

## NOTE ON A MAP OF THE TURFAN BASIN

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THE map discussed in this note is intended to record the surveys carried out, mainly in the course of my third Central-Asian expedition, within that remarkable drainageless basin which lies between the southern slopes of the eastern Tien Shan and the desert ranges of the Chöl-tagh. Special geographical interest attaches to this basin, conveniently designated by the modern name of its chief oasis, Turfan, not only because it contains the deepest depression below sea-level in the whole of Asia apart from the Dead Sea, but also on account of its characteristic physical features. These exactly reproduce, as it were, on a small scale those of the Tarim basin, the greatest drainageless area of innermost Asia.

A variety of causes, largely geographical in origin, have invested the Turfan depression with considerable political and cultural importance during early periods of Central-Asian history. This importance is reflected by the large number of ancient remains which are to be found there within a comparatively small area and which the great aridity of the local climate has allowed to survive above ground.

The archaeological interest presented by those remains and the labours claimed by their survey and partial exploration caused me on my third Central-Asian expedition to spend over three months of the winter of 1914-15 within the Turfan basin. Busy as I was kept by antiquarian labours I endeavoured to utilize this stay also for observations on those geographical features which give a strongly distinctive character to the Turfan district and especially to its inhabited portion. For this purpose a more detailed survey of its topography was essential than that which it had been possible to effect on the occasion of my first visit to this area in November 1907. At that time Rai Bahadur Lal Singh, Extra Assistant Superintendent, Survey of India, my devoted old travel companion, had carried a reconnaissance survey on the quarter-inch scale along the main routes of the area.

I accordingly arranged for a plane-table survey on the comparatively large scale of one inch to the mile to be extended by the late Surveyor Muhammad Yaqub Khan, who had been deputed by the Survey of India as my second topographical assistant, over as much of the central portion of the basin as limitations of time would permit. The cultivated areas of the district are with very few exceptions confined to this portion, and the ruins of pre-Muhammadan times are almost all to be found either within them or in their close vicinity. This circumstance made it possible for me in the course of my successive visits to the different ancient sites to keep within easy reach of the young surveyor and thus to exercise personally that measure of supervision and control which previous experience of his abilities had rendered advisable.

A special map of the Turfan basin on the scale of 1 : 250,000 has been prepared at the Geodetic Branch of the Survey of India, Dehra Dun, in order to provide the geographical and antiquarian student of this interesting ground with a cartographical representation of its topography on a larger scale than that of the 'Maps of Chinese Turkistan and Kansu' (1 : 500,000) attached as

Vol. IV to my 'Innermost Asia,' and also separately issued by the Survey of India in 1923 with a "Memoir" from my pen forming Vol. XVII of the *Records of the Survey of India*. It is from this map that, with the kind permission of the Surveyor-General of India, the map accompanying this paper has been reproduced on a reduced scale.

In addition to the above detailed material the map embodies the plane-table work which was carried out by R. B. Lal Singh in 1907 and 1914-15 to the north and south, respectively, of that central belt of the basin as well as some minor plane-table traverses in the north-west and south-east portions of the sheet from Khan Sahib Afraz Gul's routes. The representation of physical details is the same as is adopted in my 'Maps of Chinese Turkistan and Kansu' and fully explained in my "Memoir" on them.<sup>1</sup> The same applies also to the use of symbols and the record of local names.<sup>2</sup>

The area represented in the map falls within Sheets No. 28 and No. 31 of the 'Maps of Chinese Turkistan and Kansu,' and the identical values for observed longitudes and latitudes as recorded in the corresponding "Notes" of Chapter IV of my "Memoir" have been used throughout for the adjustment of the plane-table work.<sup>3</sup> Since the Turfan basin derives special interest from the great depth below sea-level to which it descends in its lowest portion, care had been taken to obtain observations with a mercurial barometer in a comparatively large number of places. The heights or depressions derived from these observations have been recorded in the "Notes" of the "Memoir."<sup>4</sup>

All the other heights entered were deduced from observations with aneroids corrected to accord with the mercurial readings at the places where these also were available. It deserves to be mentioned that the results from the aneroid readings had proved very satisfactory throughout my third expedition, as shown by Dr. De Graaff Hunter's remarks on them.<sup>5</sup> The clinometrical heights shown are based on aneroid readings observed at the points nearest to the plane-table stations from which the former were taken. The results from the numerous observations with the hypsometer, on which Surveyor Muhammad Yaqub mainly relied in the course of his work within the area below sea-level, have unfortunately proved untrustworthy and had hence to be discarded. This accounts for the largely conjectural character of the approximate datum line and contours below sea-level indicated in the map.

From the above record of the materials used in the compilation of the map I may now proceed to a brief description of the chief physical features which the area represented in it exhibits. In respect of this analysis, summary as it must be for various reasons, I may at once acknowledge some serious limitations. In the first place I ought to point out that my want of geological training, combined with my equally regretted ignorance of Russian, restricts my knowledge

<sup>1</sup> See *Records of the Survey of India*, vol. xvii, "Memoir on Maps of Turkistan and Kansu," pp. 57 sq.

<sup>2</sup> Cf. *ibid.*, pp. 59 sqq.

<sup>3</sup> See *ibid.*, pp. 83 sq.

<sup>4</sup> Regarding the methods of reduction applied to readings both by mercurial barometer and aneroids, see Dr. J. De Graaff Hunter's Appendix B, "Memoir on Maps," etc., pp. 152 sqq.

