MEMOIR ON MAPS OF CHINESE TURKISTAN AND KANSU

FROM THE SURVEYS MADE DURING SIR AUREL STEIN'S EXPLORATIONS 1900-1, 1906-8, 1913-5

BY

AUREL STEIN, K. C. I. E.

INDIAN ARCHÆOLOGICAL SURVEY

WITH APPENDICES BY

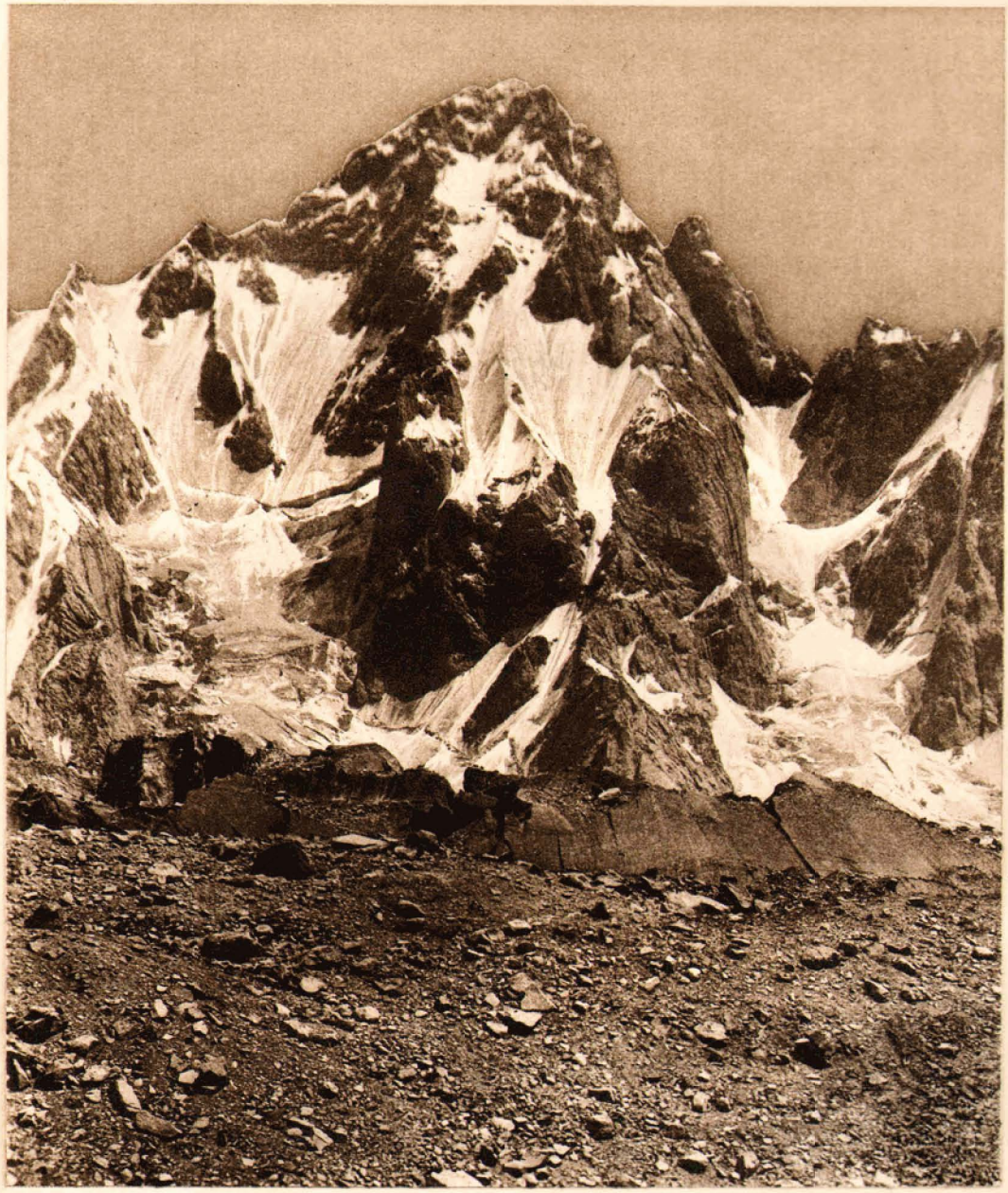
MAJOR K. MASON, M. C., R. E.

AND J de GRAAFF HUNTER, Sc. D.

TRIGONOMETRICAL SURVEY OFFICE

DEHRA DUN

1923



1.—SNOWY PEAK ABOVE OTRUGHUL GLACIER, AT HEAD OF NISSA VALLEY, SEEN FROM MORAINE ABOVE WEST FLANK OF GLACIER, AT AN ELEVATION OF ABOUT 14,800 FEET (SEE PAGE 12, NOTE 15).

The foreground shows the glacier flank completely covered with rock débris. The ice wall behind is exposed, darkened by fine detritus.

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Omnia tempus edax depascitur, omnia carpit,
omnia sede mouet, nil sinit esse diu.
flumina deficiunt, profugum mare litora siccant,
subsidunt montes et iuga celsa ruunt.

SENECA.

RECORDS OF THE SURVEY OF INDIA

VOL. XVII

MEMOIR ON MAPS OF CHINESE TURKISTAN AND KANSU FROM THE SURVEYS MADE DURING SIR AUREL STEIN'S EXPLORATIONS

TO

COLONEL SIR SIDNEY BURRARD, R. E.

K. C. S. I., F. R. S.

LATE SURVEYOR GENERAL OF INDIA

WHOSE GENEROUS HELP AND ADVICE EVER FURTHERED

THE SURVEYS OF MY CENTRAL-ASIAN EXPEDITIONS

THIS RECORD OF THEIR RESULTS

IS INSCRIBED AS A TOKEN OF

SINCERE REGARD AND GRATITUDE

PREFACE

In the introductory remarks prefixed to this Memoir I have endeavoured to indicate briefly the objects and methods which guided me in the surveys of my three Central-Asian journeys and in the preparation of the maps which contain their final cartographical record. It only remains for me to acknowledge with gratitude my manifold obligations for the effective help which alone rendered possible the topographical tasks bound up with my explorations.

Help of Survey of India

That I was able to plan and carry out those tasks was due to the fact that the Survey of India, accustomed ever since its inception to serve the interests of geographical research, not only within the vast area forming its own sphere of activity but also beyond the borders of India, supported from the start my aims with the means best suited for them. In Chapter I, dealing with the history of our surveys, I have had occasion fully to note the services rendered by the experienced Indians whom the various Surveyor Generals deputed with me, and the extent of the help which I received by the provision of instruments, equipment and funds to meet the cost of their employment. To the Survey of India was due also the compilation and publication of the results brought back by our joint efforts from each successive journey.

The topographical results thus secured have not only helped me to make my journeys directly profitable for geographical study, they have also greatly facilitated my archæological explorations in regions which, though largely desolate today in their physical aspects, have yet played a very important part in the history of Asia and its ancient civilizations. But apart from the gratitude I owe for this furtherance of my researches, the fact of my having been able to work in direct contact with the oldest of the scientific departments of India will always be remembered by me with deep satisfaction.

Interest of Surveyor Generals

Ever since in 1899 the proposals for my first Central-Asian journey had received the Government of India's sanction, successive Surveyor Generals did their best to facilitate the survey tasks of my expeditions. I still think back gratefully to the very helpful advice and instruction by which the late Colonel ST. GEORGE GORE, R.E., while at Calcutta during the cold weather of 1899-1900, showed his personal interest in the enterprise. His successor as Surveyor General, Colonel F. B. LONGE, R.E., was equally ready to meet my requests concerning the plans I had formed for my second and much more extensive expedition of 1906-08.

Guidance of Sir Sidney Burrard

But my heaviest debt of gratitude is due to Colonel SIR SIDNEY BURRARD, R.E., K.C.S.I., F.R.S., who as Superintendent of the Trigonometrical Survey since 1899 had direct charge of all arrangements for the survey work of my first and second expeditions, and who during his succeeding long term of office as Surveyor General was equally ready to extend to me unfailing support and guidance with regard to the third. Moreover quite as great a stimulus was the thought of his own lifelong devotion to the study of the geographical problems connected with innermost Asia and the great mountain systems which enclose it. I feel hence very grateful for being allowed to dedicate this record of our labours to Sir Sidney Burrard not merely as a most helpful friend and guide but also as a living embodiment of that spirit of scientific research which has never ceased to pervade the Survey of India since the days of Rennell, Lambton, and Everest.

Support of Trigonom. Survey Office.

To Colonel Sir GERALD LENOX-CONYNGHAM, R.E., who succeeded to the charge of the Trigonometrical Survey in 1913, I am indebted for much kind help in connection with my third expedition and for most of the efforts which were needed to assure the publication of the maps dealt with in this Memoir. My gratitude for his constant consideration and support must be all the greater because the protracted labours needed for the compilation and fair-drawing of these maps at the Trigonometrical Survey Office had to be carried on for the most part during the period of great stress and strain when the war caused depletion in the Survey staff. To Colonels E. A. TANDY, R.E., and H. McC. COWIE, R.E., who successively held charge of the Trigonometrical Survey Office since 1920, my special thanks are due for the steadily continued efforts which permitted the reproduction of the large number of map sheets to be completed by the summer of 1922.

Compilation and drawing of maps.

The greatness of the field covered by our surveys, extending over no less than 28 degrees of longitude and 8 degrees of latitude, and the varied nature of the materials brought back from the different journeys made the task of compilation and drawing necessarily a very heavy one. No less than fifteen draftsmen on the average were employed on it during 1917-19 under the supervision of several officers from the Provincial and Upper Subordinate Services, working at No. 2 Drawing Office, Dehra Dun. Under the exceptional difficulties created by the war, the work could not have been brought to a successful conclusion but for the special efforts which the officers successively in charge of it, Colonels G. A. BEAZELEY and H.H. TURNER and the late Colonel R. A. WAUHOPE, R. E., were prepared to devote to it by the side of much other urgent work. To the last named officer in whom the Survey of India has since lost a distinguished veteran of wide trans-frontier experience, I am indebted for a series of valuable suggestions which have helped to improve the cartographic representation of the ground.

Reproduction of maps

I owe a similar debt of gratitude to Major F. J. M. KING, R. E., who since the spring of 1919 adding the charge of No. 2 Drawing Office to that of the Photo.-Zinco. Office, Dehra Dun, has spared no pains to improve the reproduction of the maps by all technical means at his disposal. Finally I consider it my duty to record here my special thanks to Munshi KARIM BAKHSH, Head Draftsman of No. 2 Drawing Office, who brought to bear upon the drawing of the new maps the accumulated experience he had gained ever since 1901 from the cartographic elaboration of our previous Central-Asian surveys. His exemplary attention to detail and his painstaking care helped to lighten the labour which the revision of the fair drawings and the correction of proofs in their successive stage have involved for me.

Appendices to Memoir.

When in the spring of 1921 Colonel C. H. D. RYDER, C. I. E., D. S. O., R. E., Surveyor General, had accorded final sanction for the publication of the present Memoir, Major KENNETH MASON, M. C., R. E., officiating Deputy Superintendent, Survey of India, kindly agreed, with the approval of Colonel H. McC. Cowie, to provide for it an Appendix dealing with the details and merits of the triangulation executed by my survey assistants, R. S. Rām Singh and R. B. Lāl Singh. The labour involved in this task was far greater than the summary and discussion as prefixed by Major Mason in Appendix *A* might suggest in its lucid conciseness. I cannot feel too grateful to him for the expert analysis thus provided as regards the trigonometrical basis of our maps. Not content with this service Major Mason decided to incorporate in the appended tables and charts also the complete data available in the Computing Office, Dehra Dun, of the triangulation work executed by other observers, including himself, on the Pāmīrs and along the high K'un-lun ranges eastwards. It is hoped that the systematic record of these data will prove useful towards facilitating the work of future explorers.

Dr. J. de GRAAFF HUNTER, Deputy Superintendent in charge of the Computing Office and Mathematical Adviser to the Survey of India, kindly rendered a service similarly helpful by furnishing the notes of Appendix *B* on the height observations of my journeys. They explain the data and methods of correction used for the height records shown in the maps and incidentally afford guidance as to the better use of the hypsometer on future explorations of this character.

Indices of Memoir

The complete Index of Local Names which I have added to these Appendices is primarily meant to facilitate reference to the maps in respect of particular localities. But in view of the special care I had taken about the correct phonetic record of all names, I hope, it will in competent scholars' hands prove useful also for philological enquiries into the local nomenclature of that Eastern Turkish language which has spread its place names over vast regions of Asia. For the preparation of the General Index to the Memoir I am mainly indebted to the help of my archæological assistant Miss F. M. G. LORIMER.

Printing of Memoir.

The text of my Memoir has derived much benefit from the painstaking attention which my friend Major K. MASON, M.C., R.E., qualified alike by knowledge of the subject and by literary experience, has been kind enough to bestow upon it both in manuscript and in print. To him and Captain W. E. PERRY, M.C., R.E., in charge of the Printing Office of the Trigonometrical Survey, I owe my thanks for manifold assistance during the printing of the Memoir.

Illustrations.

The ready help of the Photo.-Litho. Office of the Survey of India, Calcutta, has made it possible to add to the Memoir the series of plates which, I hope, will be useful in bringing before the eyes of the reader, whether of the maps or the text, characteristic features of the ground in the mountains and deserts we surveyed. The photographs reproduced were taken by myself and have already partly served for the illustration of my Personal Narratives and Detailed Reports of the first and second journeys. For the reproduction of the panoramic views in Plates 3, 5, 7, I am indebted to the kind permission of the Royal Geographical Society which had first published them in my *Mountain Panoramas from the Pamirs and Kwen Lun.*

Help of surveyors in the field.

If I have left it to the last to express my personal gratitude to my Indian surveying assistants it is merely because the Memoir itself shows how preponderating was their share in the labours which the surveys recorded in the maps have cost. I may safely leave it to those who will use our maps, whether in the field or in the study, to judge of the value of these labours. Of the self-sacrificing efforts which my travel companions had to make in order to carry out their tasks, mostly on desert ground or in equally forbidding mountain regions, I have had ample occasion to furnish proofs in the published accounts of my journeys. Rai Sahib RAM SINGH, the earliest of my companions in the field and skilful alike with plane-table and theodolite; Rai Bahadur LAL SINGH, the veteran of indomitable energy whose exertions neither risks nor hardships could ever restrain, and young AFRAZ-GUL KHAN, now Khan Sahib, who, joining me last in the field, soon proved possessed both of a keen topographical sense and a true spirit of daring,—they all faced their duties with unflinching devotion, in spite of severe trials and privations. In Gurkha, Sikh and Pathān I was fortunate enough to find ever faithful, hardworking companions, and with their help I shall always associate my happiest recollections of travel.

AUREL STEIN.

CAMP MOHAND MARG, KASHMIR:

July 31, 1922.

LIST OF ABBREVIATED TITLES

CLEMENTI, *Summary of Geogr. Observations....* Summary of Geographical Observations, during a journey from Kashgar to Kowlun, 1907-9. By Cecil Clementi, M. A., Assistant Colonial Secretary, Hongkong,, 1911; also 'Geographical Journal', 1912, pp. 624 sqq.

FORSYTH, *Yarkand Mission Report.* ... Report of a Mission to Yarkund in 1873, under command of Sir T.D. Forsyth, K.C.S.I., C. B., Bengal Civil Service. With historical and geographical information regarding the possessions of the Ameer of Yarkund. Calcutta, Foreign Department Press. 1875.

FUTTERER, *Geograph. Skizze.* ... ... Geographische Skizze der Wüste Gobi zwischen Hami und Su-tschôu. Von Professor Dr. K. Futterer. Dr. A. Petermann's Mittheilungen, Justus Perthes, Gotha. Ergänzungsheft No. 139, 1902.

HEDIN, *Central Asia* Scientific results of a journey in Central Asia, 1899-1902. By Sven Hedin. Six vols. Stockholm, 1904-7.

STEIN, *Ruins of Khotan* Sand-buried ruins of Khotan. Personal narrative of a journey of archæological and geographical exploration in Chinese Turkestan. By M. Aurel Stein. (Second edition). London, T. Fisher Unwin, 1904.

STEIN, *Ancient Khotan* ... Ancient Khotan. Detailed Report of archæological explorations in Chinese Turkestan, carried out and described under the orders of H. M. Indian Government by M. Aurel Stein. Vols. I, II. Oxford, Clarendon Press, 1907.

STEIN, *Mountain Panoramas* ... Mountain Panoramas from the Pamirs and Kwen Lun, photographed and annotated by M. Aurel Stein. London, Royal Geographical Society, 1908.

STEIN, *Desert Cathay* Ruins of Desert Cathay. Personal Narrative of explorations in Central Asia and Westernmost China. By M. Aurel Stein. Vols. I, II. London, Macmillan & Co., 1912.

STEIN, *Serindia* ... Serindia. Detailed Report of explorations in Central Asia and Westernmost China, carried out and described under the orders of H. M. Indian Government by Aurel Stein. Vols. I-V. Oxford, Clarendon Press, 1921.

STEIN, *Third Journey* ... ... A Third Journey of exploration in Central Asia, 1913-16. By Aurel Stein. From 'The Geographical Journal' for August and September, 1916 (pp. 97-130, 193-225).

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LIST OF PLATES

NOTE.—The order of the illustrations conforms, as far as possible, to the history of the surveys as recorded in Chapter I.

PLATE

PLATE

LIST OF MAPS AND CHARTS

INDEX MAP, SCALE 1 : 3,000,000.
SPECIMEN OF MAPS, SCALE 1 : 500,000 (SHEET NO. 43).
TRIANGULATION CHART, SURVEY OF INDIA NO. 42 I,M.
" " " " " 42 J,K,N,O.
" " " " " 51 L,P AND 52 I,M.
" " " " " 60 D,H AND 61 A,E.
" " " " " 60 K,L,O,P.
" " " " " 69 C,D,G,H.
" " " " " 69 J,K,N,O.
" " " " " 75 A,B,E,F.
" " CARTE INTERNATIONALE NOS. N.K-45 K,O.
" " " " N.K-45 S,T,W,X.
" " " " N.K-46 C,D.
SECTIONAL DRAWING OF LEVELLED LINE, KUM-KUDUK TO BESH-TOGHRAK.

SUPPLEMENTARY CORRECTIONS

P. 84, r. col. l. 47. *Add*: Corrections. B. 1 The valley due south of 7540 should be named Pa-no-cha.

B. 2. The valley SE. of San-shan-k'ou should be named Karanghu-jilga. *For* Shaftalluk *read* Shaftulluk.

P. 87, r. col. l. 27. *Add*: D. 1. The height of Chindailik should be 2160.

P. 90, r. col. l. 19. *Add*: B. 1. The height of Kōshe-langza should be 2010.

C. 1. The height of Panja should be 2160.

P. 92, r. col. l. 39. *Add*: B. 4. The position of the well east of Bēsh-toghrak should be shown $1\frac{1}{2}$ miles nearer to this place.

C. 3. Delete the two northernmost Mesa symbols north of C. cxii.

P. 92, r. col. l. 42. *Add*: The position of C. 153 (of 1907) ought to be inserted two miles NW. of C. cxiii (1914).

P. 99, r. col. l. 3. *Add*: D. 3. *For* Lo-t'o-ching *read* Lo-t'o-ch'üan. *For* Kuo-ti-ch'üan *read* Kuo-ti-ching.

INTRODUCTORY

The present publication is intended to furnish a record of the topographical surveys accomplished in the course of the three expeditions which carried me from the northernmost border of the Indian Empire on the Pāmīrs through the whole length and breadth of Chinese Turkistān, as comprised between the K'un-lun and T'ien-shan ranges, and thence into westernmost China. These journeys, undertaken by me under the orders of the Government of India, had archæological exploration for their primary object; but from the first I was equally anxious also to use all possible opportunities for geographical work.

Help of Survey of India.

That I was able to realize this aim by means of systematic surveys over the whole of the ground covered by these protracted travels,—an area extending in its extreme limits from the 75th to the 102nd degree of longitude and from the 35th to near the 44th degree of latitude,— is due mainly to the generous help accorded by the Survey of India. It deputed with me experienced Indian surveyors of proved ability and energy, provided instruments, equipment and funds to meet the cost of their employment and, last but not least, compiled the results of our surveys, which comprised continuous plane-table work by my assistants and myself as well as, where conditions would permit, triangulation and astronomical observations. For the aid thus given to my efforts I cannot feel too grateful.

Publication of new maps.

On the return from my third expedition, early in 1916, Colonel Sir SIDNEY BURRARD, R.E., then Surveyor General, whose unfailing interest and experienced guidance had from the beginning greatly facilitated those labours, approved the proposal made with the support of Colonel (now Sir) G. P. LENOX-CONYNGHAM, R.E., his successor as Superintendent, Trigonometrical Survey, that the topographical results of that expedition should be published in a series of maps embodying also the surveys of my previous Central-Asian journeys, though these had already received cartographical record.

Thus the new maps have come to comprise a vast region of innermost Asia, well-defined in its chief physical features and uniformly surveyed in accordance with the methods which the Survey of India's accumulated experience has shown to be most suitable for 'reconnaissance survey' work. Within the limits of these maps appear unsurveyed and in many cases wholly unexplored areas, a fact fully accounted for by the exceptional physical difficulties of access to the great forbidding deserts and the high mountain ranges, almost equally desolate, constituting the major portion of the ground. But no less striking than the extent of uninhabitable wastes within this vast region is the uniformity which prevails in the physical characteristics of its chief zones.

Representation of physical features.

Wherever we travelled, whether in the barren mountain ranges which enclose the Tārīm basin, in the drainageless areas forming its continuation eastwards, through the great deserts of drift-sand or gravel which fill their depressions for the most part, or in the narrow stretches of cultivable ground to be met between them, it had been my constant endeavour to make our surveys as careful and detailed a record of the prevailing physical features as limitations of scale, available time, training, etc., would permit. It is, therefore, particularly gratifying to note that improved methods of drawing and reproduction have allowed in the new maps a clearer and fuller representation of that record than was possible in previous publications.

Purpose of Memoir.

If this fact is considered in addition to the great extension of the ground surveyed, the hope seems justified that these new maps will for some time to come serve as a main source of cartographical reference for an important portion of Central Asia, which, by the physical conditions of its present and by its great rôle in the past, as the meeting place of the ancient civilizations of India, China and the West, is attracting more and more interest both from the geographer and the historical student. It has hence appeared appropriate to accompany the issue of these maps by a memoir recording needful information as to the history and extent of those successive surveys; the character of the materials furnished by them; the methods adopted for the construction of the maps and the representation of topographical data in them.

CHAPTER I

HISTORY OF THE SURVEYS

SECTION I.—GENERAL CHARACTER OF THE TOPOGRAPHICAL WORK

The main facts concerning the surveys effected on my three Central-Asian expeditions and many of the more notable incidents and results which attended them have been already recorded in the 'Personal Narratives' and 'Detailed Reports' published by me of the first two journeys[1] or, as regards the third, in the fairly comprehensive preliminary account printed in the Royal Geographical Society's *Journal*.[2] I shall accordingly restrict myself here to notes on the character and range of the surveys made of each journey; on the assistance available for the topographical work of each, and on the routes along which this work was carried, distinguishing the routes upon which the surveys were effected under my personal supervision from others where the operations were conducted by my assistants or myself alone.

Methods in surveys.

Before however recording these details for each successive expedition it will be convenient here to indicate essential points regarding the methods which were uniformly observed in all our surveys. As already stated above, these methods were the same as those employed by the Survey of India for 'reconnaissance survey' work. They implied continuous plane-tabling along all routes followed, supplemented throughout by astronomical observations for latitude and by triangulation rendered possible in particular areas by proximity to previously fixed points, by the configuration of the ground, available time and similar considerations.

Scale, etc., of plane-table work.

Except on the journey of 1900-01 when a scale of 8 miles to 1 inch was used, the surveys were on the scale of 4 miles to 1 inch, this having proved by experience on the ground to be the most convenient for adequate record of topographical detail under our conditions of travel. On mountainous ground no efforts were spared to place plane-table stations on commanding heights above passes and route lines, maximum elevations of nearly 20,000 feet being climbed by us in the K'un-lun for this purpose and of over 16,000 feet at numerous points of the Pāmīr and Nan-shan ranges. In the great plains of the Tārīm basin and in the similar drainageless deserts eastwards, the flatness of the ground, the absence of recognizable landmarks and the peculiar dust-laden condition of the atmosphere, persisting for prolonged periods, made it very often impossible to fix positions by intersections or triangles. On this ground the exact measurement of distances which the use of the cyclometer invariably carried on the second and third expeditions permitted, was essential for the plane-table traverses.

Latitude observations.

For the purpose of securing points to check these traverses, astronomical observations for latitude were made by my assistants with a 6-inch transit theodolite at frequent intervals when atmospheric conditions and available time permitted. These observations were beset with serious difficulties, both on account of climatic conditions and the rapidity of movement necessitated by other scientific tasks and the wide extent of difficult ground to be covered. Prolonged periods of

[1] See for the journey of 1900-01, *Sand-buried Ruins of Khotan*, 'Personal Narrative of a journey of archæological and geographical exploration in Chinese Turkistān', London, 1903 (second edition, 1904); and *Ancient Khotan*, 'Detailed Report of archæological explorations in Chinese Turkistān, carried out and described under the orders of H. M. Indian Government by M. Aurel Stein', Clarendon Press, Oxford, 1908 (two vols. 4to).

For the expedition of 1906-08, see *Ruins of Desert Cathay*, 'Personal Narrative of explorations in Central Asia and westernmost China,' by M. Aurel Stein, London, 1912 (Macmillan & Co., two vols. 8vo) and *Serindia*, 'Detailed Report of explorations in Central Asia and westernmost China carried out and described under the orders of H. M. Indian Government by Aurel Stein K. C. I. E.,' Clarendon Press, Oxford, 1921 (five vols. 4to).

[2] See *A Third Journey of exploration in Central Asia, 1913-16*, by Sir Aurel Stein, in *The Geographical Journal* for August and September, 1916, xlviii. pp. 97-130, 193-229.

dust-haze proved a special source of trouble in this respect within and along the deserts of the Tārim and Su-lo-ho basins, while in the Nan-shan ranges to the east cloudy and rainy weather prevailed during most of the time devoted to their survey in the summers of 1907 and 1914. During the late autumn and winter months which were otherwise the best season for survey operations along the northernmost K'un-lun range between the longitudes of Khotan and Lop-nōr, the extreme cold experienced at high elevations made work with the theodolite particularly trying.

Marching distances.

In addition to the considerations already mentioned, the total absence of local resources, often even of water, both in the deserts and mountains, obliged us to move quickly. The rapid succession of daily marches, often over 25 miles in length, which such conditions entailed, is illustrated by the fact that during the two years and four months which on my second expedition were spent on Chinese soil and used for survey work, there were 488 shifts of camp, the aggregate of marching distances for the same period amounting in my own case to close on 8300 miles. On the third journey when the corresponding period was just under two years, the rate of progress was practically the same, the total length of my marches on Chinese soil being close on 7000 miles, and that covered by R. B. Lāl Singh, my indefatigable chief surveying assistant, probably even more. In addition it should be borne in mind that time spared for prolonged halts was absorbed mainly by exacting archæological labours, carried on generally at desert sites and involving further detail surveys.

Uncertainties in longitude.

Observations for longitude would not have been practicable under such conditions, and chronometers would not have been reliable. That our equipment on the third journey did not include an apparatus for receiving wireless time signals must, however, remain a matter of special regret to me. Its use would have obviated those considerable uncertainties in longitude inseparable from plane-table surveys extending for great distances mainly from west to east and checked by triangulation only for a comparatively small portion of their length.

Altitude observations.

Apart from heights measured by theodolite during the triangulation, altitudes were obtained by Watkin mountain aneroids of the Survey of India. Those used on the second and third journeys were checked at intervals with two mercurial mountain barometers and, as judged by this test, preserved a very uniform rate of index error. None of the mercurial barometers survived the trials of the journeys. One, however, of those carried on the third journey was brought back safely as far as Kāshgar and could be compared there with the instruments of the fully equipped Russian meteorological station before it, too, succumbed on its way across the Kara-koram passes. In addition hypsometrical observations were concurrently taken with boiling-point thermometers, some of which were kindly lent to me by the Royal Geographical Society. In the course of plane-table work on mountainous ground clinometers were regularly used during the second and third journeys to secure readings to prominent intersected heights. On high elevations special care was taken to obtain clinometric readings preferably from points where the mercurial barometer was available for observation of absolute heights.

Detaching of surveyors.

With the object of covering as much geographically interesting ground as possible, I detached my topographical assistants from my own party for independent work whenever practicable routes, means of transport, the attitude of the Chinese administration, etc., allowed it to be done with a reasonable degree of safety. During such periods of detachment which on occasions extended over several months, I carried on the plane-table work along my own routes myself. The comparison of the positions indicated by our traverses at the points where the surveyors and my own route-lines crossed or joined, provided a useful means of controlling the results.

Record of surface features.

Wherever we moved together, plane-tabling was done under my direct supervision and with my assistance. The latter was particularly needed in order to secure a systematic record of such geological or physiographic surface features as belts of desert vegetation, living or dead; drift-sand formations stationary or liable to movement; tamarisk-bound sand-cones; ridges and mounds produced by wind-erosion; salt-encrusted ground of different types, etc., which are charac-

teristic of the great drainageless wastes of innermost Asia and of special interest to the geographical student of their present and past. The limits of areas of absolutely bare drift-sand, clay or gravel; of desert ground supporting vegetation of some kind; of irrigated and hence cultivable ground which in these regions, under the influence of peculiar factors, is subject to comparatively rapid changes, and similar features of importance, all claimed careful attention, only assured by prolonged observation and study and not ordinarily falling within the Indian surveyor's training.

Record of local names.

The record of local names along our common routes was another task invariably effected by myself. For routes followed only by my assistants, I did my best to check and correct the record of local names brought back by them through the independent examination of natives acquainted with the ground. The methods used for a strictly phonetic record of all Turkistān local names and for their systematic transcription, as well as for the transliteration of Chinese names necessarily recorded on a different basis, will be fully explained below in the chapter dealing with the preparation of the present maps.

Section II.—First Expedition, 1900-01

After these general observations I may now proceed to a summary record of the survey operations carried out on each successive journey. For those of 1900-01 Colonel St. George Gore, R. E., late Surveyor General of India, had kindly provided the help of Sub-Surveyor Babu (now Rai Sāhib) Rām Singh, previously employed on the last of Captain Deasy's expeditions, together with the necessary equipment of surveying instruments and a grant of Rs. 2000 to cover additional expenses. After reaching the westernmost border of Chinese Turkistān from Hunza over the Kilik pass, survey work was commenced at the head of the Tāghdum-bāsh Pāmīr by the close of June 1900.

Photogrammetric work.

Here as throughout our travels in the mountains I endeavoured to supplement it, as far as my limited time permitted, by photogrammetric work with a Bridges-Lee photo-theodolite kindly lent by the Indian Meteorological Department. A large selection of the mountain panoramas taken with it on the Pāmīrs and in the K'un-lun range south of Khotan has been published by the Royal Geographical Society;[1] and though the ground west of the Muz-tāgh-atā massif is the only area which has been actually mapped from them, these photographic records have subsequently proved more than once of great value in clearing up points of topographical interest, besides serving other geographical purposes.

Survey of Sarīkol.

From the Chinese-Afghān border on the Wakhjīr pass where it overlooks the glacier sources of the main Oxus headwaters, the survey extended through the whole length of the main Sarīkol valley to the great eastward bend of the Zarafshān river below Tāsh-kurghān.[2] Triangulation was started at the head of the Tāghdum-bāsh with the help of points supplied by the surveys of the Pāmīr Boundary Commission and Captain Deasy.[3] It was subsequently extended for a considerable distance to the north along the great meridional range which is crowned by the ice peaks of the Muz-tāgh-atā and Shiwakte (or Kongur) massifs.[4] A series of triangulation stations fixed around the Little Kara-kul lake permitted the determination of several of the most prominent peaks on that range.

[1] See *Mountain Panoramas from the Pamirs and Kwen Lun*. By Dr. M. Aurel Stein, London 1908 (29 views and map, folio).

[2] See Sheet No. 3; for a descriptive account, cf. *Ruins of Khotan*, pp. 56 sqq.

[3] This triangulation in a limited area has since been superseded by the exact operations carried out here for the geodetic connection of the Indian and Russian triangulation systems; *see* Major K. Mason's Appendix *A*.

[4] Cf. Notes on Sheet No. 2; *Ruins of Khotan*, pp. 74 sqq.

Triangulation of Muz-tāgh-atā range.

The height values ascertained for them are subject to minor adjustment consequent upon the corrections which the geodetic work effected by the Survey of India in 1912-13 on the Tāghdum-bāsh Pāmīr has involved for the triangulated points of the Pāmīr Boundary Commission. But the results of Rai Sāhib Rām Singh's triangulation leave no doubt that the Kongur (or Shiwakte) portion of the range rises in at least one peak (Kongur-debe I, height 25,146 feet) considerably above the great snowy dome of Muz-tāgh-atā (24,321 feet). The photo-theodolite panoramas taken by me around Little Kara-kul served for the preparation of a detailed map of the ground between that range and the Russian Pāmīrs, by Lieut. F. B. Tillard, R. E., on the scale of 4 miles to 1 inch.[5] A recent computation of heights, by Major E. O. Wheeler, M. C., R. E., based upon the same panoramas, has fully confirmed the greater elevation of Peak Kongur-debe I, which hence may now be accepted as the culminating height north of the Hindukush and Himālaya, not merely in the Pāmīr region, but also in Asia generally.[6]

Survey of Gez route.

The narrow valley of the Gez or Yamān-yār river draining the western and northern slopes of the Kongur range, and the route followed in the plain north-eastwards as far as Kāshgar could be checked by triangulation.[7] Several high peaks previously fixed from the Little Kara-kul side could be observed by theodolite both at Tāshmalik, near the Gez river's debouchure from the mountains, and at Kāshgar where a prolonged halt necessitated by my preparations for the winter's work fortunately gave a chance of favourable atmospheric conditions towards the close of August. As evidence of the very careful work done by R. S. Rām Singh both on the plane-table and in triangulation, I may mention that the longitude of Kāshgar as shown by the former (76° 1′ 0″) differed by less than two minutes from the value which wireless observation on Sir F. De Filippi's expedition in 1914 determined (75° 59′ 5·64″), while the triangulation result (75° 59′ 15″) as computed from our Kongur-debe Peak I approaches this final determination still more closely.[8]

Kāshgar-Khotan route.

At the beginning of September we left Kāshgar first for the examination of some ruined sites north-eastwards near the outermost foothills of the T'ien-shan, and then for the journey which was to take us to Khotan in the south-east, the main base for my intended explorations.[9] For the first portion of this journey I was able to avoid the well-known high road by rejoining Rām Singh in the large and fertile tract of Khān-arik and thence by making our way to the south *via* Ordam-pādshāh.[10] By the visit to this famous pilgrimage place we gained acquaintance with the westernmost part of that great belt of absolutely barren drift-sand desert known as the Taklamakān which extends throughout the whole length of the Tārīm basin as far east as the Lop-nōr depression. From Kizil we were obliged to follow the caravan route to Khotan which, except where it passes through the rich district of Yārkand and the adjoining oasis of Karghalik, keeps close to the southern edge of the dune-covered Taklamakān.[11] Apart from rapid excursions in the last named oasis and visits to ruined sites near this ancient highway survey work had to be confined to the vicinity of the actual route line.[12]

K'un-lun range S. of Khotan.

Within a few days of our arrival at Khotan, October 13th, however, we set out for a month's interesting geographical work in the mountains to the south, a portion of the K'un-lun range hitherto practically unsurveyed. Five long marches from the debouchure of the Yurung-kāsh river led over a succession of high spurs furnishing excellent plane-table stations. Then the deep-cut valley

[5] See *Map of Muztāgh-atā and Lake Little Kara-kul prepared by Lieut. F. B. Tillard, R. E., from photo-theodolite survey of M. A. Stein, Ph. D.*, Survey of India Offices, Calcutta, 1903.

[6] For details on this peak and on other points of orographic interest, cf. Notes on Sheet No. 2.

[7] For a description of the route, cf. *Ruins of Khotan*, pp. 99 sqq.

[8] The position ascertained for Kāshgar refers in each case to the ground of the British Consulate General (Chīnībāgh) which served as 'camp' for both our expeditions as well as for that of Captain Deasy. The latter's longitude determination for the same point was 76° 1′ 2″. De Filippi's station is situated in the old Muhammadan cemetery between the British and (former) Russian Consulates.

[9] See *Ruins of Khotan*, pp. 130 sqq.

[10] See *ibid.* pp. 142 sqq.; Sheet No. 5.

[11] See *ibid.* pp. 148 sqq.

[12] Cf. *ibid.* pp. 167 sqq.; Sheets Nos. 6, 9.

was reached in which that great branch of the Khotan river has carved its way through the northernmost main range of the K'un-lun.[13] The extensive panoramic view obtained from Tōpe station above the last of those spurs (18,949 ft. as determined by subsequent triangulation) first showed serious and very puzzling discrepancies between the actual orography of these mountains and the sketch-map of the route by which Mr. W. H. Johnson had made his way from Leh down to Khotan.[14] It also made it quite certain that the head-waters of the Yurung-kāsh were much further to the east than shown on that map, as Colonel H. Trotter had already rightly conjectured in 1875.[15]

Gorge of Yurung-kāsh R.

At Karanghu-tāgh, the last inhabited place to the south and a colony of exiled malefactors, reached after crossing the Yurung-kāsh, it proved impossible to obtain any guidance or other local help for the exploration of the very difficult route by which Mr. Johnson had crossed the glacier-covered main range from the south. We succeeded, however, in penetrating for two marches along the extremely confined bed of the Yurung-kāsh until stopped by narrow impassable gorges.[16] Thus it was ascertained that the upper course of the river lies in a succession of very deep defiles passing to the south and west of Pk. 1/61A (E.61 or K.5 of the old survey records), locally known as *Muz-tāgh*, 'the ice mountain'. This is the culminating massif of the northernmost K'un-lun range and the only point on it previously fixed by the G. T. Survey from the Ladāk side.

Route towards Kara-kāsh R.

Any attempt at progress towards the high waterparting in the south was barred by local obstruction and the lateness of the season. Fortunately information was secured about another route leading across the mountains to the north-west, and this enabled us to map the glacier-fed head-waters of the streams draining the portion of the main K'un-lun range south and south-west of Karanghu-tāgh.[17] A succession of troublesome passes, practicable only for yak transport, led across the precipitous spurs dividing the valleys of Kāsh, Nissa and Chash and offered excellent stations for plane-table and photo-theodolite work. They also revealed the extraordinarily difficult nature of the ground to the south, rising with great glacier-clad heights to an ice-covered crest-line nowhere much under 20,000 feet and filled elsewhere with a maze of steep serrated ridges with deeply eroded gorges between them.[18] Further north on the Yagan-dawān we reached the watershed between the Yurung-kāsh and Kara-kāsh rivers. For the remarkable character of the region here entered, with its closely packed lines of bare rocky spurs and its deep arid gorges shut in by unscalable rock slopes, a reference to my photo-theodolite panoramas and Personal Narrative will suffice here.[19]

Triangulation from Ulūghat-dawān.

The hope of connecting our surveys by triangulation with peaks fixed by the G. T. Survey from the south on the main K'un-lun range was again and again disappointed until we reached the Ulūghat-dawān (9,890 feet),[20] the last pass above the Kara-kāsh river. Here a grand panorama permitted us to recognize with certainty at least two previously fixed peaks in the south, besides the ever conspicuous pyramid of 'Muz-tāgh' (Pk.1/61A)[21]. With our 'hill station' thus fixed in a position commanding extensive views in all directions, except in the north where the ever-present dust haze hid the Khotan oasis and the desert plain, it became possible to use the favourable atmospheric conditions fortunately prevailing on November 7th for triangulating a considerable number of prominent points from the mountains above the Kara-

[13] See *ibid.* pp 190 sqq.; Sheet No. 9.

[14] For an explanation of these discrepancies and other questions connected with Mr. Johnson's route and with the representation his record has found in that sketch-map, see the Notes by Major E. Mason, R. E., and myself in *Alpine Journal*, November, 1921, xxxiv. pp. 54 and 62.

[15] Cf. his *Account of Pandit Kishen Singh's explorations in Western Tibet* in *Records of the Survey of India*, vol. VIII, part i, p. 151.

[16] Cf. *Ruins of Khotan*, pp. 200 sqq.

[17] See *ibid.*, pp. 208 sqq.

[18] See Panor. III-IV in *Mountain Panoramas from the Pamirs and Kwen Lun.*

[19] See *loc. cit.* Panor. V. and *Ruins of Khotan*, pp. 215 sqq.

[20] This is the local pronunciation of the name, evidently meant to be *Ulūgh-art*, "the high ridge".

[21] For an account of the triangulation effected from the Ulūghat-dawān and Kaurak-kuz hill stations, cf. *Ruins of Khotan*, pp. 219 sqq. See also Panor. VI of *Mountain Panoramas*, and the notes on the computation of triangulation results from these hill stations in Appendix *A* below.

kāsh in the west to the high ice-peaks towering above the Yurung-kāsh headwaters in the south-east. Among these points I included also certain peaks in the much-eroded outer hills towards Khotan by which the longitude of the town itself might be accurately determined thereafter when a chance of exceptionally clear weather offered.

Two days later a second hill station was ascended on a high ridge above the Kunat pass (10,820 ft.), and the equally distant views there obtained rendered it possible to secure triangles to almost all those points before the veil of dust carried up by a rising wind finally hid all but the nearest ground from our horizon. Subsequent experience has shown how serious is the obstacle presented to survey operations by the fog-like haze of this region. All along the southern edge of the Tārīm basin and the adjoining mountains it rarely lifts except for short periods of the late autumn and winter.

Triangulation towards Karanghu-tāgh.

After a short halt at Khotan necessitated by manifold preparations for our winter campaign I dispatched Rām Singh on November 23rd for supplementary triangulation work in the mountains and for a survey of the high range stretching east of 'Muz-tāgh'. This would fill the gap between our previous survey and the tract explored by Captain Deasy about Pōlur and along the K'un-lun further east. In accordance with my instructions Rām Singh returned to our former route towards Karanghu-tāgh and established triangulation stations first on a prominent peak (14,900 ft.) above the Ulūgh-dawān overlooking the Buya valley, [22] and subsequently on the edge of the high plateau above the Pisha valley (Tōpe station, 13,949 ft.) close to the point where the track to Karanghu-tāgh falls steeply into the deep-cut gorge of the Yurung-kāsh [23].

Survey of range S. of Khotan-Keriya.

He then made his way by the Igin-dawān, at the head of the Pisha valley, across the range running due north from 'Muz-tāgh'. Beyond, this culminates in the conspicuous snowy massif of the Tikelik-tāgh (Pk.3/60D) and finally loses itself on the broad piedmont gravel glacis south-east of the Khotan oasis. [24] Further east he proceeded across the open plateau-like valleys in which rise the head-waters of the rivers irrigating the oases between Khotan and Keriya. Keeping there on high ground, notwithstanding the bitter cold of the season, he accurately mapped the northern slopes of the outer main K'un-lun range as far east as the valley above Tört-Imām (Imāmlar). [25] From stations established on broad elevated spurs between the glacier-fed sources of the Yulung and Nūra rivers he triangulated a number of peaks on this part of the range rising to heights above 21,000 feet.

When the increasing winter cold stopped further work at high altitudes, Rām Singh descended to the narrow belt of oases which stretches east of Chīra. They lie along the line where the subsoil water absorbed on the gravel slopes to the south comes to light again in springs and renders cultivation possible here and there, before being finally lost in the drifting sands of the Taklamakān. From Keriya, the largest of the oases, he turned northwards and, following the Keriya river down a previously unsurveyed portion of its course, rejoined me on December 23rd at the desert site of Dandān-oilik. [26]

Traverses to Dandān-oilik.

Since our separation I had myself been first occupied within the central portion of the Khotan oasis by surveys needed for clearing up manifold questions concerning its historical topography. [27] Subsequently I set out by December 7th into the desert north-eastwards for my main task, the exploration of sand-buried ancient sites. The plane-table traverse carried out by me along my route to the ruins of Dandān-oilik, the first of these, a distance of about 120 miles, had lain almost wholly through desert and for the last six marches over bare dunes, altogether very deceptive ground. Rām Singh's survey from Khotan to the same place had been brought

[22] See Sheet No. 14. A. 4, where the triangulation station symbol and the route line leading to the position of this hill station have been omitted by an oversight.

[23] See Sheet No. 9. D. 4, and for portions of a photographic panorama here taken in 1906, *Desert Cathay*, i. Figs. 66, 67.

[24] See Sheet No. 14. A. 3, 4.

[25] See Sheet No. 14. C. 4.

[26] Cf. *Ruins of Khotan*, pp. 282 sq.; Sheet No. 14. C. 1.

[27] See inset map (*Portions of Khotan oasis*, scale 4 miles to 1 inch) in map of *Ancient Khotan*; for the location of historically known points, etc., cf. *Ancient Khotan*, i. Chap. VIII, sec. i-iii.

over approximately 500 miles of route, and for the last 130 miles or so, no intersections could be obtained on it owing to the absence of all landmarks. It was hence very reassuring to find that the difference between our positions as shown by the plane-tables at the point of junction amounted only to about half a mile in longitude and less than a mile in latitude.

Explorations at Niya site.

After completing my successful excavations at and near the Dandān-oilik site I proceeded with the surveyor to Keriya and thence reached Niya, the last small oasis eastwards within the territory of old Khotan, by January 21, 1901. Valuable antiquarian information obtained here led me northward for five marches through the jungle belt along the bed of the dying Niya river. Beyond it in the area of bare dunes I discovered the widely scattered ruins of an ancient settlement abandoned to the desert sands since the third century A. D.[28] During the very fruitful explorations which kept us busy here for over a fortnight Rām Singh was fully employed on a detailed survey of the extensive site and on reconnaissances into the neighbouring desert.[29] From the termination of the Niya river we then traversed the wholly unsurveyed desert eastwards for a marching distance of over a hundred miles to the site of reported ruins not far from where the Endere river is lost in the sands.[30]

Return from Endere

Here the easternmost limit of my first expedition was attained, and after exploring with interesting results the ruins of an ancient fort and other remains, we commenced our return journey by February 26. It led us first back to Keriya along the desert track which since early times has served for caravan traffic along the southern edge of the Taklamakān from Khotan to the Lop-nōr region and to westernmost China beyond. Favourable weather conditions allowed the great rampart of the snow-covered K'un-lun range far away to the south to be sighted and in parts to be sketched on the plane-table.

Surveys below Keriya, Domoko, etc.

A rapid expedition down the Keriya river for seven long marches from Keriya brought us to a point known as *Kara-dong*, where, near the head of the desert delta of the dying river, the remains of an ancient fort required exploration.[31] Then from a point higher up the river we struck across to the west and surveyed the deceptive desert to the north of the oases of Domoko, Gulakhma and Chīra. The ample evidence this ground retains of a much greater extent of the once cultivated areas and of their shifts in position during historical times gives it a special geographical interest.[32]

The marches thence to Khotan offered opportunities for surveying similar areas of early occupation now abandoned to the desert north of the Hanguya canton. Two weeks later excavations carried on at the important ruins of Rawak and surveys of other ancient sites in the desert to the north of the Yurung-kāsh tract were successfully completed just before the increasing heat and sand-storms closed the season for sustained work on such trying ground.

Return to Kāshgar.

Our rapid return journey to Kāshgar along the great caravan route *viâ* Yārkand afforded no opportunity for fresh surveys, except from Kizil to Kāshgar. There I parted from Rām Singh who on the whole of this journey had rendered very efficient and willing services and who now returned to India. I myself gained the railway in Russian Turkistān across the Alai and T'ien-shan and thence proceeded with my archæological collections to London.

Map of first expedition surveys.

The topographical results of this journey found their first cartographic record in the 'Map of portions of Chinese Turkistān, surveyed under the direction, and with the assistance of, M. A. Stein, Ph.D., by Sub-Surveyor S.—R., 1900-01. Two sheets, scale 1 inch to 12 miles', prepared at the Trigonometrical Branch Office of the Survey of India and published in May 1903 under the orders of Colonel St. George C. Gore, C.S.I., R.E., Surveyor General of India. Owing

[28] See Sheet No. 19. B. 1, 2.

[29] Cf. *Ruins of Khotan*, pp. 334 sqq.; *Ancient Khotan*, i. Chapter XI; ii. Plans XXVII-XXXII.

[30] See Sheet No. 19. C, D. 1; *Ruins of Khotan*, pp. 389 sqq.

[31] See Sheet No. 13. D. 3, 4; *Ruins of Khotan*, pp. 405 sqq.

[32] Cf. *Ruins of Khotan*, pp. 414 sqq.; *Ancient Khotan*, i. Chap. XIII. sec. ii, iii.

partly to the small scale and partly to technical reasons connected with the methods of reproduction then used at Calcutta, this map in its printed appearance could not do justice to the care bestowed upon the drawing of the original plane-table sheets. This remark applies in particular to the hill-shading executed by hachuring and to many of the more detailed topographical features. Thus, *e. g.*, areas of sandy desert supporting vegetation were but imperfectly distinguished from cultivated ground, and perennial river courses, etc., were represented in the same manner as mere temporary flood beds.

Map in *Ancient Khotan*.

Most of the technical imperfections were remedied in the reproduction of this map which was prepared for the Royal Geographical Society's *Journal* to illustrate a paper there published on my journey and which was used also for the illustration of my Personal Narrative.[33] For this map executed under my direct supervision while 'on deputation' in England, tracings of the original plane-table sheets were also utilized with much advantage. The difficulties arising from the still more reduced scale of this map (1 : 1,500,000) could fortunately be avoided in the map accompanying *Ancient Khotan*, the detailed report of my journey. It was drawn by Mr. J. W. Addison, draftsman of the Royal Geographical Society, with the help of original records and received equally skilful reproduction in lithography. Based on the Survey of India's map but drawn on the scale of 8 miles to 1 inch it brings out very clearly the characteristic geographical features of the Khotan region, to the representation of which between the approximate longitudes of 79° and 84° it is confined.

Section III.—Surveys of Second Expedition, 1906–08

Sanction for second journey.

The results brought back from my first journey enabled me in 1905 to secure the sanction of the Government of India, then under Lord Curzon as Viceroy, and of the Secretary of State for a second Central-Asian expedition. It was undertaken with a view to explorations similar in character but had a far more extended scope, a fact sufficiently indicated by its duration of fully two and a half years, from the date of my start beyond the administrative border of the N.W. Frontier Province till the return to my base in Kashmir. The Survey of India, under Colonel F. B. Longe, R. E., Surveyor General, was as willing as ever to assist me in my geographical task and again agreed to depute an Indian surveyor, to provide the needful equipment and to bear all cost (originally estimated at Rs. 7,000) arising from his employment. Colonel (now Sir Sidney) Burrard, as Superintendent of the Trigonometrical Survey, showed again the most helpful interest in my plans and made the services of Rai Rām Singh, my former travel companion, available for the work in view.

Route through Chitrāl to Sarīkol.

Starting with him on April 28, 1906, from Fort Chakdarra in Swāt, I journeyed by a new route over interesting ground through tribal territory, Chitrāl and Mastūj to Afghān soil across the Hindukush and then by the uppermost Oxus to the Chinese border on the Pāmīrs. We reached the westernmost frontier of Chinese Turkistān on May 27th by the Wakhjīr pass and again descended the Tāghdum-bāsh Pāmīr and the main Sarīkol valley to Tāsh-kurghān. Below this place Rai Rām Singh commenced survey work by measuring a base near the hamlet of Chushmān in order to fix useful points for mapping the course of the Tāsh-kurghān or Zarafshān river beyond its great bend eastwards.[1] From here down to its junction with the Raskam-daryā, the river had never been explored, and owing to the extremely confined nature of its valley the task was bound to offer great difficulties.

[33] This reproduction, published with permission of the Surveyor General of India, first appeared in the December number of the *Geographical Journal*, 1902, with my paper: *A journey of geographical and archæological exploration in Chinese Turkestan*, xx. pp. 575-610.

[1] See Sheet No. 3. C. 1.

Survey east of Muz-tāgh-atā.

After triangulating a number of high peaks to the north of the river, Rām Singh surveyed its deep-cut gorge for some 40 miles. He took considerable risks in moving along very precipitous slopes and in repeated crossings of the river. Further progress was barred by the swollen state of the river, notwithstanding the early season, and the surveyor was obliged to turn northward. In accordance with my instructions he ascended the important tributary of Pas-robāt to its head and after crossing the Merki pass, nearly 15,000 feet high, endeavoured to follow down the Merki and Kara-tāsh rivers which drain the eastern slopes of the Muz-tāgh-atā massif. [2] Again he was thwarted by the flood from the melting snows which renders the Kara-tāsh valley quite impassable during the summer months. He was now forced north-eastwards across the Ghijak pass and gained the caravan route from Sarīkol to Kāshgar above Ighiz-yār. The Kara-tāsh valley thus remained unexplored until I descended it in September, 1913. Nevertheless Rām Singh was able to survey its debouchure into the plains west of Yangi-hissār before he rejoined me at the latter place towards the close of June.

Journey to Kāshgar.

In order to gain time for urgent preparations at Kāshgar, I had taken the main caravan route from Tāsh-kurghān across the Chichiklik plateau and *via* Chihil-gumbaz and Ighiz-yār. This having already been surveyed on the Forsyth Mission of 1873, I felt little regret that the six forced marches of nearly 180 miles left no time for plane-table work. [3] At Kāshgar the organization of my caravan which was to serve for over two years' explorations, was completed within a fort-night with the ever effective assistance of Mr. (now Sir George) Macartney, the British Consul General.

Routes to Yārkand and Karghalik.

Then I was free to set out for the initial portion of those explorations in the south of the Tārīm basin. At Kizil on the road to Yārkand I detached Rām Singh to survey the route which crosses the easternmost offshoots of the Muz-tāgh-atā range and which joins the caravan route from Chihil-gumbaz to Yārkand below Ārpalik and the Kizil-dawān. [4] Re-united at Yārkand, we proceeded at the beginning of July across the fertile tract between the Yārkand and Tiznaf rivers north-westwards to the edge of the great drift-sand desert where an old site called for examination, and then reached Karghalik by a new route along a previously unsurveyed portion of the Tiznaf river in the plain. [5]

Surveys in westernmost K'un-lun.

From Karghalik we marched to Kök-yār, a small oasis in the foothills to the south, where during a halt of over two weeks I was kept busy with a variety of scientific tasks. From there I sent Rām Singh into the mountains to the south-east to map portions of the outer K'un-lun towards Khotan which were then unexplored or imperfectly surveyed. The success with which in the course of a month he effected the tasks I had indicated deserves all the more notice in view of the considerable hardships and risks encountered. He first approached the snowy range which forms the water-parting towards the uppermost Tiznaf and Yārkand river courses by ascending the streams that carry fertility lower down to the flourishing little oases of Yül-arik and Ushak-bāshi. [6] The attempt to cross the Karlik-dawān by which I had wished the surveyor to reach the unexplored ground at the head of the Toghra-su, a tributary of the Kara-kāsh river, [7] had to be abandoned owing to the depth of snow still covering the pass. This failure, however, was compensated by the advantages which the subsequent crossing of a succession

[2] See Sheet No. 2. D. 4.

[3] See *Desert Cathay*, i. pp. 97 sqq. A plane-table survey of the route from Tāsh-kurghān to Kāshgar was carried out in 1913 on my third journey, under my personal supervision as far as Toile-bulun and beyond by Miān Afrāz-gul.

[4] See Sheet No. 5. A. 4.

[5] See Sheet No. 5. C. 4, D. 3; *Desert Cathay*, i. pp. 134 sqq.

[6] See Sheet No. 6. C. 2, 3. It deserves to be noted that Rām Singh reported the presence of conifer forest at two points in these valleys, above the little cultivated patch of Tatligh and to the south-east of the Tōpa-dawān that divides them, in both places at elevations of about 10,000 feet. His observation is of distinct interest as I know nowhere else of real forest growth in the western K'un-lun. Nor did I meet any eastwards until the Central Nan-shan was reached to the south of Su-chou and Kan-chou. Do these conifers in the above valleys represent the last remnant of forest growth once more favoured by climatic conditions in this region?

[7] See Sheet No. 6. D. 3.

of high spurs eastwards offered for the survey of a very imperfectly known portion of the range overlooking the westernmost affluents of the Kara-kāsh river.

Passage of Hindu-tāsh-dawān.

Rām Singh then crossed that range to the south by the Kiliān pass (17,910 feet), regularly used by traders to Ladāk but at that season still impracticable for caravans, and ascended the Kara-kāsh valley to its junction with the well-known Kara-koram route. [8] Here he secured Kirghiz guides to the Hindu-tāsh-dawān, which had passed out of use for many years and had not been crossed by any known traveller except the ill-fated Dr. Adolf Schlagintweit in 1862. The passage (17,750 feet) was successfully accomplished in the face of great difficulties, including the descent over a large and much-crevassed glacier on the northern side. [9] It brought the surveyor to the valley of Pusha, previously known only from native reports. In addition to some cultivation lower down, it proved to possess more abundant alpine grazing than is found elsewhere in these high K'un-lun valleys. An ascent to the Ak-tāsh-dawān (15,250 feet) permitted a distant view to be gained of the deep-cut Kara-kāsh valley.

Descent along Kara-kāsh R.

It consists here and for a considerable distance lower down of a succession of narrow gorges quite impassable except in the depth of winter when a route lies up the frozen river. In order to gain Khotan, our appointed meeting place, Rām Singh had to take a difficult route to the north-east passing over a series of high spurs which fall precipitously to the Kara-kāsh river. [10] A number of dangerous crossings of big glacier-fed tributaries, such as the Karāz-daryā and Panāz-daryā, were necessary; but in the end the surveyor's small party arrived safely at the foot of our triangulation station of 1900 on the Ulūghat-dawān. [11] Thence Khotan town was gained by the route previously followed.

I myself had arrived there a few days before, on August 5th, from Kök-yār. I had surveyed the outermost foothills of the K'un-lun with the oases of Yül-arik, Ushak-bāshi, Kiliān, Sanju, Puski and Duwa, which lie at the debouchures of the rivers descending from the main range, [12] before I struck the high road by Piālma at the foot of the great gravel glacis.

Return to K'un-lun S. of Khotan.

The heat of the plains still precluded operations at ancient sites in the desert. Hence I was free to set out into the mountains to the south, as soon as the surveyor had had a couple of days' rest, in order to renew and extend our explorations in the Karanghu-tāgh region. Our journey as far as Nissa led necessarily by the same route as followed in 1900 in the inverse direction, a circumstance which lessened regret at the persistent dust haze now hiding all the distant snowy peaks of the main range to the south. No fresh plane-table work was done by the surveyor along this already surveyed route. But I was able to profit by renewed visits to my photo-theodolite stations of 1900 and to record on my panorama reproductions then awaiting publication topographical details within the actual horizon gathered from the hillmen acting as our guides. [13]

Glaciers above Nissa.

Survey work was re-started from above Nissa and pushed up without serious obstruction on the part of the local 'Tāghliks' to the head of the valley where it is closed by high snowy spurs descending straight from the main range. [14] Two glaciers of imposing size are here the main feeders of the Nissa river. On August 19th I ascended the larger one, to an elevation of over 16,000 feet, and ascertained that it had its source on the north-eastern slopes of the triangulated peak 3/52 M, 23,071 feet high, which, as subsequent surveys showed, forms a nodal point at the junction of two main ranges of the K'un-lun. [15] At the same time the survey now

[8] See Sheet No. 9. A. 3, 4.

[9] See Sheet No. 9. B. 4; for some details extracted at Khotan from Rai Rām Singh, cf. *Desert Cathay*, i. p. 174.

[10] Cf. Sheet No. 9. C. 3, 4.

[11] See above, p. 7.

[12] See Sheets Nos. 6. C, D. 2; 9. A-C. 2; *Desert Cathay*, i. pp. 152 sqq.

[13] See *Mountain Panoramas*, Panoramas III-VI with explanatory notes on pp. 18-26, also ibid., *Introductory Note*, p. vi.

[14] See Sheet No. 9. C, D. 1; *Desert Cathay*, i. pp. 182 sqq., with Figs. 57, 58.

[15] For the ascent on this glacier, called by me the Otrughul Glacier from the chief grazing ground lower down, cf. *Desert Cathay*, i. pp. 188 sqq.; also the panoramic view II and Figs. 59, 60.

effected made it clear that the Nissa valley did not extend so far to the S.W. as shown in the map of 1900-01 when its glaciers could be sketched only from a single distant station above the Brinjak-dawān. [16]

Search for Johnson's route to Karanghu-tāgh.

From Nissa I proceeded *via* Karanghu-tāgh to the south in a fresh endeavour to trace Johnson's passage of the main range to the latter place in 1865. In my Personal Narrative I have recorded the obstruction which the Karanghu-tāgh hillmen offered to this plan and explained its obvious reasons. [17] Nevertheless with yak transport secured under great difficulties we managed to reach the big glaciers which close from the S. W. the head of the Turgap-jilga, a branch of the Busat valley. [18] The ascent made on one of these, in spite of unfavourable weather conditions, made it certain that no practicable route could lie across the precipitous ice-clad range rising above those glaciers on the south, and that this range itself is distinct from the main K'un-lun chain which further south forms the watershed towards the Kara-kāsh river drainage.

An attempt to gain from the lower Busat valley another side valley beyond a high spur to the east in which I surmised the approach to Johnson's 'Brinjgá' and 'Naiá Khán Pass' to lie was frustrated by an *émeute* of the Tāghliks. Thus the final elucidation of some interesting topographical questions connected with that route and the unexplored tributaries of the Yurung-kāsh to the south-east had to be left for a future occasion. [19]

[16] Cf. *Mountain Panoramas*, p. 20, the remarks on section IV.B of the view taken from above the Brinjak-dawān.

[17] Cf. *Desert Cathay*, i. pp. 195 sqq.

[18] See Sheets No. 9. D. 4 and No. 10. D. 1. In the latter the line of our ascent, made over the south-eastern branch of the main glacier (*Desert Cathay*, i. pp 200 sq) to an elevation of about 13,600 feet, ought to have been marked, approx. in long. 79° 42′.

[19] The surveys made in September, 1908, along the southern slopes of the southern main K'un-lun range (see below) allowed me to ascertain the position of the 'Yangi-dawān' by which Johnson had crossed it from the side of the Kara-kāsh (see Sheet No. 10. C. 1). But owing to the accident which prevented me from an actual ascent to the pass the position, etc., of the considerable valley separating it from the range further north which trends towards the triangulated peak 3/52 M (23,071) and which Johnson crossed by the 'Naiá Khán Pass' (18,660 feet) could be only conjecturally indicated in Sheet No. 10. D. 1.

Johnson's route is summarily described in Itinerary I appended to his report to the Superintendent, Great Trigonometrical Survey, dated April 22, 1866 (reprinted in the *Royal Geographical Society's Journal*, vol xxxvii. pp.1 sqq.). Its representation in the 'Map illustrating the routes taken by Mr. Johnson in travelling from Leh to Khotan and back' is necessarily affected by the extensive 'adjustment' to which his plane-table record appears to have been subjected, as explained in Major K. Mason's paper *Johnson's 'suppressed ascent' of E 61*, in *Alpine Journal*, November, 1921, vol. xxxiv. p. 54. This may account for the very considerable discrepancies between the actual topography of the K'un-lun south of Khotan and his published map, discrepancies already referred to above and discussed in more detail in my supplementary note to Major Mason's paper (*Johnson's map and the topography of the K'un-lun south of Khotan*, *Alpine Journal*, November, 1921, vol. xxxiv, p. 62).

Notwithstanding the serious defects of the map, I believe a certain agreement can be recognized between Johnson's map and the topographical data furnished by our surveys as regards some essential features of the ground traversed by him from the Yangi-dawān to Karanghu-tāgh. Starting from the Yangi-dawān his route lay down the headwaters of a considerable stream draining eastwards into the Yurung-kāsh. Its valley manifestly corresponds to the one which in Section I. b of the photo-theodolite panorama taken from the Tōpe ridge above Karanghu-tāgh (Sheet No. 9. D. 4, lat 36° 9′, long. 79° 53′; *Mountain Panoramas*, p. 12) is clearly seen separating the range above the Turap-Busat glaciers from the more distant and higher southern main range.

For this valley I have adopted the name Chomsha-jilga which on my renewed visit to the Tōpe station in 1906 I heard applied by the less secretive of the Karanghu-tāgh people with us. But it may be noted that in 1900 I heard this name in the form of *Chomsh-jilga* used for the much smaller and nearer valley which runs down to the left bank of the Yurung-kāsh just south of the Boinak-dawān then crossed on our way to the right bank of the river. It is seen to the left of this saddle in section II. b of the photo-theodolite view from the Zilan ridge (*Mountain Panoramas*, p. 16). Considering that in 1906 we sighted from afar a well-marked track leading south-eastwards into the mountains past this little valley (see *Desert Cathay*, i. p. 209; Fig. 67), it is quite possible that the name in the former instance was used merely because the little valley in question lay on *the way to* the Chomsha-jilga.

However this may be, we can see from Johnson's map that the route by which he ascended northward after leaving the previously mentioned stream at 'Khushlash-langar' (*i. e.* Kashlash-langar, 'the halting place at the confluence') and reached the 'Naiá Khán pass', must have taken him to some point on the northern snowy range trending eastwards from Peak 3/52 M (23,071) and passing above the head of the Turgap-jilga. It is on this eastern continuation of the range, as seen in the Tōpe ridge panorama I. b near the last vertical cross-line on the right and again in the Zilan panorama II. b near the last vertical cross-line on the left, that I feel inclined to look

Preparations for winter campaign.

Having moved north to Pisha, I sent the surveyor to follow a new route to Khotan skirting eastwards the slopes of the Tikelik-tāgh (18,780 feet),[20] while I myself proceeded there by the direct route, already surveyed in 1900, in order to gain time for multifarious preparations for the desert campaign of the autumn and winter. On September 15th I set out for a series of ruined sites to the north-east and east of the Khotan oasis. At the same time Rām Singh was sent off independently to the foot of the main K'un-lun range south of Keriya in order to resume his survey work where it had stopped in December 1900 near Imāmlar (Tört-Imām),[21] and to extend his triangulation along the northern main range of the K'un-lun as far as possible eastwards.

Triangulation along K'un-lun east of Keriya.

Having gained Imāmlar *viâ* Keriya, Rām Singh was able to utilize for his hill survey to the south and south-east the points fixed by his triangulation of 1900 as well as a number of high peaks on the spurs above the gorges of Pōlur which Captain Deasy's triangulation had determined in 1898-99.[22] He then measured a base for triangulation above the hill village of Achchan further east (Sheet No. 14. D. 4.), connecting it with two of Captain Deasy's points. Information as to the determination of this base and the methods by which the triangulation there started was successfully extended to the east, first as far as Surghāk, south of Niya, and subsequently beyond Charchan to a peak in longitude 86° 46′ (Sheet No. 27. B. 1), will be found in Major Mason's Appendix *A*. The total length of new triangulation work thus accomplished by Rām Singh along the K'un-lun range extended over five degrees of longitude.

Explorations resumed at Niya site.

After completing archæological explorations in the desert north of the Khotan-Keriya line, partly on ground not previously surveyed, I reached the Niya oasis by October 14th. There the surveyor rejoined me from his work near Surghāk[23] and, being by chance favoured by clear atmospheric conditions was able to fix the position of the small market-town of Niya by means of triangulation from the K'un-lun. It is the first and so far only instance of an oasis on the edge of the great desert having thus been exactly located. From Niya he accompanied me to the ancient sand-buried site beyond the termination of the Niya river first visited by me in 1901. There

for Johnson's 'Naiá Khán Pass' by which he made his way over glaciers to the head of a valley containing the grazing grounds of 'Brinjgá', as marked on his map to the south-east of Karanghu-tāgh, at a direct distance of some 11 miles.

Now reliable information obtained by me at Pisha and recorded in *Desert Cathay* (see i. pp. 209 sq.) makes it certain that this name 'Brinjaga' is applied by the Karanghu-tāgh people to a valley which debouches on the left bank of the Yurung-kāsh some four miles above the confluence of the Kāsh river with the latter, as shown in Sheet No. 9. D. 4. The information I collected leaves no doubt that Brinjaga contains good grazing grounds visited by the flocks and yaks of Karanghu-tāgh but accessible only before or after the summer months when the flood from the glaciers completely blocks the track leading up in its stream-bed. (Johnson who passed down from 'Brinjgá' by September 9th, 1865, describes the road as "particularly rocky and dangerous from passing over a succession of steep and rugged lateral spurs, running down into the river from two high ranges on either side; the bed of the stream is therefore very contracted"). From Brinjaga down to Karanghu-tāgh Johnson's route sketch shows fair agreement with the actual configuration of the ground as seen in Sheet No. 9. D. 4 and the above quoted photo-theodolite panoramas.

I may add in conclusion that the obstinate passive resistance which the Karanghu-tāgh people opposed both in 1900 and 1906 to my efforts at tracing Johnson's route is fully accounted for partly by the great natural difficulties which would have to be faced on it and still more, perhaps, by the fear of the hardships and exactions to which their small settlement would be exposed if that route were re-opened for traffic. According to Johnson (see para. 11 of his above quoted report) the Yangi-dawān "was said to have been only very recently discovered by Jumō Khān, the Khotan ambassador to the British Government, who was compelled to find his way over this part of the range, because the regular road from Ilchī to Leh, *viâ* Sanjū and the Kārākoram pass, was in the hands of the Yārkandees, who were then at war with the people of Khotan". It was thus only desperate necessity which brought about the use of this extremely difficult route during the brief reign of the rebel ruler Hājī Habībullah (1863-66).

But there is reason to believe that it was known for centuries before to the wily hillmen as a track to be used in emergencies. Thus the difficult mountain track by which according to Mīrzā Haidar's contemporary record Abā Bakr, the dethroned tyrant of Yārkand, after passing through Karanghu-tāgh effected his escape to safety in Ladāk A. H. 920, could scarcely have been any other but the Yangi-dawān route; cf. *Tārīkh-i-Rashīdī*, transl. Elias-Ross, pp. 323 sqq., 327 sq., also Stein, *Ancient Khotan*, i. p. 130.

[20] See Map Sheet No. 14. A. 3, 4, B. 3, 4.

[21] See Sheet No. 14. C. 4.

[22] See Sheet No. 14. C, D. 4; also *Map of Portions of Western China and Tibet, explored by Capt. H. H. P. Deasy*. Sheet No. 4.

[23] See Sheet No. 19. B. 3.

he gave useful help by large-scale surveys of the extensive area over which its ruins are scattered, while renewed excavations rewarded by abundant results kept me busy for a fortnight. [24]

Surveys to Endere, Charchan, Charkhlik.

After this we once again separated, Rām Singh returning southwards to the mountains, while I proceeded partly over unsurveyed desert eastwards to the ruined site of Endere, [25] where the easternmost limit of our surveys of 1900-01 was reached. After the exploration of earlier remains discovered in the vicinity, I continued my journey north-eastwards to Charchan by the old caravan track along the line where a belt of sandy desert supporting scanty grazing meets the area of bare dunes covering the northern fringe of the great gravel glacis of the K'un-lun. [26] From Charchan I carried my plane-table traverse along the unsurveyed route near the right bank of the Charchan river or along the line of adjoining marshes as far as the grazing ground of Lashkar-satma; thence I followed the usual caravan track by the old site of Vāsh-shahri to Charkhlik. [27]

Survey along N. foot of K'un-lun.

Here at the only permanently inhabited place of any size in the whole Lop region representing the terminal basin of the Tārīm, I was obliged to make a few days' halt for the manifold preparations necessary for my explorations in the waterless desert north-eastwards. Before moving again I was rejoined by Rām Singh who had fixed his triangulation stations along the K'un-lun range from Surghāk past Kara-sai and Kapa as far as Salkanji, south of Charchan. After a rapid visit to Charchan he had returned to the foot of the mountains in the south-east, but owing to the severe cold of the season and an attack of rheumatism was obliged to confine himself thereafter to plane-table work. This, however, could as far as approximately the 87th degree of longitude be controlled by intersections from high peaks he had already triangulated from the west. Increasing pains had then forced him to regain the caravan track near Vāsh-shahri. [28]

Start for Lop desert.

On December 6th I started from Charkhlik for the expedition which was to take me across the waterless Lop desert north-eastwards to the ruins of the ancient *Loulan* site first located by Dr. Hedin in 1901. The route chosen led past the small colony of Mīrān, then only spasmodically cultivated, and near it I was able to trace remains of an extensive ancient settlement. [29] Rapid excavations soon proved its importance and determined my subsequent return to the site. Rām Singh had followed me to Mīrān, but the rheumatic attacks from which he was suffering then and during most of the following winter months made effective work very difficult for him on the trying ground ahead. Nevertheless we brought him along on the only camel which could be spared as a mount, the remainder of the twenty-one animals being needed for the transport of indispensable baggage, food supplies and water, *i. e.* ice. With a party of fifty men including labourers for excavations, I crossed the Tārīm at the small fishing hamlet of Abdal. Thence after leaving behind the last salt lagoons of the dying river I pushed on northward across a forbidding waterless waste of bare wind-eroded clay and drift-sand for seven marches from the Tārim to where the principal ruins of Lou-lan were found in the position correctly indicated by Dr. Hedin's map. [30]

[24] Cf. *Desert Cathay*, i. pp. 269-299; *Serindia*, i., Chapter VI; iii. Plans 7-18; Sheets Nos. 18. B. 4; 19. B. 1.

[25] See Sheet No. 19. D. 1; *Desert Cathay*, i. pp. 300 sqq.

[26] See Sheets Nos. 23. A-C. 1; 22, C. 4; *Desert Cathay*, i. pp. 317 sqq.

[27] See Sheets Nos. 22. D. 3, 4; 26. A-D. 3; *Desert Cathay*, i. pp. 321 sqq.

[28] For the surveyor's route from Surghāk, partly followed also in 1913 by R. B. Lāl Singh, see Sheets Nos. 19. B-D. 3; 23. A. 3, B.2, C-D. 1, 2; 26. A-C 4.

[29] See Sheet No. 30. B. 2; *Desert Cathay*, i. pp. 348 sqq.

[30] For the route followed from Abdal, see Sheets Nos. 30. B, C. 1; 29 C. 4, D. 3,4; for observations on topographical features of interest such as the formation of wind-eroded clay ridges (*yārdangs*), ancient dry river beds, etc., see *Desert Cathay*, i. pp. 361 sqq.; *Serindia*, Chap. x, sec. ii, iii. For the topographical significance of rows of dead trees (wild poplars) marking ancient river courses, cf. in particular *Serindia*, i. pp. 355 sq.; for their indication on the maps, see below Chap. III sec. ii.

Explorations at ancient Lou-lan.

Excavations were carried on from the 18th to the 28th of December at the site of the ruined station of Lou-lan (L.A.), once guarding the ancient Chinese route to the Tārīm, and at other ruins to the north-west (marked L.B.) with important results.[31] Constant supervision on my part and the surveyor's ailing condition precluded topographical reconnaissances beyond the immediate vicinity of the ruins, demanded by the interest of the ground both from geographical and archæological points of view. Thus the task of surveying the ancient delta of the Kuruk-daryā ('Dry River') which once had brought water to this now utterly desolate region, or of tracing the line of the ancient Chinese route where it passed across the great dried-up salt sea eastwards, remained for my third expedition.

Desert crossing to Tārīm.

On completion of such exploratory work as the condition of the hard-tried men and our limited store of ice permitted, I sent the main camp under the surveyor back to Abdal while I struck across the wholly unexplored desert to the south-east. Seven trying marches, almost wholly over bare dunes, heaped up at intervals into high ridges or 'Dawāns', brought me on January 3rd, 1907, to the line of lagoons formed by the Ilek branch of the Tārīm.[32] By following them up to the small ruined site of Merdek-tim and subsequently proceeding down to Lop where the delta of the Charchan river joins the Tārīm at the final eastward bend of its course, a useful addition was made to our surveys of the terminal depression in which the united drainage of the Tārīm basin is lost.[33]

Marco Polo's route through Lop desert.

From Charkhlik I returned to the ruins near Mīrān. Their exploration under very trying climatic conditions yielded abundant finds of interest and detained me till February 11th. Then after needful preparations at Abdal I set out with the surveyor for the desert journey of three weeks by the lonely track, once followed by Marco Polo but almost forgotten for centuries, and reached Tun-huang on the westernmost marches of China proper. This route, some 330 miles long, leads first by the southern shore of the great dried-up salt basin marking the pre-historic Lop sea, then up a wide desert valley by the foot of the southernmost Kuruk-tāgh range, and finally through the terminal basin, and along the lowermost course, of the Su-lo-ho river.[34] Its careful survey proved of very considerable geographical interest.

Discovery of ancient Chinese *Limes*.

From this terminal basin onwards I traced important, and, owing to the extremely arid climate, in many parts remarkably well-preserved, remains of an ancient fortified border, a true *Limes*, which the Chinese Emperor Wu-ti, towards the end of the 2nd century B.C., had constructed for the protection of the earliest line of China's expansion into Central Asia. The exploration of this ancient *Limes* which was subsequently traced for a total distance of over 160 miles west of An-hsi, formed a fascinating and fruitful task for more than two months after my arrival at Tun-huang. The ground, almost all desert, over which the wall with its watch-towers and military posts had been built, was as interesting from a geographical point of view as the ruins in their archæological and historical aspect. Hence all the more care was bestowed upon an exact topographical survey of it.

Explorations along ancient border line.

The work was started on the *Limes* portion extending to the north-east of the Tun-huang oasis[35] and subsequently after a visit to the outlying small oasis of Nan-hu, the ancient 'Yang barrier', continued along the whole length of the *Limes* westwards. This was found to run parallel to the Su-lo-ho bed from its outlet at the western end of the Khara-nōr lake and to extend to the southern extremity of the great marsh basin where the river terminates, fully a degree of

[31] See *Desert Cathay*, i. pp. 376-411; *Serindia*, Chap. XI. sec. i-xi.

[32] See Sheets Nos. 29. B, C. 4.; 30. A. 1; *Desert Cathay*, i. pp. 415 sqq.

[33] See Sheet No. 30. A. 1, 2; *Desert Cathay*, i. pp. 424 sqq.

[34] See Sheets Nos. 30. B-C. 2, D. 1; 33. A-C. 1; 32. D. 4; 35. A-D. 4; 38. A-B. 4. For a descriptive account of the route, cf. *Desert Cathay*, i. pp. 503 sqq.; ii. pp. 1 sqq. For an analysis of the geographical features met along it, see *Serindia*, Chap. XIV. sec. i, iv.

[35] See Sheet No. 38. C. 4; *Serindia*, Chap. XV. sec. ii-v.; *Desert Cathay*, ii. pp. 44 sqq.

longitude further west than the latest maps had shown it.[36] As the scale of our plane-table sheets was not sufficiently large to record all topographical details of interest from an archæological or geographical point of view, I supplemented them by numerous sketches. The additional materials thus secured were afterwards embodied in a half-inch map of the westernmost *Limes* which in turn served for the 'Detailed Map of the Ancient Chinese Limes west of Tun-huang' reproduced in *Serindia*.[37]

Subsequently weeks of most fruitful archæological labour were spent by me in exploring a great hoard of ancient manuscripts and art relics discovered at the 'Caves of the Thousand Buddhas' south of Tun-huang. During this time no fresh topographical work was possible as the surveyor's impaired health demanded consideration. But when on June 24th I left An-hsi, after depositing my archæological spoils, etc., at the district headquarters, some months became available for geographical work in the western and central Nan-shan.

Survey in westernmost Nan-shan.

First an extensive ruined site was surveyed near Ch'iao-tzu between the two outermost hill ranges of the former. Then we turned into the mountains due south and mapped the high snowy chain separating the headwaters of the T'a-shih river from the elevated plateaus of Tsaidam.[38] Passing along the northern slopes of that chain and crossing the Su-lo-ho near the hill oasis of Ch'ang-ma, we made our way by unsurveyed routes to the famous defile of Chia-yü-kuan near Su-chou.[39] There we struck the highway which since the earliest historical times has been the main line of communication between China and Central Asia.

Surveys in Central Nan-shan.

Great efforts were needed to secure needful transport and official help at Su-chou for explorations southwards in the Central Nan-shan. But by July 28th we were able to set out and after crossing the Richthofen Range reached the high plateau, nearly 13,500 feet above sea-level, separating the valley of the Hung-shui-pa river from the wide uplands at the headwaters of the Kan-chou river.[40] No guidance was obtainable beyond the small gold-mining camp here encountered, nor were any humans again sighted for nearly a month. Fortunately the well-defined character of the four great ranges in which the Central Nan-shan rises towards the uplands of the Koko-nōr and Khara-nōr region and the open character of the great valleys between them facilitated systematic survey work.

By marches aggregating over 400 miles we managed during August to cross and survey the three northernmost ranges, all rising to snowy peaks of 18,000 feet or more, between the approximate longitudes of 98° and 100°, together with a portion of the outer spurs of the Richthofen Range further east towards Kan-chou. In the course of these surveys, all rivers descending to the oases from Su-chou to Kan-chou, as well as the Su-lo-ho, were traced to their snow-fed headwaters. Wherever possible we travelled by routes and passes different from those taken by the Russian explorers, MM. Potanin, Obrucheff and Col. Kozloff, who had first visited parts of this mountain region.

Exploration of Su-lo-ho sources.

Excellent stations for the plane-table and for photographic panoramas could be climbed above the passes, over 15,000 feet in height, by which we crossed the To-lai-shan and Alexander III ranges.[41] The magnificent glacier-clad range which divides the headwaters of the Su-lo-ho from

[36] For Nan-hu and the route to it, see Sheets Nos. 38. B. 4; 39. A. 1; for its geographical and historical aspects cf. *Serindia*, Chap. xv. sec. i-v.

The topographical results of the exploration of the *Limes* line and the adjoining areas west of Tun-huang are shown by Sheets Nos. 38. A, B. 4; 35. C, D. 4. Detailed observations on the configuration of the ground traversed by the *Limes*, on the ancient beds of the Su-lo-ho, on the water levels in its riverine marshes, etc., are recorded and discussed in Chapters XVII-XIX of *Serindia* which deal with the exploration of these Limes sections. For a general account of the work here and the trying conditions in which it was effected, see *Desert Cathay*, ii. pp. 92-158.

[37] See *Serindia*, iii. Plan 33, on the scale of 3 miles to 1 inch.

[38] See Sheet No. 40. A. 4 for Ch'iao-tzu, and No. 39. D. 1; 41. A. 1 for the high open valleys at the head of the T'a-shih R. drainage; *Desert Cathay*, ii. pp. 242 sqq.

[39] See Sheets Nos. 41. A-D. 1; 43. A. 1; *Desert Cathay*, ii. pp. 265 sqq.

[40] See Sheet No. 43. B. 2, 3; *Desert Cathay*, ii. pp. 296 sqq., Fig. 235.

[41] See Sheet No. 43. A. 2, 3; *Desert Cathay*, ii. pp. 311 sqq. with Panorama x taken above the Huo-ning-to pass on the To-lai-shan Range.

the elevated plateaus draining into the Khara-nōr and Koko-nōr lakes was surveyed along its northern face and proved to rise in its western portion to peaks over 20,000 feet high. [42] From the wide mountain-girt basin some 13,000 feet above sea-level, where the Su-lo-ho gathers its main sources on ground showing a curious combination of dunes and marshes similar to that of the river's terminal basin in the Tun-huang desert more than 300 miles away, we made our way over bog-covered uplands to the headwaters of the Ta-t'ung river. [43] This is the northernmost large tributary of the Hoang-ho, and here our surveys touched the drainage area of the Pacific Ocean.

Route across Richthofen Range.

Thence we gained the valley of the uppermost Kan-chou river by a difficult snowy pass and finally effected our passage through the Richthofen Range. A succession of high transverse spurs dividing the western tributaries of the Kan-chou river, had to be crossed on our way to the Li-yüan-ho and the valley plains of Kan-chou. They provided very good plane-table stations and thus offered compensation for the trouble experienced from the flooded streams in the deep-cut tortuous valleys between them. [44]

Journey from Kan-chou to An-hsi.

At Kan-chou I had reached the easternmost goal of my journey, and on September 3rd we started again westwards in order to gain our base at An-hsi. While I followed the high road to Su-chou and from it made an excursion northward beyond the oasis of Chin-t'a, Rām Singh skirted the foot of the mountains and thus usefully supplemented the survey of the Richthofen Range. [45] For the journey from Su-chou to An-hsi we followed what since ancient times must have been the great Chinese highway from Kan-su towards the Tārīm basin. A long reconnaissance pushed to the north of Yü-mên-hsien enabled me to determine the point where the line of the ancient *Limes* coming from the east first struck the course of the Su-lo-ho near the river's great westward bend. [46]

Rām Singh relieved by Lāl Singh.

