entry into the war.

One route leaves the coast road about midway between Sirte and Misurata and runs south to Hun, whence a branch runs eastward to Zella. The main road continues southward from Hun through Socna and Sebha to Murzuch, and a further section branches a little south of Sebha, runs westward through Ubari and then south along the wadi Tanezzuft to Gat. The Fezzan is thus traversed by roads which pass through the oases and wadis which are the essential locations of population. Sources of water have been explored and improved, and the Italian administration would seem to have little cause for anxiety on this score.[1]

From the network of roads that has been built in the Tripolitanian coastal

[1] In addition to 'Il Sahara Italiano,' see a review of recent successful deep borings for water "Verso la soluzione del problema delle acque profonde in Libia"; "Rivista Libia," Anno II, Luglio, 1938 (No. 7).

plain and Jebel, the detail of which we need not consider here, two important routes run south. The eastern passes from Garian (railhead) through Mizda to Brach, whence there is a west–east road to the head of the wadi esc Sciati and to join the Fezzan road between Socna and Sebha. The western road from the coast, as already mentioned, runs close to the Tunisian frontier through Nalut to Gadames.

Although these roads were ordained by internal needs, it is nevertheless a fact that they lead to the western frontier and that they provide alternative north–south routes, and in view of the elaborate defences in the north, facing Tunisia, it seems reasonable to assume that the roads were laid down as part of a strategic policy as well as for internal security.

The war having taken an unexpected turn, Italy finds her interior communications in Libya secured from the west but threatened from the east, from which side more than one motor road, as well as numerous passable tracks, lead by the back door, so to speak, to the very centre of Tripolitania. The Italian Command may question, therefore, whether their roads leading south and east are really an asset in the present circumstances unless new German and Italian mechanized and motorized units can roll along some of them, and above all along the road that leads to Bengasi.

So our minds turn to the sea. It is easy to appreciate the benefits that would accrue to Germany and Italy if Bizerte or French African ports with adequate unloading equipment were fully at their disposal. Roads lead thence to Tripolitania, with some rail facilities there, as in Tunisia. The value of naval and air bases on both sides of the Mediterranean is obvious enough. These are but elementary considerations of obvious military and political problems in western Libya: they are only part of the problem of the French Empire in Africa. Farther west is the enigma of the Atlantic coast, Casablanca perhaps analagous to Sfax, Tunis, Bizerte or an Algerian port, Dakar possibly more desirable in German eyes than Suez.

Sources of water.—Incidental references have been made to water supply, and it has been suggested that they might be amplified. The following notes describe only the generalities of the subject, with some examples. A considerable amount of detailed information is available.

Sources may be described as surface and sub-surface, and deep. The former have long been exploited by the native population, the latter have usually been beyond the capacity of native enterprise but have been tapped by the Italians, sometimes with spectacular results.

Native sources of water.—The surface and sub-surface sources are such as may be found throughout arid Africa and adjacent parts of Asia, their exploitation by primitive means long since mastered by native Berber peoples and Arabs alike. It is unnecessary to review them in detail here, and a description of a very similar area was published in the *Journal* a few years ago (*Geogr. J.* 85 (1935) 412). It will be sufficient to give a few examples: sources in wadi beds and saturated sands; flowing water from springs; and water-tables either exposed or reached by wells. It is probably true to say that the native supplies in the Fezzan are dominantly of these categories. In the high-

lands of the south-west the run-off, carried into the valleys, sinks into the alluvial sands, clays, and pebble beds, whence it is obtained by digging pits and deeper wells, *e.g.* the wadi Tanezzuft. The best-sited wells are those where the alluvial beds are thickest, those over shallower parts of the valley's cross-section may run dry as the season advances. Within the hills the usual rock-pools and the like may be expected.