<sup>5</sup> See "Memoir," Appendix B, p. 151.

as regards the most remarkable physical feature of the Turfan basin, its great depth below sea-level, to what information I can gather from the brief abstract Professor Suess's great classic, 'The Face of the Earth,' gives of the accounts contained in the publications of several distinguished Russian geologists.<sup>1</sup> The same applies also to the formation of the very striking hill chain which overlooks that great fault-trough from the north, and with its much disturbed deposits of sandstones and conglomerates represents the upthrown fault-ridge of this mighty dislocation.

It is at the foot of this hill chain, so utterly barren and forbidding with its red glow as to account for its Chinese name of "Hills of Fire," that the depression receives that supply of water which is utilized for irrigation to the utmost and alone renders cultivation possible. Most of the irrigation thus secured depends not upon the surface flow from springs but upon an elaborate system of *karezes* or underground wells and canals which tap subterranean drainage. This system is nowhere else practised in Chinese Central Asia and is believed locally to be of comparatively recent introduction from distant Persia. A close examination of it seems essential for a proper estimate of the economic resources of the Turfan district.

An exact comparison of the cultivated area now dependent on *karezes* with that irrigated from spring-fed streams might well throw light on the much-discussed question of climatic change; for archaeological evidence distinctly suggests that the economic importance of Turfan was quite as great, if not greater, during ancient and early mediaeval times, when we must assume that its oases depended wholly on irrigation from surface drainage. Yet, interesting as the question thus raised must be for the geographical student and the antiquarian also, it was not possible for me to spare time for the collection of adequate data regarding those different sources of irrigation used in the scattered oases of Turfan.

It would have been of distinct interest also from more than one point of view if it had been practicable to collect reliable data as to the population in the oases, large and small, comprised within the cultivable belt. But it was not possible for me to secure access to official statistics, supposing that such were to be found in the Chinese magistrates' *Yamêns*. What figures as to the number of households I was able to obtain by local inquiries at certain of the oases can scarcely be taken for more than rough traditional estimates indicating their relative importance. Yet even in this respect more reliable guidance may probably be gained from the extent of land actually under cultivation as the map's record based on the detailed survey shows it.

As already mentioned above, we find most of the physical features which divide the Tarim basin into well-marked different zones reproduced also in the Turfan basin, though on a much smaller scale. A determining factor affecting all those zones is the aridity of the climate, and this is equally great in both basins. To it is due the fact that in the Turfan basin, just as in its much larger counterpart westwards, settled existence implying cultivation is entirely dependent on irrigation and on what water is supplied for it by the mountains.

<sup>1</sup> Cf. Suess, 'The Face of the Earth,' translated under the direction of Professor W. J. Sollas, iii, pp. 166 *sqq.* Full references will be found there to the accounts of the brothers Grum-Grimailo, Bogdanovich, Obrucheff, Roborovski, etc.

In the case of the Tarim basin two great snowy ranges, glacier-crowned in many parts, the Kunlun in the south and the Tien Shan in the north, feed rivers which carry considerable volumes of water over their alluvial fans and allow large compact oases to be maintained there. The Turfan basin too is enclosed by two ranges stretching along its longitudinal axis. But the southern one rises nowhere to heights which could retain snow and is throughout so defective of moisture as fully to deserve its local designation of *Chöl-tagh*, the "Desert Hills." Water, usually brackish, can be found there only in rare wells or natural cisterns. Only on exceptional occasions may flood water descend in some gorges of this barren range to lose itself in the salt-encrusted marsh-bed of the Aidin-köl which stretches along its northern foot and forms the lowest part of the depression.

It is due solely to the vicinity of the Tien Shan main range stretching north of the basin that Turfan owes its oases and its economic importance attested all through historical times. That portion of the main range which sends its drainage southwards into the Turfan basin rises, as the map shows, to peaks over 14,000 feet. It attains over most of its length a crest-line which cannot fall much short of 11,000 feet and to the west is certainly higher. There it carries permanent snow-beds for a distance which from the observations made on our crossing of the Pa-no-p'a pass may be estimated as at least 50 miles. The conditions there noted on 23 October 1914 indicated an approximate level of about 12,500 feet for the snow-line. Its comparative lowness is largely accounted for by the fact that a far moister climate prevails on the northern slopes of the Tien Shan. This is abundantly attested by the fact that ample conifer growth is to be found there from an elevation of about 6500 feet upwards, while along the northern foot of the range cultivation is possible with the sole help of rain- and snow-fall right down to elevations between 2000 and 3000 feet.

The rich quasi-alpine vegetation to be met on the northern slopes of the range makes the contrast of the stony barrenness to the south of the crest-line all the more striking for the traveller. There only the scantiest grazing is to be found even at the very heads of the valleys. Farther down scrub and occasional growth of willows and wild poplars are closely confined to the banks of the small streams which descend here between spurs of utterly bare rock and conglomerate. These streams carry a considerably increased volume of water during the spring melting of the snow-beds on the crest of the range and on the rare occasions when heavy rain clouds pass across it from the north. But nowhere does their water succeed on the surface in crossing the zone of utterly bare piedmont gravel. This, from 20 to 25 miles wide on the average, everywhere separates the foothills of sandstone or conglomerate from the nearest areas of cultivation.

Whatever water is brought down by those streams is quickly absorbed by those huge beds of detritus or else evaporates under the fierce sun of the spring and summer of the Turfan basin. Springs are to be met only at certain points of the dry flood-beds which traverse this huge gravel glacia. These beds are clear marks left behind by the far more abundant drainage of periods when climatic conditions were moister. Near those springs small patches of vegetation, such as the map shows at Shaftulluk, Chichan, Örtang-aghzi, usually

including some orchards and arbours, serve as much-needed halting-places for travellers and traders who proceed from the Turfan oases to the passes of Pa-no-p'a, Sardakdawan, and Qara-dawan.