At An-hsi Rām Singh whose health had proved unequal to the hardships of a second winter campaign in the desert, was relieved by Surveyor Rai Sahib Lāl Singh whom Sir Sidney Burrard in response to the request made by me on return from the expedition into the Lop desert in the preceding spring had kindly started on his long journey. Rai Lāl Singh subsequently gave splendid proofs of his exceptional zeal and fitness for surveying work under trying conditions, as tested before on many hard survey tasks he had shared from the Yemen to Tibet and Eastern China. Rai Rām Singh regained India *via* Khotan. Advantage was taken of his journey to traverse with a plane-table the more circuitous route through the mountains from Tun-huang to Charkhlik which alone is available for use until the salt springs on the desert route freeze towards the end of December. [47]

Desert route to Hāmi.

On October 8th we commenced the two months' journey of nearly 900 miles from An-hsi to Kara-shahr for our winter's work in the Tārīm basin. Lack of time and a heavy convoy of antiques obliged me to follow the usual caravan track across the stony desert of the Pei-shan to the oasis of Hāmi. [48] Though it has been followed by more than one European traveller since the days of the old Jesuit surveyors of the 17th century, its detailed survey proved of interest for the historical topography of a route which since the 1st century A. D. has served the Chinese as the main line of access to their Central-Asian dominions whenever they were able to assert their control. [49] The short stay I made in the Hāmi tract in order to

[42] See Sheets Nos. 41. D. 4; 43. A. 4; *Desert Cathay*, ii. pp. 322 sq.

[43] See Sheet No. 43. A. 4, B, C. 4; *Desert Cathay*, ii. pp. 323 sqq., Figs. 155, 242-244.

[44] Cf. Sheets Nos. 43. D. 3, 4; 46. A. 3, 4; *Desert Cathay*, ii. 328 sqq.; Figs. 245, 250, 251.

[45] See Sheets Nos. 46. A, B. 2; 43. B-D. 1-2; 42. C. 4.

[46] Cf. Sheet No. 40. C. 4; *Serindia*, pp. 1136 sqq. For the high road from Su-chou to An-hsi, see Sheets Nos. 43. A. 1; 41. D. 1; 40. A. 4, B. 4, 5, C, D. 5.

[47] See for this route Sheets Nos. 38. B. 4; 39. A. 1; 36. A-C. 2, D. 1; 33. A-D. 2; 30. B-D. 2. The latitude observations and clinometrical heights as well as some other details shown along it are added from Rai Lāl Singh's survey who retraced this route in the opposite direction from Mīrān to Nan-hu in November-December, 1913.

[48] See Sheets Nos. 38. B. 1, C. 1, 2, D. 2, 3; 37. A, B. 4; 34. D. 3.

[49] Cf. my paper *The desert crossing of Hsüan-tsang*, Geographical Journal, 1919, liii. pp. 265 sqq.

examine ruined sites near Ara-tam and Lapchuk was utilized by Lāl Singh for a rapid survey of the southern slopes of the Karlik-tāgh, the easternmost portion of the T'ien-shan range, rising to snowy peaks between 13,000 and 14,000 feet. [50]

Surveys in, and S. of, Turfān basin.

The same plan was followed during the three weeks spent in the Turfān depression. While visits to its numerous and important ruins and excavations at an unexplored desert site in its south-eastern corner kept me busy, Lāl Singh rapidly surveyed the ground over which the principal oases of the district are scattered. He also mapped portions of the southern slopes of the snowy T'ien-shan which overlooks this basin, so interesting to the geographer. [51] On resuming my journey to Kara-shahr on December 1st, I sent Lāl Singh southwards for independent survey work among the low desert ranges of the Kuruk-tāgh. He accomplished his task successfully by first reaching Singer, the only permanently occupied spot in a vast region of crumbling rock, bare gravel or salt-encrusted ground, and thence carried his survey westwards through wholly unexplored hills to Korla at the extreme north-east corner of the Tārīm basin proper. [52] The local experience gained on this journey proved of very great help to Lāl Singh on his far more extensive explorations in the Kuruk-tāgh during 1914-15.

Explorations in Kara-shahr region.

I myself after gaining the Kara-shahr valley by rapid marches on the caravan route from Turfān was busily occupied by excavations at the large site of ruined Buddhist temples north of Shōrchuk. [53] Lāl Singh having rejoined me by Christmas, we moved up the valley to the ruins of Khōra whence we reached Korla by New Year's day, 1908. Reports received there about sand-buried 'old towns' drew me then into the unsurveyed desert belt between the Inchike and Charchak river beds to the south-west. [54] When our surveys there had proved these reports to be based on mere folklore beliefs, current all along the Taklamakān, we took separate routes to Kuchā. I struck across the scrubby desert to the north of those river beds and after reaching Bugur followed the ancient road along the foot of the T'ien-shan westwards, while Lāl Singh mapped the unsurveyed course of the Inchike-daryā to Shahyār, rejoining me at Kuchā. [55]

Crossing of Taklamakān.

After rapid visits to ancient remains on the outskirts of this large and important oasis I started towards the close of January, 1908, to the south of the great desert for the exploration of ruined sites in the Taklamakān. In order to reach them by a 'short cut' we followed the line indicated by Dr. Hedin's pioneer journey of 1896 and leading from Shahyār due south through the desert of large dunes to where the Keriya river loses itself in the sands. This desert tramp of fifteen days from the Tārīm to the point where we first reached the water, or rather ice, of the dying Keriya river proved beset with serious difficulties and risks. [56] Yet it also was attended by plenty of interesting topographical observations regarding the ancient dead delta of the river; the high ridges of dunes (*dawān*) which here as in the Lop desert usually keep parallel to ancient river beds, however long ago they may have been dried up and smothered, and other typical features. [57] When at last we had reached the ever errant river it was found to have formed a new bed at a considerable distance to the west of the one where Hedin had seen it.

Explorations in desert E. of Khotan.

After fresh excavations at the Kara-dong site (Sheet No. 13. D. 3) we moved by a new route to the desert belt north of the Domoko oasis. While I was engaged there in exploring an extensive but much scattered series of ruins, Lāl Singh carried out useful supplementary surveys both to the

[50] See Sheet Nos. 34. D. 2, 3; 37. A. 2, 3; *Desert Cathay*, ii. pp. 345 sqq.

[51] See Sheet No. 28, C. 2, 3, D. 3; *Desert Cathay*, ii. pp. 353 sqq.

[52] See Sheets Nos. 28, B. 4; 29. B. 1, 2; 25. A. 1, B. 2, C. 1, 2, D. 1; 21. D. 1.

[53] See Sheet No. 25. A. 1; *Desert Cathay*, ii. pp. 364 sqq. For the route from Turfān, see Sheet No. 28. A. 3, 4, B-C. 3; 24. A-D. 4.

[54] See Sheet No. 21. C. 1, 2, D. 2; *Desert Cathay*, ii. pp. 374 sqq.

[55] See Sheets Nos. 21. A, B, 1, 2; 17. B-D. 1, 2.

[56] See Sheets Nos. 17. A. 3, 4; 18. A. 1-3; cf *Desert Cathay*, ii. pp. 382 sqq.

[57] Cf. *Serindia*, pp. 1239 sq.

north and south of the line of oases stretching westwards to Khotan.[58] After more archæological labours at sites in the desert fringing the Khotan oasis to the north and north-west,[59] we started early in April for Ak-su by the route which leads through the heart of the Taklamakān along the united bed of the Yurung-kāsh and Kara-kāsh rivers, then practically dry.

Hill range of Mazār-tāgh.

On this journey I was able to explore interesting ancient remains on the curious desert hill of Mazār-tāgh which juts out to the left bank of the Khotan river as the last offshoot of a low and now almost completely eroded range coming from the north-west. A reconnaissance made by the surveyor showed that this range is still traceable amidst high dunes for a distance of at least twenty miles.[60] Its exploration beyond was impossible at that season of increasing heat and sand-storms.

Journey to Ak-su.

We descended the Khotan river bed to the neighbourhood of its junction with the Tārīm which we crossed.[61] By the left bank of the Ak-su river we reached the town of that name, the present Chinese headquarters for the eastern portion of the Tārīm basin, early in May. There we separated for nearly three months. I myself travelled up the Uch-Turfān valley and crossed a barren and very rugged outer range of the T'ien-shan, previously unsurveyed, to the little-known oasis of Kelpin.[62]

Return to Khotan *via* Yārkand.

Moving southwards I traced remains of ancient settlements in the desert between the arid outer hills of Kelpin and the terminal course of the Kāshgar river, before reaching the Ak-su–Kāshgar highway near the ruined sites of Tumshuk.[63] A series of low parallel hill ranges in the unsurveyed desert belt to the north-east of Marāl-bāshi offered an opportunity for interesting topographical work. Then the increasing heat and the call of many heavy tasks obliged me to return to my base at Khotan. Proceeding by rapid marches along the left bank of the Yārkand river I carried my plane-table traverse to Yārkand,[64] whence the caravan route already followed in 1900 brought me back to Khotan by June 9th.

Lāl Singh's surveys along T'ien-shan and in W. K'un-lun.

Here I was detained by exacting labours needed for the safe packing of my large collection of antiques and by the manifold preparations for the planned explorations in the high K'un-lun to the south. The halt fortunately allowed me to give Lāl Singh adequate time for independent survey work, and with his unfailing energy he used it to the best advantage. Injury to a level of the theodolite prevented, it is true, the triangulation I had wished him to carry from Ak-su to Khotan. Nevertheless he effected very useful plane-table surveys along the main T'ien-shan range from the valley below the Muz-art pass to the watershed north of Kāshgar.[65] Descending a second time to Kāshgar, he travelled to Gūma through the districts of Yārkand and Karghalik by a route different from the high-roads already surveyed.[66] He then succeeded in mapping, as directed, the last portions of *terra incognita* on the northern slopes of the K'un-lun between the Kiliān valley and the middle Kara-kāsh river above Pujiya in the lower Khotan hills. In addition he connected his survey with Rām Singh's work in 1906 by crossing the Sanju-dawān and ascending the Kara-kāsh river as far as Kiliān-kurghān.[67]

[58] See Sheet No. 14. A-B. 2, C. 3; *Desert Cathay*, ii. pp. 413 sqq.

[59] See Sheet No. 9. D. 2.

[60] See Sheet No. 13. A. 3, B. 4; *Desert Cathay*, ii. pp. 417 sqq.

[61] See Sheets Nos. 13. A. 4, B. 1-4; 12. A. 3, 4, B. 4.

[62] See Sheet No. 7. B. 2, 3, C. 2, D. 2; *Desert Cathay*, ii. 421 sqq.

[63] See Sheets Nos. 7. B. 4; 8. B. 1.

[64] See Sheets No. 8. A, B. 1; 5. C. 3. 4; D. 1, 2.

With regard to this plane-table work between Ak-su and Yārkand I may briefly note that the route I had followed was crossed by that of Lāl Singh only at one point, the small oasis of Ābād, two marches north of Yārkand (Sheet No. 5. C. 2). The distance covered by me from our common starting point, Ak-su, amounted to over 350 miles, while that on the surveyor's route *via* Kāshgar was considerably greater. It was hence no small satisfaction to me to find that the position shown for Ābād by my own plane-table differed from that of Lāl Singh by only one mile in longitude and about two in latitude.

[65] See Sheets Nos. 12. A, B. 1; 7. A. 3, B. 2, 3, C. 2, D. 1, 2; 4. A-C. 4, D. 3, 4; 1. C, D. 4.

[66] For the route to and from Kāshgar, see Sheets Nos. 2. D. 1, 2; 5. A. 1. For the route from Kāshgar *via* Abād-Merket-Karghalik to Gūma, see Sheets Nos. 5. A-C. 2, 4, D. 3; 6. C. 1, D. 1, 2; 9. A. 1, 2.

[67] See Sheets Nos. 6. D. 2; 9. A. 1-3, B. 2, 3, C. 3, D. 2.

Start for Yurung-kāsh sources.

After the surveyor had rejoined me towards the end of July, I dispatched my heavy convoy of antiques to the foot of the Kara-koram passes and started myself with Lāl Singh on my long-planned expedition to the sources of the Yurung-kāsh river. My previous explorations in the Karanghu-tāgh region had shown that the furthest headwaters of the river were quite inaccessible through the narrow and deep gorges in which it has cut its way westwards past the massif of 'Muz-tāgh' (Pk. 1/61 A, 23,890 ft.). My fresh effort was therefore to be made from the east where that unexplored mountain region adjoins the extreme north-west of the high Tibetan plateaus.

Ascent above Pōlur.

We reached the latter by ascending the very confined gorges above Pōlur and by crossing the northern main range of the K'un-lun to the Seghiz-kōl lake.[68] A two days' halt here enabled Lāl Singh to effect some supplementary triangulation based on peaks first fixed by Captain Deasy. Fortune secured the guidance of a hunter of wild yaks, and this enabled us by proceeding thence westwards to discover the deep-cut valley of Zailik, draining into the Yurung-kāsh. It had remained unknown to previous explorers, though its extensive old gold-pits, now almost deserted, must have been worked for many years.[69]

Discovery of Zailik valley.

The Zailik valley proved of great value for our survey work. In spite of its extremely confined nature it became possible to ascend from it several spurs falling steeply from the main range on the north and thus to map a considerable portion of the grand and wild mountain system containing the unexplored headwaters of the Yurung-kāsh. On the magnificent snowy range which flanks them on the south, visible from these hill stations for a distance of over 60 miles, a number of glacier-clad peaks rising to more than 21,000 feet could be sighted.[70]

Exploration of upper-most Yurung-kāsh.

By collecting from among the little groups of miners still toiling in this gloomy gorge of Zailik a small number of carriers for the transport of instruments and a minimum of baggage we managed to push our way into the main valley of the Yurung-kāsh and to follow it upwards over a succession of high side spurs. Above one of the passes crossed, the Mandār-kōl-dawān, an excellent hill-station was climbed at an elevation of 18,612 feet and fixed by triangulation. Finally after seven trying marches from Zailik we penetrated through the extremely confined gorge of the main river to the great glacier-bound basin, about 16,000 feet high at its bottom, where its easternmost and largest branch takes its rise.[71]

Passage to Keriya R. sources.

After thus tracing the river to its ice-bound head, we turned eastwards and having by September 3rd picked up near the Ulūgh-kōl our depot of spare transport and supplies, crossed the southern main range of the K'un-lun by the Bāba-Hātim pass (17,584 feet). Thence for three marches we followed the Pōlur–Lanak-lā route to the south-west.[72] It led us to the bleak plateau, over 17,000 feet in height, where the Keriya river gathers its sources at the foot of a line of glaciers. Our survey proved these to descend from the same ice-clad range which encloses the head basin of the Yurung-kāsh sources from the east.[73] From the watershed at the head of the Keriya river sources we moved westwards to survey the ground which in our atlases has generally figured as a high plain with the name of *Ak-sai-chin* but which the provisional issue of the Survey of India's 1 : 1,000,000 map for this area rightly showed as a blank.

Instead of a plain we found there high snowy spurs separated by broad valleys, and

[68] For the route to Pōlur village, see Sheet No. 14. A. 2, 3, B. 3, 4, C. 4; for that across the range Nos. 14. C, D. 4; 15. C, D. 1. Cf. *Desert Cathay*, ii. pp. 440 sqq.

[69] See Sheet No. 15. C. 1; *Desert Cathay*, ii. pp. 444 sqq.

[70] See Sheet No. 15. A, B. 1, 2; *Desert Cathay*, ii. pp. 446 sqq.

[71] See Sheet No. 15. C. 1; *Desert Cathay*, ii. pp. 449 sqq.; Panorama XII; Fig. 324, 327-330.

[72] See Sheet No. 15. D. 1, 2; *Desert Cathay*, ii. pp. 456 sqq. The triangulated stations and points shown by Sheet No. 15 along the portion of the Pōlur-Lanak-lā route here followed, with the exception of those on and beyond the snowy range enclosing the Yurung-kāsh sources from the south, are taken from Captain Deasy's work.

[73] See Sheet No. 15. D. 2; *Desert Cathay*, ii. pp. 457 sq.

High plateaus S. of main K'un-lun range.

descending from the great main range of the K'un-lun which overlooks the Yurung-kāsh headwaters from the south. A series of lake basins extends along the foot of those spurs at elevations of 15,000 to 16,000 feet; but the streams draining the wide valleys to the north rarely reach them, and are lost in vast detritus fans.[74] Crossing the debouchures of these valleys we made our way still westwards over the easy divides, separating the lake basins; but progress was made very trying by the inclement weather and by the utter barrenness of the ground which together with the great elevations told heavily on our ponies and donkeys. With the transport nearing exhaustion and the fodder supply running out it was impossible to spare time either for triangulation or visits to the heads of the valleys descending from that portion of the southern K'un-lun range which stretches from the triangulated peak 8/52M (23,309) south-eastwards as far as circ. long. 80° 30′.

Johnson's route retraced.

After six long marches from where we had left the Pōlur–Lanak-lā route (C. 468), we reached the east end of a large salt lake, now mostly dry, which a party of the G. T. Survey of Ladāk appears to have sighted some forty-five years before.[75] Marching thence to the north-west for three more days over very dismal ground, we passed dry salt-encrusted lagoons and struck by September 17th traces of the forgotten route by which Hājī Habībullah had tried to open direct communication with Ladāk and over which Johnson had been taken to Khotan in 1865.[76] As we followed the track still clearly marked by cairns and other relics, and crossed two easy passes to the north-west, the main range came again into full view and allowed our position accurately to be fixed with the help of two triangulated peaks (4/52M or E 57; 6/52M or E 58) of the G.T. Survey. At last we emerged on September 18th in the valley of an eastern feeder of the Kara-kāsh where some abandoned stone-huts still showed Johnson's camp 'Kárákásh'.[77]

Ascent to glacier col in search of *Yangi-dawān*.

It only remained to trace Johnson's route to his 'Yangí-diwán Pass' by which he crossed the main K'un-lun range towards Karanghu-tāgh. A line of cairns showed the side valley where the pass would have to be looked for; but towards its head all trace of the old route had become obliterated by advancing masses of ice and snow. Information gathered from some Kirghiz who had joined us lower down in the Kara-kāsh valley, induced me on September 22nd to make a reconnaissance with the surveyor due north up a steep glacier which appeared to offer the nearest approach to the watershed. When after a very trying ascent over much-crevassed ice and *névé* it was gained on a snowy col for which hypsometer and aneroid readings indicated a height of about 19,900 feet, the extensive view opening northward supplied the hoped-for links with our former surveys of 1900 and 1906 from the Khotan side of the main range.[78] But instead of the 'Yangi-dawān' which was to give access eastwards to a tributary of the Yurung-kāsh (Chomsha-jilga?), we had reached the crest-line of the main range where it overlooks the glacier-fed headwaters of the Panāz river which flows into the Kara-kāsh.

Junction of K'un-lun ranges.

The triangulated snowy peak, 3/52 M, 23,071 feet, rising to the east of our position, effectively blocked all view towards the unexplored portion of the range flanking the Yurung-kāsh headwaters. But as a compensation this highest of our survey stations furnished definite proof of the interesting orographic fact that the high peak in question represents not merely the point of junction of the two K'un-lun ranges between which the Yurung-kāsh rises, but that it is also the head of the great northward spur dividing the drainage areas of the Yurung-kāsh and Kara-kāsh rivers.

Frostbite accident.

Unfortunately this important gain to our survey work was attended by a very serious accident to myself. The delay at that icy height necessitated by mapping and photographic work, together with incidents arising from a late and hurried descent to escape the risk of being altogether

[74] See Sheet Nos. 15. A.-C. 2; 10. D. 2; *Desert Cathay*, ii. pp. 459 sqq.

[75] Compare in the *Map illustrating the routes taken by Mr. Johnson* the lake shown in circ. 80° long. 35° 10′ lat., with the one to south of our C. 475 in Sheet No. 10. D. 2; see *Desert Cathay*, ii. pp. 465 sqq.

[76] Cf. above pp. 7, 13 sq.; *Desert Cathay*, ii. pp. 468 sq. The cairn symbol in the N.E. corner of Sheet No. 10. C. 2 corresponds approximately to 'Camp Yangpá' in Johnson's map.

[77] See Sheet No. 10. C. 1; cf. Stage 18, in Itinerary attached to Johnson's Report, dated April 22, 1866, to the Superintendent, G.T. Survey.

[78] See Sheets Nos. 10. C. 1; 9. C. 4. For the ascent to the col and the view gained from it, cf. *Desert Cathay*, ii. pp. 476 sqq., with Panorama XIII.

benighted on the glacier, resulted in the toes of my feet being severely injured by frostbite. The urgency of securing surgical aid obliged me to have myself carried by forced marches to Leh which was reached by October 12th and where the toes of my right foot were amputated. However, I had the satisfaction of knowing that the exploratory tasks of this journey had been completed.

Journey across Kara-koram.

I could leave the heavy caravan of antiques which had awaited my arrival lower down the Kara-kāsh valley, to be brought safely across the high passes under the care of Lāl Singh. He carried the plane-table survey up to the Indian frontier on the Kara-koram pass[79] and proved to the end, as throughout the journey, the most devoted and energetic of helpers. It was to me a special satisfaction that the recommendation of the Surveyor General secured for him due official recognition by the bestowal of the title of Rai Bahādur at the close of the year, and that this was followed some months later by the award of the Back Grant on the part of the Royal Geographical Society.

Quarter-inch maps of 1906-08 surveys.

A detailed cartographical record of the surveys made on this journey was prepared at the Trigonometrical Survey Office, then under the direction of Colonel Sir Sidney Burrard, R.E., in the shape of an atlas of 94 sheets, drawn on the scale of 4 miles to 1 inch and each extending over one degree of latitude and longitude. These sheets reproduced by helio-zincography were intended primarily for publication with *Serindia*, the Detailed Report on the scientific results of my expedition. But the preparation of this large work was bound to take some years owing to the great abundance and very varied nature of the archæological discoveries, etc., and to the need of utilizing for it also the help of numerous expert collaborators. Hence a certain number of copies of this atlas were made available in advance by presentation in 1913 to leading geographical institutions in Europe and America and to scholars specially interested in researches concerning these parts of Central Asia. This advance issue has proved all the more justified because the publication of *Serindia* has suffered considerable delay, first on account of the break caused in its preparation by my third Central-Asian expedition and subsequently, after my return in 1916, by the difficulties arising from the war which beset the printing and issue of those bulky volumes.

Difficulties beseting map revision.

The technical execution of these map sheets considerably benefited by the comparatively large scale and by improved methods of reproduction introduced since the publication of the map showing the surveys of my first journey. But the heavy tasks awaiting me at the British Museum in connection with the elaboration of the archæological results necessitated my departure for England immediately after my return from the expedition and my stay there for the next three years, and these circumstances together with the rapid production of the maps which other considerations demanded, made it difficult for me to bestow upon their details all the precise care which I should otherwise have done. This applies in particular to the hill-shading, done by hachuring instead of the 'form lines' of the original plane-tables. Owing to the great distance separating me from the Dehra Dun drawing office my revision of the sheets had to be restricted to the two stages of 'outline' and 'black and brown' proofs. No examination of the drawings themselves having been possible in the first instance, the range of corrections in these proofs was necessarily limited by considerations of delay and expense.

Maps reproduced by R. Geogr. Society.

Fortunately the difficulties just indicated did not make themselves felt in the case of the maps illustrating my explorations of 1906-08 which with the kind permission of the Surveyor General I was able to get prepared and published by the Royal Geographical Society and subsequently to use also for my *Ruins of Desert Cathay*.[80] They comprised a general map of the whole area over which the surveys of those years extended, on the much reduced scale of 1 : 3,000,000, and two maps, on the scale of 1 : 1,000,000 showing important mountain regions, portions of the K'un-lun range south of the Karghalik-Khotan-Keriya line and of the Western and Central

[79] See Sheets Nos. 9. A, B. 4 ; 10. A. 7.

[80] See *Note on maps illustrating explorations in Chinese Turkestan and Kansu, Geographical Journal*, March, 1911, pp. 275 sqq.

Nan-shan, together with insets on the same, or on a larger scale, of certain archæologically interesting areas. These maps were all prepared by Mr. J. W. Addison, Draftsman of the R. Geographical Society, from the 4 miles to 1 inch sheets then in course of publication. But as the latter were available at the time only in outline proofs, the hill-shading as well as certain other details were supplemented from tracings of the original plane-table drawings. In addition the surveys of 1900-01 were utilized for filling in certain portions of the ground. Superior draftsmanship and skilful lithographic reproduction compensated to some extent for the disadvantages of a much reduced scale and make these maps still very convenient for purposes of general reference.

Compilation of maps.

In the note accompanying the publication of these reduced-scale maps in the *Geographical Journal* I have already had occasion to record essential data regarding the compilation of the 4 miles to 1 inch sheets, as kindly communicated to me at the time by Mr. J. Eccles, late Superintendent, Survey of India, who, in succession to Captain (now Colonel) H. H. Turner, R.E., had supervised the work. Explanations on specific points of the surveys as there represented will be found in the Notes given below in Chapter IV with regard to individual sheets of the new map publication. Finally reference may be made here to Chapter III for an account of the methods by which certain topographical features of the ground surveyed on the second journey have received in the new 1: 500,000 maps a more adequate representation than it was possible to give in the 4 miles to 1 inch sheets.

SECTION IV.—SURVEYS OF THE THIRD EXPEDITION, 1913-15

Plentiful as were the results brought back from my second Central-Asian journey, they could not keep me from remembrance of the openings for interesting exploratory work which, on my previous travels, disproportion between the available time and the vast extent of the ground had obliged me to pass by both within Chinese Turkistān and in adjacent regions. The generous consideration and help of the Government of India, under the Viceroyalty of Lord Hardinge, enabled me to use in 1913 the favourable political conditions prevailing in those regions for my start on a third expedition. Planned to last for a slightly longer period than the second, it was to take me also across the Pāmīrs and adjoining mountain regions of Russian Turkistān as well as over parts of easternmost Persia. If my work in these parts was to be mainly antiquarian it seemed all the more important to employ the time available on Chinese soil to full advantage for geographical and topographical labours.

Assistance of Survey of India.

Our previous surveys in the Tārīm basin and in the adjoining regions east and north-eastwards, closely related to it geographically and historically, had left great gaps which I was particularly anxious to fill. I therefore felt deeply grateful for the generous assistance which Colonel Sir Sidney Burrard, then Surveyor General, was once again ready to assure to me on the part of the Survey of India. In accordance with my request he deputed with me my old travel companion, Rai Bahādur Lāl Singh, now Sub-Assistant Superintendent, whose previous local experience and oft-proved energy under conditions of hardship and risk were a specially valuable asset. He also sanctioned the services of a second surveyor, along with all necessary equipment and a grant to cover their travel expenses. In addition I was accompanied by a young military surveyor, Miān Afrāz-gul Khān, of the Khyber Rifles. Primarily chosen by me to give practical aid in archæological field work he soon proved by his topographical sense and superior intelligence a very useful assistant for survey tasks.

Start through Darēl and Tangīr.

For the journey to the Chinese border on the Pāmīrs which was started on July 31, 1913, from Srinagar, I was fortunately able to follow a new route, leading partly over ground never visited by any European. It took us across Chilās and the Indus to the independent Dard territories of Darēl

and Tangīr where Rāja Pakhtūn Wālī, an exile of the Khushwaqt family of Yāsīn, had for some years past established a chiefship of his own. The mountain tracks over which we were taken under his protection crossed a series of high passes and offered great advantages for survey operations. We were fortunately allowed full freedom to use them.

A number of triangulated points on the high ranges to the south and north helped to control the half-inch plane-table work, and, thanks to Lāl Singh's devoted exertions, a fortnight's hard travel sufficed to map some 1200 square miles of ground distinctly difficult in parts and hitherto wholly unsurveyed. The mapping then accomplished awaits separate publication in the Royal Geographical Society's Journal, and the briefest mention of it must suffice here. [1]

Journey across Hindukush.

Subsequently we crossed the Indus-Gilgit river watershed and the Darkōt pass to the headwaters of the Chitrāl river. This route allowed me to see ground of distinct historical and geographical interest. From here we made our way past the glaciers feeding the Karambār river and across the difficult Chilinji pass into uppermost Hunza, where we picked up Muhammad Yakūb, the second surveyor, with the heavy baggage. Finally we gained the Chinese border on the Ming-taka pass by September 7th.

Survey resumed in Sarikol.

The journey down to Tāsh-kurghān allowed the main Sarikol valley to be re-surveyed on a larger scale than before. From it we followed for a couple of days the usual caravan route through the mountains towards Kāshgar over the Chichiklik pass. Beyond the Tangitar gorge our routes divided. [2] Lāl Singh moved off by rapid marches *via* Yārkand and Khotan in order to reach the main K'un-lun range near Kapa from where I was anxious to extend our triangulation of 1906 as far eastwards as climatic and other conditions would permit. Afrāz-gul, in charge of the heavy baggage, executed a plane-table traverse to Kāshgar by the usual route *via* Ighiz-yār and Yangi-hissār.

Route down Kara-tāsh valley.

I myself set out for the same goal with Muhammad Yakūb by a new route leading due northwards across the Merki pass and down the valley of the Kara-tāsh or Bēsh-kan river. [3] Owing to special difficulties this important valley, in which most of the eastern drainage of the great glacier-clad range of Muz-tāgh-atā finds its way into the plains between Yangi-hissār and Kāshgar, had never been explored in its whole length. During spring and summer the big floods from the melting snow and ice of the range render the extremely narrow gorges of the Kara-tāsh river in the north quite impassable. By the time the waters subside in the autumn, heavy snow on the Merki and Kara-tāsh passes closes the approaches from the south. In the spring of 1906 I had sent Rām Singh to descend the valley, but the flooded river had obliged him to abandon the attempt.

Difficult river gorges.

We were more fortunate this time. Exceptionally early snowfalls had stopped the melting of the glaciers just in time to allow of a passage while the Buramsāl pass (14,940 feet), though under deep snow, could still be traversed with laden yaks. Nevertheless the descent through the extremely confined gorges of the river below Chimghan proved very difficult and in places risky. The constant crossings of the river tossing between precipitous rock walls could not have been effected without the help of hardy local camels secured from Kirghiz camps higher up the valley. The trials attending these marches showed that Muhammad Yakūb, if not equal to my other surveying companions in experience and general aptitude for independent work, was anyhow not wanting in pluck.

Preparations at Kāshgar.

After emerging from the last of those gloomy defiles, two marches across fertile tracts brought us to Kāshgar by September 21st. Once again Sir George Macartney's unfailing help greatly facilitated the organization of my caravan at the ever hospitable British Consulate General, and by

[1] For a preliminary account of this visit to Darēl and Tangīr, cf. *A Third Journey of Exploration in Central Asia*, Geographical Journal, 1916, xlviii. pp. 101 sqq.

[2] See Sheet No. 2. D. 4.

[3] See Sheet No. 2. D. 3, 4; *Third Journey, G.J.*, xlviii. p. 110.

October 9th I was free to set out for my first winter's work in the desert. The region around the dried-up ancient Lop sea was its main goal, and for various reasons that eastern-most corner of the Tārīm basin had to be reached by me *viâ* Khotan and beyond it by the already familiar route skirting the southern edge of the Taklamakān. Opportunities for topographical work on new ground were thus confined to the journey from Kāshgar to Khotan, and the time available for it was limited.

Desert route to Marāl-bāshi.

I first moved due east to the oasis of Marāl-bāshi by an unsurveyed route which local tradition vaguely remembered as having been in use for traffic during earlier periods of Chinese domination, instead of following the present high 'road' along the lower Kāshgar river. The route led beyond the outlying oases of Āstin-ārtush and Kalta-yailak closely along the foot of the steep and barren hill chain which forms here the southernmost rampart of the T'ien-shan.[4] The fact that most of the desert glacis of this hill chain is now wholly without water added to the geographical interest of the series of small ruined sites and dry river beds we succeeded in tracing near the old route. Considerable changes within historical times in the course of the terminal Kāshgar-daryā were indicated also by the survey made on a reconnaissance which took me from Marāl-bāshi to the detached hills of the Bēl-tāgh and Lāl-tāgh in the desert north-eastwards.[5]

Search for eroded desert range.

Our surveys of 1908 seemed to justify the belief that the Mazār-tāgh hill chain traced then for about 20 miles from the west bank of the Khotan river bed in the Taklamakān was in geological structure but a remnant of an ancient range starting at an angle from the outermost T'ien-shan near Marāl-bāshi and once extending in a south-easterly direction across the Taklamakān.[6] That the bold island-like hills which rise from the desert plain to the east and north-east of Marāl-bāshi and which mark the north-western end of that assumed ancient hill range, have been carved out and isolated by the action of wind-driven sand, a most potent physical factor throughout the Tārīm basin, was clearly proved by the observations made on the above reconnaissance. The same process prolonged through geological ages would obviously account for much bigger breaks in the continuity of the range in the great drift-sand desert further south. To test this hypothesis on the ground by a 'short cut' through the Takla-makān in the direction of the Mazār-tāgh on the Khotan river, I set out on October 25th after careful preparations at Marāl-bāshi.

Progress stopped by high sand ridges.

Crossing the Yārkand river we reached by three marches the end of the last of those sand-scoured hills, known as Chok-tāgh.[7] From a lake near it Dr. Hedin had started in May 1896 on that bold journey eastward which ended with the destruction of his caravan and his own narrow escape. Having taken water supply there we forced our way for three more trying marches into the sea of bare dunes.[8] The ridges or 'Dawāns' into which they were heaped grew steadily higher and rose invariably in a line diagonal to our intended direction. This bearing and the almost total absence of level ground between the endless succession of 'Dawāns' made progress very slow and exhausting with heavily laden camels. By the evening of the third day the animals hired to form a 'supporting party' for our own had broken down. Assuming that our rate of progress could be maintained, there still remained some eleven marches to the nearest point of the Mazār-tāgh hill chain previously sighted. The same forbidding expanse of huge sand ridges spread before us on the fourth day, and I realized from previous experience the difficulty of steering a correct course or even of recognizing low eroded offshoots of that hill chain from a distance.

Observations in dune-covered area.

These considerations together with others concerning the work ahead forced me to turn back, however reluctantly. Compensation was afforded by two interesting discoveries which had already attended the effort. On the third march between the high dunes we had again and again come upon patches covered with minute but easily recognizable fragments of slatey rock flakes, the

[4] See Sheets Nos. 5. A-D. 1; 8. A. 1.
[5] See Sheets Nos. 8. A, B. 1; 7. A. B. 4.
[6] Cf. *Desert Cathay*, ii. p. 419; above, p. 20.
[7] See Sheet No. 8. B. 1, 2.
[8] See Sheet No. 8. B. 2, C. 2.

last but unmistakable traces of that ancient wind-eroded hill range. Elsewhere, near Camp XXVII, fully 30 miles from the nearest point of the present Yārkand river course, the surface of a small belt of wind-eroded clay was covered with plentiful relics of the Stone Age, proving occupation by a Palæolithic settlement of what is now absolutely lifeless desert.

Yārkand R. regained.

We regained the Yārkand river to the east of the Chok-tāgh in a violent sand-storm which, if encountered amidst the high dunes, would certainly have brought us to a standstill for some days. Then we surveyed rapidly the tracts of riverine jungle on the left bank to the southern extremity of the Ak-su cultivation, near Ghōra-chöl, where the last dried-up offshoots of the Kāshgar-daryā lose themselves. [9] Thence the head of the Khotan river delta was gained by a route not previously surveyed. It was of distinct interest as showing the great change which the terminal course of the river had undergone since my passage in 1908. [10]

Journey along Khotan-daryā.

The journey further up the Khotan-daryā, accomplished by a series of forced marches, led necessarily along the route already followed in that year. But a renewed visit to the Mazār-tāgh was rewarded by the discovery of Buddhist remains, of special interest as proving the antiquity of the local worship from which this desert hill derives its modern name. Before reaching Khotan the opportunity was used also for surveying a small unmapped portion of the Kara-kāsh river course.

Fresh surveys east of Khotan.

After a brief halt at Khotan necessitated by manifold practical arrangements I set out on November 28 for the long journey eastwards. Some 700 miles still separated me from Lop-nōr, and for the work planned in the desert region beyond, it was essential that I should reach it while the winter cold allowed water to be transported in the convenient form of ice. Rapid progress was therefore important and this could only be assured by following in the main my previous route by the southern edge of the Taklamakān. Nevertheless I was able to use what opportunities for surveying new ground were presented by archæological work to the north-east of the Domoko oasis and at the ancient site beyond the termination of the Niya river. [11] Elsewhere occasion could be taken to observe and record on the map the interesting changes which extended cultivation had brought about in the limits of the oases since our previous surveys.

From Yār-tungaz to Endere.

Subsequently a 'short cut' taken from the Yār-tungaz to the Endere river allowed us to survey an unexplored desert area to the north of the caravan route. [12] When following this towards Charchan, in bitterly cold weather with minimum temperatures down to 50° F. below freezing point, exceptionally clear atmospheric conditions allowed us to sight day after day the snowy K'un-lun range far away to the south. At most seasons it remains quite invisible to the traveller between Niya and Charchan. Now intersections from peaks previously triangulated on it permitted the route to be mapped with greater accuracy than before.

Difficulties encountered at Charkhlik.

We left Charchan on New Year's Eve of 1914 and did the desert journey to the western border of the Lop district by seven long marches, mainly through the jungle belt along the left bank of the Charchan river, a new route to me. [13] I had detached Muhammad Yakūb to follow the Charchan-daryā down from Lashkar-Satma where we crossed to its right bank, and was approaching Yāsh-shahri, the first little Lop settlement, when I learned of the upheaval which a band of Chinese 'revolutionaries', *recte* bandits, had created at Charkhlik, the headquarters of Lop. Tungan troops had suppressed the murderous outbreak by the time of my arrival there, January 8, 1914; but its consequences greatly impeded the collection of the supplies, transport and labour needed for the explorations I had planned during the next three months in the desert between Lop and Tun-huang. [14] The six days' stay needed for securing at least a portion of our requirements was hence an anxious time for me; but fortunately it could be used also for profitable archæological work at two ancient sites to the south of the little oasis.

[9] See Sheets Nos. 8. B, C. 1; 7. C, D. 4; 12. A. 3.

[10] See Sheets Nos. 12. A. 4; 13. A. 1.

[11] See Sheets Nos. 14. C. 2; 19. B. 1; cf. *Third Journey, G. J.*, xlviii. pp. 115 sq.

[12] See Sheet No. 19. B-D. 1.

[13] See Sheets Nos. 22. D. 3, 4; 26. A-D. 2, 3.

[14] For some details about these disturbances, cf. *Third Journey, G. J.*, xlviii. p. 117.

On the last day of my stay R. B. Lāl Singh safely rejoined me to my great relief after fully four months of separation. After leaving me in September in the mountains beyond Tāsh-kurghān he had pushed on to Kapa and started triangulation along the main K'un-lun range from the points to which Rām Singh's work of 1906 had brought it. Trying hardships attended his operations at great elevations and on ground devoid of all resources. But Lāl Singh faced them with his often proved determination and succeeded in extending his system of triangles eastward for fully five degrees of longitude, reaching peaks close to the west of Bāsh-kurghān, before excessive cold and heavy snowfall obliged him to cease observations in the mountains. [15] The special difficulties with which the surveyor had to contend in establishing satisfactory stations and securing safe connections by well-conditioned triangles along a line of mountains running mainly from west to east, have been noted by Major K. Mason in Appendix *I*, when dealing with R.B. Lāl Singh's triangulation work of 1913-15. There an explanation will also be found of the corrections which the positions shown in the map for his triangulated points and stations require in order to bring them into agreement with the coordinates deduced by computation.

Lāl Singh's triangulation along K'un-lun.

It was characteristic of R.B. Lāl Singh's energy that having found further triangulation impossible, he persisted in continuing survey work with the plane-table towards Tun-huang, taking special care to obtain astronomically determined latitudes and many height observations by mercurial barometer and clinometer along the route through those inhospitable snow-covered mountains. [16] After reaching the small oasis of Nan-hu he struck through the desert northwards and returned by the track leading to Mīrān and Charkhlik south of the salt-encrusted basin of the ancient Lop sea. The difficulties of this track, already surveyed by us in 1907, received fresh illustration by the fact that Lāl Singh's party found no ice yet formed at the most brackish of the springs along its western portion, and consequently suffered much from the want of drinkable water.

Survey of mountain route to Tun-huang.

On January 15, 1914, our reunited party moved from Charkhlik to Mīrān where renewed excavations at the ancient site marking the earliest capital of the 'Kingdom of Shan-shan or Lou-lan' kept me busy for a fortnight. [17] Other exacting tasks were provided by the final preparations for the explorations which were to take our several parties into the waterless desert north and north-east of the extant Lop-nōr.

News of threatened obstruction on the part of the provincial Chinese administration was a cogent reason for setting out for them with the least possible delay. An edict had in fact been issued by headquarters at Urumchi ordering the district authorities to prevent all surveying work on our part and in case of any attempt at continued explorations to arrest and send us 'under escort' to Kāshgar. How the 'revolutionary' outbreak at Charkhlik opportunely had saved my plans from being frustrated by passive local obstruction which certainly would have resulted from these orders, has been related elsewhere. [18]

Threatened Chinese obstruction.

On January 23rd I started Lāl Singh northward by the Tārīm to Tikenlik. Joined there by Abdurrahīm, the hardy hunter, who had been his guide in the Kuruk-tāgh in 1908, he carried out an exact survey of the ancient river bed and its branches by which the waters of the Konche-daryā once reached the area, now wholly desiccated desert, containing the remains of ancient Lou-lan. [19] The site of the ruined Chinese station of Lou-lan, first discovered by Dr. Hedin and explored by me in 1906, was to be our rendez-vous. Surveyor Muhammad Yakūb, who could not be employed for independent work on unexplored desert ground without risk to himself and others, was sent off some days later by the Tun-huang caravan track in order to carry out the levelling operations referred to below from the eastern end of the salt-encrusted ancient Lop sea basin.

Survey of 'Dry River' to *Lou-lan*.

[15] See Sheets Nos. 23. C, 2, D. 1, 2; 27. A. 1; 26. A-C. 4, D. 3, 4; 30. A-D. 3.

[16] See Sheets Nos. 33. A-D. 2; 36. A-C. 2, D. 1, 2.

[17] See Sheet No. 30. B. 2; *Third Journey, G. J.*, xlviii, p. 119.

[18] See *Third Journey, G. J.*, xlviii. pp. 119 sq.

[19] See for Lāl Singh's route Sheets Nos. 30. A. 1, B. 2; 29. A. 4; 25. C. 3, D. 3, 4; 29. A-D. 3.

Start on Lop desert explorations.

By February 1st I started myself into the desert north-eastward. My party numbered thirty-five men, having to include an adequate posse of labourers for excavations. What with big loads of ice sufficient to assure minimum allowances of water for at least one month, with food supplies of one month for all and of an additional month for my own people, and with the indispensable outfit, the thirty camels I had managed to secure barely sufficed for the transport. After five marches from the dying Tārīm my first goal was reached in a series of small ancient sites, to the west of the route followed in 1906. They were found to extend along a well-marked dry river course, clearly proved by our survey to be a southern branch of the ancient *Kuruk-daryā* ('the Dry River') which had once carried water to the area of ancient Lou-lan.[20] Abundant relics recovered at these sites showed that they had been abandoned about the beginning of the fourth century A. D., and the antiquarian evidence thus obtained makes it possible to date a variety of physical features which throw fresh light on the hydrography and occupation of this region during early historical times and those immediately preceding them.[21]

Ancient delta of 'Dry River.'

Observations and finds made on our subsequent marches to the Lou-lan site proved to have a similarly important bearing on the so-called 'Lop-nōr problem', the discussion of which has long been carried on among geographers without an adequate basis of surveys. In the wind-eroded clay desert crossed there we met a succession of ancient river-beds all lined by rows of dead *toghrak* (wild poplar) trees such as are invariably found along actual river courses in this region. These beds were clearly recognizable by their direction as having branched off from the 'Dry River' skirting the foot of the Kuruk-tāgh; and it was easy to trace their connection with others similarly marked, shown on our plane-table traverses to and from the Lou-lan site in 1906 further to the east or west.

A careful comparison of all the data thus recorded and of those ascertained a year later by Afrāz-gul's plucky survey of the western edge of the great salt-encrusted basin has convinced me that it was a considerable delta, not a large terminal lake, which had existed here in the area south of the Lou-lan remains during historical times. The extent of this delta to the south and south-west can plainly be traced from our several surveys as now shown on the map.[22]

Reconnaissances in desert around 'Lou-lan site.'

After my arrival by February 10th at the ruined site (*L. A.*) which marks the ancient Chinese station of Lou-lan, I sent reconnaissances into the unknown desert of wind-eroded clay and low drift-sand to the east and north-east, at the same time keeping my diggers at work on unexplored remains at the site. These reconnaissances in which Afrāz-gul Khān displayed remarkable zeal and intelligence, were attended with important results. They revealed a series of ruins to the north-east stretching along what I conjectured to have been the line of the earliest Chinese route leading into the Tārīm basin from Tun-huang and the extreme west of China proper, as first opened by the Han Emperor Wu-ti's operations in the last quarter of the second century B. C.[23] The discoveries made there included a fortified *castrum* which had served as a *point d'appui* for Chinese missions and troops where they first reached Lou-lan territory after crossing the salt-encrusted bed of the dried-up Lop sea. They furnished me with a safe starting-point for the difficult task of tracing the line of that famous ancient route eastwards.

[20] See Sheet No. 29. C, D. 4, for the sites marked L. K., L. L., L. M.

[21] For some account of these sites and the 'finds' made there, see my paper *Explorations in the Lop Desert*, *Geographical Review*, New York, 1920, ix. pp. 11 sqq.

[22] See Sheet No. 29. C, D. 4. The direction of the branching ancient river beds, generally from N. W. to S. E. south of 40° 28′ latitude, and from W. to E. further north, is shown on the map by the bearing of the rows of dead tree symbols as carefully entered on the plane-table at the time.

[23] For the discoveries made at these ruins cf. *G. J.*, xlviii. pp. 123 sqq.; *Geographical Review*, ix. pp. 19 sqq. Regarding the Chinese historical records of the ancient route which served for Chinese trade and military expansion into Central Asia during the first centuries before and after Christ, cf. *Serindia*, ii. pp. 553 sqq.

Before, however, setting out for this it was imperative to give our hard-tried camels a brief rest with water and grazing at the salt springs of Āltmish-bulak.

Move to Āltmish-bulak salt springs.

Lāl Singh had just safely arrived at the Lou-lan site after his survey of the Kuruk-daryā, and with him I proceeded by a new route to those springs at the foot of the Kuruk-tāgh northward, while labourers and antiques were sent back to our depot at Mīrān.[24] After replenishing our ice-supply and taking an indispensable store of fuel we left Āltmish-bulak on February 25 for our respective tasks. Lāl Singh was to survey the extreme north-eastern extension of the great salt-encrusted basin once filled by the Lop sea and the southernmost hill ranges of the Kuruk-tāgh overlooking them. I myself wished to trace the ancient Chinese route from the eastern edge of the once habitable Lou-lan area right through to the point where it was likely to have diverged from the line still followed by the desert track from Tun-huang along the southern shore of the dried-up sea.

It was a task of special geographical and historical interest but beset also by serious physical difficulties and risks; for on the ground to be crossed no water could be expected—over most of it not even fuel—before striking the Tun-huang caravan track near the eastern extremity of the ancient sea bed, a matter of some ten days of hard marching. Apart from the serious risk of physical obstacles which would cause delay and exhaust our hard-tried camels, there was the problem of striking the line of the ancient route and of tracking it through a wilderness devoid of all resources since the dawn of historical times. I have related elsewhere how hints derived from topographical and archæological observations, combined with fortunate finds of relics left behind by the ancient traffic of centuries, helped to guide me and to solve the problem.[25] Here the briefest explanation of the route, as now shown on the map, will suffice.

Search for ancient Chinese route from Lou-lan to Tun-huang.

After regaining across difficult wind-eroded ground the vicinity of the terminal *point d'appui* above mentioned at Camp c, we moved for two long marches to the north-east until we struck the belt of salt-encrusted erosion terraces which the early Chinese accounts of this dreaded 'northern road' knew as the 'White Dragon Mounds'.[26] Then on a very trying march we crossed to the south-east the dried-up sea-bottom with its crumpled-up crust of hard salt, fortunately at the very point where it was narrowest. Thence continuing over easier ground to the south along the ancient sea shore, we reached three days later its extreme eastern extension in the shape of a great bay overlooked from the north by a low offshoot of the southernmost Kuruk-tāgh.

Crossing of salt-encrusted Lop sea bed.

For two more days we skirted this bay eastwards under the steep cliffs of its shoreline, and then crossed its salt-encrusted expanse, here still showing patches of actual salt bog. After a long day's march on March 6 we finally reached the wells of Kum-kuduk, on the Tun-huang caravan track.[27] Here I found Lāl Singh just arrived after having duly surveyed the wide northernmost bight of the dried-up sea and of the straggling low ranges further to the east. In conjunction with the work pluckily done a year later by Afrāz-gul along the western shore our 'circumnavigation' of the ancient Lop sea was thus successfully achieved.

Tun-huang caravan track gained.

After the timely arrival of our heavy baggage from Mīrān a day later, we were able to turn once more northwards across the eastern bay and in separate parties to survey in detail the ground close to the foot of the Kuruk-tāgh where the early Chinese route to Lou-lan had passed. At Bēsh-toghrak, near the eastern end of the great desert valley leading down towards the Lop sea basin, I picked up Surveyor Muhammad Yakūb who had meanwhile carried with praiseworthy perseverence a line of levels, carefully observed with a Zeiss instrument, all the way up from the bottom of the bay north of Kum-kuduk to the curious Mesa-filled basin east of

Desert valley E. of Lop sea basin.

[24] See Sheet No. 29. D. 3.

[25] Cf. *G. J.*, xlviii. pp. 126 sqq.; *Geographical Review*, ix. pp. 26 sqq.

[26] See Sheet No. 32. A, B. 3, for the route from Camp xcix to Camp cii. The point where the belt of salt-coated 'Yārdangs', as distinct from Mesas, was first reached is marked by the entry referring to an important find of relics of ancient traffic, circ. 6 miles E. of C. ci.

[27] See Sheet No. 32. B. 3, C. 3, 4, D. 4.

Bēsh-toghrak.[28] Extending over a distance of 60 miles it has proved a continuously descending slope with a total drop of 250 feet from the latter point.

Connection of Su-lo-ho and Lop basins.

Coupled with other observations, the result of this levelling has confirmed the belief formed on my passage in 1907 that the waters of the Su-lo-ho at a period relatively recent in a geological sense had drained into the Lop basin.[29] In this connection the fresh surveys effected in the desert area which lies east of Bēsh-toghrak and north of the present terminal basin of the Su-lo-ho, proved of special geographical interest; they showed that its depressions still receive subsoil drainage from abandoned branches of the Su-lo-ho delta, and that its mazes of Mesas are those typical of all lacustrine basins in this region.[30] The importance of the connection thus traced here between the drainage area of the Tārīm which has its western limits on the Pāmīrs, and that of the Su-lo-ho which extends as far as the watershed of the Pacific Ocean, fully 24 degrees of longitude further east, scarcely needs to be emphasized.

Chinese *Limes* explored to Tun-huang.

Leaving Lāl Singh and Muhammad Yakūb behind for supplementary surveys within the present terminal basin of the Su-lo-ho,[31] and along the river's course between it and Lake Khara-nōr, I proceeded to the vicinity of the latter along the line of the ancient Chinese *Limes* first discovered by me in 1907. From there I completed my detailed exploration of the Tun-huang *Limes* on ground stretching eastwards which circumstances in 1907 had obliged me to leave unsurveyed.[32]

Survey in westernmost Nan-shan.

A brief halt was necessary at Tun-huang during the last days of March to allow men and animals to recover from the trials of our winter campaign. Then we separated once more. While I paid a fresh visit to the famous cave temples of the 'Thousand Buddhas,' or Ch'ien-fo-tung, south-east of Tun-huang, not without archæological profit, Lāl Singh proceeded to the mountains due south. Owing to deep snow he was obliged to content himself with surveying the northern slopes of the westernmost Nan-shan near the debouchure of the river of Tun-huang or Tang-ho, before re-joining me by the middle of April at An-hsi *via* Tung-pa-t'u and T'a-shih.[33] Muhammad Yakūb was sent north of the Tun-huang oasis by a new route and then mapped the Su-lo-ho river along a previously unsurveyed portion of its course to An-hsi.

Ancient *Limes* traced to and beyond An-hsi.

The task I had set myself for the spring was to trace the line of the Chinese *Limes* of Han times from Tun-huang as far as possible to the east and to explore whatever ruins might have survived along it. I commenced this task by skirting across a belt of difficult salt marshes into the desert north-eastwards of Tun-huang. At a point not far from where our exploration of 1907 ended, I came again upon the ancient border wall and traced it thence through to An-hsi.[34] From there, accompanied by Lāl Singh, I moved up the right bank of the Su-lo-ho and found further remains of the Limes wall and its watch-towers opposite the low hills of Wang-shan-tzu, exactly where our survey of 1907 carried along the left bank of the river had led me to look for them.[35]

Survey to east of Su-lo-ho bend.

The search for the ancient defensive line which at the end of the second century B.C. had been raised to protect China's great line of communication into Central Asia from Hun raids was now successfully continued to the sharp southward bend of the Su-lo-ho southward. Here near the small village of Shih-êrh-t'un we touched the easternmost point at which on my previous expedition I had been able to trace remains of the Limes line.[36] The more careful survey of the

[28] For a chart recording the result of this levelling see Appendix *C*. There information has also been given as regards the value to be attached to the elevation which has been accepted for the starting point of the levelling at Camp XCVIII; see Sheet No. 32. D. 4.

[29] See *Desert Cathay*, i. pp. 535 sqq; *Serindia*, ii. pp. 551 sq.

[30] See Sheet No. 35. B, C. 3, 4.

[31] See Sheet No. 35. B, C. 4.

[32] See Sheet No. 38. A, B. 4.

[33] See Sheet No. 38. B, D. 4; 39. B-D. 1.

[34] See Sheet No. 38. B, C. 4.

[35] The point where the Limes line coming from the east was carried across the Su-lo-ho to the left bank which it thence followed right through to h river's terminal basin is marked in Sheet No. 40. A. 3 by the ruined watch-towers T. XL. a-c.

[36] See Sheet No. 40. C. 4.

ground which the renewed visit rendered possible, proved the geographically interesting fact of a bifurcation taking place here in the waters of the Su-lo-ho. While the river itself turns sharply westwards to terminate fully 180 miles beyond in the marshes flanking the westernmost section of the Limes, a small stream, fed by an inundation bed of the river below the oasis of Yü-mên-hsien and also by subsoil drainage from the irrigation received from the Su-lo-ho, flows to the east and ultimately is lost in a separate basin to the north of the small oasis of Hua-hai-tzu or Ying-p'an. [37]

Explorations in Ying-p'an basin.

It was along this stream and thus to the east that we discovered the continuation of the *Limes* line, instead of south-eastwards in the direction of Su-chou as I had been previously led to assume. The ground crossed by it had remained so far unsurveyed, and the exploration of the ruins along it was made increasingly difficult beyond by the distance which separated the long forgotten border from the nearest water. Nevertheless we succeeded in tracking it for some distance to the north-east of Ying-p'an before ultimately losing its line where it passed into an area covered by big dunes close to the barren foothills of the Pei-shan. [38] Thence we proceeded to the large town and oasis of Su-chou at the beginning of May in order to make preparations for our next move northward.

Ancient *Limes* traced N. of Su-chou.

This journey led me down the united course of the rivers of Su-chou and Kan-chou into a portion of southernmost Mongolia offering geographical and historical interest. Leaving Su-chou on May 10, I marched by a new route to the oasis of Chin-t'a, already visited in 1907. Following the Su-chou river beyond, I succeeded in tracing afresh the line of the ancient *Limes* where it emerged on less impracticable ground near the south-eastern extremity of the Pei-shan. Thence we tracked it through to the north of the Mao-mei oasis, the last Chinese settlement. There Lāl Singh rejoined me after having followed a hitherto unsurveyed route along the Kan-chou river where it breaks through the westernmost hill range of the Ala-shan. [39] As we moved down the Etsin-gol, as the united river is called by the Mongols, we found evidence that the ancient border line after crossing the river beyond Mao-mei had continued into the desert eastwards. But by the time of our return from the Etsin-gol delta in June the summer heat precluded its further exploration on this waterless ground.

Explorations along Etsin-gol.

The survey of the ground passed on the long trying marches along the Etsin-gol bed, then completely dry, proved of distinct geographical and also quasi-historical interest. In a striking way it illustrated physical conditions such as must have prevailed in the Lou-lan area north of Lop-nōr before its final desiccation. [40] While I was kept busy by fruitful excavations at the ruined town of Khara-khoto, first visited by Colonel Kozloff and identical with Marco Polo's 'City of Etzina,' and by explorations in its vicinity, Lāl Singh carried out surveys right down the Etsin-gol delta to the two marshy lake-basins in which the river terminates. [41]

Journey to Kao-t'ai and Kan-chou.

On the conclusion of these tasks I let our hard-worked camels depart for their summer holiday in the Kungurche hills north-eastward. By sending Muhammad Yakūb with them it became possible to map some hitherto unsurveyed ground on the border of independent Mongolia. [42] I myself with Lāl Singh turned southwards for fresh explorations in the Nan-shan ranges. From below Mao-mei we followed a route through hitherto unsurveyed portions of the desert hills to the east and north of the Kan-chou river and after considerable fatigues due to heat and scarcity of water reached this near the town of Kao-t'ai. [43] From there I proceeded to Kan-chou by the main road in order to gain time, while Lāl Singh after visiting a ruined site to the west of Kao-t'ai followed me by a new route along the right bank of the river.

[37] See Sheet No. 40. D. 4. This bifurcation accounts for the curious representation of the hydrography of this region as it appears in old Chinese maps (cf Futterer, *Geographische Skizze der Wüste Gobi*, Petermann's Mittheilungen, Ergänzungsheft No. 139, p. 24.). The big lake which these show in the direction of Hua-hai-tzu has no existence in fact but still continues to be reflected in Western atlases.

[38] See Sheets Nos. 42. C, D. 4; 45. A. 4.

[39] See Sheets Nos. 43. B-D. 1; 42. B-D. 4.

[40] See Sheet Nos. 45. A. 3, B. 2, C. 1; cf. *Third Journey, G. J.*, xlviii. pp. 197 sq.

[41] See Sheet Nos. 45. B, C. 1; 44. C, D. 4.

[42] See Sheet Nos. 44. C. 4; 47. A, B. 2.

[43] See Sheets Nos. 45. A. 4; 46. A. 1, 2.

Start for Kan-chou R. headwaters.

The arrangements made during a short halt in the pleasant oasis of Kan-chou enabled me to set out by July 6th for the new surveys I had planned in the Central Nan-shan. Their main object was to extend the mapping effected in 1907 near the sources of the Su-lo-ho, Su-chou and Kan-chou rivers to the high ranges to the east of the latter's headwaters. In conjunction with our labours in the Etsin-gol region, they were intended to complete the surveys of those extreme north-western marches of Kan-su which, inasmuch as they send all their waters into drainageless basins, may well be considered in respect of their hydrography and general physical conditions as forming part of Central Asia rather than of China. Two marches brought Lāl Singh and myself by different routes to the foot of the mountains at Nan-kou-ch'êng, where fertile slopes cultivated without irrigation bore evidence to a distinct change in climatic conditions, foreshadowing our approach to the watershed of the Pacific Ocean. [44]

Ascent to E. sources of Kan-chou R.

Proceeding thence eastwards we struck the route leading to Hsi-ning, and ascended by it through the gorge and pass of O-po to the broad valley where the feeders of the eastern branch of the Kan-chou river gather at an elevation of over 11,000 feet. Thence we were following it westwards over high alpine grazing grounds when I met with a serious riding accident which badly injured my left leg and made movement of any kind impossible to me for over two weeks. Fortunately the arrangements already made allowed Lāl Singh to carry on the topographical work I had planned. He thus reached Ta-ssu where the two branches of the Kan-chou river unite before breaking through the mountains northward in deep-cut gorges impassable except in the depth of winter and as yet unexplored. [45] He then ascended the western and larger branch of the river to beyond the short stretch we had followed in 1907, and thus supplemented very usefully our preceding surveys of the To-lai-shan and Richthofen ranges. [46]

Survey towards Ta-t'ung-ho drainage.

I had myself intended to cross the former to the headwaters of the Ta-t'ung-ho and to survey this river down to where the Kan-chou–Hsi-ning route meets it. But the Chinese escort and ponymen refused to enter the Ta-t'ung valley from fear of meeting Tangut robbers, and Lāl Singh was reluctantly obliged to return to the camp which still retained me in my helpless condition. The rest of our programme, however, he completed successfully by surveying the range which divides the easternmost headwaters of the Kan-chou river from the Ta-t'ung-ho, and by then descending along its northern spur which forms the watershed between Kan-chou and Liang-chou. [47]

Exploration in Richthofen Range.

By the second week of August Lāl Singh met me at Kan-chou whither I had been carried in a litter, and then set out promptly westwards for fresh work in the Richthofen Range. He there surveyed an important and previously unexplored portion of this range which with its glaciers and perpetual snows feeds the sources of the Li-yüan-ho, the largest tributary of the Kan-chou river. [48] Crossing to the Po-nan-ho drainage area and then moving northwards, he rejoined me by August 26 at Hsiang-p'u. Though still severely feeling the strain to my leg, I had managed to reach this place on horseback by the right bank of the Kan-chou river, thereby completing the survey of its middle course. [49]

New route across desert ranges of Pei-shan.

After regaining Mao-mei where I found Muhammad Yakūb duly arrived with the camels from the Etsin-gol side, we commenced on September 2, 1914, the long journey which carried us right across the great desert area occupied by the Pei-shan ranges, where its width is greatest, in the direction from south-east to north-west. The routes we followed for close on 500 miles had never been surveyed, and only at one point, the wells of Ming-shui, did we touch ground previously approached by Russian explorers. The difficulties met in crossing these wastes, with crumbling hill ranges and desolate valleys between them, were much increased by the fact that only a single small Mongol camp was encountered, and that the scant local knowledge of our two Chinese 'guides' completely gave out after less than the first half of the

[44] See Sheet No. 46. B. 3.
[45] See Sheet No. 46. A. 4, B. 4, 5, C. 4, 5.
[46] See Sheets Nos. 43. C. 3, D. 3, 4; 46. A. 4.
[47] See Sheet No. 46. C. 3-5, D. 4, 5.
[48] See Sheets Nos. 43. D. 2, 3; 46. A. 3.
[49] See Sheet No. 43. D. 1, 2.

journey. At the beginning, however, it allowed us to move in two parties and thus to increase the extent of the area mapped. [50] The same advantage was taken after reaching Ming-shui, [51] whence the guidance afforded by a fairly clear caravan track permitted Muhammad Yakūb to be detached towards Tāsh-bulak and Hāmi. [52]

Passage of easternmost Karlik-tāgh.

Our main party now moved north-westwards, the great snowy mass of the Karlik-tāgh coming into view far away and serving to direct us when in doubt. Serious trouble was, however, still encountered, when making our way through the last barren range, an easternmost extension of the T'ien-shan, owing to want of water and the confusing configuration of its rugged valleys. It was with relief that we descended to the little village of Bai, situated on a wide gravel plateau which receives some subsoil water from the easternmost snows of the Karlik-tāgh and slopes down to the plains of Dzungaria. [53] Careful height observations with mercurial barometer and clinometer taken along the whole of our routes will help to throw fresh light on the morphology of the Pei-shan.

Journey along N. foot of T'ien-shan.

A rapid journey then carried us during the first half of October from Bai westwards to Barkul and Guchen (Ku-ch'êng-tzu) along the northern foot of the eastern T'ien-shan. The route followed permitted a closer survey being made of this portion of the great range than had been possible in 1907 from the south. [54] I also became acquainted with the physical conditions of a region which possesses distinct historical interest and in geographical character differs greatly from the Tārīm basin and the smaller but equally arid basins eastwards; for these valleys and plateaus of Dzungaria, favoured by a somewhat moister climate and offering abundant grazing grounds, have played an important part in the great nomadic migrations affecting the history of Asia, since the times of the Indo-Scythians and Huns.

Passage of Bogdo-ula range.

After leaving Guchen I surveyed, near Jimasa westwards, the site of the ancient capital of this region, the Chin-man or Pei-ting of the Chinese Annals, and then proceeded south to the Turfān depression by the most direct route, difficult in places and hitherto unsurveyed. It led across the Bogdo-ula range, a rugged portion of the T'ien-shan rising to numerous snowy peaks, by a pass of over 12,000 feet and bearing perpetual snow-beds. [55] Lāl Singh, by following with the camels the usual caravan route and crossing further east by the easy Ku-ch'üan pass above Jam-bulak, was able to survey a portion of the range which unfavourable weather conditions had previously hidden from view. [56]

Desert route from Hāmi terminal basin.

The first days of November saw all our parties safely reunited at Kara-khōja, an important ancient oasis in the centre of the Turfān depression, the heavy baggage having safely arrived from Su-chou and An-hsi in charge of Naik (now Jamadār) Shams Din. Surveyor Muhammad Yakūb had also rejoined me. From Hāmi he had in accordance with my instructions first revisited the oasis of Lapchuk and thence descended to the deep basin south-westwards where the waters of Hāmi terminate in the marshes of Shona-nōr, then completely dry. [57] His surveys there and in adjoining depressions were of interest as revealing mazes of wind-eroded Mesas and other surface features characteristic of all terminal basins, from the Lop desert to the Su-lo-ho drainage area. From here he made his way by a difficult desert route, waterless for some eight marches, to Pichan, the easternmost of the larger Turfān oases. [58]

Excavations and surveys in Turfān district.

A combination of geographical and archæological tasks made the Turfān district our base during the autumn and winter of 1914-15. I myself with my devoted Indian helpers, Afrāz-gul and Shams Din, was hard at work from November till the first half of February on excavations and surveys at the numerous ruined sites in the central part of the depression. [59] I also organized a

[50] See Sheet No. 42. A, B. 3, C. 3, 4. D. 4.

[51] Sheet No. 40. A. 1, and for preceding route portions *ibid.* B. 1, 2, C. 2, 3, D. 4.

[52] See Sheet No. 37. A, B. 3, C, D. 4.

[53] See Sheet No. 37. C. 2, 3, D. 4.

[54] See Sheets Nos. 37. A,B. 2; 34. A-D. 1, 2; 31. A-D. 1; 28. C,D. 1, 2.

[55] See Sheet No. 28. B. 1,2, C. 1.

[56] See Sheet No. 31. A, B. 1, 2.

[57] See Sheet No. 34. A, B. 3.

[58] See Sheet No. 31. A-D. 3.

[59] See Sheet No. 28. C, D. 3; *Third Journey, G. J.*, xlviii. pp. 202 sqq.

series of expeditions for the exploration of unknown or as yet inadequately surveyed portions of the Kuruk-tāgh and Lop deserts to the south.

Geographical interest of Turfān basin.

At the same time it became possible also to utilize my prolonged stay for a detailed large-scale survey of the chief parts of the Turfān basin. Geographical and antiquarian interests united in calling for such a survey; for apart from containing in its terminal salt lake probably one of the deepest land depressions below sea-level of our globe, it exhibits, within close topographical limits and hence in a particularly characteristic form, all those physical features which make the Tārīm basin, its great neighbour and counterpart, so instructive both to the geographer and the historical student. For the latter a close survey of the territory must offer additional archæological interest on account of the very numerous ancient remains which have survived within or near its oases, and which strikingly attest its importance and resources in the past when Turfān served as a chief link between Buddhist Central Asia and the Far East.

Detailed surveys in Turfān depressions.

This work, on the one-inch scale and with clinometrically observed contours, was entrusted to Muhammad Yakūb and carried on by him under such control as his periodic visits to my archæological camps permitted me to exercise. In the end his plane-table sheets, seven in number, covered the whole of the central part of the Turfān depression and comprised all its oases ancient or modern with the exception of Toksun in the extreme west of the basin.[60] With this and the other surveys of my two expeditions it is hoped to prepare a detailed map of the Turfān district, on the scale of 1:250,000, for publication in the Royal Geographical Society's *Journal*, together with a short monograph on the geography and historical topography of the territory. In addition, I may mention, both Afrāz-gul and Muhammad Yakūb were engaged during our work at Turfān in preparing large-scale plans of important ancient sites, such as the ruined towns of Kara-khōja and Yār-khoto, etc., to be published in my Detailed Report on the third expedition.

Plan for Lāl Singh's surveys in Kuruk-tāgh.

By November 12th I was able to let R. B. Lāl Singh start from Kara-khōja for fresh hard work in the Kuruk-tāgh to the south. His instructions were to reach Singer, the only small inhabited place in those truly 'Dry Mountains', by a new route from the south-east corner of the Turfān basin[61] and thence to start triangulation towards Āltmish-bulak in the south-east with a view to securing, if possible, a connection across the Lop desert with the easternmost points on the K'un-lun range fixed during the preceding autumn. Owing to the incipient season of dust storms no chance for sighting those distant peaks had offered during our stay at Āltmish-bulak in February, 1914. But experience during my first explorations at the Lou-lan ruins in December, 1906, had shown the possibility of such rays being observed under particularly favourable conditions. At the same time the rapidly increasing cold gave hope that after Lāl Singh's arrival at Singer and the establishment of a triangulation base there, the season would be sufficiently advanced to permit of the difficulties arising from the want of drinkable water further east being overcome by the use of ice formed on salt springs.

Triangulation from Singer to Āltmish-bulak.

Lāl Singh carried out this programme with his accustomed persevering energy in the face of great hardships and privations, helped once again by that experienced hunter Abdurrahīm and his hardy camels. By the middle of December he had carried a system of triangles from his measured base near Singer to Āltmish-bulak.[62] There a fresh base was measured, but the chance of sighting the K'un-lun range south was vainly awaited for a week, the usual desert haze and the distance, over 130 miles, effectively preventing a view. Lāl Singh then moved one march further south to the salt spring of Āstin-bulak and after again waiting under still more trying conditions of extreme cold and exposure succeeded at last on December 23rd in sighting a portion of the distant range. Observations were made from both ends of a new base to a peak

[60] The one-inch scale survey extended from the Pichan oasis in the east (Sheet No. 31. A. 3) to the vicinity of Āltun-mazār in the west (No. 28. B. 3), and from about lat. 43° south to the terminal salt lake bed forming the deepest portion of the Turfān basin.

[61] For the route followed from Deghar to Ārpishme-bulak, two marches N. of Singer, see Sheet No. 28. B. 4. C. 4. D. 3.

[62] See Sheet No. 29. B, C. 2, D. 3.

which Lāl Singh believed to be identical with Pk.1/75 E near Bāsh-kurghān, fixed by him more than a year earlier at the eastern end of his K'un-lun triangulation. [63] Thus the hoped-for junction between this and the Kuruk-tāgh section of triangulation seemed achieved. [64]

Exploration of eastern Kuruk-tāgh.

By December 24th, 1915, he started from this point on the northern edge of the Lop desert basin north-eastwards in order to search for a series of salt springs shown on the Russian Asiatic Trans-frontier map of 40 versts to the inch, in the unexplored eastern portion of the Kuruk-tāgh, on the basis of information collected by Colonel Kozloff in 1893 from native hunters. Abdurrahīm's expert guidance enabled Lāl Singh to reach their line on wholly unsurveyed ground. [65] Not satisfied with this he pushed his way to the north-east across unknown ground devoid of even the scantiest vegetation, until the complete exhaustion of the fuel store, needed for melting his ice, forced him to turn again to the north-west from beyond longitude 91°. [66] After a number of marches to the north he picked up an old desert track once used by hunters of wild camels from Hāmi, before certain salt springs had dried up, and followed it down to the salt marsh that forms the deepest part of the Turfān basin. He then carefully surveyed this terminal marsh moving along the southern shore and taking observations at different points with the mercurial barometer. [67] These have made it possible to determine its depression below sea-level with greater accuracy than before as close to 1000 feet at the deepest point.

Surveys in western Kuruk-tāgh.

On his return from this long desert expedition which for the hardships faced can scarcely have been surpassed even in the annals of the Survey of India, Lāl Singh allowed himself but a few days' rest at our Kara-khōja base, and by February 4th set out afresh for the Kuruk-tāgh. The main task I had in view was the extension of the triangulation from the Singer base westwards to the foot of the T'ien-shan near Korla. In addition as much as possible of hitherto unsurveyed ground in the western part of the Kuruk-tāgh was to be visited. Hence Lāl Singh's route to Singer led this time through the south-western end of the Turfān basin to the gorge of Su-bāshi and from the station of Ūjme-dong near its top to the south-east. [68]

The severest cold had now passed; also the Kuruk-tāgh to the west of Singer proved less arid. But the dust-haze raised by the incipient season of sand-storms and in parts the very rugged configuration of the hill ranges proved very serious obstacles to triangulation. Hence Lāl Singh's work which from Azghan-bulak on the Singer-Tikenlik route to where he regained his own track of 1907 near the Eljigan-dawān lay over wholly unsurveyed ground, [69] was not completed till our reunion at Korla in the beginning of April.

Supplementary surveys in Lop desert and Kuruk-tāgh.

On February 6, 1915, I sent off Afrāz-gul Khan from Kara-khōja to the Lop desert for supplementary surveys in the easternmost portion of the once occupied Lou-lan region and along the dried-up ancient sea-bed to the east and south of it. I myself, after dispatching my large convoy of antiques to Kāshgar and making a detailed survey of the important site of Yār-khoto, the earliest capital of Turfān, set out for the Kuruk-tāgh due southwards by February 16th. Muhammad Yakūb was left behind to complete the one-inch survey of the central portion of the district.

[63] See the intersected peak marked with height of 13170 feet, in Sheet No. 30. D. 2.

[64] In Major K. Mason's notes (see below Appendix *A*), on the triangulation executed by R. B. Lāl Singh, para. 2, a full explanation has been given of the reasons, derived from a re-examination of the computation of the work both in the K'un-lun and Kuruk-tāgh sections, which make it highly probable that the identification of the point Pk. 1/75 E was faulty. There an account will also be found of the circumstances which previous to that re-examination had led to some of Lāl Singh's triangulated stations and points, particularly in the northern or Kuruk-tāgh section, being shown in the published sheets, Nos. 25, 29, with values adjusted on the assumption of that distant connection between the Āstin-bulak base and Pk. 1/75 E being right.

The coordinates of stations and points in both sections, as correctly derived from the observations independent of that connection, are shown in the *List of Latitudes, Longitudes*, etc., of Appendix *A*. There the values, wrongly adjusted owing to the supposed connection, are also given to aid identification of the points on the published map sheets.

[65] For the line of these springs from Yetim-bulak northward, but rarely visited by hunters of wild camels from Deghar and Singer, see Sheet No. 32. A. 1-3.

[66] See Sheet No. 32. A. 1, B. 1, 2, C. 1.

[67] See Sheet No. 28. C, D. 3.

[68] See Sheets Nos. 28. A. 3, 4; 29. A, B. 1, 2.

[69] See Sheets Nos. 29. A, B. 2; 25. A. 1, B-D. 2

I reached Singer by the route already surveyed in 1907 and, after securing there Abdurrahīm's youngest brother as guide, I proceeded westwards to examine localities where traces of earlier occupation were reported. Passing thus from P'o-ch'êng-tzu to Shindī I was able to map interesting and as yet unsurveyed ground in the mountains; their rugged ranges and deeply eroded valleys were in striking contrast with the worn-down uplands met in the Kuruk-tāgh further east. The Khangol peaks passed on this route seemed to exceed 10,000 feet and probably represent the greatest elevation of the Kuruk-tāgh. [70]

I then made my way south-eastwards over barren gravel plateaus to the salt spring of Yārdang-bulak at the south foot of the Kuruk-tāgh and by the second week of March entered the waterless desert to the south. Besides exploring certain ancient burial grounds I completed the survey of the Kuruk-daryā, the dried-up river-bed which once carried the water of the Konche-daryā to the Lou-lan sites and the ancient delta to the south. [71]

Afrāz-gul's surveys along dried-up Lop sea.

The day after my return to Yārdang-bulak I was rejoined by Afrāz-gul whose safe arrival at this appointed desert meeting place I had been eagerly awaiting. Some anxiety about the safety of the overdue little party was justified by the truly forbidding nature of the ground he had to traverse and the length of the strain put on our brave camels. Afrāz-gul had carried through the difficult programme laid down by me with remarkable completeness and intelligence, his success on this survey alone fully justifying the award to him two years later of the Macgregor Silver Medal by the Intelligence Department of the Indian General Staff.

Guided by a third brother of Abdurrahīm he first gained Āltmish-bulak by the most direct track leading due south of Deghar. [72] Thence he surveyed certain ancient remains in the extreme north-east of the once-watered Lou-lan area for the examination of which I had been unable to spare time a year earlier. Replenishing his supply of ice from the salt springs, he struck out to the south-east for the point where my explorations of the preceding year had shown the ancient Chinese route from Lou-lan to Tun-huang to have entered the salt-encrusted bed of the Lop sea. [73] From there he traced its shore-line to the south-west, making plenty of interesting observations on inlets and terminal flood-beds once carrying water from the Kuruk-daryā. Finally he reached, at Chainut-köl, the northern edge of the area in which the spring floods of the dying Tārīm spread themselves out to undergo rapid evaporation in lagoons and marshes. [74] He arrived, as I had intended, just before the usual inundation could interfere with his progress to ground affording some scanty grazing for his hard-tried camels.

Crossing from terminal Tārīm marshes to 'Dry River.'

After a few days' rest he turned northwards into the wind-eroded desert and striking the line of the southernmost branch of the 'Dry River' traced more remains of the ancient settlement discovered along it a year before. Finally after crossing my route of December, 1906, in an area of formidable dunes, he gained the main riverine belt of the Kuruk-daryā along the foot of the outermost Kuruk-tāgh. [75] From this exceptionally difficult exploration which had kept Afrāz-gul and his three plucky companions from contact with any human being for a month and a half, he brought back, besides interesting archæological finds, an accurate plane-table survey and careful records of topographical details such as I could not have hoped for from any of my surveying assistants employed on this or my previous expeditions.

Explorations near Ying-p'an.

From Yārdang-bulak we moved westwards to the point known as Ying-p'an where the ancient bed of the Kuruk-daryā is crossed by the Turfān-Lop track. There a short halt was made in order to explore interesting remains at and near a fortified station situated at the debouchure of the dried-up stream of Shindī and occupied during the early period when it guarded the ancient Chinese high road from Lou-lan. The same opportunity was used also for surveying the belt of drift-

[70] See Sheets Nos. 29. A. 1, 2, B. 1; 25. D. 2. The hypsometrical height measurements taken by me on this route had not been worked out at the time when these map sheets were compiled.

[71] See Sheet No. 29. A. 2, 3, B. 3; cf. above p. 28.

[72] See Sheets Nos. 28. D. 3, 4; 29. D. 1, 2.

[73] See Sheet No. 32. A, B. 3; cf. above p. 30.

[74] For Afrāz-gul's route from Āltmish-bulak as marked by Camps C. ccxxxvii a — ccxliv a, see Sheets Nos. 32. A. 3, 4, B. 3; 29. D. 4; 30. C. 1. The details of Afrāz-gul's plane-table traverse are on this route as on all his independent surveys supplemented by a full and exact record of topographical features in the form of a route report in Urdu from which I hope to publish extracts.

[75] See Sheet No. 29. A, B. 3, C. 3, 4.

sand to the west and south in which lie the dry beds marking the connection between the Kuruk-daryā and the present course of the Konche-daryā. [76] This area is of particular hydrographical interest as it witnessed the change which sometime after the middle of the third century A. D. caused the waters of the Konche-daryā and, perhaps, a Tārīm branch united with it, to abandon the Kuruk-daryā bed and the easterly direction towards Lou-lan for a south-easterly course and the subsequent junction with the Tārīm. [77]

Survey from 'Dry River' to Korla.

From Ying-p'an I sent Afrāz-gul to Tikenlik to survey the main Lop–Kara-shahr route along branches of the Tārīm and across the Inchike-daryā to the new settlement of Kara-kum on the Konche-daryā. He subsequently surveyed the course of the latter river as far as Korla. [78] I myself proceeded to this place by Dr. Hedin's interesting desert route of 1896 along the line where the gravel glacis stretching down from the foot of the Kuruk-tāgh overlooks the riverine belt of jungle extending along the left bank of the Konche-daryā. This route, now waterless almost throughout for a length of about a hundred miles, is marked by a series of ruined towers and watch-stations which my explorations have proved to date back to approximately the same period as the construction of the Tun-huang Limes (end of 2nd century B. C.). They clearly mark a continuation of the ancient Chinese high road *via* Lou-lan.

Parties re-united at Korla.

By the end of the first week of April our four lines of survey had been successfully brought to their appointed meeting point at Korla, the flourishing oasis in the north-eastern corner of the Tārīm basin, Muhammad Yakūb having rejoined from the Turfān side after a survey of the southern shore of the Baghrash lake. [79] We then set out in three separate parties for the long journey westwards with Kāshgar as our common goal. Lāl Singh's task was to keep close to the T'ien-shan and to survey as much of its southern main range as the early season and the available time would permit. Muhammad Yakūb, with most of our brave camels, was sent southwards across the Konche and Inchike rivers to the Tārīm, [80] with instructions to survey its present main channel to the vicinity of Ābād in the Yārkand district.

My own antiquarian tasks obliged me to keep in the main to the long line of oases which fringes the southern foot of the T'ien-shan and through which since ancient times the chief trade and military route of the Tārīm basin has always passed. Well-known as is this high-road, over which lay most of my journey to Kāshgar, some 900 miles in length, yet its detailed survey proved of distinct interest by the light thrown both on its physical and historical geography.

Surveys around Kuchā.

By detaching Afrāz-gul wherever the need of inspecting old remains off the main road rendered this advisable, it became possible to survey also portions of the scrub-covered desert southwards before reaching Kuchā on April 14th. [81] Three busy weeks spent within and around this great oasis, important both on historical and archæological grounds, enabled me with Afrāz-gul's efficient help to survey in some detail both its present cultivated area and that which, by the evidence of the numerous ancient sites scattered in the scrubby desert from south-east to south-west, must have once formed part of it. [82] Apart from archæological finds of interest, these surveys have furnished clear evidence of 'desiccation'. They have shown that the volume of water available for the irrigation needs of the oasis from the Kuchā and Muz-art rivers has considerably decreased within historical times.

Lāl Singh's surveys along T'ien-shan to Ak-su.

The centre of the Kuchā oasis was touched also by the survey of Lāl Singh who from Korla had kept as close to the T'ien-shan as transport and other conditions would permit. From Yangi-hissār he had succeeded in reaching the top of the Kara-dawān pass, still covered by deep snow, over which

[76] See Sheet No. 25. C, D. 3.

[77] For an important early Chinese record bearing on the former course of the Konche-daryā towards Lou-lan, cf. my comments in *Serindia*, i. pp. 420 sqq. There also I have discussed the hydrographic facts underlying the story related in the same text about a barrage which appears to have been constructed in the second century A. D. in order to assure to the Kuruk-daryā bed the water needed for irrigation in the Lou-lan area.

[78] See Sheets Nos. 25, A. 2, B, C. 3; 21. D. 1.

[79] See Sheet No. 25. A, B. 1.

[80] See Sheet No. 21. D. 1-3.

[81] See Sheets Nos. 21. A-D. 1; 17. C, D. 1, 2.

[82] See Sheet No. 17. A-D. 1, 2.

a route leads to the high Yulduz plateau.[83] From Kuchā he proceeded again northwards and keeping throughout along the line of the highest localities with cultivation, many of them never surveyed before, made his way to where the Muz-art river debouches from the mountains into the basin-like district of Bai. He then ascended the river to its headwaters below the ice-clad T'ien-shan in the vicinity of the great Tengri-khān peak. Notwithstanding the heavy winter snow still covering the glacier approach to the Muz-art-dawān he pushed up to within about a thousand feet of the top of the pass; the summit of it was quite impracticable at this early season.[84] When coming to meet me at Ak-su he had to follow the route already surveyed in 1907, none other being available.

Surveys between Kuchā and Kāshgar.