The largest valleys of the Fezzan, as already described, conduct sub-surface water for long distances through arid country, and this water is obtainable at favourable spots, *e.g.* the wadis Irauen and esc Sciati. Where these valleys fade out in the plains, sands and finer alluvial deposits hold the water and make it accessible near the surface, and it may be exposed in pools. Where these conditions coincide with the run-off from ridges into channels which are bordered by wind-blown sands the prospects of water being available in large quantities are enhanced, *e.g.* the wadi Bergiug and El Hofra region. Thus the numerous oases of the eastern and central Fezzan can support a considerable native population with flocks, palms, and some agriculture. Water is also available in the heavily sand-burdened areas; where permanently exposed such water may become saline or support salt marsh, *e.g.* Murzuch area, Edeien Ubari.

The widespread and varied sandstones which are so prominent in the geology of highland and lowland alike in the Fezzan and in southern Libya are not only capable of containing much water but of transmitting it at some depth over great distances. Inequalities of surface may allow springs to flow on the surface from these water-tables, either as running water in broken country or as permanent pools in the desert plains. Adjacent uplands of rocks such as basalts may add to the available water near the margins or in the surrounding country. Sources in the eastern Fezzan and central Libya are probably to be attributed to these origins, and, as already stated, the Italians have found them to be of excellent quantity and good quality, *e.g.* Bu Hascischia, Uau el Chebir, Kufra.

North of the Fezzan the great expanses of limestone present new conditions, since water is likely to sink deeply through them and possibly to be canalized along fissures. Again large quantities may be preserved, but depth may be considerable. Where faults and flexures are present, or where, as in Tripolitania and Cyrenaica, the limestones are broken by scarps and deep valleys, prolific springs may occur, especially where clays and shales are interbedded with or underlie the limestones. The native sources of these parts therefore differ considerably from those of the south. In these northern territories moreover successive ruling nations in antiquity have superimposed on yet more ancient native methods a high degree of engineering skill in finding, conducting, and storing water, building of retaining walls in valleys, well-digging and cutting of vast numbers of subterranean rock cisterns, especially in Cyrenaica.[1] Arab invasion, infiltration, and eventual population here led to neglect and decay of some of these works.

The coastal plains, where wide, both in Tripolitania and Cyrenaica, consist often of old beach deposits, sands, gravels, clays, and alluvial material. Moreover the rainfall on the coast is considerable and there is an appreciable run-off

[1] See especially H. W. Ahlmann, "La Libye septentrionale," *Geogr. Annaler*, 1928.

from the adjacent highlands. Water has therefore been fairly readily available along these coasts in favourable localities.

The shores of the Gulf of Sirte seem in theory to fulfil the conditions just outlined and yet to fall short in practice. The reasons are to be found in a number of circumstances, not all of which are yet fully known. In the first place transmitted water may find its way toward the surface in these coastal lowlands, and salt pans and marsh result. The Miocene and more recent beds which overlie them include clays and marls which hold the water in pockets and prevent even distribution. Such pools and small supplies may be saline, muddy, or liable to dry up. Shallow wells sunk in this area may be ephemeral or saline. Here and there good springs have been found and small centres have sprung up round them. It is common also in areas like this for springs to reach the surface near the shore either on the beach (or below sea-level) or inland behind sand dunes. It will be realized then that local conditions, as well as a lesser rainfall than in the coastal highlands, minimize the prospects of obtaining good water either near the surface or at some depth.

Deep sources of water.—There are three types of source available to European exploitation with good well-digging and boring apparatus. First, in the highlands wells may be sunk deep in the thick water-bearing alluvial deposits of the wadis, or in the adjacent sandstones.[1] Secondly, the water-table of the great desert plains which supplies the oases can be tapped with advantage by deep wells and borings, artesian water thus being made available. This may also be done in the coastal highlands, but in Cyrenaica the geological conditions have so far presented special difficulties to effective boring. In these coastal areas good results have been obtained by following the methods of antiquity, *e.g.* the water supply of Bengasi, which is brought from distant springs.