These passes give direct access across the Tien Shan to the fertile tracts around Guchen in the north. They are all open to traffic with horses for the greater part of the year, while the more devious but easier routes to the east and west by the saddles of Ta-fan-ch'êng and Ku-ch'üan are available for cart and camel transport at all seasons. This fact largely accounts for the close economic relation which exists between the districts of Turfan and Guchen, notwithstanding the intervening mountain range. It is also duly reflected by their close political connection throughout earlier historical periods.<sup>1</sup>

Before proceeding to visit the series of minor oases which are met after descending that wide gravel glacis, we may acquaint ourselves rapidly with that very striking feature of the Turfan basin, the rugged hill range which forms the northern rim of the great fault-trough. It is the result of geological flexing and fracturing which has produced the basin. It has upheaved and greatly disturbed "not only the coal-bearing clays and variegated sandstones of the Angara series, but also the red conglomerates and friable sandstones of the Gobi series."<sup>2</sup> As shown by the map, this hill range, known over different sections by varying local names such as Tuz-tagh or Kawan-tagh, stretches with a general east-to-west direction along the whole length of the depression from the Pichan oasis to north of Toksun.

It is to the east of its middle portion marked approximately by the gorges of Sengim and Toyuk that it attains its greatest height, rising in rugged ridges to approximate elevations between 2200 and 2700 feet. The slopes throughout show the effects of excessive erosion by water action, as seen in photographs taken near the Toyuk gorge.<sup>3</sup> Except at the bottom of the gorges in which small streams gathering from springs at the foot of the gravel glacis have cut their way through the range, these hills are absolutely bare of vegetation. Their reddish colour and fantastically fissured slopes add still further to their forbidding appearance.

Masses of drift sand are found in some places heaped up on the north slopes, as near Murtuk.<sup>4</sup> Near its eastern extremity the range merges in an area of huge ridges of dunes, appropriately known as *Kum-tagh*, "The Sand Mountains." These have been rightly assumed to overlie the eastern continuation of the fault-trough towards Hami. On the south they are adjoined by the waterless wastes of the Chöl-tagh.

There can be little doubt that the drift-sand ridges of the Kum-tagh owe their position in the south-east of the Turfan basin to the effect of "aspiration." The violent north-west winds which sweep over the basin during the spring and summer are obviously due to the cold air of the mountains and of Dzungaria being drawn into the Turfan basin by the fierce summer heat which

<sup>1</sup> Regarding the economic intercourse and common political fate of the two territories (known to the Chinese Annals as Cismontane and Transmontane *Chü-shih*), as a result of geographical factors, cf. 'Innermost Asia,' ii, pp. 569 sqq.

<sup>2</sup> See Suess, 'The Face of the Earth,' trans. Sollas, p. 166.

<sup>3</sup> See "Mémorial on Maps," Fig. 29, B; 'Innermost Asia,' ii, Figs. 309, 311.

<sup>4</sup> See 'Innermost Asia,' ii, Figs. 314, 315.

prevails in the depression and causes the hot air to rise there. This heat itself directly results from so great a portion of the basin lying deep below sea-level.

It is equally clear that those winds, ever since the great fault-trough was formed, must have been constantly at work deflating the slopes of the mountains and the glaciis below them, both wholly unprotected by vegetation. The fine drift sand thus eroded is bound to be carried to the south-eastern extremity of the depression and to find its place of deposit where the effect of that "aspiration" is countered and neutralized by the air current from the cooler heights of the Chöl-tagh and the great Pei-shan plateaus eastwards.

That wind erosion actually asserts itself in places also within the cultivated area I had occasion to observe in the north-western portion of the Turfan oasis. This, as the map shows, occupies a gap about 5 miles wide in the hill chain fringing the fault-trough. It may be described as marked on the east by the bed of the stream which issues from the valley of Buluyuk and on the west by the two deep-cut ravines of the 'Yar' which enclose the island-like site of the ancient Turfan capital of *Chiao-ho*, now known as Yar-khoto. There to the east of the Yar in close vicinity to cultivation I noticed patches of ground overrun by small dunes. The inroad of fine sand driven by the *burans* from the north-west threatens the fields in the vicinity, and in order to protect them from the risk of attending wind erosion their surface is covered with clods of hard clay before the windy spring season sets in. The intrinsically fertile fine sand, or rather dust, which is deposited between the clods is considered on such ground an adequate substitute for manuring.

Owing to the position of the tract of Turfan proper in the gap above mentioned the physical features affecting cultivation are there less clearly defined than in the smaller oases which are found along the northern foot of the hill chain overlooking the fault-trough. Throughout the string of these oases, from Buluyuk in the west to Pichan in the east, the water supply needed for irrigation is primarily derived from springs rising in close vicinity of the cultivated area either within flood-beds or else on their alluvial fans. It is obvious that the rise of these springs is due to drainage from the mountains having been absorbed higher up by the gravel-beds of the glaciis and being here forced to the surface on striking impermeable strata of the fault-ridge. The supply of these springs is in the several oases supplemented to a varying extent by that of karezes. These tap the subterranean drainage farther away from the flood-beds and allow water to be brought to portions of the ground which irrigation channels taking off direct from the springs would not command.