I myself after visiting a number of interesting Buddhist sites in the district of Bai away from the high road which crosses it, reached the 'Old Town' of Ak-su on May 17th. At Kara-yulghun, two marches to the east, Afrāz-gul had rejoined me. From Kuchā he surveyed an old and more direct track through the scrub-covered desert belt along the foot of the barren hill range fringing the Bai basin.[85] During my two days' halt at Ak-su I was able to secure the needful official help and the guidance which enabled Lāl Singh to proceed to Kāshgar by a new route leading over ground almost wholly unsurveyed. It took him through and along the utterly arid hill ranges which form the southern and outermost rampart of the T'ien-shan, first to the small oasis of Kelpin and then past the Kirghiz winter grazing grounds of Kara-jol to Kalta-yailak, the north-eastern outpost of Kāshgar cultivation.[86]

I myself was obliged to proceed to Kāshgar by forced marches in order to secure adequate time for manifold and urgent labours, and had hence necessarily to follow the main road *via* Marāl-bāshi. My regret at this necessity was tempered by the fact that this journey of close on 300 miles covered in eleven days made it possible to complete our survey of the northern main trade route of the Tārīm basin right through to its western terminus.[87]

Stay at Kāshgar.

I reached Kāshgar on May 31st and was during the following five weeks kept incessantly busy at the British Consulate General with the careful repacking of my collection of antiques (eighty heavy camel-loads in all) for dispatch to India; I had also to prepare for my own journey across the Russian Pāmīrs to Bokhāra territory and Persia. Within a week of my arrival I was rejoined by Lāl Singh and after a fortnight also by Muhammad Yakūb who had safely effected his long journey along the left bank of the Tārīm from west of the Inchike junction to above Ābād.[88]

Muhammad Yakūb's survey along Tārīm R.

The inundations caused by the spring floods had considerably impeded his progress and confined his plane-table work, somewhat rough as was usually the case when carried on by him independently, to the close vicinity of the track followed from one riverine shepherd station to another. The defects inherent to a plane-table traverse of such length from the accumulation of errors in distance estimates, etc., could fortunately be checked by reference to previously surveyed route lines which crossed or touched this traverse at a number of points between Shahyār and Merket. During the remaining weeks of my stay at Kāshgar the surveyors were kept fully occupied by the preparation of tracings from the many plane-table sheets (157 in all) which our combined surveys had yielded.

The completion of all my arrangements allowed me by July 6, 1915, to leave Kāshgar

[83] See Sheet No. 20. A. 4; for Lāl Singh's route from Korla to Kuchā, see Sheets Nos. 21. A-D. 1; 17. C, D. 1.

[84] See Sheet No. 11. A, B. 4. Lāl Singh's route from Kuchā to the Muz-art river is shown by Sheets Nos. 17. A, B. 1; 16. A, B. 4; 12. B-D. 1.

[85] For Afrāz-gul's route, see Sheets Nos. 17. A. 1, 2; 12. B-D. 2; for my own between Kuchā and Ak-su, see Sheets Nos. 17. A, B. 1; 12. A, B. 2, C, D. 1; 7. D.2.

[86] See Sheets Nos. 7. A, B. 4, C. 3, D. 2, 3; 4. B-D. 4; 5. A, B. 1.

[87] See Sheet No. 7. C. 3, 4, D. 2, 3; 8. A, B. 1; 5. A. 2. B. 1, 2. C, D. 1.

I must regret that the rapidity of the journey and the difficulty about water at that advanced season rendered it impossible to search in the desert northward of the stages between Chilan and Chādir-köl (Sheet No. 7. B, C. 4) for remains of the line which the Chinese high road is likely to have followed in ancient times; cf. above p. 26.

[88] See Sheets Nos. 21. A-D. 2, 3; 17. A-D. 2, 3; 12. A. 4, B. 3, 4, C. 3, D. 3; 7. D. 4; 8. A. 1, 2, B, C. 1; 5. D. 2, 3.

Survey towards Kāshgar R. headwaters.

for the mountains westwards. But the summer floods in the K'un-lun valleys would not allow the valuable convoy of antiques to be started at once towards the Kara-koram and Leh. I was therefore able to let Lāl Singh to whose care I had to entrust it, set out meanwhile with me for a survey of the high snowy mountain chain which continues the Muz-tāgh-atā range to the headwaters of the Kāshgar river south-east of the Alai. We separated at Ōpal whence Lāl Singh made his way round the northern end of that chain to the great Pāmīr-like valley of Mōji bordering the watershed towards the Great Kara-kul and Rang-kul Lakes on the Russian Pāmīrs.[89] By descending this valley to below Kun-tigmaz he connected his survey with the work effected in 1900 from the Muz-tāgh-atā side and thus practically completed our mapping along the Chinese portion of the Pāmīrs. Crossing thence the high Ulūgh-art pass, flanked by a magnificent glacier, he rejoined me for final instructions at the mountain camp of Bostān-arche[90] where much urgent writing work had detained me before my start from Chinese soil.

Return of surveyors to Ladāk.

The short journey which carried me thence to the Russian Pāmīr frontier below the Kizil-art pass, lay mostly along Lāl Singh's recent route and offered no opportunity for fresh topographical work. Lāl Singh himself after taking charge of the big convoy of antiques at Kāshgar, was obliged to proceed with it to Yārkand and thence to follow the usual caravan route which leads to Ladāk *via* Kök-yār. Beyond the latter place the ground had remained outside the area of our previous surveys. Plane-table work was therefore resumed here by Lāl Singh and carried across the Tiznaf river headwaters and the Yangi-dawān to the uppermost Yārkand river and finally to the Indian frontier on the Kara-koram pass.[91]

His constant personal supervision was needed to assure safe transit for the many loads of precious and often very fragile antiques on these marches, with their frequent river crossings and other risks, and the complete success with which this difficult task was carried through sufficiently explains why the survey work was here necessarily limited to what could be accomplished while keeping to the route line.

Extent of survey operations.

The survey operations of my third expedition thus completed had extended, as far as work in Chinese territory was concerned, over a period of exactly two years. Though their duration was thus about four months shorter than the corresponding period of my second journey yet the area covered by our surveys of 1913-15 was if anything even more extensive than before. This result was very largely due to the indefatigable energy displayed by R.B. Lāl Singh.

Recognition of surveyors' services.

It was hence a special satisfaction to me to see his services to geography on this expedition duly recognized by the award of the Cuthbert Peek Grant of the Royal Geographical Society in 1916, and those he had rendered to the Survey of India during 37 years of work in fields as widely apart as Arabia, Persia, the Indian N.W. Frontier, Tibet and China, by the grant of a valuable Jāgir which the Government of India bestowed upon him on his retirement in 1919. The equally zealous help I had received from Afrāz-gul Khān and the special aptitude for topographical work which he had proved on this journey, led to his appointment in 1918 as Sub-Assistant Superintendent in the Survey of India and received due acknowledgment also by the bestowal in 1917 of the Macgregor Silver Medal for Military Surveyors.

[89] See Sheet No. 2. A-C. 2.

[90] See Sheet No. 2. B, C. 2 3.

[91] For the route from Kök-yār, see Sheet No. 6. C. 1-3, D. 4; 9. A. 4; 10. A. 1.

CHAPTER II

THE REGIONS SURVEYED

SECTION I.—THE TĀRĪM BASIN AND ITS MOUNTAIN RAMPARTS

In the introductory remarks reference has already been made to the decision arrived at after my return from the third expedition in the spring of 1916 that its topographical results should be published in the form of maps embodying also the surveys of my previous Central-Asian journeys. This decision was due mainly to the fact that the great extent of the new surveys and the care which had been taken to fill up gaps left by the preceding ones had rendered it possible to use the accumulated materials for the preparation of maps which could serve as comprehensive cartographic representations of certain vast and yet well-defined regions of innermost Asia. Great as is the area of these regions, yet a striking uniformity of physical features prevails within each of them. The consistency of the methods employed throughout our surveys in the field and in the cartographic record of their results is bound to bring out these characteristic features of each region in a way specially useful to the geographer, and in this may be found compensation for whatever defects and lacunae may appear in these maps prepared from 'reconnaissance surveys' and without the help of extraneous materials.

This memoir is in no way intended to include a systematic treatment of the geography of any of those regions. But a brief indication of the limits of each of them and of the chief physical features determining their geographical character may usefully precede a description of the methods followed in preparing the maps.

Meridional range of *Imaos*.

Starting from the west, we have first the great meridional mountain chain, the *Imaos* of the ancients, which divides the elevated region of the Pāmīrs from the huge drainageless basin of the Tārīm. Sheets Nos. 2, 3 show the main portions of that chain which lie between the headwaters of the Kāshgar river in the north and the easternmost Hindukush in the south. While the high snowy range of Muz-tāgh-atā and those of Kongur and Ulūgh-art continuing the chain northward, are adjoined on the west by open Pāmīr-like valleys, the rivers draining the latter as well as the eastern slopes of the ranges all descend towards the Tārīm basin in deep-cut and extremely narrow gorges, shown on the maps along the courses of the Gez, Kara-tāsh and Tāsh-kurghān rivers. The ranges themselves break up eastwards in mazes of deeply eroded arid hills. These rise abruptly above the wide piedmont gravel glacis which everywhere fringes their foot, and form the western rim, as it were, of the great basin proper.

Extent of Tārīm basin.

This basin slopes gently away eastwards to its deepest part within the bed of the dried-up Lop sea. Even here it does not appear to sink below an elevation of about 2,000 feet. Its whole drainage is collected in the Tārīm river and is ultimately lost in the marshes of Lop-nōr which now occupy the western extremity of that ancient sea. From the plain around Kāshgar at its westernmost limit to the easternmost inlet of the salt-encrusted bed of the ancient Lop sea, the greatest length of the Tārīm basin stretches over some 850 miles. Its greatest width, from the alluvial fan of Kuchā in the north to the foot of the K'un-lun glacis south of Niya, is not less than about 330 miles.

K'un-lun range.

On the south this huge drainageless area is bordered throughout by the northernmost chain of the mighty mountain system of the K'un-lun and by the spurs it sends down towards the plains. Carrying perpetual snow on its crest line for almost the whole of its length, this great rampart of the northernmost K'un-lun is broken through by the Yārkand river, the main feeder of the Tārīm, and a number of other considerable rivers, such as those of Khotan, Keriya and Charchan, all of which have their sources further south. But all their valleys and those directly descending from the main range are extremely confined, and nowhere within these high barren mountains do we meet with cultivable areas of any size.

For the western and higher portion of this mountain rampart which rises to peaks of over 23,000 feet, the Sheets Nos. 6, 9, 10, 14, 15 afford ample cartographical materials. To the east of the Keriya river the character of the chain overlooking the Tārīm basin does not change; but its width is reduced and the elevated Tibetan plateaus approach it closer from the south. Throughout the whole length of the chain the foot of its northern slopes is formed by a glacis of piedmont gravel, attaining in parts a width of 40 miles and more, and everywhere utterly sterile.

T'ien-shan range.

On the north the basin of the Tārīm is enclosed by the great T'ien-shan chain. In the west it meets the meridional range above mentioned near the Alai and the headwaters of the Kāshgar river. Thence it stretches away unbroken to its north-easternmost corner near Korla where the Konche-daryā, fed by the Baghrash lake, enters the plains (Sheets No. 24, 25). North of Ak-su, the T'ien-shan attains its culminating point in the great peak of Tengri-khān (Sheet No. 11). Thence eastwards a branch of the main chain, gradually diminishing in height, forms the enclosing wall of the basin. To the west of Ak-su a series of outlying lower ranges intervenes between the main chain and the plains (Sheets No. 4, 5, 7).

While our surveys show this portion of the northern rim in some detail, east of Ak-su they were confined mainly to the southern slopes of the range immediately overlooking the basin (Sheets No. 16, 17, 20, 21). Nevertheless they suffice to bring out certain characteristic differences between this northern mountain border and the K'un-lun. Among them I may mention the much smaller width, or complete absence, of the gravel glacis at the foot of the T'ien-shan, and the less arid character of the main range as demonstrated by the presence of conifer forest in a number of valleys on its southern slopes.[1] Both these facts bear evidence to the influence asserted by the far moister climatic conditions which prevail north of the T'ien-shan.

Desert ranges of Kuruk-tāgh.

Beyond Korla the desert uplands of the Kuruk-tāgh, the 'Dry Mountains', take the place of the T'ien-shan as the border of the Tārīm basin both to the north and north-east. The character of this barren succession of much-decayed parallel ranges with wide gravel-filled valleys and drainageless basins between them, is adequately illustrated by the surveys embodied in Sheets No. 25, 28, 29, 32. What scanty moisture ever reaches the southern slopes of the Kuruk-tāgh and escapes evaporation on its wide gravel glacis, descends in wide flood-beds to the Konche-daryā and its ancient continuation eastwards, the Kuruk-daryā or 'Dry River', which once carried its waters to the Lou-lan area. The aridity of the Kuruk-tāgh steadily increases eastwards until at about longitude 91° even the rare salt springs, which rendered its exploration possible, are no longer encountered.

Section II.—THE TAKLAMAKAN DESERT.

Central desert of drift-sand.

Within the Tārīm basin enclosed by the mountain barriers briefly described above, we may conveniently distinguish four main regions. By far the largest, and perhaps the best defined, comprises the huge central area of bare drift-sand desert, popularly known as the Taklamakān. Its borders to the west, north, and east are roughly determined by the belts of vegetation accompanying the Tiznaf, the Yārkand and the Tārīm rivers, the last being the name generally given to the Yārkand-daryā after receiving the rivers of Kāshgar, Ak-su and Khotan. The dune-covered area has outliers beyond these riverine borders in a number of places. But only two of these, both at the extreme ends of the central area, are sufficiently large to deserve here special mention. In the west we have the moving sands of Ordam-pādshāh stretching from the vicinity of Yangi-hissār to the left bank of the Yārkand river

[1] See Sheet No. 12. B, C. 1; 16. B. 4; 20. A, B. 4.

(Sheet No. 5). In the east a zone of high and utterly barren sand-ridges spreads beyond the Tārīm, filling a big triangular space between the foot of the Kuruk-tāgh and the belt of wind-eroded desert along the western shores of the ancient salt-encrusted Lop sea bed (Sheets No. 25, 29, 30).

Southern border of Taklamakān.

In the south, the border of the Taklamakān lies along the northern ends of the oases, mostly small, which line at intervals the foot of the K'un-lun glacis from Karghalik to Niya (Sheets Nos. 6, 9, 14, 19). Further east this line finds its continuation in patches of sandy jungle intermittently watered by rivers of small size and extending below that gravel glacis (Sheets No. 19, 23) as far as the small oasis of Charchan. From there onwards to the vicinity of Lop-nōr the narrow belt of vegetation which accompanies the Charchan river right down to its junction with the Tārīm forms the well-marked border of the Taklamakān.

'Terminal oases.'

With the exception of the Khotan-daryā, not one of the numerous rivers descending from the snowy K'un-lun succeeds in making its way through the Taklamakān. All the rest are lost in this 'sea of sand' at a greater or lesser distance from the line occupied by the existing oases or by areas of coarse desert vegetation. But within historical times, as proved by remains dating from the third century A. D. onwards, a number of these terminal river courses carried a greater volume of water and permitted ground to be cultivated lying considerably further north than the present 'terminal oases'.[1] My explorations of such ancient sites abandoned to the desert led to extensive surveys in this southern portion of the Taklamakān, and these were supplemented by others along the routes followed right across it from the Tārīm to the Keriya river delta and along the bed of the Khotan-daryā.[2]

Physical features of desert.

The topographical record of these travels in the Taklamakān illustrates in a striking manner the uniformity prevailing in the character of this huge desert. Whether the traveller enters it from the edge of cultivated ground in oases, or from the jungle belts along river courses and in tracts where subsoil drainage from the mountains approaches the surface again at the foot of the gravel glacis, he first passes through a zone with desert vegetation, mostly in the shape of tamarisks, wild poplars and reeds, surviving amidst low drift-sand. A very peculiar and topographically interesting feature of this zone consists of 'tamarisk-cones', hillocks of conical form and often closely packed, which the slow accumulation of drift-sand around tamarisk growth has in the course of centuries built up to heights reaching fifty feet and more.[3] Further out in the Taklamakān only shrivelled and bleached trunks of trees or sand-cones with dead tamarisk growth emerge from the dunes, until finally these too disappear among high and utterly bare ridges of sand.[4]

Section III.—THE OASES OF THE TĀRĪM BASIN.

The areas left between the Taklamakān and the encircling mountain ranges to the north, west and south have geographically so much in common that they might well be treated as one region. If I prefer here to separate the western and northern margins of the

[1] See, *e.g.*, Sheet No. 14. C. 1 for the Dandān-oilik site; 14. B, C. 2 for the ancient sites north of Chīra-Domoko line; 18. B. 4 and 19. B. 1 for the site beyond the Niya river end; 19. D. 1 for the Endere site. Cf. also above pp. 8 sq., 14 sq., 19 sq.

[2] Cf. above pp. 19 sq., 27.

[3] Regarding the representation in the maps of these 'tamarisk-cones' and of desert vegetation, living or dead, see below Chap. III. sec. ii.

[4] About the formations shown by the sands of this innermost and largest desert area it will suffice here to mention that while the shape of individual dunes conforms to the prevailing wind-direction, the big hill-like ridges (*dawāns*), into which they are heaped at intervals, according to my observations, seem generally to stretch parallel to those river-beds which lie nearest, whether still receiving water or dry since long ages. See for such high Dawāns parallel to river courses, *e.g.*, Sheet 14. B. 2, C. 1, 2, D. 1-3; 17. A. 4; 18. A. 1-3; 19. B-D. 1; 29. B. 4; 30. A. 1. Cf. also *Serindia*, pp. 241, 451 sq., 1239.

basin from the one in the south it is mainly because it is thus easier to indicate certain topographical distinctions deserving of notice. [1] But both share the essential feature of containing whatever ground within the Tārīm basin is capable of permanent cultivation under existing conditions.

Western and northern belt of oases.

The cultivable area is considerably greater within the western and northern belts. This may be taken as extending in a big arc from Yārkand and Kāshgar to Korla and the tract immediately south of it. It contains the far larger number of important oases, such as Yārkand, Kāshgar, Ak-su, Kuchā, and owing to them and to the short distances at which smaller ones are strung out between them, the route passing through this belt of cultivable ground has from the earliest historical times to the present day been the chief line of communication and trade within the Tārīm basin. These advantages for permanent occupation and traffic result mainly from the fact that irrigation—that indispensable condition of all cultivation in this basin—is here greatly facilitated by the volume and number of the rivers as well as by physical features of the ground which favour full use of their irrigation resources.

Position of cultivated areas.

Among such features may be mentioned the absence or comparative narrowness of barren gravel stretches at the foot of the outer hills, which allows cultivation to be started from the very debouchure of the rivers; also the protection which the Yārkand river or Tārīm with its broad riverine jungle belt affords from the moving sands of the Taklamakān. Hence we find in the case of the larger oases cultivation extending for considerable distances along the beds of the rivers. [2] Since all of these reach the Tārīm and on their lower courses command extensive areas inundated during flood times, grazing grounds adequate for the needs of the oases are also available. On the other hand the map shows a complete absence of cultivated areas of any size along the Tārīm itself after the river has passed the northern edge of the Yārkand district. This striking fact is explained by the great difficulties which the very slight fall in the river's bed and the consequent constant shifts of its course here oppose to the construction and maintenance of irrigation canals of any size.

Kara-shahr basin.

With the northern belt of oases may conveniently be mentioned also the subsidiary basin of Kara-shahr which adjoins the extreme north-eastern corner of the Tārīm basin proper. [3] Though draining into the latter by the Konche-daryā, it shows characteristic geographical features of its own. It is divided from the plains of the Tārīm by the westernmost hill-range of the Kuruk-tāgh which encircles it on the south, and a considerable portion of its area is occupied by the large fresh-water lake of the Baghrash-köl. This gathers the waters brought down by the Kara-shahr river from high plateaus of the Central T'ien-shan and, acting as a big natural reservoir, discharges them with an almost constant volume through the defile above Korla. An abundant water supply and an apparently less arid climate assure to Kara-shahr chances of extensive cultivation, and the historical importance of the territory shows that in antiquity these were adequately utilized. Their present neglect seems to be largely due to the population containing a considerable element of semi-nomadic Mongol herdsmen. The latter's presence alone serves to illustrate the difference in climatic conditions between the Kara-shahr district and the rest of the Tārīm basin. [4]

[1] This distinction is supported also by evidence derived from the historical geography of the Tārīm basin. The detailed descriptions given of it by the early Chinese historical records always separate the territories situated along the 'Northern Road', *i. e.* those at the south foot of the T'ien-shan, from those on the 'Southern Road' which passed through Charkhlik and Khotan. In this as in many other notices of those records relating to Central Asia the keen topographical sense of the Chinese clearly reflects itself.

It is significant that though *So-chü*, *i. e.* Yārkand, is duly indicated as the point through which passed the 'Southern Road' to the Pāmirs and beyond, yet this territory is always described in its proper geographical nexus, along with Kāshgar; see Wylie, 'Notes on the Western Regions', *Journal of the Anthropol. Institute*, x. p. 21, 47 sq.; Chavannes, *T'oung-pao*, 1907, pp. 170, 196 sqq.

[2] See Sheets No. 2. D. 2; 5. A, B. 2; 7. D. 2, 3; 12. A. 3; 17. A. 1. B, C. 1, 2.

[3] See Sheets No. 20. D. 4; 24. A-D. 4; 25. A-C. 1.

[4] Cf. *Serindia*, iii. pp. 1179 sq., regarding the limited cultivation of Kara-shahr and its causes.

Southern belt of oases.

In the southern marginal belt of the basin, stretching along the foot of the K'un-lun from Karghalik to the Lop tract, conditions differ in various ways. Here only one oasis of real importance is found, that of Khotan, and the rest in most cases are separated from each other by considerable expanses of true desert. To the east of Niya, over a marching distance of some 350 miles to Vāsh-shahri, the westernmost hamlet of Lop, there is met now only the single small oasis of Charchan, and our historical records show even this to have been in abeyance again and again during intervals of centuries.[5]

Khotan oasis.

Geographical conditions duly reflected by the map fully account for the thinness, or else the complete absence, of cultivated areas along the whole belt. With the single significant exception of Khotan, all oases in the plains are separated from the debouchure of the rivers which supply their irrigation by great stretches of absolutely sterile gravel forming the glacis of the K'un-lun. But in the case of the Khotan tract the vast volume of water brought down by the Yurung-kāsh and Kara-kāsh rivers has led to the formation of large and extremely fertile beds of alluvial loess almost reaching their debouchure from the mountains. The combined presence of an extensive area of fertile soil and of abundant water, aided by the configuration of the ground particularly favourable to its full use for irrigation, adequately accounts for the presence here of a large, and throughout historical times a very important, oasis.[6]

Irrigation by *kara-su* and *ak-su*.

Elsewhere along the foot of the K'un-lun the big glacis causes much of the water brought down by the rivers to be lost on its way from the foot of the mountains through evaporation or absorption in its huge gravel deposits. Near its northern edge however, some of the water thus absorbed comes to the surface again in the form of springs. The supply of irrigation furnished by them, known as *kara-su*, or 'black water,' is of great importance. Without it cultivation would be greatly restricted in all oases of this region and in many altogether impossible; for it is only during the height of the summer, when the snow and ice on the big mountain ranges melt, that flood water (distinguished as *ak-su*, 'white water') passes across the broad gravel glacis in such volume as to provide ample irrigation, and more, for the oases beyond.[7]

Subterraneous drainage.

The same subterraneous drainage from the rivers debouching on the gravel glacis makes it possible for desert vegetation to subsist in the sandy tracts along the southern edge of the bare dune-covered wastes of the Takla-makān or skirting the oases.[8] It also accounts for the rare wells which permit traffic to be maintained through, or along, these areas of desert vegetation east of the line of existing oases.

Location of southern oases.

Excepting Khotan and Karghalik, all oases of the southern belt are 'terminal oases,' *i.e.*, they occupy the furthermost ground at which the water supply derived from the rivers of the K'un-lun can be utilized for cultivation. Their location is primarily determined by the presence of fertile loess soil, and this itself owes its existence to the moisture brought there, either by the summer floods or by subsoil drainage; for it is only this moisture and the vegetation it supports which can retain the fine alluvium washed down from the mountains as well as the sub-aerial deposits of fine 'sand' constantly brought by the dust-laden desert winds from the north and north-east, and then protect the loess thus formed from the powerful erosive action of the same winds.[9]

When discussing elsewhere this process constantly at work in the region here described,

[5] For the ground from Niya to Vāsh-shahri, see Sheets Nos. 19, 22, 23, 26. Regarding the chequered history of the oasis of Charchan, cf. *Serindia*, i. pp. 295 sqq.

[6] See Sheets No. 9. D. 2; 14. A. 2. For a detailed analysis of the physical aspects of the Khotan oasis, cf. *Ancient Khotan*, i. pp. 124 sqq.

[7] Regarding the general conditions governing irrigation in the region from Karghalik to Niya, cf. my observations in *Ancient Khotan*, i. pp. 94 sqq., 125 sq.; for a particularly instructive local instance as to the importance of the supply of *kara-su*, cf. *Serindia*, i. pp. 202 sqq.

[8] See Sheets No. 9, 14, 19, 23.

[9] Cf. the remarks, *Ancient Khotan*, i. pp. 204 sq., regarding the formation of the loess soil of Khotan, as determined from microscopically analyzed specimens; also i. pp. 588 sq. for Prof. de Lo'czy's analysis.

Remains of abandoned oases

I have also explained the causes which render such 'terminal oases' particularly liable to changes in position and extent during different periods.[10] Evidence of these changes survives in the remains of those numerous ancient settlements abandoned to the desert which my explorations have enabled me to trace. The fact of the most important among them being found far to the north of the present line of 'terminal oases' furnishes definite proof of the progress of desiccation in this region within historical times.[11] Thus the detailed surveys attending those explorations may claim special interest in connection with a much-discussed geographical question.

Section IV.—The Terminal Depression of Lop and the Turfān Basin.

Extent of Lop depression.

The last of the regions comprised within the Tārīm basin is the terminal depression of Lop. The smallest in extent and particularly well defined, it exhibits a variety of interesting geographical features. It may be appropriately described as containing the terminal course of the Tārīm with its fringe of lagoons, the marshes in which its waters are finally lost, and the great salt-encrusted bed of the dried-up Lop sea beyond them, together with the wastes of gravel, drift-sand and wind-eroded clay which surround it. In accordance with the traditional application of the name *Lop*, itself of very ancient origin,[1] we must include in this region also the dune-covered area to the east of the Tārīm's final course, already referred to as an outlier of the Takla-makān, as well as the area, mostly scrubby desert or gravel 'Sai', which extends southwards of the last sections of the Charchan river and the Tārīm to the foot of the mountains.

Population of Lop area.

Here the streams of Vāsh-shahri, Charkhlik and Mīrān have in recent years rendered it possible for a few small settlements to resume cultivation near ancient sites abandoned for centuries.[2] Apart from the people in these tiny oases and the survivors of the scanty nomadic population of Lopliks ('Lop people') fishing and hunting along the terminal Tārīm, the whole region is now wholly uninhabited. The same applies also to the surrounding areas: in the west the Taklamakān; in the north the barren hills of the Kuruk-tāgh; in the east the terminal basin of the Su-lo-ho, and in the south the arid ranges of the Altin-tāgh, an eastern extension of the K'un-lun.

Prehistoric sea bed.

In spite of its desolate character, considerable interest, historical and geographical, attaches to the Lop region. This explains the special efforts devoted to its survey both on my second and third expeditions, notwithstanding the great physical difficulties besetting topographical work in a region which for the most part is devoid of drinkable water. In the great salt-encrusted bed, proved by our surveys to extend for fully 170 miles from south-west to north-east with a maximum width of some 80 miles, we have a visible remnant of that prehistoric salt sea which was fed by the drainage of the Tārīm basin during periods when the climate of Central Asia was moister.

Marshes of *Lop-nōr*.

A variety of observations justify the assumption that this dried-up terminal basin, still showing salt bogs in places, even now periodically receives water at its south-west end, either by inundation or percolation, from the adjoining Kara-koshun marshes of the Tārīm.[3] The fact that these marshes of '*Lop-nōr*'—to use the Mongol designation which from modern Chinese maps and

[10] Cf. *Ancient Khotan*, i. pp. 95 sq., 285 sq., 383 sq., 419 sq.; *Serindia*, i. pp. 202 sqq.

[11] See Sheet No. 14. C. 1, 2 for the sites of Dandān-oilik, Uzun-tati, etc.; Nos. 18. B. 4; 19. B. 1 for the Niya site.

[1] Regarding the history and early application of the local name Lop, cf. *Serindia*, i. pp. 318 sqq. In its present form it is first recorded by Marco Polo, see Yule, *The Book of Ser Marco Polo*, (third edition) i. pp. 194 sqq.

[2] See Sheets Nos. 26. C. 3; 30. A, B. 2.

[3] See Sheet No. 30. C. 1, 2.

texts has become familiar to geographers—contain moderately fresh water, at least in the parts near the entrance of the Tārīm, has given rise to the much-discussed 'Lop-nōr question', complicated perhaps quite as much as elucidated by the controversial literature which since the days of Prejevalsky and Richthofen has accumulated over it in the absence of adequate surveys. [4]

Ancient delta of *Kuruk-daryā*.

Beyond the northern edge of those marshes, with their fringe of dried-up salt lagoons filled at times by exceptional floods of the Tārīm, there extends an area of bare clay overrun by light sand and undergoing excessive wind-erosion. It is crossed by a series of well-marked dry river-beds, and of these our surveys have proved that they represent the southern portion of an ancient delta formed by the dried-up 'Kuruk-daryā', which during the first centuries before and after Christ carried the waters of the Konche-daryā (together, perhaps, with some addition from northern tributaries of the Tārīm, like the Inchike-daryā) to the then-occupied territory of Lou-lan. [5]

Wind-eroded desert of *Lou-lan*.

The erosive action of wind-driven sand has covered the dried-up delta and the whole area of that ancient territory as far as the foot of the Kuruk-tāgh with an endless succession of '*yārdangs*', steep ridges carved out of the alluvial clay and separated by parallel trenches. All lie in the direction of the prevailing north-east winds which 'aspiration' draws down from the plateaus of the Kuruk-tāgh and southern Mongolia into the Lop depression during great portions of the year. [6] Abundant archæological evidence, brought to light at various ancient sites of Lou-lan, makes it certain that the waters carried by the Kuruk-daryā reached this once habitable territory and the delta to the south and east until the first half of the fourth century A.D. At that time the early Chinese route leading from Tun-huang through the Lou-lan area and thence along the Kuruk-daryā to the northern belt of oases in the Tārīm basin was finally abandoned, and the territory itself became an arid and lifeless wilderness. [7]

Ancient route across dried-up sea bed.

Eastwards the ancient delta ends on the shores of the prehistoric sea bed. The ancient Chinese trade and military route which had crossed this, as we know from descriptions in Chinese historical records, was traced by me to where the difficult salt-encrusted expanse is narrowest. [8] Brief reference must suffice here to the curious topographical features which the ground near these shores presents in the shape of high 'Mesas' of earlier lacustrine formation and of strings of salt-coated 'Yārdangs'. The ancient Chinese accounts, ever exact in topographical details, duly refer to them. [9]

Bay joining Su-lo-ho basin.

The opposite shore of the sea-bed lies along the foot of the Kuruk-tāgh. Further south we find a long bay extending to the north-east. It occupies a broad valley-like depression which lies between the southernmost hill range of the Kuruk-tāgh and a line of high sand-ridges lining the foot

[4] There is definite historical evidence in early Chinese texts that the Kara-koshun marshes and the termination of the Tārīm already occupied in the early centuries after Christ approximately the same position as at present, and that at the same time while the Kuruk-daryā still carried its waters past the Lou-lan area into the northwestern portion of the great Lop basin; see *Serindia*, i. pp. 326 sqq. 419 sqq.

This evidence, fully in accord with the results of our surveys, is important, as it disposes of a recent theory on the 'Lop-nōr question' which assumes that the Tārīm took its present course to the south, with its termination in the Kara-koshun marshes, only in comparatively recent times after abandoning an older course represented by the Kuruk-daryā. A detailed analysis of that evidence with special references to the surveys of my third journey must be reserved for the final report on the latter.

[5] See Sheet No. 29. C, D. 3, 4, where the position and bearing of dry river-beds are indicated by the rows of dead tree (wild poplar) trunks which invariably mark their banks; the direction of these rows has been shown in the map as recorded on the plane-table. Cf. also *Serindia*, i. pp. 355 sqq.

[6] The extent of wind-eroded ground has been marked in Sheet No. 29 and elsewhere by the use of the special 'Yārdang' symbol. Regarding the exact direction of 'Yārdangs' in this area, their formation, etc., cf. *Serindia*, i. pp. 353 sqq., 360, 369, etc.; also Figs. 92, 93, 105, 106.

[7] Cf. *Serindia*, i. pp. 426 sq., for the data concerning this abandonment; for the position of ancient sites, see Sheet No. 29. C. 4, D. 3, 4; 32. A. 3.

[8] See Sheet No. 32. A-C. 3. The actual ancient crossing of the dried-up sea-bed lay probably near a line between C. ccxxxviii. a and the find-spot of Han coins as marked on the map.

[9] Cf. *Serindia*, i. pp. 340 sqq., 423 sq., regarding the location of the 'White Dragon Mounds' (salt-coated Yārdangs) and the Mesas of the 'Dragon Town'.

of the Āltin-tāgh glacis.[10] It is apparently in this bay that the depression reaches its deepest point, and here it may be supposed in earlier geological times to have received also the drainage from the terminal basin of the Su-lo-ho which adjoins eastward. Down the southern side of this valley and beyond along the clearly marked southern shore-line of the ancient sea, leads the difficult desert track from Tun-huang to Lop, graphically described by Marco Polo and still used by rare caravans during the few winter months when it is practicable.[11]

Turfān depression.

Before leaving the Tārīm basin for regions further east a brief account may conveniently be given here of the small but geographically very interesting basin of Turfān north of the Lop depression, to which a good deal of our survey work was devoted in 1914-15. Quite detached from the Tārīm basin it shares so many of its physical characteristics that it appears like a small scale reproduction of it. As Sheet No. 28 shows, it is enclosed in the north by a rugged snowy portion of the T'ien-shan, rising to peaks over 14,000 feet in height, by an outlying range of the same in the west, and by utterly barren hills and plateaus of the Kuruk-tāgh in the south and east. Within these limits it contains a succession of well-defined zones exactly corresponding to the gravel glacis, the belts of cultivation and desert vegetation, and the dune-covered areas of the Tārīm basin.

Character and depth of Turfān depression.

The terminal sea-bed of the latter has also its pendant in the narrow salt lake, for the most part dry,[12] stretching along the south-eastern edge of the basin. Into its lowest portion at the time of the summer floods gathers whatever drainage from the mountains escapes evaporation. To the east of it we have a miniature edition as it were of the Taklamakān in the plateau-like area covered by high ridges of dunes known as *Kum-tāgh*, the 'Sand Hills'.[13] Its position seems to be determined by the direction of the prevailing winds which as a result of 'aspiration' sweep down from the cooler region in the north-west when the great heat of the spring and summer causes the air to rise from the lower parts of the basin. A very remarkable feature of the Turfān basin is the depth of its terminal depression. Along the lake-bed above mentioned it descends to a level which according to our mercurial barometer observations lies in places close on 1,000 feet below the sea, while most of the principal oases lie also about or below sea-level.[14]

Irrigation in Turfān oases.

To the very high summer temperatures resulting from this low position may be attributed, at least partly, the peculiar conditions affecting the water supply of the basin and in consequence the cultivation in its oases.[15] The streams which carry down the melting snows of the T'ien-shan in the spring and summer lose most of their water on the descent over the bare glacis of gravel. A portion of the water absorbed in the ground, it is true, comes to light again, like the *kara-su* of the Khotan region, in marshy springs at the northern foot of the low and utterly arid hill range stretching across the middle of the basin from east to west and dividing its cultivable area into two unequal belts.[16]

Kārēz irrigation.

But this water supply, too, would permit of irrigation only over very limited ground were it not at the present time supplemented on a big scale by means of sub-terraneous channels or '*Kārēzes*' which catch the subsoil water beneath the gravel slopes and carry it, protected from evaporation, over considerable distances to ground otherwise hopelessly sterile but under irrigation extremely fertile. The use of Kārēzes is unknown elsewhere throughout Chinese Turkistān, and in the Turfān district, too, it can apparently not be traced further back than the 18th century. Yet

[10] See Sheets Nos. 32. C, D. 4; 35. A. 4.

[11] See *Serindia*, ii. pp. 549 sq., 560 sqq.

[12] See Sheet No. 28. C, D. 3.

[13] See Sheets Nos. 28. D. 3; 31. A. 3.

[14] See Sheet No. 28. C, D. 3.

[15] These and other physiographical aspects of the Turfān oases have been lucidly discussed in Professor E. Huntington's *Pulse of Asia*, pp. 306 sqq. The physical features of the Turfān basin as a whole will be fully treated in the paper which I hope to prepare for publication along with a detailed map based on the one-inch survey of the central area of the territory.

[16] See Sheet No. 28. C. 2, 3, D. 3, for springs near Murtuk, Singim, Su-bāshi, Lamjin; Sheet 31. A. 3 for those in the bed above Pichan.

the importance of the territory already in ancient times is amply attested by archæological remains and historical records alike. If we compare this fact with the great extent of that portion of the cultivated area which now, as the map shows, depends solely on Kārēz irrigation, the progress made by desiccation in this region receives striking illustration.

Section V.—THE SU-LO-HO BASIN

Extent of Su-lo-ho basin.

East of the Lop depression our surveys extended to a series of drainageless regions which, if not comparable in size to the Tārīm basin, yet resemble it closely in various physical features of importance and are linked up with it also in historical interest. Proceeding from the extreme eastern end of the Lop depression across a dry lake-bed once apparently draining into it, [1] we enter directly the lowest portion of the basin of the Su-lo-ho, containing this river's delta and terminal marshes. [2] This basin, as shown on Sheets Nos. 35, 38, 40, extends for some 220 miles from east to west with an average width of 30-40 miles between the foot hills of the ranges which bound it. These are the western Nan-shan in the south and the utterly barren Pei-shan northward.

Course of Su-lo-ho.

The Su-lo-ho, a considerable river, fed by glaciers and eternal snows of the Central Nan-shan, descends into the basin at its eastern end. After breaking through a succession of ranges in gorges, of which those to the south are as yet unexplored, [3] it skirts a low divide separating its basin from one much smaller adjoining eastwards. Below the oasis of Yü-mên-hsien the Su-lo-ho turns sharply westwards. Maintaining this course it passes through the Khara-nōr lake, supposed to be its terminal basin until our surveys proved this to be situated some 80 miles further west in the salt marshes already referred to. [4] On its whole course through the basin the Su-lo-ho receives only one affluent, the Tang-ho or Tun-huang river, rising on high plateaus towards Tsaidam. This provides ample irrigation for the large oasis of Tun-huang, or Sha-chou, which occupies its alluvial fan.

Importance of Tun huang oasis.

Tun-huang is the only settlement of considerable size in the whole region, and its local resources were of special value in ancient times when the great natural passage of the Su-lo-ho basin served as the earliest high road of Chinese expansion into Central Asia. [5] It was for the protection of this important trade-route leading through Lou-lan to the oases of the Tārīm basin that the far-flung westernmost portion of the ancient Chinese border line was constructed towards the second century B. C. [6] The extreme aridity of the desert ground, over which it led past the Su-lo-ho and its riverine marshes, explains the abundance and remarkable preservation of the ancient records, etc., brought to light by my explorations along this ruined *Limes*.

Desert features of basin.

Excepting the narrow belt of desert vegetation which accompanies the river's lower course and the limited ground capable of irrigation beside the oasis of Tun-huang, the Su-lo-ho basin consists mainly of slopes of absolutely bare gravel, corresponding to the 'Sai' of the K'un-lun. Immediately south of Tun-huang, however, and again beyond the small oasis of Nan-hu in the south-west, huge accumulations of drift-sand approach or overlie the foot-hills of the Nan-shan. [7] These have been heaped up by the violent east and north-east winds which for a great part of the year blow down into the basin from the plateaus of the Pei-shan,—another case of 'aspiration'.

[1] See above p. 31.

[2] See Sheet No. 35. B, C. 4.

[3] See Sheet No. 41. B. 1, C. 1-3.

[4] See Sheets No. 35. B-D. 4; 38. A. 4.

[5] Cf. *Serindia*, ii. pp. 578 sqq. on the 'Geographical features of the lower Su-lo-ho basin'.

[6] The main facts concerning this extension of the ancient Chinese Limes along the Su-lo-ho basin, as elucidated by my explorations of 1907, are summarized in Chapter XX of *Serindia*, ii. pp. 727 sqq.

[7] See Sheets No. 36. C, D. 1; 38. B. 4; 39. A, B. 1; see also No. 35. B. 4 for the big sand ridges skirting the terminal bed of the Su-lo-ho.

The effect of their powerful erosive action can be traced all along the Su-lo-ho basin almost as clearly as in the Lop depression. [8]

Headwaters of Su-lo-ho.

Of the big mountain area drained by the Su-lo-ho, only the great alpine valley where its headwaters gather far away to the south-east, and the ranges and valleys south of An-hsi and Yü-mên-hsien came within the range of our surveys. The former lying close to the Hoang-ho watershed and the plateaus of the Koko-nōr region shares the physical character of the Central Nan-shan, as described further on. The latter consist of a succession of parallel ranges, the southernmost rising into peaks of 19,000-20,000 feet. [9] The broad valleys dividing them are very arid, and the small patches of cultivation existing there owe their irrigation almost solely to springs bringing subsoil water to the surface at the foot of the huge slopes of piedmont gravel. [10]

Hua-hai-tzu basin.

Immediately to the east of the Su-lo-ho basin lies a much smaller drainageless area which from its terminal depression may be called that of Hua-hai-tzu. [11] As this by a curious bifurcation, mentioned already above, receives also a small stream from the Su-lo-ho, it may conveniently find mention here along with its big western neighbour. Sheets Nos. 40, 41 show the scanty streams descending northward from that portion of the Nan-shan which divides the valleys of the Su-lo-ho and Pei-ta-ho or Su-chou river; these have cut their way through a rugged hill-range, apparently a continuation of the Ala-shan, and lose themselves in the depression stretching north of the small oasis of Hua-hai-tzu or Ying-p'an to the foot of the Pei-shan. The aridity of that hill-range as well as of the portion of the Nan-shan due south is so marked that irrigation in this area, too, is possible only from subsoil drainage. To the north-east dune-covered or utterly waterless bare ground adjoins for a considerable distance; but even the great physical obstacle thus created did not prevent the ancient Chinese *Limes* being carried through it to the vicinity of the Pei-ta-ho. [12]

Section VI.—FROM THE CENTRAL NAN-SHAN TO THE ETSIN-GOL BASIN

Area drained by Etsin-gol.

If we follow the high road south-eastwards from Yü-mên-hsien across the open plateaus above the Hua-hai-tzu basin it takes us through the famous Chia-yü-kuan 'Gate' of the mediæval 'Great Wall' of China into the easternmost of the drainageless areas comprised within our surveys. It extends from the headwaters of the Kan-chou river in the south-east (Sheet No. 46) to the marshy lake-beds where terminates the Etsin-gol carrying the united waters of the rivers of Kan-chou and Su-chou (Sheet No. 44). This great area divides itself into three well-defined regions, all clearly marked by features which indicate transition to adjoining zones of very different climatic conditions.

Ranges of Central Nan-shan.

In the south we have the Central Nan-shan rising in three big ranges to snowy peaks over 18,000 feet in height (Sheets Nos. 43, 46). In the wide valleys which divide them gather the headwaters of the rivers of Su-chou and Kan-chou and of their principal tributaries. Other rivers which descend in deep-cut valleys from the outer slopes of the Richthofen Range, the northernmost of those ranges, also find their way into those two, after traversing the second, or submontane, region to be presently mentioned.

All through the Central Nan-shan we find striking evidence of a climate far moister

[8] For 'Yārdang' and 'Mesa' formations, see Sheets Nos. 35. C. 3, 4; 38. A, B. 4, D. 3, 4; 40. A. 5, B. 5; cf. also *Serindia*, ii. pp. 575 sq., 589, 642 sqq.; iii. pp. 1095 sqq., 1100 sqq.

[9] See sheet No. 41. A, B. 1, 2; also Sheets Nos. 38, 39, 40.

[10] See Tung-pa-t'u, Sheet No. 38. D. 4; Ch'iao-tzu No. 40. A. 5; Ch'ang-ma No. 41. B. 1.

[11] See for this depression Sheets Nos. 40. D. 5; 42. A. 4.

[12] See Sheet No. 42.

Climate of Central Nan-shan.

than that of the Western Nan-shan or of the K'un-lun. It indicates the vicinity of the Pacific drainage area which extends to the adjoining parts of Kan-su and of the north-eastern uplands of Tibet. Abundant vegetation clothes the valleys from the westernmost limits of the Pei-ta-ho or Su-chou river's drainage [1] and makes the big open troughs at the headwaters excellent summer grazing grounds, notwithstanding their great elevation, above 11,000 feet, and Pāmīr-like appearance. Further to the south-east increasing snow and rainfall permits of plentiful forest growth in the valleys of the Richthofen Range draining into the Kan-chou river. [2]

Cultivated area N. of Nan-shan.

Along the northern foot of this range at an elevation of about 5,000—6,000 feet, stretches a broad belt of fertile alluvial fans, separated in places by scrub-covered table-lands. [3] Its northern limit is formed by the barren hill-chain overlooking the middle course of the rivers of Kan-chou and Su-chou, and belonging to the Ala-shan system of southernmost Mongolia. Over great parts of this second region, cultivation is assured by abundant irrigation from the rivers and also by the fact that from about the longitude of Kan-chou city eastwards, climatic conditions along the fertile foot of the Nan-shan permit of cultivation dependent on snow and rainfall only. Hence we find in this region not only large and populous oases occupying the alluvial fans of the Su-chou and Kan-chou rivers, but also an almost continuous chain of smaller village tracts skirting the foot of the mountains beyond those fans.

Passage through N.W. marches of Kan-su.

The physical features here briefly indicated have made this region historically a very important 'land of passage' between China and Central Asia. For the Chinese its possession was indispensable in economic and military respects ever since their policy of Central-Asian expansion more than two thousand years ago first opened the route through the north-western marches of Kan-su and along the Su-lo-ho into the Tārīm basin. But before their advent and during the periods when their control of the route ceased, the abundant winter grazing which parts of this region afford, made it also for centuries a goal of conquest for a succession of nomadic nations. [4]

Cultivated areas on Etsin-gol.

A region of very different character stretches from the barren hill-range north of the chain of oases down to the terminal basin of the Etsin-gol. We find there, indeed, two narrow strips of cultivation, those of Chin-t'a and Mao-mei, lying beyond the gorges in which the rivers of Su-chou and Kan-chou, respectively, have cut their way through that range. [5] But apart from them the whole of this region consists of desert ground, affording now but limited grazing in the delta which the Etsin-gol forms from a point about 60 miles below the lower end of Mao-mei cultivation. [6] Amidst the almost waterless valleys and plateaus which adjoin the Etsin-gol on the east and west, even camel grazing is scanty and confined to rare patches of ground.

Etsin-gol valley as highway.

Nevertheless, the Etsin-gol valley has always possessed considerable importance as a highway for nomadic migration and trade from Mongolia into north-western China. It resembles in this respect the territory of ancient Lou-lan, now completely abandoned to the desert, and this affinity is curiously illustrated also by the evidence of desiccation within historical times which the Etsin-gol delta and its mediæval remains afford. [7] The fact that the river loses itself in two separate lake-beds (Sheet No. 44. C. 4) is also of interest with regard to the observations made above concerning the simultaneous existence in earlier periods of two terminal basins of the Su-lo-ho, and concerning that of the Lou-lan delta by the side of the Kara-koshun. [8]

[1] Near the T'u-ta-fan, Sheet No. 41. D. 1.

[2] See Sheets Nos. 43. D. 3, 4; 46. A. 3, 4, B. 4, C, D. 4, 5.

[3] See Sheets Nos. 43 A-D, 1,2; 46. A. 2, B. 2. 3, C. 3,4.

[4] Cf. *Serindia*. ii. pp. 1130 sq. Such grazing is to be found in plenty along the lower courses of all rivers that drain the northern slopes of, or pass through, the Richthofen range. It is not altogether absent even in the tracts of drift-sand to be met with between them; see Sheet No. 43. C, D. 1, 2.

[5] See Sheet No. 42. B-D. 4.

[6] See Sheet No. 45. B. 2.

[7] Cf. *Third Journey, Geogr. Journal*, xlviii. pp. 197 sq. For the site of Khara-khoto, Marco Polo's 'City of Etzina', see Sheet No. 45. C, D. 1.

[8] Cf. above pp. 31 sq., 47.

Section VII.—THE PEI-SHAN AND THE EASTERNMOST T'IEN-SHAN

There still remain within the limits of our maps two distinct regions to be noticed. Both are of very great extent, and in both the ground actually surveyed along a couple of route lines is necessarily limited. Nevertheless such is the uniformity of physical features prevailing within each that the topography of even a restricted area may prove very instructive.

Desert area of Pei-shan.

The first of these regions is the great desert area entirely occupied by the barren ranges and plateaus of the Pei-shan (the 'Northern Mountains'). It may be described as extending westwards from the Etsin-gol course to about longitude 93° where it probably joins with, or merges in, the Kuruk-tāgh. In the north it is bounded by the slopes of the easternmost T'ien-shan and its offshoots and in the south by the Hua-hai-tzu and Su-lo-ho basins.

Routes through Pei-shan.

Our surveys through it lay along two lines, one the well-known caravan track connecting An-hsi with Hāmi, and the other a route, previously unexplored, which took us from Mao-mei to east of the Karlik-tāgh. The record of these surveys in Sheets Nos. 37, 38, 40, 42 and that of other tracks followed by Russian and German travellers between Hāmi and Su-chou show [1] that this huge area is traversed by a series of much-decayed hill ranges, the axis of all trending roughly in the direction from E.N.E. to W.S.W. Between them spread broad detritus-covered plateaus where ill-defined depressions, alternating with the outcrops of almost completely smothered rocky ridges, mark the former existence of side spurs with their corresponding valleys.

Trough between T'ien-shan and Pei-shan.

The scanty drainage observed along our eastern route in dry beds and shallow troughs, up to about latitude 42°, seemed to tend towards the Etsin-gol, while along the An-hsi–Hāmi track the direction appeared to lie to the west or south-west. North of latitude 42° both routes descend into a deep and well-marked trough which seems to separate the Pei-shan formation from the gravel glacis of the easternmost T'ien-shan. Whatever drainage this big depression carries on the rare occasions of floods must find its way into some, as yet unexplored, basin in the desert further west. [2]

Morphology of Pei-shan.

The general bearing and character of the Pei-shan ranges, nowhere apparently much exceeding 8,000 feet in height, seems to point to a close morphological connection with the Kuruk-tāgh system. But this can only be decided by expert geological examination. Scanty wells or springs found at intervals in the depressions render the crossing of this stony 'Gobi' practicable for small parties at one time, and near them a very limited amount of grazing on scrub or reeds is ordinarily to be found. But neither nomadic occupation nor large migrations were ever possible here during the historical period.

Easternmost T'ien-shan range.

To the north of the Pei-shan extends the easternmost T'ien-shan, the second of the regions referred to at the head of this section. As far as our surveys are concerned, it may be said to extend from above the Turfān basin to about longitude 95° 30′, if not further. It maintains throughout the general direction from west to east and ultimately dies away in the 'Gobi' of the southern Altai. Our survey of it was confined practically to the main range and to some portions of the neighbouring ground in the south. Along the whole length, considerably more than 300 miles, three sections of the main range rise to heights about 13,000 feet and carry perpetual snow.

[1] See for these the map attached to Professor Futterer's careful paper, *Geographische Skizze der Wüste Gobi*, Petermann's Mittheilungen, Ergänzungsheft No. 139.

[2] The An-hsi–Hāmi route crosses the trough near the well of Yen-tun, Sheet No. 37. A. 4, at an elevation of about 1,730 feet; our eastern route near the spring of Chin-êrh-ch'üan, Sheet No. 37. D. 4, at about 4,020 feet above sea-level.

The assumed basin may account for the lake 'Toli' which is shown by Russian maps on a supposed route from Hāmi to Tun-huang, apparently obtained from native information; this lake has never been located.

Karlik-tāgh and Hāmi oasis.

It is only at the foot of these sections that cultivation to any appreciable extent is found. The easternmost of them is the Karlik-tāgh ('The Snowy Mountains'), and the irrigation derived from its snows accounts for the thin string of oases along its southern slopes. [3] Those in the east about Tāsh-bulak and Khotun-tam are small. But Hāmi or Kumul (Sheet No. 34. C,D. 3) is larger and claims importance as its agricultural resources make it the northern bridge-head, as it were, of the road from An-hsi which, ever since the ancient route into the Tārīm basin *via* Lou-lan had to be abandoned, has served as the main artery of trade and traffic between China and Central Asia. [4] Here, as everywhere along the southern slopes of the Eastern T'ien-shan, irrigation is chiefly supplied by the subsoil drainage from the range gathering in springs at the foot of the absolutely barren gravel glacis.

Terminal basin of Shona-nōr.

Surplus water, which does not percolate into the soil, or which at the time of spring and summer floods escapes evaporation on the surface, makes its way down into a terminal basin, known as Shona-nōr, usually quite dry. The Mesa formations which surround this and some adjoining smaller basins occasionally reached by floods from the range further west, [5] distinctly recall a characteristic feature of the ground near the ancient terminal basins of the Su-lo-ho and the dried-up Lop sea.

S. slopes of T'ien-shan.

Continuing further along the southern slopes of the T'ien-shan we come to the oases of Lapchuk—Kara-döbe where cultivation of some extent is maintained by subsoil drainage from the snowy part of the range above Barkul. Beyond them the only route westwards practicable for caravans at the present time hugs closely the foot of the mountains. But nowhere is cultivation possible after leaving the slopes of the Barkul portion of the range until, after travelling some 150 miles, the vicinity of the Turfān basin is reached at Chik-tam. The separate small region represented by that basin has already received notice above.

Climate of Dzungaria.

Turning now to the opposite slopes of the Eastern T'ien-shan we recognize there conditions which clearly reflect the influence of a different climate. It is that of the wide plateaus of Dzungaria stretching northward as far as the Altai mountains and southernmost Siberia. The abundant grazing grounds, which moisture drawn from the north provides in Dzungaria, have at all times attracted there waves of nomadic nations, from the Huns to the Mongols. This moister climate affects the whole length of the northern slopes of the main T'ien-shan in spite of intervening ranges and of the drift-sand areas met with further west. In the extreme east of the range, around Bai, [6] we find indeed a glacis of gravel as bare as that on the slopes to the south. But proceeding further west we come to plentiful grazing along the north of the Karlik-tāgh, and from the far side of the Tor-köl lake conifer forest clothes the higher slopes as far as Barkul and beyond. [7]

T'ien-shan slopes W. of Barkul.

The perpetual snowbeds on this portion of the range provide ample irrigation for the wide grassy valley which stretches down to the town of Barkul and its lake, [8] and only scarcity of population, mainly due to political vicissitudes, stands in the way of far more extensive cultivation. West of Barkul the crest of the range sinks below the level of perpetual snow, and the amount of water descending its slopes is correspondingly much reduced. Yet springs and small patches of cultivation are to be found all along them, until near Mu-li-ho the route takes us to the foot of that high snowy portion of the range which divides the Turfān basin from the fertile tracts about Guchen. [9]

Cultivation near Guchen.

Cultivation in the vicinity of this large town and in that of the ruined site of Pei-t'ing, the ancient capital of the territory, is not restricted to the amply watered alluvial fans, but is also carried on without irrigation over extensive grounds immediately adjacent to the belt of forest on the

[3] See Sheets Nos. 34 A 2. 3; 37. A, 2, 3.
[4] Cf. *Serindia*, iii. pp. 1147 sqq.
[5] See Sheets Nos. 31, D. 3; 34. A. 3.
[6] See Sheet No. 37. B, C. 2.
[7] See Sheet No. 34. A, B. 1, C, D. 2.
[8] See Sheet No. 34. B. C. 1.
[9] See Sheets No. 31. A. 1; 28. C, D. 1.

northern slopes of the mountains. The physical conditions here observed present a very striking contrast to those found in the Turfān basin just across the range.

Connection with Turfān basin.

This sudden change is particularly impressive owing to the close connection which, facilitated by several direct passes practicable during the greater part of the year, has been maintained with the flourishing oases of that basin throughout historical times. [10] We have seen that the Turfān district reproduces on a small scale all the typical features of the Tārīm basin. Hence the inclusion in the same map sheet, No. 28, which represents its topography, of this edge of Dzungaria, a specimen, as it were, of another vast division of Central Asia, cannot fail to be geographically instructive.

[10] The closeness of the relations, political as well as economic, which have always linked Turfān with the territory in the north, known to the Chinese administration of T'ang times (7th-8th century A.D.) as the Protectorate of *Pei-t'ing* and under the Mongols as *Bish-balik*, the 'Five Towns', is illustrated by the significant fact that the earliest historical records, contained in the Annals of the Han dynasty and dating from the first centuries before and after Christ, distinguish them only as 'Anterior' and 'Posterior *K'u-shih*'; cf. Chavannes, in *T'oung-pao*, 1907, pp. 210 sq.

CHAPTER III

THE MAPS

SECTION I.—COMPILATION OF MAPS

The preparation of the present maps was commenced in 1916, after a brief visit paid by me to the Trigonometrical Survey Office, Dehra Dūn, on my return from the third expedition in March of that year, had allowed the main lines of the work to be settled with the approval of the Surveyor General. My deputation to England immediately thereafter for work on the archæological results of my journeys prevented me from being consulted with regard to details, while the work of compilation was being pushed on in 1916-17 with commendable rapidity under the direction of Colonels G. A. Beazeley, H. H. Turner and R. A. Wauhope, R.E., successively in charge of No. 2 Drawing Office. Notwithstanding the serious difficulties arising from war conditions it had by the close of 1916, progressed sufficiently far to permit the fair drawing of certain sheets to be begun. My return to India in the autumn of 1917 fortunately rendered it possible for me to revise each sheet in the original drawing and subsequently to pass it in proofs through the successive stages of reproduction.

Drawing of maps.

The magnitude of the work involved is indicated by the fact that the section of No. 2 Drawing Office engaged on these maps during the years 1917-19 comprised on the average fifteen draftsmen under the supervision of one officer of the Provincial Service and of two of the Upper Subordinate Service. The assistance of R.B. Lāl Singh was assured from the start until his retirement in August, 1919, and his personal knowledge of much of the ground proved of great value. Similarly very helpful was the continued supervision of the drawing work by M. Karīm Bakhsh, Head Draftsman, who since 1901 had taken a share in the cartographical work resulting from our surveys. The drawing and reproduction work was not completed until 1922, having been carried on since the spring of 1919 under the direction of Major F. J. M. King, R.E., in joint charge of No. 2 Drawing and Photo-Zinco Offices, Dehra Dūn, to whose constant care the technical execution of the maps owes much.

Triangulation results.

The main basis for the compilation of the maps was provided by the series of triangulations and of astronomically observed latitudes brought back from the three journeys and worked up by the Computing Office, Dehra Dūn. In Appendix *A*, Major K. MASON, M.C., R.E., has been kind enough to record a summary of needful information concerning the character and extent of the several triangulation series and the methods of computation employed, together with a list of latitudes, longitudes, and heights for all triangulation stations and points. There, too, an explanation has been furnished of the circumstances which at the time of compilation caused some stations and points derived from R. B. Lāl Singh's triangulation on the third journey to be inserted in the maps with values different from those which were finally adopted in 1921 after careful re-consideration of the computation work. The whole of the triangulation of the three journeys has been shown in a series of charts accompanying Major Mason's Appendix.

Extraneous materials used.

A complete list of astronomically determined latitudes will be found in the *Notes* of Chapter IV dealing separately with each sheet. There, too, I have furnished a summary of the information which the Drawing Office has recorded as to the methods and materials used in the compilation of each sheet. Special mention has been made there of all instances where it had been considered advisable in the compilation to utilize latitudes and longitudes of particular places derived from the observations of other travellers or in some cases taken from previously published maps. Among such extraneous materials the following deserve special mention; the series of chronometrically determined longitudes which Mr. C. Clementi obtained on his

journey in 1907-08 along the Chinese high road from Kāshgar to Kan-chou;[1] the latitudes observed by Dr. Sven Hedin along the Tārīm river and in the Lop depression;[2] Captain H. H. P. Deasy's extensive triangulation work on the Chinese Pāmīrs and in the K'un-lun range east of Khotan;[3] the triangulation done on the Kara-koram range in connection with Sir F. De Filippi's expedition.[4]

Co-ordination of successive surveys.

Apart from the use of certain latitude and longitude determinations just referred to, the topography of the maps now published is based solely on the results of our surveys. Special care has been taken throughout correctly to coordinate these results where the same or closely adjoining areas were surveyed on successive journeys. In order to assure greater accuracy in details reference was also made throughout to the original plane-table sheets in the case of ground already represented in the maps illustrating the first two expeditions. This has proved of particular advantage for the delineation of mountainous ground surveyed on the second journey, since the hachuring on the previous maps did but inadequate justice to the horizontal 'form lines' shown on the original plane-tables.

Use of descriptive records.

Where the same route was followed on more than one journey preference was given to the representation of the ground by the later survey, if done under my direct supervision or on a larger scale. When revising the 'fair drawings' of the map sheets I endeavoured to check, and, if necessary, to supplement topographical details by reference to the descriptive records I had kept of all routes personally followed. This task was greatly facilitated wherever the preceding preparation of my Detailed Reports had obliged me to make a thorough study of these diary records. Reference to them proved particularly useful in respect of minor features which the original plane-tables of the first and second journeys did not sufficiently differentiate, *e.g.*, as regards the various types of desert vegetation (tamarisk-cones, reed beds, etc., living or dead), and the permanence of water in stream beds, etc.[5]

Altitude records.

Apart from those determined by triangulation, height records were obtained on all three journeys by aneroid barometer and hypsometer observations. On the second and third journeys the aneroid barometers were controlled by simultaneous readings of a mountain mercurial barometer whenever time and conditions permitted. Height records obtained by mercurial barometer were given preference for entry in the maps and intermediate aneroid readings adjusted to those of the mercurial barometer readings. The methods used for the computation of barometric heights have been indicated in Appendix *B*, supplied by the kindness of Dr. J. de Graaff Hunter, in charge of the Computing Office. Comparison with the mercurial barometer records proved that the aneroids preserved a very uniform rate of accuracy throughout the third journey. As their readings were also found to agree more closely with the heights deduced from vertical observations with the theodolite in the course of triangulation they were adopted in preference to the hypsometrical heights. The latter were, however, used where no barometrical records were available.

Hill-shading by contours.

On the second and third journeys extensive use was made of the clinometer to fix the approximate elevation of points intersected from positions of which the heights were barometrically determined. The help derived from these additional data as well as from the 'form lines' of the plane-tables and from photographic records, such as the numerous photo-theodolite panoramas I secured on the first journey, led to the hill-shading of the new maps being given the form of regular contouring, with approximate contour intervals of 250 feet. Where trigonometrically determined heights were available, these have been used as the basis for levels, barometric and clinometric heights serving the same purpose elsewhere.

[1] See *Summary of Geographical Observations taken during a journey from Kashgar to Kowlun*, 1907-09, by Cecil Clementi, M. A., Assistant Colonial Secretary, Hongkong, 1911; also *Geographical Journal*, 1912, pp. 624 sqq.

[2] See Hedin, *Central Asia*, Vol. V., Part Ia.

[3] See 'Map of portions of Western China and Tibet explored by Capt. H. H. P. Deasy in 1897-99'. (Dehra Dun, 1906), Sheets Nos. 1, 4, 5.

[4] See the map of *Regions between Leh and Kargalik mapped by Cav. F. De Filippi's expedition in 1913-14*, Survey of India, Dehra Dūn, 1916.

[5] Cf. below pp. 67, 69.

It need scarcely be emphasized that in view of the disproportion between the great extent of the areas represented and the comparatively small number of observed elevations, this contouring can only be roughly approximate. In areas practically flat to the eye, such as the Taklamakān desert and the Lop depression, where the available data are altogether inadequate, no contouring has been attempted. Where mountainous ground could be surveyed only from a considerable distance and its features only roughly sketched, contours have been shown in broken lines.

Section II.—Representation of Physical Details

Level of perpetual snow.

The use of approximate contours has apart from other advantages facilitated the rough distinction of those portions of high mountain ranges which bear perpetual snow. They have been shown by contours in a greenish-grey tint instead of brown used elsewhere. In the selection of the contour above which the slopes of mountains have been treated as 'snowy', I was guided solely by the observations recorded at the time on the plane-table and in descriptive notes or photographs. Help from the last two sources was not available in the case of areas which I had not personally visited. Considering that observations were ordinarily possible only at one time of the year, not necessarily the most suitable for the purpose, and that in many cases they were made only on one side of a particular range, the estimated level of the snow-line can represent only a rude approximation. This level varies greatly in the different ranges, sometimes even within the limits of a single map sheet. In the *Notes* of Chapter IV, the varying levels adopted for the snow-line have been indicated for facility of reference.

Permanent snow-beds and glaciers.

In this connection I may refer also to the difficulty of distinguishing permanent snow-beds from glaciers where ranges were surveyed only from a distance or without personal supervision on my part. Cases of the latter kind, where I have reason to doubt whether the glaciers shown by the surveyors on their plane-tables were more than snow-beds, have been specially indicated in the *Notes* of Chapter IV. The indication of glaciers by form-lines in blue contours conforms to that in modern topographical maps of the Survey of India.

Permanent water-forms shown in blue.

In accordance with the practice introduced by the Survey of India in its topographical maps since 1908, permanent water-forms, *i. e.* those portions of rivers, streams and lakes which generally contain water, together with their lettering, have been shown in blue. This distinction had not been observed in the surveys of the first and second journeys preceding that change. For making this distinction in the new maps in respect of areas surveyed before 1913 it was necessary to fall back upon my personal records and knowledge of the ground or the recollection of R. B. Lāl Singh. The task was, however, rendered easier by the uniformity of physical conditions prevailing within each of the main regions and by the fact that considerable portions of previously surveyed ground were passed through again on the third journey, though on different routes.

Distinction of river beds.

In the case of large beds containing rivers or carrying at times considerable floods I have thought it useful to introduce some minor distinctions. Those portions of a river in which the bed is completely filled for the greater part of the year, have been shown with blue stipple over the whole space between the banks. In the case of portions where the water channel, sometimes very narrow, ordinarily occupies only a part of the bed, the blue stipple has been confined to a strip of varying width. Finally those river-beds which, except at times of great floods, do not contain a continuous water channel, yet in which water can always be found either in pools and springs or as subsoil drainage, have been shown white with both banks in blue.[1] It is

[1] For illustration of these distinctions, see *e. g.* Sheets Nos. 13, 14.

scarcely necessary to point out that the use of these distinctions can serve only for approximate guidance.

Lettering of temporary water-forms.

Here I may conveniently mention that for quasi-technical reasons, names, usually ending in *-jilga* (Turkī), indiscriminately applied both to streams and the valleys containing them, have always been printed in blue without regard to whether the streams generally carry water or not. For the same reasons the lettering of all temporary water-forms, such as flood-beds, seasonal marshes, etc., has been shown in blue.

Representation of marshes.

Marshy areas, being subject to considerable seasonal changes in arid regions, such as those represented by most of the maps, introduce a special element of uncertainty into cartographical representation. I have tried to restrict the use of marsh symbols in blue to ground which is likely to be covered with water for the greater portion of the year. But it should be remembered that where drainage beds, ordinarily dry, terminate in areas shown as sandy tracts with living desert vegetation (reeds or scrub), extensive portions of the ground are likely to be found boggy during the season of spring floods from the melting snows of the mountains. [2]

Salt-encrusted areas.

Salt-encrusted areas, marking dried-up lake-beds and marshes or ground subject to inundation or percolation at intervals followed by evaporation, form very important features of the surface in the lower portions of the Tārīm basin and of the adjoining drainageless regions. They date from different periods and present considerable geographical or geological interest. I have accordingly thought it desirable in the course of our later surveys to distinguish areas showing marked differences in the salt formation covering their surface.

Varieties of salt symbols.

Three varieties of new symbols have been introduced for this purpose, all derived from the conventional symbol in use for water of lakes and marshes, but all shown in black. Thin lines with hook-like ends turned upwards on the right indicate a crust of hard salt, practically pure, crumpled up into hummocks or small ridges, such as covers the greater portion of the ancient Lop sea bed. The crust of salt-permeated clay, usually formed into big lumps quite as hard as the first variety, and usually found near the edges of ground still receiving some water, has been shown by similar lines with hooks turned downwards on the left. Finally, ground where a soft crust of salt of varying depth covers the underlying soil is indicated by lines with downward hooks on the right. [3] Ordinary salt efflorescence (known as in India by the term *shōr*) is present to a greater or less extent almost everywhere in the Tārīm basin where subsoil drainage comes to the surface or temporarily inundated areas are near; it has hence not been specially marked.

Representation of drift-sand.

Among other permanent surface features drift-sand is the most important in the regions represented by the majority of the map sheets; for it covers the greater portion of the Tārīm basin. For drift-sand bare of vegetation, or nearly so, brown stipple has been used. The indication of dunes within areas of bare drift-sand by small clusters of thicker stipple facing to the south-west is meant to be purely conventional. It has been chosen with regard to the prevailing wind direction, though the bearing of individual dunes varies greatly in different desert areas. But where large accumulations of dunes in the shape of high ridges or *dawāns* are met with, usually near river courses or parallel to them, they have been shown with the true bearing of their axis as actually surveyed. [4]

Representation of *yārdangs* and 'Mesas'.

Two surface formations of desert ground often associated with drift-sand are of sufficient importance to claim representation by special symbols. The one adopted for *yārdangs* or wind-eroded clay ridges and trenches, so characteristic of different parts of the Lop depression, shows a form meant to represent the usual bearing of the ridges from N.E. to S.W. and their tail-like end tapering to S.W. For the high clay terraces or 'Mesas' also due to erosion but of earlier

[2] See for such areas, *e. g.* Sheets No. 34. A.B. 1; 38. C. 4.

[3] For areas showing all these varieties of salt-encrustation, see *e. g.* Sheets Nos. 32, 35.

[4] As regards such 'Dawāns', cf. above pp. 16, 19, 26; for specimens, see *e. g.* Sheets Nos. 18. A. 1-3; 29. A, B. 4.

geological origin and usually found in ancient lacustrine basins, a different symbol has been used. [5]

Sandy tracts with vegetation.

Sandy tracts supporting desert vegetation of some kind have been distinguished from bare drift-sand by the use of a light yellow tint. The character of the vegetation found in such tracts has been marked by separate symbols representing its principal forms, *viz.* reeds or low scrub, wild poplars (by far the most frequent tree growth), and tamarisks. Where the long-continued presence of tamarisk growth has led to the formation of regular 'tamarisk-cones' *i. e.* high hillocks built up by prolonged accumulation of sand around the roots, etc., of tamarisk bushes, this characteristic feature of the ground has also been marked by a special symbol. Wherever these forms of desert vegetation were found dead, throughout or for the most part, the respective symbols have been shown in black, instead of in green, the colour used for living vegetation.

Symbols for vegetation.

The same symbols have been used also to mark patches of vegetation on otherwise bare desert ground of detritus, gravel or clay, and to indicate grazing in mountain tracts barren elsewhere. [6] In mountains, however, like the central Nan-shan where a moister climate allows vegetation to grow practically everywhere on the slopes up to the snow-line, only conifer forest or particularly rich grazing in the valleys has been specially shown.

It is obvious that the limits between bare drift-sand areas and sandy tracts with vegetation are often difficult to determine even approximately. The same applies also to the limits between the latter and gravel or clay desert with scrub. Wherever such limits could be clearly observed they have been marked by fine dotted lines.

Limits of cultivated ground.

The same device has been used with particular care for the purpose of indicating the limits of cultivated ground (shown green throughout) where observed at the time of survey. Special interest attaches to this record of the extent of cultivated ground in view of the comparatively frequent and rapid changes to which cultivation throughout Chinese Turkistān is subject owing to peculiar physical and economic conditions. In this respect a comparison of the cultivation limits in particular oases as recorded in the new maps with those shown by the surveys of the first or second journey will prove distinctly instructive. [7]

Changes of cultivated areas.

Such changes become necessarily far more striking where they can be observed over a considerable distance of time, and for this the Tārīm basin, especially in its southern portion, offers plenty of typical evidence. The ancient sites now found in utterly waterless wastes of the Taklamakān and Lop deserts, and the even more numerous remains of abandoned settlements and other ruins traced in the sandy tracts adjoining still extant oases, all bear witness to such changes of the cultivated areas within the historical period. The use of distinctive red colour for the various symbols indicating ancient remains as well as for the local names relating to them makes it easy to gauge the extent of those changes by a glance at the map.

Section III.—SYMBOLS AND LOCAL NAMES

Among the symbols and other cartographic entries in the map, most of those relating to works of man conform to the system adopted by the Survey of India and do not stand in

[5] For Yārdangs and Mesas, cf. above pp. 30, 47, 53; for ground showing them in typical formations see *e. g.* Sheet No. 32. A-D. 3.

[6] The insertion of these vegetation symbols on such ground has not been systematically made throughout (see *e. g.* Sheets 37, 40), descriptive entries having often been used instead.

[7] Compare, *e. g.*, the cultivated areas of the oases from Gūma to Khotan in the map of 1900-01 with those shown in Sheet No. 9. A. 1, B-D. 2; or those from Chīra to Keriya in Sheets Nos. 27. D. 4; 32. A-C. 1 of the 1906-08 maps with Sheet No. 14. B, C. 2, 3, D. 3; or Charchan in Sheet No. 46. C. 4 of 1906-08 with Sheet No. 22. C, D. 4.

need of special explanation. [1] Others which had to be specially introduced for the marking of ancient sites, ruins and other objects of antiquarian interest, are sufficiently explained in the table of symbols reproduced at the foot of each sheet.

Ancient remains shown in red.

No exact chronological limits can be fixed for the 'antiquity' which the use of red colour indicates in the case of these symbols; but generally it may be considered as defining those objects which have ceased for a considerable time past to serve their original purpose.

Symbols for inhabited sites.

In the case of symbols for inhabited sites, no attempt at systematic differentiation according to importance could be made. Large towns, however, have been distinguished by black outlines approximately corresponding to the extent of ground they cover, and among other settlements the more populous are made recognizable by slightly enlarged solid blocks. The market-towns of village tracts in the Tārim basin are easily recognized by the addition of *-bāzār* (often coupled with a week-day) to the name of the tract. In Kan-su where practically all villages and hamlets are walled, the use of the fort symbol has been restricted to small towns to avoid over-crowding. Throughout the maps a small open square has been used to distinguish temporarily occupied structures such as roadside stations (*langar*), shepherds' huts (*čhil*), and the like, from permanent habitations.

Representation of 'roads'.

As in the 1/Million sheets of the Survey of India, no distinction has been made between different classes of roads, except that the few main lines of traffic connecting the principal oases and usually marked by the Chinese administration with 'mile-stones', *recte* mud towers, at distances of 10 *li* (approximately 2 miles) have been shown with double lines in red. Throughout the regions represented, 'roads' are only natural tracks, practicable for camels everywhere in the plains and for carts also, except where the stretches of drift-sand to be crossed are extensive, as is the case all the way between Khotan and Tun-huang.

Indication of tracks.

In regions where desert areas vastly predominate, some difficulty is naturally experienced as to which tracks can reasonably be marked as 'roads and paths'. Tracks such as those which traverse the western Kuruk-tāgh or lead along the foot of the easternmost K'un-lun, though well-known to more venturesome people in the nearest small settlements, may remain unused for many months, or even years. The principle I have endeavoured to observe was to mark with the red line of 'road or path' only those tracks which an experienced traveller in possession of the map might *with due care* be able to follow unguided. It goes without saying that of such tracks, too, many are liable to be lost in places when unfavourable atmospheric conditions obscure landmarks, etc.

Within the oases, on the other hand, well-trodden tracks between villages and hamlets are so numerous that it would be impossible to show them all on the scale of our maps. Hence within cultivated ground it has often been found necessary for the sake of clearness to show only the routes followed, without marking the roads along which they led. [2]

Marking of surveyed routes.

Special care has been taken to mark all routes along which survey work was done, by rows of small crosses, the colours black, blue and red being used to distinguish routes followed on the first, second and third expedition respectively. Where the same route was surveyed on more than one journey, crosses of corresponding colours have been used alternately. The successive route stages on each journey have been shown by the insertion of 'camp numbers' in the same distinctive colours as the routes to which they refer; a special camp symbol was added where the stage lay at a spot away from any habitation. The numerical order of camps makes it possible to follow the direction in which the survey on each route proceeded. On the first and second expeditions, routes surveyed by myself only are recognizable by 'camp

[1] With regard to the symbols marking temples and Muhammadan shrines, respectively, I regret to note that draftsman's errors in the slight distinction between them have frequently escaped attention. These errors are, however, not of serious consequence inasmuch as practically all modern shrines shown within the Tārim basin are Muhammadan and all those in Kan-su Chinese.

[2] See *e.g.* Sheet No. 9. D. 2 for the Khotan oasis.

numbers' with the addition of the letter *a*. On the third expedition different series of 'camp numbers' in Arabic, large Roman and small Roman figures have been used to distinguish routes surveyed respectively by R.B. Lāl Singh, Muhammad Yakūb, and Afrāz-gul or myself. [3]

Method of lettering.

The method of lettering conforms generally to that adopted in 1909 for the 'International Map of the World' on the 1/Million scale. Place names and other topographical information have accordingly been printed in upright or Roman type (Doric) while Sanserif Italic lettering has been used for names of water-forms and communications. [4] Hill names have been further distinguished by the use of Condensed Antique type. [5]

The wish to record in the map as much of topographical information as space would permit, together with certain limitations of available type founts, has led to the majority of village and similar local names being printed in a somewhat small Doric type (Diamond on Nonpareil), while the larger type sizes were reserved for more important names. From this rule a departure has, however, been made in some cases for the sake of better legibility. Thus along desert tracks where adequate space was available, Nonpareil type has been used for the names of certain localities, such as well-known roadside stations or camping places which, though not permanently occupied, are yet of some importance to the passing traveller. It may be noted here also that where local names are shown without any corresponding symbol, they refer to localities such as grazing grounds, small valleys, etc., closely adjoining the route line.

Record of local names.

Throughout our common surveys I charged myself personally with the record of local names. For routes which were followed only by my assistants I did my best to check and correct the record of local names they brought back through an independent examination of natives acquainted with the ground. On some occasions, when an assistant had to be detached for prolonged survey work at a considerable distance from my own routes, I endeavoured to assure greater accuracy of record by sending with him a literate person capable of recording Turkī local names more or less correctly in Arabic script. Nevertheless, I fear, it has not always been possible in the case of independent surveys by assistants to eliminate mistakes due to imperfect hearing, inadequate training in phonetic spelling, or occasional misapprehension of a language with which they could acquire but a limited colloquial familiarity.

Chinese local names.

In the case of Chinese local names in Kan-su the difficulties in the way of correct record were much greater than in that of Turkistān names. Not being a Sinologue myself I took the very necessary precaution of having them, wherever possible, written down on the spot also in Chinese characters by my Chinese *literatus*. Where, as frequently happened on the third expedition, surveys had to be effected on Chinese ground without him, an endeavour was made to obtain a record of local names in Chinese writing by other means. That notwithstanding these precautions numerous mistakes are likely to have occurred, particularly as regards the names of small localities, will not surprise those familiar with the intricacies of Chinese phonetics and dialectic variations. The latter were bound to be often very puzzling to my *literati* whose home was distant Hu-nan and who, owing to the prevailing secretiveness of the Kan-su population, found it difficult at times to secure ready help from Mandarin-speaking local people. In transcribing Chinese names the Wade system as adopted in Professor Giles's Dictionary has been followed. For the transcription of all names recorded in Chinese characters I am indebted to the kind help of Dr. Lionel Giles.

With regard to Turkī and Īrānian names it was my aim to record in each case the

[3] Information as to where the work of any of the three surveyors was done under my immediate supervision, can readily be obtained by reference to the account given in Chapter I, section iv.

Routes of the third expedition surveyed by Afrāz-gul alone are distinguished by camp numbers in small Roman figures with the addition of the letter *a*.

I may note here that in some Sheets like No. 25, 29, the diversions made from the main routes to reach hill-stations for triangulation, etc., have occasionally remained unmarked.

[4] That Sanserif Italic type has been used also for names of passes (not coming correctly under the head of 'communications') is due to a misinterpretation of the rules laid down by the International Map Conference of 1909.

[5] It is probable that in some cases names recorded by the surveyors for distant peaks or spurs (see *e.g.* in Sheet No. 4. B. 4, Koterek, Bāgh-suget) are really the names of valleys or other localities lying in their direction.

Spelling of Turkī local names.

form of the name as actually pronounced by the local inhabitants or guides, refraining from any attempt to spell the name in accordance with its presumed correct Turkī etymology. I am aware that this method of record has implied in certain cases obvious inconsistencies.[6] But it appeared the safest in the case of a geographical student like myself who, though an Orientalist familiar with Persian and the spoken language of Chinese Turkistān, does not profess to be a Turkologist. It must also be remembered that the Eastern Turkī spoken in the Tārīm basin and adjacent regions has not evolved a standard literary form, and that any attempt to spell their local names after the fashion adopted in modern literary productions of the Turkish-speaking population of Russian Central Asia and regions further west would very often render them unrecognizable to the people on the spot.

System of transliteration.

In recording Turkī and Īrānian names I have followed the system of transliteration approved by the International Congress of Orientalists and used also, in its simplified Hunterian form, for Indian Government publications. The use of diacritical marks has, however, been restricted to the indispensable minimum. Hence no distinction has been made in the case of words derived from Arabic between the several kinds of sibilants, gutturals, etc., which are pronounced alike by the people of Chinese Turkistān.

Composition of Turkī and Iranian names.

It has seemed to me convenient to separate the component parts of Turkī and Īrānian names, wherever clearly recognizable as distinct words, by the uniform employment of hyphens, and to use these, too, to mark the connection with the names proper of such common terms as *dawān* or pass, *mazār* or shrine, *köl* (also *kol*, *kul*) or lake, etc. I must, however, confess in this matter of hyphens and similar points to occasional inconsistencies, hoping that they will be the more readily excused in view of the prolonged period over which both the original surveys and their cartographic elaboration have extended. Finally, I trust that the convenient brevity and significance of such Turkī terms as *sai* (gravel plateau or stony glacis), *yār* (ravine in alluvial soil), *yārdang* (wind-eroded ridge), and a few others, will be held to justify their use in descriptive entries of the map, even on ground where Turkī is not the local tongue.

[6] Thus the word for 'lake' may appear as the concluding part of local names in the same region as *-kul*, *-kol* or *-köl*; similarly the word for 'hillock' as *-döbe*, *-debe* or *-daba*; the word for 'mill' at the beginning or end of compound names as *tigharman*, *tüghürmen*, *tüghemen*, or *tügemen*, etc.

CHAPTER IV

NOTES ON INDIVIDUAL MAP SHEETS

NOTES ON SHEET No. 1 (TURUG-ART-DAWĀN)

The survey of the small area comprised in the S. E. corner of this sheet was made by R. B. Lāl Singh in 1907. Owing to the damage his theodolite had suffered on the way from Ak-su, no latitude observations of his were available for this area. His route from Kāshgar to the Turug-art-dawān (Sheet No. 1. C. 3) on the Russian frontier lying almost due north, it was considered advisable to accept for the position of the latter the coordinates obtained from the latest Russian surveys and to adjust the details shown in this sheet on that point and on the accepted position of Kāshgar (see below Notes on Sheet No. 2). The position of the Turug-art pass on the surveyor's plane-table, as indicated by Sheet No. 1 of the 1906-08 Map, lies about 4 minutes of lat. to the south and circ. 4 minutes of long. to the west of that shown by the Russian map.

The fact that the Turug-art-dawān is reached from Kāshgar by a road which shortly before 1907 had been made practicable for country carts at the instance of the Russian authorities, sufficiently indicates the comparatively easy character of the ground over which this route along the Chakmak valley leads up to the T'ien-shan watershed.

NOTES ON SHEET No. 2 (KĀSHGAR, MUZ-TĀGH-ATĀ)

The area shown by this sheet comprises a considerable portion of the great meridional range connecting the westernmost K'un-lun with the T'ien-shan in the north and forming the eastern rim of the Pāmīr region. In it appears also the extreme north-western corner of the Tārīm basin proper, occupied by the large oasis of Kāshgar and the much smaller ones of Ōpal and Tāsh-malik.