Thirdly, the Italians have in recent years undertaken an ambitious programme of deep boring along the coast of Tripolitania, and highly productive water-bearing beds have been tapped. The very existence of their agricultural colonies depends on these deep supplies, several of them reached by borings 1000–1500 feet deep. The water is generally of good quality, and very remarkable yields are reported.[2] It is possible that these schemes are "drawing on capital" in that the water so utilized may not be replaced at depth as fast as it is removed from the wells, in some of which the water reaches the surface with considerable force. Critics of the agricultural development suggest that yields may diminish and that the water may suffer from increasing salinity, but at present, so far as I know, there is no unmistakable sign of any such failure either of quality or quantity.

DISCUSSION

Before the paper the PRESIDENT (Sir GEORGE CLERK) said: The paper this afternoon will be read by Dr. Kenneth Sandford, who needs no introduction to this Society. He is a member of our Council who is distinguished for his geo-

[1] A preliminary survey of water resources, presumably with a view to such improvement, had been made by the Italians in the years before the war: see A. Desio, "Acque superficiale e sotterranee" in *Il Sahara Italiano* (part I, Fezzan e oasi di Dat, p. 121).

[2] See A. Desio, "Verso la soluzione del problema delle acque profonde in Libia"; "Rivista Libia," Anno II, Luglio, 1938 (No. 7).

graphical work both in the Arctic and in the deserts of Egypt and Libya. Dr. Sandford is associated with those other Fellows of the Society who have done such good service as leaders of the Long-range Desert Group and is particularly fitted by his knowledge of geology to inform us upon the strategical importance of the desert land forms in Western Libya. We could not have a subject more appropriate to the time. I am sure we shall enjoy immensely listening to one who can speak with authority on a part of the world which is having such great influence on the war in its present stages.

Dr. Sandford then read the paper printed above.

The PRESIDENT: We have, I am sure you will agree, listened to an extraordinarily interesting lecture, especially so at this particular time. We owe a great debt of gratitude to the lecturer for the clear account he has given us and for showing us the country in which our men are fighting now.

Admiral Sir WILLIAM GOODENOUGH: I should have hesitated to speak but for the use of the word "strategical" by our President and the reference to military matters and communications which the lecturer made in an extraordinarily clear lecture. Dr. Sandford spoke of the domination of certain roads by forts and of the difference between camel and mechanized transport, but one frontier which he had not time to mention is the northern, the sea. As long as it was camel transport it did not matter much, but once it becomes mechanized, the motive spirit being petrol, it is vital we should hold that northern frontier of the sea.

I should like to refer to a matter more personal to this Society: the distinction which has been earned by one of the Society's Gold Medallists, Colonel Bagnold. What he has done in the desert is no longer one of the vital secrets everybody talks about. He recently wrote me a letter in which he said he had never anticipated that a peace-time amusement would have become a war-time usefulness, or necessity.