As the construction of karezes involves very heavy expense the provision of irrigation by this means must necessarily depend on the extent and quality of the arable land within convenient reach of the karez mouths. This explains why, *e.g.* in Pichan, reckoned at 2000 households, the water from springs suffices to irrigate twice as much land as that derived from karezes, while Khando, the oasis nearest to the west, with its 500 households, is almost wholly dependent on karezes. Conditions closely resembling those of Khando are found also at Sengim, whereas at Murtuk, where the use of its spring-fed stream provided for a settlement of about 300 households previous to the Chinese reconquest of the Province, the construction of 28 karezes is believed

to have added 200 more. At Lamjin, reckoned at about 400 households, spring-fed streams and karezes may be supposed to account for about one-half each of the irrigated area.

The assured supply of water which both springs and karezes provide throughout the seasons, coupled with the warmth of the climate during eight or nine months of the year, make it possible in these oases, as in all the others of the basin, to reap two annual harvests. In all kinds of cereals, as well as in fruits and in cotton, the produce of cultivation in the Turfan oases is plentiful. The exceptional fertility of the soil when irrigated under such favourable climatic conditions and the profit derived from such a valuable and easily exported produce as cotton sufficiently explain the use of the karez system notwithstanding the heavy expenditure of money and labour it involves.

At the same time, as a consequence of the great extent of the profitable cotton cultivation for export to Dzungaria and beyond, and owing also to the presence of a considerable trading population in the large southern oases, Turfan is obliged to supplement its foodstuffs by imports from the north. On the other hand, the absence of grazing both in the mountains and in the depression makes Turfan depend on the tracts across the Tien Shan for livestock and wool. The economic interdependence thus created by diversity of geographical conditions is reflected throughout the political history of those territories.<sup>1</sup>

The agricultural conditions just described apply equally to the much larger oases to the south of the hill chain, but with a difference as regards that portion of irrigation which is not derived from karezes. Practically nowhere do we meet with springs along the southern foot of those utterly barren hills; but instead, as a look at the map shows, we find a number of streams breaking through that range and carrying a surface supply of water to parts of the potentially fertile belt of ground which forms its glacis. Those streams receive all the water of the springs and karezes which is left after having served the needs of the northern oases and bring it in deep-cut narrow gorges to where these debouch. The fertile loess-like ground which slopes down from the foot of the range permits the water of the streams to be utilized for irrigation within comparatively short distances from the mouth of the gorges and thus saves it from being lost through evaporation before it could be turned to use.

Thus we find the position of the three large and compact oases of Lukchun, Qara-khoja, and Turfan directly determined by the points at which the streams from the gorges below Lamjin, Murtuk-Sengim, and Buluyuk debouch into the depression. An examination of the map affords interesting evidence as to the close correspondence between the areas of cultivation in those oases and the observed volumes of water in the streams which feed their canals.<sup>2</sup>

<sup>1</sup> Cf. 'Innermost Asia,' ii, pp. 568 *sqq.*, regarding this interdependence.

<sup>2</sup> Measurements taken on different dates of November 1914 showed volumes of 125 cubic feet per second in the stream coming from Lamjin which irrigates the important oasis of Lukchun, and of 120 cubic feet per second at Sengim-aghiz. There the stream from Murtuk and Sengim debouches, and there the canals irrigating the fields of Qara-khoja, around the large ruined town of ancient *Kao-ch'ang*, have their heads. I regret not to have had an occasion to measure the volume of the stream of Buluyuk at its debouch. But lower down, where it is crossed by the road from Qara-khoja, it still

Reference to the map is equally instructive also as regards the great extent to which cultivation in those main oases is nowadays supported by irrigation from karez. The absence of statistical data, such as only proper revenue records could supply, makes this cartographical evidence particularly useful. At none of those oases is it more striking than at the extensive area used mainly for the cultivation of cotton which stretches to the north-west and south-east of the town of Turfan, the modern administrative and trade centre of the territory. Here we have a continuous series of karez, more numerous than limitations of scale would permit to be individually shown on the map. They tap the subterranean drainage both at the foot of the gravel glaciis which stretches down from Shaftulluk towards the previously mentioned gap, and also along the foot of the hill range east of Buluyuk. The utter barrenness of this range and the extreme rarity of occasions when it receives any rainfall, suggest that the subsoil water which the wells at the heads of the karez strike may also be derived from the precipitation which the snowy heights of the Tien Shan regularly receive. But only competent geological investigation could prove whether such an assumption is compatible with the character of the strata likely to underlie that fault-ridge.

It is obvious that the comparatively gentle declivity which marks the northern side of the subsidence facilitates the use of the subterranean water supply over a broad belt of ground. This helps to explain why we find the map marking an almost continuous string of detached cultivation plots, usually small, extending below the main oases from the south-west of Turfan to the south-east of Lukchun. All of them depend solely on karez, and the construction of new ones, though often a speculative undertaking, is still proceeding.

As already stated, the construction of a karez involves heavy outlay; for the number of successive shafts to be sunk while cutting the subterranean channel amounts sometimes to two hundred or more. Figures up to 10,000 taels of silver were named to me as having been spent over certain karez. It is obvious that the extension of karez cultivation must be determined not merely by the configuration of the ground, which may or may not permit the water-carrying stratum to be struck at a "paying" depth, but equally also by the quality of the soil on the ground to which the discharge of the karez can be brought. This observation may help to explain a certain inequality shown by the map in the distribution of those detached karez-irrigated plots. Whereas in the vicinity of Turfan proper these plots keep within a comparatively short distance of the foot of the hill chain, they are found to extend much farther away from it to the south below Qara-khoja and Lukchun.