The routes surveyed on the first journey led along the western slopes of the meridional range, usually known after its most prominent peak as that of Muz-tāgh-atā, as far as the great defile of Gez-dara (C.3) and then through this to Tāsh-malik and Kāshgar. The surveys of 1906-08 falling within this sheet were confined to the ground in its south-eastern and north-eastern corners. Those of 1913-15 were of greater extent and were carried not only through the main valleys receiving the drainage from the eastern flanks of the Muz-tāgh-atā massif, but also along both sides of the northern portion of the range, where it approaches the T'ien-shan and gives rise to the main feeders of the Kāshgar river.

For the delineation of the Muz-tāgh-atā range, between the approximate latitudes of 38° and 39°, and of the great valleys which flank its western slopes, a considerable number of triangulated points were available. These were derived mainly from the triangulation work of 1900, analyzed in sections B, C of Major Mason's Appendix *A*. In addition, certain points on the main range fixed by the operations of the Pāmīr Boundary Commission and Captain Deasy could also be utilized. The extension of R. S. Rām Singh's triangulation to Tāsh-malik (D.2) permitted the course of the Gez-dara, or valley of the Yamān-yār river, to be accurately shown on the map right down to where it debouches into the great plain of the Tārīm basin.

Besides the triangulation results just referred to, the position accepted for the 'old town' of Kāshgar and those for Yārkand and certain other places in the adjoining sheets Nos. 1, 3, 5 were used for the adjustment of the plane-table surveys embodied in this sheet. The value assigned to Kāshgar, lat. 39° 28′ 45″, long. 75° 58′, is that hitherto adopted by the Survey of India from the mean of numerous observations by successive expeditions. It deserves, however, to be noted that the longitude value which wireless observation on Sir F. De Filippi's expedition furnished for a point close to Chīnī-bāgh, the British Consulate

General, was 75° 59′ 5″·64.

As regards the positions accepted for Yārkand, Yangi-hissār and Tāsh-kurghān, the starting and terminal points of the routes represented in the south-eastern portion of the sheet, reference may be made to the notes on sheets Nos. 3 and 5. Toile-bulung (D.4) where these several routes cross each other, served as a convenient point for their adjustment, the latitude for this place being derived from an astronomical observation of 1906 and the longitude by interpolation between Kāshgar–Tāsh-kurghān and Yangi-hissār–Tāsh-kurghān.

In the northern half of the sheet use was made of the values assigned to the Kosh-bēl pass (A.2), lat. 30° 11′ 15″ and long 74° 1′ 7″, by Russian surveys. The position determined for Ōpal-bāzār (C.2) by a latitude observation of the Forsyth Mission and by the longitude derived from interpolation on our routes between Tāsh-malik and Kāshgar was also used. For the route which R. S. Lāl Singh in 1915 followed from Ōpal to the headwaters of the Kizil-daryā (A-C.2) and thence back to Ōpal across the Ulūgh-art-dawān (B.3), a very helpful check was afforded by the fact that the position of this pass could be fixed by direct observation of several triangulated points.

The routes leading north of Kāshgar (D.1) have been adjusted to the co-ordinates shown for the Turug-art pass (Sheet 1.C.3) by the latest Russian surveys, the latitude observations of Captain Trotter being also used for the determination of certain intermediate points. In addition to the above, astronomically determined latitudes were obtained in 1900 and 1906 for a number of places, as shown in the list below.

For the interesting mountain area which comprises the Muz-tāgh-atā massif and the great glacier-clad range north of it, culminating in the Kongur-debe peak, 25,146 feet, as well as for the Pāmīr-like ground south and north of the Little Kara-kul lake (B. 4, C. 3, 4), very useful additional material was furnished by the photographic panoramas taken by me in July, 1900, with a Bridges-Lee photo-theodolite. This material was worked up in the *Map of Muz-tāgh-atā and Lake Little Kara-kul*, on the scale of 4 miles to 1 inch, prepared by the late Lieut. F. B. Tillard R.E. and published in 1903.

The same panoramas, reproduced in Plates VIII and IX of my *Mountain Panoramas from the Kwen-lun and Pamirs* (1907), have since proved specially useful also by confirming the greater height of Kongur-debe I peak (25,146) over Muz-tāgh-atā (24,388 feet), [1a] previously accepted as the culminating point of the whole range, and by affording direct evidence as to the approximate level of the snow-line. For this an elevation of about 17,000 feet has been accepted on that part of the range which lies south of the Gez defile, while the observations made on my crossing of the Ulūgh-art-dawān in July, 1915, indicated a somewhat lower level of perpetual snow, circ. 16,000 feet, on the northern continuation of the range.

The area represented in this sheet may be divided into three regions distinguished by well-defined physical features. The high plateau-like valleys to the west of the great meridional range, which extend from above Tagharma in the south to the wide rolling downs above Mōji, share all the chief characteristics of the Pāmīrs. Grazing of the scanty kind usual on these uplands is to be found almost everywhere at the bottoms of the open valleys. In the valleys to the east of the range, as far as and including the Gez-dara, vegetation is distinctly more limited, and this barrenness increases in a very striking manner as the traveller descends through the outer ranges to the much-eroded and utterly bare foot-hills.

North of the Gez defile, the approach to the moister climate of the T'ien-shan makes itself felt by a somewhat larger amount of grazing in the valleys and by the conifer growth to be found at their heads over fairly large patches of ground (see Bostān-terek, B. 2; Bostān-arche, C. 3). In the irrigated areas below the debouchures of the Kara-tāsh, Yamān-yār and Kizil rivers, the character of the ground corresponds in all essentials to that of the other oases of the Tārīm basin situated between the glacis of the mountains and the great drift-sand belts.

For a fairly detailed description of the

[1a] It is of interest to note that the height as graphically determined by Major E. O. Wheeler, M. C., R. E., for Kongur-debe I peak, 25,116 ft., from the Panorama taken at Kara-kul, Camp 9 (C.4), differs only by 30 feet from the elevation deduced from Rām Singh's triangulation.

ground visited by me in 1900 along the slopes of the Muz-tāgh-atā range and on the way down to Kāshgar, see *Ruins of Khotan*, pp. 77 sqq., and for that crossed in 1906 on the journey from Tāsh-kurghān to Yangi-hissār *via* the Chichiklik pass, *Desert Cathay*, i. pp. 97 sqq. The historical topography of the latter route, as well as the legendary tradition attaching to the great snowy dome of Muz-tāgh-atā, have been discussed in my *Ancient Khotan*, i. pp. 40 sqq.; see also *Serindia*, i, pp. 76 sqq.

For a preliminary account of the route followed by me in 1913 across the Buramsāl pass and down the extremely difficult gorges passed by the lower Kara-tāsh river which drains the eastern slopes of Muz-tāgh-atā and Shiwākte (D. 3, 4), see *Geographical Journal*, xlviii, p. 110. There, too, p. 211 brief reference has been made to the journey which in 1915 took me from Kāshgar *via* Ōpal and over the Ulūgh-art pass to Russian territory at the southern headwaters of the Kizil-daryā and on the Alai.

Astronomically observed latitudes.

1900-01.	Ghujak, Camp 5 (B. 4) ...	38° 2′ 55″
	Kara-su-karaul, Camp 6 (B. 4) ...	38° 11′ 44″
	Su-bāshi-karaul, Camp 9 (C. 4) ...	38° 24′ 34″
	Keng-shewar, Camp 10 (C. 4) ...	38° 25′ 40″
	Camp below Ak-tiken pass, Camp 16 (D. 3)	38° 51′ 59″
	Tāsh-malik, Camp 18 (D. 2) ...	39° 7′ 5″
	Kurghān-tim, Camp 21 (D.1) ...	39° 28′ 32″
1906-08.	Toile-bulung, Camp 7 (D. 4)	38° 5′ 42″
	Karghai-aghzi, Camp 11 (D. 3)	38° 30′ 42″

NOTES ON SHEET No. 3 (SARĪKOL)

This sheet comprises the Tāghdum-bāsh Pāmīr and the southern and main portion of Sarīkol. The delineation of the ground shown in it is based on numerous triangulated points which the work of the Pāmīr Boundary Commission (1905) and Captain Deasy (1896-98) had furnished. They are mostly high peaks and the open character of the large Sarīkol valley renders them easily recognizable from the main route followed. These fixed points taken from the available triangulation charts were used throughout for the plane-table surveys of 1900 and 1913 south of the latitude of Tāsh-kurghān. To the north of this place, the triangulation which Rai Rām Singh effected in 1906 from a base measured near Chushmān (see Appendix *A*) supplied an additional number of fixed points, and these, being visible at different places of the difficult route followed by him down the Tāsh-kurghān river valley, permitted the details of this route to be adopted as shown in the original plane-table. An astronomical value of latitude obtained at Udurghuk (D. 1) helps to confirm them.

Topographical details at the head of the Tāghdum-bāsh Pāmīr (from the Wakhjīr pass in the west to the junction of the main valley at Ming-taka-aghzi with that coming from the Ming-taka pass) are taken from the plane-table survey of 1900. From Ming-taka-aghzi down to Ghujak-bai (lat. 37° 15′ 0″, long. 75° 23′) details were added to the 1900 work from the plane-table survey of 1913 done on double the scale. Further down as far as Tāsh-kurghān, the topography is shown from the latter survey only, this having been done under my direct supervision. There are also a number of astronomically fixed latitudes available in the main valley, and these agree with the positions shown by the plane-table for the corresponding camps.

Besides the route followed down the Tāsh-kurghān R. by Rai Rām Singh and already referred to, two routes diverging north of Tāsh-kurghān are shown within this sheet. The one leading north-westwards to Tagharma and past the western flanks of the Muz-tāgh-atā range was surveyed in 1900 by Rai Rām Singh. As astronomical values for three camps and a number of triangulated peaks were available here for the plane-table work, the representation of the adjoining ground could be taken over without change from the 1900-01 map.

The third route leading north-eastwards to Yārkand and Kāshgar was surveyed in

1913. Two triangulated points on either side confirm its position as here shown. The plane-table traverse along the route has been adjusted to the fixed position of Tāsh-kurghān and to the position of Toile-bulung (Sheet No. 2. D. 4). For this an astronomical value of latitude is available and a longitude value representing the mean between two values obtained by interpolation between (a) Kāshgar and Tāsh-kurghān, and (b) Yangi-hissār and Tāsh-kurghān.

An alternative route towards Kāshgar used chiefly during the winter months follows the narrow gorge which descends from the Chichiklik-maidān (Sheet No. 2. C. 4) to Shindī below the sharp eastern bend of the Tāsh-kurghān R. The portion of this route falling within this sheet has been shown from Rai Rām Singh's plane-table work of 1906 and from notes kept by myself when following it early in June of that year.

The snow-line on the high ranges which enclose the Sarīkol valley could be but approximately indicated, as it was actually approached only on the Wakhjīr pass leading to the Oxus (Āb-i-Panja) source and on the Kilik and Ming-taka passes. From my observations when crossing the Wakhjīr pass in July, 1900, and the Ming-taka pass early in September, 1913, I was led to take the elevation of about 16,500 feet as the approximate limit of permanent snow-beds on the range which forms the watershed between the Hunza and Tāsh-kurghān rivers. The same snow-line was adopted also for the range to the east of the Sarīkol valley which divides the drainage areas of the Tāsh-kurghān and Raskam branches of the Yārkand river. On the range to the north and west which separates Sarīkol from the Pāmīrs proper the snow-line seemed to me to lie distinctly higher, a circumstance fully accounted for by the reduced amount of moisture which penetrates north of the Hindukush and Kara-koram ranges. It has been conjecturally shown on the 17,000 contour line, but may in really be somewhat higher.

Grazing of the scanty sort usual on the Pāmīrs is to be found over most of the ground at the bottom of the main valley and in the lower portion of those joining it from the ranges on either side. This has not been specially indicated. But in a few areas (as at Rang; C. 2) yellow tint has been used to mark the presence of riverine loess soil allowing of more luxuriant vegetation.

Some account of the physical features of the ground shown in this sheet will be found in my *Ruins of Khotan*, pp. 57 sqq. and *Desert Cathay*, pp. 83 sqq. Its historical topography has been fully discussed in Chapter II of *Ancient Khotan* (i. pp. 22-40) and some additional information about its old sites furnished in Chapter III of *Serindia*, i. pp. 72-76.

Astronomically observed latitudes.

1900-01.	Dafdār, Camp 1 (C. 2)	37° 22′ 26″
	Tāghlak-gumbaz, Camp 2 (C. 1)	37° 34′ 38″
	Tāsh-kurghān, Camp 3 (near British Ak-sakāl's house; C. 1)	37° 46′ 58″
1906-08.	Chushmān, Camp 1 (C. 1) ...	37° 51′ 28″
	Udurghuk, Camp 5 (D. 1)	37° 50′ 38″

NOTES ON SHEET No. 4 (YAI-DÖBE)

The area shown in this sheet was surveyed from two routes, both followed by R. B. Lāl Singh only. The one of 1907 led from Uch-Turfān and the Taushkan river along the foot of an outer range of the T'ien-shan to the Terek-dawān (Sheet No. 1. D. 4); the other, followed in 1915, lay over previously unexplored ground from Kelpin (Sheet No. 7. B. 4) *via* the Kirghiz grazing grounds of Yai-döbe and Chong-kara-jol to Kalta-yailak (Sheet No. 5. B. 1). On the latter route the position of Tunguzluk had its latitude fixed by astronomical observation. No other fixed points being available within the limits of this sheet, its delineation was determined by adjustment of the details to the fixed places of the adjoining sheets. The result was satisfactorily checked by comparison of the position thus obtained for the Bilōti-dawān (Sheet No. 4. D. 3) which was found to agree very closely in latitude with that observed by Colonel Trotter, viz. 40° 40′ 20″.

Though scarcely any of the streams coming from the outer T'ien-shan ranges shown in this sheet ordinarily carry water, yet springs found in various places at the foot of the northern one, combined with

occasional floods, permit of cultivation in small patches. In the basin of Yai-döbe subsoil drainage supports sufficient vegetation for winter grazing of Kirghiz camps.

Astronomically observed latitude.

Tunguzluk, C. 346 (to N.W. of spring; C. 4) 40° 8′ 31″

NOTES ON SHEET No. 5 (YANGI-HISSÂR, YÂRKAND)

This sheet embodies the surveys made on a series of routes on all three expeditions. The area surveyed is proportionate to the great extent of cultivated ground to be found within the limits of this sheet. The routes followed in 1900-01 lay mainly within and between the populous districts of Kāshgar and Yārkand. [1] Those of 1906-08 covered ground all along the Yārkand river as well as portions of the hill area in the north-west and south-west corners of the sheet, while on the journey of 1913-15, the new routes surveyed lay chiefly from Kāshgar to Marāl-bāshi and along the right bank of the Yārkand river below Yārkand.

The well-determined positions of Yārkand, Yangi-hissār, Kāshgar, Marāl-bāshi and Karghalik served as base points for the construction of the sheet. Of these, the last three fall outside its limits and for the observations which fix them reference may be made to the Notes on Sheets Nos. 2, 6 and 8.

For Yārkand the latitude observed in 1900 and 1906 at our quarters of Chīnī-bāgh (about one mile south of the city walls) is supported by the observations of the Yārkand Mission of 1873 and Sir F. De Filippi's expedition of 1914, while the longitude now shown, which is derived from the wireless observation of the latter (77° 15′ 46″), differs only by 15 seconds from the one which was adopted in Sheet 11 of our 1906-08 map. [2] For Yangi-hissār the co-ordinates adopted are those deduced from the observations of Cav. De Filippi's expedition. For the determination of other positions the latitude observations of 1900-01 and 1906-08, as noted below, have been used, as well as those of Captain H. H. P. Deasy on his route from Kāshgar to Yārkand *via* Khān-arık; those of Dr. Hedin along the Yārkand river, and others recorded in the Yārkand Mission Report.

In respect of topographical details full advantage was taken of the fact that several of the chief routes in this sheet were surveyed more than once in the course of my three expeditions (see the routes from Kāshgar to Karghalik; from Kizil-dawān to Yārkand; from Ābād to Kāshgar, etc.). The physical character of the area comprised in the sheet exhibits considerable variety. Besides the compact well-cultivated tracts of the Kāshgar, Yangi-hissār, and Yārkand districts and the minor oases between, or near, them we find here a fairly large outlier of the central drift-sand desert around Ordam-pādshāh and extensive belts of riverine jungle below Faizābād in the north (B-D. 1) and below Ābād in the east (C,D. 2).

For brief descriptive accounts of the routes followed by me, cf. *Ruins of Khotan*, pp. 133 sqq.; *Desert Cathay*, i. pp. 126 sqq.; for the early historical topography of the region, see *Ancient Khotan*, i. pp. 42 sqq., 86 sqq.

Astronomically observed latitudes.

1900-01.	Eski, Camp 23 (A. 1) ...	39° 33′ 59″
	Yamān-yār, Camp 24 (A. 2)	39° 25′ 17″
	Dong-arik, Camp 25 (B. 2; symbol omitted in map)	39° 16′ 1″
	Achchik-bāzār, Camp 26 (B. 2) ...	39° 7′ 49″
	Ordam-pādshāh-mazār, Camp 27 (B. 3) ...	38° 55′ 34″
	Kizil-bāzār, Camp 29 (half a mile S. of Sarai; B. 3)	38° 39′ 20″
	Ak-rabāt, Camp 111 (B. 3)	38° 32′ 39″
	Kök-rabāt, Camp 30 (beyond S.E. end of village; B. 4)	38° 25′ 40″

[1] I have kept the conventional spelling of Yārkand without using the hyphen between the clearly recognizable parts of the compound name (*Yār-kand*, *i. e.* settlement by the 'Yār' or eroded ravine).

[2] As evidence of Rām Singh's very careful work I may mention that his plane-table of 1900-01 showed for Yārkand the longitude of 77° 19′ 10″, a remarkably close approach to the true one, considering the small scale used and other circumstances.

	Yārkand, Camp 31 (at Chīnī-bāgh, circ. 1 mile S. of City walls; C. 4)	38° 23′ 45″
1906-08.	Yārkand, Camp 19 (at Chīnī-bāgh as above, outside garden; C. 4)	38° 23′ 49″
	Ighiz-yār, Camp 12 (A. 3)	38° 40′ 9″
	Bāgh-jigda, Camp 21 (Dōgha Bēg's house; C. 4) ...	38° 28′ 17″

NOTES ON SHEET No. 6 (KARGHALIK, KILIAN)

This sheet shows the mountainous areas south of the Karghalik-Khotan road up to the valley of the uppermost Yārkand river. Most of the ground was surveyed from routes followed in 1906 and 1908, the surveys being supplemented by work done in 1900 on the main road to Khotan along the edge of the Taklamakān, and in 1915 by that on the caravan route which leads from Kök-yār up the Tiznaf river headwaters to the Yārkand river valley and the Kara-koram pass.

For Karghalik and Kök-yār astronomically observed latitudes were available, and for the former place the longitude of 77° 26′ 30″ was adopted as the mean of Colonel Trotter's traverse value and that obtained by Captain Deasy by chronometer; these differed only by 1′ 51″. The accepted positions of Karghalik and Khotan, as well as the triangulated points in the adjoining sheets Nos. 9 and 10, served as pivots for fitting the plane-table work. In addition to other latitudes those observed on Sir F. De Filippi's expedition were used for fixing the positions of R. B. Lāl Singh's Camps 366, 370, 375, 377 along the Karghalik-Kara-koram route (C. 2-4, D. 4).

In the absence of any height determinations on the main range, the indication of the snow-line in this sheet at an approximate elevation of 17,500 feet can only be considered as conjectural. Taking into account that the snowy portions of the main range near the Karlik-dawān (D.3) were seen by Rai Rām Singh only in the early summer of 1906, this approximately assumed limit of perpetual snow represents a sufficiently close approach to the snow-line of 18,000 feet as shown on the map of Sir F. De Filippi's expedition.

For brief descriptions of the routes followed by myself from Karghalik to Gūma and from Karghalik to Kiliān, see *Ruins of Khotan*, pp. 167 sqq.; *Desert Cathay*, i. pp. 142 sqq. As regards the early topography of Karghalik and the hill tracts south, cf. *Ancient Khotan*, i. pp. 89 sqq.; *Serindia*, i. pp. 85 sqq.

Apart from the large and fertile oasis of Karghalik, cultivation is limited in this area to a series of small settlements, Kök-yār, Yül-arik, Ushak-bāshi, Kiliān, all situated where the rivers from this part of the western K'un-lun debouch on a broad plateau overlooking the desert plains. The higher valleys on the Tiznaf river headwaters and east of them afford sufficient summer grazing for large flocks of sheep owned at Kök-yār, etc.

Corrections. C. 1. The grass symbols N. of Bēsh-terek-langar ought to be in green.

C.2. The symbol for astronomical latitude observation should be added against C. 26 Kosh-yüz-öghil.

D.2. The area of 'low dunes with tamarisks' should have been shown in yellow as 'sandy tract with vegetation'.

C,D. 2,3. Hill contours ought to have been interrupted where broken river courses mark valleys sketched from a distance.

Astronomically observed latitudes.

1900-01.	Karghalik, Camp 33 (at Yetim-lukum, circ. 1 mile S.W. of Bāzār; C. 1)	37° 53′ 32″
1906-08.	Kök-yār, Camp 24 (Chavash Bēg's house; C. 2)	37° 24′ 1″
	Kosh-yüz-öghil, Camp 26 (C. 2) ...	37° 3′ 20″

NOTES ON SHEET No. 7 (AK-SU, UCH-TURFĀN, KELPIN)

The surveys shown in this sheet extend roughly from the valleys of the feeders of the Ak-su river in the north to the riverine belt of the Yārkand-daryā in the south. The routes from Ak-su along the foot of the main T'ien-shan and from Uch-Turfān due south to Kelpin and Tumshuk (B.2-4) were followed in the spring of 1908 and those

further south towards Marāl-bāshi in that of 1915. On both occasions the atmospheric conditions of the season seriously interfered with astronomical observations as well as with distant views towards the mountains. This, together with the damage suffered by R.B. Lāl Singh's theodolite on the former journey, explains why only a single latitude observation of our own (that for Kelpin, B.3) falls within this sheet.

Fortunately Mr. C. Clementi's astronomical work of 1907 along the Kāshgar-Ak-su highroad met this want by supplying latitudes and chronometric values of longitude for Ak-su (Yangi-shahr) and for several of the roadside stations between that place and Marāl-bāshi. [3] The longitude thus determined for Ak-su, 79° 55′ 25″, shifts the position accepted in the Russian Trans-frontier map and shown also in Dr. Hassenstein's map accompanying Dr. Hedin's *Reisen in Zentral-Asien*, 1900, by some 29 minutes to the west, while the difference in the same sense from the longitude deduced from our plane-table traverses of 1908, as shown in Sheet No. 23 of the *Serindia* map, is only about 8 minutes. [4] The difference in latitude of the position in the latter from that of Mr. Clementi (41° 7′ 57″) is less than 6 minutes to the south. The routes passing through Uch-Turfān and Kelpin were checked by the accepted positions of Ak-su, Kāshgar and Marāl-bāshi, use being made also of the latitudes observed at Kelpin and Tunguzluk (Sheet No. 4. C. 4).

A descriptive account of the route surveyed by me from Ak-su to Uch-Turfān and thence through the previously unexplored barren outer ranges of Kelpin to the desert south, is given in *Desert Cathay*, ii. pp. 423 sqq. The general physical conditions of the region from Ak-su to Kelpin and Marāl-bāshi have been summarily discussed, along with its historical topography, in *Serindia*, iii. pp. 1296 sqq.

The large if imperfectly cultivated areas of Ak-su and Uch-Turfān owe their occupation to the abundant irrigation supplied by the Taushkan [5] and Kum-arik rivers which unite close to the 'Yangi-shahr' or Chinese town of Ak-su. Both are fed by portions of the T'ien-shan carrying perpetual snow and in their higher (unsurveyed) valleys affording ample grazing. The outer ranges to the south of the Taushkan river are on the other hand extremely arid, and the few small settlements at their foot wholly dependent on subsoil drainage.

South of those ranges extends a wide desert plain, partly bare clay or gravel but mainly covered with sand from alluvial deposits; in this plain, percolation from the Yārkand and Kāshgar rivers aided by occasional inundation maintains abundant jungle vegetation. The winding Kara-köl bed, together with other branches (C, D. 4) filled at times of flood, carries the water of the dying Kāshgar-daryā occasionally as far as the southern end of Ak-su cultivation. The curious wind-eroded low hill-chains (A, B. 4) striking across this desert plain at right angles to the T'ien-shan axis have been referred to already above; see p. 26.

Astronomically observed latitude.

1913-15. Kelpin, Camp 342 (Bēg's house, E. of Bāzār; B. 3)... 40° 31′ 23″

NOTES ON SHEET No. 8 (MARĀL-BĀSHI)

The surveyed area of this sheet is confined to the Marāl-bāshi district and the adjacent parts of the Yārkand river course and the Taklamakān desert to the south-east. The route followed in 1908 lay mainly along the high road from Tumshuk towards Yārkand; to the ground then surveyed much was added both in the south and north by the work of 1913 and 1915.

Owing to Muhammad Yakūb's astronomical observations having proved unreliable here as elsewhere, no positions fixed in latitude were available besides those recorded by previous travellers. Among these Mr.

[3] See *Summary of Geographical Observations taken on a journey from Kashgar to Kowlun*, by C. Clementi, Assistant Colonial Secretary, Hong-kong, 1911; also *Geogr. Journal*, 1912, p. 626.

[4] This comparison fully confirms Mr. J. Eccles' observation quoted in my *Note on maps illustrating explorations in Chinese Turkestan and Kansu*, *Geogr. Journal*, 1911, March, p. 279.

[5] The spelling *Taushkan* of Sheet No. 4 appears more correct than *Tushkan*, the one used in this sheet, and should have been substituted for the latter.

Clementi's latitude of 39° 46′ 42″ for Marāl-bāshi town and several latitudes observed by Dr. Hedin on the Yārkand river were used. The longitude adopted for Marāl-bāshi (78° 15′ 15″) was obtained by fitting the several traverses passing through it to the accepted positions of Kāshgar and Ak-su and proportionately dividing the error in distances.[6] Similarly the position of Tumshuk was adapted to that shown by Sheet No. 7 for Kelpin and Yaka-kuduk. It may be noted that the several isolated rocky heights of the Mazār-tāgh and other hills rising above the alluvial plains are of great help to the surveyor for the correct location of details in the vicinity of Marāl-bāshi.

For brief descriptive accounts of the routes followed in this area, see *Desert Cathay*, ii. p. 428; *Geogr. Journal*, xlviii. pp. 112 sq.; *Serindia*, iii. pp. 1309 sqq.

The oasis of Marāl-bāshi is of interest on account of its irrigation system in which the inadequate water-supply received from the terminal Kāshgar river is supplemented by big reservoirs (A. 1) fed from the Yārkand river. The dykes on the latter (Sheet No. 5. D. 2) securing water for the Zai canal and those around the reservoirs of Kölde and Anār-köl represent the largest irrigation work in the Tārīm basin. The geological interest presented by the Mazār-tāgh and the other isolated hills, as the remnants of an ancient range distinct from the T'ien-shan, has been touched upon above, p. 26, as well as the formidable character of the drift-sand desert which extends south of the Yārkand river.

Correction 8. C. 1. Cultivation patches ought to have been shown around the habitation symbols of Kizil-ziārat-terelgha.

NOTES ON SHEET No. 9 (KHOTAN, SANJU)

This sheet shows almost the whole of the mountainous area which extends from the edge of the Taklamakān between Gūma and Khotan and southwards to the main K'un-lun range and the upper Kara-kāsh valley. The routes from which it was surveyed all belong, with a slight exception in the extreme north-east, to the first and second expeditions. For the southern portion of the sheet, the triangulation of 1900 supplied a considerable number of fixed points;[7] in addition astronomically observed latitudes were available for numerous camps. For Khotan town a longitude of 79° 55′ 51″ was adopted, this being the mean of the astronomical values obtained by several observers (Dutreuil de Rhins, Piewzoff, Deasy) and in close agreement also with the position which our triangulation of the hills due south of the oasis indicates for the town.[8] The positions adopted for Khotan and Karghalik (see above under Sheet No. 6) were used in fitting the traverses between the two oases, both by the main road and along the outer hill; on the former route available latitude observations were also utilized.

The approximate levels indicated for the snow-line in different portions of the main range are uncertain, most of the work having been done in the early summers of 1906 and 1908 and by different surveyors. In the mountains due south of Khotan my own observations of the autumn of 1900 and late summer of 1906 have led me tentatively to assume an average snow-line at 17,000 feet.

The routes followed by myself in the plains and mountains and the observations attending my repeated sojourns in the important Khotan oasis have been described in *Ruins of Khotan*, pp. 169 sqq, 462 sqq.; *Desert Cathay*, i. 155 sqq., ii. 416 sqq. The geography of the Khotan region, in its physical, economic and historical aspects, together with the route from Karghalik and the *topographia sacra* of the Khotan district, is fully discussed in Chapters V-VIII of my *Ancient*

[6] It deserves to be noted that Mr. Clementi's longitude for Marāl-bāshi is 78° 6′ 20″, while that recorded as approximate in the *Yarkand Mission Report* is 78° 11′ 20″. Dr. Hassenstein's map shows for Marāl-bāshi 78° 35′ 12″.

[7] See Appendix *A*, stations and points in 51L, 51M.

[8] Owing to adverse atmospheric conditions no occasion offered for direct observation of any of the triangulated peaks from Khotan town or its immediate vicinity, though the distance to the nearest two of them (D. 3) is less than 20 miles.

Our latitude value, 37° 6′ 45″, relates to Ākhūn Bēg's garden, in Tüwen-Gujan, about a mile south-east of the centre of Khotan town, and about a quarter of a mile south of the position where Dutreuil de Rhins observed his latitude of 37° 7′.

Khotan (pp. 123-235); see also *Serindia*, i. pp. 90 sqq.; iii. 1273 sqq.

Great as the differences in elevation and general configuration are between the several zones which this sheet comprises, from the Taklamakān sands up to the high K'un-lun ranges, extreme aridity characterizes them all. The vicinity of fertile loess soil to the debouchure of the rivers accounts for the large cultivated area in the main Khotan oasis and for the string of minor oases stretching along the glacis of the outer hills westwards and facilitating traffic. The narrowness of the deep-cut valleys further south confines irrigation, and hence cultivation, to small isolated patches barely sufficient to maintain a few little settlements of hillmen, such as Pusha, Nissa and Karanghu-tāgh (C, D. 4.) In spite of the thick deposits of fertile loess dust which the winds have carried from the desert plains up to the highest valleys, the aridity of the climate reduces vegetation and grazing in these mountains to very modest limits. Communications through the mountains from north to south are difficult and owing to the impassable nature of the middle Kara-kāsh valley confined to very few routes.

Corrections. Symbols of latitude station to be added for Camps 55-61 of 1900-01 (as per list below).

A. 1.—Sandy tract with scrub should have been shown W. of Gūma as far as Siligh-langar.

B. 2.—A belt of drift-sand ought to have been marked at, and to the west of, Bēl-kum, on route from Zanguya to Pialma.

B. 3.—The glaciers shown by R.B. Lāl Singh on the northern slope of the range east of the Sanju-dawān, near peaks not rising much above 17,000 feet, are likely to be mere snow-beds.

D. 4.—A small patch of cultivation should have been entered at Omsha hamlet.

Astronomically observed latitudes.

1900-01.	Khotan town Camp 42 (Ākhūn Bēg's garden in Tüwen-Gujan suburb; D. 2)	37° 6′ 45″
	Bīzil, Camp 43 (Bēg's garden; D. 3) ...	36° 59′ 13″
	Yagan-dawān, Camp 55 (D. 3)	36° 31′ 30″
	Yagan-aghzi, Camp 56 (C. 3)	36° 35′ 36″
	Camp 57, below Kunat-dawān (D.3) ...	36° 42′ 50″
	Ulūgh-art, Camp 58 (S.W. of pass; C. 3) ...	36° 46′ 53″
	Lānghru, Camp 59 (near N.E. end of village; D. 3)	36° 55′ 52″
	Ujat, Camp 61 (near left bank of river; D. 3) ...	37° 0′ 54″
1906-08.	Pusha, Camp 42 (near Shamshel-mazār; C. 4) ...	36° 26′ 50″
	Tashte-öghil, Camp 44 (in Kurat-jilga; C. 3)	36° 30′ 4″
	Camp 46, below Ashpak (C. 3) ...	36° 39′ 5″

NOTES ON SHEET No. 10. (KARA-KORAM, KHITAI-DAWĀN)

With the exception of the route from Shahīdullah to the Kara-koram pass (A. 1), the area comprised in this sheet was surveyed at the close of the second expedition. It shows interesting portions of the main K'un-lun range near the triangulated peak 23,071 (Pk. 3/52M), where it bifurcates towards Muz-tāgh (Pk. 1/61A) and the peaks near the sources of the Yurung-kāsh river; [9] also two of the drainageless basins of the Tibetan uplands to the south.

For the construction of this sheet a number of triangulated points were available, [10] among them three determined in the Kashmīr G. T. series. Those shown near the Kara-koram route are taken from the work of Sir F. De Filippi's expedition, together with the clinometrical heights of peaks in A. 1. The value adopted for the approximate snow-line, 18,000 feet, is derived from the observations made near the Yangi-dawān and at the head of the Turgap-jilga (C, D. 1). In A. 1 the limits of perpetual snow have been indicated in accordance with the map of Sir F. De Filippi's expedition.

A description of the route followed and of the ascent to the snowy col on the K'un-lun watershed west of Peak 23,071 is given in *Desert Cathay*, ii. pp. 463 sqq. For some

[9] See above p. 22.

[10] See Appendix A, points in 52 M.

topographical details concerning Mr. Johnson's Yangi-dawān and his route beyond towards Karanghu-tāgh, see my note on *Johnson's map and the topography of the K'un-lun south of Khotan*, in the *Alpine Journal*, 1921, xxxiv. pp. 62 sqq.

Limited as the actually surveyed area within this sheet is, it includes three well-marked portions of distinctive character: utterly sterile basins characteristic of the extreme north-west of Tibet; the main K'un-lun range with its deep-cut valleys draining northward into the Yurung-kāsh river, and the high open plateaus between the Kara-koram and the Kara-kāsh river.

Corrections. D. 1. The ascent up the glacier at the head of the Turgap valley (Sheet No. 9. D. 4), to about long. 79° 42′ lat. 35° 59′, ought to have been indicated; cf. *Desert Cathay*, i. 200 sq.

D. 2. The approximate position of Mr. Johnson's 'Naiá Khán-dawán' may conjecturally be placed at about long. 79° 46′ lat. 35° 58′.

D. 2. Peak 8/52 M (23,309) has not been shown on the map according to its computed longitude 79° 51′ 0″; see Appendix *A*, points in 52 M.

NOTES ON SHEET No. 11 (MUZ-ART)

The survey shown in this sheet is confined to the vicinity of the route leading from the south to the Muz-art pass on the main T'ien-shan range, and to a small portion of the outer hills above the tract of Kara-bāgh. The plane-table work of R. B. Lāl Singh was adjusted to the position adopted for the Tengri-khān Peak in the map accompanying Dr. Merzbacher's *The Central Tian-shan Mountains*, London, 1905, and to the plotting of the adjoining sheet No. 12.

The heights shown for Tengri-khān and another high snowy peak sighted from the route are taken from Dr. Merzbacher's map in the *Central Tian-shan Mountains*. So is also that of the Muz-art pass, the summit of which the surveyor was unable to reach owing to the heavy snow encountered. His visit took place in the first half of May when the snow still lay low, and on this account the approximate level of the snow-line and the extent of the glaciers shown are subject to doubt.

NOTES ON SHEET No. 12 (KARA-YULGHUN, BAI)

Of the routes falling within this sheet only those from the terminal course of the Khotan river to Ak-su and north-east of this town were followed in 1908; the rest were all surveyed in 1915, that along the foot of the mountains by R. B. Lāl Singh, the one between Bai and Ak-su by myself, and the two further south by surveyors Afrāz-gul and Muhammad Yakūb, respectively.

The plotting of the sheet is based on the positions adopted for Ak-su and Kuchā in Sheets No. 7, 17 and on that for the junction of the Ak-su and Yārkand rivers. For the latitude of the last the value observed by Dr. Hedin, viz. 40° 28′ 47″, was used, while the longitude adopted is the mean between the values obtained by interpolation between Kāshgar and Korla and between Khotan and Ak-su. Latitude observations taken by Dr. Hedin were utilized for a number of points on the Tārīm river. For Muhammad Yakūb's traverse along this river, a check on longitude was afforded also by the position of Peres (Sheet No. 17. B. 2), where the former is crossed by the desert route from Kuchā to the Keriya river. Similarly the adopted position of Tengri-khān (see Notes on Sheet No. 11) was used for the adjustment of the route leading from Ak-su to the Muz-art pass.

In the northern portion of the sheet lies the subordinate basin of Bai (C, D. 1), enclosed between the foothills of the main T'ien-shan and a much-eroded outer range. The Muz-art river and some of its tributaries supply irrigation to considerable tracts in this basin. The same is the case with part of the submontane area between Ak-su and Jam (A. 2) which receives water from the snowy main range. The large volume of the Ak-su river renders irrigation possible along both its banks for a considerable distance.

Between the foot of the above mentioned outer range and the jungle belt accompanying the Tārīm stretches an area of scrubby desert. The existence of certain

wells makes it possible to pass through it direct from Kuchā to Ak-su by an old but now little frequented track (B-D. 2). South of the Tārīm extends the dune-covered Taklamakān, interrupted only by the delta through which for a brief period of the year the summer floods of the Khotan-daryā effect their junction with the former. For changes in this delta, cf. *Serindia*, iii. p. 1296; *Geograph. Journal*, xlviii. p. 114.

Astronomically observed latitude.

1913-15. Kök-yār, Kara-bāgh, C. 330 (Bēg's house; B. 1) 40° 49′ 13″

NOTES ON SHEET No. 13 (MAZĀR-TĀGH, KARA-DONG)

The surveys shown by this sheet are confined to the terminal courses of the Khotan and Keriya rivers passing through the Taklamakān. The route along the former was followed both on the second and third expeditions, that along the latter on the first and second. The former traverse, which owing to its north-south direction was well controlled by latitude observations, was adjusted in longitude to the positions accepted for Khotan and the Tārīm–Ak-su river junction (see Notes on Sheets No. 9, 12). The Keriya river route, for which similarly several observed latitudes could be used, has been adjusted to the positions adopted for Kuchā and Kochkar-öghil (see Notes on Sheets 14, 17).

For descriptive accounts of the Khotan river route, see *Desert Cathay*, ii. pp. 417 sqq., and of the Keriya river route, *Ruins of Khotan*, pp. 405 sqq. Some observations on the historical topography of the routes are recorded in *Ancient Khotan*, i. pp. 449 sq; *Serindia*, iii. 1240 sq., 1291. As regards the character and connection of the wind-eroded hill range of which the Mazār-tāgh on the Khotan river forms the easternmost traceable remnant, see above pp. 20,26.

Astronomically observed latitudes.

1900-01. Kara-dong, Camp III (N.W. corner of ancient fort; D. 3) ... 38° 32′ 39″

1906-08. Malghun, Camp 367 (A. 4) ... ... 38° 3′ 5″

Mazār-tāgh, Camp 369 (on left river bank, circ. 1/2 mile N.E. of ruined fort, B. 4) ... ... 38° 27′ 12″

Ayak-üstang-aghzi, Camp 371 (B. 2), (by Polaris) ... 39° 0′ 1″

(by Sun's meridional altitude) ... ... 39° 0′ 4″

NOTES ON SHEET No. 14 (SAMPULA, CHĪRA, KERIYA)

This sheet comprises much varied and interesting ground between the rivers of Khotan and Keriya and extending from the northernmost limit of ancient cultivation to the snowy spurs of the main K'un-lun range. It has been compiled from numerous surveys on all three journeys, and is crossed in the middle by the old caravan road which connects the oases along the southern edge of the Taklamakān. The exploration of a large series of ancient sites now abandoned to the desert accounts for the network of surveys to the north of that road, while in the south most of the routes were followed in connection with the triangulation work along the K'un-lun.

The numerous points fixed in the course of this work and by Captain Deasy's triangulation (see Appendix *A*), together with the conspicuous G.T. Peak 3/60D (Tikelik-tāgh), furnished an adequate basis for both plane-table work and cartographical construction in the southern portion of the sheet. For the main road from Khotan to Keriya, a series of latitude observations were available, while longitudes could be determined with fair accuracy by interpolation of the results of three separate plane-table traverses between the accepted position of Khotan and that of Niya, fixed by triangulation (see Notes on Sheet No. 19).

On the route leading northwards along the Keriya river, the longitude of Kochkar-öghil was derived from the concordant results of interpolation between Keriya and Kuchā and between Khotan and Domoko-bāzār *via* Dandān-oilik. The routes along the Yurung-kāsh and Kara-kāsh rivers are adjusted, as in Sheet No. 13, to the longitudes accepted for Khotan and the Tārīm–Ak-su river junction. The snow-line has been conjecturally assumed at an elevation of about 16,500 feet, in conformity with that observed in Sheet No. 15.

For descriptive accounts of the different routes followed by me in the northern portion of the sheet, see *Ruins of Khotan*, pp. 250 sqq., 413 sqq.; *Desert Cathay*, i. pp. 222 sqq.; ii. pp. 413 sqq., 400 sqq. The historical topography and the interesting questions connected with the abandonment of the numerous ancient sites traced in this area (A, B. 2, C. 1-3) have been discussed in *Ancient Khotan*, i. pp. 283 sqq., 452 sqq., 470 sqq.; *Serindia*, i. pp. 127 sqq.; 201 sqq.; iii. 1243 sqq., 1262 sqq., 1320 sqq.

The area shown in this sheet typically illustrates three main zones characteristic of the Tārīm basin as already briefly described; see above pp. 41 sqq. In the north extends the dune-covered waste of the Taklamakān, here cut through by the rivers of Khotan and Keriya with their narrow jungle belts. [1]

Adjoining to the south we have the zone where subsoil drainage from the streams absorbed on the glacis of the mountains supports desert vegetation in a wide sandy belt, once occupied by terminal oases such as still exist further south at Chīra, Gulakhma and Domoko. At either end of their line we have the large cultivated tracts of Yurung-kāsh, Sampula, Lop, belonging to Khotan, and of Keriya, irrigated by rivers large enough to carry water beyond them.

Finally in the south the wide barren glacis of piedmont gravel stretches up to the foot of the mountains. This is bordered here and there by narrow patches of cultivation, where the configuration of the valleys and the presence of fertile soil at the debouchures permit the water of the smaller rivers to be used for irrigation before it is absorbed on the 'Sai'. Only where some of the valleys open out at their top into broad uplands and the vicinity of perpetual snow and ice secures adequate moisture, is summer grazing to be found at great elevations.

Corrections. A. 1. For *Otro-misli* (on left bank of Yurung-kāsh) read *Otro-misil.*

A. 3. At Tārīm-kishlak a habitation should be marked.

A.2. At Kotāz-langar the symbol of a latitude station ought to be shown and 444 printed in blue. For *Kīne-tomak* read *Kīne-tokmak.*

A.4. Route crosses in black ought to be inserted between the Ulūgh-dawān and the triangulation station, 14,904 feet.

C.2. The cultivation area of Gulakhma and Domoko should be extended to a line running from Hungatlik to Ak-köl.

D.3. Omit the latitude observation symbol at Keriya.

Astronomically observed latitudes.

1900-01.	Yangi-langar, Camp 44 (A. 3) ...	36° 44′ 47″
	Tārīm-kishlak, Camp 45 (S. of habitation ; A. 3) ...	36° 36′ 16″
	Tam-öghil, Camp 64 (A. 4)	36° 13′ 41″
	Chakitmak-sulāgh, Camp 66 (B. 4)	36° 17′ 49″
	Ak-chigh, Camp 68 (B. 4) ...	36° 9′ 26″
	Chīra, Camp 71 (Bēg's house in Bāzār ; B. 2)	37° 0′ 48″
	Gulakhma-bāzār ; Camp 72 (Bēg's house ; C. 2)	37° 1′ 18″
	Yaka-langar, Camp 73 (rest-house ; C. 3)	36° 52′ 15″
	Saghizlik-yailak, Camp 75 (D.2) ...	37° 4′ 12″
	Yoghan-toghrak-yailak, Camp 76 (D 2) ...	37° 13′ 1″
	Burhānuddīn-mazār, Camp 77 (Sheikhs' quarters ; D. 2)	37° 26′ 57″
	Kochkar-öghil, Camp 78 (D. 1)	37° 42′ 45″
	Dandān-oilik Site, Camp 81 (N. of ruin D. XIII ; see *Ancient Khotan*, ii. Pl. XXIV ; C. 1)	37° 46′ 38″
	Camp 115 (about 1¼ miles N. of Lāchin-atā-mazār ; C. 2)	37° 10′ 51″
	Yurung-kāsh-bāzār, Camp 117 (Bēg's house ; A. 2)	37° 6′ 2″
	Rawak Stūpa, Camp 119 (south of Vihāra court ; A. 2)	37° 20′ 47″
1906-08.	Jiga-tal, Camp 57 (B. 4) ...	36° 21′ 8″
	Kotāz-langar, Camp 60 (A. 2) ...	37° 1′ 12″
	Toghrak-langar, Camp 63 (D. 3) ...	36° 34′ 50″

[1] Special attention may be called to the high ridges of sand running parallel to the direction of the river-courses of which the map shows here striking examples on both sides of the Keriya river (Kizil-kum); regarding this formation, see above p. 43.

1906-08.	Sok-terek, Camp 68 (D. 4)	36° 21′ 49″
	Triangulation Station above Achchan, Camp 69 (D. 4)	36° 24′ 41″
	Ulūgh-mazār, Camp 350 (near sacred tombs; B. 2)	37° 12′ 18″

NOTES ON SHEET No. 15 (YURUNG-KĀSH AND KERIYA R. SOURCES)

The survey within the portion of the K'un-lun represented in this sheet was made during August and September, 1907, only the westernmost snowy peaks, including 'Muz-tāgh' (Pk. 1/61 A) and those on the northern main K'un-lun range (A-D. 1), having been sighted in 1900-01. The plane-table work was based on a great number of previously triangulated peaks which are shown in Appendix *A* (61 A, 61 E). Of these five were fixed by the Kashmir triangulation of the G. T. Survey (Johnson, 1862). Of other trigonometrical points most were determined by Captain Deasy, while some are derived from triangulation work of my first and second journeys.

An account has been given above of the routes by which the survey was first carried to the very difficult ground at the head-waters of the Yurung-kāsh river and subsequently extended past the basin of the Keriya river sources (D. 2) to the high and barren plateaus stretching along the southern range of the K'un-lun (see pp. 21 sqq.). Observations made in different parts of these ranges indicated an approximate snow-line at levels varying from about 17,500 to 18,500 feet.

For a fairly detailed description of the routes followed in this rugged mountain region and on the plateaus to the south, see *Desert Cathay*, ii. pp. 443 sqq., Figs. 318-332. The only track through it, occasionally used, leads from Polur to Ladāk over the Bāba-Hātim and Lanak-lā passes. Its difficulties are great, and, though, no doubt, known since early times, it cannot be traced in old records.

Among the physical features of this elevated region the most striking, perhaps, is the great contrast between the extremely deep-cut, and in many places quite inaccessible, gorges of the Yurung-kāsh headwaters and the wide, in parts ice-clad, basins in which gather the sources of this and the Keriya river. Quite different, too, from the former is the character of the forbiddingly barren uplands of northernmost Tibet which lie south of the southern main range and extend also between the Keriya river drainage and the northern chain.

As the Yurung-kāsh gorges west and south of the great and conspicuous massif of 'Muz-tāgh' (Pk. 1/61 A), and probably those below the Zailik valley debouchure (B. 1) also, are quite impassable, access to that portion of the upper Yurung-kāsh drainage which the map shows as wholly unexplored will have to be sought by some glacier pass across the northern range from the Gonju or Ulūgh-sai headwaters (No. 14. B. 4).

Correction. The contours and cliff symbols along the Yurung-kāsh river course below Zailik (A, B. 1) should throughout be brought close to the left bank.

NOTES ON SHEET No. 16 (KERE-BĀZĀR, BAI)

The small area at the foot of the T'ien-shan, shown in this sheet, was surveyed from a single route and by R. B. Lāl Singh alone towards the end of April, 1915. The early season and adverse atmospheric conditions prevented extension of his work further towards the main range. The watershed of this appears to have been nowhere within view, and on various grounds it is probable that the headwaters of both the Kizil and Kuchā rivers reach considerably further north than conjecturally indicated on the plane-table.

The traverse was fitted to the position adopted for Kuchā (see below), and details adjusted to the latitude observed at Kara-kul (B. 4) and to the route lines Kuchā–Muz-art pass and Kuchā–Korla.

The surveyor's observation of conifer forest on the southern slopes of the range at elevations from about 7000 to 9000 feet is fully borne out by Dr. Merzbacher's observations in the Terek valley north-west of Bai, and in other T'ien-shan valleys further west; cf. Merzbacher, *The Central Tian-shan* (London, 1905) pp. 133 sq., 141, etc.

Astronomically observed latitude.

1913-15.	Kara-kul, Camp 323 (Bēg's house; B. 4)	42° 16′ 52″

NOTES ON SHEET No. 17 (KUCHĀ)

The surveys recorded in this sheet were made in 1908 and 1915. The comparatively close net of routes around Kuchā dates mainly from the spring of the latter year when archaeological interests kept me at work for several weeks in the vicinity of that great, and since early times important, oasis. While Miān Afrāz-gul assisted me in plane-table work here, R. B. Lāl Singh surveyed the outer slopes of the T'ien-shan northward. The routes southwards to Shahyār and beyond were mapped on the occasion of our joint crossing of the Taklamakān in January-February, 1908.

For the town of Kuchā the astronomical latitude agreed closely with that of Mr. Clementi. Its longitude was determined by taking the mean of the values interpolated between the accepted positions of Kāshgar and Korla and between Korla and Tengri-khān, respectively. This longitude (82° 53′ 30″) was found to agree very closely with that obtained by plotting the route from the side of Keriya river *via* Peres and Shahyār and was therefore accepted, [12] though differing some 15 minutes from that shown in Mr. Clementi's list. In addition to the latitudes recorded below, those observed by Dr. Hedin along the Tārīm river and by Mr. Clementi on the main road were used.

A brief descriptive account of the routes followed by me in 1908 is to be found in *Desert Cathay*, ii. pp. 375 sqq. Points connected with the historical topography of the riverine tract between the Muz-art (Inchike) and Tārīm rivers have been discussed in *Serindia*, iii. pp. 1236 sq. A record of the observations collected in 1915 concerning the present and ancient topography of the Kuchā oasis and its vicinity must be reserved for the report on my third expedition.

The area represented in this sheet, apart from the portion of the subsidiary basin of Bai occupying its north-western corner, falls into three distinct zones. In the north, at the foot of the outermost spurs of the T'ien-shan, we have the wide alluvial fan which the Muz-art and Kuchā rivers form at their debouchure and which is occupied by the great oasis of Kuchā. That its cultivation extended within historical times much further into the reed- and scrub-covered belt surrounding it on the east, south and west, is clearly demonstrated by the numerous ruined sites shown on the map (A-D.2).

In its ample irrigation resources, due to two rivers issuing near to each other from the foothills, as also in various other aspects, Kuchā forms a curiously close *pendant* to the Khotan oasis in the south. If desiccation has not left here quite so striking evidence of its progress in the shape of sand-buried ruins, wind-eroded 'Tatis', etc., the explanation is easily furnished by the broad riverine belt of the Tārīm which adjoins in the south.

This second zone with its jungle and inundation tracts effectively protects the irrigable area from encroachment by the drift-sands of the Taklamakān. The latter forms the third zone and stretches its dune-covered wastes away to the thin string of oases lining the extreme edge of the glacis of the K'un-lun on the other side of the Tārīm Basin. In the strip of Taklamakān ground shown by the southern portion of the sheet (A,B.4), the change in the direction of the high dune ridges or 'Dawāns' may be specially noted. While in the north they run from east to west parallel to the Tārīm, further south they bear approximately from N.N.E. to S.S.W., corresponding to the direction of the terminal course of the Keriya river where it dies away in the sands.

Corrections. B. 1. Cliffs should be shown above Duldul-okur close to the right bank of the Muz-art R., the river gorge being practically impassable from below Kizil-mingoi down to the caves of Ming-oi, above Kum-tura.

The name *Su-bāshi* at the debouchure of the Kuchā river should be in red, being applied to the ruins on both banks.

Astronomically observed latitudes.

1906-08. Kuchā City, Camp 309 (near Ya-mên; B. 1) ... 41° 42′ 58″
1913-15. Ishtala, Camp 318 (hamlet near centre of cultivation; C. 1) 41° 51′ 18″

[12] The longitude adopted in our map has since received gratifying confirmation by Dr. Louis Vaillant's 'Note sur quelques points astronomiques déterminés en Asie Centrale (Mission Pelliot 1906-09)', in *La Géographie*, 1921, xxxv. pp. 494 sqq. It shows the longitude of Kuchā, determined by three lunar occultations, as 82° 53′,6 and its latitude as 41° 42′,5.

NOTES ON SHEET No. 18 (KERIYA RIVER END)

With the exception of small areas, near Tonguz-baste on the dying Keriya river (A.4) and at the northern end of the 'Niya Site' (B.4), the surveys shown in this sheet are confined to the route followed on my Taklamakān crossing of February, 1908. Apart from three positions of which the latitudes were observed astronomically, the plane-table traverse has been adjusted to the longitudes of Kochkar-öghil and Kuchā, determined as explained in the Notes on Sheets No. 14 and 17.

A fairly detailed account of the physical features observed in crossing the Taklamakān from the Tārīm to the terminal delta of the Keriya River has been given in *Desert Cathay*, ii. pp. 386 sqq. The use of this difficult desert route as an old 'robbers' track' and the probable shrinkage of the terminal course of the Keriya river within historical times have been discussed in *Serindia*, iii. pp. 1240 sq. For the exploration of the ruins at the northern extremity of the 'Niya Site', the ancient *Ching-chüch* of the Chinese, abandoned in the third century A. D., see *Ancient Khotan*, i. pp. 376 sqq.; *Serindia*, i. pp. 215 sqq.

The surveyed portion of the sheet shows in section (A. 1) the northernmost traceable extension of the dried-up Keriya river delta. The presence here of high 'Dawāns', running transversely to the direction of the dying river (Camps 320, 321), suggests the possibility of the latter having once formed terminal marshes on this ground. Further south an old bed of the river, overrun by dunes and passing through a confusing dead delta, was followed with breaks to a point (Camp 327)where the recently formed new terminal course of the river was encountered.

The bed seen near the shepherd-hut of Tonguz-baste (A. 4), which in 1901 still carried water, had been abandoned some three years later owing to a change at the head of the delta at Yoghan-kum (Sheet No. 13. D. 4).

Correction. A. 3. To figure *300* above Camp 327 add *r*.

Astronomically observed latitudes.

1906-08.	Dead tamarisk-cone 3¼ miles N. of Camp 323 (A. 2)	...	39° 18′ 19″
	Position 1 mile N. N. W. of Camp 327 (A. 3) ...	...	38° 42′ 7″
	Camp 327 (on new Keriya River bed; A. 3) ...	...	38° 41′ 43″
	Tonguz-baste, Camp 330 (near shepherd's hut; A. 4)	...	38° 23′ 13″

NOTES ON SHEET No. 19 (NIYA)

The northern half of this sheet shows surveys made on all three expeditions, the presence of two important ancient sites having induced me to pay repeated visits to this ground. The mountain area in the south was surveyed in the autumn of 1906 in connection with the triangulation then carried along the northern main range of the K'un-lun by Rai Rām Singh.

The numerous positions trigonometrically fixed in the course of this work have furnished a safe base for the construction of this portion of the sheet. In addition it was possible to use for it in the S. W. a series of high peaks on the main range (A, B. 4) which Captain Deasy had fixed by triangulation, and the positions of which were plotted on the plane-table at the time of surveying (see Appendix *A*, Sheets 60L, P). Besides the latitude observations shown below, several more taken by Captain Deasy and other explorers were also utilized.

For the adjustment of the numerous route-traverses shown in the northern portion of the sheet, a sound basis was fortunately available in the position of Niya-bāzār, fixed as a triangulation station in 1906 with the value of lat. 37° 3′ 34″, long. 82° 45′ 32″. The caravan route leading thence north-eastwards to Endere and Charchan could also be checked by the position of Kalasti (Camps 116 a, LXXIV; Sheet No. 22. C. 4). In 1913 this was fixed on the plane-table by intersection with a Reeves telescopic alidade from several previously triangulated peaks above Charchan; it then proved to agree very closely with that laid down in Sheet No. 46 of the 1906-08 map. For several points north of the caravan route latitude observations were available. The triangulation attempted in October, 1906, from the ruins of the Niya Site failed to give a reliable result owing to the narrow angle observed and the excessive distances.

Owing to the lateness of the season

when the surveys along the mountains were effected, and for other reasons, no safe observations of the snow-line were available; the adoption for it in this sheet of an approximate contour of 17,500 feet is, therefore, conjectural.

Descriptive accounts of the routes of 1901 and 1906 which took me to and from the sand-buried sites of ancient terminal oases of the Niya and Endere rivers (B. 1, D. 1), are given in *Ruins of Khotan*, pp. 320 sqq., 388 sqq.; *Desert Cathay*, i. pp. 266 sqq., 300 sqq. The important archaeological discoveries made there raised numerous questions regarding physical changes, mainly due to desiccation, affecting the ground at those sites. These questions and the points relating to the historical geography of this region in general have been fully discussed in *Ancient Khotan*, i. pp. 382 sqq., 435 sqq.; *Serindia*, i. pp. 241 sqq., 272 sqq., 286 sqq. For a brief preliminary account of my third visit to the Niya Site (the ancient *Ching-chüeh* of the Chinese Annals), cf. *Geograph. Journal*, xlviii. p. 115.

As in the adjoining sheet No. 14, three well-marked zones can be distinguished within this area. On the north we have the drift-sands of the Taklamakān interrupted by the terminal courses of the Niya, Yār-tungaz, and Endere rivers and the belts of desert vegetation which are supported by them.

The ground once occupied by two large terminal oases of the first and last of those rivers can no longer be reached by irrigation, and the small patches of cultivation now found near the present ends of those rivers are ever threatened with extinction owing to the vagaries of the dying river-courses.

Southward of these stretches the vast glacis of piedmont gravel or detritus, some thirty miles and more in width and utterly barren, except on its northern edge. There subsoil water, absorbed higher up from smaller rivers, comes to light again in scanty springs or supports scrubby jungle with scattered wild poplar growth. The small Niya oasis is the only agricultural settlement to be found in this zone, and it, too, owes its existence mainly to the needs of the gold-miners' camps at Surghāk (B. 3) and elsewhere along the foot of the mountains.

These rise as an unbroken snowy rampart as far east as the headwaters of the Yār-tungaz and Endere rivers, and form part of the northern main range of the K'un-lun. Their valleys seem for the most part very narrow and barren, and cultivation is restricted to a string of small hamlets near where the lesser streams debouch on to the 'Sai' glacis (A-D. 3).

Corrections. B. 3. The name *Ken-köl* should be in black.

C. 2. Divide the river names thus: *Yār-tungaz, Ak-tāsh.*

D. 1. Symbols of 'hard salt crust' to be changed to those of 'hard salt-encrusted clay'.

Omit the latitude observation symbol at Endere Site.

C.3. The triangulated point Pk. 6/60P, with height 12,200, to be inserted at lat. 36° 35′ 35″ long. 83° 0′ 34″.

Astronomically observed latitudes.

1900-01.	Ovraz-langar, Camp 87 (station quarters; A. 3) ...	36° 53′ 12″
	Niya-bāzār, Camp 88 (near south end of village; B. 2) ...	37° 4′ 13″
	Imām-Jāfar-Sādik-mazār, Camp 91 (inner court of pilgrims' Sarai; B. 1)	37° 44′ 16″
	Niya Site, Camp 93 (close to ruined Stūpa; B. 1)	37° 58′ 44″
1906-08.	Kara-bulak, Camp 72 (A. 3)	36° 30′ 53″
	Malghun, Camp 75 (within hamlet; A. 3) ...	36° 36′ 21″
	Kuchkach-bulaki (B. 3)	36° 36′ 29″

NOTES ON SHEET No. 20 (KARA-DAWĀN, KARA-SHAHR RIVER)

The mapped area in this sheet shows a small portion of the wide valley of the Kara-shahr river or Khaidu-gol near its eastern end, together with a part of the outer range of the T'ien-shan which divides it from the Tārīm basin. Most of the latter range was surveyed from the route followed in 1915 by R. B. Lāl Singh along its southern foot and shown in Sheet No 21. The south-eastern corner of the sheet was surveyed in connec-

tion with my visit of 1907 to the ruined site of Khōra (D. 4). The plane-table work has been adjusted to the positions adopted for Kara-shahr, Korla and Bugur; see Notes on Sheets 21, 24.

For an account of my visit to Khōra, cf. *Desert Cathay*, ii. p. 372; *Serindia*, iii. pp. 1224 sqq. The northern slope of the outer T'ien-shan range then seen, appeared very barren, and even in the wide valley of the Khaidu-gol, stony but scrub-covered in parts, there was little to suggest the rich grazing which has made the plateaus of Yulduz at its head favourite haunts for nomad tribes from the times of the Huns down to the Mongols of the present day. But on ascending to the Kara-dawān (A.4) by a route which leads from Yangi-hissār to Yulduz, Lāl Singh noticed fine pine-forest clothing the southern slopes of the range from an elevation of about 8000 feet upwards.

NOTES ON SHEET No. 21 (BUGUR, KORLA)

The area shown in this sheet forms part of the extreme north-eastern corner of the Tārim basin proper. Of the routes along which the surveys lay, those leading from Korla to the Inchike-daryā were followed in 1908 and the rest, mainly north and south of them, in 1915.

The compilation of this sheet and those immediately adjoining to the east and south-east has been adversely affected by the erroneous longitude adopted at the time for the position of Korla in connection with R. B. Lāl Singh's northern triangulation series along the Kuruk-tāgh. In paras. 2-4 of Major Mason's Memorandum prefixed to Appendix *A*, the circumstances have been explained which necessitated in 1921 a re-examination of the computations relating to this triangulation and led to the rejection of its distant connection with the southern series of the same surveyor's triangulation along the K'un-lun range.

The western extremity of the northern series, as marked by station CC 85 (3170) in Sheet 25. A. 1, approaches Korla within about 5 miles, and as a result of the revised computation it was decided to base the work of the northern series on Mr. Clementi's value of Korla (lat. 41° 44′ 20·8″, long. 86° 10′ 10·4″). While the tables of Appendix *A* now show throughout the revised values for R. B. Lāl Singh's triangulation stations and points, it has been impossible to rectify their positions as shown in the map sheets. The corresponding correction in the case of Korla necessitates a shifting of its longitude by about 15′ 30″ to the east, while the latitude remains practically unchanged.[13]

In addition to the latitude observations recorded below, use was made also for the main road of those available from Mr. Clementi's work and for the Tārīm river route (Ugen-daryā) from that of Dr. Hedin. The latter route and that along the Inchike-daryā were adjusted in longitude to the values derived for Peres and Shahyār (Sheet No. 17) from the traverse between Kuchā and the Keriya river.

For a brief account of my observations regarding the Korla oasis and the ancient topography of this region, see *Serindia*, iii. pp. 1230 sqq. There the reasons for the surveys made in the desert between the Konche-daryā and Inchike-daryā have also been explained. The part played by the riverine tracts of the Inchike-daryā and Tārīm in early historical topography is discussed in *Serindia*, iii. pp. 1236 sq.

Except for the presence of some drift-sand belts towards the Konche-daryā, the area shown in this sheet south of the line of oases along the foot of the T'ien-shan, shares the character of the scrub- and jungle-covered zone extending around the cultivated

[13] With reference to Major Mason's statement in para. 4 of his above quoted Memorandum about the difficulties attending compilation owing to war conditions, I may conveniently here mention that my absence in England during 1916-17 prevented my being consulted at the time as to the doubts thrown upon the computation results of the northern series in relation to the position of Korla.

In Sheet No. 49 of the 1906-08 Map the approximately correct longitude of 86° 10′ is shown for Korla. That the erroneous longitude now adopted for Korla has not seriously affected the compilation of the work further west may be concluded from the notes above (Sheet No. 17) concerning the longitude of Kuchā, and also from the fact that the longitude 84° 10′ 20″ shown for Bugur-bāzār in our sheet, (A. 1) accords well with the chronometrical value of Dr. Vaillant, *viz.* 84° 11′, 1 (see *La Géographie*, 1921, p. 498).

tracts of Kuchā and Shahyār to the Tārīm. The Charchak R. bed, usually dry, appears to carry occasional floods from the marshes fed by the Kuchā river.

Among the oases in the north, Korla is of special interest on account of the ample and constant water supply assured by the Konche-daryā, draining the great reservoir of the Baghrash lake (Sheet No. 25. A-C. 1). The considerable extent of the Bugur oasis suggests that the Kizil river irrigating it drains a portion of the outer snow-covered T'ien-shan range which carries perpetual snow. This river's terminal marshes appear to have been much exaggerated in former maps.

Astronomically observed latitudes.

1906-08.	Korla, Camp 287 (main Bāzār; D. 1)	41° 44′ 32″
	Jigda-salā, Camp 295 (C. 2) ...	41° 14′ 38″
	Inchike-gumbaz, Camp 299 (old tombs; C.2)	41° 14′ 39″

NOTES ON SHEET No. 22 (CHARCHAN)

The surveyed area in the south-eastern corner of this sheet is confined to the vicinity of the Charchan oasis and the course of the Charchan river below it. The routes followed along the latter in 1906 and 1913 lay on opposite banks, while that leading from the west to Charchan was the same on both journeys.

On December 28, 1913, a chance of exceptionally clear weather enabled me to fix the position of Kalasti (Camp 116a of 1906; C. 4) by intersection from four peaks triangulated on the K'un-lun range on the previous journey. This position, which lies about 2′ to the west of the one shown in Sheet No. 46 of the 1906-08 map but agrees with it in latitude, has been adopted and used for the determination of Charchan, along with the observed latitude of this place. The routes along the river were adjusted to a point (Keng-laika), half-way between Tatran and Tim, for which Dr. Hedin's latitude observation was available (38°29′34″), and to the longitude of Lashkar-satma (Sheet No. 26. B. 3), which agreed very closely in the surveys of 1906 and 1913-14.

The route followed in 1906 has been described in *Desert Cathay*, i. pp. 319 sqq. The historical topography of the Charchan oasis which, notwithstanding its small size and chequered fortunes, has always been of importance for the ancient caravan route to the south of the Taklamakān, is fully discussed in *Serindia*, i. pp. 293 sqq. There, too, I have explained the special geographical reasons which have throughout historical times prevented extensive cultivation at Charchan, notwithstanding the abundant supply of water in its river, and have repeatedly caused it to be altogether abandoned for centuries; see *Serindia*, i. p. 295.

Corrections. C. 3. For *Ayaktar* River read *Ayak-tār* R.

D. 3. The route line of 1906 from Camp 119a should be extended north to *Tim* ruin.

Astronomically observed latitude.

1906-08.	Charchan-bāzār, Camp 103 (Bēg's house, west of Bāzār; D. 4)	38° 8′ 21″

NOTES ON SHEET No. 23 (KAPA, ACHCHAN)

This sheet shows a portion of the northern main K'un-lun range surveyed in 1906, and again in 1913, from the route leading along its lower slope past the gold pits of Mölcha and Kapa to the Charchan river, as well as the ground traversed by me in both those years along the desert track between the Endere river and Charchan.

The delineation of the ground along the K'un-lun range is based on the triangulation effected in 1906 by Rai Rām Singh, and continued eastwards from the hill-station of Ushlung (near Gudāche, 10,690; D. 2) by R. B. Lāl Singh in 1913; for stations and intersected points see Appendix *A*, Sheets 69 D, G. The desert route is adjusted to the triangulated position of Niya (see Notes on Sheet No. 19) and to that of Kalasti in Sheet No. 22. C. 4, resected from trigonometrical points.

The surveys along the range in the late autumn rendered no reliable observations of the snow-line possible. Its level has been conjecturally shown at 17,000-17,500 feet.

For a brief descriptive account of the desert route, see *Desert Cathay*, i. pp. 317

sqq.; for historical references to it, *Serindia*, i. pp. 293 sq.

The desert route (A-C. 1) keeps to the southern edge of the sandy belt where vegetation, mostly in the form of scrubby jungle and tamarisk-cones, is supported by subsoil drainage. It thus shares the character of the route leading from Niya north-eastwards (Sheet No. 19); but here the foot of the glacis of the mountains is overrun by coarse drift-sand, rising to dunes of considerable height. The water found in wells along the route is very brackish, and the latter in consequence is scarcely ever used during the late spring and summer.

Higher up stretches the bare glacis of piedmont gravel, broken by numerous deep-cut flood-beds (*chap*), but utterly waterless for the greatest part of the year. It is only near the heads of those valleys descending from the highest portions of the range that cultivation is carried on by small scattered hamlets of hillmen.

Corrections. A. 3. Symbol △ of triangulation station to be inserted against Ārpalik-chakil 15,500; also the route to it from C. 95.

D.2. The name *Ushlung* to be shown against the triangulation station 10,690 above Gudāche.

Astronomically observed latitudes.

1906-08. Kapa, Camp 99 (near gold pits; B. 2)		37° 14′ 53″
Kapa, Camp 99 (Īle-dong hill station; B. 2)	...	37° 14′ 5″
1913-16. Gudāche, Camp 4 (Ushlung hill station; D. 2)	...	37° 19′ 52″

NOTES ON SHEET No. 24 (KARA-SHAHR)

The survey shown on the southern edge of this sheet is confined almost wholly to the traverse made along the high road passing from east to west through the Kara-shahr basin; this was followed in 1907 by myself and in 1915 by M. Muhammad Yakūb. As the compilation of this sheet was adjusted to the positions adopted for Turfān (Sheet No. 28) and Korla (No. 21. D. 1), the longitudes throughout are affected by the error in placing the latter town about 15′ 30″ too far west, as explained in the Notes on Sheet No. 21. While at Kara-shahr town the divergence from Mr. Clementi's and Gen. Pyewzow's fairly concordant longitude values is about the same as just noted for Korla, the difference at Kumush near the eastern edge of the sheet is reduced to about 9′ as against Dr. Vaillant's longitude 88° 4′,6. The latitudes shown for several stations along the route are derived from the observations recorded by Mr. Clementi and various Russian explorers.

With the exception of the ground east and north-east of Kumush the whole of the area represented falls within the drainage of the Baghrash lake. The wide expanse of the latter, only roughly indicated in outline, affects the physical conditions of the whole Kara-shahr basin. They are briefly described in *Serindia*, iii. pp. 1178 sqq., where the historical topography of the district and the peculiar conditions impeding cultivation and permanent settlement within it have also been discussed.

Corrections. A-B. 4. The upper courses of the streams descending into the basin from the north between Ushak-tal and Kara-shahr ought to be shown in broken lines, as well as the hill contours adjoining.

D. 4. The well symbol at Kara-kizil Station ought to be shifted close to road.

NOTES ON SHEET No. 25 (KONCHE-DARYĀ)

This sheet shows the surveys made north and south of the westernmost Kuruk-tāgh and along portions of the courses of the Tārīm and Konche-daryā lying south of it. The former belong to the work of the second and third expeditions, the latter exclusively to that of the years 1914-15.

The several traverses were adjusted to the positions adopted for Korla and Āltmish-bulak before the re-examination of R. B. Lāl Singh's triangulation had proved the serious error made in the connection, as explained in Appendix *A* and the Notes on Sheets Nos. 21 and 29. In consequence all places in this sheet appear considerably to the west of their correct longitudes.

For the very numerous points in the Kuruk-tāgh shown by this sheet as trigono-

metrical stations and intersected points the tables in Appendix *A* (International Sheet N.K-45, K, O, S) indicate the correct positions, based upon Clementi's chronometrically determined value of Korla. A list of the positions which have been shown in accordance with their astronomically observed latitudes is given below.

For a description of the ground near the interesting ruined site of Shōrchuk, shown in the N.W. corner of the sheet, see *Desert Cathay*, ii. pp. 365 sqq.; *Serindia*, iii. pp. 1182 sqq.; for a brief account of the Ying-p'an site (D.3), at the head of the ancient river-bed of the Kuruk-daryā, and of the early Chinese route thence traced along the foot of the Kuruk-tāgh glacis towards Korla, cf. *Geograph. Journal*, xlviii. pp. 208 sq. The historical topography of the tract along the Konche-daryā below Korla is discussed in *Serindia*, iii. p. 1231.

Apart from the south-western corner of the Kara-shahr basin (A, B. 1) this sheet comprises portions of two very distinct areas. To the north-east it shows barren much-eroded hill-ranges of the Kuruk-tāgh and to the south of them the wide belt of riverine scrub and jungle watered by the interlacing beds of the Inchike-daryā, Tārīm and Konche-daryā. On the west this belt is bordered by the sands of the Taklamakān.

From the east it is approached by the Lop desert. An outlier of the last-named divides the ancient continuation of the Konche-daryā course towards Lou-lan, represented by the dry bed of the Kuruk-daryā, from the present course of the Konche-daryā (C, D. 3).

The small oases of Kara-kum and Tikenlik and those further south owe their existence to attempts of the present Chinese administration to facilitate communication between the routes leading along the northern and southern sides of the Tārīm basin. The great difficulties with which irrigation has to contend here, mainly owing to the frequent shifts of the river-beds, account for the very limited extent and quasi-peripatetic character of cultivation in this riverine zone.

Corrections. B. 3. *Ulūgh-köl* should be in black.

C. 1. Red line of path to be extended north to Camp Āltun-ghol and beyond.

Astronomically observed latitudes.

1906-08.	Dasokho-bulak, Camp 281 (D. 1)	41° 32′ 18″
	Ming-oi Site, N. of Shōrchuk, Camp 288 (A. 1; for position, see *Serindia*, iii. Plan 51)	41° 55′ 48″
1913-15.	Tikenlik, Camp 71 (near mosque; C. 3) ...	40° 38′ 26″
	Ying-p'an, Camp 73 (near ruin of Chinese rest-house; D. 3)	40° 56′ 59″
	Shindī, Camp 295 (on hillock, north of huts; D. 2)	41° 14′ 34″
	Hill-station N.W. of Suget-bulak, Camp 298 (C. 2)	41° 26′ 41″
	Hill-Station S. of Yetim-bulak, Camp 301 (B. 2)	41° 26′ 10″

NOTES ON SHEET No. 26 (VĀSH-SHAHRI)

The surveys shown in this sheet were made from routes followed on the second and third expeditions. The delineation of the mountainous ground in the south is based on R. B. Lāl Singh's triangulation of 1913 (see Appendix *A*, Stations and Intersected Points in 69 J, 69 N), the details of his plane-table work being supplemented by Rai Rām Singh's survey of 1906. The traverses along the Charchan–Charkhlik route, surveyed by myself in 1906 and again under my immediate supervision in 1913, were adjusted to the position adopted for Charkhlik, as indicated in Notes on Sheet No. 30. Apart from the latitude observations recorded below, use was made also of Dr. Hedin's latitude value for Lash-kar-satma (B. 3) and that of Roborovsky for Vāsh-shahri. [13a]

The ground seen by me along my route of 1906 is described in *Desert Cathay*, i. pp. 329 sqq.; the historical topography of the route is discussed in *Serindia*, i. pp. 306 sqq.

The southern portion of the sheet shows the outer spurs of the northernmost K'un-lun range, separated by extremely barren valleys. None of the streams which bring down water from the snowy main range

[13a] See *Scientific Results of Roborovsky's Expedition* (Russian), astronomical observations, p. 7.

succeed in making their way to the Charchan river across the gravel glacis and the belt, partly scrubby desert and partly bare drift-sand, which stretches south of the river.

The small colony of Vāsh-shahri (C. 3), recently re-established near a site abandoned for centuries, and Tatran (D. 2), an outlying portion of the Charkhlik oasis, are the only patches of permanently occupied ground within the area comprised in this sheet.

Astronomically observed latitudes.

1906-08.	Yol-sai, Camp 110 (C.4)	38° 20′ 2″
1913-15.	Kizil-kum, Camp 14 (hill-station, 5128, on sand-ridge, N.E. of Camp; B. 4)	38° 22′ 12″
	Tatlik-bulak, Camp 19 (west end of base, rock near ravine; D. 3) ...	38° 37′ 59″

NOTES ON SHEET No. 27 (KHĀDALIK)

The area surveyed in the N. W. corner of this sheet is confined to spurs of the main K'un-lun range, descending north of the Charchan river gorge, and to a portion of the gravel glacis near the gold pits of Khādalik. For its delineation a number of trigonometrically determined stations and points from R. B. Lāl Singh's work of 1913 were available, besides some peaks intersected at the close of Rai Rām Singh's triangulation of 1906 (see Appendix *A*, *sub* 69 K). Two latitude observations were also utilized.

The level assumed for the snow-line is quite conjectural and probably far too low, both surveyors having visited the ground very late in the autumn.

Astronomically observed latitudes.

1906-08.	Kara-tāsh Sai, Camp 106 (A. 1) ...	37° 52′ 24″
1913-15.	Khādalik, Camp 8 (A. 1)	37° 50′ 18″

NOTES ON SHEET No. 28 (TURFĀN)

The main routes passing through the central and the south-western portion of this sheet were surveyed in 1907. But most of these were followed again in 1914-15, and as much of the Turfān depression (B-D. 3) was then surveyed in detail on the scale of 1 mile to the inch and much fresh ground both to the north and south of it mapped, the greatest portion of the work now shown in this sheet belongs to the third expedition.

For the adjustment of the plane-table work, the position of the 'Yangi-shahr' of Turfān, falling near the centre of the sheet, furnished a convenient base. The value adopted for its longitude is 89°6′30″, this being the approximate mean between the value chronometrically observed by Mr. Clementi (89° 6′ 3″) and that accepted in the 1906-08 map (89°7′). The longitude shown in our map for the town of Lukchun, 89° 41′ 30″, receives welcome confirmation from the value of 89° 42′ 28″ which Roborovsky's astronomical observations indicate for his meteorological station, established close to that important town.

The latitude observation of 1907, as shown below, agrees with Mr. Clementi's within 22 seconds. The traverse along the main road eastwards was adjusted on the position adopted for Hāmi, and the traverse to the southwest on that of Korla. The shifting to the west which the latter position has under gone through erroneous adjustment of R. B. Lāl Singh's triangulation in the Kuruk-tāgh, as explained in group I of Major Mason's Appendix *A*, has affected also the positions of Singer (No. 29. B. 2) and Āltmish-bulak (No. 29. D. 3) in the adjoining sheet, with corresponding discrepancies in longitudes for the routes which from the Turfān basin lead south to these two places.

In addition to the latitude observations recorded below, several others taken by Mr. Clementi on the main road and by Russian explorers have also been used.

The details in the Turfān depression have as far as possible been taken from the one-inch survey carried out by M. Muhammad Yakūb from December, 1914, to March, 1915. This extended over practically the whole of the cultivated area of the Turfān basin, from Yamshi in the west to Pichan (No. 31. A. 3) in the east, and included a great portion of the depression in the south lying below sea-level. For this detailed survey a base was measured near Kara-khōja (C. 3), and the longitude of this place deduced from that of Turfān 'New Town' (Yangi-shahr).

One of the features which invest the

Turfān basin with special interest, as briefly mentioned above (p. 48) is the great depth below sea-level to which it descends in its lowest portion around the Aidin-kŏl marsh. It may hence be specially noted that the heights or depressions recorded in the map for the following places are derived from observations made with a mercurial barometer:

Kara-khōja, Camp 242 (house of Bēg, near N.E. corner of ruined town; C. 3), −110 ft.

Kara-khōja, Camp 242 (in Bāzār; C. 3), −140 ft.

Yār-mahalla, Camp 243 (house of Russian Ak-sakāl; C. 3), 250 ft.

Sai-kārēz, Deghar, Camp 275 (D. 3), −630 ft.

Tuz-kan, Camp 276 (near east end of dry lake-shore; D. 3), −940 ft.

Plane-table station, N.W. of Camp 276 (on dry lake-shore; D. 3), −980 ft.

Camp 277, (on edge of gravel Sai; C. 3), −860 ft.

Fixing S.W. of Camp 277 (on gravel Sai; C. 3), −720 ft.

Camp 279, N. of Bējān-tura (by bed of dry stream; C. 3), −780 ft.

Bējān-tura, Camp 282 (foot of ruined tower; C. 3), −910 ft.

Turfān, Yangi-shahr, Camp 280 (C. 3), −80 ft.

The approximate datum-line and contours below sea-level, at approximate intervals of 250 feet, have been shown by broken lines of greyish-green.

Other heights shown in this sheet are mostly derived from aneroid observations, checked in the case of those taken in 1914-15 by R. B. Lāl Singh, with reference to readings at mercurial barometer stations.

The assumed snow-line was fixed at a level of 12,500 feet with regard to the conditions observed on crossing the pass above Pa-no-p'a (B.1) on October 23, 1914.

As already observed above in Chap. I (p. 35) the Turfān basin reproduces on a small scale most of the physical features characteristic of the different zones of the Tārīm basin. Thus below the rugged T'ien-shan main range in the north, rising with part of its crest above the snow-line, we find a wide and utterly barren gravel glacis (B-D. 2). The underground drainage, caught by means of *kārēzes* at its foot and at that of a low but rugged outer hill-range which traverses the basin from east to west, supplies most of the irrigation for the richly cultivated tracts scattered north and south of that transverse hill-range.

Between and below these oases extends a belt of scrub-covered and for the most part sandy ground right down to the long-stretched narrow lake-bed, mostly dry and salt-encrusted, which occupies the deepest part of the basin. This descends near the eastern end of the lake-bed to a level close on 1000 feet below sea-level. To the east of these rises a dune-covered expanse, the Kum-tāgh, like a miniature Taklamakān. In the south there lies the ascent, over a gravel glacis and a succession of arid plateaus, to the northernmost of the Kuruk-tāgh ranges.

The northern end of the sheet shows the slopes of the T'ien-shan which descend, forest-clothed at elevations from about 6000 to 9000 feet and receiving ample water, towards the plateaus and open plains of Dzungaria. Extensive cultivation dependent on rainfall only is found on these northern slopes, evidence of the great climatic divide formed by the T'ien-shan range.

The historical importance of the Turfān depression, especially during the early Turkish (Uigur) domination, is attested by a large number of ruins within or close to the cultivated tracts. For a brief account of the visits paid to these in 1907, see *Desert Cathay*, ii. pp. 353 sqq.; *Serindia*, iii. pp. 1159 sqq. A short summary of my prolonged labours in the district during 1914-15 is given in *Geograph. Journal*, 1916, xlviii. pp. 202 sqq.

Astronomically observed latitudes.

1906-08.	Chong-hassār, Camp 267 (north of central keep of ruined fort; D. 3)	42° 39′ 7″
	Turfān, Yangi-shahr, Camp 274 (S.E. quarter of Chinese town; C. 3)	42° 55′ 39″
1913-15.	Ku-ch'êng-tzu (Guchen), Camp 235 (Nōgai trader's house in N.E. quarter of city; 28. C. 1)	44° 2′ 3″
	Kara-khōja, Camp 242 (Zāwat Bēg's house, N.E. of ruined town; C. 3)	42° 51′ 13″
	Yār-mahalla, Turfān, Camp 243 (Russian Ak-sakāl's house, 1¼ miles N.W. of Kōna-shahr; C. 3)	42° 57′ 59″

1913-15	Sai-kārēz, Deghar, Camp 275 (Bēg's house ; D. 3) ...	42° 35′ 1″
	Shōr-bulak, Camp 287 (close to spring ; A. 4) ...	42° 6′ 35″

NOTES ON SHEET No. 29 (SINGER, LOU-LAN)

The surveys represented in this sheet, which comprises the ancient territory of Lou-lan in the western portion of the Lop desert and the Kuruk-tāgh ranges to the north of it, date mostly from the third expedition. The work of 1906-08 is confined to the desert routes followed from the Tārīm to the ruins of the Lou-lan Site (D. 3) and back, and to that leading from Turfān to Singer (B. 2) and thence to Korla.