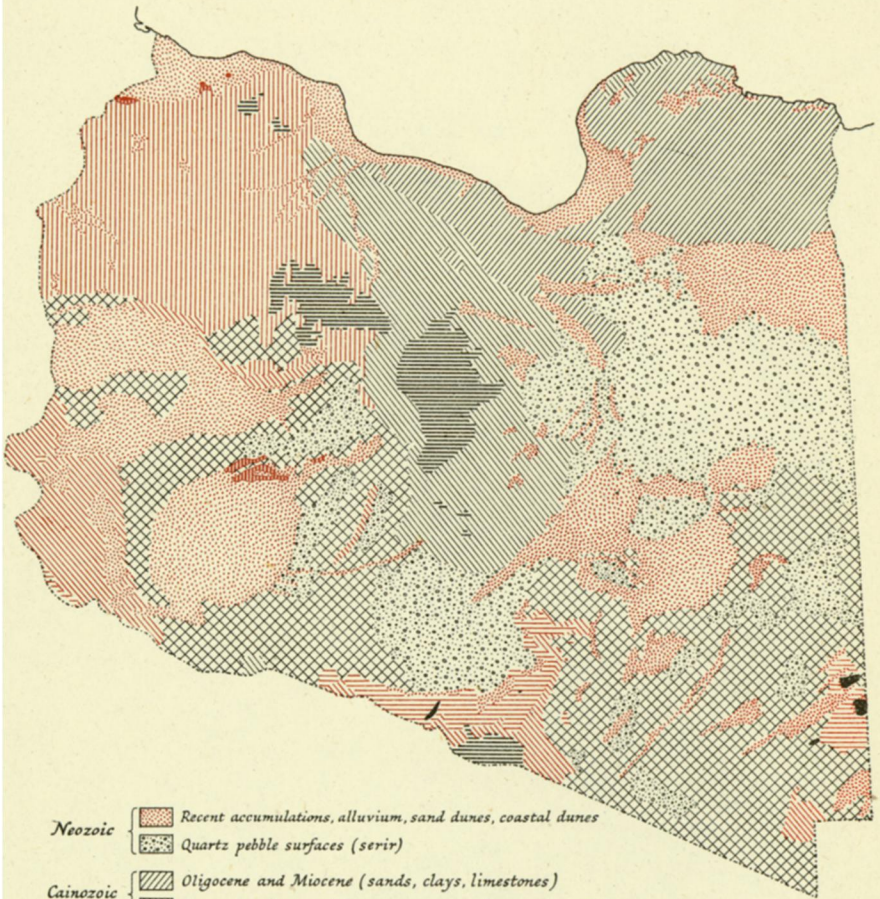
The PRESIDENT: I am sure you all join me in expressing our gratitude to Dr. Sandford for what he has told us.

THE NUER

THE NUER: a description of the modes of livelihood and political institutions of a Nilotic people. By E. E. EVANS-PRITCHARD. *Oxford: Clarendon Press*, 1940. 9×5½ *inches;* xii+272 *pages; illustrations and sketch-maps.* 17*s* 6*d*

THE author here describes, in certain of their aspects, that tall, slender, black, dolichocephalic, dour, and very conceited people, the Nuer of the Egyptian Sudan. The Nuer are very similar to the Dinka, both physically and in language and customs, while the Shilluk are somewhat less akin. Their physical type stretches right across the Sudan to the Chad region, where the Bana and others bear a very distinct resemblance to this Nilotic folk.

The present volume treats of their modes of livelihood and political institutions, reserving their domestic life for a second volume. There is no mention of what appear to many the most interesting features of anthropological research, namely, religion and magic. The investigation, which lasted about a year in all, was carried out under very serious difficulties, the chief being the passive resistance of the people shown to any seeker for information. Finally the author obtained most of his facts by taking up his residence in the middle of villages and witnessing, and taking part in, the actual life of the people. The next



Neozoic
- Recent accumulations, alluvium, sand dunes, coastal dunes
- Quartz pebble surfaces (serir)

Cainozoic
- Oligocene and Miocene (sands, clays, limestones)
- Eocene (predominant limestones, some clays and sands)

Mesozoic
- Cretaceous (upper limestones and lower limestones, sands and marls)
- Jurassic (marine limestone, continental limestone of Murzuch
- Trias (limestones and marls, marine)

"Nubian" — Continental sandstones, Palaeozoic to Mesozoic

Palaeozoic — Middle Carboniferous to ? Cambrian (marine beds, for the greater part, sandstones)

Archaean — Pre-Cambrian, crystalline schists, gneisses and intrusive rocks

Volcanic rocks (for the greater part of Tertiary to Recent age)
- effusive
- intrusive