I believe that a likely explanation is to be found in the greater salinity of the soil as we proceed westwards in that portion of the trough which lies below the approximate level of 500 feet below sea-level. The increased appearance of a soft salt-crust covering the ground, as observed on the route from below carried on 8 February 1915 a volume of 52 cubic feet per second, and several canals take off from it higher up.

On the other hand it is interesting to note that the water of the stream which descends the rugged gorge of Toyuk and the volume of which below Subashi measured 45 cubic feet per second on 17 November 1914, suffices only for the limited cultivation of Toyuk and Yankhe, notwithstanding the very careful use made of it for the famous vineyards of the former place.



Faka-bulak towards Bejan-tura, is certainly due to this area forming the terminal delta of the river which descends past Toksun into the deepest part of the trough marked by the Aidin-köl marsh. It is the latter's main feeder; but, as the shrunk size of the marsh shows, much of the flood water brought down by the Toksun river from the high Algoi valley in the west is lost before reaching the Aidin-köl, through inundation of the deltaic ground. Evaporation then causes the soil there to become impregnated with salt.

A notable contrast to this is presented by the ground to the north of the Aidin-köl and to the east of it. To the north we find the large karez-irrigated oasis of Chige-bulak approaching within a few miles the shore of the ancient dried-up lake-bed of which the Aidin-köl is a remnant. Then, farther away to the east, there is similarly below Lukchun and towards Deghar karez cultivation to be seen at no great distance from that dried-up lake-bed. On my visit to the ruined site of Chong-hassar, only about 2 miles from the shore of the hard salt-encrusted bed, I found the scrub-covered loess-like ground still capable of cultivation if it were possible now to provide for its irrigation.

Here I may conveniently mention that the oasis of Toksun, which through unavoidable circumstances remained outside the detailed survey of 1914-15, presents the same features of cultivation as noted above in the case of oases like Qara-khoja and Lukchun. While irrigation supplied by the river apparently accounts for the major part of the cultivated area, the presence of karezes on both sides of the river-bed is also noted. Toksun, at a depression of 140 feet below sea-level, shares the climatic conditions of the other oases within the Turfan trough.

Before leaving that zone of the Turfan basin to which permanent human occupation has been confined all through historical times up to the present, I may aptly quote here from 'Innermost Asia' an observation concerning it which has a wider geographical bearing: "The development of Karez irrigation in the Turfan area is of comparatively recent date, and its introduction does not reach back farther than the eighteenth century.<sup>1</sup> But that the district possessed a dense population, wealth and corresponding economic importance in much earlier periods also, is abundantly proved by the large number, size, and elaborate character of its ruins as well as by its recorded history. Irrigation must have been all through historical times indispensable to cultivation within the Turfan area. We are therefore driven to the conclusion that the water supply brought down in streams from the mountains was more plentiful in ancient times than it is now, when subterranean drainage has to be tapped by Karezes in order to supplement it in a proportion which at present is probably close on one-half of the total available supply." The bearing of this conclusion upon the question of desiccation in Central Asia, whether local or general, is clear.

<sup>1</sup> Regarding the karez cultivation of Turfan and its introduction, cf. the remarks of Professor E. Huntington, based on careful observation, 'Pulse of Asia,' pp. 310 *sqq.*

The total absence in Chinese historical notices relating to Turfan of any reference to so striking a feature as the use of karezes may safely be considered clear evidence that this method of cultivation was not known there down to T'ang times and even later. It is very difficult to believe that the detailed and exact description of the territory of Kao-ch'ang in the *T'ang shu*, which duly mentions the two annual crops and the cultivation of cotton there, could have passed over the karez system if it had then existed.

There still remains to be noticed that deepest portion of the Turfan depression which forms the terminal basin of whatever surface drainage is to be found in it. My remarks on it must be brief; for, as plentiful archaeological labours, to my regret, did not allow me to devote myself personally to its study, I have little to add to what the map clearly shows. I had however taken special care to entrust the survey of the dried-up lake-bed which forms the most characteristic feature of this area to R. B. Lal Singh, and to secure through this ever-careful and painstaking topographical assistant a series of reliable mercurial barometer observations along its shore.

They extend from the eastern extremity of the salt-encrusted dry bed at the point known as *Tuz-kan*, the "Salt Pit," to the ruined watch-tower of Bejan-tura, the "Tower of the lifeless (ground)."<sup>1</sup> Examination of the readings thus observed leaves little doubt that the greatest depth of —980 feet recorded on the actual surface of the bed about 3 miles to the north-west of Tuz-kan represents as close an approach to the maximum of the subsidence as could be obtained without exact levelling operations. In their absence it cannot be considered as certain whether the Aidin-köl salt marsh, which at the time of the survey, 18–21 January 1915, was seen to hold water, marks the deepest portion of the bed. It is obviously the one which is most likely to be reached by flood water from the Toksun river. But evaporation and the presence of ridges of hummocky hard salt such as I observed rising above the flat expanse of crumpled-up salt cakes on a short reconnaissance made east of Bejan-tura, may well keep such water from spreading farther eastwards.