The exploration of all ancient remains traceable in the Lou-lan area, once passed by the Chinese high road from Tun-huang to the Tārīm basin, formed an important task both on the second and third expeditions. This accounts for the comparatively close network of traverses covering what is now all waterless desert of wind-eroded clay, salt and drift-sand, in the south-eastern quarter of the sheet.

In the course of compilation all plane-table work was adjusted on the positions which had been adopted for Āltmish-bulak, Korla and intermediate points on the basis of an erroneous adjustment of R. B. Lāl Singh's triangulation. This error arose through acceptance of the very distant connection between the northern and southern sections of the triangulation, which rays observed from the Āstin-bulak stations (D. 3) to Pk. 1/75 E (Peak 13,170, in Sheet No. 30. D. 2) were assumed to furnish. The reasons, which on re-examination in 1921 indicated faulty identification of this junction point and caused this distant connection to be rejected, are fully explained in Major Mason's notes in Appendix *A* (Groups H and I, para. 2). The position of Āltmish-bulak Camp Station, as previously adopted and shown in the map, is lat. 40°56′27″, long. 89°52′36″; the coordinates of the same, as determined on the basis of Mr. Clementi's values of Korla, are lat. 40° 53′ 29″, long. 90° 19′ 55″ (see Appendix *A*, Sheet N. K 46D). It deserves to be noted that Dr. Hedin's map assigns to Āltmish-bulak the values of lat. 40° 57′ 16″, long. 89° 59′ 24″.

The position of Āltmish-bulak as adopted in the map has resulted also in a shift to the west of that assigned to the Lou-lan Site (Camp 83, 124, at L.A. Stūpa ruin; D.3). This junction of numerous routes is now placed with long. 89° 46′ 20″ against 89° 52′ 40″ in Sheet No. 60 of the 1906-08 map and Dr. Hedin's longitude 89°50′53″ for the same point. The same may be noted also in the location of Singer (B.2), another important route junction, which is now shown with long. 88° 38′ 10″ against 88°47′ 40″ of the 1906-08 map.

In addition to the latitude values recorded below, use was made of one observed by Dr. Hedin on the Tārīm river (A.4).

The area comprised in this sheet, all desert and almost wholly waterless throughout, falls into two regions quite distinct in physical charcter. In the northern portion we have the utterly barren and much-decayed hill-ranges of the Kuruk-tāgh. They are divided by wide plateaus descending for the most part into drainageless basins, salt-encrusted and dry except after rare floods. The highest of these ranges is the one which, striking approximately from east to west, passes close to Singer. To the west of this, the only permanently inhabited place in the Kuruk-tāgh with a small patch of cultivation, the range culminates in the rugged Hsi-ta-shan (A.2), probably the greatest elevation of the whole Kuruk-tāgh.[14] To the east of Singer the rare springs found are all salt. What scanty vegetation exists is confined to the vicinity of springs and to some of the depressions.

From the gravel glacis at the foot of the Kuruk-tāgh, there extends southwards an utterly waterless desert, over-run by drift-sand and, wherever bare of dunes, undergoing

[14] As explained in Major Mason's note (Appendix *A*, Group I, para. 4), the heights shown in the map for triangulated points from Āstin-bulak to Korla were derived from the faulty connection above mentioned. They require an addition of about 237 feet, as now shown in the tables for International Sheets N. K-45 K, O, S, W, X, to bring them into accord with the height of the Āstin-bulak base (2,830 feet), derived from mercurial barometer readings.

excessive wind-erosion. Its triangular area is limited to the west and south by the Tārīm and its terminal marshes, and to the east by the salt-encrusted bed of the ancient dried-up Lop sea. Within this area the Kuruk-daryā, 'the Dry River', once fed by the Konche-daryā and partly, perhaps, also by branching beds of the Tārīm river, had its delta during early historical times.

Its water rendered nomadic occupation of the riverine belt in the north possible for the indigenous herdsmen and fishermen of Lou-lan, and along the same belt passed, until the beginning of the fourth century A. D., the ancient Chinese highway from Tun-huang. Its line is marked by the ruins of the Lou-lan Site and those explored by me to the west and north-east of it (D.3). The extension of the Kuruk-daryā delta much further to the south, too, is proved for the same period by the ancient river-bed, traced along the ruined sites which stretch from L. R. to L. K. (C, D. 4).[15]

A descriptive account of my explorations of 1906-07 in the Lop desert and among the ruins of the Lou-lan Site is given in *Desert Cathay*, i. pp. 359 sqq. The ancient topography of the Lou-lan territory and the physical features of the Lop desert, having a direct bearing on the early Chinese route which passed through it, have been fully discussed in Chapter IX-XI of *Serindia*; see in particular, i. pp. 332 sqq., 340 sqq., 349 sqq., 416 sqq. For a preliminary account of my renewed explorations in the Lou-lan region, during the winters of 1914 and 1915, cf. *Geograph. Journal*, 1916, xlviii. pp. 120 sqq., 206 sq.; *Geographical Review* (New York), ix. pp. 11 sqq.

Corrections. A. 4. *Chong-köl-satma* to be printed black.

C. 4. Symbols for ancient dwellings at L. M. Site (Camp xcii) should be printed red.

D. 3. 'Lou-lan Site' should be printed red.

Astronomically observed latitudes.

1906-08.	Lou-lan Station, L. A., Camp 124 (Stūpa ruin, near N.E. corner of circumvallation; D. 3)	40° 31′ 14″
	Camp 125, Lou-lan Site (about half a mile S.E. of temple ruins, L. B.; D. 3)	40° 34′ 30″
1913-15.	Yaka-yārdang-bulak, Camp 76 (tamarisk-cone near spring; A. 3)	40° 44′ 22″
	Lou-lan Station, L. A., Camp 83 (Stūpa ruin, near N.E. corner of circumvallation; D. 3)	40° 30′ 57″
	Örkash-bulak, Camp 248 (near spring; B. 1)	41° 59′ 13″
	Singer, Camp 250 (near station A of base, on S. bank of Nullah; B. 2)	41° 27′ 57″
	Āltmish-bulak, Camp 86 (near westernmost spring; D. 3)	
	(Camp of 1914, February)	40° 56′ 55″
	(Camp of 1914, December)	40° 56′ 48″
	Āstin-bulak, Camp 81 (at E. end of base, on E. bank of Nullah; D. 3)	40° 50′ 8″
	do. (near spring)	40° 50′ 40″
	Azghan-bulak, Camp 292 (at spring; A. 2) ...	41° 18′ 27″

NOTES ON SHEET No. 30 (LOP-NOR)

The surveyed area of the sheet shows the terminal course of the Tārīm, with the marshes usually known to geographers as Lop-nōr, as well as the ground extending southwards to the outermost range of the K'un-lun. Most of the routes were followed on both the second and third expeditions with slight variations.

The delineation of the mountainous ground in the south is adjusted to the stations and intersected points of R. B. Lāl Singh's triangulation of 1913. As a result of the error already referred to in the Notes on the preceding sheet and fully explained by Major Mason in Appendix *A*, the positions of the triangulated points from those near Toghrak-chap (B. 3) eastwards have been shown in the map with longitude values

[15] Here as in other parts of this ancient delta the direction of the old river-beds has been indicated by rows of symbols for dead trees. These, once growing on the banks of these beds, invariably mark their courses, even where partially filled by drift-sand or cut up by wind-erosion. As the map shows, the general direction of these beds south of the Lou-lan site is approximately from N.W. to S.E.

somewhat in excess of the true ones. This easterly shift increases from about 1 minute in the case of the Toghrak-chap base stations to about 5′ 10″ in that of Peak 1/75 E (13,170; D. 2), the easternmost of the triangulated points. For the correct longitudes, see Appendix *A* (Sheets 75 A, B, E, F).

The longitude adopted for Charkhlik (88° 2′ 10″) is the mean between Dr. Hedin's value and that shown by R.B. Lāl Singh's plane-table work (88° 1′). The longitudes adopted for Mīrān and Abdal are derived from traverses connected with triangulated points at the debouchure of the Mīrān river. The routes leading to the Lou-lan Site and Tikenlik are adjusted on the positions adopted for these places, and that along the southern shore of Lop-nōr on the position of Kum-kuduk (see Sheet No. 32). Besides the latitude observations shown below, a number of others along the Tārīm river were used from Dr. Hedin's work.

Descriptive accounts of the routes followed by me in 1906-07 and of the archæologically important ground near Mīrān are given in *Desert Cathay*, i. pp. 343 sqq., 427 sqq., 438 sqq., 503 sqq. The historical topography of the Lop territory, which during the first centuries before and after Christ included also 'Lou-lan', has been fully discussed in *Serindia*, i. pp. 318 sqq.; for that of the two small oases, Charkhlik and Mīrān, the only places of permanent occupation in modern times, cf. *ibid.* pp. 310 sqq., 326 sqq. [16]

Both these small cultivated patches occupy ground where the wide gravel 'Sai' descending from the foot of the mountains meets the southern edge of the belt of desert vegetation which accompanies the Tārīm river and its tributary, the Charchan-daryā. The junction of the two lies in the area marked by the lakes and marshes south of the fishing hamlet of Lop (A. 2). Apart from these two zones, the sheet shows in the north a dune-covered portion of the Lop desert, and in the north-east the western extremity of the great salt-encrusted bed of the dried-up Lop sea.

Corrections. A.3. Koyumal, Bāsh-koyumal should be printed red.

C.2. The latitude station symbol to be shown against Donglik (C. 142; C. 2) and to be removed from Mīrān Fort (B. 2).

Astronomically observed latitudes.

1906-08	Donglik, Camp 142 (near spring; C. 2)	39° 22′ 51″
1913-15	Charkhlik, Camp 20 (Bēg's house; N. of Bāzār; A. 2) ...	39° 1′ 35″
	Toghrak-chap, Camp 22 (E. end of base, on E. bank of Nullah; B. 3)	38° 57′ 9″
	Camp 24, S. of Mīrān (on east bank of Mīrān river; B. 2) ...	39° 12′ 12″
	Khunugu, Camp 27 (on east bank of river; D. 2)	39° 10′ 22″
	Mīrān, Camp 63 (within hamlet; B. 2)	39° 15′ 54″

NOTES ON SHEET No. 31 (PICHAN, CHIK-TAM)

The surveys represented in this sheet lay partly along both slopes of the T'ien-shan and partly in the westernmost portion of the Turfān basin (Pichan) and the desert plateaus to the east and south of it. With the exception of the high-road from Hāmi to Turfān followed in 1907, all the routes surveyed belong to 1914-15.

For the work shown north of latitude 42° 30′, the positions adopted for Turfān, Hāmi and Barkul served as base-points. In adjusting the traverses between them, use was made of the latitude observations shown below. The satisfactory character of the result is borne out by the close agreement with values astronomically determined by Dr. Vaillant in 1908 for two points on the Turfān-Hāmi high-road. [17] The small portion

[16] The early Chinese record discussed in the last quoted passage is of special geographical interest for the so called 'Lop-nōr problem', as it conclusively proves that at the very period when the ancient Lou-lan territory in the north still received water from the Kuruk-daryā, there existed a terminal lake of the Tārīm in a position corresponding to the present Lop-nōr, *recte* Kara-koshun marshes.

[17] See *La Géographie*, 1921, xxxv. p. 499. Dr. Vaillant's chronometric longitude for Pichan (position not recorded) is 90° 7′, 4 against 90° 8′ 30″ of our Pichan Camp 265, the latitude also agreeing within less than a minute. At Ch'ü-ku-lou, Camp 261 (D. 2) the latitudes are also identical, while Dr. Vaillant's longitude (91° 52′, 6) exceeds that shown on the map by only about 3 minutes.

of R. B. Lāl Singh's route in the south-western corner of the sheet is adjusted on the positions of Āltmish-bulak, its starting point, and of Turfān.

This route at Donglik, near its northern end (A. 4), struck an old desert track from the terminal basin of the Hāmi river, once used by hunters of wild camels before certain salt springs along it had completely dried up. A more northerly route which M. Muhammad Yakūb surveyed from the same basin to Chik-tam (B-D. 3) has also become impracticable to traffic for the same reason.

Apart from these desert plateaus in the south, which in their utter barrenness fully share the character of the eastern Kuruk-tāgh, there falls within this sheet the small portion of the Turfān basin around Pichan and Chik-tam. Like the rest of the cultivated area of the basin these oases owe their irrigation almost exclusively to Kārēzes which catch the subsoil drainage from the elevated portion of the eastern T'ien-shan. To the east of the meridian of Chik-tam the crest-line of the range falls considerably, and the moisture it receives is even on the northern slope too scanty to permit of cultivation in more than a few small patches (see B-D. 1). It is only to the west of that meridian that conifer forest is found on the northern face of the range, and a small village tract (Mu-li-ho, A. 1) with some grazing.

The southern slope of the range is far more barren still, and the passage of the Chinese highroad along its foot is made possible only by rare springs and wells and some scanty vegetation found in small basins (B-D. 2). The pass by which it crosses from Ch'i-ku-ching to the north of the range is low enough to be practicable for carts.

Astronomically observed latitudes.

1906-08.	Tung-yen-tzu, Camp 262 (close to Chinese station; C. 2) ...	43° 29′ 10″
	Pichan, Camp 265 (Bēg's house above W. bank of river bed, circ. 1 mile from town; A. 3) ...	42° 51′ 56″
1913-15.	Jam-bulak, Camp 236 (B. 1)	43° 39′ 16″
	Jōjan-kārēz, Camp 239 (village inn, 2 miles N.W. of Chik-tam post; B. 2)	43° 1′ 13″
	Tügemen-tāsh, Camp 271 (in patch of scrub; A. 4) ...	42° 6′ 13″

NOTES ON SHEET No. 32 (ANCIENT LOP LAKE BED)

With the exception of the caravan track leading along the southern shore of the ancient salt-encrusted Lop sea bed which had been followed before in 1907, all the surveys shown in this sheet date from my third expedition. Those in the northern half of the sheet belong exclusively to R. B. Lāl Singh's work of the winter of 1915, while most of those further south were carried out by Miān Afrāz-gul and myself.

In the S.E. corner the position of Kum-kuduk (D.4), on the caravan track from Charkhlik to Tun-huang, was fixed by adjusting the traverses on the positions adopted for An-hsi (see Sheet No. 38) and Mīrān (No. 30. B.2). The longitude thus derived, 91° 55′ 30″, was found to agree very closely with the one shown in Sheet No. 67 of the 1906-08 Map. For the correction of its latitude the observations taken in 1914 on the route both west and east of Camp 95 could be utilized.

The traverses of the routes followed to Kum-kuduk from Āltmish-bulak and the ruins north-east of the Lou-lan Site (A.3), were adjusted on the positions adopted for the latter two points as well as on Kum-kuduk.[18] The correction in longitude which the revised computation of R. B. Lāl Singh's triangulation indicates for Āltmish-bulak and the Lou-lan Site, has been referred to in the Notes on Sheet No. 29. The traverse carried by R. B. Lāl Singh from Yetim-bulak (A.3) northward through wholly unexplored parts of the Kuruk-tāgh was adjusted on the adopted positions of Āltmish-bulak and Deghar (in the Turfān depression; No. 28. D.4). A useful check was afforded by the series of latitude observations taken along this route (see below).

[18] It deserves to be noted that the two traverses carried across exceptionally trying ground by R. B. Lāl Singh and myself, respectively, differed at their junction at Kum-kuduk, Camp 95, cviii, only by about 2 miles in longitude and 3 miles in latitude.

The area represented in this sheet comprises two distinct regions. In the north there extend the low desert ranges and the plateaus of the Kuruk-tāgh; in the south, the great salt-encrusted basin occupied in prehistoric times by the Lop sea, together with its desolate shores of bare gravel or clay. Both regions are utterly lifeless, except for the occasional passage of wild camels. Their character is illustrated by the fact that apart from the wells of Kum-kuduk there is to be found no drinkable water in this vast area, nor living vegetation, except in scanty patches close to the rare salt springs in the north and in narrow strips along the shores of the great eastern bay of the ancient lake-bed (C,D.4). [19]

While the Kuruk-tāgh region here shown has never known human life except for rare visits of hunters in its western part, distinct historical interest is imparted to the lake-basin by the fact that across its wastes of hard salt-crust and along its equally barren shores of gravel and wind-eroded clay there led the route which from the second century B. C. onwards formed the earliest, and for a long time the chief, line of communication from China into the Tārīm basin. The complete 'desiccation' of the Lou-lan territory some four centuries later finally closed it to traffic. The Chinese historical notices of this Lop desert route and the topographical facts concerning it, as elucidated in the course of our surveys, have been set forth in *Serindia*, ii. pp. 553 sqq. [20]

The caravan track along the southern shore of the dried-up lake bed, is described in *Desert Cathay*, i. pp. 520 sqq. For a full account of the historical topography of this interesting route, the same which Hsüan-tsang (A.D. 645) and Marco Polo followed, see *Serindia*, Chapter XIV. sec. i-iii (ii. pp. 549 sqq.). A preliminary report on my explorations among the easternmost ruins of the Lou-lan territory (A. 3), and on the journey by which I traced the earliest Chinese route from Tun-huang to Lou-lan across the salt-encrusted Lop lake bed, is contained in *Geograph. Journal*, 1916, xlviii. pp. 126 sqq.; *Geographical Review* (New York), 1921, ix. pp. 22 sqq.

Corrections. A. 1. Delete the latitude station symbol from Bir-atai-bulak, Camp 270.

C. 3. For Achchik-bulak the height 2270 (aneroid; of 1913) ought to be adopted.

D. 4. For Kum-kuduk, Camp 52, the height 2245, observed by mercurial barometer, ought to have been shown. Delete height 2750 (aneroid) at adjoining Camp 95 and height 2730 (aneroid) at Camp 94.

Astronomically observed latitudes.

1913-15	Kaurük-bulak, Camp 88 (near spring; A. 2)	41° 4′ 0″
	Camp 92, southernmost Kuruk-tāgh (D. 3)	40° 35′ 0″
	Palgān-bulak, Camp 260 (near spring; A. 2)	41° 19′ 44″
	Camp 266, S. of Achi-tāgh (B. 1) ...	41° 45′ 24″

NOTES ON SHEET No. 33 (LOWAZA, BĀSH-KURGHĀN)

The two routes from which all the ground shown in this sheet was surveyed, are the only lines of communication now practicable between Tun-huang and the Lop region. They were followed both on the second and third expeditions, the latitude observations taken on the latter (see below) making it possible to lay down the route lines more correctly than before. The traverses of both routes are adjusted on the positions adopted for Mīrān and An-hsi. In the case of the former place, it must be noted that reconsideration of R.B. Lāl Singh's triangulation in 1921 brings its longitude about 2 minutes to the west of the one shown in Sheet No. 30. B. 2.

The route shown in the north-western portion of the sheet forms part of the old

[19] No vegetation of any kind, whether living or dead, was met with by R. B. Lāl Singh on his five long marches in the unexplored Kuruk-tāgh between Camps 262-267. I myself in February, 1914, left behind the last remains of dead vegetation near the easternmost ruin (*L. J.*) of ancient Lou-lan (A.3), and did not come upon any living vegetation until I had crossed some 120 miles of the salt-encrusted sea-bed and its shores to Camp cvi on the shore of the above-named bay (D. 4).

[20] For details of the ancient topography of this route as traced in the course of my surveys of 1914, cf. also *Serindia*, i. pp. 341 sq., 423 sqq.

caravan track along the southern shore of the salt-encrusted bed of the Lop sea. For its description and its historical topography, see the reference given above in the Notes on Sheet No. 32. As all the springs along this portion of the route are salt, it is used by caravans only from about December to early April, when the ice formed at those springs can be used for the supply of drinkable water. At other seasons the hill route along the northern slopes of the Āltin-tāgh, an easternmost extension of the K'un-lun, is alone available. This route, too, is rendered very difficult by the rarity of springs and the extreme barrenness of the ground. Regarding the historical topography of this route, mentioned in early Chinese records and now known to the Lop people as *tāgh-yol*, 'the mountain route', see *Serindia*, i. pp. 320, 418; ii. pp. 549, 622.

The portion of the Āltin-tāgh actually surveyed does not appear to reach the snow-line at any point and is characterized by extreme aridity. The wide glacis of gravel and detritus descending from it towards the ancient Lop sea-bed is overrun in parts by high drift-sand and is even more barren than the range. The occasional flood-water from the mountains is absorbed on this glacis. But the scanty subsoil drainage thus created probably accounts for the few salt springs and adjoining narrow reed-beds to be found along the well-marked shore-line of the salt-encrusted sea-bed at Lowaza, Kōshe-langza and Panja (A-C. 1).

Corrections. Replace height figure 1890 at Lowaza, Camp 57, by 2037 (cf. Appendix *B*).

Astronomically observed latitudes.

1906-08.	Panja, Camp 147 (at eastern spring; C. 1)	39° 59′ 31″
1913-15.	Tāsh-köl, Camp 33 (C. 2) ...	39° 9′ 4″
	Lowaza, Camp 57 (near spring; A. 1)	39° 46′ 5″

NOTES ON SHEET No. 34 (BARKUL, HĀMI)

Of the surveys recorded in this sheet, those to the north of the T'ien-shan and a few to the south of it belong to the third expedition, while most of the work on the latter ground dates from the autumn of 1907. The traverse along the main caravan road passing through the Hāmi or Kumul oasis had two observed latitudes and was adjusted on the positions adopted for Pichan (see Sheet No. 31) and An-hsi (No. 38).

The location thus derived for the town of Hāmi (C. 3) agrees very closely in longitude (circ. 93° 26′) with that shown by the Russian Trans-frontier map, but falls some 8 minutes to the east of Mr. Clementi's chronometric value (93° 18′ 16″). On the other hand the position obtained in the same way for Hoang-lung-kang, a small village on the highroad a short march to the south-east of Hāmi, agrees almost exactly in longitude (93° 44′ 40″) as well as in latitude with that observed by Mr. Clementi. The traverse made by M. Muhammad Yakūb from Toghucha (B. 2) to Pichan (Sheet No. 31. A. 3), when adjusted from the latter place, was found to indicate for Toghucha a position closely agreeing with that of the former survey.

On the route passing along the northern foot of the T'ien-shan, the position of Barkul (B. 1) was fixed by adjustment of the traverses to Ku-ch'êng-tzu and Turfān, corrected to its observed latitude; a further check for the longitude was supplied by the location of the Barkul-dawān (D. 2) in the 1906-08 survey. The longitude thus accepted for Barkul (92° 51′ 20″) falls about 4′ 40″ to the west of the one shown by the Russian maps. The indication of the snow-line at about 12,000 feet is necessarily conjectural, since the range between the meridians of Barkul and Hāmi was sighted on both journeys at the close of October when fresh snow had already fallen as low as the Barkul-dawān (circ. 9,200 ft.).

A short account of my stay at Hāmi and of the observations on archæological excursions thence made to the small oases of Ara-tam (D. 3) and Lapchuk-Kara-döbe (B. 3) has been given in *Desert Cathay*, ii. pp. 342 sqq. Notwithstanding the limited extent of cultivable ground, Hāmi, owing to its position on what has since the first Chinese occupation of the district (A. D. 73) remained a main line of traffic between Kan-su and Chinese Turkistān, has played an important part in China's political and commercial relations with Central Asia; its

historical topography is fully discussed in *ertndia*, iii pp. 1147 sqq.

The area comprised in the sheet falls into two climatically well-defined regions, divided by the easternmost extension of the T'ien-shan. To the north of it stretch the plateaus and open valleys of Dzungaria where the amount of precipitation received maintains sufficient grazing for nomadic existence and in places facilitates cultivation independent of irrigation. Owing to these conditions Barkul has throughout historical times played the part of a gate for nomadic invasions threatening the extreme north-west of China.

While on the northern slopes of the snowy part of the range, known here as Barkul-tāgh, conifer forest is abundant (A,B.1, C, D.2), the southern side of the range and the wide glacis of piedmont gravel along its foot are extremely arid. Leaving aside the small patches of cultivation to be found in the narrow and deep-cut valleys of the Karlik-tāgh eastwards (D.2,3), most of the cultivation in the fertile but small oases scattered along the foot of the gravel glacis from Toghucha-Lapchuk (B.3) to Hoang-lung-kang (D.3) is possible only through the use of subsoil water (*kara-su*) coming to light in the usually dry flood-beds.

The latter all terminate in the drainageless basin of the Shona-nōr (A.3), found in November, 1914, completely dry as far as M. Muhammad Yakūb's survey extended. To the south of the line of oases and the adjacent narrow belt of loess steppe with desert vegetation, the utterly barren Pei-shan 'Gobi' stretches its stony or gravel wastes.

Corrections. A. 3. Omit the latitude observation symbol at Oda-nōr.

B. 1 In the environs of Lake Barkul much difficulty was experienced in distinguishing real marsh areas from sandy ground with vegetation under temporary inundation.

D. 3. The name of *Ara-tam* near ruins should be printed red.

Astronomically observed latitudes.

1906-08.	Hāmi, Camp 252 (Bēg's garden near W. bank of river-bed outside town; C. 3)	42° 48′ 44″
	Taranchi, Camp 259 (field north of hamlet; B. 2)	43° 6′ 33″
1913-15.	Barkul, Camp 226 (temple beyond N.W. corner of Chinese town; B. 1) ... ... ,, ...	43° 36′ 29″

NOTES ON SHEET No. 35. (SU-LO-HO DELTA)

The surveyed part of this sheet shows the ground along the eastern portion of the desert route from the Lop region to Tun-huang, together with the geographically and archæologically interesting area containing the terminal course and marsh basin of the Su-lo-ho. The caravan track leading from Tun-huang to the southern shore of the dried-up Lop sea bed was followed both in 1907 and 1914, while the numerous detailed surveys to the north and south of it were also made on the second and third expeditions.

In compilation the several traverses along the desert track were fitted upon the positions adopted for Mīrān and An-hsi. The longitude values of Bēsh-toghrak, as derived thus from the route from Mīrān, and as obtained from the traverse from Āltmish-bulak agreed within a few minutes. The mean adopted between them, circ. 92° 46′ 40″, falls short by only two minutes of the longitude shown in Sheet No. 70 of the 1906-08 map; but account must be taken also of the correction, already referred to under Sheet No. 30, which the reconsideration of the triangulation of 1913 indicates for the position of Mīrān. Owing to prolonged explorations along the ancient Chinese *Limes*, comparatively numerous latitude observations were available for the ground near the terminal course of the Su-lo-ho.

In view of the special geographical interest which, as stated above, pp. 30 sq., attaches to the well-defined valley stretching down from near Bēsh-toghrak to the easternmost bay-like extension of the dried-up Lop sea bed, a line of exact levelling was carried from a point north of Kum-kuduk, marked by C. XCVIII (Sheet No. 32. D. 4), to the western edge of the ancient lacustrine basin showing strings of Mesas and wet sand to the east of Bēsh-toghrak (B. 3). The heights shown along this line of levelling against Camps XCVIII—CII, as well as the

height 2,391 for the western edge of that basin, are derived from this levelling operation. The height of Bēsh-toghrak (2,340), obtained as the mean of several observations, was accepted as datum point.[20a] The record of levels, as shown in Appendix *C*, proves a continuously descending slope from the ancient lacustrine basin to the dried-up Lop sea bed.

A descriptive account of the ground along the caravan track, as seen on my first passage, is given in *Desert Cathay*, i. pp. 525 sqq.; ii. pp. 1 sqq., and a summary of its characteristic features in *Serindia*, ii. pp. 549 sqq.; cf. also *Geogr. Journal*, 1916, xlviii. pp. 129 sq. The topography of the ground south of the Su-lo-ho, along the ancient Chinese border line or *Limes* (C,D.4), and of that on its western flank which the terminal marsh basin of the Su-lo-ho served to protect (C.4), has been touched upon *passim* in the account given of my fruitful archæological explorations on this Limes portion, in *Desert Cathay*, ii. pp. 92-158. The physical character and historical topography of the ground along the several sections of the Limes has been discussed in the detailed record of those explorations, in *Serindia*, ii. Chapters XVII-XIX; see in particular pp. 633 sqq., 656 sq., 662 sqq., 693 sqq., 705 sqq. There frequent reference has been also made to the evidence furnished by the ancient remains and records regarding the physical conditions, water levels, etc., prevailing here during the first centuries before and after Christ.

Though limited in extent and fairly uniform in character, the surveyed area of this sheet possesses special geographical interest. It comprises the wide trough of the terminal course of the Su-lo-ho, separating the southernmost Kuruk-tāgh from the gravel glacis of the easternmost Altin-tāgh. To the north of the marshy depression (B,C. 4) in which the present bed of the river ends, we have other branches, now dry, of an ancient delta descending into an earlier terminal basin; the lacustrine character of this is clearly marked by its strings of Mesas.[21]

Immediately to the west of this basin, the 'Su-lo-ho trough' is continued in the previously mentioned valley leading down from Bēsh-toghrak to the eastern bay of the dried-up Lop sea bed. There is evidence supporting the belief that through this northern basin the Su-lo-ho drainage reached the ancient Lop sea until a recent geological period.[22] It is probable also that percolation from it, even within historical times, helped to facilitate the use of the Bēsh-toghrak valley for the early Chinese route towards Lou-lan. It certainly accounts for the desert vegetation to be found today in this valley, notwithstanding the utter barrenness of the Kuruk-tāgh on one side of it, and of the high ridges of drift-sand on the other.

Along the Su-lo-ho course and the line of spring-fed marshes which accompany it, such vegetation is abundant. But the configuration of the ground precludes irrigation, and the evidence of the plentiful documents recovered from the ruined watch-stations of the *Limes* makes it certain that already in ancient times no cultivation existed along this desolate border-line.

Corrections. A. 4. R. B. Lāl Singh's Camps 50 and 51 of 1913 should be shown circ. 6 miles S.W. of Kosh-kuduk and circ. 7 miles S.W. of Yantak-kuduk, respectively. Against Camp 50 of 1913 should be added the height 2,500.

C. 4. The height of Toghrak-bulak should be corrected into 2,837 (see Appendix *B*).

Astronomically observed latitudes.

1906-08. Bēsh-toghrak, Camp 152 (at well; B. 4)	...	40° 29′ 41″
Toghrak-bulak, Camp 154 (on left bank of river bed; C. 4)		40° 19′ 35″

[20a] It must, however, be noted that the mercurial barometer observation taken in 1913 indicated for Bēsh-toghrak a height of 2,010. ft. only; cf. below Appendix *B*.

[21] Exactly corresponding strings of Mesas are found at the end of the narrow plateau-tongues jutting out into the actual terminal basin of the Su-lo-ho (C. 4), as correctly shown in the 'Detailed Map of the ancient Chinese Limes', 3 miles to 1 inch, in Plan 33 of *Serindia*, vol. iii.

I regret that the representation of this feature, characteristic also of other lacustrine basins along the Su-lo-ho, *e. g.*, the Khara-nōr and the lagoons below it (Sheet No. 38. A. 4), has been omitted in the small-scale map. The origin of these Mesas has been explained in *Serindia*, ii. pp. 576, 589, 642.

[22] See *Serindia*, ii. pp. 551 sq.

	Camp 172, Su-lo-ho terminal basin (at spring, S. of ruin T. VI. b; C. 4)	40° 8′ 16″
1913-15.	Camp 46, Chong-köl (at springs, S. of lake, W. of ruin T. XI; D. 4)	40° 19′ 59″
	Camp 51, S.W. of Yantak-kuduk (at well, same as C. 150; A. 4)	40° 18′ 25″
	Su-lo-ho basin, 9 miles S.W. of Camp 102 (east of sand-ridge; B. 4)	40° 13′ 14″
	Toghrak-bulak, Camp 103 (above left bank of river bed; C. 4) ...	40° 19′ 26″

NOTES ON SHEET No. 36 (KHANAMBAL OR ANAMBAR)

The outermost ranges of the Āltin-tāgh and their glacis towards the Su-lo-ho terminal basin, shown in this sheet, were surveyed mainly from the *tāgh-yol* or 'hill route' connecting Tun-huang with the Lop region and already mentioned above (Sheet No. 33). This was followed by Rai Rām Singh in 1907 and again by R. B. Lāl Singh in 1913. The belt of high sand-ridges fringing the southern edge of the glacis was reached by reconnaissances from the termination of the ancient Chinese *Limes* in 1907. The traverses along the 'hill route' have been adjusted on the positions adopted for Mīrān and Nan-hu (Sheet No. 39). The observations of 1913 at Khanambal (C. 2) and Su-mu-t'ou (D.1) have proved the latitudes shown for these places in Sheet No. 75 of the *Serindia* map as correct within about a minute.

References regarding the historical topography of the 'hill route' have been given in the Notes on Sheet No. 33. The range along which it leads is exceedingly barren also in this section; but some modest grazing is found at Khanambal, a winter camping ground of Mongols, and at Khalastai, while a little patch of cultivation exists at Su-mu-t'ou, occupied by a couple of Chinese families.

Astronomically observed latitudes.

1913-15.	Khanambal, Camp 39 (north bank of river-bed; C. 2)	39° 15′ 36″
	Su-mu-t'ou, Camp 42 (N. end of cultivation; D. 1) ...	39° 49′ 32″

NOTES ON SHEET No. 37 (KARLIK-TĀGH)

This sheet shows the surveys made along the Karlik-tāgh, the eastern extremity of the T'ien-shan range, and those carried towards it from the south-west across the northernmost Pei-shan desert. With the exception of the caravan road from An-hsi to Hāmi and some routes in 1907 on the southern slopes of the snowy portion of the Karlik-tāgh, all belong to the third expedition.

The positions accepted for Barkul, Hāmi, An-hsi and Su-chou in adjoining sheets have served for the adjustment of the several traverses, besides the latitude observations noted below. For two points on the Hāmi–An-hsi caravan road latitude and chronometrically obtained longitude values of other travellers are available for control. Dr. Vaillant's position of Yen-tun (A. 4), 42° 21′,6 lat., 94° 4′,9 long., agrees closely in latitude with that shown in the map, while his longitude is about 2 minutes less than on the map. At K'u-shui (B. 4) Mr. Clementi's observed latitude is the same, but his longitude value, 94° 26′ 25″, is exceeded by fully 8 minutes on the map; this difference conforms to that already noted as regards Hāmi (see *sub* Sheet No. 34).

It is satisfactory to note that M. Muhammad Yakūb's traverse from Ming-shui (No. 40. A. 1) to Tāsh-bulak (A. 3) shows between his Camps CLXI and CLXIV very close agreement with the careful route survey carried by Professor K. Futterer over the same ground.[23]

The approximate snow-line shown on the 12,000 ft. contour is necessarily conjectural, the range having been surveyed

[23] See Dr. Hassenstein's map (1 : 500,000) in Futterer, *Geographische Skizze der Wüste Gobi*, Petermann's Mittheilungen, Ergänzungsheft No. 139 (1902). Prof. F.'s *Utun-oszü* corresponds to *W'u-t'ung-wo-tzu* (C. 4), while his *Utun-da-tschuan*, where his route diverged to the south, lies probably in the same depression as Mu-t'on-ching (D. 4), but some little distance to the south.

I may note that the Chinese local names which Muhammad Yakūb heard from his guide along this route could not be checked from any record in Chinese characters.

both in 1907 and 1914 after fresh snow-fall in October.

The historical topography of the Chinese 'highroad' from An-hsi to Hāmi has been discussed by me in *Serindia*, iii. pp. 1141 sqq., and also in connection with the adventurous desert crossing of Hsüan-tsang (A. D. 631). The record of this in the pilgrim's *Life* throws interesting light on the physical features of the forbidding 'Gobi' to the S.E. of Yen-tun; cf. *Geograph. Journal*, November 1919, pp. 273 sqq. For a brief account of the route followed in 1914 from Mao-mei to the northern slopes of the Karlik-tāgh, cf. *Geograph. Journal*, xlviii. pp. 200 sq.

Here in its easternmost portion the T'ien-shan, as elsewhere along its far-flung line, forms a great geographical divide. To the north of that part of the range which raises its crest above the line of perpetual snow and which is appropriately known as *Karlik-tāgh*, 'the Snowy Mountains', we find plateau-like ground (A. 2), typical of Dzungaria, with abundant grazing and water more than sufficient for the limited area actually under cultivation. But eastwards where the range steadily falls in height, ultimately to merge in the plains of Mongolia, the character of its northern slope rapidly changes and the wide amphitheatre of piedmont gravel surrounding the small village of Bai (C. 2) is as arid as any 'Sai' of the K'un-lun.

The southern slope of the Karlik-tāgh is extremely barren throughout, and only where subsoil drainage from the snows is available for the irrigation of naturally fertile loess beds at the top of the gravel glacis, is permanent occupation possible, as marked by the string of small oases from Khotun-tam to Tāsh-bulak.

The southern glacis of the T'ien-shan sinks down to a trough-like depression which is clearly marked from Chin-êrh-ch'üan (D. 4) down to Yen-tun on the An-hsi–Hāmi road (A. 4) and probably extends for some distance beyond to the south-west. This depression, not unlike that of the Su-lo-ho but without running water throughout, divides the T'ien-shan glacis from the desert uplands of the Pei-shan. The northernmost range of the latter projects into the south-eastern corner of this sheet and is crossed by the Shuang-ch'üan-tzu pass (D. 4). The absolutely bare glacis of the same desert range is crossed further west by the very exposed and much dreaded portion of the caravan road between K'u-shui and Yen-tun (A, B. 4).

Corrections. B. 3. The road-line west of C. CLXIV should be marked as leading to Hāmi.

D. 4. A vegetation area with spring should be shown 8 miles S. E. of Pan-tzu-ch'üan, with a route diverging to the south.

A pass symbol to be added against Shuang-ch'üan-tzu pass.

Astronomically observed latitudes.

1906-08.	K'u-shui, Camp 248 (south of station; B. 4) ...	42° 2′ 50″
1913-15.	Chin-êrh-ch'üan, Camp 215 (to W. of springs; D. 4)	42° 28′ 58″
	Bai, Camp 220 (near Bēg's house, by stream; C. 2)	43° 13′ 6″

NOTES ON SHEET No. 38 (TUN-HUANG, AN-HSI)

The greater portion of this sheet, in the north, comprises the desert ranges and plateaus of the Pei-shan. Here the survey was confined to the ground along the Chinese cart road leading from An-shi to Hāmi and followed in 1907; only in the north-eastern corner and in the south-west were hill features observed from routes of the third journey. The southern part of the sheet shows the wide trough-like valley of the lower Su-lo-ho course, together with the foot-hills of the westernmost Nan-shan range. This ground, owing to the archæological and historical interest of the remains I was able to trace of the ancient Chinese border-line along the Su-lo-ho course, was surveyed on numerous routes both in 1907 and 1914.

The various traverses were adjusted on the position adopted for An-hsi (D.3). The observed latitude is 40° 31′ 38″. The longitude 95° 57′ was derived from the closely concordant results of the three traverses brought in 1914 from the side of Tun-huang (or Sha-chou; B. 4). This longitude showed a difference of only one minute from the value assigned to An-hsi in Sheet No. 81 of the 1906-08 Map and was hence finally accepted. But inasmuch as the longitude

shown for Tun-huang, 94° 47′, is itself affected by the erroneous adjustment of R. B. Lāl Singh's triangulation which, as explained above under Sheet No. 30, brought the easternmost triangulated point on the Mīrān–Tun-huang route by 5′ 10″ too far to the east, it is possible that the longitude value adopted for An-hsi is also somewhat overestimated. This suspicion is borne out by Mr. Clementi's chronometric longitude value for An-hsi, which is 95° 47′ 20·6″, and by Dr. Vaillant's values for Tun-huang and Hung-liu-yüan (D. 2), N.W. of An-hsi, each derived from observation of two lunar occultations. These are 94° 36′,5 and 95° 23′,7 against circ. 94° 47′ and 95° 33′ respectively in our sheet. [24]

Roborovsky's observations at Tun-huang (Sha-chou), based on chronometric values and taken with special care, indicate for his station (a short distance from the town and almost due N. of it) the longitude of 94° 42′ 24″. [24a] This agrees very closely with the position derived from our surveys and shown in this sheet, 94° 47′, if allowance is made for the correction of – 5′ 10″ which, as just mentioned, has to be made in the longitude of the easternmost triangulated point near the Mīrān–Tun-huang route.

It deserves to be further noted that the plotting of available traverses from the Tibet side brings An-hsi to a longitude of about 95° 52′, and that the Russian Trans-frontier map shows one of approximately 95° 58′. The various routes radiating from Tun-huang and An-hsi are controlled by the comparatively large number of latitude observations recorded below.

Regarding the historical topography of the An-hsi–Hāmi 'highroad', see the references given above for Sheet No. 37. The geographical features of the lower Su-lo-ho basin have been fully discussed in *Serindia*, ii. pp. 578 sqq., with special reference to the natural line of defence offered by the Su-lo-ho for the earliest Chinese road into the Tārīm basin past Lou-lan. There, too, I have indicated the importance of the large oasis of Tun-huang with regard to this road and the irrigation facilities it derives from its situation on the alluvial fan of the Tang-ho, the largest tributary of the Su-lo-ho.

For descriptions of the desert belt, both marsh-edged and gravel 'Sai', extending along the Su-lo-ho from the Khara-nōr lake towards the cultivated area of An-hsi, and followed by the line of the ancient Chinese *Limes*, see *Desert Cathay*, ii. pp. 5 sqq., 40 sqq., 131 sqq.; for the oases of Tun-huang and An-hsi, and the important sacred site of the 'Thousand Buddhas' near the former, see *ibid*, ii. pp. 10 sqq., 159 sqq., 235 sqq. The topography and remains of the *Limes* sections falling within this sheet are treated in *Serindia*, ii. pp. 585 sqq., 717 sqq.; iii. pp. 1089 sqq.

Within the area of the sheet we distinguish three well-marked zones. In the north the surveyed route towards Hāmi, first opened by the Chinese in A.D. 73 and since then a main line for China's Central-Asian expansion, crosses in succession the much-decayed hill ranges of the Central Pei-shan. Those shown on the map between the stations Sha-ch'üan-tzu (B.1) and Pi-ting-tzu (D.3) are manifestly connected with the five Pei-shan ranges distinguished by Professor Futterer's very careful topographical and geological survey along his more easterly route from near Mu-t'ou-ching (No. 37. D. 4) to near the Su-lo-ho bend (No. 40.B.4). [25] On both routes water and scanty grazing can be found only in a few isolated depressions of the broad desert valleys separating those ranges.

The low southernmost range of the Pei-shan towards the west seems to merge in an outlier of the Kuruk-tāgh (A,B.3). Between it and the foothills of the Nan-shan in the south extends the trough of the lower Su-lo-ho valley. The portion lying to the west of Tun-huang entirely shares the character of the delta and terminal basin of the Su-lo-ho, as shown in Sheet No. 35. C,D.4.

The abundant supply of water provided

[24] Cf. *La Géographie*, xxxv (1921). p. 499. The uncertainty inherent to all astronomical longitude observations under ordinary travel conditions is illustrated by the fact that the same observer's list shows for Ch'ien-fo-tung (B.4) a longitude of 95° 6′ which is quite irreconcilable with the position of this place relative to Tun-huang, the longitude difference indicated being at least 16′, if not more, in excess of the real one.

[24a] See *Scientific Results of Roborovsky's Expedition* (Russian), Astronomical Observations, p. 7; also his map, scale 20 versts to 1 inch.

[25] See Futterer, *Geograph. Skizze der Wüste Gobi*, in Petermann's Mittheilungen, Ergänzungsheft No. 139, pp. 11-22 and map.

by the Tang-ho for irrigation on its alluvial fan accounts for the fertile oasis of Tun-huang. The local resources of this western-most outpost of China proper were of special importance during the early period when the Lop desert route, protected in part by the Tun-huang *Limes*, served as the chief line of traffic into Central Asia. East of Tun-huang the flat bottom of the Su-lo-ho valley narrows, and at the starting point of the Hāmi road it i occupied for the most part by the cultivation of An-hsi, the ancient *Kua-chou*. The facilities here for irrigation by the Su-lo-ho are limited, and thus are also the extent and economic importance of the oasis.

Finally in the south extend the utterly barren foothills of the Nan-shan. The outermost chain, immediately south of Tun-huang, is completely overlain by high ridges of drift-sand which have given the town its later name of *Sha-chou*, 'the City of Sands'. Behind this outer hill-chain a wide plateau, mostly bare gravel waste, slopes up towards the well-defined second low range (D. 4) within which lies the small oasis of Tung-pa-t'u. The T'a-shih river coming from the snowy range further south has cut its way through both outer chains in deep narrow gorges.

Corrections. A. 4. Add ancient wall-line between towers T. XXII b and T. XXII c and eastwards to lake-shore.

B. 4. Add symbol of astronomical latitude station at Ch'ien-fo-tung.

Astronomically observed latitudes.

1906-08.	Tun-huang town, Camp 159 (garden about 1 mile S. of South gate; B. 4)	40° 8′ 9″
	Ruined watch-tower, T. XXVIII, ancient *Limes*, Camp 164 (C. 4)...	40° 25′ 45″
	Ch'ien-fo-tung, Camp 178 (monks' quarters near S. end of caves; see *Serindia*, iii. Plan 42; B. 4) ...	40° 2′ 37″
	Kua-chou-k'ou, Camp 181 (near station; D. 4)	40° 22′ 7″
	An-hsi, Camp 182 (house near temple circ. 1 mile S.W. of West gate; D. 3)	40° 31′ 38″
	Ma-lien-ching-tzu, Camp 245 (near rest-house; C. 1)	41° 33′ 40″
1913-15.	Camp 107, about 9 miles to E. of camp (B. 3)	40° 32′ 49″
	Tun-huang town, Camp 110 (garden about ½ mile outside E. gate; B. 4)	40° 8′ 55″
	An-hsi, Camp 120 (temple circ. 1 mile S.W. of West gate; D. 3)	40° 31′ 56″

NOTES ON SHEET No. 39 (NAN-HU)

The surveyed area of this sheet shows a portion of the extreme western end of the Nan-shan system and possibly its junction with the Āltin-tāgh. Of the morphological connection between the two I am unable to form any definite view. The ground around the small oasis of Nan-hu (A. 1) was explored by me in 1907 and the high plateau above Shih-pao-ch'êng (D. 1) visited in the same year. The survey of the intermediate area was made by R. B. Lāl Singh in 1914.

A description of the Nan-hu oasis, which is of some antiquarian and historical interest as marking the position of the '*Yang* barrier' of the ancient Chinese border-line, is given in *Desert Cathay*, ii. pp. 71 sqq. The historical topography and physical features of this ground have been fully treated in *Serindia*, ii. pp. 611 sqq.

The positions adopted for Tun-huang and An-hsi in Sheet No. 38 and the adjusted traverse of the *tāgh-yol* from Mīrān to the former place served as a basis for the compilation of the plane-table work. Besides the observed latitude of Nan-hu, the astronomical values for Ch'ien-fo-tung (No. 38. B. 4) and Shih-pao-ch'êng (No. 41. A. 1), places falling just outside this sheet, offered a useful check.

The deep-cut, and for a considerable distance wholly inaccessible, valley of the Tang-ho or Tun-huang river divides the surveyed area into two portions, both closely allied in character. In the western one the great gravel glacis holds a basin with fertile loess soil, and irrigation supplied mainly by subsoil drainage permits limited cultivation here under conditions closely resembling

those of the small oases below the glacis of the K'un-lun east of Khotan.[26] To the west and south of Nan-hu, the gravel glacis and the low ridges emerging from it are often overrun by dunes of considerable height. Further to the south rise two successive ranges which, as Sheet No. 36 shows, are continued westwards.

In the eastern portion we can distinguish three chains of which the southernmost and highest forms the outer rim as it were of the mountain wall containing the region occupied by the drainageless plateaus of Makhai and Tsaidam. In the east (D. 1) this chain is joined by another which, though lower, has its distinct continuation eastwards to the middle course of the Su-lo-ho and beyond among the Central Nan-shan ranges.

Elsewhere, the southernmost chain sinks down with uniformly gentle slopes of detritus and gravel to the outer chain of dune-covered foothills south of Tun-huang (B,C.1). Without having seen the ground myself I am unable to judge whether on this intervening wide plateau indications can be traced of the second outer chain, that of Tung-pa-t'u (No. 38. D. 4) and Ch'iao-tzu (No. 40. A. 4), buried among the huge accumulations of detritus. Throughout the westernmost Nan-shan far-advanced decomposition is a very striking feature.

Correction. In the 'Index to adjoining sheets', Sheet Nos. 41 and 42 should read 40 and 41 respectively.

Astronomically observed latitude.

1906-08. Nan-hu, Camp 168 (central hamlet, fields west of 'Yār'; A.1) 39° 54′ 39″

NOTES ON SHEET No. 40 (YÜ-MEN-HSIEN)

The area comprised in this sheet divides itself like that of Sheet No. 38, of which it forms the eastward continuation, into two well-defined zones. The northern and much larger one, surveyed in 1914 on a single and previously unexplored route, is occupied by the desert ranges and plateau-like valleys of the Pei-shan. In the south extends the eastern portion of the lower Su-lo-ho valley and the adjoining depression of Hua-hai-tzu. The former is flanked on the south by the outermost hill chains of the Nan-shan and the latter by the end of a hill-range continuing north-westwards of Su-chou.

This southern zone was surveyed from different routes of both the second and third journeys. The plane-table work in this sheet is adjusted for the routes in the southern zone on the positions accepted for An-hsi and Su-chou (Sheets Nos. 38, 43), and for the route in the northern zone on those of the latter place and Barkul (Sheet No. 34). Observed latitudes available for six points are recorded below.

The ground shown in the south-western corner of the sheet was explored by me in the summer of 1907 for the sake of the ruined sites near Ch'iao-tzu and Wan-fo-hsia (A. 5) and is described in *Desert Cathay*, ii. pp. 242 sqq. The historical topography of the ground along the ancient highroad leading from Su-chou past the oasis of Yü-mên-hsien to An-hsi (Kua-chou) and Tun-huang is discussed in *Serindia*, iii. pp. 1099 sq., 1136 sqq.

That the ancient Chinese *Limes*, meant for the protection of this great line of communication, crossed the Su-lo-ho at the extremity of the Wang-shan-tzu ridge (A. 4) and thence lay along the right bank of the river as far as Shih-êrh-tun, near its southerly sharp bend (C. 5), was ascertained by me already on my rapid passage of 1907. But the *Limes* line along the right bank of the river and its continuation further east into the Hua-hai-tzu basin was surveyed only in 1914; cf. *Geograph. Journal*, 1916, xlviii. pp. 194 sq. For brief notes on the desert journey of 1914 across the Pei-shan, see *loc. cit.* p. 200.

The wholly unsurveyed area of the Pei-shan, traversed and mapped on this journey from Mao-mei (Sheet No. 42. D. 4) to the easternmost end of the T'ien-shan, proved to conform closely in character to that further west, crossed by the An-shi–Hāmi 'high-road' and briefly referred to in the Notes on Sheet No. 38. The detailed description of our route to be recorded hereafter will furnish support for this statement. Here it must suffice to point out that the succession of much-decayed and utterly barren ranges, striking generally from east to west, shown on our map from the north of Ming-shui

[26] See above pp. 45, 74.

(A. 1) to the south of Lo-t'o-ching (D. 3), appears to correspond in position and configuration to the first four ranges of the Pei-shan, described and mapped by Professor Futterer on his route from west of Ming-shui to the Su-lo-ho bend. [27]

Just as is the case on this far more westerly route, the second and third of the ranges, encountered by us north of Camps 212 and 209 respectively (B. 2, C. 3), showed the highest pass-levels, but without any strikingly great elevations above either pass. [28] Whereas, however, on Prof. Futterer's route-line the wide valleys or plateaus separating the ranges all seem to descend gently westward, those crossed by our route invariably appeared to have their drainage to the east or north-east, *i.e.*, in the direction of the Etsin-gol valley and basin. The chain of low hills shown on our map extending north of the Su-lo-ho bend and the Hua-hai-tzu depression, and an easterly continuation crossed by our routes from Mao-mei (Sheet No. 42. B, C. 3), evidently represent the fifth and southernmost Pei-shan range.

The zone in the southern part of the sheet shows several geographically interesting features. In the west we have the head of the lower Su-lo-ho valley, below the river's debouchure from the mountains. Further down (A. 4) its bed is hemmed in by a well-marked defile between the bold Wang-shan-tzu ridge, representing the eastern extremity of the outermost Nan-shan chain on the south, and a flat spur of the southernmost Pei-shan range on the north.

Into the basin-like head of the lower Su-lo-ho valley thus formed, there slopes down the almost imperceptible watershed, dividing it from the plateau between the two outer hill chains of the Nan-shan, which contains the small oases of T'a-shih and Ch'iao-tzu (A. 5). The latter derives its irrigation from springs, and the existence of a large ruined site above these, at the foot of a gravel glacis sloping down from the outer Nan-shan range to the south, here offers clear evidence of desiccation within historical times. [29] Whether this outer range, the second from the north, has a traceable continuation eastward on the wide gravel glacis sloping up towards the Su-lo-ho debouchure remains doubtful.

The oasis of Yü-mên-hsien (C. 5) derives its name from the ancient 'Jade Gate' (*Yü-mên*) of the *Limes*, originally situated in Han times far to the west of Tun-huang (No. 35. D. 4). Its cultivation stretches down to the neighbourhood of a practically level flat of scrubby, and in parts boggy, ground dividing the Su-lo-ho valley from the Hua-hai-tzu depression eastwards. This peculiar feature accounts for the curious bifurcation previously mentioned by which the Su-lo-ho, partly through irrigation channels and partly through inundation in the season of floods, feeds a stream flowing past the hamlets of Shih-êrh-tun and Shih-tun into the Hua-hai-tzu basin. [30]

This last named basin (D. 5) is a drainageless area, bordered in the north by the foot of the outermost Pei-shan range and in the south by a rugged hill-chain which trends to the south-east and attains its greatest height near Chia-yü-kuan west of Su-chou (No. 43 A. 1). The relation of this hill-chain to the Ala-shan mountain system, of which it appears like an extreme western continuation, must remain for the present doubtful. Apart from the stream below Yü-mên-hsien there drain into the Hua-hai-tzu basin the rivers of Ch'ih-chin and Po-yang-ho, coming from the Nan-shan and cutting through the hill chain just named in deep gorges. The subsoil drainage from the former gathers in springs below its alluvial fan and supplies irrigation to the

[27] See above p. 95, note 25.

[28] See Futterer, *loc. cit.*, p. 17. The highest point of Futterer's route, reached on the pass of his third range was 2,130 metres or 6,988 feet. This corresponds almost exactly to the elevation of our pass, 7,010 feet, across the Ma-tsun-shan (C. 3), the third range from the north.

[29] Cf. *Serindia*, iii. pp. 1100 sqq.

[30] See above pp. 32, 50. Prof. Futterer's above quoted paper, *Geograph. Skizze der Wüste Gobi*, p. 24, mentions that the Chinese 'Wu-chang Map', dating from the 17th century, shows a long-stretched lake or marsh bed to the north of the Su-lo-ho bend, extending also for a considerable distance to the east. This extensive lake has continued to be shown in modern maps, though its existence was rightly denied by Russian travellers.

The question as to how far the Chinese cartographic representation can be accounted for by the boggy ground below Yü-mên-hsien *plus* the basin of Hua-hai-tzu must be left for examination elsewhere. The line followed by the remains of the ancient *Limes*, which I traced both to the east and north-west of Shih-êrh-tun, makes the existence here of an extensive lake during or since Han times highly improbable.

small oasis of Hua-hai-tzu or Ying-p'an in the centre of the basin.

Corrections. A. 5. Add name *Wan-fo-hsia* in red against symbols of cave temples at Camp 186.

C. 5. For *Shih-êrh-t'un* read *Shih-êrh-tun*.

Astronomically observed latitudes.

1906-08.	Ch'iao-tzu, Camp 184 (large temple within S.W. corner of circumvallation; A. 5)	40° 19′ 40″
	Ch'ih-chin-sê, Camp 237 (rest-house near ruined temple on left river-bank; D. 5)	40° 5′ 34″
1913-15.	Shih-êrh-tun, Camp 125 (in hamlet S. of stream; C. 5) ...	40° 28′ 18″
	Lo-t'o-ching, Camp 208 (near spring; D. 3)	41° 10′ 29″
	Tsagan-gulu, Camp 211 (near spring; B. 2)	41° 47′ 31″
	Ming-shui, Camp 213 (at well, close to ruined enclosure; A. 1) ...	42° 2′ 6″

NOTES ON SHEET No. 41 (CH'ANG-MA)

The sheet shows the mountain area surveyed from the foot hills of the Western Nan-shan to the high snowy range dividing the upper Su-lo-ho valley and the headwaters of the T'a-shih river from the plateaus drained by the sources of the Tang-ho or Tun-huang river. All the work here shown was done in 1907. The plane-table traverses have been adjusted on the positions accepted for An-hsi and Su-chou; for the correction to which the longitude of the former place is probably subject, see Notes on Sheet No. 38. Observed latitudes are available for three points in this sheet.

For a brief description of the ground seen between the headwaters of the T'a-shih river (A. 1) and the T'u-ta-fan pass (D. 1), see *Desert Cathay*, ii. pp. 262 sqq.; for that of the ranges on either side of the upper Su-lo-ho course falling within the S.E. corner of the sheet, cf. *ibid.* ii. pp. 320 sq.

Within the mountain area comprised in this sheet may be sought the division between the Western and Central Nan-shan. But along which line this division could conveniently be placed does not appear clearly from the topographical facts observed by me. Except for one important distinction, that of climatic conditions, the division might be treated as merely conventional; for the grouping into several parallel ranges which is characteristic of the Central Nan-shan has its close counterpart also in the western portion of the mountain system.

Whereas, however, all these ranges in the west, almost up to the snow-covered slopes of the southernmost and highest, are extremely arid, a distinct change to the moister climate of the Central Nan-shan was observed by me in the valley leading up to the T'u-ta-fan pass (D. 1). From there to the east ample vegetation, found even in the valleys of the outermost range and at comparatively low altitudes, affords evidence of a far more abundant rain- and snow-fall.

No such signs of increased humidity were observed by me on crossing the Su-lo-ho valley near Ch'ang-ma (B.1). In the oasis of Ch'ang-ma, lying more than 7,000 feet above the sea, cultivation depends wholly on irrigation from subsoil drainage, caught where it comes to the surface at the foot of the huge gravel glacis descending from the high snowy range to the south. Further east, however, conditions seem less arid; for there surface drainage from the outer ranges is available for the small patches of cultivation found on the plateau (D.1) between the Nan-shan foothills and the chain south of the Hua-hai-tzu basin.

The climatic difference just mentioned is clearly reflected also in the snow line level which our observations made in July-August, 1907, indicated. In the high range south of Ch'ang-ma it seemed to lie at an elevation represented by an approximate contour line of 17,250 feet, whereas further east, in the ranges sighted from the T'u-ta-fan (D. 1) and on our way to the Su-lo-ho headwaters, the snow-line descended distinctly lower and has been shown accordingly at a level approximately corresponding to 16,000 feet.

As already noted, the disposal into successive parallel ranges which is peculiar to the Central Nan-shan continues also into this sheet. But owing to the absence of well-marked longitudinal valleys between them, and partly also in consequence of the

gap left in our surveys on either side of the middle Su-lo-ho course (C, D. 2,3), the exact connection between the clearly defined Nan-shan ranges eastwards (see Sheet No. 43) and those in this sheet is more difficult to trace. This question of morphological relationship must be left for future expert investigation. I may however record the impressions derived from what our surveys in the outer ranges and those of Roborovsky and Kozloff along and south of the Su-lo-ho suggest.

The latter surveys made it appear highly probable that the high snowy range in the south, called by Russian explorers after the great geologist, the late Professor Suess, has its continuation in the big range south of Ch'ang-ma (A,B.1,2) rising to peaks above 19,000 and 20,000 feet and crossed by the Ta-kung-ch'a pass. The next range northward, called after the Emperor Alexander III, may well be connected with the one which our route from the T'a-shih river showed as striking with an approximately west-east bearing from near Shih-pao-ch'êng (A.1); the conspicuous massif of the Erh-lung-shan south of Ch'ang-ma (B.1) might be taken for a link in the chain. The To-lai-shan range may be traced in the succession of high peaks our sheet shows as running towards the 'Chu-chia-shan' just north-west of Ch'ang-ma, this chain itself having its continuation in the direction of the low but very distinct range south of T'a-shih and Ch'iao-tzu (No. 40.A.5). Finally it is tempting to recognize the western extremity of the Richthofen Range, the northernmost of all, in the range which stretches from the T'u-ta-fan pass (D.1) to the north-west, the Yao-mo-shan and Tung-yüeh-shan (C.1) being among its culminating points, and the Su-lo-ho debouchure below Ch'ang-ma (No. 40.B.5) breaking through it. If this assumption is justified the low hill-chain overlooking the lower Su-lo-ho valley from Wang-shan-tzu (No. 40.A.5) to Tun-huang might well prove the last western outlier of the same range.

Addition. A. 1. The name 'T'a-shih R.' should be shown in blue along the river-bed passing Shih-pao-ch'êng.

Astronomically observed latitudes.

1906-08. Shih-pao-ch'êng, Camp 188 (on right bank of river-bed, half a mile N. of ruined fort; A. 1)	39° 49′ 3″
Ch'ang-ma-pao-tzu, Camp 193 (temple near west wall of central village; B. 1)	39° 51′ 45″
Ch'ing-ts'ao-an-tzu, Camp 197 (near temple; D. 1) ...	39° 53′ 35″

NOTES ON SHEET No. 42 (CHIN-T'A)

The area surveyed in this sheet during the spring and summer of 1914 comprises the south-eastern extremity of the Pei-shan, the eastern portion of the Hua-hai-tzu basin and a part of the wide trough in which the rivers of Kan-chou and Su-chou (Pei-ta-ho) unite to form the Etsin-gol. The positions accepted for An-hsi and Su-chou served for the adjustment of the plane-table work in the latter two sections, while the traverse through the Pei-shan was plotted upon the two terminal points of Barkul (No. 34. B.1) and Mao-mei (D. 4). For the latter place a latitude observation was available, the longitude value being derived from the mean of two independent traverses from Su-chou.

Historical and antiquarian interest is imparted to the ground in the south by the line of the ancient Chinese *Limes*, the remains of which I succeeded in tracing from the Hua-hai-tzu basin to the point where it crossed the Etsin-gol below the northern end of Mao-mei cultivation. For a brief account of this border-line and the forbidding desert ground through which most of it was constructed, see *Geograph. Journal*, 1916, xlviii. pp. 195 sq. The ground at and beyond the oasis of Chin-t'a (B, C. 4) which I visited in 1907 on my first fruitless search for the *Limes* line in this direction, is described in *Serindia*, iii. p. 1134.

The south-eastern portion of the Pei-shan shown here completely shares the character of the utterly barren ranges and plateaus adjoining to the north-west and briefly described in the notes on Sheet No. 40. The fifth and southernmost of the Pei-shan ranges was crossed by our route south of the coal pits of Mou-wo (B. 3). In the eastern part of the Hua-hai-tzu

basin (A. 4) the appearance of belts of drift-sand and wind-eroded clay terraces, features common to all ancient lacustrine depressions further west, may be noted.

A stony plateau separates this basin from the ill-defined valley containing the end of the Pei-ta-ho above its junction with the Kan-chou river. The narrow but long-stretched cultivation areas of Chin-t'a and Mao-mei share the physical features characteristic of all terminal oases in the Tārim basin. The high dune ridges which stretch parallel to the Kan-chou river course on the east (D. 4), help to illustrate this similarity of aspect on the map.

Corrections. C. 4. For *T'o-tun* (Camp 235a) read *T'on-tun.*

Astronomically observed latitudes.

1913-15.	Camp 130, N.E. edge of Hua-hai-tzu basin (A. 4) ...	40° 20′ 58″
	Mao-mei, Camp 138 (temple outside S.E. corner of town walls; D. 4)	40° 17′ 49″
	Shuang-ch'êng-tzu, Camp 139 (temple, 1 mile north of village; D. 4)	40° 24′ 50″
	Mou-wo, Camp 204 (near N. coal pits; B. 3) ...	40° 42′ 40″

NOTES ON SHEET No. 43 (SU-CHOU)

The surveys recorded in this sheet belong for the most part to the second expedition, but were to a considerable extent supplemented in the portions lying along the northern edge of the sheet and in its easternmost section by work done in 1914. The extensive routes surveyed on the second journey all closed upon their starting point, Su-chou (B.1), and the position adopted for this important city served as a pivot for the compilation of the sheet. The latitude of 39° 45′ shown for it is derived from closely concordant astronomical observations made on both journeys at the temple of Chiu-ch'üan outside the eastern city gate. The longitude of 98° 33′ now adopted represents the mean between Mr. Clementi's chronometrical value (98° 26′ 56·3″) and the value previously accepted by the Survey of India. It differs but slightly from the longitude assigned to Su-chou in Sheet No. 88 of the 1906-08 map in *Serindia.* The routes leading to Su-chou from the west and south-east have been adjusted on the accepted positions of An-hsi and Kan-chou, respectively (*see* Notes on Sheets Nos. 38, 46).

The southern portion of the sheet comprises an extensive mountain area occupied by the four main ranges of the Central Nan-shan. Its delineation on the plane-table was greatly facilitated by the distant views gained from above the high passes over which the three northernmost of these ranges were crossed, as well as by the open character of the ground in the wide valleys which separate them. The topography of the high spurs which descend from the Richthofen Range to the east of the Ma-yang-ho valley (C, D. 2, 3), received important additions by the survey made by R. B. Lāl Singh in 1915 from the side of the Li-yüan-ho.

The approximate elevation of 15,500 feet, adopted for the snow-line in the portions of the Central Nan-shan falling within this sheet, is derived from what I observed when crossing its passes in August, 1907, and the photographic panoramas then taken support it.

For a fairly detailed descriptive account of the ground visited in 1907 between the plateau at the north foot of the Richthofen Range and the high mountain chain overlooking the headwaters of the Su-lo-ho, Kan-chou and Ta-t'ung rivers from the south, see *Desert Cathay*, ii. pp. 297 sqq.; for that of the famous defile of Chia-yü-kuan, the westernmost 'Gate' of China 'within the Wall', and of the Su-chou oasis east of it, see *ibid.* ii. pp. 273 sqq. The historical topography of the 'passage land', which this western end of the mediæval 'Great Wall' was intended to close, and that of the mountain region which adjoins on the south, has been discussed in *Serindia*, iii. pp. 1116 sqq., 1124 sqq. Brief references to the ground visited by me north of the Chinese high road passing from Kan-chou to Su-chou will be found in *Geograph. Journal*, xlviii. pp. 196, 200.

The area shown by this sheet aptly illustrates the three main regions into which the ground between the Central Nan-shan

and the Etsin-gol basin is divided. The chief physical features of these regions have been indicated above in section vi of Chapter II, and brief reference to their extent and character will suffice here.

The mountain region in the south clearly shows the wide trough-like uplands at the headwaters of the Su-lo-ho and the Su-chou and Kan-chou rivers, as well as the tortuous narrow gorges in which these rivers have cut their way through the two northern ranges of the Nan-shan. The increased moisture of the climate eastwards is demonstrated by the forest growth which the map shows at elevations from about 8,000 to 10,000 feet in the valleys approaching the watershed of the Pacific drainage, as marked by the Ta-t'ung river (C, D. 4).

In the same direction the change in the character of the Richthofen Range, from a steep mountain rampart into a system of broad spurs with easier slopes at their top, becomes noticeable. This change in the lateral expansion of the Richthofen Range determines the width of the second region, that of the plateau-like belt stretching along its northern foot. Owing to the line of oases comprised in it this belt has formed an important 'land of passage' all through historical times.

At the north-western end of the belt we have the large oasis of Su-chou, occupying the broad alluvial fans of the Pei-ta-ho and of the smaller rivers which to the east of it descend from the Richthofen Range. Further east the width of the plateau at the foot of the range is still great. But the lesser volume of water carried by the streams here draining it restricts the cultivated area to a string of minor oases along their alluvial fans, from Chiu-fo-ssu (B. 2) to Nan-ch'üan (D. 2). The rest of the belt consists here mainly of scrubby steppe, affording ample winter grazing, with interspersed areas of drift-sand (C, D. 1, 2). Beyond the lower course of the Hsi-ta-ho (D. 2) a projecting outer spur of the range, bare and much eroded, confines the plateau-like belt to its narrowest limits near the town of Kao-t'ai.

The northern edge of the second region is formed throughout by a low and utterly barren hill-range (A-D. 1), representing a western extension of the Ala-shan. This hill-range with its slopes of bare gravel or sand shares throughout the character of the Etsin-gol basin described in the Notes on Sheets Nos. 44, 45. Cultivation stops above the points where the rivers of Kan-chou and Su-chou break through the desert range (B. 1, D. 1) to unite further down near the isolated oasis of Mao-mei (Sheet No. 42. D. 4).

Astronomically observed latitudes.

1906-08.	Chia-yü-kuan, Camp 200 (near springs, south of eastern gate of fort, A. 1)	39° 48′ 16″
	Su-chou, Camp 201 (at Chiu-ch'üan temple, outside eastern gate of city; B. 1)	39° 45′ 6″
	Chin-fo-ssu, Camp 203 (garden, circ. 1 mile to south of eastern gate; B. 2)	39° 25′ 27″
	Ta-pên-kou, Camp 207 (gold miners' camp; B. 3)	38° 59′ 54″
	Camp 211 (at spring near bed of southern tributary of Pei-ta-ho; A. 3)	38° 54′ 54″
	Camp 214 (above bed of rising Su-lo-ho; A. 4)	38° 29′ 28″
	Camp 223 (on right river bank, north of Fêng-ta-fan; D. 3)	38° 38′ 31″
	Chien-ch'üan-tzu, Camp 231 (D. 2)	39° 20′ 3″
1913-15.	Su-chou, Camp 133 (at Chiu-ch'üan temple, outside eastern city gate; B. 1)	39° 44′ 51″
	Lo-t'o-ch'êng, Camp 165 (within ruined town; D. 2)	39° 20′ 59″

NOTES ON SHEETS Nos. 44,45 (ETSINGOL, ETSIN-GOL DELTA)

These two sheets may conveniently be commented upon together as they combine to show the course of the Etsin-gol from below Mao-mei right down to its terminal lake basins. The route in the extreme south-west (45.A.4) was fitted upon the position adopted for Kan-chou (46. B. 3), and the rest of the traverses in these sheets compiled on the

observed latitudes in the azimuth derived from this setting. All surveys were done in May-June, 1914, when the atmospheric conditions of the season seriously interfered with both astronomical observations and distant views.

The terminal course of the Etsin-gol and the drainageless basin into which it carries all the moisture brought down from the ranges of the Central Nan-shan, are of distinct geographical interest, both in their physical aspects and with regard to historical topography. The route leading along the river has always possessed importance as a great natural highway from the Mongolian steppes into westernmost Kan-su and thus into China. This has been briefly explained by me in *Geograph. Journal*, 1916, xlviii. pp. 196 sqq., with special reference to Marco Polo's notice of the 'City of Etzina', marked by the ruins of Khara-khoto (45.C.1), and to Chingiz Khān's conquest of Kan-su. There, too, attention has been drawn to the striking parallel presented by this route to that once leading from Tun-huang, past the ancient Lop sea bed, to Lou-lan and the Kuruk-daryā delta. The evidence of desiccation noticed along the Etsin-gol aptly illustrates conditions such as are likely to have prevailed in the Lou-lan area before its final abandonment.

The riverine area comprised in our surveys falls into three distinct sections. From below Mao-mei to the outlying rocky spur of Bayin-bogdo (45.B.2), the river is confined to a single wide bed, lying in a trough which is flanked on the west by the steep gravel glacis of the Pei-shan and on the east by one sloping down more gently from the westernmost hill chain of the Ala-shan.

At the southern end of the Bayin-bogdo spur the river spreads out into a steadily widening delta. Among a number of traceable branches but few ever receive water now, and these, too, only during the short season of summer floods. For the greater part of the year water can be obtained in them only from wells dug in deep hollows at rare intervals. Yet in the narrow belts of riverine jungle flanking the beds, wild poplars are found living right down to the two terminal salt lakes, the Gashūn-nōr and Sogo-nōr, (No. 44. C.3,4).

The presence of these two lakes separated by a well-marked ridge and occupying different levels—the Sogo-nōr lies about 200 feet higher than the Gashūn-nōr [31]—strikingly illustrates the relations which our surveys at the end of the Su-lo-ho delta have led me to suppose between that river's present terminal marsh bed and the ancient lacustrine basin found at the head of the Bēsh-toghrak depression. [32]

There is definite evidence, as the map shows, of the shrinkage which the Sogo-nōr must have undergone in comparatively quite recent times, and which is obviously connected with the drying-up of the eastern beds of the delta. Having been prevented by my excavations at the Khara-khoto site from visiting the terminal depression myself, I am unable to judge what indications of older shore-lines, etc., may also be traceable in the case of the larger lake. In the north the whole basin is fringed by low hills, evidently outliers of the great Altai system of Mongolia proper.

Corrections. 44. C.4. *Owang-gol* should be printed in blue.

45. B. 1. For *Kök-zilgda* read *Kök-zigda*.

Astronomically observed latitudes.

1913-15. Buk-tokhai, Camp 142 (on right bank of Etsin-gol, near ruined tower; 45. B.3) ... ... 40° 58′ 32″

Atik-tsagan, Camp 145 (on right bank of Etsin-gol; 45.C.1) ... 41° 30′ 27″

Ulān-bōrūk, Camp 151 (on right bank of western river branch; 44.B.4) 42° 3′ 0″

NOTES ON SHEET No. 46 (KAN-CHOU)

The surveys recorded in this sheet represent the easternmost extension of our work. They were made mainly in June-August, 1914; but some of the routes west

[31] This difference of level is marked also in the Russian Transfrontier map No. XXII, which shows the Sogo-nōr at 2,885 feet above sea-level and the Gashūn-nōr at 2,790 feet.

[32] See above pp. 31, 92.

of Kan-chou were surveyed on the second expedition.

The compilation of the sheet is primarily based on the positions adopted for Su-chou (see Notes on Sheet No. 43) and Kan-chou. The latitude of the latter city was determined by closely concordant astronomical observations taken on the two journeys (38° 55′ 41″ and 38° 55′ 36″, respectively). But the plotting of the several traverses carried on the third expedition between Kan-chou and points lower down on the Kan-chou river (No. 43. D. 1, 2) has led to a change in the longitude value assigned to Kan-chou. It is shown now as 100° 38′ 20″ against 100° 49′ 30″ in the map of the second journey (see Sheet No. 94. D. 1 in *Serindia*, vol. v).

This new value approximates very closely to the longitude of Kan-chou as indicated in Sheet No. XXI of the Russian Asiatic Transfrontier map (circ. 100° 37′ 30″), but differs notably both from Mr. Clementi's chronometric longitude, 100° 21′ 29·16″, and that adopted by the Survey of India in previous publications, approximately 100° 49′ 30″. These discrepancies as to the position of an important and well-known city strikingly illustrate the need of exact longitude observations by telegraphic or wireless methods along this great highroad from China into Central Asia.

The area shown in this sheet corresponds in all essential physical features to the three regions distinguished in Sheet No. 43, of which this is the continuation. In the south we have the eastern portion of the Central Nan-shan, as far as it is drained by the headwaters of the Kan-chou river and by its upper tributaries. The broad valley of the O-po-ho, the river's eastern main feeder (B. 4, 5, C. 5), is a *pendant* to the wide uplands met near the sources of the river's main western branch (No. 43. B, C. 3). But the snow-line appears to lie somewhat higher on the eastern continuation of the enclosing ranges. The difficult gorges in which the Kan-chou river, below the junction of both branches, has cut its way through the Richthofen Range, are impassable except in the depth of winter and still await their explorer.

The plateau stretching along the northern foot of this range gradually widens south-eastwards as the spurs descending from the latter recede. The large cultivated area around Kan-chou (A, B. 3) is accounted for by the fact that the abundant waters of the Kan-chou river can be utilized here to full advantage for irrigation over a wide alluvial fan. The same holds good also with regard to the oases around Sha-ho-p'u (A. 2), irrigated by the Li-yüan-ho.

To the east of the longitude of Kan-chou cultivation along the foot of the Richthofen Range becomes independent of irrigation, owing to the increased precipitation which approach to the Pacific drainage assures. This important change of climatic conditions is duly reflected also in the extensive patches of conifer forest which the map shows here right down to the foot-hills (A. 3, B, C. 4). Further away from the Nan-shan, however, this influence of a moister climate appears to diminish rapidly, and north of latitude 38° 45′ no cultivation seems possible without irrigation.

The hill range which on the north separates the inhabited plateau from southernmost Mongolia rises in the vicinity of Kan-chou to heights well over 10,000 feet; yet its slopes are uniformly barren throughout. The route surveyed from Mao-mei to the Kan-chou river near Kao-t'ai (A. 1, 2) afforded striking evidence of the great aridity of the climate prevailing in the belt of low hills and wide desert valleys which stretches north of the middle course of the Kan-chou river.

The route through the mountains, followed in 1907 from the Kan-chou river headwaters to the city of Kan-chou, is described in *Desert Cathay*, ii. pp. 328 sqq. For observations on the historical topography of the Kan-chou tract and of the old Chinese highroad passing through it, see *Serindia*, iii. pp. 1131 sqq. Brief preliminary notes on the routes followed by me in 1914 from the Etsin-gol basin to Kan-chou, and thence to the eastern headwaters of the river, are recorded in *Geographical Journal*, xlviii. pp. 199 sq.

Astronomically observed latitudes.

1906 08. Sha-ho-p'u, Camp 227 (above left river-bank, outside eastern gate; A. 2) ... ... 39° 9′ 24″

	Kan-chou, Camp 228 (temple outside S.E. corner of city wall; B. 3)	38° 55′ 41″
1913-15.	Kan-chou, Camp 168 (temple near S.E. corner of city wall; B. 3)	38° 55′ 36″
	Nan-kou-ch'êng, Camp 171 (near temple outside N.E. corner of town wall; B. 3)	38° 32′ 18″
	Hung-shui, Camp 172 (temple outside S.W. corner of town wall; B. 4)	38° 25′ 24″
	Camp 175, above left bank of O-po-ho (B. 4)	38° 0′ 4″
	Hsin-ch'êng-pao, Camp 186 (temple south of walled village; D. 4)	38° 12′ 2″

NOTES ON SHEET No. 47 (KUNGURCHE).

The surveyed area in this sheet is restricted to a narrow belt of hilly ground which was visited only by M. Muhammad Yakūb, while accompanying the camels of my caravan during their summer grazing-time. The boundary between 'independent' Mongolia and Chinese territory passes through this ground, and objections raised on the Mongolian side prevented the surveyor from extending his plane-table work further. It has been plotted in conjunction with the traverses in Sheets Nos. 44, 45.

Judging from their general east-west bearing these low hill chains of Kungurche seem to belong to the southern Altai system.

APPENDIX A

A SHORT SUMMARY OF, AND DISCUSSION INTO, THE MERITS OF THE TRIANGULATION EXECUTED BY RAI SĀHIB RĀM SINGH AND RAI BAHĀDUR LĀL SINGH, SURVEY OF INDIA, DURING THE THREE EXPEDITIONS OF SIR AUREL STEIN, K.C.I.E., IN CHINESE TURKISTĀN

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INTRODUCTORY

The triangulation discussed below falls into nine groups, *viz.*,

(A)—On the Tāgh-dumbāsh Pāmīr, 1900-01 (Rām Singh).

(B)—In the neighbourhood of Muz-tāgh-atā and the Little Kara-kul, 1900-01 (Rām Singh).

(C)—At Tāsh-malik hill, 1900-01 (Rām Singh).

(D)—Near Tāsh-kurghān fort, 1906-08 (Rām Singh).

(E)—South and east of Khotan, 1900-01 (Rām Singh).

(F)—From Achchan to Kapa, 1906-08 (Rām Singh).

(G)—In the headwaters of the Yurung-kāsh, 1908, (Lāl Singh).

(H)—From Kapa to latitude 39° 0′, longitude 89°47,′ 1913-15 (Lāl Singh).

(I)—From Āstin-bulak to Korla, 1913-15 (Lāl Singh).

Basis of triangulation.

It must be remembered that at the time of these operations, with the exception of one or two points on the K'un-lun mountains south of Khotan, no intersected points, from which the observers could resect their position, had been rigorously fixed by the Survey of India; and that therefore the relative accuracy and value of the triangulation are dependent on the merits of Capt. Deasy's work, on which it is largely based.

On the Pāmīrs there existed a few points fixed by Colonel Wauhope during the Pāmīr Boundary Commission of 1895, but they alone were insufficient for the needs of R. S. Rām Singh at any one of his stations.

Deasy's and Wauhope's work were both connected indirectly by resection to unmarked peaks fixed by the Survey of India. Neither of these observers could be certain that he resected his own positions from the exact points observed by the Survey triangulators, and Rām Singh and Lāl Singh must have been in doubt as to the exact summits, fixed by Deasy and Wauhope, from which they resected their own stations. In many cases the peaks employed had been intersected from long distances by badly formed triangles and were themselves liable to some error.

Sources of possible error

Wauhope's work is known to have been accurate within a very few seconds, and the regular work of Deasy is also good. Nevertheless, in many cases, the stations of the latter have been fixed by observed latitudes and azimuths to distant peaks, determined previously by himself or Wauhope, and the intersection of the azimuthal ray and the latitude parallel has been very acute, thereby introducing a further error.

The accumulation of small errors may become large in the aggregate, and since all resection work from unmarked peaks must introduce uncertainty, it is remarkable that the triangulation described below is in the main so accurate.

At the same time, it is absolutely necessary to lay stress on the fact that it is in the nature of pioneer work, and that when the regularly connected triangulation of the Survey of India reaches the areas concerned, the points of Rām Singh and Lāl Singh will be superseded, as has indeed already been the case on the Tāghdum-bāsh Pāmīr. The fixed points of the systematic work should therefore invariably be used for extensions, wherever possible, even if it should mean a considerable delay in commencing operations. These points are shown in the tables under class A.

As will be seen from what follows, section (I) is disconnected entirely from the rest of the work and is dependent on a single observation of Cecil Clementi. The work of the latter, where it has been capable of check, has been found generally accurate, but should the value of Korla be subsequently revised, it will be possible to convert the whole of this section bodily into the new terms.

Method of classification of peaks, &c.

In the accompanying lists, the Survey of India method of classification has been adopted, points and stations have been grouped by degree areas, and peaks have been given formal "peak numbers" which bear no relation to those in the original angle-books. Points fixed with a higher order of accuracy are listed under class A, while those derived from explorers' reconnaissance triangulation are shown under class B.

(A)—ON THE TĀGHDUM-BĀSH PĀMĪR, 1900-01 *(RĀM SINGH)*

Rām Singh's work was entirely based on resection from three peaks of Captain H.H.P. Deasy's triangulation in 1897-99. Since these pioneer operations were executed, the Tāghdum-bāsh has been covered with a net-work of triangles, observed with greater accuracy during the Indo-Russian Link, rigidly connected with the G. T. work of India, and adjusted to Indian terms on the Everest spheroid.

The three peaks of Captain Deasy used by Rām Singh were Pks. 11, 24 & 25/42K. During the Indo-Russian triangulation the first two were converted into the stations Karakokti and Tomtek respectively. The values obtained by Deasy and the Indo-Russian observers were

Point	observer	latitude			longitude		
		°	′	″	°	′	″
Pk. 11/42K ...	Deasy ...	37	12	50	74	43	49
Karakokti H. S. ...	Indo-Russian ...	37	12	9·05	74	44	30·98
Pk. 24/42K ...	Deasy ...	37	11	51	74	58	34
Tomtek H. S. ...	Indo-Russian ...	37	11	18·02	74	58	58·47

While the observer of the rigorous work cannot be certain that his stations are identical with Deasy's peaks, he is of opinion that they are probably within a few feet of them, since his stations are on the highest points in the immediate vicinity, and no other peaks exist where shown by Deasy. In the above cases the positions given by Deasy are approximately 41 and 33 seconds too far north and 42 and 22 seconds too far west.

Deasy's Pk. 25/42K was not identified during the Indo-Russian work, but the observer believes that a peak exists roughly a mile south-east of Deasy's position for it, which discrepancy would agree tolerably well with that of the other peaks shown above. These errors in the

initial points are not excessive, considering the nature of the work, and they are all in the same direction; nevertheless they are sufficient to throw out Rām Singh's work which was based on it on the Tāghdumbāsh; and since this area is now rigorously triangulated and surveyed on the one-inch scale, Rām Singh's work is now superseded, and is not tabulated in the data here given.

(B)—IN THE NEIGHBOURHOOD OF MUZ-TĀGH-ATĀ AND THE LITTLE KARA-KUL, 1900-01 *(RĀM SINGH)*

(*Vide* charts 42J, K, and O).