Based on material compiled for the E

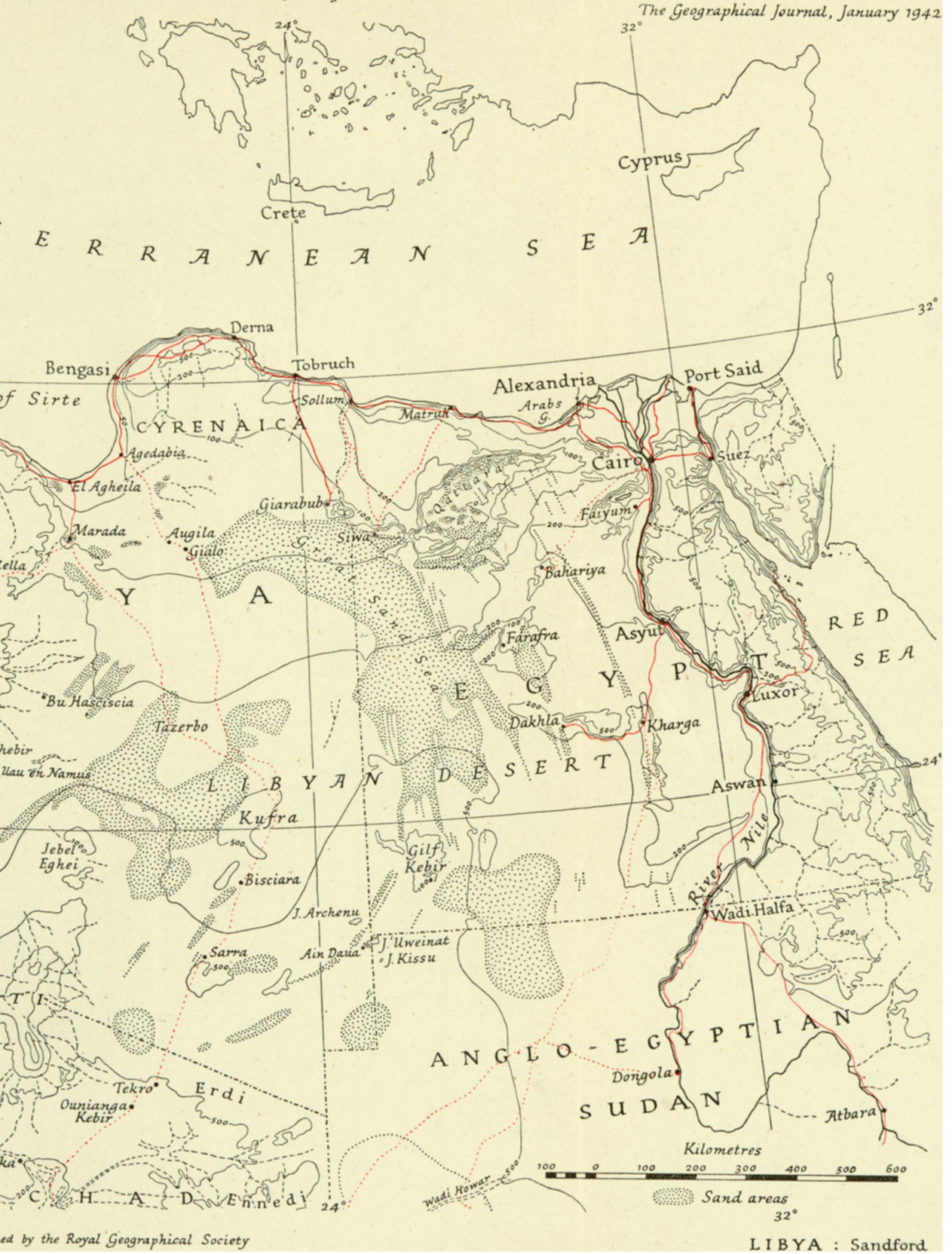
THE WESTERN FRONTIERS OF LIBYA

Based on material compiled for the British Council map

Published by the Royal Geographical Society

RONTIERS OF LIBYA by Major K.S. Sandford T.D.

The Geographical Journal, January 1942



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LIBYA : Sandford