In this, as in other respects also, this terminal depression of the Turfan trough, having a total length of some 30 miles, presents a striking pendant to the dried-up salt sea-bed of the Lop Desert,<sup>2</sup> though on a much reduced scale. Here too the southern shore of the salt-encrusted bed is overlooked by a steadily rising glaciis of coarse gravel and detritus, utterly devoid of vegetation, leading up to the foot of the northernmost range of the Chöl-tagh. The rise of the ground adjoining the northern shore is far more gentle, and here subsoil moisture derived from the irrigated areas farther north permits of the growth of low scrub, reeds, and tamarisks. It is dreary arid ground, yet not as forbiddingly bare as the slopes of the Chöl-tagh to the south of the dried-up lake-bed.

Up those slopes, covered with stony detritus and in parts also with accumulations of drift-sand, there lead tracks crossing the rocky wastes of plateaux and much decayed ranges towards the Lop region in the extreme east of the Tarim basin. Those ranges all belong to a system appropriately designated as the *Kuruk-tagh*, the "Dry Mountains." Of them the one crossed by the passes of At-ölgan-dawan and Igar-dawan at elevations of about 4000 feet above sea-level forms the watershed towards the Turfan basin. Nowhere between that watershed and the bottom part of the trough can drinkable water be found, except to the west, where the ancient highway from Toksun towards Qara-

<sup>1</sup> It is probably from a careless pronunciation of this name, inadequately recorded, that Russian maps and other publications have derived the apocryphical name "Bujento," not known locally as a designation of the marsh.

<sup>2</sup> For observations on the characteristic features of the dried-up bed of the ancient Lop Sea, cf. 'Innermost Asia,' i, pp. 295 sqq.

shahr and the north-eastern corner of the Tarim basin crosses a higher portion of the range.

The rapidly rising ground to the west of Toksun, with the great valley of Algoi and those descending from the side of Urumchi, has remained outside our surveys. Nor have I had an opportunity of becoming personally acquainted with that portion of the depression which may be assumed to extend due east of the Kum-tagh towards Hami. So here I may close this summary account of a well-defined Central-Asian region which, small as it is in extent, can yet lay claim to special geographical interest as illustrating all physical features that are typical of innermost Asia.

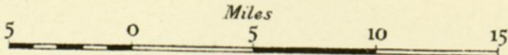
*Note by the Editor:*

When Sir Aurel Stein consented some two years ago to write for the *Journal* a note on his Map of the Turfan Basin, it was at first contemplated that we should ask the Surveyor-General of India to print for us an edition of the "Map showing the main portions of the Turfan Basin" which had been drawn on the scale of 1/250,000 under his direction at the Trigonometrical Survey Office, Dehra Dun, and is included among the special maps published by the Survey of India. But further consideration showed that not only was this sheet inconveniently large for the *Journal*, but the complexity of its names and detail, and the emphasis given by colour to the cultivated areas, had inevitably obscured to some extent the remarkable topography of the basin. With the consent, therefore, of Sir Aurel Stein and of the Surveyor-General, we have extracted the topography from the larger sheet, and have emphasized the relief by adding a simple layer-colouring. The resulting map, on half the scale of the original, must be considered as a supplement to the latter, made for a special purpose; for a full appreciation of the above paper the student will necessarily refer to the map published by the Survey of India.

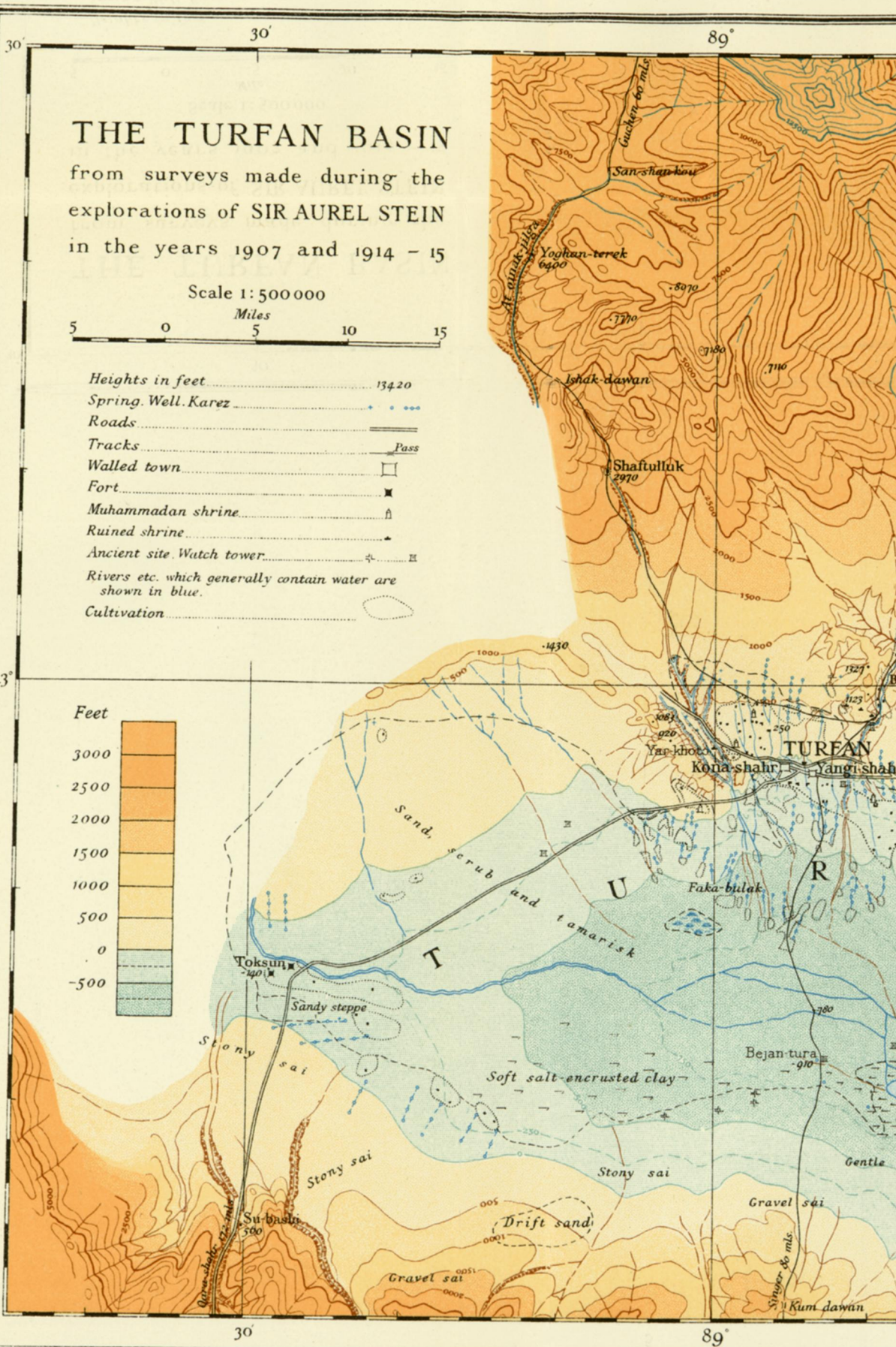
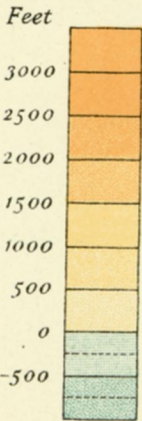
# THE TURFAN BASIN