Rām Singh's work in this region is independent of his triangulation on the Tāghdumbāsh, discussed above; but it is still dependent largely on Deasy's work.

The latter is based on observed latitudes and azimuths to Pk. 5/42K and Pk. 3/42O, of the Pāmīr Boundary Commission; these were proved to be accurately fixed within a very few seconds by the subsequent Indo-Russian work. Small corrections of −4″·7 (latitude) and −3″·3 (longitude) have since been applied to the Boundary Commission work to bring it into the terms of the Indo-Russian, but Deasy's observations are not sufficiently precise to warrant the application of this small correction.

Rām Singh's work from camp 9, in this area, was based almost entirely on resection:

"A"	was fixed from	Pks. 14 and 21/42O, and Pk. 14/42K (Deasy).
"B"	do.	Pks. 1 and 14/42O (Deasy) and Pk. 3/42O (Boundary Commission).
"C"	do.	"A" h. s., "B" h. s. and Pk. 3/42J, which latter was fixed from "A" and "B".
"D"	do.	"A", "B", and "C" h. s.
Camp 9	do.	"C", "D" h. s. and Pk. 5/42K, which latter was fixed from "C" and "D".

Checks were available at camp 9, and the latitude as derived above was 17 seconds greater than the astronomical value. At the same camp, a longitude check was afforded by an azimuth to the Pāmīr Boundary Commission value of Muz-tāgh-atā. The longitude value derived by the check was 35 seconds less than that found by the previous computations.

The heights of these stations were not very satisfactory; that of 'A' h. s. is derived from the observations to Pk. 14/42K and Pk. 21/42O, the mean of the two values 15,155 and 15,011 feet being accepted, though it would perhaps have been better to give less weight to the latter, as the peak is very distant. The height of 'B' h. s. was also derived from the mean of two observations and that of 'C' and 'E' obtained from 'A' and 'B'.

The height of camp 9, near Little Kara-kul, was from the mean of those derived from 'C' h. s., 'D' h. s. and the Pāmīr Commission value of Muz-tāgh-atā, *viz.*, 11,054, 11,014, and 11,041, which also agree very well, considering the nature of the work. The height, (25,146), of Pk. 4/42K, (Kongur I), is derived from the mean of two observations from 'A' h. s. and 'D' h. s., differing by 135 feet.

In view of the above considerations, and owing to Deasy's work being well based in this area, Rām Singh's triangulation is accurate for exploration work, and more so than on the Tāghdum-bāsh; *inter se* the work is accordant, and the error in position is probably less than half a mile from Survey of India terms.

(C)—TASH-MALIK, "E" H. S., 1900-01 *(RĀM SINGH)*

(*Vide* charts 42M and K).

This station was fixed by resection from Pks. 2 and 3/42K, previously observed by Deasy from Kāshgar, and Pk. 4/42K, (Kongur I) of Rām Singh's earlier work. By the latter observation alone, it is very weakly connected to his triangulation in the Little Kara-kul area.

Deasy's fixings of Pks. 2 and 3/42K are not very good, being based on an observed latitude and a chronometric longitude at Kāshgar. Only one of his chronometers was working fairly satisfactorily and from a comparison with Sir F. De Filippi's careful observations for latitude and longitude at Kāshgar in 1914, it is probable that his position, though fairly

correct for latitude, is some 30 seconds too far west in longitude. This naturally introduces an error into Rām Singh's work, though a rough check on the latitude of Tāsh-malik hill-station was obtained from the fact that its latitude, computed from resection (39° 7′ 47″), is 42 seconds greater than the astronomical value (39° 7′ 5″), observed at camp 18 about half a mile south-west of it.

The height of this station was obtained from the mean of the observations to Pks. 2 and 3/42N and agreed within 2 feet, which goes to prove that this station is well fixed relatively to Deasy's position of Kāshgar.

It was unfortunate that Rām Singh's observations to peaks previously fixed by him gave discordant results; the resection from the three peaks noted above being the only ones which could be computed.

(D)—NEAR TĀSH-KURGHĀN FORT, 1906-08 *(RĀM SINGH)*

(*Vide* charts 42N and O)

A base was measured near Chushmān in the valley north of Tāsh-kurghān and astronomical observations made at its extremities. The latter however were defective, and the hill-stations in the neighbourhood could only be located by resection from peaks previously fixed by Captain Deasy and based on observed latitudes and azimuths to well-fixed peaks of the Pāmīr Boundary Commission work.

'D' h. s. was resected from Pk. 9/42N and Pks. 1 and 12/42O.

'B' h. s. was resected from 'D' h. s. and Pks. 1 and 2/42O.

'C' h. s. was resected from 'B' and 'D' h. s. and Pk. 9/42N.

'A' h. s. and 'F' h. s. were resected from 'C' and 'D' h. s. and Pk. 1/42O.

'D' h. s. is apparently well fixed, for the height derived from the mean of observations to Muz-tāgh-atā and Pk. 9/42N differ by only 12 feet. Unfortunately observations for height were not taken to Pks. 1 and 12/42O, which would have afforded a valuable check. The heights of the other stations are dependent on that of 'D' h. s.

Of the intersected points, Pks. 40 and 41/42O are the most reliable, being fixed by double triangles.

(E)—SOUTH AND EAST OF KHOTAN, 1900-01 *(RĀM SINGH)*

(i). (*Vide* charts 51L and P, 52I and M, 60D, 61A and E)

The work was commenced from the neighbourhood of Camp 58. No attempt was made to form a continuous chain of triangles and the positions of all stations were determined by resection from well-fixed points. The work is connected by fairly well-shaped triangles, and the heights are generally accordant, showing that the work is reliable.

'B' h. s. and 'D' h. s. were computed from observations to Pk. 3/60D, Pk. 1/61A, and Pk. 3/61A. All these points had previously been fixed by the Survey of India.

'A' h. s. was computed from 'B' h. s., Pk. 3/60D, and Pk. 1/61A. The latitude at 'A' h. s. was checked astronomically and the two values agreed within 8 seconds.

'C' h. s. was fixed by resection from 'D' h. s., Pk. 1/61A, and Captain Deasy's Pk. 8/61A; the height of the latter was determined by Rām Singh. The longitude was checked independently from another point and found to agree within 40 seconds.

(ii). (*Vide* charts 60D, H, and L and 61A)

The work here is not quite so well connected but is reliable, and the heights fairly accordant. Both 'E' and 'F' h. s. were fixed by resection from Pk. 1/61A (G.T.) and Captain Deasy's Pk. 1/60L and Pk. 8/61A. The longitude of 'F' h. s. was checked independently from another point of Captain Deasy. The two values agreed to within 9 seconds.

(iii). Various peaks were fixed from these stations, generally speaking by means of double triangles, and the values are generally in good accord.

(F)—FROM ACHCHAN TO KAPA, 1906-08 *(RÂM SINGH)*

(i). (*Vide* charts 60H, and L)

A base was measured near Achchan with a subtense bar, and the latitude and azimuth observed astronomically. The position of 'C' h. s. was directly computed relatively to the extremities of this base. The latitude of 'C' being thus determined, its longitude was derived from observations at it to Pks. 1 and 2/60L previously fixed by Captain Deasy. Identification of the peaks was roughly checked by the two latitude results at 'C', which differed by 50 seconds from Deasy's value. The value derived from the astronomical observations has been accepted.

With the exception of stations 'G', 'J' and 'M', which were fixed by resection, the triangulation connexion to 'O' h. s. is continuous, straightforward and reliable.

(ii). (*Vide* charts 69C, D, G, and K)

The connexion between 'P' and 'O' h. s. was distant and unreliable, and has been obtained as follows. This link is weak.

At 'S' h. s. the latitude and azimuth to Pk. 2/69D (of Deasy) were observed astronomically and the distance computed. An azimuth was also taken to Pk. 38/60L and from these two peaks the longitude of 'S' was derived. It was found that these values differed by about *8 minutes*. The longitude of Pk. 2/69D of Deasy was based on two chronometer observations, which were not in accordance, and which differed by some 15 minutes of arc: it was therefore decided that though Pk. 38/60L is a far more distant peak, the longitude derived from it is in all probability much the more accurate, and this value has been accepted. 'S' h. s., being now in terms of the triangulation previously computed, the positions of the stations in its neighbourhood, of 'P' h. s., and of 'T', 'U' and 'V', were directly derived from it, with the exception of the last named, which was fixed by resection.

(iii). A rough check for latitude was furnished by Rām Singh's observations. In 1900-01 he observed an astronomical latitude at the village of Niya. His value is 37° 4′ 13″. This station is roughly a furlong north of a triangulation station of his work in 1906-08, which he fixed by resection from Pks. 28, 35, 38/60L and for which he obtained a latitude of 37° 3′ 34″.

(G)—ON THE HEADWATERS OF THE YURUNG-KĀSH, 1908 *(LÂL SINGH)*

(*Vide* charts 61A, and E)

Towards the close of Sir Aurel Stein's second expedition, a little triangulation was effected by R. B. Lāl Singh on the upper Yurung-kāsh. At only three stations were the observations sufficient to determine their positions by resection:

Seghizköl, 'A' h. s., was fixed by observations to Pks. 4, 25 and 31/61E, previously fixed by Captain Deasy.

Zailik, 'D' h. s., was similarly fixed with reference to Pk. 1/61A, of the G. T. Survey, Pk. 2/61A, of Rām Singh's previous work, and Pk. 8/61A of Captain Deasy.

Tār-köl, 'E' h. s., was fixed by observations to Pk. 8/61A, and Pks. 4 and 6/61E of Deasy.

The heights of these stations derived from the mean of two observations are very discordant, the differences being 194 feet, 748 feet, and 924 feet respectively. These discrepancies throw great doubt on the observations and the positions laid down for them should be treated with suspicion.

(H) and (I)—KAPA TO KORLA, 1913-15 *(LÂL SINGH)*

1. *General.*—The triangulation is considered in two sections, firstly, (H), from Kapa *via* Charkhlik to Pk. 1/75E, (*i. e.* from latitude 37° 20′, longitude 85° 35½′, to latitude 39° 0′, longitude 89° 47′); and secondly, (I), from Āstin-bulak, (latitude 40° 47′, longitude 90° 19′) to Korla (41° 44′ 20″·8, 86° 10′ 10″·4). The sections each comprise about 300 miles of work and are separated by the Lop desert.

During the computation it was found that there were several very weak links. The difficulties of the work in the field, the rapidity with which it was executed, and the physical obstacles due to desert haze and dust, rendered the work exceedingly arduous, and Sir Aurel Stein and his assistants are to be congratulated on having accomplished so much.

2. *Computations.*—Further details of the computations will be found below, and a synopsis of stations and points is given at the end of these notes. Briefly the former may be summed up as follows.—

In the first section from Kapa to Pk. 1/75E, a rough through-connexion was obtained with the assistance of four measured bases, astronomical latitudes and azimuths, one angle and one longitude being deduced from the plane-table. The eastern end of the northern section was shown in the records as connected to Pk. 1/75E—point 66 in the records— and the computation was carried through with this supposed connexion to its western extremity near Korla. It was then found that Lāl Singh's value of this place was about 32 miles west of Clementi's position, obtained during his journey from Kāshgar to Hong-Kong in 1907. Weak links occurred in Lāl Singh's triangulation, but it was obvious that these links could hardly be responsible for the accumulation of so large an error.

The whole case was then carefully re-considered in 1921. An examination of the work pointed to the likelihood of there being a mistake in identification of the junction point of the two sections. Some fifteen months elapsed between the two observations; desert haze prevented a long section of the southern range being visible from Āstin-bulak during the observations, and Lāl Singh himself expressed a doubt as to whether he had observed the same peak from the north as from the west.

Re-examination of the plane-table sections with the rays drawn from the observation stations seemed to confirm faulty identification, and pointed to a distance apart of some 30 miles between the two peaks observed. Under these circumstances, it was decided in consultation with Sir Aurel Stein and Lt.-Col. Cowie, Superintendent, Trigonometrical Survey, to ignore the distant connexion between the two sections, and to base the northern work on Clementi's value of Korla, throughout Lāl Singh's northern work.

3. *Datum points of the two sections.*—In view of these decisions, the two sections, the data of which are here published, should be considered unconnected and in separate terms:

(*a*). The southern section is directly based on Rām Singh's triangulation with Sir Aurel Stein in 1906-08 and is thereby indirectly connected to Indian triangulation.

(*b*). The northern section is based on Clementi's values of Korla. The heights in this section are founded on trigonometrical observations from the eastern end of the Āstin-bulak base, the initial height at this point being derived from barometric readings.

No adjustments are made in either section, and the coordinates of stations and points in both sections are those directly derived from the observations.

4. *Discrepancy between triangulated values and those on the published map sheets.*—

It will be noticed that some of these values do not agree with those shown on Sir Aurel Stein's published map sheets; this is particularly the case in the northern section. The maps were redrawn at Dehra Dūn during the war, when work was very heavy and the offices understaffed.

The compilation of the maps at times appears to have been considerably ahead of the triangulation computations, and it was thought inadvisable to delay the publication of the former, which are generally consistent in themselves, until the computations had been completed and could be reconsidered *in toto*. As far as possible in the list of triangulated points and stations, the latitudes and longitudes as shown on the published map have been also given *(in italics)* to the nearest 10 seconds for the purposes of identification. The heights shown on the maps which were derived from the faulty connexion and which are about 287 feet low are also shown in italics.

(H)—KAPA TO PK. 1/75E, 1913-15 *(LĀL SINGH)*

(i). (Chart 69G). The work is based on the side 'T' h.s.—'U' h.s. of Rām Singh's triangulation, 1906-07. From this side Pk. 7/69G, Pk. 8/69G and Pk. 9/69G were fixed from single triangles.

(ii). (Chart 69G). Ushlung h.s., near Gudache, was fixed by resection from 'V' h.s. and Pk. 2/69G, all of Rām Singh's work, 1906-07.

(iii). (Chart 69G). Ak-tāgh h. s. was fixed from Rām Singh's Pk. 1/69K and Ushlung h.s., the side between these two points being computed from their co-ordinates and the included angle at Pk. 1/69K being deduced.

(iv). (Charts 69G and K). From here onwards to the first base near Khādalik the connexion is weak, and this base has been put into Rām Singh's terms by means of his two points Pk. 1/69K and Pk. 3/69K. The observed latitude at Khādalik 'A' h.s. was 25 seconds in excess of the triangulated value.

(v). (Charts 68K and J). By means of the stations near Khādalik and Chigelik-chap, points were intersected as far as Kichik-jangal-sai to the north-east.

(vi). (Chart 69J). The second base was measured at Yūnus-chap. A connexion between this and the first was only possible through the Kichik-jangal-sai stations, 'J' h.s. and '28' h.s., Yulghun-dong 'K' h.s., and Kujong-dong 'L' h.s. The observations were deficient; and one triangle could only be computed with the aid of an angle measured from the chart. Unfortunately the astronomical observations at the Yūnus-chap base proved unreliable, and the co-ordinates of its stations are therefore very weakly connected to Rām Singh's work.

(vii). (Chart 69J). A triangle at Yūnus-chap was then computed to fix the position of Pk. 4/69J.

(viii). (Chart 69N) The connexion between this point and the third base at Tatlik-bulak was now taken up. The latitude and azimuth at the 'A' end of the base were observed, the longitude being derived from the plane-table. The intermediate points were then computed with these elements back to Pk.4/69J. In these terms the latitude of this peak is greater by 39 seconds and the longitude greater by 11 seconds than the co-ordinates of the same peak in the terms of Yūnus-chap.

The Tatlik-bulak base terms have been accepted.

(ix). (Chart 75B). From the Tatlik-bulak base, Pk. 1/75B and Pk. 2/75B were then computed.

(x). (Chart 75B). Three triangles were formed between these two points and the stations at the fourth base at Toghrak-chap, where astronomical observations were made. With the latter as initial elements, the latitude of Pk. 1/75B and Pk. 2/75B were 62 and 43 seconds respectively less than their latitude co-ordinates in terms of the third base at Tatlik-bulak.

(xi). (Charts 75A, B, E, and F). The longitude of the fourth base was converted into the terms of the third base, and the co-ordinates of all points up to Pk. 1/75E were computed. The last named was fixed from the double triangles formed by the three Mīrān stations.

(I) ĀSTIN-BULAK TO KORLA, 1913-15 *(LĀL SINGH)*

(i). (Charts NK 45W, NK 45X, NK 46C, and NK 46D). This section was computed from a measured base at Āstin-bulak; astronomical observations for latitude and azimuth were taken at the east end of the base. A chain of triangles was then computed to 'D' h.s. near Singer, the original longitude being derived from the supposed "peak 66" (Pk. 1/75E). Two triangles were then formed, 'D' h.s., Kara-koshun and 'A' h.s. at Singer and 'A' h.s., 'B' h.s., 'D' h.s., the base of the latter, AB, being measured.

The mean of the common side AD, has been accepted and the co-ordinates of 'A' h.s. thereby put into terms of Āstin-bulak.

(ii). (Charts NK 45S and NK 45W) In the absence of sufficient observations to connect Shindī h.s. by regular triangles, Shindī No. 1 h.s. and No. 2 h.s. were fixed by resection from observations to CC 5 and CC 6, already fixed. Astronomical checks showed 1′ 14″ greater and 1′ 45″ less than the triangulated values of latitude and azimuth respectively.

(iii). (Charts NK 45K and NK 45O). It was only with difficulty, owing to deficient observations, that the computations were then carried to the point CC 85 in the neighbour-

hood of Korla, where the discrepancy with Clementi's value was noted.

(iv). (Chart NK 45K). Korla was not actually fixed by triangulation, but the distance is short from CC85, and was surveyed by plane-table; the value of Korla was by this means put into terms of the computed triangulation. The difference in values between these terms and Clementi's was then applied throughout the northern work, thereby converting the whole into terms of Clementi.

LIST OF LATITUDES, LONGITUDES AND HEIGHTS OF STATIONS AND POINTS OF THE TRIANGULATION OF SIR AUREL STEIN AND OF OTHER OBSERVERS WHO HAVE WORKED IN THE SAME AREAS

Intersected Points in Sheet 42. I

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Stein's first expedition point (Ram Singh), 1900-01			
			° ′ ″	° ′ ″	*feet*
$42\frac{I}{16}$	*1*	Pk.1/42 I ...	39 9 51	74 51 5	18564

Stations in Sheet 42.J

RUSSIAN STATIONS 1912*

Station	Latitude	Longitude
	° ′ ″	° ′ ″
Tache-matik ...	38 20 37·98	74 5 43·93
Tchitchecti-bachi ...	38 18 18·77	74 0 44·33
Itchke-touchegan ...	38 14 0·41	74 4 11·87
Kankri ...	38 9 27·46	74 1 22·75
Mingue-hadjir-tan ...	38 8 1·52	74 12 9·61
Kisil-belcce-tan ...	38 5 59·10	74 6 1·69
Mouse-dic-bouac ..	38 3 2·70	74 7 45·79

EXPLORATION

Station	Latitude	Longitude	Height
	Stein's first expedition stations (Ram Singh), 1906-08		
	° ′ ″	° ′ ″	*feet*
Camp 9 "B" *h.s.*	38 20 19	74 54 10	14711
Camp 9 "A" *h.s.*	38 9 55	74 54 37	15083

* The heights of these stations are not available. The values here given are adjusted to Indian triangulation. The spelling of the names is that submitted by the Russian triangulators.

Intersected Points in Sheet 42. J

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's first expedition points (Ram Singh), 1900-01									
42 J/15	*1*	Pk.1/42 J ...	38	26	55	74	55	1	15999
	2	Pk.2/42 J ...		24	38		58	27	15446
	3	Pk.3/42 J ...		22	11		50	56	16142
42 J/16	*4*	Pk.4/42 J ...	38	8	17	74	46	22	15461

Stations in Sheet 42.K

GEODETIC

Station		Latitude			Longitude			Height
		°	′	″	°	′	″	*feet*
Indo-Russian connexion (Bell and Mason), 1912-13 *								
Karakokti	*h.s.*	37	12	9·05	74	44	30·98	17708
Kukturuk	*h.s.*	37	8	37·48	74	37	27·12	17237
Kilik East	*h.s.*	37	4	39·31	74	42	28·08	18203
Kilik West	*h.s.*	37	4	12·83	74	39	3·72	18020
Tomtek	*h.s.*	37	11	18·02	74	58	58·47	18608
Jalung Jilga	*h.s.*	37	6	59·97	74	49	42·73	17510
Mintaka Akhsai	*h.s.*	37	5	0·00	74	57	46·77	16907
Bell's Station (Lup Gaz)	*h.s.*	37	4	2·79	74	51	42·86	17695

MINOR STATIONS IN SHEET 42.K

Station		Latitude			Longitude			Height
		°	′	″	°	′	″	*feet*
Pamir Boundary Commission (Wauhope), 1895†								
Jarti-Gumbaz	*h.s.*	37	29	24·05	74	6	53·14	15240
Benderski	*h.s.*	37	24	52·35	74	14	21·38	17058
Chakmaktin	*h.s.*	37	14	7·8	74	7	50·4	13838

* The Indo-Russian stations are all marked with a circle and dot cut in a rock either *in situ* or embedded, and protected by a cairn.

† A correction of $\lambda = -4''{\cdot}7$, $L = -3''{\cdot}3$, H = + 176 feet has been applied to the original values of these stations to bring them into the same terms as the values of three points Pk.15/42K, Pk.16/42K, Pk3/42O, which were common to the Pāmīr Boundary Commission and the Indo-Russian Triangulation, and which have been adjusted to the Indian triangulation.

Stations in Sheet 42.K—(*continued*)

Station		Latitude			Longitude			Height
		°	′	″	°	′	″	*feet*
Chakmaktīn S. end base	*s.*	37	12	45·6	74	8	31·9	13197
Bōzai-Gumbaz N. end base	*s.*	37	8	42·5	74	0	42·7	12788
Bōzai-Gumbaz S. end base	*s.*	37	8	31·2	74	0	57·4	
Andamin	*h.s.*	37	22	19·55	74	18	41·95	17449
Mihmān Yol (upper)	*s.*	37	24	37·89	74	41	16·89	12957
Mihmān Yol (lower)	*s.*	37	24	29·01	74	41	18·05	12862
Kizil Rabāt	*h.s.*	37	28	36·37	74	45	39·65	14020
Tagharman-su	*h.s.*	37	24	26·82	74	47	59·90	14959

RUSSIAN STATIONS, 1912*

Station		Latitude			Longitude		
		°	′	″	°	′	″
Cara-belece-bachi	...	37	58	58·04	74	9	54·40
Chour-boulac	...	37	53	33·41	74	13	16·12
Chour-boulac-bachi	...	37	52	30·07	74	10	0·31
Coutatore	...	37	47	19·06	74	9	43·91
Bouddha	..	37	59	11·84	74	15	29·41
Ac-boura-bachi	...	37	49	29·67	74	15	36·04
Chour-djima	...	37	46	33·53	74	18	11·39
Outch-djima	...	37	44	2·37	74	16	9·59
Costanate-ausi	...	37	43	11·81	74	22	8·53
Bosse-maidan	...	37	40	8·55	74	25	0·99
Tchalkir	...	37	36	25·84	74	22	5·15
Oulan-djima-tau	...	37	34	17·27	74	27	53·63
Salantchour-coul	...	37	30	2·22	74	26	53·18
Darbasi-cri	...	37	33	19·06	74	30	16·32
Belek-kir	...	37	31	44·20	74	37	37·74
Cara-djima-cri	...	37	30	16·14	74	30	33·09
Injtchca-djima-bachi	...	37	29	49·55	74	42	41·37
Teschik-tache	...	37	28	38·29	74	35	14·13
Djoul-belece	...	37	27	42·52	74	36	22·99
Kisil-rabate	...	37	27	23·57	74	44	34·85
Pyr. de la base S.W.	...	37	26	38·80	74	44	24·05

* The heights and descriptions of these stations are not available. The values here given are adjusted to Indian triangulation. The spelling of the names is that submitted by the Russian triangulators.

Stations in Sheet 42.K—(*continued*)

Station	Latitude			Longitude		
	°	′	″	°	′	″
Pyr. de la base N. O. ...	37	27	45·68	74	49	55·23
Ouou-tache ...	37	24	21·29	74	55	1·57
Ac-belece ...	37	21	48·76	74	50	1·65
Tchapac-tache ...	37	20	53·91	74	56	39·61

EXPLORATION

Station	Latitude			Longitude			Height
Deasy's stations, 1897-99							
	°	′	″	°	′	″	*feet*
Camp 1 "A" h.s.	37	12	23	74	43	33	18520
Camp 1 "C" h.s.	37	12	6	74	43	50	18020
Camp 1 "A" end base.	37	8	44	74	43	26	13950*
Camp 1 "B" end base.	37	8	33	74	42	49	...
Camp 2 "B" end base.	37	8	4	74	53	29	...
Camp 1 "B" h.s.	37	7	49	74	45	2	16820
Camp 2 "A" end base	37	7	35	74	54	16	12940*
Stein's first expedition stations (Ram Singh), 1900-01†							
Camp 1 "A" h.s.	37	10	10	74	42	11	16619
Camp 1 (Stein)	37	8	46	74	43	21	...
Camp 1 "B" h.s.	37	7	49	74	45	1	16824

Intersected Points in Sheet 42.K

CLASS A

Sheet	Series	No.	Intersected Point	Latitude	Longitude	Height ground level
I. Pamir Boundary Commission (Holdich and Wauhope), 1895‡						
II. Indo-Russian Connexion (Bell, Mason, Collins, and McInnes), 1912-13						
				° ′ ″	° ′ ″	*feet*
42 K/3	1	*1*	Island in lake ...	37 26 55·2	74 0 46·4	14054
		2	Pk. 1/42 K ...	20 11·0	11 59·7	18638

* Aneroid.

† Owing to slight inaccuracies in the coordinates of Pk25/42 K, and Pk11/42 K, which have since been omitted from the data lists, Ram Singh's triangulation is very weakly connected to G.T. work, and should not be used here as the basis of further extensions. Stein's stations in 42 K are not shown in the chart of 42 K, as they have been superseded by the Indo-Russian connexion.

‡ *Vide* footnote on page 119.

Intersected Points in Sheet 42.K—(*continued*)

Sheet	Series	No.	Intersected Point	Latitude	Longitude	Height ground level
				° ′ ″	° ′ ″	*feet*
42 K/4	I	*3*	Pk. 2/42 K ...	37 6 44·0	74 9 43·0	18455
		4	Pk. 3/42 K ...	5 47·1	0 5·2	...
42 K/6	I	*5*	Pk. 4/42 K ...	37 32 24·9	74 17 12·4	16266
42 K/7	I	*6*	Pk. 5/42 K ...	37 22 57·7	74 19 29·2	17767
42 K/8	I	*7*	Pk. 6/42 K ...	37 13 49·4	74 23 18·8	18007
42 K/10	I	*8*	Pk. 7/42 K ...	37 32 58·5	74 39 57·5	17392
42 K/11	I	*9*	Pk. 8/42 K ...	37 27 26·9	74 32 39·6	17590
		10	Kizil Rabāt Sarai ...	27 21·8	44 32·7	12751
		11	Boundary pillar 8 ...	24 38·5	41 35·6	...
		12	Pk. 9/42 K ...	19 26·6	38 10·2	...
42 K/12	II	13	Pk. 26/42 K ...	37 13 58·9	74 44 49·4	18060
		14	Pk. 27/42 K ...	13 20·5	41 58·5	18675
		15	Pk. 28/42 K ...	7 45·4	41 13·6	16943
		16	Pk. 29/42 K ...	5 56·0	41 32·9	17702
		17	Pk. 30/42 K ...	3 37·7	37 24·0	18755
		18	Pk. 31/42 K ...	2 12·0	43 28·9	19394
42 K/14	II	19	Pk. 15/42 K ...	37 34 38·02	74 49 6·53	17348
		20	Pk. 16/42 K ...	32 23·24	57 57·54	18011
42 K/15	I	*21*	Pk. 17/42 K ...	37 29 11·2	74 45 45·9	15543
		22	Pk. 18/42 K ...	24 59·7	52 20·7	15401
		23	Pk. 19/42 K ...	23 59·0	49 57·3	15991
		24	Pk. 20/42 K ...	20 27·9	46 1·4	17241
		25	Pk. 21/42 K ...	17 47·9	45 8·1	18265
		26	Pk. 22/42 K ...	16 24·8	48 7·1	17885
42 K/16	II	27	Pk. 32/42 K ...	37 13 47·2	74 48 3·3	18390
		28	Pk. 33/42 K ...	11 52·2	54 31·8	18845
		29	Pk. 34/42 K ...	5 50·9	49 40·6	18172
		30	Pk. 35/42 K ...	2 8·8	55 15·1	17926
		31	Pk. 36/42 K ...	37 0 25·3	74 57 53·8	18171

* A correction of λ = − 4″·7, L = − 3″·3, H = + 176 feet has been applied to the original values of these points to bring them into the same terms as the values of three points Pk.15/42 K, Pk.16/42 K, Pk.8/42 O, which were common to the Pāmīr Boundary Commission and the Indo-Russian Triangulation, and which have been adjusted to the Indian triangulation.

1. Serial Nos. 19 and 20 were common to the Indo-Russian triangulation and Pāmīr Boundary Commission work.

2. Pk.10/42 K of Pāmīr Boundary Commission triangulation and the explorer's points, Pk.12/42 K, Pk.13/42 K, Kilik pass, Pk.14/42 K, Pk.23/42 K, and Pk.25/42 K were found inaccurate during the Indo-Russian Connexion, and are omitted.

3. The explorer's points, Pk.11/42 K, and Pk.24/42 K, have been superseded by the stations Karakokti and Tomtek respectively.

Stations in Sheet 42.M

ASTRONOMICAL

Station	Latitude	Longitude	Height
De Filippi's latitude and longitude station, 1914			
Kashgar latitude and longitude station	° ′ ″ 39 28 19·74	° ′ ″ 75 59 5·64	...

The astronomical latitude and longitude were determined here in 1914 by Sir F. De Filippi. The station has not been connected to G.T. triangulation, and the geodetic values are therefore not yet known. The longitude was determined by wireless telegraphic signals transmitted from Lahore and timed simultaneously at Dehra Dūn and Kāshgar.

The station is situated in the old Muhammadan cemetery between the British and Russian consulates north of Kōne-shahr. The exact nature of the station is not yet known (1921).

EXPLORATION

Station	Latitude	Longitude	Height
Deasy's stations, 1899			
	° ′ ″	° ′ ″	*feet*
Kāshgar (Camp 162)	39 28 19	75 58 35	4400*
Camp 162 "A" h.s.	39 32 47	75 54 55	5120†
Stein's first expedition station (Ram Singh), 1900-01.			
Tāsh-malik (Camp 18) "E" h.s.	39 7 47	75 36 21	5313
Clementi's station, 1907			
Kāshgar (Chīnī-bāgh) (Minor astronomical station)	39 28 45·1§	75 58 0·0*	4213‡

In the British Consulate at Chīnī-bāgh outside the Muhammadan walled city. Latitude by sun observations with 4″-transit theodolite. Longitude by chronometric meridian distance from Ikul.

Intersected Points in Sheet 42.M

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
Stein's first expedition point (Ram Singh), 1900-01					
			° ′ ″	° ′ ″	
$42\frac{M}{7}$	*1*	Pk.1/42M ...	39 28 21	75 17 4	

* Hypsometer.
† Aneroid.
‡ Mercurial barometer.
§ Unadjusted values.

Stations in Sheet 42.N

EXPLORATION

Station	Latitude	Longitude	Height
Stein's first expedition stations (Ram Singh), 1900-01			
	° ′ ″	° ′ ″	*feet*
Camp 9 "D" h.s.	38 25 3	75 0 49	14326
Camp 9. (L. Kara-kul)	38 24 51	75 3 19	11036
Camp 9 "C" h.s.	38 21 47	75 3 25	14570

Intersected Points in Sheet 42.N

CLASS A

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
Pamir Boundary Commission (Holdich and Wauhope), 1895*					
			° ′ ″	° ′ ″	*feet*
42 N/3	1	Pk.7/42 N (Muz-tāgh-atā)	38 16 37·8	75 7 2·3	24388
42 N/4	2	Pk.8/42 N ...	38 13 55·3	75 6 42·0	22956

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
Second Yarkand Mission (Trotter), 1873-74					
			° ′ ″	° ″	*feet*
42 N/6	3	Pk. 15/42 N. ...	38 35 15	75 22 47	25350
Deasy's points, 1897-99					
42 N/1	4	Pk.2/42 N (Chakkarkul W.)	38 51 49	75 6 27	22070
	5	Pk.3/42 N (Chakkarkul E.)	50 19	8 52	21480
42 N/3	6	Pk. 6/42 N. ...	38 17 50	75 12 55	19840
42 N/4	7	Pk. 9/42 N. ...	38 12 22	75 6 52	22240
	8	Pk. 10/42 N. ...	11 53	11 29	...

* A correction of A = − 4·″7, L = −3·″3, H = + 176 feet has been applied to the original values of these points to bring them into the same terms as the values of three points Pk. 16/42K, Pk. 16/42K, Pk. 3/42O, which were common to the Pāmir Boundary Commission and the Indo-Russian triangulation, and which have been adjusted to the Indian triangulation.

Intersected Points in Sheet 42.N—(*continued*)

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Deasy's points, 1897-99—(*continued*)			
			° ′ ″	° ′ ″	*feet*
42N/6	*9*	Pk. 12/42 N. ...	38 39 26	75 21 37	23530
42N/8	*10*	Pk. 14/42 N. ...	38 5 21	75 17 24	17480
		Stein's first expedition points (Ram Singh), 1900-01			
42N/1	*11*	Pk. 1/42 N. ...	38 54 30	75 1 0	20573
42N/2	*12*	Pk. 4/42 N. (Kongur I) ...	38 39 23	75 13 5	25146
42N/3	*13*	Pk. 5/42 N. ...	38 27 6	75 5 10	12399
42N/5	*14*	Pk. 11/42 N. ...	38 54 27	75 20 27	14898

N. B.- Pk. 13/42 N (Kongur II) has been rejected.

Stations in Sheet 42.O

GEODETIC

Station	Latitude	Longitude	Height
Indo-Russian Connexion* (Bell and Mason), 1912-13			
	° ′ ″	° ′ ″	*feet*
Sarblock † (*Russian E.*) *h.s.*	37 18 59·15	75 4 41·29	17284
Kukhtek ‡ (*Russian W.*) *h.s.*	37 17 33·16	75 0 12·28	17031
Tongder *h.s.*	37 14 55·19	75 3 21·02	17611
Takhtakhun *h.s.*	37 10 49·58	75 8 24·33	17595
Dastur *h.s.*	37 4 38·16	75 2 30·53	16924

* The Indo-Russian stations are all marked by a circle and dot cut in a rock either *in situ* or embedded, and protected by a cairn.

† Known to the Russians as "Beik".

‡ Known to the Russians as "Ac-tourouc-tau".

Stations in Sheet 42.O—(*continued*)

EXPLORATION

Station	Latitude			Longitude			Height
Deasy's stations, * 1897-99.							
	°	′	″	°	′	″	*feet*
Camp 4 "B" end base	37	14	21	75	23	6	...
Camp 4 "A" end base	37	13	24	75	23	38	11620
Camp 6 "A" end base	37	11	4	75	29	53	14930
Camp 5 observing station	37	9	32	75	27	45	...
Camp 5 "A" end base	37	9	10	75	27	31	12070
Camp 5 "C" s.	37	8	21	75	25	53	12530
Camp 5 "B" end base	37	8	7	75	28	4	.
Camp 120 "C" h.s.	37	36	20	75	43	56	13940
Camp 120 "B" h.s.	37	31	11	75	42	18	13220
Camp 6 "B" end base	37	11	47	75	30	10	...
Camp 5 "A" h.s. †	37	11	39	75	32	39	17650
Camp 4 "A" h.s. †	37	11	36	75	32	39	17650
Camp 6 "A" h.s. †	37	11	21	75	32	39	17650
Camp 120 "A" end base	37	32	59	75	45	59	12230
Camp 120 "A" h.s.	37	32	49	75	48	43	15140‡
Camp 121 (Minor astronomical station)	37	37	0	75	37	22	10700‡
Camp 122 (Minor astronomical station)	37	29	53	75	39	29	12250‡
Camp 123 (Minor astronomical station)	37	23	8	75	39	29	11050‡
Camp 10 (Minor astronomical station)	37	1	55	75	42	2	14350‡
Camp 45 (Minor astronomical station)	37	37	56	75	53	14	11750‡
Camp 128 (Minor astronomical station)	37	24	59	75	55	52	10600‡
Camp 124 (Minor astronomical station)	37	19	40	75	51	21	8700‡
Camp 127 (Minor astronomical station)	37	19	4	75	56	22	
Camp 137 (Minor astronomical station)	37	2	0	75	56	19	8800‡

* Deasy's work is based on the original values of certain Pāmir Boundary Commission points, which were in 1920 slightly adjusted to the Indo-Russian Connexion. It is not considered sufficiently accurate to apply the small corrections necessary to bring it into the revised terms. No descriptions of Deasy's stations are available from his records.

† "A" h. s. is common to Camps 4, 5 and 6.

‡ Aneroid.

Stations in Sheet 42.O—(*continued*)

Station		Latitude			Longitude			Height
Stein's second expedition stations* (Ram Singh), 1906-08								
		°	′	″	°	′	″	*feet*
Camp 1 "C"	*h.s.*	37	54	22	75	11	44	12720
Camp 1 "B"	*h.s.*	37	53	45	75	13	26	9970
Camp 1 "A"	*h.s.*	37	52	29	75	13	5	9950
Camp 1 "F"	*h.s.*	37	55	49	75	25	45	13730
Camp 1 "D"	*h.s.*	37	51	58	75	15	28	13180

Intersected Points in Sheet 42.O

CLASS A

Sheet	Series No.	No.	Intersected Point	Latitude	Longitude	Height Ground level
I. Pamir Boundary Commission (Holdich and Wauhope), 1895† II. Indo-Russian Connexion (Bell, Mason, Collins and McInnes), 1912-13						
				° ′ ″	° ′ ″	*feet*
42 O/2	II	1	Pk.3/42 o ...	37 33 48·4	75 9 44·9	20898
		2	Pk.24/42 o ...	37 33 15·1	75 0 55·8	18513
		3	Pk.25/42 o ...	37 31 37·8	75 3 52·4	18439
42 O/3	I	4	Pk.4/42 o ...	37 28 7·7	75 7 8·9	18887
		5	Pk.5/42 o ...	37 23 3·5	75 6 50·1	18236
	II	6	Pk.26/42 o ...	37 24 19·2	75 11 14·0	19268
		7	Pk.27/42 o ...	37 22 7·7	12 54·1	18659
42 O/4	II	8	Pk.28/42 o ...	37 10 43·9	75 1 11·4	18182
		9	Pk.29/42 o ...	37 10 10·1	75 4 50·2	18003
		10	Pk.30/42 o ...	37 9 46·7	75 3 6·6	17975
		11	Rock pillar on flank of Pk.31/42 o ...	37 8 41·2	75 13 45·0	17425§
		12	Pk.31/42 o ...	37 8 31·9	75 13 54·8	18329
		13	Pk.32/42 o ...	37 7 36·5	75 13 39·9	18467
		14	Pk.33/42 o ‡ ...	37 7 28·4	75 14 53·9	19256
		15	Pk.34/42 o ...	37 7 14·5	75 9 41·8	16194
		16	Spur cairn ...	37 5 17·9	75 2 30·2	16190
		17	Pk.35/42 o ...	37 3 4·6	75 12 18·0	19188
		18	Pk.36/42 o ...	37 3 4·5	75 13 15·2	18952
42 O/8	II	19	Pk.37/42 o ...	37 14 29·9	75 16 32·6	18336
		20	Pk.38/42 o ...	37 10 2·5	75 17 16·6	17203
42 O/11	II	21	Pk.39/42 o ...	37 18 23·7	75 34 23·4	18737

* Rām Singh's work in this area is based on Deasy's and that of the Pāmīr Boundary Commission previous to its adjustment in 1920. No attempt has yet been made to adjust it, and it is therefore in slightly different terms to G. T. work. No descriptions of his stations are available.

† A correction of $\lambda = -4''{\cdot}7$, $L = -3''{\cdot}3$, $H = +176$ feet has been applied to the original values of these points to bring them into the same terms as the three points Pk. 15/42 K, Pk. 16/42 K, Pk.3/42 O, which were common to the Pāmīr Boundary Commission and the Indo-Russian Triangulation and which have been adjusted to the Indian triangulation.

‡ Probably identical with explorer's point, Pk. 6/42 O.

§ Top.

Intersected Points in Sheet 42.O

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Deasy's points, 1897-99			
			° ′ ″	° ′ ″	*feet*
42 O/2	*22*	Pk.1/42 o ...	37 41 48	75 9 34	...
	23	Pk.2/42 o ...	37 38 46	75 9 48	...
42 O/8	*24*	Pk.7/42 o ...	37 13 9	75 20 5	16540
	25	Pk.8/42 o ...	37 11 46	75 21 32	13640
	26	Pk.9/42 o ...	37 8 25	75 21 24	17220
	27	Pk.10/42 o ...	37 3 36	75 20 39	
42 O/10	*28*	Pk.11/42 o ...	37 43 25	75 39 26	16920
42 O/11	*29*	Pk.12/42 o ...	37 29 38	75 31 22	18130
	30	Pk.13/42 o ...	37 28 20	75 31 23	18240
	31	Pk.14/42 o ...	37 27 17	75 30 29	18550
	32	Pk.15/42 o ...	37 21 57	75 31 32	18170
	33	Pk.16/42 o ...	37 17 3	75 33 58	17500
	34	Pk.17/42 o ...	37 16 0	75 34 37	...
42 O/12	*35*	Pk.18/42 o ...	37 13 21	75 39 13	18000
	36	Pk.19/42 o ...	37 1 18	75 38 33	17790
	37	Pk.20/42 o ...	37 0 36	75 40 25	...
42 O/14	*38*	Pk.21/42 o ...	37 30 38	75 51 55	18190
42 O/16	*39*	Pk.22/42 o ...	37 9 36	75 53 25	18560
	40	Pk.23/42 o ...	37 2 21	75 54 3	16590
		Stein's second expedition points (Ram Singh), 1906-08			
42 O/1	*41*	Pk.40/42 o ...	37 48 12	75 5 57	...
	42	Tāsh-kurghān Fort ...	48 0	75 14 35	10225*
42 O/5	*43*	Pk.41/42 o ...	37 58 1	75 18 58	16890
	44	Pk.42/42 o ...	37 55 36	75 19 25	14990
42 O/9	*45*	Pk.43/42 o ...	37 56 28	75 30 7	18746
	46	Pk.44/42 o ...	37 55 52	75 30 46	17857

Note.—The explorer's point Pk.6/42 o has been replaced by the intersected point Pk.33/42 o.

* Top.

Stations in Sheet 51.L

ASTRONOMICAL

Station	Latitude	Longitude	Height
De Filippi's latitude and longitude station, 1914			
	° ′ ″	° ′ ″	*feet*
Suget Karaul	36 20 54·91	78 1 36·09	...

Latitude and longitude station at the Chinese fort; longitude was obtained by wireless time signals transmitted from Lahore recorded simultaneously at Suget Karaul and Debra Dūn. De Filippi's values were not available during Sir Aurel Stein's surveys nor for the construction of his map, which shows the fort at λ 36° 20′ 55″, Long. 78° 6′ 35″.

EXPLORATION

Trotters' topographical latitude and longitude station, 1874			
Ak-tāgh No. 2 Camp	36 0 11	78 3 20	15330

Station undescribed; latitude by one north and three south stars; longitude from the mean of three 'Pandit' traverses; not shown on Stein's map.

Intersected Points in Sheet 51.L

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
Stein's first expedition points (Ram Singh), 1900-01					
			° ′ ″	° ′ ″	*feet*
51 L/8	*1*	Pk.1/51L* ...	36 10 25	78 29 46	...
51 L/10	*2*	Pk.2/51L ...	36 37 13	78 37 3	17178
51 L/12	*3*	Pk.3/51L ...	36 5 37	78 34 57	23757
51 L/16	*4*	Pk.4/51L ...	36 4 9	78 50 11	23205

Stations in Sheet 51.P

EXPLORATION

Station	Latitude	Longitude	Height
Stein's first expedition stations (Ram Singh), 1900-01			
	° ′ ″	° ′ ″	*feet*
Ulūgh-art-dawān 'A' *h.s.*	36 46 45	79 29 57	9891
Kunat-dawān 'B' *h.s.*	36 43 16	79 32 41	10815
Tōpe 'D' *h.s.*	36 8 10	79 53 48	13949

* This peak is doubtful; it does not seem to have been found during the detail survey.

Intersected Points in Sheet 51. P

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Stein's first expedition points (Ram Singh), 1900-01			
			° ′ ″	° ′ ″	*feet*
51 P/5	*1*	Pk. 1/51 P ...	36 49 48	79 19 10	9399
51 P/7	*2*	Pk. 2/51 P ...	36 16 47	79 22 2	17885
	3	Pk. 3/51 P ...	36 15 52	79 17 25	18845
51 P/9	*4*	Pk. 4/51 P ...	36 54 0	79 43 11	7246
	5	Pk. 5/51 P ...	36 52 47	79 34 24	7633
51 P/10	*6*	Pk. 6/51 P ...	36 38 28	79 38 57	11456
51 P/11	*7*	Pk. 7/51 P (Mudache-tāgh)	36 20 0	79 32 50	17220
51 P/13	*8*	Pk. 8/51 P ...	36 53 35	79 45 6	7530
	9	Pk. 9/51 P ...	36 49 8	79 46 17	8616

Intersected Points in Sheet 52.M

CLASS A

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Kashmir triangulation (Chang-chenmo, Johnson), 1860-62			
			° ′ ″	° ′ ″	*feet*
52 M/4	*1*	Pk. 1/52 M ...	35 14 27	79 5 29	21040
	2	Pk. 2/52 M ...	35 7 52	79 13 53	...
52 M/5	*3*	Pk. 4/52 M ...	35 53 36	79 26 5	21750
52 M/8	*4*	Pk. 5/52 M ...	35 2 27	79 22 32	
52 M/9	*5*	Pk. 6/52 M ...	35 52 29	79 32 34	21960

Intersected Points in Sheet 52.M—(*continued*)

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Stein's first expedition points (Ram Singh), 1900-01			
			° ′ ″	° ′ ″	
52 M/5	6	Pk. 3/52 M ...	35 59 14	79 24 26	23071
52 M/13	7	Pk. 7/52 M ...	35 47 8	79 49 47	22590
	8	Pk. 8/52 M* (Cholpanglik)	35 46 47	79 54 1	23309

Stations in Sheet 60.D

EXPLORATION

Station	Latitude	Longitude	Height
	Stein's first expedition stations (Ram Singh), 1900-01		
	° ′ ″	° ′ ″	*feet*
Ulūgh-dawān 'C' *h.s.*	36 27 27	80 7 33	14904
Boko-dong 'F' *h.s.*	36 10 38	80 59 53	12265
Uku-tāgh 'E' *h.s.*	36 6 32	80 49 56	13566

Intersected Points in Sheet 60.D

CLASS A

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Kashmir triangulation (Johnson), 1862			
			° ′ ″	° ′ ″	*feet*
60 D/7	1	Pk.3/60 D (Tikelik-tāgh) ...	36 29 34	80 22 59	18780
60 D/11	2	Pk.8/60 D ...	36 21 21	80 31 8	

* The value shown on Stein's map No. 10, for this peak is λ 35° 46′ 40″, L 79 51′ 0″. It is not known whether the value shown above as obtained from his first expedition was subsequently found inaccurate.

Intersected Points in Sheet 60.D—(*continued*)

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Deasy's points, 1897-99			
			° ′ ″	° ′ ″	
60^{D}_{6}	3	Pk.1/60 D ...	36 32 46	80 28 35	
60^{D}_{10}	4	Pk.7/60 D ...	36 33 31	80 30 38	
		Stein's first expedition points (Ram Singh), 1900-01			
60^{D}_{7}	5	Pk.2/60 D* ...	36 29 47	80 26 15	...
	6	Pk.4/60 D ...	36 21 55	80 23 58	16542
60^{D}_{8}	7	Pk.5/60 D† ...	36 10 26	80 25 28	
	8	Pk.6/60 D ...	36 7 36	80 16 22	
60^{D}_{12}	9	Pk.9/60 D† ...	36 3 30	80 32 22	

Stations in Sheet 60.H

EXPLORATION

Station	Latitude	Longitude	Height
	Stein's second expedition stations (Ram Singh), 1906-08		
	° ′ ″	° ′ ″	*feet*
Achchan base, N. end, s. (*Shum-dong*)	36 25 43	81 56 35	8807
Achchan base, S. end, s.	36 24 41	81 55 57	8964
'A' *h.s.*	36 24 13	81 55 9	9583
'B' *h.s.*	36 23 49	81 58 52	10971

* This point is not shown on Stein's map, Sheet No. 14; it is not known whether it is identical with Pk. 3/60 D.

† The existence of these peaks is doubtful. They do not appear to have been located during Sir Aurel Stein's detailed surveys.

Intersected Points in Sheet 60.H

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Deasy's points, 1897-99									
60 H/8	1	Pk. 1/60 H	36	3	39	81	23	4	18810
	2	Pk. 2/60 H ...	36	1	37	81	28	33	15930
60 H/12	3	Pk. 3/60 H (Ghāzi-kunghak) ...	36	9	37	81	43	33	15800
	4	Pk. 4/60 H ...	36	7	57	81	42	35	16650
	5	Pk. 5/60 H ...	36	6	10	81	38	51	18400
	6	Pk. 6/60 H * ...	36	1	49	81	35	38	...
	7	Pk. 7/60 H ...	36	1	44	81	34	36	20080
	8	Pk. 8/60 H ...	36	1	38	81	34	31	20280
	9	Pk. 9/60 H ...	36	0	8	81	36	37	21840
Stein's second expedition points (Ram Singh), 1906-08									
60 H/14	10	Kapa village tree ...	36	32	41	81	54	0	6926
60 H/15	11	Pk. 14/60 H ...	36	15	13	81	50	1	13552
60 H/16	12	Pk. 15/60 H	36	12	7	81	57	51	18948

Station in Sheet 60.K

EXPLORATION

Station	Latitude			Longitude			Height
	°	′	″	°	′	″	*feet*
Stein's second expedition station (Ram Singh), 1906-08							
Niya-bāzār *h.s.*	37	3	34	82	45	32	4400

* This peak is probably non-existent and is not shown on Stein's map, Sheet No. 14.

Stations in Sheet 60.L

EXPLORATION

Station		Latitude			Longitude			Height
		°	′	″	°	′	″	*feet*
Stein's second expedition stations (Ram Singh), 1906-08								
'D'	*h.s.*	36	31	17	82	8	58	9630
'B'	*h.s.*	36	31	12	82	14	4	11315
'C'	*h.s.*	36	28	35	82	2	59	9637
'I'	*h.s.*	36	35	17	82	25	25	10622
'J'	*h.s.*	36	34	43	82	26	22	11561
'H'	*h.s.*	36	33	39	82	24	9	11745
'F'	*h.s.*	36	32	33	82	16	31	10509
'G'	*h.s.*	36	30	33	82	19	38	12642
'M'	*h.s.*	36	38	13	82	44	23	8509
'K'	*h.s.*	36	36	26	82	35	24	9466
'L'	*h.s.*	36	35	18	82	32	22	10852
'O'	*h.s.*	36	35	19	82	56	36	11600
'N'	*h.s.*	36	34	59	82	51	55	11769

Intersected Points in Sheet 60.L

CLASS B

Sheet	No.	Intersected Point		Latitude			Longitude			Height ground level
				°	′	″	°	′	″	*feet*
Deasy's points, 1897-99										
60 L/4	1	Pk. 1/60 L.	...	36	12	59	82	3	17	21850
	2	Pk. 2/60 L.	...	36	12	52	82	2	58	21660
60 L/8	3	Pk. 3/60 L.	...	36	11	48	82	24	22	20330
	4	Pk. 4/60 L.	...	36	11	45	82	17	42	20400
	5	Pk. 5/60 L.	...	36	11	31	82	23	14	20310
60 L/12	6	Pk. 6/60 L.	...	36	14	4	82	39	53	20760
	7	Pk. 7/60 L.	...	36	13	48	82	40	44	20380
	8	Pk. 8/60 L.	...	36	13	34	82	37	46	20380
	9	Pk. 9/60 L.	...	36	13	28	82	33	59	20490

Intersected Points in Sheet 61.L—(*continued*)

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's second expedition points (Ram Singh), 1906-08									
60 L/2	*10*	Pk. 10/60 L ...	36	31	25	82	13	21	11053
60 L/3	*11*	Pk. 13/60 L ...	36	28	49	82	13	29	12885
	12	Pk. 15/60 L ...	36	27	35	82	0	51	9321
	13	Pk. 16/60 L ...	36	26	44	82	8	3	13505
	14	Pk. 17/60 L ...	36	24	15	82	8	35	16266
	15	Pk. 18/60 L ...	36	22	30	82	4	35	14595
	16	Pk. 19/60 L ...	36	18	10	82	9	22	18606
60 L/6	*17*	Pk. 21/60 L ...	36	35	8	82	29	26	10821
	18	Pk. 23/60 L ...	36	33	46	82	28	2	12596
	19	Pk. 25/60 L ...	36	33	27	82	16	0	9581
	20	Pk. 26/60 L ...	36	32	41	82	28	22	14550
	21	Pk. 28/60 L ...	36	31	5	82	28	27	17050
60 L/7	*22*	Pk. 30/60 L ...	36	25	35	82	20	0	19970
60 L/10	*23*	Pk. 34/60 L ...	36	34	28	82	43	20	11279
	24	Pk. 35/60 L ...	36	34	25	82	43	28	12516
	25	Pk. 36/60 L ...	36	34	8	82	34	27	12839
	26	Pk. 37/60 L ...	36	34	3	82	31	16	13091
60 L/11	*27*	Pk. 38/60 L ...	36	29	37	82	33	56	19982
	28	Pk. 39/60 L ...	36	25	12	82	32	59	19592
	29	Pk. 40/60 L ...	36	24	52	82	33	18	19764
60 L/14	*30*	Pk. 41/60 L ...	36	39	36	82	45	48	8068
	31	Pk. 43/60 L ...	36	35	1	82	49	7	11443
	32	Pk. 45/60 L ...	36	32	29	82	57	41	15000
60 L/15	*33*	Pk. 46/60 L ...	36	25	26	82	51	4	17300

Intersected Points in Sheet 60.P

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Deasy's points,* 1897-99			
			° ′ ″	° ′ ″	*feet*
$60\frac{P}{13}$	*1*	Pk. 1/60 P ...	36 50 12	83 53 1	
$60\frac{P}{14}$	*2*	Pk. 2/60 P ...	36 43 24	83 53 1	13700
	3	Pk. 3/60 P ...	36 43 9	83 58 12	14150
	4	Pk. 4/60 P ...	36 42 41	83 49 49	13050
	5	Pk. 5/60 P ...	36 42 25	83 48 52	12900
		Stein's second expedition points (Ram Singh), 1906-08			
$60\frac{P}{2}$	*6*	Pk. 6/60 P ...	36 35 35	83 0 34	12200 †
	7	Pk. 7/60 P ...	36 33 5	83 0 18	14735
	8	Pk. 8/60 P ...	36 31 32	83 2 58	16606

Stations in Sheet 61.A

EXPLORATION

Station		Latitude	Longitude	Height
		Stein's second expedition station (Lal Singh), 1906-08		
		° ′ ″	° ′ ″	*feet*
Zailik 'D'	*h.s.*	35 50 38	80 51 48	14486

Intersected Points in Sheet 61.A

CLASS A

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Kashmir triangulation (Chang-chenmo, Johnson), 1862			
			° ′ ″	° ′ ″	*feet*
$61\frac{A}{1}$	*1*	Pk. 1/61 A ‡ (Muz-tāgh or K 5) ...	35 56 21	80 14 10	23890

* Deasy's points in 69.D were reported inaccurate in longitude by Rām Singh in 1906-08 and it is possible that these points of his in 60.P, which are not shown on Stein's maps and were therefore probably not located, are also inaccurate.

† Height omitted in map, Sheet No. 19.

‡ This peak was originally known in the Survey of India as E 61.

Intersected Points in Sheet 61.A—(*continued*)

CLASS A

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
		Kashmir triangulation (Chang-chenmo, Johnson), 1862			
61 A/6	2	Pk. 3/61 A ...	35° 35′ 16″	80° 18′ 56″	21250
61 A/7	3	Pk. 4/61 A	35 27 27	80 20 58	21240
	4	Pk. 5/61 A ...	35 26 6	80 24 54	21160
	5	Pk. 6/61 A	35 25 13	80 26 53	20980

CLASS B

		Deasy's points, 1897-99			
61 A/13	7	Pk. 7/61 A * ...	35 58 48	80 57 56	...
	8	Pk. 8/61 A	35 55 38	80 52 24	21430†
61 A/15	9	Pk. 9/61 A ...	35 19 27	80 55 55	23490
		Stein's first expedition point, 1900-01			
61 A/1	6	Pk. 2/61 A ...	35 48 20	80 1 53	22639

Stations in Sheet 61.E

EXPLORATION

Station	Latitude	Longitude	Height
	Deasy's stations, 1897-99		
	° ′ ″	° ′ ″	*feet*
Camp 116 "A" end base	35 52 46	81 27 56	...
Camp 116 "B" h.s.	35 52 44	81 27 24	17420
Camp 116 "A" h.s.	35 52 23	81 28 40	17580
Camp 116 "C" h.s.	35 50 1	81 26 31	16310
Camp 97 "D" h.s.	35 42 15	81 43 59	16890
Camp 97 "A" h.s.	35 41 54	81 44 5	16980

* This peak must be considered doubtful as it was not located during Sir Aurel Stein's detail surveys.

† The height of this point was determined during Sir A. Stein's first expedition. In the map, Sheet No. 15, it is wrongly shown as 21460.

Stations in Sheet 61.E—(*continued*)

Station	Latitude			Longitude			Height
	°	′	″	°	′	″	*feet*
Camp 97 "B" h.s.	35	40	15	81	44	12	17140
Camp 97 "C" h.s.	35	39	17	81	43	58	16390
Camp 97 "B" end base	35	41	41	81	46	20	...
Camp 97 "A" end base	35	41	17	81	52	24	17890
Camp 98 "D" h.s.	35	41	10	81	46	30	15670
Camp 98 "A" end base	35	41	4	81	51	34	16500
Camp 98 "A" h.s.	35	41	2	81	50	41	17660
Camp 98 "B" h.s.	35	40	21	81	50	24	18250
Camp 98 "C" h.s.	35	39	45	81	51	56	18150
Camp 98 "E" h.s.	35	38	55	81	51	51	18160
Camp 112 "A" h.s.	35	30	24	81	49	51	16930
Camp 112 "A" end base	35	29	59	81	49	57	16340
Camp 112 "B" h.s.	35	29	3	81	54	25	17860
Camp 112 "C" h.s.	35	28	24	81	51	23	17570

Stein's second expedition stations (Lal Singh), 1906-08

	°	′	″	°	′	″	*feet*
Tār-kōl 'E' h.s.	35	39	38	81	4	43	18612
Seghiz-kōl 'A' h.s.	35	42	42	81	31	20	15824

Intersected Points in Sheet 61.E

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
Deasy's points, 1897-99									
			°	′	″	°	′	″	*feet*
61 E/1	*1*	Pk. 1/61 E* ...	35	58	37	81	6	50	...
	2	Pk. 2/61 E ...	35	57	41	81	8	27	21360
61 E/2	*3*	Pk. 4/61 E	35	44	17	81	10	51	20470
	4	Pk. 5/61 E	35	31	21	81	3	17	21850
	5	Pk. 6/61 E	35	30	57	81	8	48	21270
61 E/5	*6*	Pk. 7/61 E ...	35	59	2	81	28	32	18290
	7	Pk. 8/61 E* ...	35	58	50	81	25	38	...
	8	Pk. 9/61 E ...	35	58	50	81	26	5	19320
	9	Pk. 10/61 E	35	58	32	81	24	30	20340
	10	Pk. 11/61 E ...	35	58	7	81	18	55	20420

* These points are not shown on Stein's map, Sheet No. 15; it is not known whether they are correct or not.

Intersected Points in Sheet 61.E—*(continued)*

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*Feet*
61 E/7	*11*	Pk. 12/61 E ...	35	29	33	81	21	3	20250
	12	Pk. 13/61 E ...	35	26	51	81	22	54	21040
61 E/8	*13*	Pk. 14/61 E* ...	35	2	2	81	26	49	
61 E/9	*14*	Pk. 15/61 E ...	35	59	49	81	36	55	21320
	15	Pk. 16/61 E ...	35	59	43	81	39	43	21020
	16	Pk. 17/61 E ...	35	59	42	81	36	35	21820
	17	Pk. 18/61 E* ...	35	59	19	81	36	40	21820
	18	Pk. 19/61 E ...	35	51	3	81	41	34	19880
	19	Pk. 20/61 E ...	35	50	31	81	31	24	18530
61 E/10	*20*	Pk. 21/61 E* ...	35	36	21	81	42	33	...
	21	Pk. 22/61 E ...	35	31	55	81	35	48	20280
	22	Pk. 23/61 E* ...	35	31	51	81	35	21	20040
	23	Pk. 24/61 E ...	35	30	48	81	43	32	20850
61 E/11	*24*	Pk. 25/61 E ...	35	29	43	81	34	49	21910
	25	Pk. 26/61 E ...	35	28	40	81	41	16	20950
	26	Pk. 27/61 E ...	35	22	31	81	33	43	22070
	27	Pk. 28/61 E ...	35	22	2	81	33	32	22150
61 E/12	*28*	Pk. 29/61 E ...	35	14	54	81	43	12	20010
61 E/13	*29*	Pk. 30/61 E* ...	35	53	1	81	59	21	19140
	30	Pk. 31/61 E ...	35	52	41	81	58	19	20170
	31	Pk. 32/61 E ...	35	52	20	81	48	23	19690
61 E/14	*32*	Pk. 33/61 E* ...	35	44	10	81	51	31	18690
	33	Pk. 34/61 E* ...	35	41	14	81	52	46	20600
	34	Pk. 35/61 E* ...	35	39	54	81	48	45	
	35	Pk. 36/61 E ...	35	34	17	81	46	17	19790
	36	Pk. 37/61 E ...	35	34	12	81	46	24	19830
61 E/15	*37*	Pk. 38/61 E	35	23	1	81	55	1	21200
	38	Pk. 39/61 E	35	15	16	81	48	37	20850

Stein's first expedition point (Ram Singh), 1900-01

61 E/1	*39*	Pk. 3/61 E* ...	35	47	48	81	8	42	

* *Vide* foot-note on p. 135.

Stations in Sheet 69.C

EXPLORATION

Station	Latitude	Longitude	Height
Stein's second expedition stations (Ram Singh), 1906-08			
	° ′ ″	° ′ ″	*feet*
Kapa 'S' (Île-dong) h.s.	37 14 5	84 52 3	9210
Kapa 'R' (Ak-bai) h.s.	37 12 44	84 50 28	9967
Kapa 'Q' (Mālghun) h.s.	37 11 52	84 50 27	11006

Station in Sheet 69.D

EXPLORATION

Station	Latitude	Longitude	Height
Stein's second expedition station (Ram Singh), 1906-08			
	° ′ ″	° ′ ″	*feet*
Arpalik-chakil 'P' h.s.	36 51 41	84 11 25	15500

Intersected Points in Sheet 69.D

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
Deasy's point, 1897-99					
			° ′ ″	° ′ ″	*feet*
$69\frac{D}{1}$	*1*	Pk. 2/69D	36 50 34	84 1 12	14750
Stein's second expedition points (Ram Singh), 1906-08.					
$69\frac{D}{1}$	*2*	Pk. 3/69D ...	36 45 40	84 11 28*	17450
	3	Pk. 4/69D ...	36 45 5	84 9 19*	16300

* The longitudes of peaks 3 and 4, as found by Captain Deasy and as hitherto accepted, were 84° 8′ 21″ and 84° 7′ 21″ respectively; these values were reported inaccurate by Rām Singh in 1906-08, and the latter's values have been inserted.

Stations in Sheet 69.G

EXPLORATION

Station		Latitude			Longitude			Height
		°	′	″	°	′	″	*feet*
Stein's second expedition stations (Ram Singh), 1906-08								
Ak-tāgh 'T'	*h.s.*	37	12	33	85	13	34	10473
Kāznik 'I'	*h.s.*	37	16	0	85	20	34	9486
Kāznik 'U'	*h.s.*	37	15	42	85	19	32	9782
Stein's third expedition stations (Lal Singh), 1913-15								
Ushlung	*h.s.*	37	19	52	85	35	27	10690
Ak-tāgh	*h.s.*	37	27	50	85	48	17	8486

Intersected Points in Sheet 69.G

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's second expedition points (Ram Singh), 1906-08									
69 G/4	*1*	Pk. 2/69 G (Mazdak) ...	37	6	40	85	6	12	16494
69 G/8	*2*	Pk. 5/69 G ...	37	3	23	85	20	14	17742
69 G/16	*3*	Pk. 6/69 G ...	37	14	4	85	47	5	19728
Stein's third expedition points (Lal Singh), 1913-15									
69 G/7	*4*	Pk. 7/69 G* ...	37	15	33	85	22	21	
69 G/8	*5*	Pk. 8/69 G† ...	37	10	38	85	20	38	13529
	6	Pk. 9/69 G*	37	5	32	85	27	38	
69 G/14	*7*	Pk. 10/69 G (Astin-tāgh)	37	36	5	85	53	45	8131
	8	Pk. 11/69 G ...	37	32	9	85	59	10	10106
69 G/15	*9*	Pk. 12/69 G* ...	37	19	37	85	46	29	...
	10	Pk. 13/69 G ...	37	18	12	85	48	21	18948
69 G/16	*11*	Pk. 14/69 G* ...	37	7	14	85	45	31	

* These four peaks are not shown on Stein's map Sheet No. 23 and are doubtful.

† The coordinates of this peak as shown on Stein's map Sheet No. 23 are λ 37° 10′ 38″ L 85° 18′ 30″. It is not known whether the triangulated value given above was found incorrect during the plane-tabling.

Stations in Sheet 69.K

EXPLORATION

Station		Latitude			Longitude			Height
Stein's third expedition stations (Lal Singh), 1913-15								
		°	′		°	′	″	*feet*
Khādalik 'F'	*h.s.*	37	52	2	86	9	40	5979
Khādalik 'C'	*h.s.*	37	50	23	86	8	5	5626
Khādalik 'D'	*h.s.*	37	50	1	86	9	0	6253
Khādalik 'A'	*h.s.*	37	49	53	86	7	55	5622
Khādalik 'B'	*h.s.*	37	49	49	86	8	13	5649
Chigelik-chap 'H'	*h.s.*	37	59	32	86	20	13	6052
Chigelik-chap 'G'	*h.s.*	37	58	22	86	16	41	6333

Intersected Points in Sheet 69.K

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
Stein's second expedition points (Ram Singh), 1906-08									
			°	′	″	°	′	″	*feet*
69 K/2	1	Pk. 1/69 K ...	37	31	8	86	10	15	15859
69 K/5	2	Pk. 3/69 K ...	37	49	28	86	27	15	16160
	3	Pk. 4/69 K ...	37	49	10	86	29	59	16900
69 K/13	4	Pk. 5/69 K ...	37	47	27	86	47	42	18407
Stein's third expedition points (Lal Singh), 1913-15									
69 K/2	5	Pk. 6/69 K ...	37	42	37	86	2	23	8190
69 K/5	6	Pk. 7/69 K ...	37	57	57	86	15	26	6217
	7	Pk. 8/69 K ...	37	56	3	86	23	7	10875

NOTE.—Pk. 2/69K of the second expedition was found inaccurate in the third and is omitted.

Stations in Sheet 69.J

EXPLORATION

Station	Latitude			Longitude			Height
Stein's third expedition stations (Lal Singh), 1913-15							
	°	′	″	°	′	″	*feet*
Yūnus-chap, 'B' End base, s.	38	12	34	86	49	54	4466
Yūnus-chap, 'A' End base s.	38	12	20	86	50	1	4560
Yulghun-dong 'K' h.s.	38	11	46	86	46	44	5109
Kujong-dong 'L' h.s.	38	11	37	86	48	50	5062
Kichik-jangal-sai 'J' h.s.	38	9	51	86	39	37	5558
Kichik-jangal-sai '28' h.s.	38	9	2	86	42	7	5721
Kizil-kum h.s.	38	22	7	86	57	9	5128

Intersected Points in Sheet 69.J

CLASS B

Sheet No.		Intersected Point	Latitude			Longitude			Height ground level
Stein's third expedition points (Lal Singh), 1913-15									
			°	′	″	°	′	″	*feet*
$69\frac{J}{12}$	1	Pk. 1/69 J ...	38	3	0	86	38	33	...
	2	Pk. 2/69 J	38	2	44	86	39	51	
$69\frac{J}{16}$	3	Pk. 3/69 J ...	38	13	23	86	55	59	...
	4	Pk. 4/69 J ...	38	11	46	86	54	19	8991
	5	Pk. 5/69 J	38	7	36	86	48	14	9274
	6	Pk. 6/69 J ...	38	6	39	86	49	16	

Stations in Sheet 69.N

EXPLORATION

Station	Latitude			Longitude			Height
Stein's third expedition stations (Lal Singh), 1913-15							
	°	′	″	°	′	″	*feet*
Chukur-chap 'N' h.s.	38	31	19	87	40	36	6068
Tūghemen '47' h.s.	38	27	18	87	41	52	10466
Kum-chak 'M' h.s.	38	24	49	87	32	11	7634
Tatlik-bulak, 'A' end base s.	38	38	23	87	53	10	5232
Tatlik-bulak, 'B' end base s.	38	38	12	87	53	28	5323
Tatlik-bulak 'O' h.s.	38	37	29	87	54	2	5570

Intersected Points in Sheet 69.N

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
		Stein's third expedition points (Lal Singh), 1913 15							
			°	′	″	°	′	″	*feet*
69 N 3	*1*	Pk. 1/69 x ...	38	15	59	87	13	41	11604
69 N 7	*2*	Pk. 2/69 x ...	38	21	51	87	27	52	10473
69 N 14	*3*	Pk. 3/69 x	38	36	28	87	57	33	8862
	4	Pk. 4/69 x	38	31	16	87	51	56	11794

Station in Sheet 75.A

EXPLORATION

Station		Latitude			Longitude			Height
		Stein's third expedition station * (Lal Singh), 1913-15						
		°		″	°	′	″	*feet*
Mīrān '59'	*h.s.*	39	1	2	88	45	9	4667
					88	*17*	*0*	

Stations in Sheet 75.B

EXPLORATION

Station		Latitude			Longitude			Height
		Stein's third expedition stations *(Lal Singh), 1913-15						
			′	″	°		″	*feet*
Mīrān '60'	*h.s.*	38	58	10	88	42	15	5120
					88	*11*	*0*	
Mīrān '61'	*h.s.*	38	57	54	88	44	21	5821
					88	*16*	*10*	
Toghrak-chap, 'B' end base,	*s.*	38	57	24	88	32	21	4039
					88	*33*	*10*	
Toghrak-chap, 'A' end base,	*s.*	38	57	9	88	32	30	4088
					88	*33*	*50*	
Toghrak-chap, 'C'	*h.s.*	38	56	28	88	32	8	4279
					88	*33*	*30*	

* The longitudes shown in italics are those which were adopted on Sir Aurel Stein's map Sheet No. 30, before the final consideration of his triangulation ; see above p. 110.

Intersected Points in Sheet 75. B

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
			° ′ ″	° ′ ″	*feet*
Stein's third expedition points* (Lal Singh), 1913-15					
75 B/2	*1*	Pk. 1/75 B ...	38 44 42	88 8 28 *88 8 40*	9631
	2	Pk. 2/75 B ...	38 44 42	88 10 16 *88 10 50*	10063
	3	Pk. 3/75 B ...	38 42 47	88 13 40 *88 14 20*	11802
	4	Pk. 4/75 B ...	38 41 59	88 14 26 *88 15 30*	11557†
75 B/9	*5*	Pk. 5/75 B ...	38 51 16	88 30 59 *88 32 40*	10490
	6	Pk. 6/75 B ...	38 50 7	88 34 54 *88 36 50*	13166
75 B/13	*7*	Pk. 7/75 B ...	38 56 27	88 59 18 *89 2 0*	8935
	8	Pk. 8/75 B ...	38 55 32	88 58 9 *89 1 10*	9232
	9	Pk. 9/75 B ...	38 54 2	88 47 31 *88 49 50*	10289

Intersected Point in Sheet 75.E

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
			° ′ ″	° ′ ″	*feet*
Stein's third expedition point* (Lal Singh), 1913-15					
75 E/16	*1*	Pk.1/75 E ...	39 0 12	89 46 59 *89 52 10*	13170

* The longitudes shown in italics are those which were adopted on Sir Aurel Stein's map Sheet No. 30, before the final consideration of his triangulation ; see above p. 110.

† Misprinted on Sir A. Stein's map Sheet No. 30 as 11657.

Intersected Points in Sheet 75.F

CLASS B

Sheet	No.	Intersected Point	Latitude	Longitude	Height ground level
			° ′ ″	° ′ ″	*feet*
Stein's third expedition points* (Lal Singh), 1913-15					
75 F/1	*1*	Pk.1/75 F ...	38 57 32	89 0 48	8602
				89 3 50	
75 F/13	*2*	Pk.2/75 F ...	38 56 2	89 46 15	12373
				89 51 30	

Stations in International Sheet NK.45.K

EXPLORATION

Station	Latitude	Longitude	Height
	° ′ ″	° ′ ″	*feet*
Clementi's station, 1907-08			
Korla, minor latitude and longitude station	41 44 20·8	86 10 10·4	
Stein's third expedition stations† (Lal Singh), 1913-15			
'CC 84' s.	41 39 38	86 21 0	3508
	41 42 40	*86 3 30*	*3221*
Camp 305 s.	41 39 11	86 19 18	
'CC 85' s.	41 38 36	86 18 15	3457
	41 41 30	*86 0 30*	*3170*
'CC 79' s.	41 35 39	86 28 10	3749
	41 38 40	*86 10 20*	*3462*
Kalmak-ölgan-bulak, 'CC 74' s.	41 33 55	86 38 7	4093
	41 36 30	*86 20 0*	*3806*
Kara-tāgh 'CC 73' s.	41 31 25	86 38 57	3711
	41 34 10	*86 20 20*	*3424*
'CC 72' s.	41 26 50	86 52 18	3922
	41 29 40	*86 33 20*	*3635*
'CC 67' s.	41 26 11	86 53 49	3943
	41 29 0	*86 34 50*	*3656*

* The longitudes shown in italics are those which were adopted on Sir Aurel Stein's map, Sheet No. 30, before the final consideration of his triangulation.

† Stein's stations in this area are based on Clementi's value of Korla given above; the values shown in italics are those which were adopted on his map, Sheet No. 25, before the final consideration of his triangulation. The heights shown in upright type are based on the barometric height of Āstin-bulak, E. end base.

Intersected Points in International Sheet NK. 45.K

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's third expedition points* (Lal Singh), 1913-15									
NK.45 K/1	*1*	'CC 89' ...	41	51	33	86	14	15	
NK.45 K/6	*2*	'CC 88' ...	41	40	48	86	20	5	3627
			41	*43*	*44*	*86*	*2*	*10*	*3340*
	3	'CC 83' ...	41	38	11	86	20	6	...
	4	'CC 80' ...	41	36	40	86	28	20	3973
	5	'CC 82' ...	41	35	21	86	22	26	...
NK.45 K/10	*6*	'CC 77' ...	41	38	9	86	39	31	5858
			41	*41*	*10*	*86*	*21*	*20*	*5571*
	7	'CC 78' ...	41	37	41	86	42	29	5904
			41	*40*	*30*	*86*	*23*	*30*	*5617*
	8	'CC 76' ...	41	37	25	86	35	25	5104
			41	*40*	*40*	*86*	*17*	*10*	*4817*
	9	'CC 75' ...	41	34	35	86	38	0	4387
			41	*37*	*30*	*86*	*19*	*40*	*4100*
NK.45 K/14	*10*	'CC 65' ...	41	34	26	86	51	39	6096
			41	*37*	*10*	*86*	*32*	*40*	*5809*
	11	'CC 64' ...	41	30	50	86	56	1	4909
			41	*33*	*30*	*86*	*36*	*50*	*4622*
NK.45 K/15	*12*	'CC 68' ...	41	26	20	86	57	51	3947
			41	*29*	*20*	*86*	*38*	*50*	*3660*
	13	'CC 63' ...	41	24	33	86	56	24	3807
			41	*27*	*30*	*86*	*36*	*40*	*3520*
	14	'CC 70' ...	41	22	11	86	48	59	3492
			41	*25*	*20*	*86*	*30*	*20*	*3205*

Stations in International Sheet NK. 45.O

EXPLORATION

Station	Latitude			Longitude			Height
	°	′	″	°	′	″	*feet*
Stein's third expedition stations* (Lal Singh), 1913-15							
Yetim-bulak "CC 59" s.	41	25	1	87	3	45	4287
	41	*28*	*0*	*86*	*11*	*10*	*4000*
Yetim-bulak "Camp" s.	41	24	33	87	2	52	3907
	41	*27*	*10*	*86*	*13*	*20*	*3620*
Yetim-bulak h.s.	41	23	12	87	3	0	3967
	41	*26*	*20*	*86*	*13*	*30*	*3680*

* Stein's stations and points in these areas are based on Clementi's values of Korla. The values shown in italics are those which were adopted on his map, Sheet No. 25, before the final consideration of his triangulation. The heights shown in upright type are based on the barometric height of Ästin-bulak, E. end base.

Stations in International Sheet NK. 45.O—(*continued*)

EXPLORATION

Station		Latitude			Longitude			Height
		°	′	″	°	′	″	*feet*
Stein's third expedition stations* (Lal Singh), 1913-15								
"CC 51"	*h.s.*	41	25	28	87	22	21	6489
		41	*28*	*10*	*87*	*2*	*30*	*6202*
"CC 50"	*h.s.*	41	25	15	87	21	53	6230
		41	*28*	*0*	*87*	*2*	*0*	*5943*
Camp 299	*h.s.*	41	24	5	87	21	10	5835
		41	*27*	*0*	*87*	*1*	*10*	*5548*
"CC 45"	*h.s.*	41	23	43	87	36	32	5444
		41	*26*	*30*	*87*	*15*	*50*	*5157*
"CC 48"	*h.s.*	41	21	31	87	40	46	5356
		41	*24*	*10*	*87*	*19*	*30*	*5069*
"Jilun South"	*h.s.*	41	21	8	87	40	2	5613
		41	*23*	*50*	*87*	*18*	*40*	*5326*

Intersected Points in International Sheet NK. 45.O

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's third expedition points* (Lal Singh), 1913-15									
NK.45 O/2	*1*	"CC 69" (Kodailek-tāgh)	41	38	20	87	0	21	8358
			41	*41*	*10*	*86*	*41*	*0*	*8071*
	2	"CC 66" ...	41	32	1	87	10	28	7591
			41	*34*	*50*	*86*	*50*	*50*	*7304*
NK.45 O/3	*3*	"CC 54" ...	41	21	50	87	10	53	5187
			41	*21*	*40*	*86*	*51*	*10*	*4900*
NK.45 O/6	*4*	"CC 46" ...	41	32	31	87	25	45	9503
			41	*35*	*20*	*87*	*5*	*20*	*9216*

* Stein's stations and points in these areas are based on Clementi's value of Kor'a (NK. 45.K.). The values shown in italics are those which were adopted on Stein's map, Sheet No. 25, before the final consideration of his triangulation. The heights shown in upright type are based on the barometric height of Āstin-bulak, E. end base.

Intersected Points in International Sheet NK. 45.O—(*continued*)

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's third expedition points* (Lal Singh), 1913-15									
NK.45$\frac{O}{7}$	5	"CC 44" (Chin-shan-kou)	41	27	48	87	27	23	8054
			41	*30*	*40*	*87*	*7*	*10*	*7767*
	6	"CC 43" ...	41	26	36	87	21	35	7262
			41	*29*	*30*	*87*	*1*	*20*	*6975*
	7	"CC 42" ...	41	26	29	87	20	58	7220
			41	*29*	*30*	*87*	*0*	*40*	*6933*
	8	"CC 56" ...	41	25	9	87	15	54	5401
			41	*28*	*50*	*86*	*56*	*0*	*5114*
	9	"CC 55" ...	41	24	10	87	15	25	5592
			41	*27*	*0*	*86*	*55*	*20*	*5305*
	10	"CC 41" (Chin-shan-kou)	41	23	48	87	27	16	7382
			41	*26*	*50*	*87*	*7*	*0*	*7095*
	11	"CC 53" ...	41	23	15	87	17	3	6405
			41	*26*	*10*	*86*	*57*	*0*	*6118*
	12	"CC 52" ...	41	21	29	87	21	26	7575
			41	*24*	*20*	*87*	*1*	*10*	*7298*
	13	"CC 40" ...	41	21	20	87	24	1	7088
			41	*24*	*10*	*87*	*3*	*40*	*6801*
NK.45$\frac{O}{10}$	14	"CC 47" ...	41	30	58	87	31	47	8689
			41	*33*	*40*	*87*	*11*	*30*	*8402*
NK.45$\frac{O}{11}$	15	"Ground" ...	41	23	18	87	38	7	5132
			41	*26*	*20*	*87*	*17*	*10*	*4845*
NK.45$\frac{O}{15}$	16	"CC 38" ...	41	23	4	87	57	24	8687
			41	*25*	*40*	*87*	*36*	*0*	*8400*
	17	"CC 37" ...	41	20	42	87	58	17	8152
			41	*23*	*20*	*87*	*36*	*50*	*7865*
	18	"CC 35" ...	41	17	5	87	57	26	7679
			41	*19*	*40*	*87*	*35*	*20*	*7392*
	19	"CC 39" ...	41	16	29	87	52	50	6898
			41	*19*	*0*	*87*	*31*	*30*	*6611*

* *Vide* foot-note on p. 145.

Stations in International Sheet NK. 45. S

EXPLORATION

Station	Latitude			Longitude			Height
	°	′	″	°	′	″	*feet*
Stein's third expedition stations* (Lal Singh), 1913-15							
Shindī, No. 2 h.s.	41	11	52	88	15	14	5315
	41	*14*	*40*	*87*	*52*	*40*	*5023*
Shindī, No. 1 h.s.	41	11	37	88	15	51	5699
	41	*14*	*30*	*87*	*53*	*30*	*5412*
Shindī Camp s.	41	10	22	88	13	18	4689
	41	*13*	*20*	*87*	*50*	*50*	*4402*

Intersected Points in International Sheet NK. 45. S

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's third expedition points * (Lal Singh), 1913-15									
NK.45 S/4	*1*	"CC 34" (Shindī-tāgh)	41	9	18	88	7	31	7104
			41	*12*	*10*	*87*	*45*	*0*	*6817*
NK.45 S/7	*2*	"CC 18" ...	41	16	18	88	21	41	
NK.45 S/11	*3*	"CC 12" (Mohur-shan)	41	20	21	88	37	50	8412
			41	*23*	*0*	*88*	*14*	*50*	*8152*
NK.45 S/12	*4*	"CC 11" ...	41	5	24	88	32	29	6097
			41	*8*	*10*	*88*	*10*	*0*	*5810*
NK.45 S/15	*5*	"CC 7" (Kizil-tāgh)	41	24	49	88	59	53	5467
			41	*27*	*30*	*88*	*35*	*10*	*5180*
	6	"CC 6" (Dunda-shan)	41	21	44	88	46	18	7341
			41	*24*	*30*	*88*	*22*	*50*	*7054*
	7	"CC5"(Kichik-azghan)	41	17	15	88	49	54	5812
			41	*20*	*20*	*88*	*26*	*30*	*5525*
NK.45 S/16	*8*	"CC 10" (Kök-tāgh)	41	2	6	88	53	24	4389
			41	*5*	*0*	*88*	*29*	*30*	*4102*

* Stein's stations and points in these areas are based on Clementi's value of Korla (NK. 45. K). The values shown in italics are those which were adopted on his map, Sheets Nos. 25 and 29, before the final consideration of his triangulation. "CC 18" is not shown on the map. The heights shown in upright type are based on the barometric height of Āstin-bulak, E. end base.