from surveys made during the explorations of SIR AUREL STEIN in the years 1907 and 1914 - 15

Scale 1: 500 000



- Heights in feet ..... 13420
- Spring, Well, Karez .....
- Roads .....
- Tracks .....
- Walled town .....
- Fort .....
- Muhammadian shrine .....
- Ruined shrine .....
- Ancient site, Watch tower .....
- Rivers etc. which generally contain water are shown in blue.
- Cultivation .....



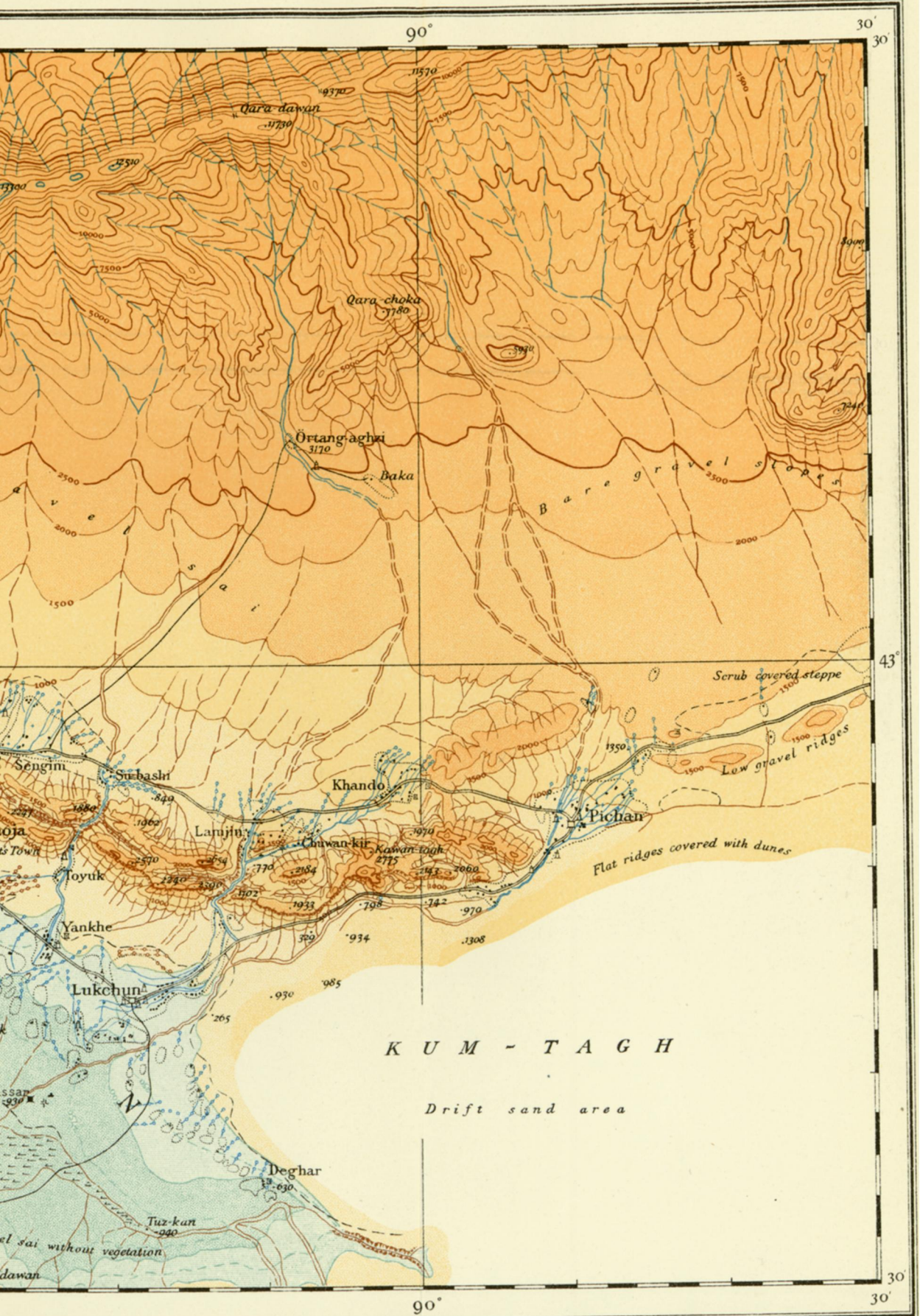
89°

30'