Stations in International Sheet NK. 45.W

EXPLORATION

Station	Latitude	Longitude	Height
Stein's third expedition stations* (Lal Singh), 1913-15			
Kizil-hedir 'D' h.s.	41 25 55	89 4 21	4749
	41 28 40	*88 40 30*	*4462*
Singer, 'A' end base, s.	41 24 22	89 2 20	4646
	41 47 10	*88 38 20*	*4359*
Singer, 'B' end base, s.	41 24 15	89 2 57	4610
	41 27 0	*88 39 0*	*4323*
Singer, 'C' h.s.	41 23 57	89 2 14	4807
	41 26 40	*88 38 10*	*4520*
Kara-koshun s.	41 21 52	89 9 19	4769
	41 24 40	*88 45 10*	*4482*
Nanchan, No. 1, s.	41 12 41	89 12 52	3696
	41 15 50	*88 48 10*	*3409*
Nanchan, No. 2 s.	41 10 12	89 13 42	3578
	41 13 10	*88 49 9*	*3291*
Bēsh-bulak "CC 14" s.	41 8 3	89 40 4	4436
	41 11 0	*89 14 40*	*4149*
Burutu "CC 16" s.	41 1 28	89 46 48	4523
	41 4 20	*89 20 30*	*4236*

Intersected Points in International Sheet NK. 45.W

CLASS B

Sheet	No.	Intersected point	Latitude	Longitude	Height ground level
Stein's third expedition points* (Lal Singh), 1913-15					
NK.45 W 3	1	Kizil-hedir "2" ...	41 25 45	89 6 40	4843
			41 29 0	*88 42 10*	*4556*
NK.45 W 6	2	"CC 1" ...	41 34 48	89 22 0	4990
			41 37 30	*88 56 50*	*4703*

* Stein's stations and points in these areas are based on Clementi's value of Korla (NK. 45.K). The values shown in italics are those which were adopted on his map Sheet No. 29 before the final consideration of his triangulation. The heights shown in upright type are based on the barometric height of Astin-bulak, E. end base.

Intersected Points in International Sheet NK. 45.W—(*continued*).

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
NK.45 W/7	*3*	"CC 8" ...	41	17	34	89	22	46	5296
			41	*20*	*30*	*88*	*57*	*20*	*5009*
NK.45 W/11	*4*	"CC 2"	41	18	49	89	40	19	6548
			41	*20*	*10*	*89*	*20*	*50*	*6261†*
	5	"CC 3" (Chöl-togh-rak-tāgh)	41	16	41	89	40	39	6897
			41	*19*	*30*	*89*	*15*	*0*	*6610*
NK.45 W/16	*6*	"CC 13" (Bēsh-bulak)	41	7	9	89	53	19	5486
			41	*10*	*0*	*89*	*26*	*10*	*5199*
	7	"CC 15" ...	41	1	33	89	47	2	4531
			41	*4*	*40*	*89*	*21*	*0*	*4244*
	8	"CC 21" ...	41	0	50	89	58	27	4327
			41	*3*	*50*	*89*	*32*	*10*	*4040*

Intersected Points in International Sheet NK. 45. X

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's third expedition points* (Lal Singh), 1913-15									
NK.45 X/5	*1*	"CC 4" (Yārdang-bulak-tāgh) ...	40	48	22	89	16	28	4407
			40	*51*	*10*	*88*	*52*	*20*	*4120*
NK.45 X/9	*2*	"CC 9"	40	56	10	89	41	24	4217
			40	*59*	*0*	*89*	*15*	*40*	*3930*

Intersected Points in International Sheet NK. 46.C

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°		″	°		″	*feet*
Stein's third expedition point* (Lal Singh), 1913-15									
NK.46 C/4	*1*	"CC 22" ...	41	5	47	90	4	6	5657
			41	*8*	*50*	*89*	*37*	*10*	*5370*

* Stein's points in these areas are based on Clementi's value of Korla (NK.45.K). The values shown in italics are those which were adopted on his map, Sheet No 29, before the final consideration of his triangulation. The heights shown in upright type are based on the barometric height of Āstin-bulak, E. end base.

† It is not certain whether the point shown on map Sheet No 29 with the height 6261 was identical with "CC 2". If so, the coordinates derived from the triangulation are probably in error.

Stations in International Sheet N K. 46.D

EXPLORATION

Station	Latitude			Longitude			Height
	°	′	″	°	′	″	*feet*
Stein's third expedition stations * (Lal Singh), 1913-15							
Ulun-temen-tu							
" CC 23" s.	40	57	23	90	3	0	4103
	41	*0*	*10*	*89*	*36*	*30*	*3816*
Ältmish-bulak, "No. 1" s.	40	56	18	90	19	23	4247
	40	*59*	*0*	*89*	*52*	*0*	*3960*
Ältmish-bulak, "Camp" s.	40	53	29	90	19	55	3218
	40	*56*	*10*	*89*	*52*	*40*	*2931*
Ältmish-bulak, "No. 2" s.	40	52	55	90	19	46	3262
	40	*55*	*40*	*89*	*52*	*10*	*2975*
Ästin-bulak, E. end base s.	40	47	10	90	18	57	2830†
	40	*50*	*10*	*89*	*51*	*20*	*2543*
Ästin-bulak, W. end base s.	40	46	53	90	18	5	2893
	40	*49*	*30*	*89*	*50*	*30*	*2606*

Intersected Points in International Sheet N K. 46.D

CLASS B

Sheet	No.	Intersected Point	Latitude			Longitude			Height ground level
			°	′	″	°	′	″	*feet*
Stein's third expedition points * (Lal Singh), 1913-15									
NK.46 D/1	*1*	"CC 20" (Ulun-temen-tu) ...	40	58	30	90	8	32	4809
			41	*1*	*20*	*89*	*41*	*50*	*4522*
	2	"CC 26" ...	40	54	48	90	3	17	3923
			40	*57*	*30*	*89*	*36*	*30*	*3636*
	3	"CC 30" ...	40	53	37	90	14	53	3913
			40	*56*	*40*	*89*	*47*	*10*	*3626*
NK.46 D/5	*4*	"CC 28" ...	40	58	2	90	29	36	
	5	"CC 27" ...	40	57	48	90	24	33	4410
			41	*40*	*0*	*89*	*57*	*20*	*4123*

* Stein's stations and points in these areas are based on Clement's value of Korla (NK 45. K). The values shown in italics are those which were adopted on his map, Sheet No. 29, before the final consideration of his triangulation. The heights shown in upright type are based on the barometric height of Ästin-bulak, E. end base.

† Height by mercury barometer. This height is used as the datum for the heights of stations in the section Ästin-bulak to Korla.

APPENDIX B

NOTES ON HEIGHT OBSERVATIONS

MADE DURING SIR AUREL STEIN'S EXPLORATIONS

1900-01, 1906-08, 1913-15

BY

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DEPUTY SUPERINTENDENT, MATHEMETICAL ADVISER, SURVEY OF INDIA

THE BAROMETRIC AND HYPSOMETRIC HEIGHTS

Numerous readings of mercury barometers, aneroid barometers and hypsometers were made by the surveyors who accompanied Sir Aurel Stein on his three journeys—1900-01, 1906-08 and 1913-15. The results of the mercury barometers are satisfactory, those of the aneroids are surprisingly so, seeing that all aneroids are subject to erratic changes; but the hypsometer results have proved to be worthless. Hence only heights derived from mercurial or aneroid barometer readings have been shown in the maps recording these surveys.

At places where all three instruments have been observed, the aneroid has rarely differed from the mercury by as much as 200 feet; while the range of variation of the difference of mercury barometer and hypsometer attains a maximum of about 2000 feet. This is the more disappointing when the very large number of hypsometer readings taken on these journeys is considered. This failure of the hypsometer height results must be attributed to improper use of the instrument, such as

(1) not allowing the water to boil properly and accordingly getting too low a reading, resulting in too great a height deduced;

(2) immersing the bulb of the thermometer in the water, instead of seeing that it is wholly in the steam above;

(3) blunders in reading.

The first of these faults can be avoided by allowing the heating to go on after the water is believed to be boiling, and seeing whether any further rise of the mercury occurs; then booking the highest reading. If the second fault is avoided it is a matter of indifference whether the water is pure or not. Blunders should only be rare if the graduations of the thermometer are rubbed over with lamp black when they become faint.

At the time that the readings of the first two journeys were reduced, the view prevailed in the Survey of India that hypsometric results were not trustworthy, and these hypsometric results were abandoned without seeking for any further reason. While I am confident that good results may be obtained with the hypsometer, I have had to reject the results of the 1913-15 journey, because comparison with the mercury barometer results show them to be quite unreliable.

METHODS OF REDUCT ON OF THE READINGS

Hypsometer readings have been converted into equivalent air pressure by means of tables of Regnault (revised by Moritz). This pressure is the same as would be given by a mercury barometer, fully corrected for temperature, altitude and gravity; it is also the same as a *perfect* aneroid would give. The rest of the process of reduction for readings of all three instruments should be the same for all. This is the case for the journey 1913-15. In the two earlier journeys hypsometer readings were worked out with reduced labour by assuming sea-level pressure to be constant 29″·92, and also that air temperature changed 1° F per 331 feet of height. The resulting height should be the height above the level at which the pressure is 29″·92, which may or may not be that of sea-level.

As regards the barometer reductions of these two earlier journeys both mercury and aneroid were computed on Baily's formula. Corrections were applied to the aneroid readings, to make them accord with the mercury readings at all places where these were available also. The deduction of each barometer station of Rām Singh 1900-01 and 1906-7 was made using the previous one as a base station; while for some of Lāl Singh's stations* of 1907-08, Leh Fort, with a constant value of pressure 19·50 inches and temperature 55° F, was used as base station. For others, though Leh was still the base station, instead of the constant values as above, the readings at Leh corresponding to the time and date of the deduced stations were taken off the Daily Weather Report for use in the calculations. In Rām Singh's observations no account was taken of either the diurnal or seasonal change in barometer; but the procedure adopted for the reduction of his observations does give a better representation of the actual temperature of the air. It only remains to be said of Rām Singh's heights that Trotter's height of Camp 3 (Tāsh-kurghān) was used as initial height for the 1900-01 results and the height of Chitrāl for the 1906-7 results.

1913-15 JOURNEY

In the journey of 1913-15 there were three observers, Lāl Singh, Yakūb Khān and Afrāz-gul. Of these Lāl Singh alone used a mercury barometer, in addition to aneroids and hypsometer. He compared his mercury barometer with the barometer at the well-equipped Russian meteorological station, Kāshgar, with the following results:—

TABLE I

Comparison of Barometers at Kāshgar

Date and time of observation	Lāl Singh's Mer. Barometer	Russian Mer. Barometer	Lāl Singh's Thermometer	Russian Thermometer	Barometers Reduced to 32° F		Difference of Barometers, Thermometers	
					Lāl Singh's Barometer	Russian Barometer	Russian—Lāl Singh's	Russian—Lāl Singh's
	Inches	*m. m.*	*Fahr.*	*Centd.*	*Inches*	*Inches*	*Inches*	*Fahr.*
6 A.M. 2. 7. 15	25·50	645·7	83°	24°·7	25·37	25·31	−0·06	−6°·5
6 A.M. 3. 7. 15	25·42	645·5	79°	25°·7	25·30	25·30	0	−0·7
6 A.M. 4. 7. 15	25·54	645·6	80°	24°·3	25·41	25·31	−0·10	−4·3

At some stations Lāl Singh observed with all three instruments, and the following table shows the discrepancies which occur in these cases between the height by mercury barometer and aneroid, and between mercury barometer and hypsometer.

* Group—Camp 451, Art-dawān, Camp 455, Kuch-kach-bulak-dawān, Yurung-kāsh below Zailik, Camp 457. On the 1907-08 journey Lāl Singh compared his aneroid with the mercurial barometer at Leh. In the computation of results the aneroid readings were corrected for the discrepancy between mercury and aneroid.

TABLE II

Mercurial Barometer observations, with corresponding aneroid and hypsometer readings.

1913-15

Camp	Difference of Height in ft.		
		Mercurial—Aneroid	Mercurial—Hypso
		feet.	feet.
Chichiklik Pass	...	+ 63	— 608
Kichik-jangal-sai, C. 12	...	+ 92	— 505
Bāsh-kurghan, C. 28		+ 95	— 516
Jau-bulak (E. of C. 31)	...	+161	— 444
Khanambal, C. 39 ...	...	+ 88	
Su-mu-t'ou, C. 41 ...		+425	
Toghrak-bulak, C. 47		+ 97	
Bēsh-toghrak, C. 49		+ 32	
Kum-kuduk, C. 52		+ 95	
Lowaza, C. 57 ...		+147	— 466
Ying-p'an, C. 73 ...		+120	—1925
Jaka-yārdang-bulak, C. 76		+225	—1380
Āstin-bulak, C. 81 ...		+191	— 469
Āltmish-bulak, C. 86		+158	— 336
An-hsi, C. 120 ...		+ 19	+ 9
Su-chou, C. 133		+ 0	+1121
Kan-chou, C. 168 ...		— 32	
Hung-shui, C. 172 ...		+ 16	— 262
Lo-t'o-ching, C. 208		+ 26	— 517
Ming-shui, C. 213 ...		— 53	— 432
Bai, C. 220 ...		— 31	— 606
Barkul, C. 226 ...		— 34	— 356
Ku-ch'êng-tzu, C. 235		+ 45	— 174
Kara-khōja, C. 242	...	+173	— 156
Yār-mahalla, Turfān, C. 243	...	+ 69	— 348
Orkash-bulak, C. 248 ...	...	— 34	— 309
Singer, △ Station A ...	...	+ 65	— 621
Nanchan-bulak, C. 252 ...	...	— 40	— 637
Burutu-bulak, C. 255 ...	...	— 58	— 655
Āstin-bulak, E. end of △ base ...		+147	— 511
Palgān-bulak, C. 260		— 42	— 542
Tügemen-tāsh, C. 271	...	+ 90	— 492
Deghar, C. 275 ...	...	+123	— 275
E. extremity of Aidin-köl bed, C. 276	...	+137	— 102
Camp S. of Aidin-köl bed, C. 277	...	+123	— 221
P.T. Station W. of Camp 276	...	+135	— 122
P.T. Station W. of Camp 277 ...	...	+130	— 250
Camp N. of Bējān-tura C. 279 ...	...	+130	— 250
Turfān, Yangi-shahr, C. 280	...	+130	— 286
Kara-khōja (Bēg's house)	...	+148	+ 112
Bējān-tura, C. 282	...	+143	— 280
Singer, C. 291 ...	...	+137	— 332
Korla, C. 306 ...	...	+363	— 466
Yangi-hissār, C. 313 ...	...	+159	— 84
Kuchā .	...	—118	— 329
Kāshgar, C. 351 ...	...	— 9	— 139
Kāshgar, C. 351 ...	...	— 63	
Kāshgar, C. 351 ...		+ 10	
Arche-bēl-dawan (W. of C. 354)...		+ 14	— 224
Oirama, C. 357 ...		— 56	— 132
Kiyak-bāshi, C. 358 ...	...	+ 44	— 306

This table gives the explanation for the rejection of these hypsometric heights.

APPENDIX *B*

METHOD OF REDUCTION, 1913-15 JOURNEY

Hypsometer readings, corrected for thermometer scale-error, were reduced to equivalent air pressure, and these were treated as fully corrected. Mercury barometer readings were corrected for scale-error and reduced to freezing point. Aneroid readings were treated as fully corrected. In this way each instrument yields a fully corrected pressure.

Next from a table, based on the International Meteorological Formula (1905) the height above a standard pressure level, 29·92, was read off. The result was multiplied by a factor, taking account of the mean air temperature. By means of the Indian Daily Weather Report chart, the value of pressure at sea-level at the station is estimated. Its difference from the value 29·92 multiplied by 873 is the necessary correction to the height in feet. The differences between results of aneroid and mercury barometer were taken out, and applied to succeeding aneroid readings until the next comparison occurred. The same would have been done for the hypsometer results, if it had been decided to retain them.

MISTAKES OF COMPUTATION

By a mistake on the part of the computer, uncorrected aneroid heights were given in four cases in place of the corrected mercury heights. Places and corrections are as follows.

Place	Height given	Correction	Final height
Toghrak-bulak	2740	+ 97	2837
Bēsh-toghrak	1980	+ 32	2012
Kum-kuduk	2150	+ 95	2245
Lowaza	1890	+147	2037

RECORDS AND COMPUTATIONS

These are at Dehra Dūn, in the Computing Office, Survey of India, and are available for reference.

INDEX OF LOCAL NAMES.

NOTE.—Each local name is followed by the number of the map sheet and section in which it occurs.

In the brief descriptive notes added to the names the following abbreviations have been used: *cultiv.* for cultivated ground (without permanent occupation); *Gl.* for glacier; *habit.* for habitation (isolated abode); *loc.* for locality; *mt.* for mountain; *vill.* for village (without distinction of size; also for hamlet).

Different localities, etc., bearing identical names have been distinguished by the addition in brackets of the tracts, etc., to which they belong, or of the nearest topographical features of importance.

Regarding the record and transliteration of local names, whether Turkī, Īrānian, Chinese, etc., the explanations given above, pp. 61 sq., may be consulted. Errors of spelling and misprints have been rectified in Index entries.

B.

C.

E.

F.

G.

H.

I.

J.

K.

L.

M.

N.

O.

R.

S.

T.

U.

V.

W.

Y.

Z.

GENERAL INDEX

NOTE.—Owing to want of the requisite 'peculiar' types a few transcriptional characters in Chinese and other names have been printed here as well as in the text and the preceding 'Index of local names' without their proper diacritical marks.

Errors of spelling and misprints have been rectified in the Index.

ADDENDA ET CORRIGENDA

P. 45, r. col., last line. *For* de Lo'czy's *read* de Lóczy's.

P. 70, l. col., l. 38. *For* Piewzoff *read* Pyewzoff.

P. 75, r. col., l. 36. *Add* B. 1. The height of the intersected point, Pk. 8/61 A, should be 21430, not 21460.

P. 83, r. col., l. 5. *Add* Correction. B. 4. The triangulated point 5721 ought to have been shown as a triangulation station (Kichik-jangal-sai).

P. 87, r. col., l. 24. *Add* A. 3. The height of the intersected point Pk. 4/75 B should be 11557, not 11657.

P. 87, l. col., l. 39. *For* westernmost *read* easternmost.

P. 155, r. col. l. 3. *For* 21. A. 2. *read* 21. B. 3.

P. 156, l. col. l. 1. *For* 12. A. 2. *read* 14. A. 2.

P. 157, l. col. l. 41. *For* 12. A. 2. *read* 14. A. 2.

r. col. l. 61. *For* 12. A. 2. *read* 14. A. 2.

P. 158, l. col. l. 58. *For* Ayak-shilwe *read* Ayak-kara-shilwe.

r. col. l. 4. *For* 12. A. 2. *read* 14. A. 2.

r. col. l. 58. *For* 12. A. 2. *read* 14. A. 2.

P. 159, l. col. l. 13. *For* Bāsh-shilwe *read* Bāsh-kara-shilwe.

l. col. l. 50. *For* 12. A. 2. *read* 14. A. 2.

r. col. l. 60. *Omit* the entry Bombāk which ought to *read* Dombāk.

P. 160, l. col. l. 35. *For* 9. D. 2. *read* 9. D. 4.

r. col. l. 28. *For* 12. A. 2. *read* 14. A. 2.

r. col. l. 30. *Add* after this line: Dombāk, vill., 9. D. 2.

P. 161, l. col. l. 1. *For* 12. A. 2. *read* 14. A. 2.

P. 161, l. col. l. 39. *For* 12. A. 2. *read* 14. A. 2.

P. 163, l. col. l. 17. *For* 41. D. 4. *read* 4. D. 4.

r. col. l. 19. *For* 45. C. 4. *read* 45. A. 3.

P. 164, r. col. l. 15. *For* Dobe-chap *read* Döbe-chap.

r. col. l. 23. *For* 12. A. 2. *read* 14. A. 2.

P. 165, r. col. l. 42. *For* 12. A. 2. *read* 14. A. 2.

P. 166, l. col. l. 17. *For* 12. A. 2. *read* 14. A. 2.

r. col. l. 20. *For* 12. A. 2. *read* 14. A. 2.

r. col. l. 21. *For* 12. A. 2. *read* 14. A. 2.

P. 167, l. col. l. 26. *For* Hsia-chêng-ti *read* Hsia-shêng-ti.

r. col. l. 28. *For* Hui-chin-tzu *read* Hui-ching-tzu.

r. col. l. 51. *For* Hung-shang-ssu *read* Hung-shan-ssu.

P. 168, r. col. l. 41. *For* 12. A. 2. *read* 14 A. 2.

P. 170, l. col. l. 45. *For* 14. B. 2. *read* 14. B. 3.

r. col. l. 16. *For* Kara-chika *read* Kara-choka.

r. col. l. 17. *For* 21. A. 2. *read* 21. B. 3.

r. col. l. 51 *For* Kara-jong *read* Kara-jang.

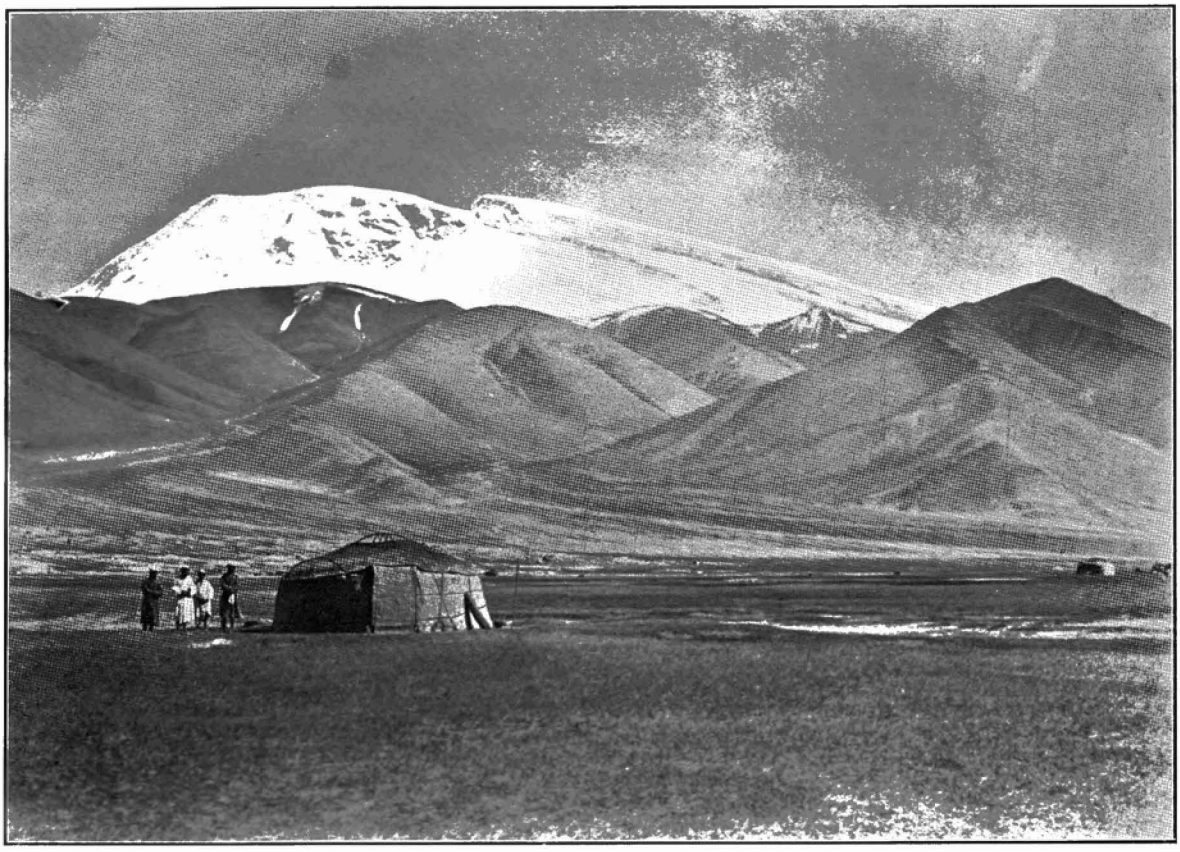
P. 171, l. col. l. 7. *For* 12. A. 2. *read* 14. A. 2.

P. 172, r. col. l. 52. *For* 5. A. 1. *read* 5. A. 3.

P. 173, l. col. l. 40. *For* Khaman-dawān *read* Khamar-dawān.

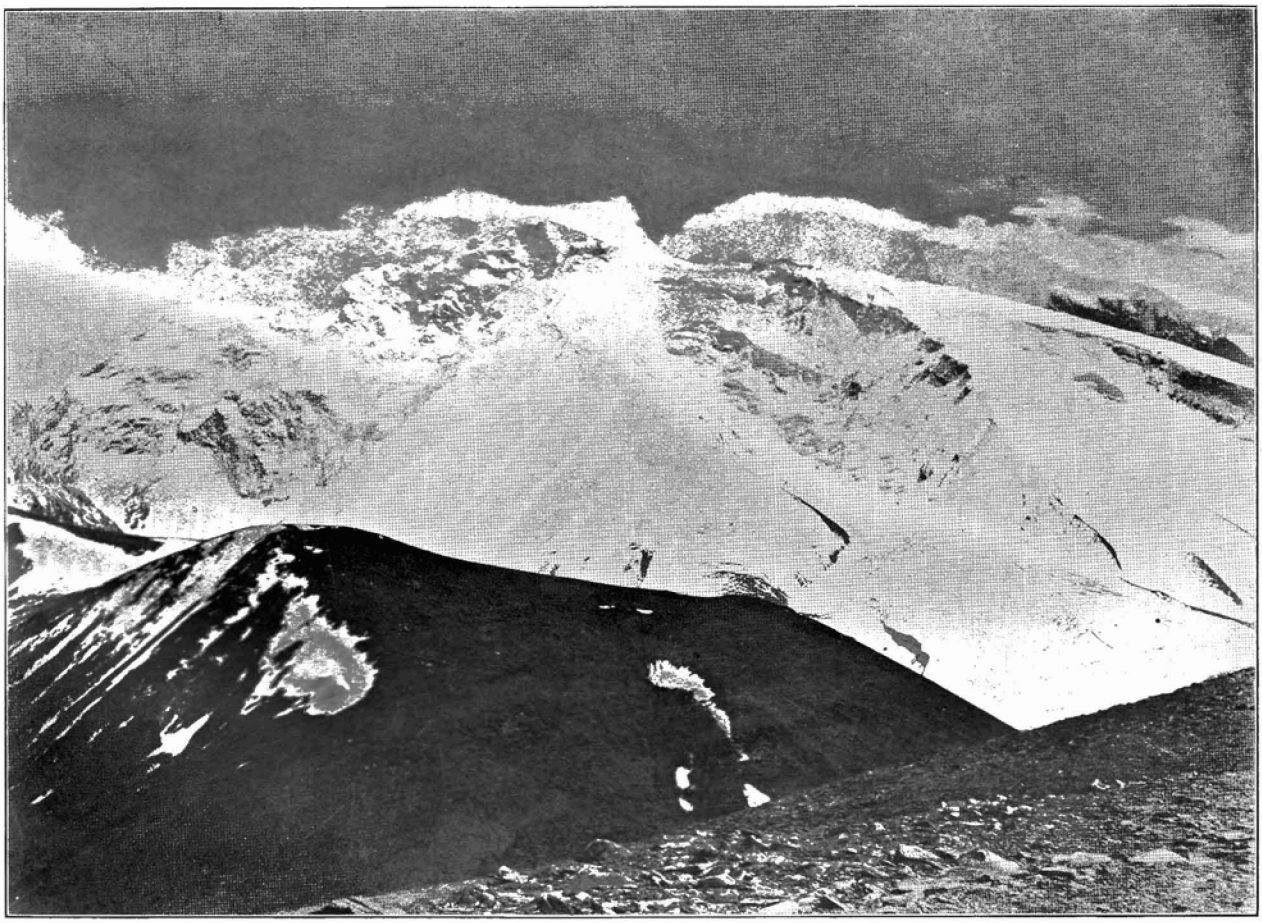
P. 174, l. col. l. 21. *For* 12. A. 2. *read* 14. A. 2.

FINIS



2. A. — MUZ-TAGH-ATA (24,321 FEET) SEEN FROM CAMP 9 SOUTH OF LITTLE KARA-KUL (SEE PAGES 6, 64).

Shamalda spur (h.s. C, 14,570 feet) on right.



2. B. — MUZ-TAGH-ATA (24,321 FEET) SEEN FROM SHAMALDA SPUR (h.s.C, 14, 570 FEET: SEE PAGES 6, 64).

Kara-kir
Pk. 5
42 N
12,399

Muztagh-ata
Pk. 7
42 N
24,388

Kara-su-Gl. Shiwakte Toyakuiruk J. Kochkorche Gl. Yambulak Gl.

Continued in 3. B.

Little Kara-kul Su-bashi

3. A.—PHOTO-THEODOLITE VIEW FROM KOK-TUMSHUK HILL, ABOVE WESTERN SHORE OF LITTLE KARA-KUL, TO SOUTH-EAST AND SOUTH (SEE PAGES 6, 64).

Pk. 3
42 N
21,480

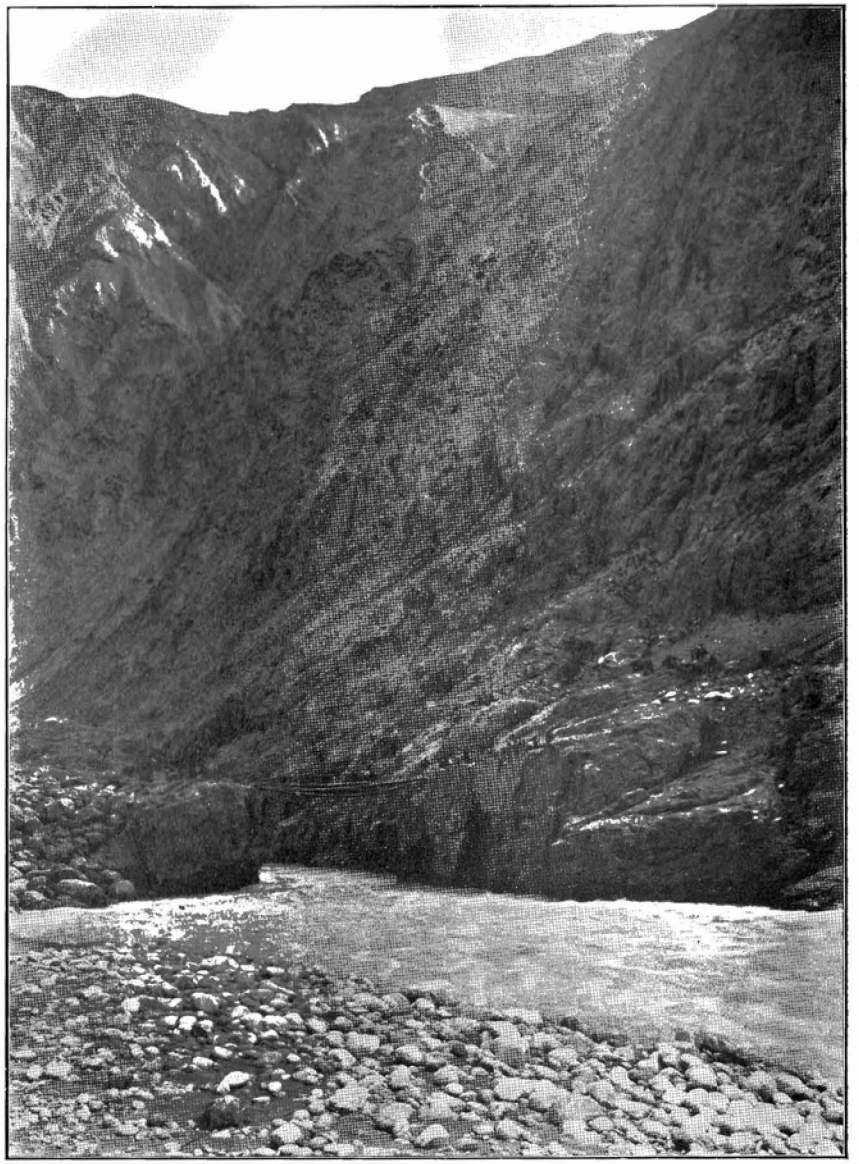
Kongur
Pk. 4
42 N
25,146

Ak-sel Gl. Kok-sel Gl. Kizil-sel Gl.

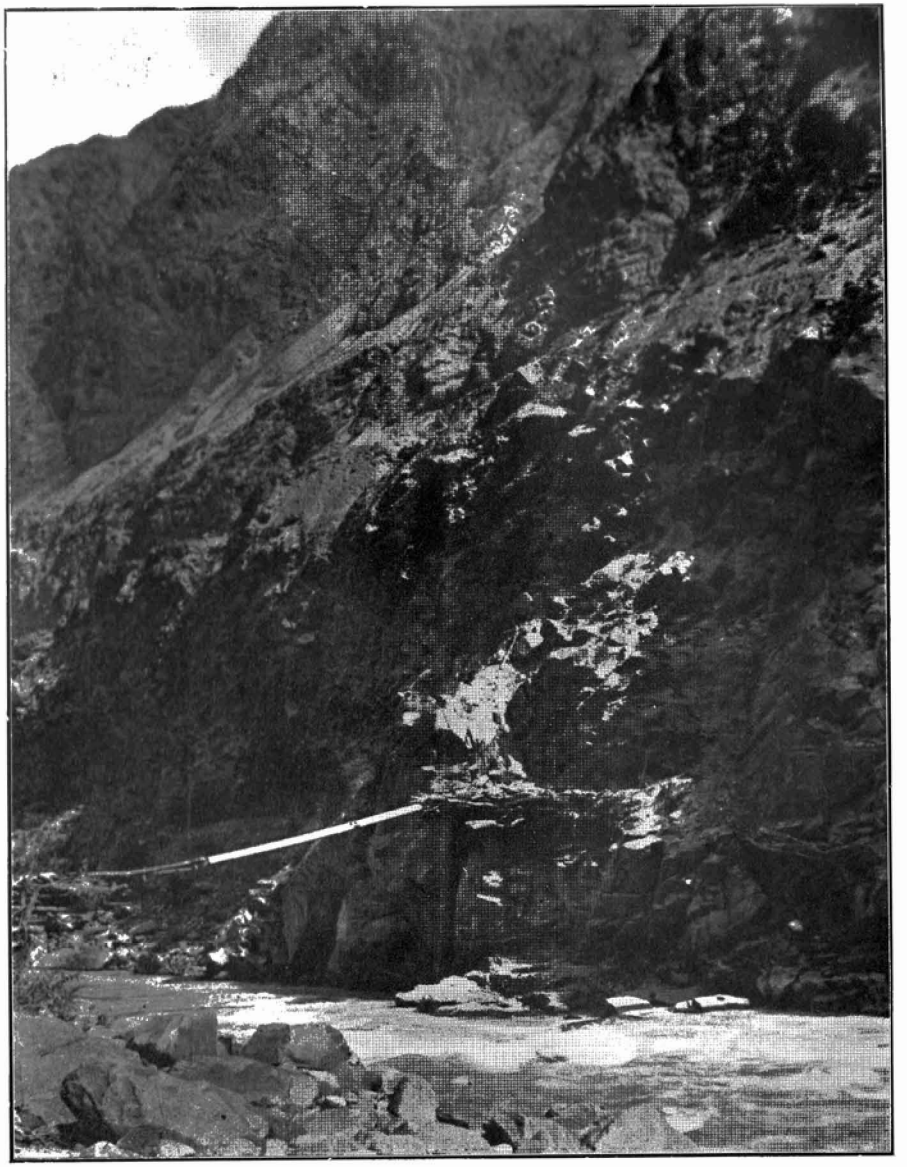
Continued from 3. A.

Upper Basik-kul Lower Basik-kul Outflow of Little Kara-kul

3. B.—PHOTO-THEODOLITE VIEW FROM KOK-TUMSHUK HILL, ABOVE WESTERN SHORE OF LITTLE KARA-KUL, TO NORTH-EAST AND NORTH (SEE PAGES 6, 64).



4. A.—YURUNG-KASH RIVER GORGE, WITH BRIDGE BELOW KARANGHU-TAGH (SEE PAGE 7).



4. B.—KARA-TASH RIVER GORGE, WITH BRIDGE BELOW PITLIK-AGHZI (SEE PAGE 25).

Muz-tagh
Pk. 1
61 A
23,890.

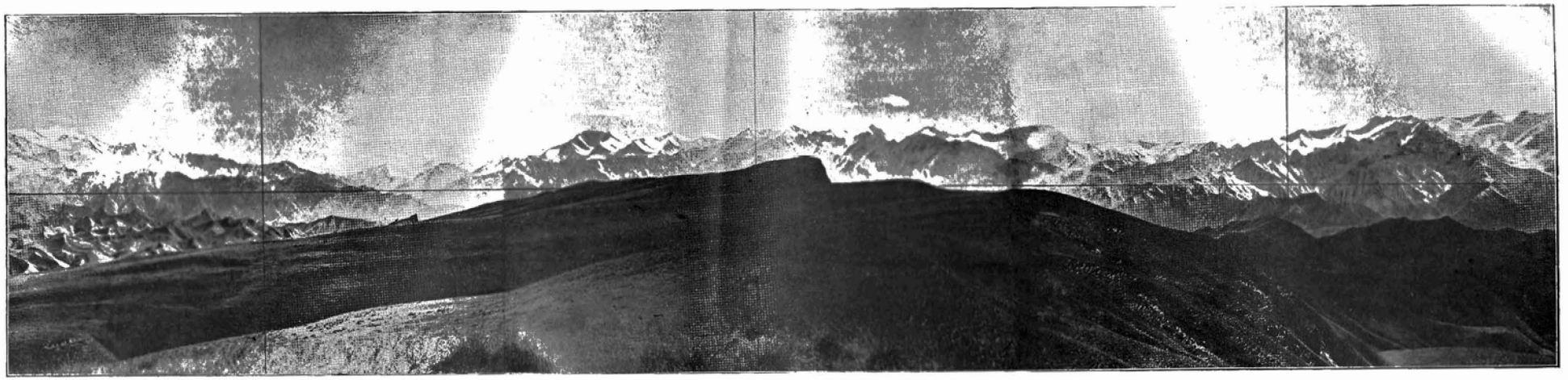
Yurung-kash
river gorge.

Pk. 2
61 A
22,639.

Pk. 8
52 M
23,309

Approx. position of
Yangi-dawan (?).

Glaciers at
head of
Busat valley.



Continued in 5.B.

5. A. PHOTO-THEODOLITE VIEW FROM TOPE RIDGE, ABOVE YURUNG KASH VALLEY, TO SOUTH-EAST AND SOUTH (SEE PAGE 7).

Glaciers above
Busat valley.

Glaciers at head of Kash valley.

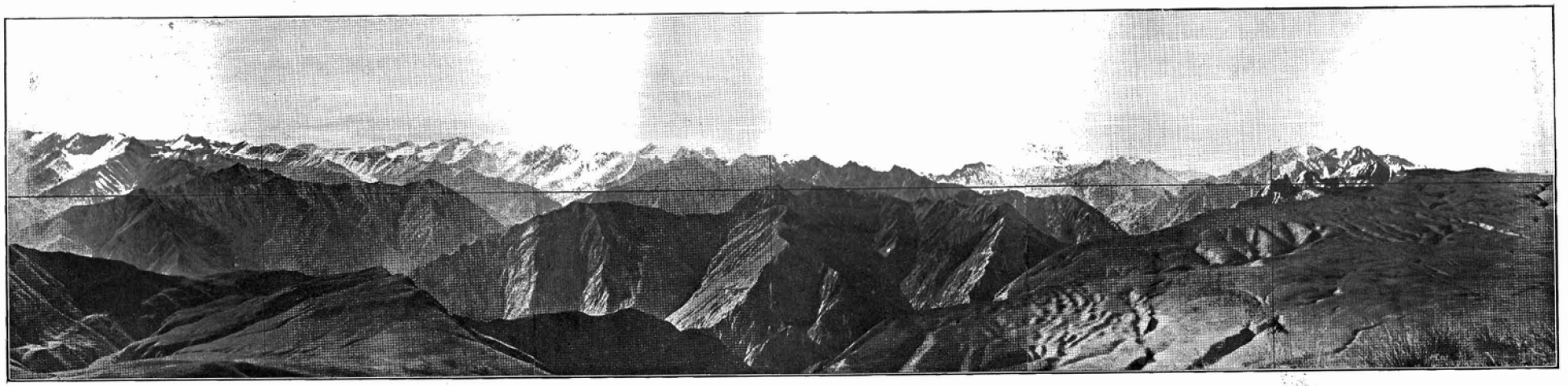
Nissa valley.

Pk. 2
51 P
17,885

Brinjak Pass.

Pk. 7
51 P
17,220

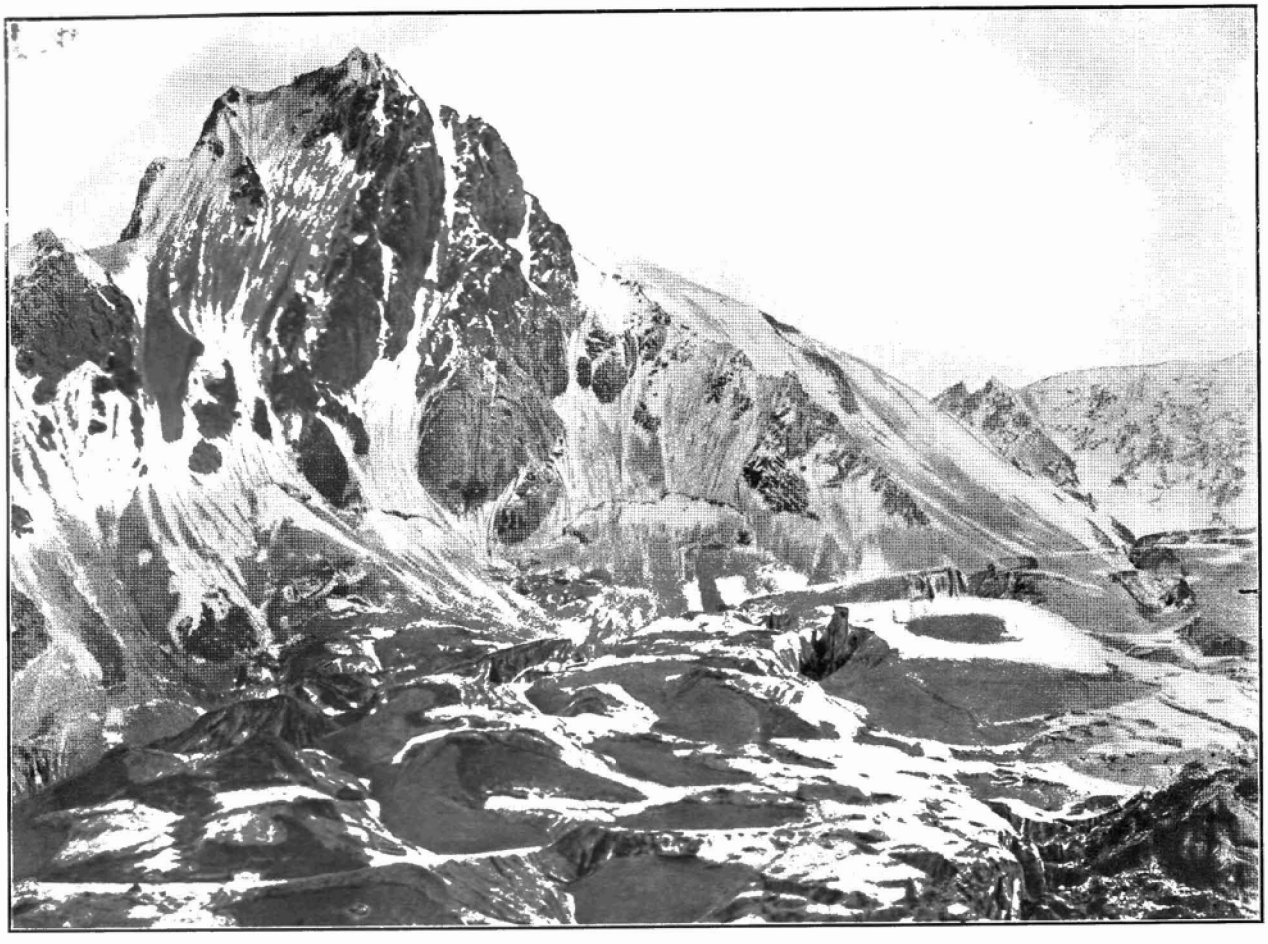
Continued from 5.A.



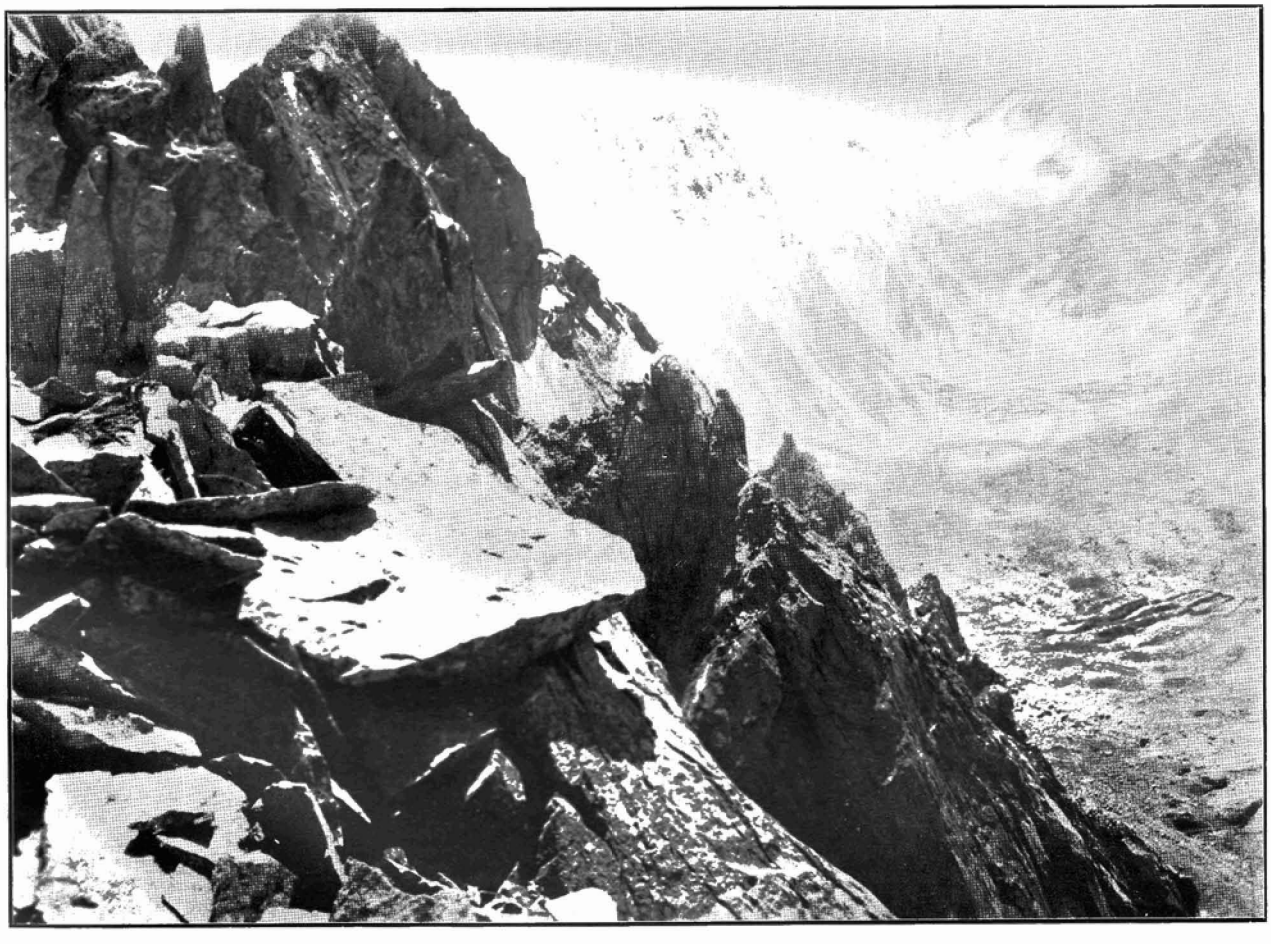
5. B.—PHOTO-THEODOLITE VIEW FROM TOPE RIDGE, ABOVE YURUNG-KASH VALLEY, TO SOUTH-WEST AND WEST (SEE PAGE 7).

The foreground in both sections of plate shows loess deposits of peneplain sloping up from Pisha valley.

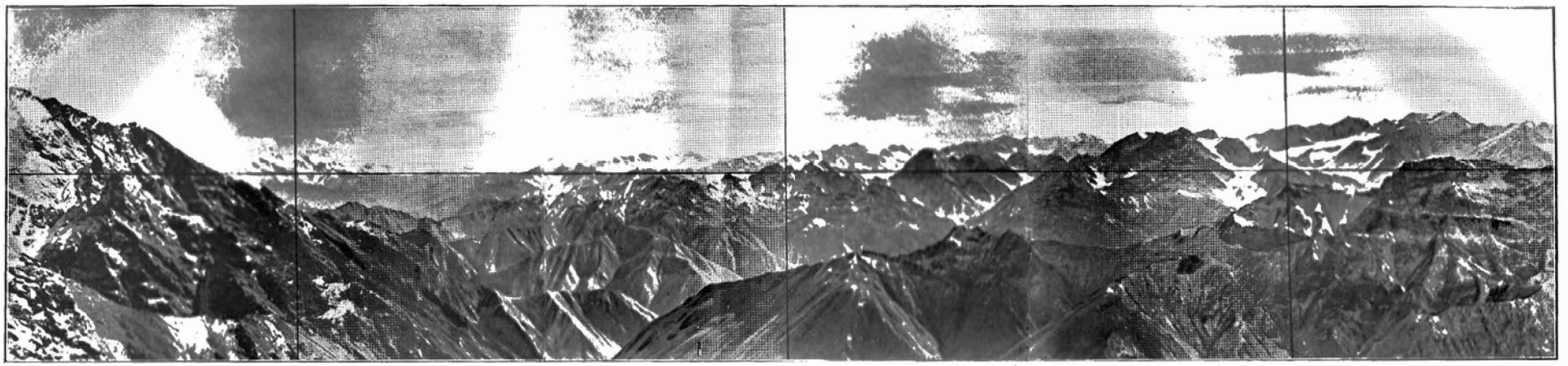
Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1923.



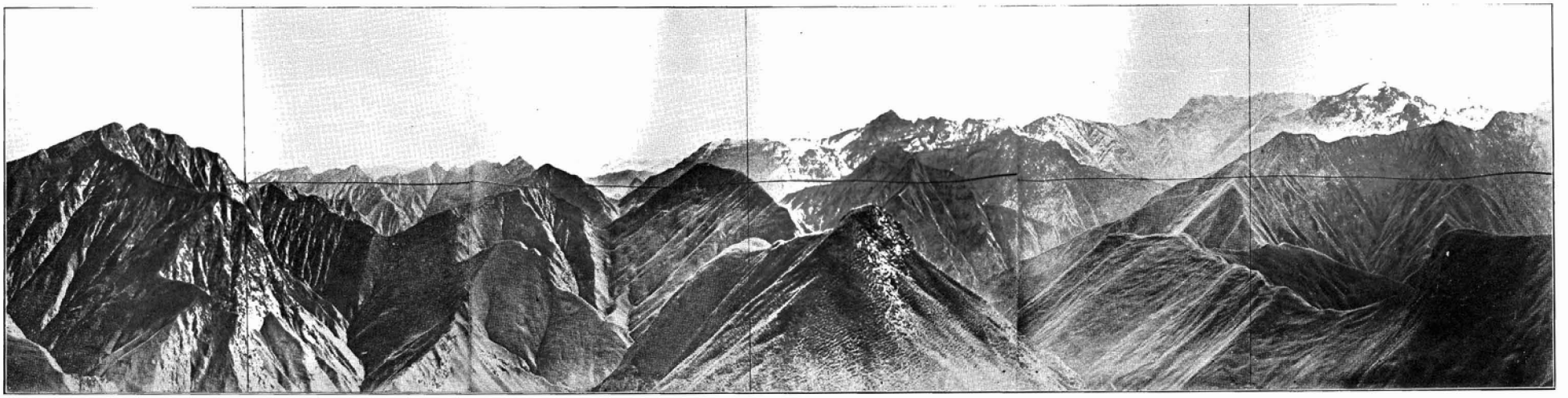
6. A.—VIEW OF OTRUGHUL GLACIER, LOOKING TOWARDS SOUTH-EAST FROM MORAINE AT CIRC. 16,000 FEET (SEE PAGE 12).



6. B.—HEAD OF KASHKUL GLACIER SEEN FROM GRAT AT CIRC. 15,000 FEET, LOOKING TOWARDS NORTH-EAST (SEE PAGE 12).



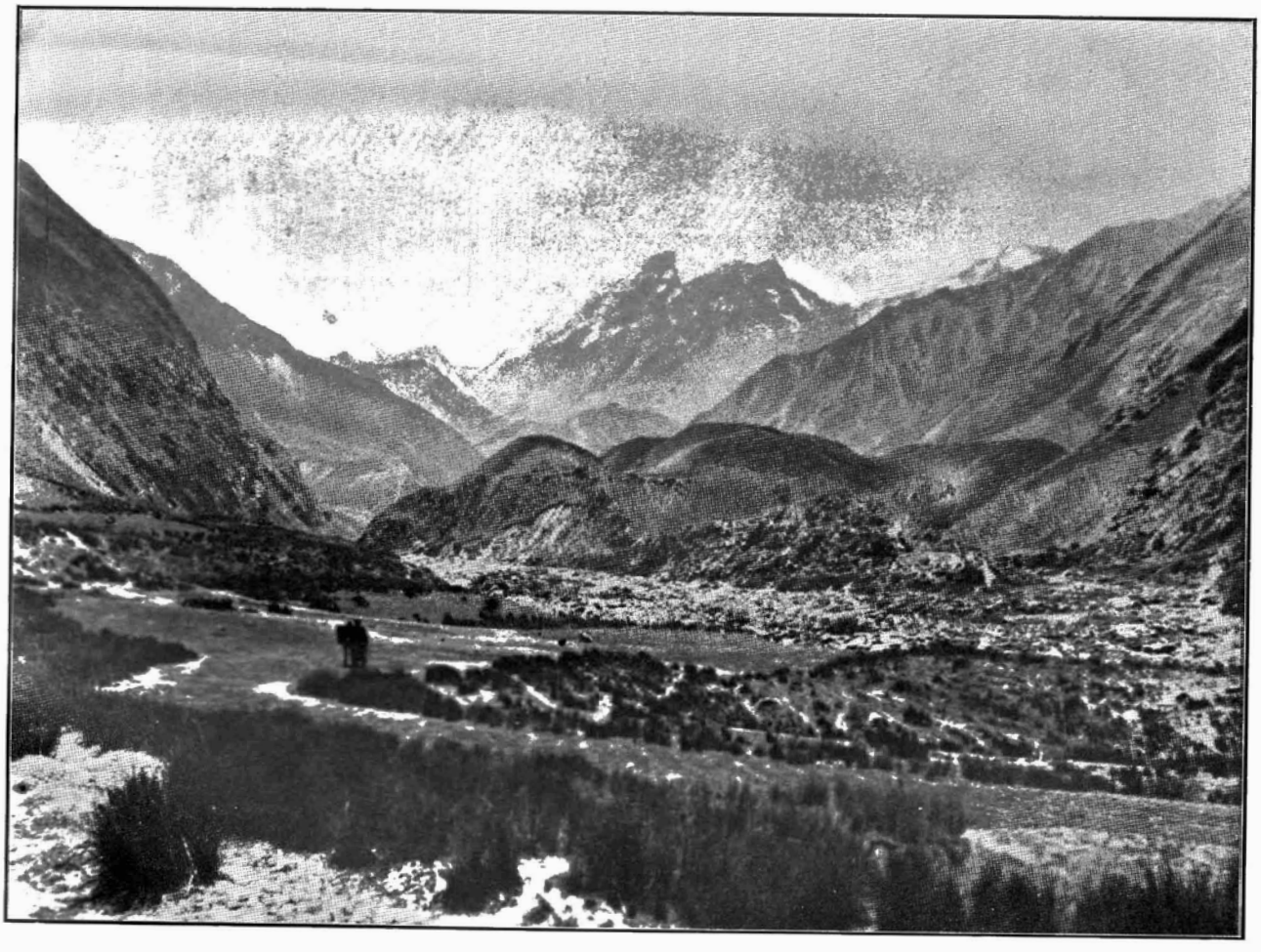
7. A. PHOTO THEODOLITE VIEW FROM SLOPE OF MUDACHE-TAGH, ABOVE BRINJAK PASS, TO SOUTH-EAST AND EAST (SEE PAGE 7).



7. B.—PHOTO-THEODOLITE VIEW FROM ABOVE YAGAN-DAWAN, TO SOUTH-EAST AND SOUTH (SEE PAGE 7).
Note the loess deposits covering the slopes in the foreground.

S. A.—ERODED RANGES OF OUTER K'UN-LUN, LOOKING TO N.W. FROM ABOVE YAGAN-DAWAN (SEE PAGE 7).

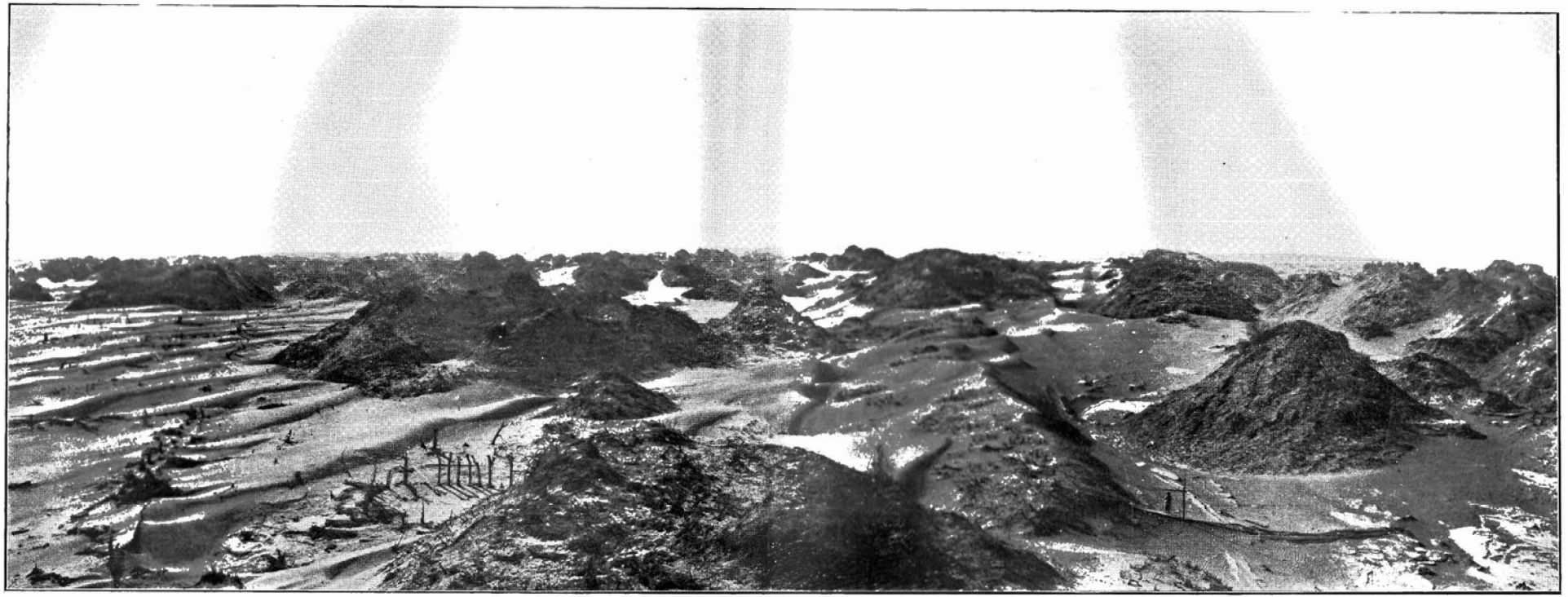
Loess-covered spurs in foreground.



S. B.—HEAD OF NISSA VALLEY SEEN FROM TAM-OGHIL ABOVE TOR (SEE PAGE 12).

Loess-covered old moraine ridges in foreground.

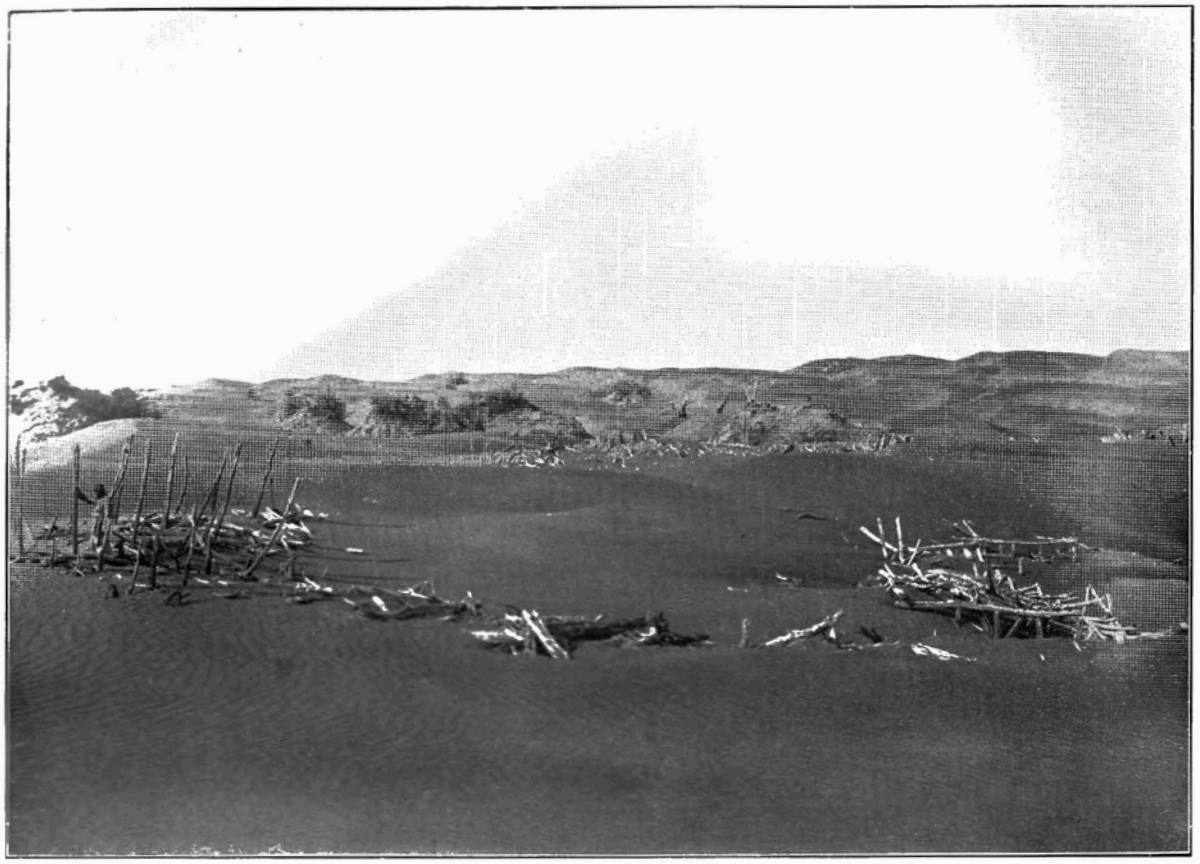
A B



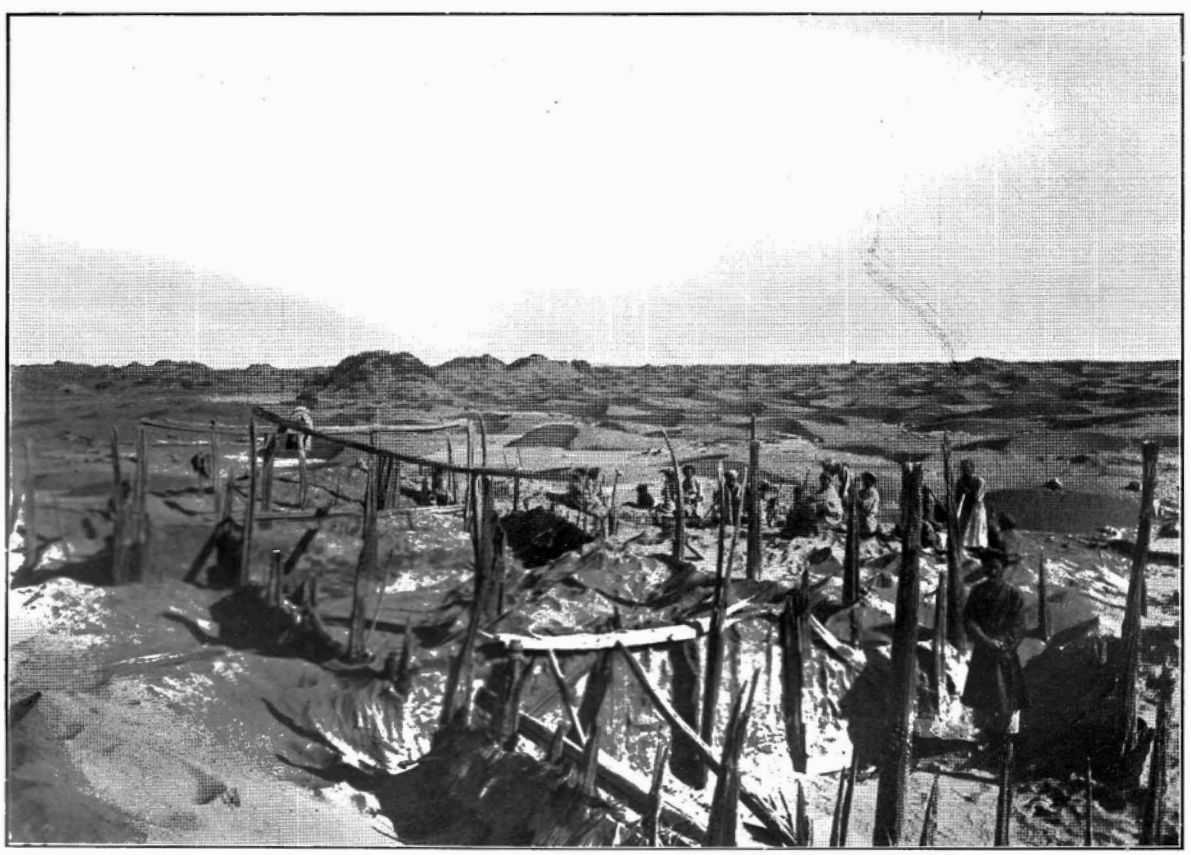
9.—VIEW NEAR SOUTHERN END OF NIYA SITE, SHOWING ANCIENT ARBOUR WITH TANK (A) AND FOOT-BRIDGE (B) STRETCHED ACROSS DRY RIVER-BED, ALL ABANDONED DURING THIRD CENTURY A.D. (SEE PAGES 9, 14).

The view extends from south (left) to south-west (right). In the foreground are seen the remains of dead trees and fences, marking ancient avenues and gardens overrun by dunes. In the near background rise chains of tamarisk-covered sand-cones; in the distance high ridges of dunes.

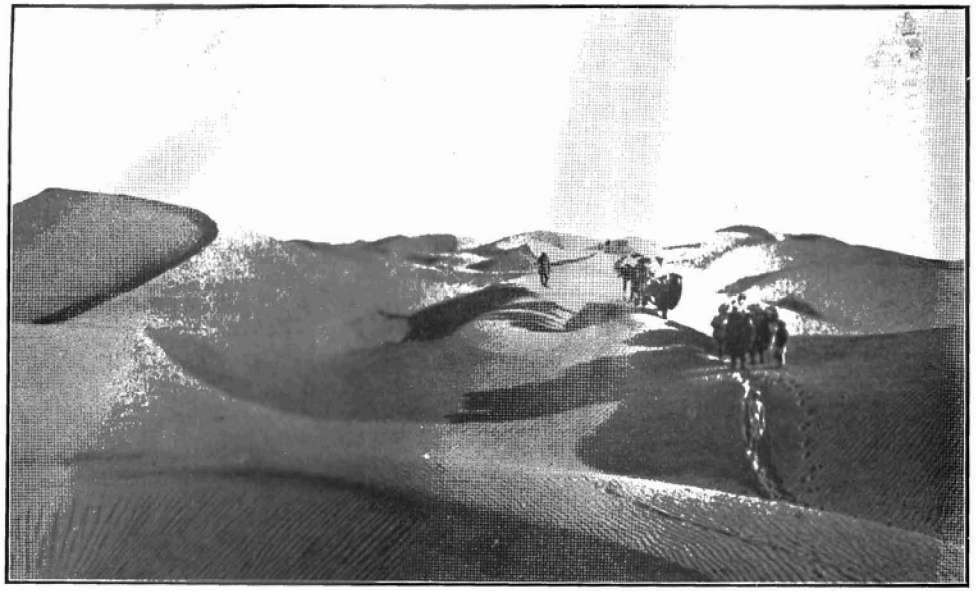
Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1923.



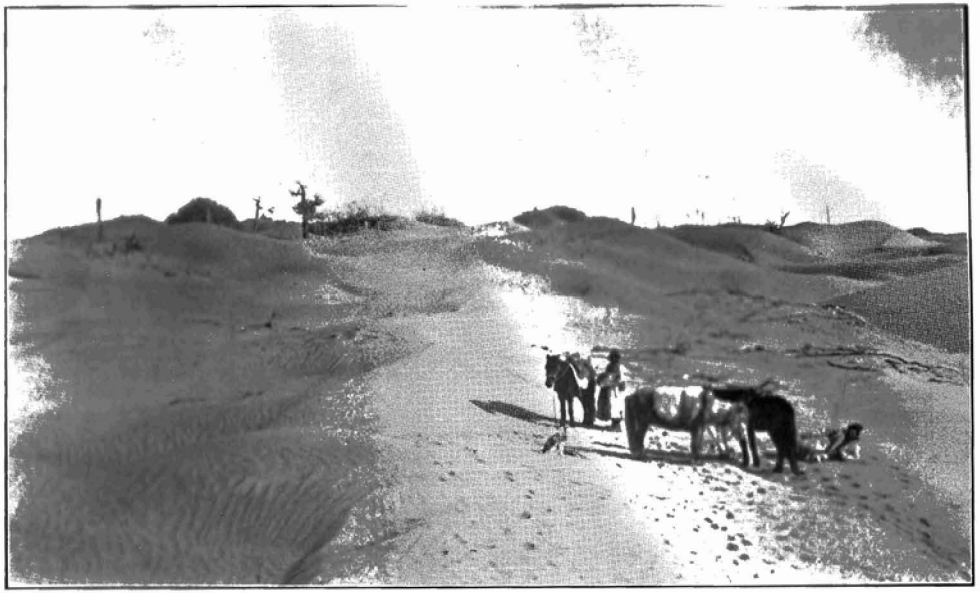
10.A.—SAND-BURIED ANCIENT QUADRANGLE, KARA-DONG SITE (SEE PAGE 19).



10.B.—SAND-BURIED ANCIENT HOUSE (N. XXIV), NIYA SITE, AFTER EXCAVATION (SEE PAGE 14).

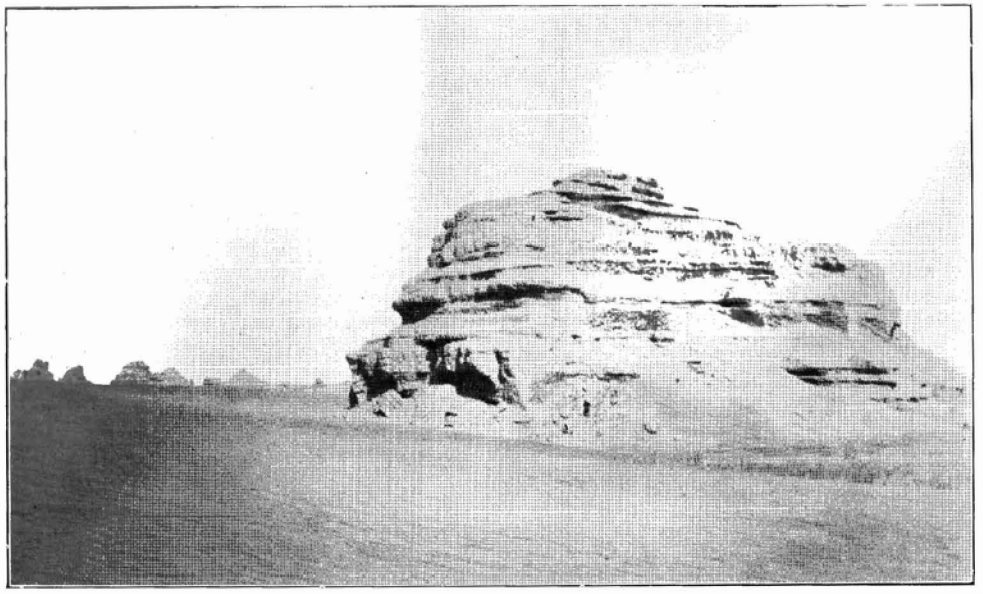


II. A. MARCH ACROSS HIGH DUNES IN TAKLAMAKAN, TOWARDS KERIYA RIVER END (SEE PAGE 19).

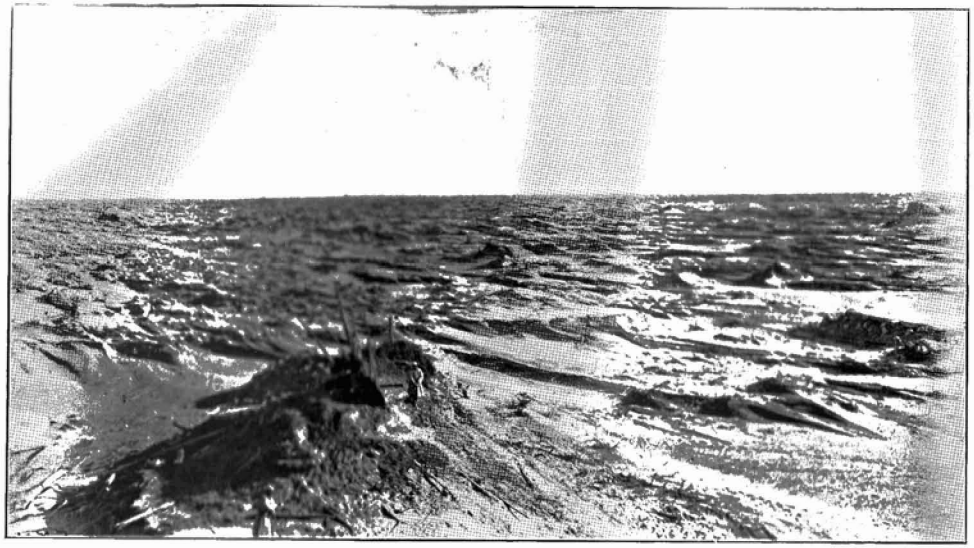


II. B. OLD RIVER-BED BETWEEN CHARCHAK AND INCHIKE RIVERS (SEE PAGE 19).

II. C. SAND 'DAWANS' IN TAKLAMAKAN, SOUTH-EAST OF CHOK-TAGH (SEE PAGE 26).



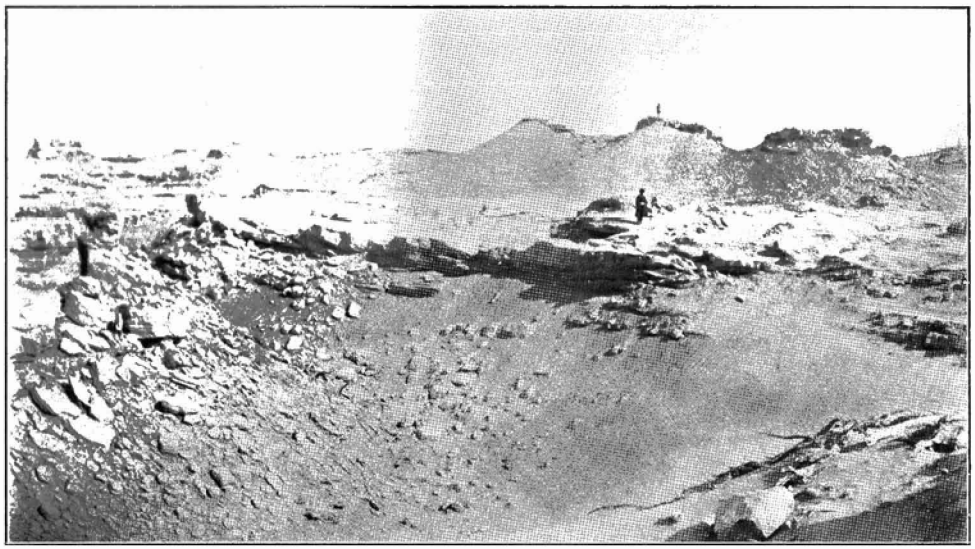
II. D.—WIND-ERODED CLAY TERRACE (MESA) NEAR W. EDGE OF OLD TERMINAL BASIN OF SU-LO-HO (SEE PAGE 16).



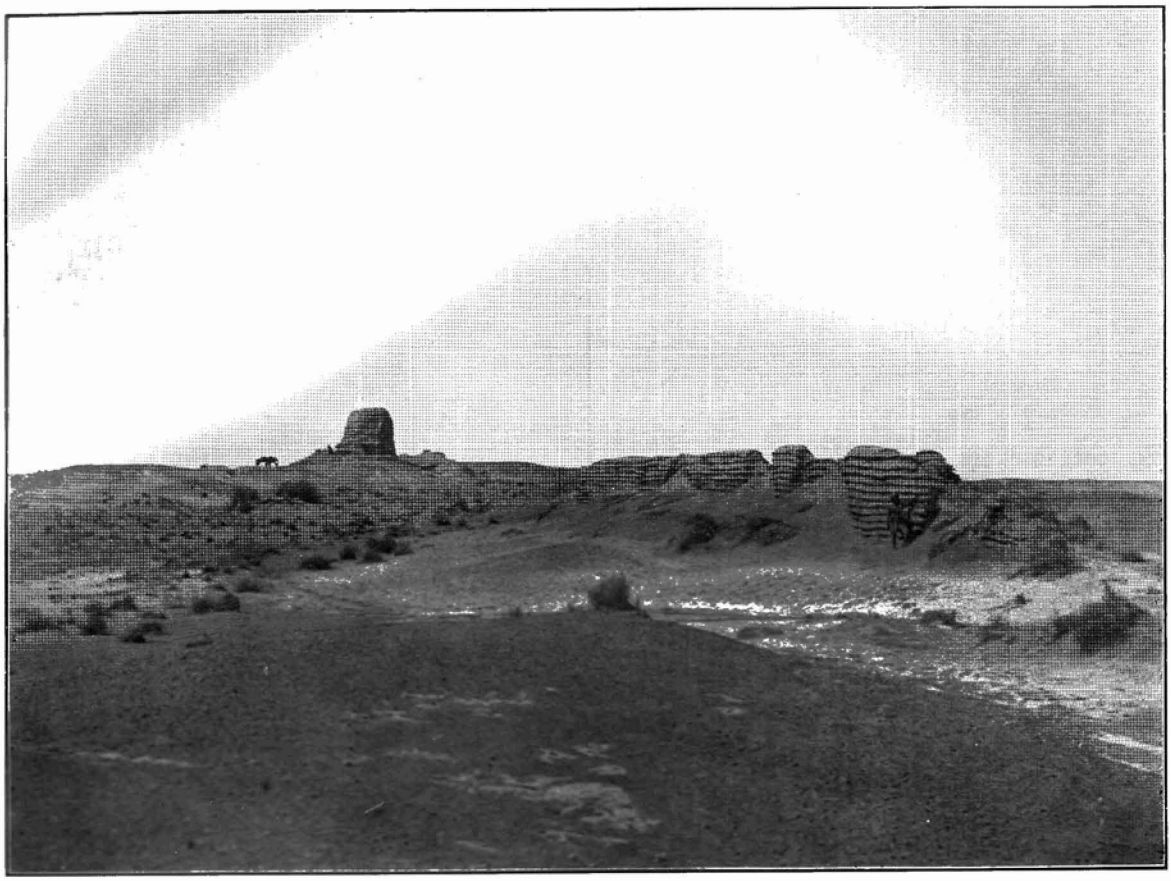
12. A. VIEW TO SOUTH-EAST FROM LOU-LAN STUPA, ACROSS WIND-ERODED GROUND SHOWING YARDANGS (SEE PAGE 16).
Ruined dwelling in foreground.

12. B.—VIEW TO SOUTH FROM LOU-LAN STUPA, ACROSS WIND-ERODED GROUND SHOWING YARDANGS (SEE PAGE 16).
Erosion terrace bearing ruin in foreground.

12. C.—WIND-ERODED WALLS AND INTERIOR OF RUINED FORT L. K., LOP DESERT (SEE PAGE 29).
Timber débris of eroded quarters in foreground.

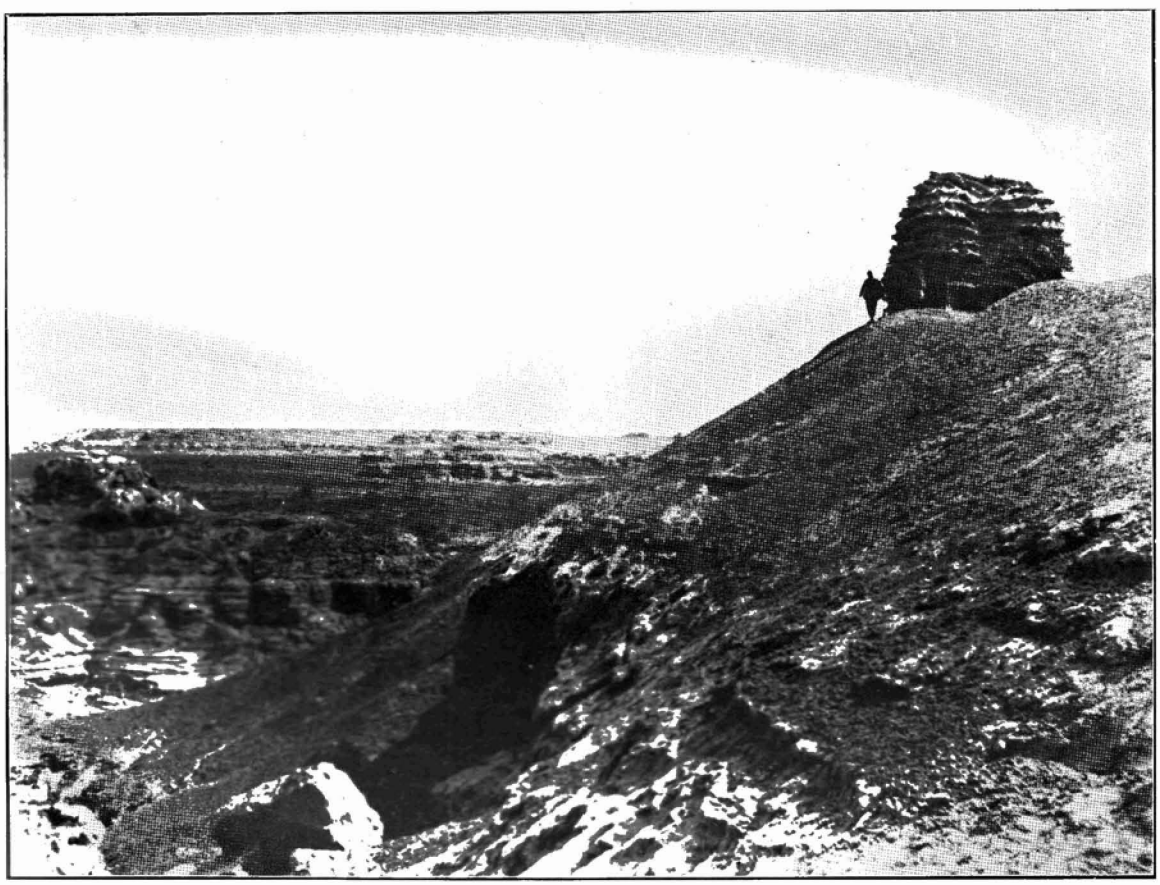


12. D.—WIND-ERODED GROUND OUTSIDE WESTERN WALL OF RUINED FORT L. K., LOP DESERT (SEE PAGE 29).
Note Nullah excavated by wind in foreground. Dead tree trunks on right.



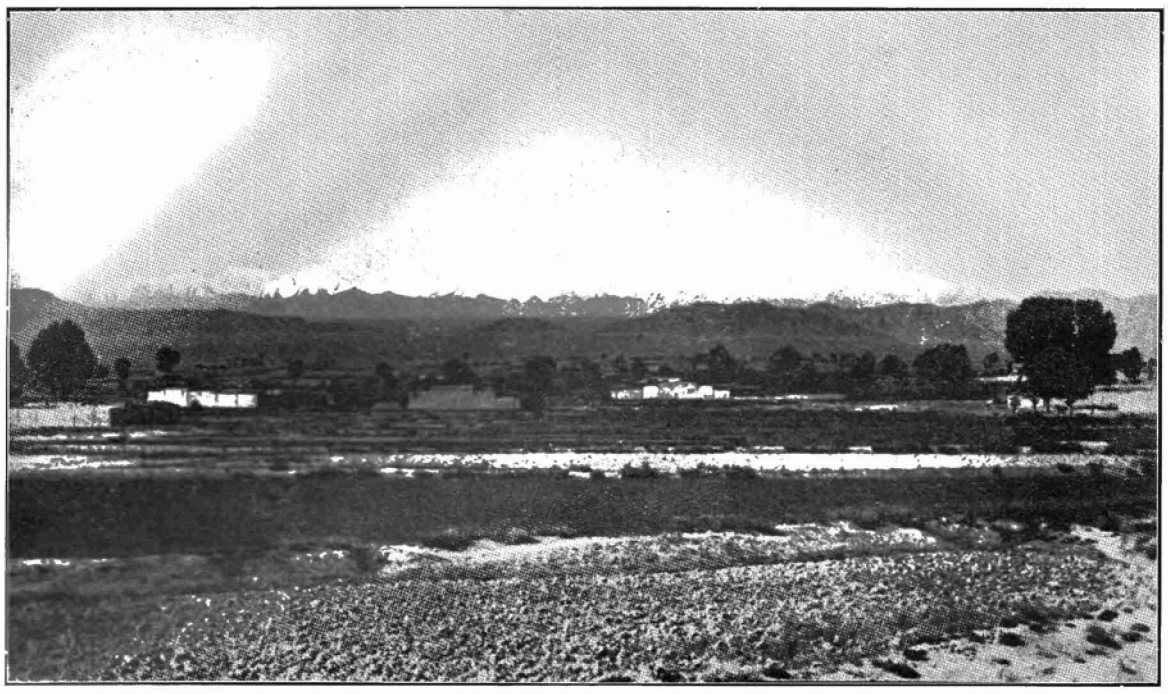
B.A.—REMAINS OF ANCIENT CHINESE *LIMES* WALL IN DESERT WEST OF TUN-HUANG (SEE PAGES 16, 31).

Wall built of stamped clay and reed fascines in second century B.C.

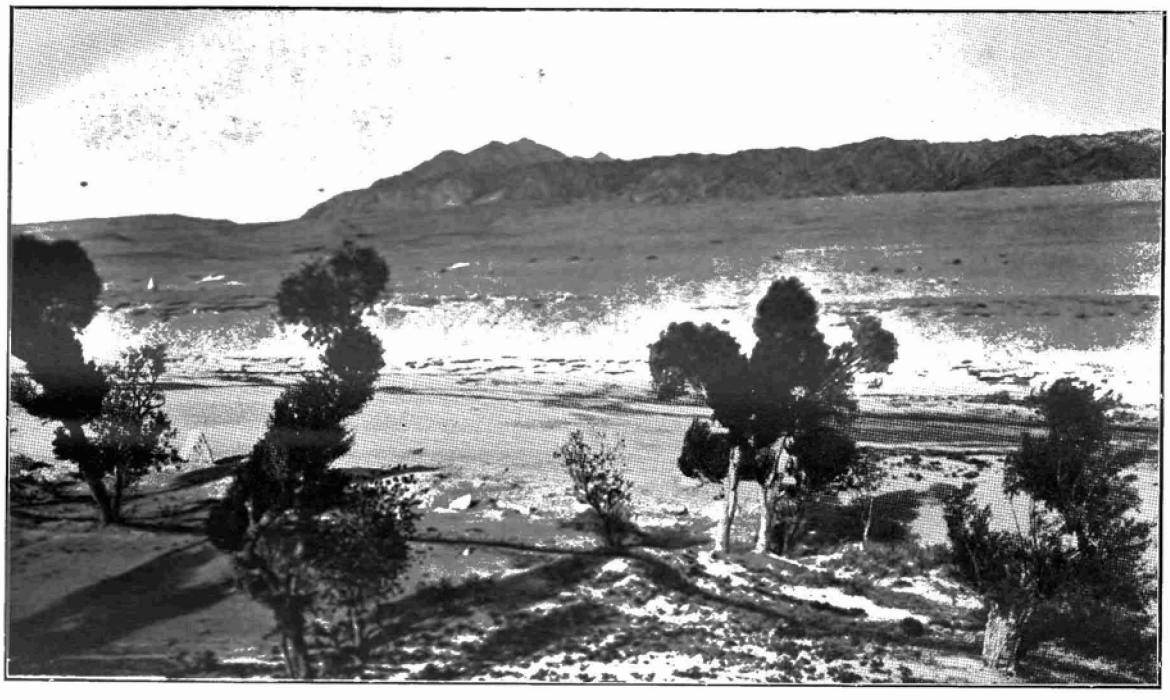


B.B.—VIEW TOWARDS ERODED TERRACES OF TERMINAL BASIN OF SU-LO-HO FROM ANCIENT WATCH-TOWER OF TUN-HUANG LIMES (SEE PAGE 16).

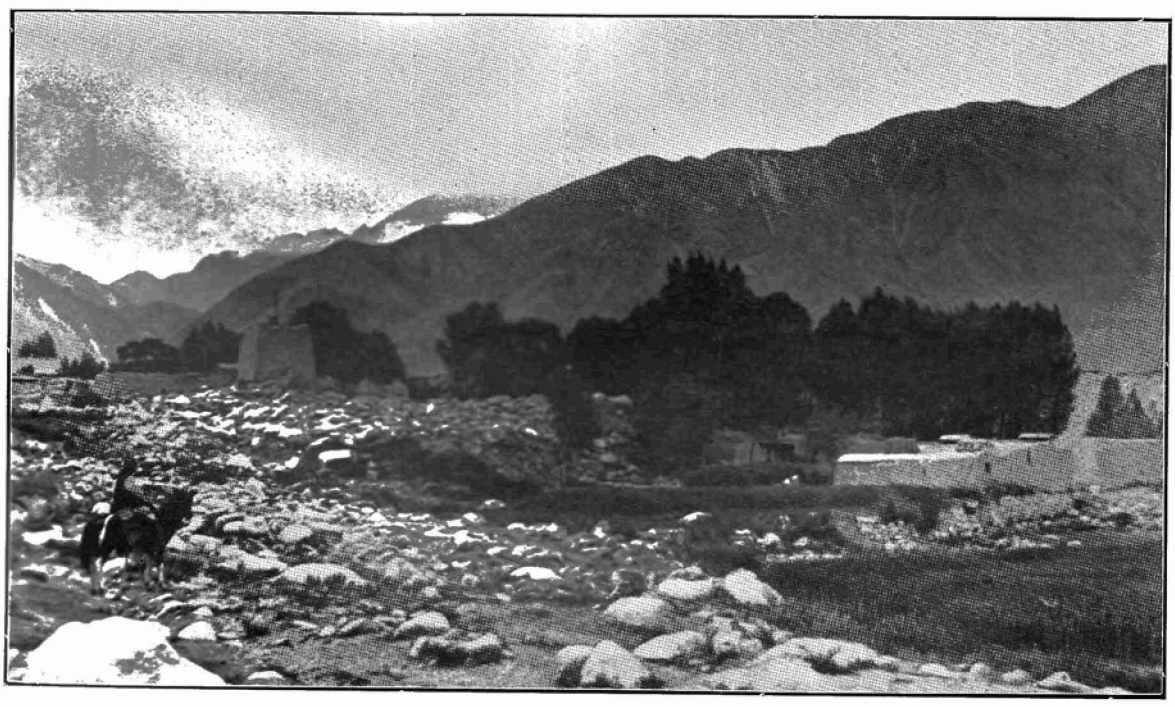
Eroded Mesa on left; gravel 'Sai' in distance.



14. A.—VIEW SOUTH-WEST TOWARDS SNOWY MAIN RANGE FROM CH'ANGMA VILLAGE (SEE PAGE 17).

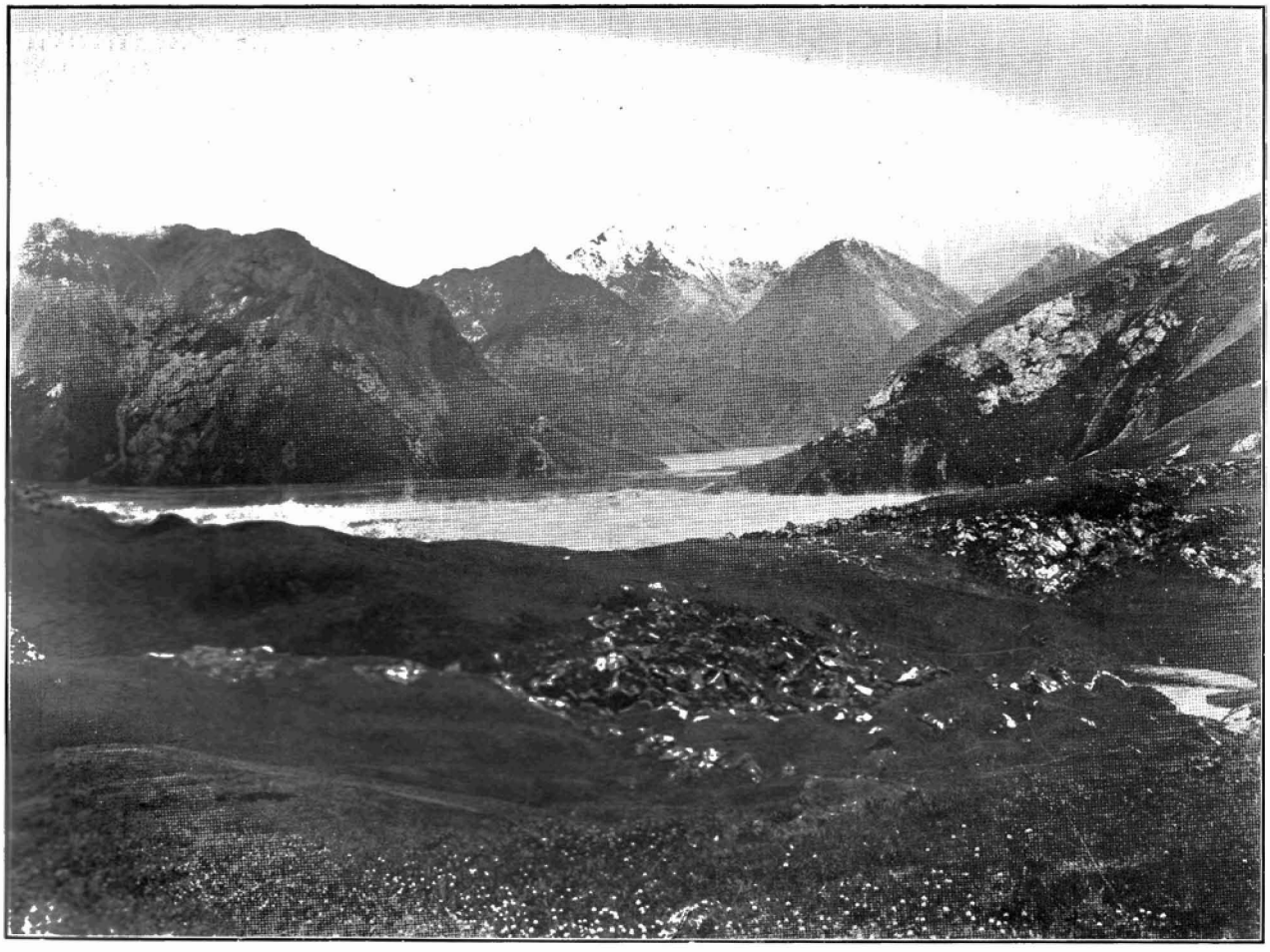


14. B.—BARREN HILL RANGE EAST OF 'CAVES OF THE THOUSAND BUDDHAS', SOUTH OF TUN-HUANG (SEE PAGE 17).



14. C.—FOOT-HILLS OF RICHTHOFEN RANGE SEEN FROM CHIN-FO-SSU VILLAGE (SEE PAGE 17).

15. A. — RICHTHOFEN RANGE, FROM CHIN-TO-AN-SHEN PASS, LOOKING TO SOUTH-WEST (SEE PAGE 17).



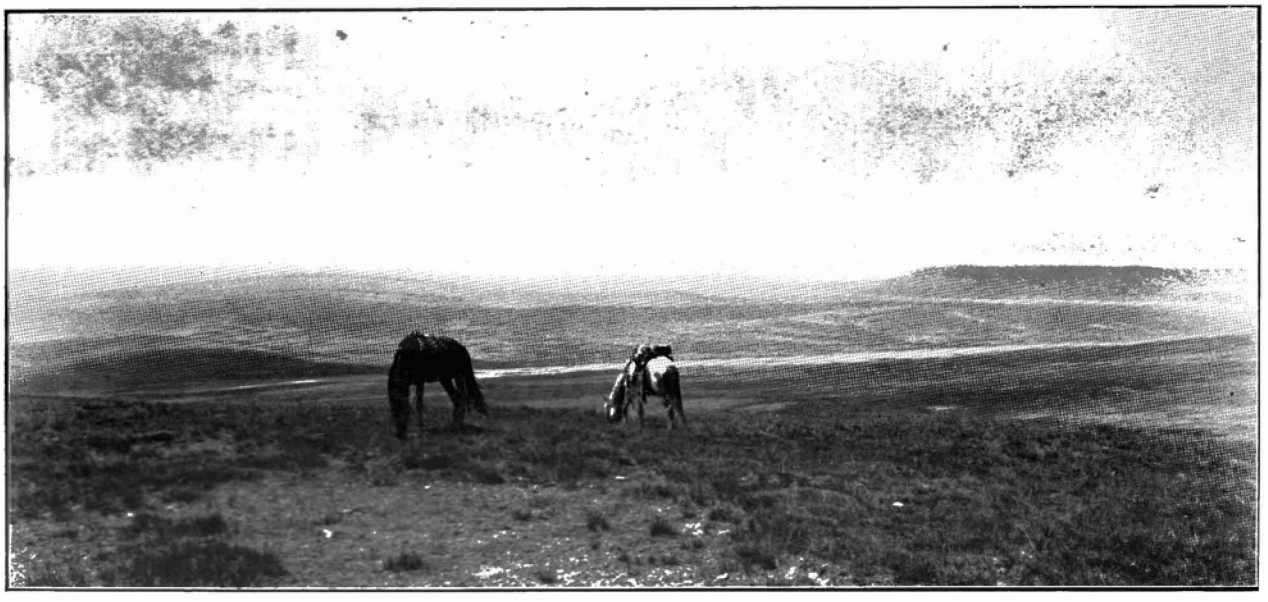
15. B. — RICHTHOFEN RANGE, LOOKING SOUTH FROM HOU-TZU PASS ACROSS DRY LAKE BASIN (SEE PAGE 17).

16. A. — TO-LAI-SHAN RANGE, LOOKING SOUTH FROM WATERSHED ABOVE KAN-CHOU R. SOURCES (SEE PAGE 17).

16. B. — RICHTHOFEN RANGE, LOOKING NORTH-EAST FROM ABOVE HUO-NING-TO PASS, AT CIRC. 15,600 FEET (SEE PAGE 17).

16. C. — ALEXANDER III. RANGE, LOOKING SOUTH-WEST FROM ABOVE HUO-NING-TO PASS ACROSS PEI-TA-HO VALLEY (SEE PAGE 17).

17. A.—SUESS RANGE OF NAN-SHAN, LOOKING SOUTH-EAST FROM CAMP 212 ACROSS SU-LO-HO VALLEY (SEE PAGES 17, 18).



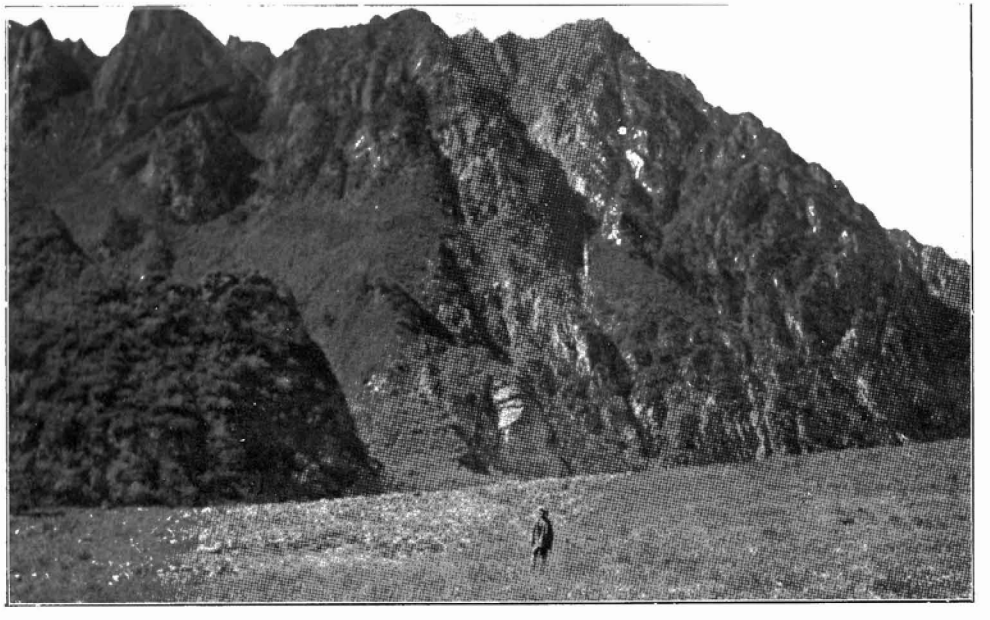
17. B.—SUESS RANGE, LOOKING SOUTH FROM CAMP 212 ACROSS SU-LO-HO VALLEY (SEE PAGES 17, 18).

17. C.—VIEW SOUTH FROM SHEN-LING-TZU PASS ACROSS KAN-CHOU RIVER VALLEY TOWARDS TO-LAI-SHAN (SEE PAGE 18).

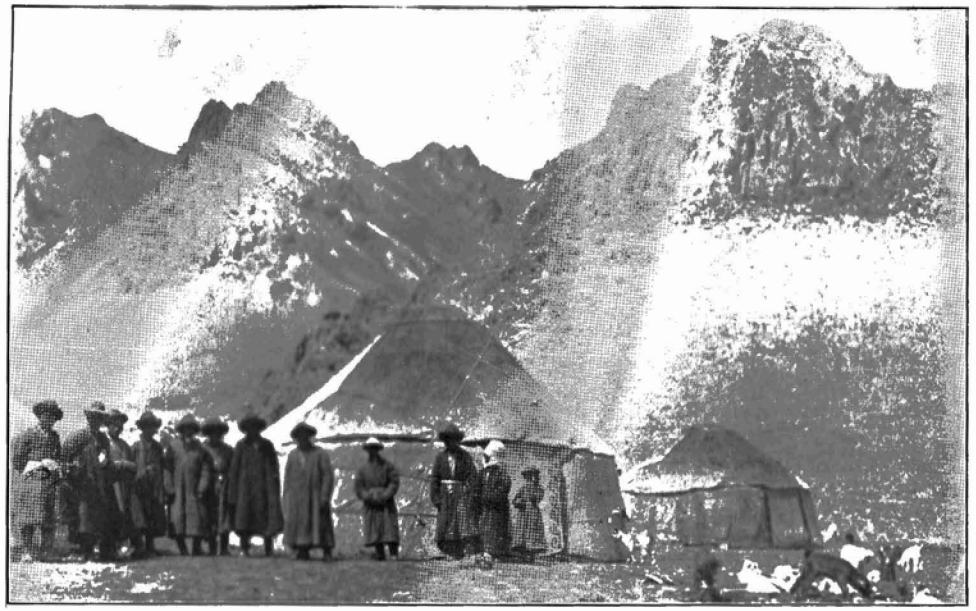
18. A. KHAZAN-GOL VALLEY, RICHTHOFEN RANGE, SEEN FROM FOREST-CLAD RIDGE TO NORTH (SEE PAGE 18).

18. B. VIEW SOUTH FROM FENG-TA-FAN TOWARDS MAIN RICHTHOFEN RANGE (SEE PAGE 18).

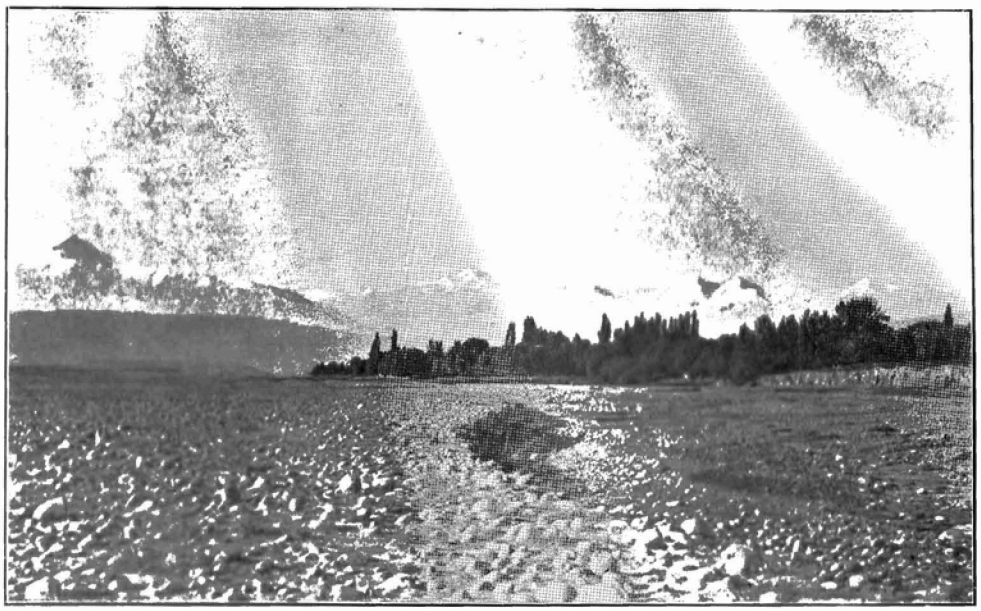
18. C. — VALLEY NORTH OF FENG-TA-FAN, LOOKING DOWN FROM CAMP 223 (SEE PAGE 18).



18. D. — VALLEY BELOW PIEN-TUNG-K'OU, RICHTHOFEN RANGE, ON ROUTE NORTH OF O-PO (SEE PAGE 33).

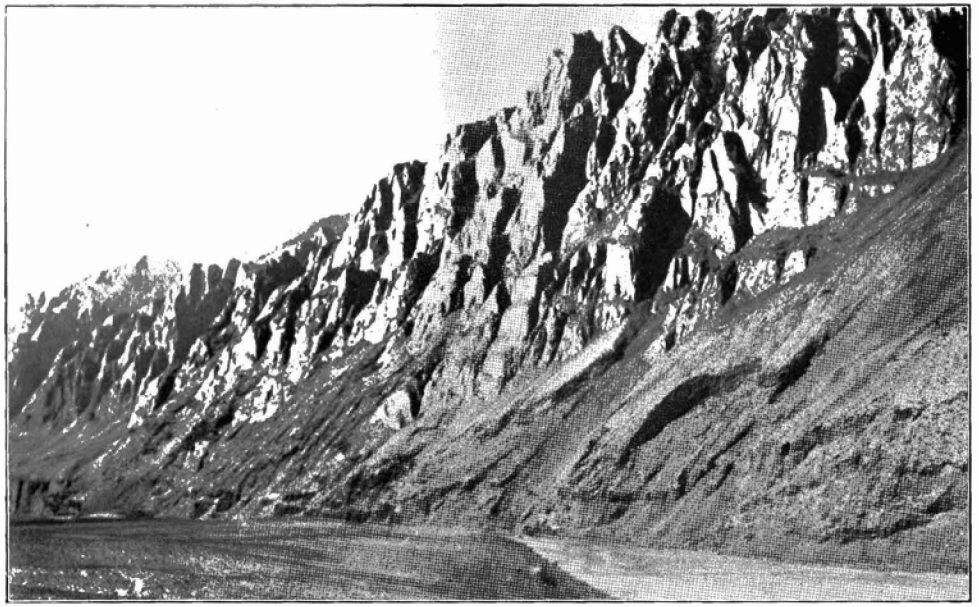


19. A. KIRGHIZ CAMP AT SAR-BEL, IN OUTER T'IEN-SHAN RANGE, NORTH OF KELPIN (SEE PAGE 20).



19. B. SNOWY PEAKS OF MAIN K'UN-LUN RANGE TO S.S.W. AND S.W. OF NURA OASIS (SEE PAGE 21).

19. C.—GORGE OF YURUNG-KASH RIVER AT DEBOUCHURE OF ZAILIK VALLEY (SEE PAGE 21).

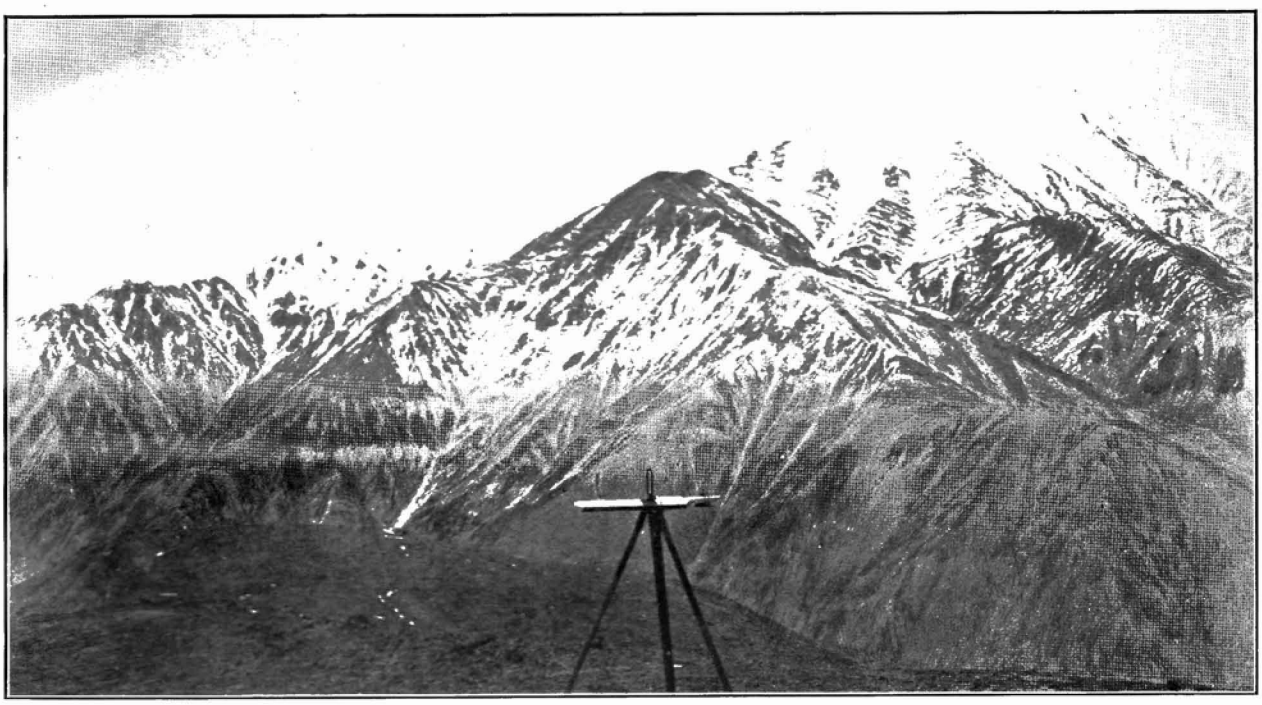


19. D.—SLATE CLIFFS ABOVE RIGHT BANK OF YURUNG-KASH RIVER, NEAR DEBOUCHURE OF TUGE-TASH STREAM (SEE PAGE 21).

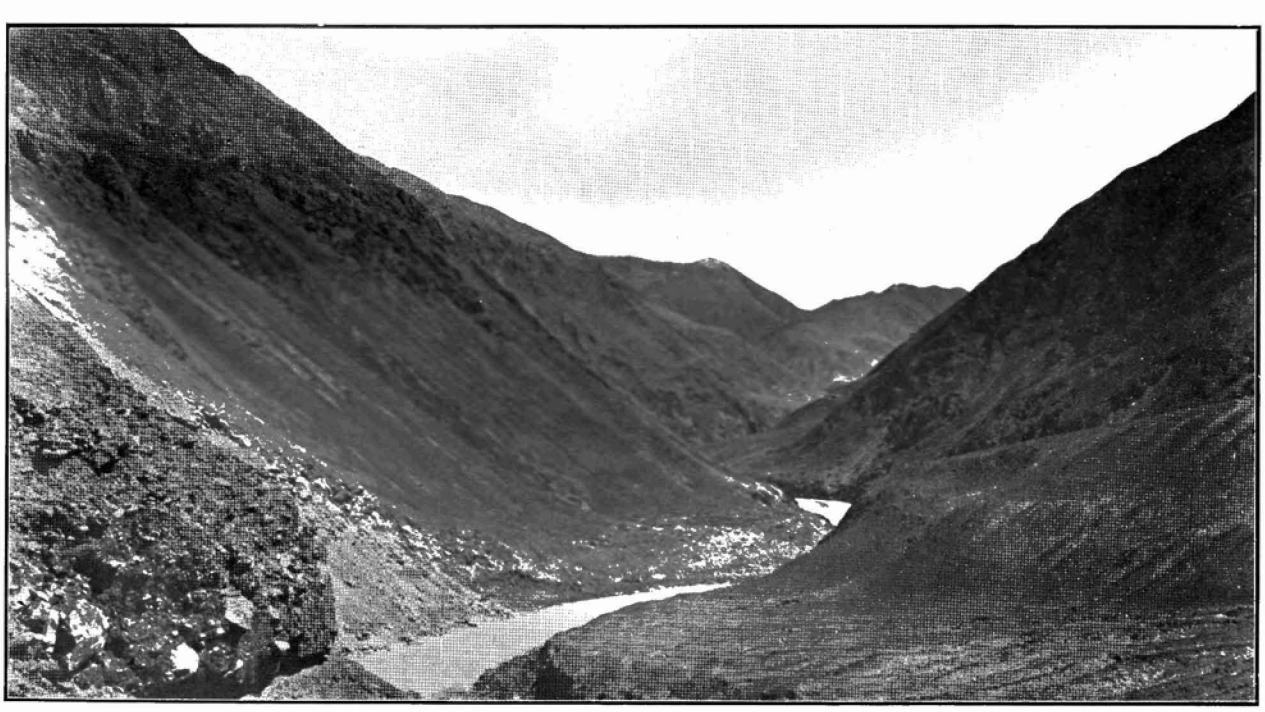
20. A. — VIEW OF K'UN-LUN PEAKS EAST OF POLUR GORGE FROM ABOVE KAR-YAGDI (SEE PAGE 21).

20. B. — ROUTE IN POLUR GORGE, THROUGH MAIN K'UN-LUN RANGE, LOOKING NORTH FROM SARIK-KORAM (SEE PAGE 21).

21. A.—SOUTHERN K'UN-LUN RANGE. LOOKING SOUTH FROM h. s. D ABOVE ZAILIK VALLEY
(SEE PAGE 21 c.

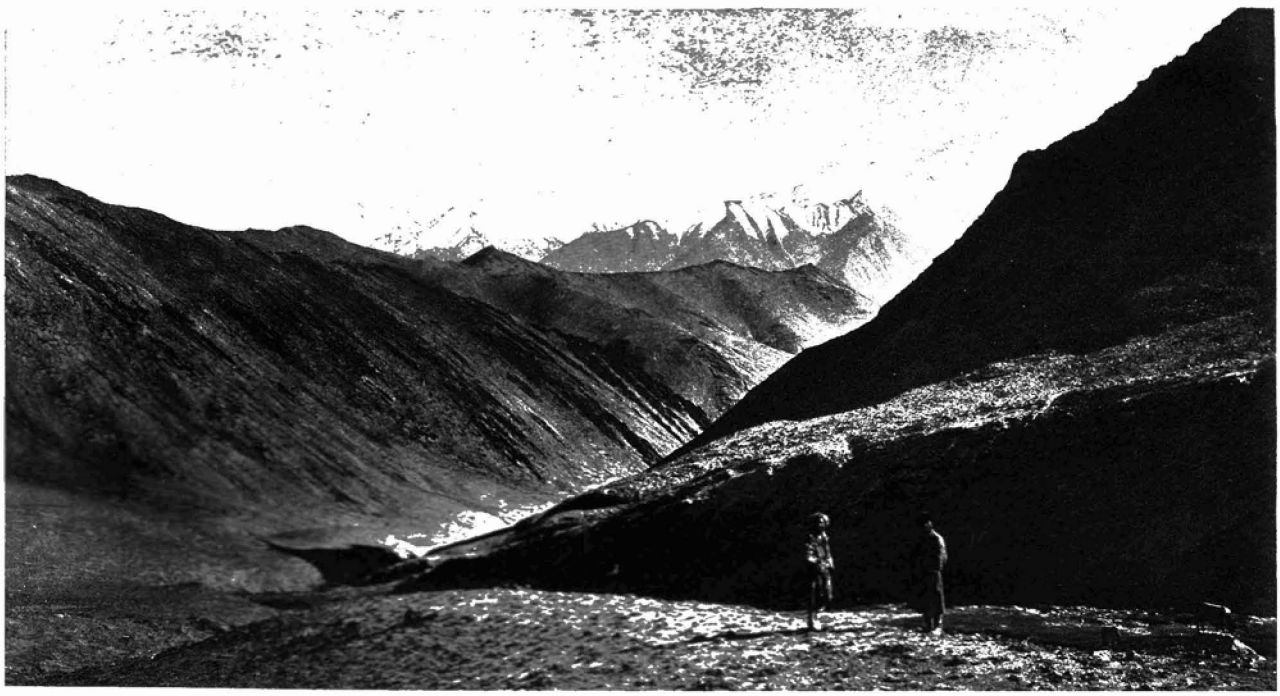


21. B. NORTHERN K'UN-LUN RANGE. LOOKING NORTH FROM h. s. D ABOVE ZAILIK VALLEY; ON RIGHT Pk. 8 61A. 21.430 Ft. (SEE PAGE 21).

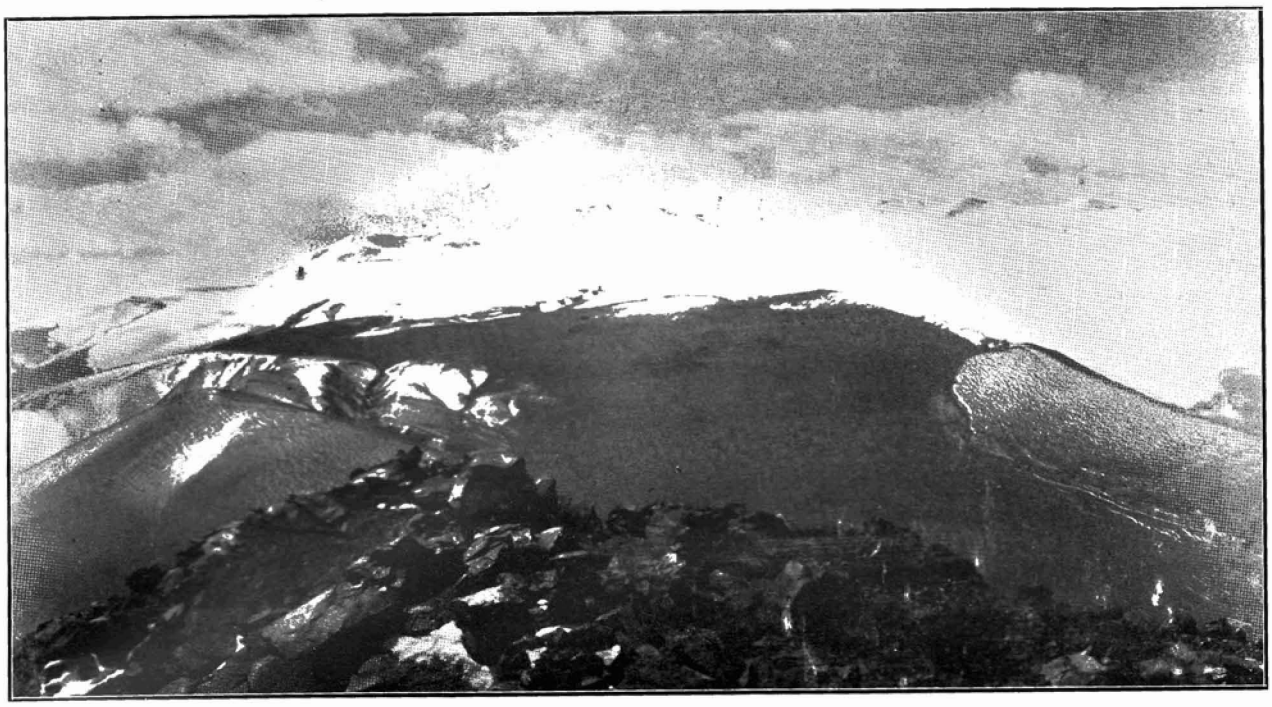


21. C.—VIEW UP THE YURUNG-KASH RIVER GORGE FROM DEBOUCHURE OF ZAILIK STREAM
(SEE PAGE 21).

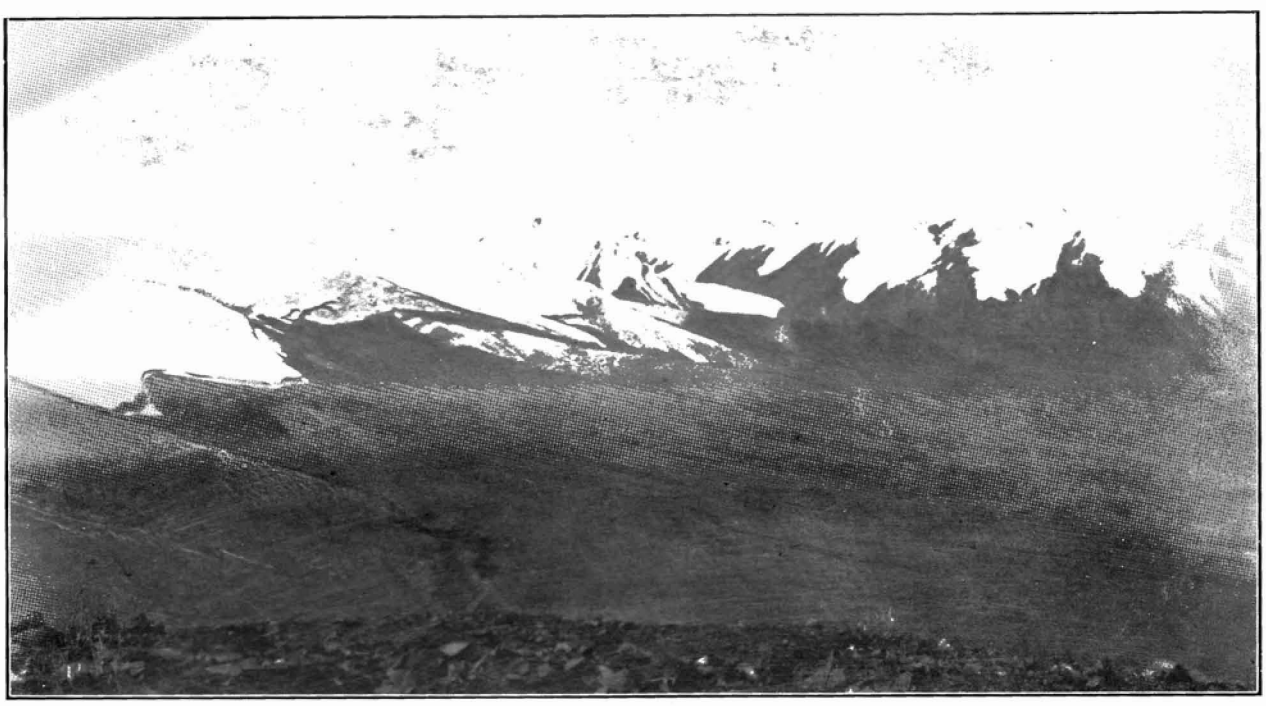
22.A. — VIEW TO SOUTH WEST TOWARDS MAIN K'UN-LUN RANGE FROM TRIANGULATED PEAK (C.S. E. 18,612 FEET) ABOVE MANDAR-KOL PASS (SEE PAGE 21).



22.B. — VIEW TOWARDS MAIN K'UN-LUN RANGE, SOUTH OF YURUNG-KASH RIVER, FROM CAMP 158, TAR-KOL (SEE PAGE 21).

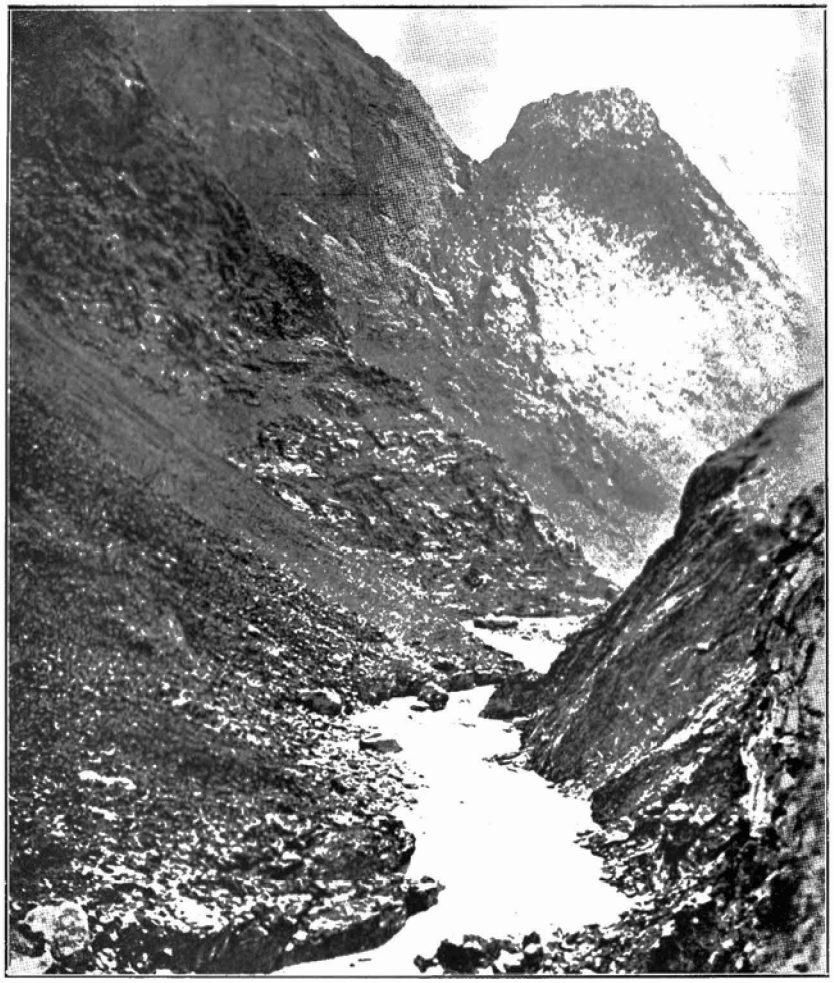


23. A.—GLACIER-CROWNED K'UN-LUN RANGE ABOVE YURUNG-KASH R. SOURCES, LOOKING SOUTH FROM FIXING ABOVE CHIGELIK-CHAP. 17,400 Ft. (SEE PAGE 21).

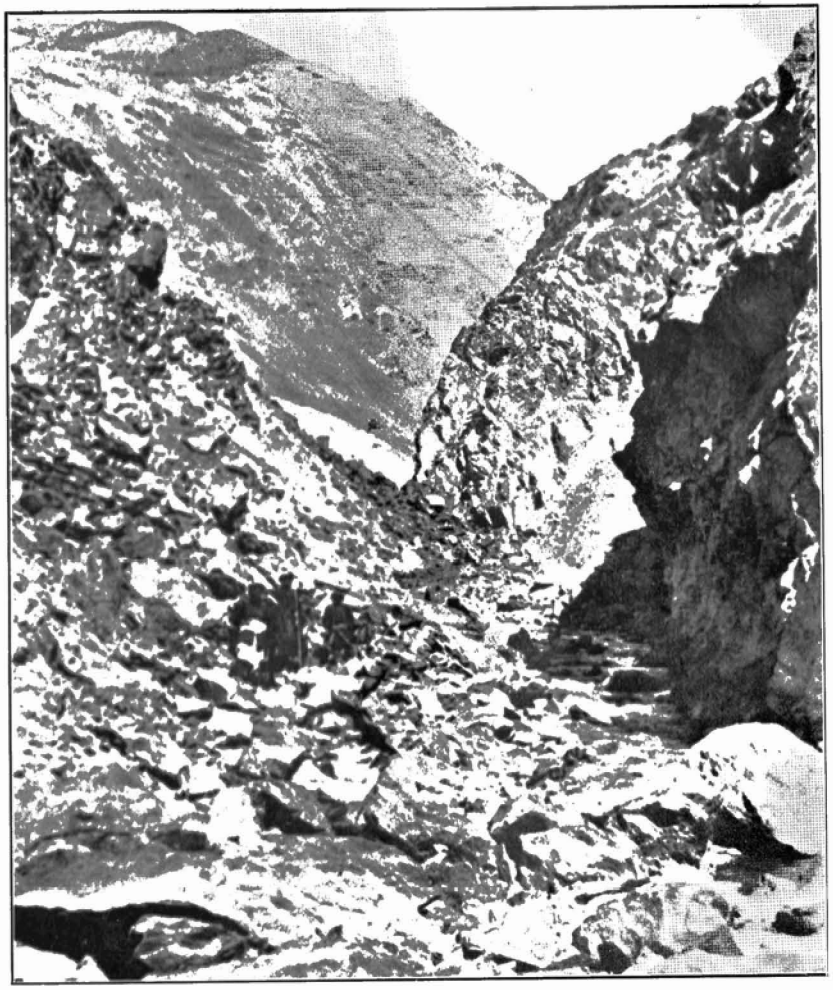


23. B.—GLACIER-CROWNED K'UN-LUN RANGE ABOVE YURUNG-KASH R. SOURCES, LOOKING SSW. FROM FIXING ABOVE CHIGELIK-CHAP. 17,400 Ft. (SEE PAGE 21).

23. C.—GLACIER-CROWNED K'UN-LUN RANGE ABOVE YURUNG-KASH R. SOURCES, LOOKING SW. FROM FIXING ABOVE CHIGELIK-CHAP. 17,400 Ft. (SEE ABOVE PAGE 21).

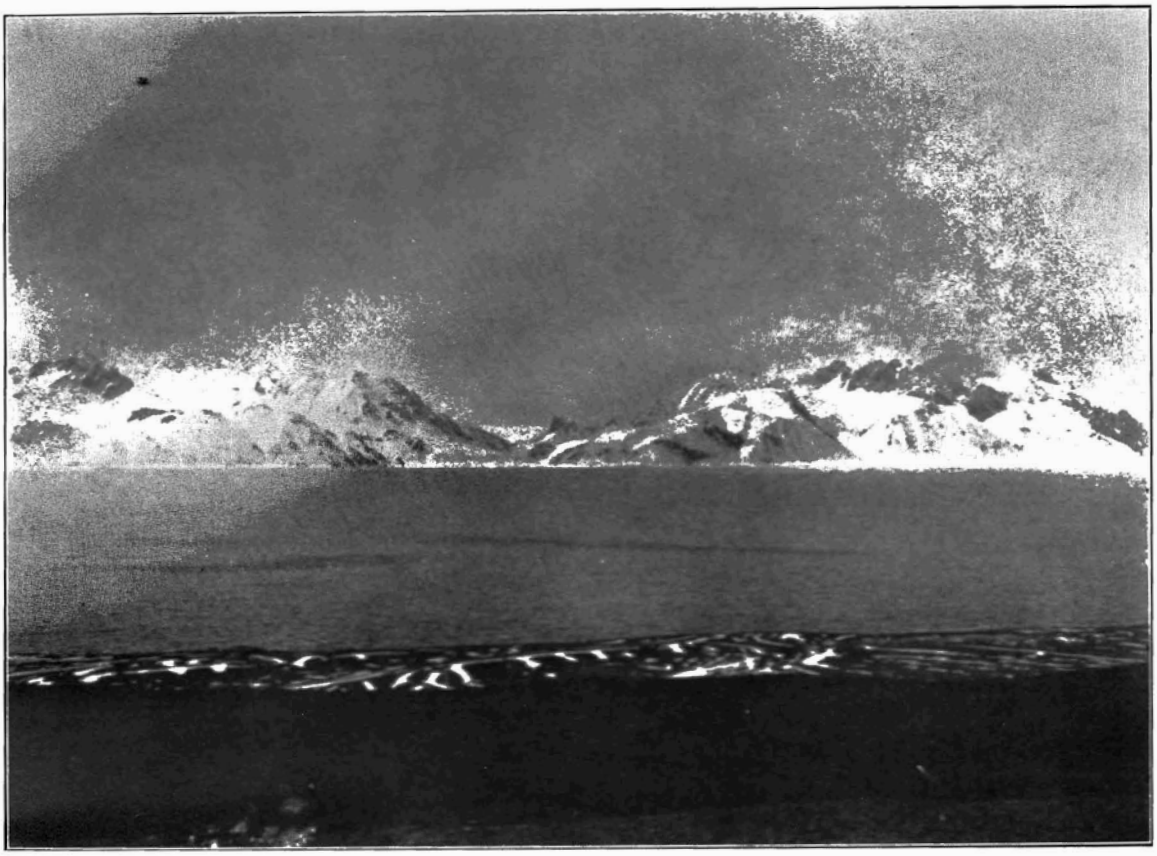


24. A. — VIEW DOWN HEAD GORGE OF YURUNG-KASH RIVER FROM BELOW KANGRE-CHIMLIK, CIRC. 15,000 FEET (SEE PAGE 21).



21. B. — ZAILIK GORGE NEAR GOLD-PITS OF SAGHIZ-BUYAN, LOOKING WEST (SEE PAGE 21).

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1923.

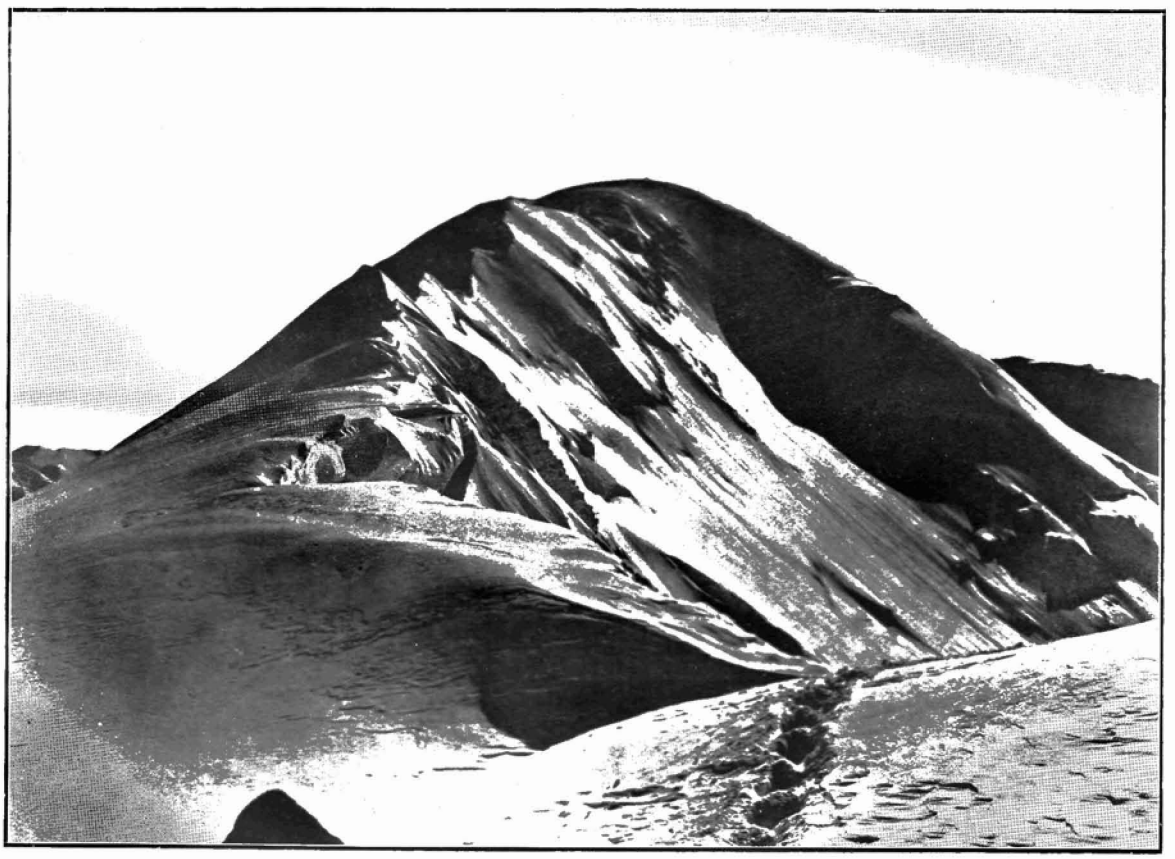


25. A. — VIEW ACROSS SOUTH-WEST END OF LAKE LIGHTEN FROM NORTH (SEE PAGE 22).

25. B. — GLACIERS OVERLOOKING THE BASIN OF THE KERIYA RIVER SOURCES FROM WEST (SEE PAGE 21).

Photo-engraved & printed at the Offices of the Survey of India, Calcutta. 1923

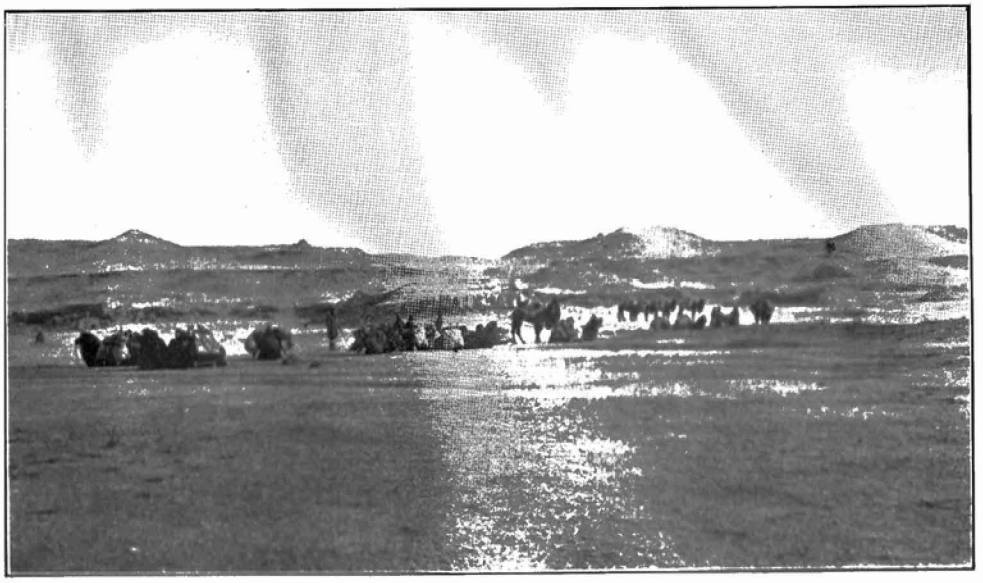
26. A. — VIEW TO NORTH FROM SNOWY COL ON WATERSHED OF MAIN K·UN-LUN RANGE, CIRC. 19,900 FT. ABOVE SEA, WEST OF PK. 3/52 M (SEE PAGE 22).



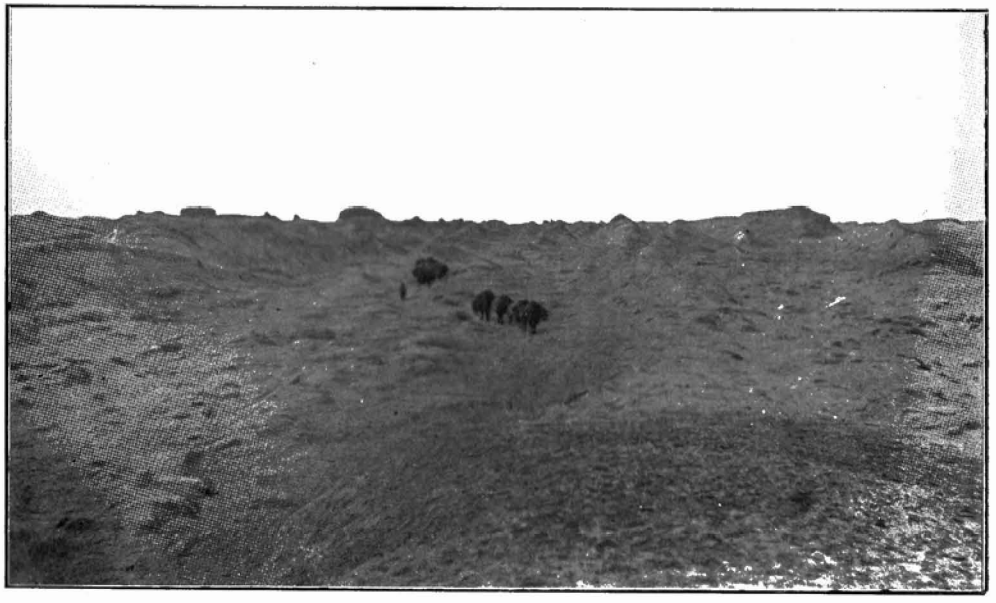
26. B. — VIEW TO SOUTH-WEST FROM SNOWY COL ON WATERSHED OF MAIN K·UN-LUN RANGE, CIRC. 19,900 FT. ABOVE SEA, WEST OF PK. 3/52 M (SEE PAGE 22).

Photo-engraved & printed at the Offices of the Survey of India, Calcutta.

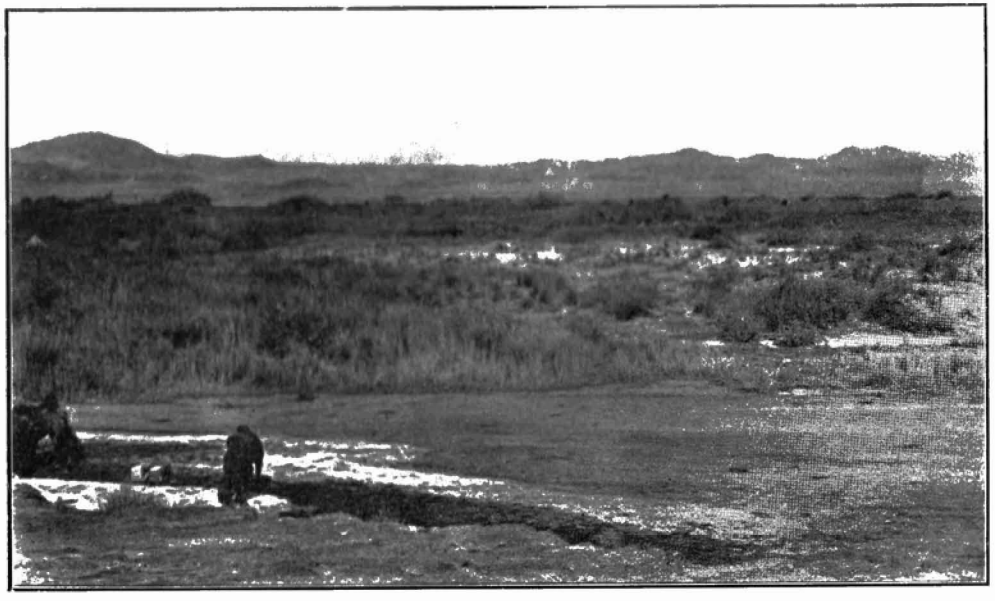
27. A.—SALT-ENCRUSTED BED OF ANCIENT LOP SEA, N.W. OF KUM-KUDUK (SEE PAGE 30).
Patch of actual salt bog shows up white.



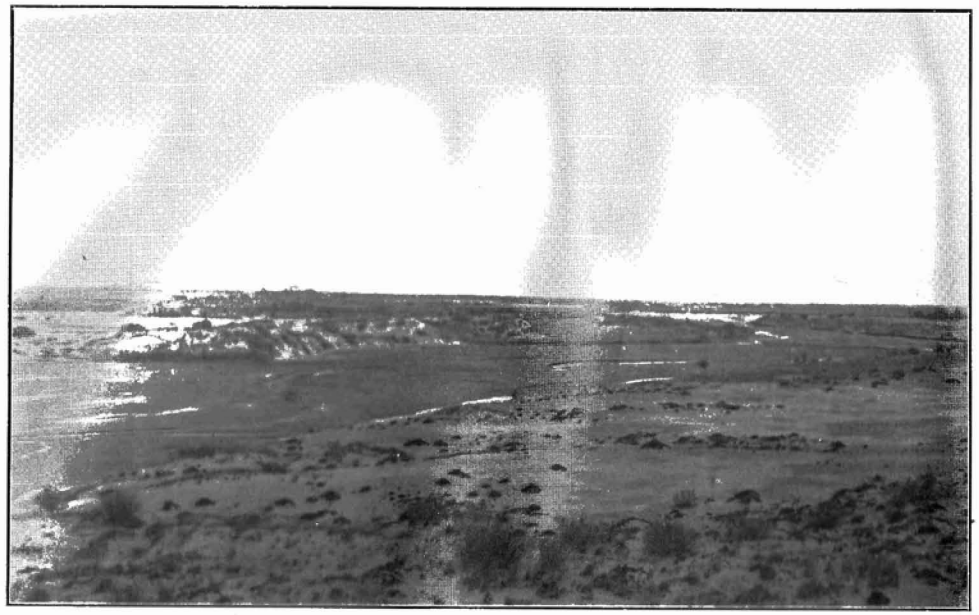
27. B.—CLAY TERRACES MARKING SHORE LINE OF ANCIENT LOP SEA, N.W. OF KUM-KUDUK (SEE PAGE 30).



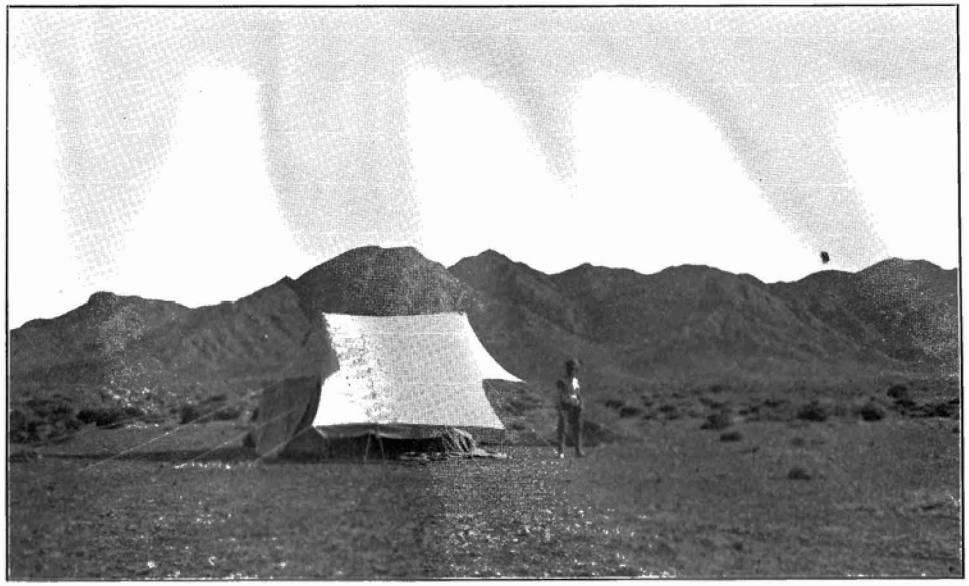
27. C.—SALT-COATED EROSION TERRACES ('WHITE DRAGON MOUNDS') NEAR N.W. SHORE OF ANCIENT LOP SEA (SEE PAGE 30).



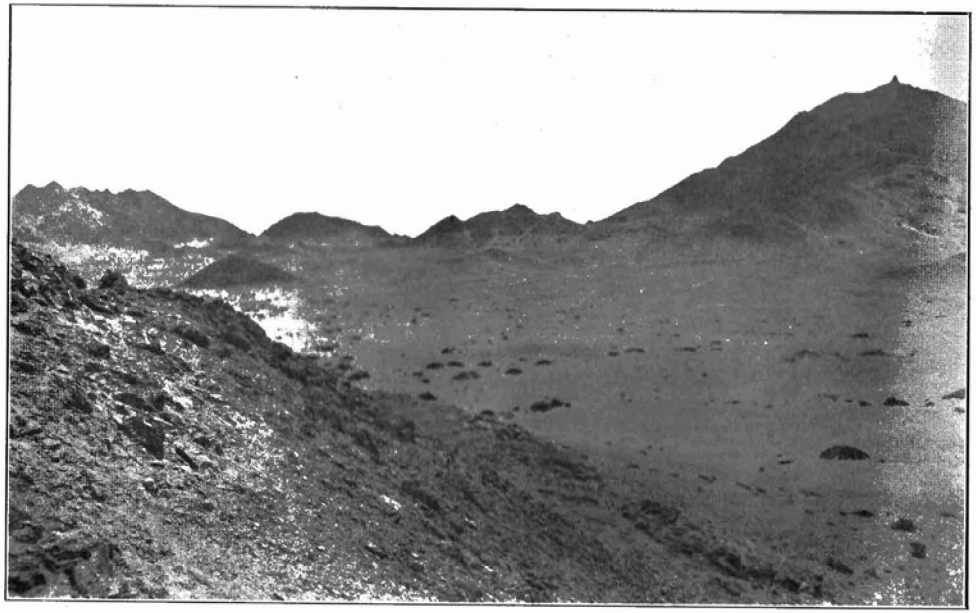
27. D.—ALTMISH-BULAK AT SOUTH FOOT OF KURUK-TAGH (SEE PAGE 30).
Frozen salt spring and reed-bed in foreground.



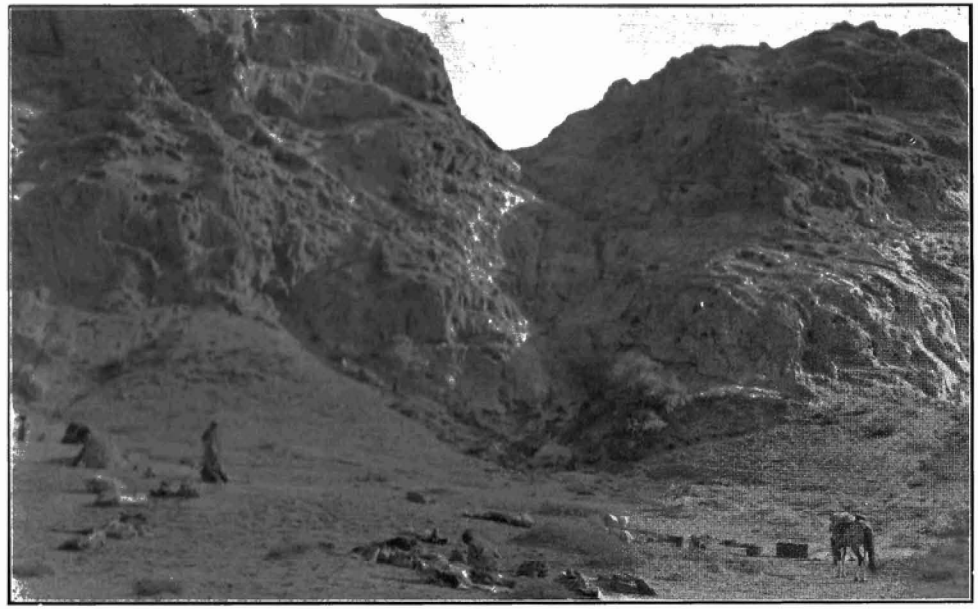
28. A VIEW ACROSS ETSIN-GOL BED TO NNE. FROM BELOW BAYIN-BOGDO HILL (SEE PAGE 32).



28. B. HILL RANGE OF PEI-SHAN, LOOKING SOUTH FROM CAMP 214, TUNG ERH-SHAN (SEE PAGE 31).



28. C.—BAYIN-BOGDO HILLS, SEEN FROM ABOVE ETSIN-GOL NEAR CAMP 113 (SEE PAGE 32).



28. D. CAMP 161 AT ZIGDA-KAYA, IN DESERT HILLS SOUTH OF MAO-MEI (SEE PAGE 32).

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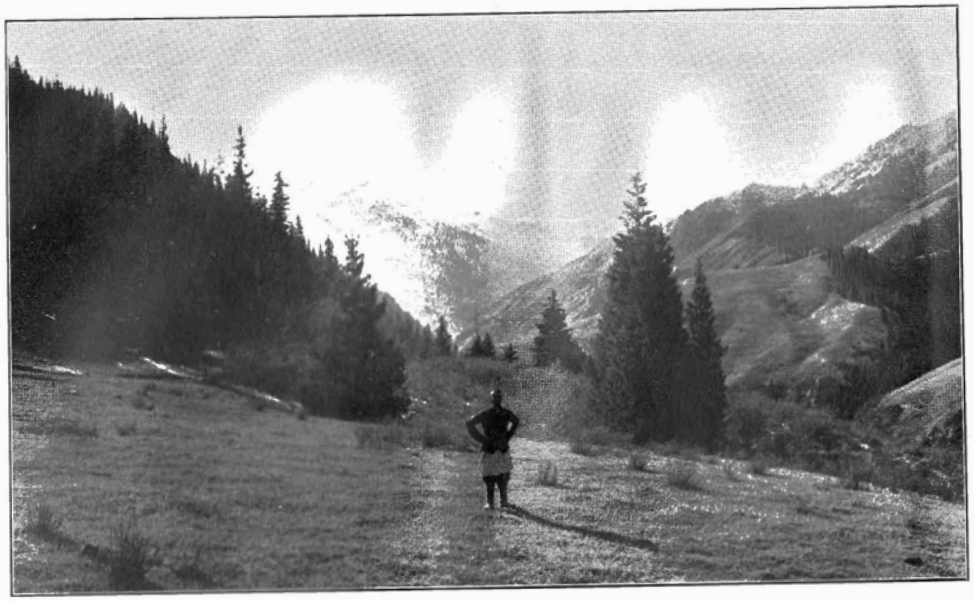
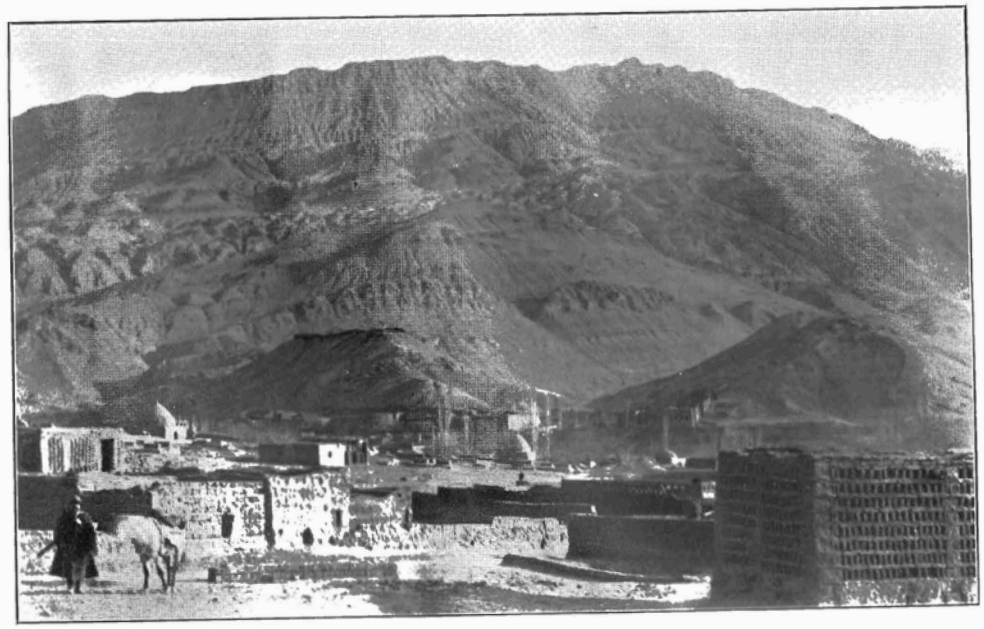
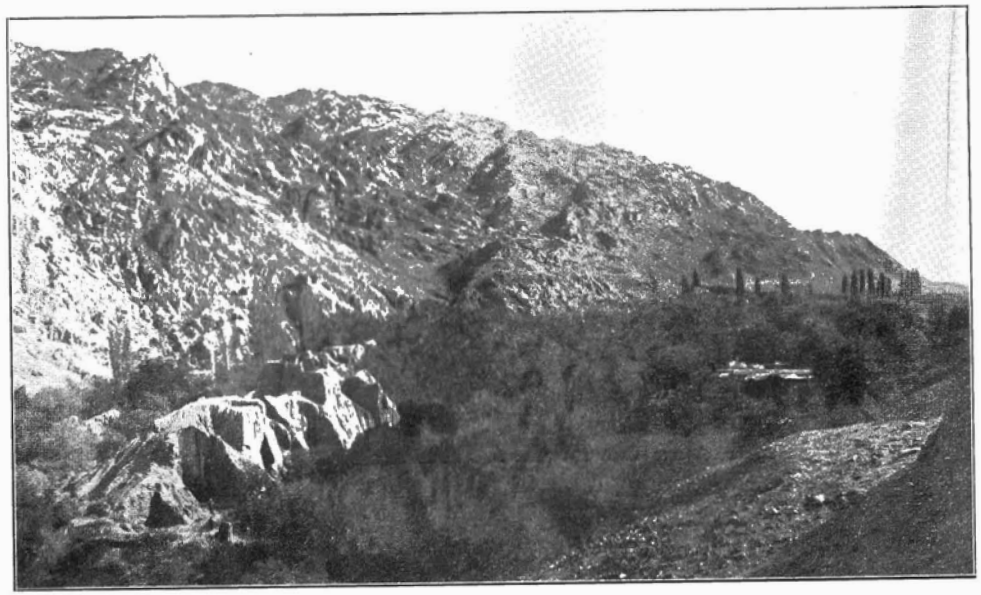


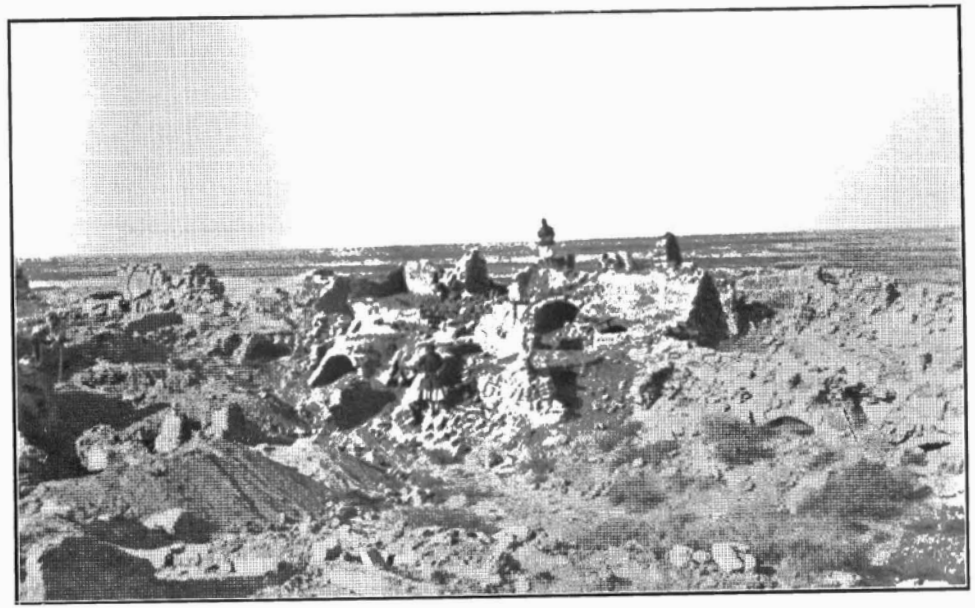
29. A. VIEW UP PA-NO-P'A VALLEY, BOGDO-ULA RANGE, FROM ABOVE LO-T'O-P'U-TZU (SEE PAGE 34).



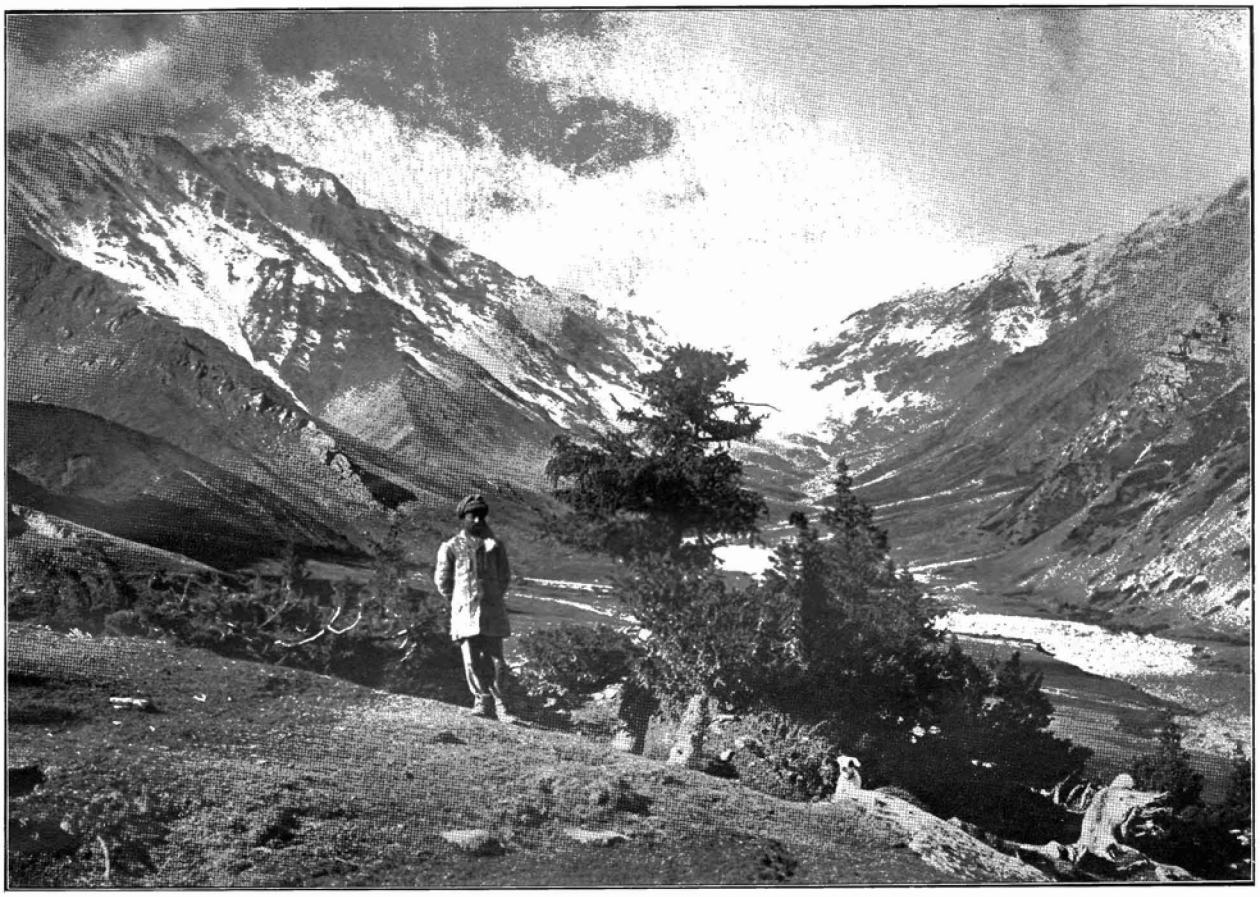
29. B.—ERODED HILL RANGE ABOVE TOYUK, TURFAN, LOOKING NORTH-WEST (SEE PAGE 35).



29. C.—HILLS AT FOOT OF KARLIK-TAGH, ABOVE RUINED SITE OF ARA-TAM, HAMI (SEE PAGE 19).

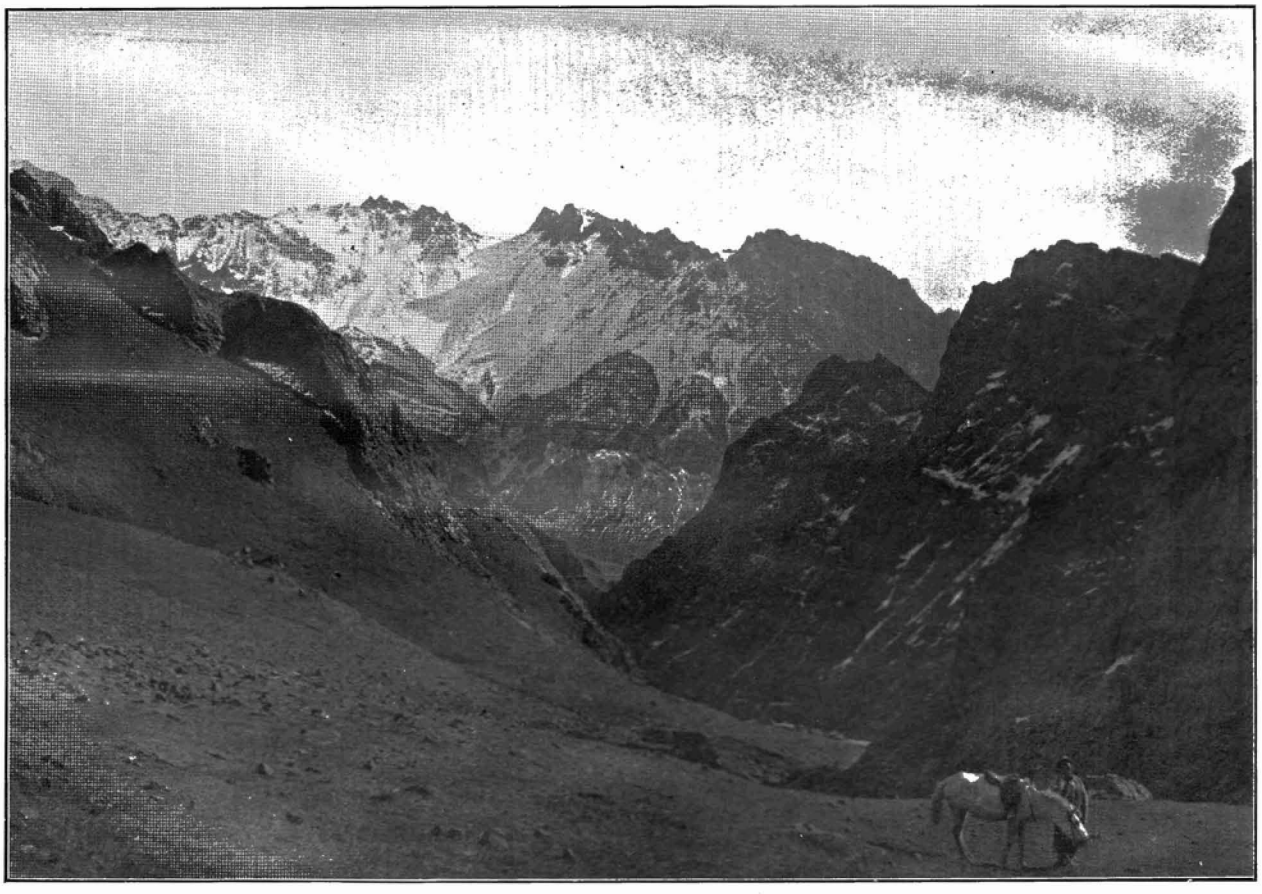


29. D.—RUINED SITE OF CHONG-HASSAR, TURFAN, LOOKING SOUTH-WEST ACROSS DRIED-UP LAKE BASIN (SEE PAGES 19, 36).



30. A.—HEAD OF BOSTAN-ARCHE VALLEY, ULUGH-ART RANGE. LOOKING WEST
(SEE PAGE 40).

K.S. AFRĀZ-GUL IN FOREGROUND. CLOUDS ABOVE HEAD OF VALLEY HIDE HIGH SNOWY PEAK OF CHAKRAGIL GROUP.



30. B.—VALLEY BELOW PA-NO-PA PASS, BOGDO-ULA RANGE. LOOKING SOUTH
(SEE PAGE 34).

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