89

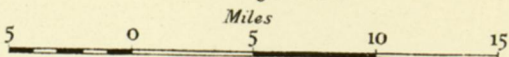
30'



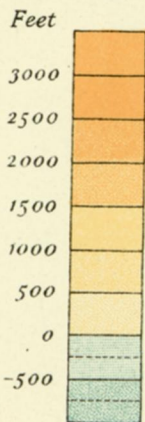
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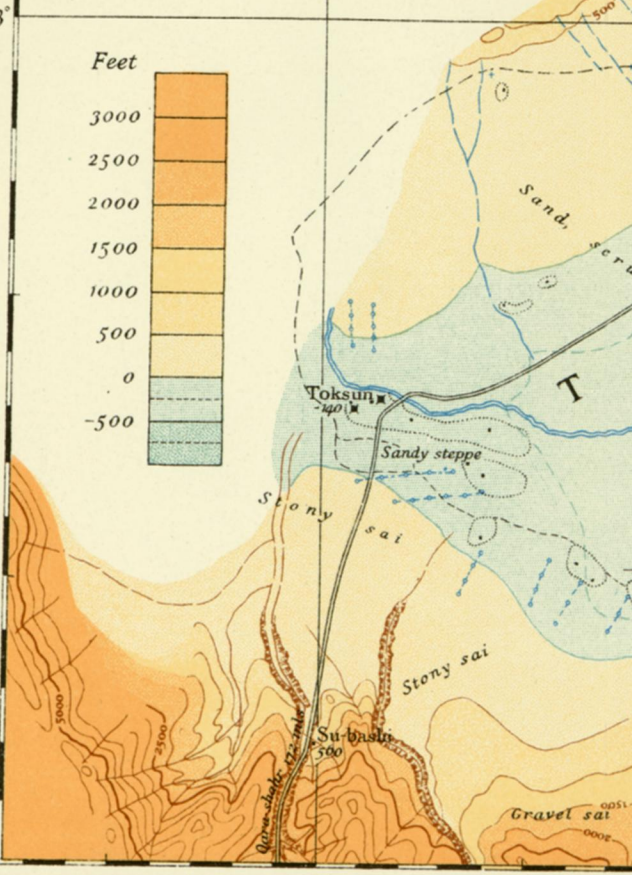
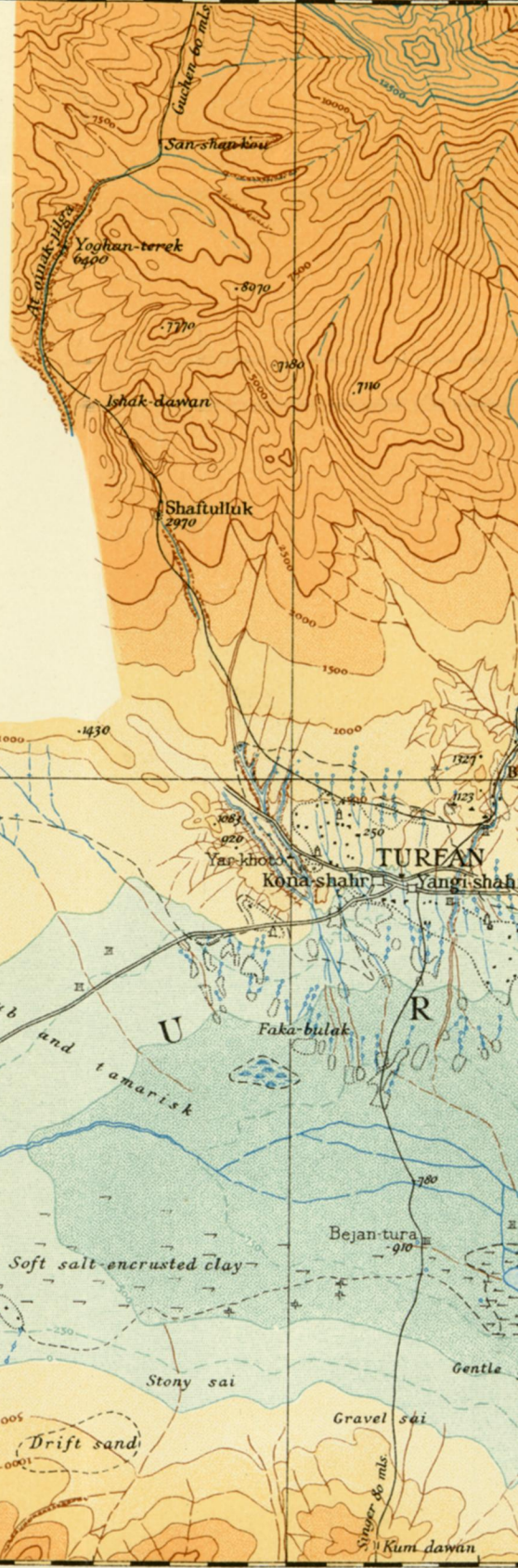


43°

30°

30

89°





89°

30'





TURFAN BASIN  
Stein