

GLACIER EXPLORATION IN THE EASTERN KARAKORAM.*

By T. G. LONGSTAFF, M.A., M.D. Oxon.

OF the mountain regions of High Asia which are politically accessible to the ordinary traveller, there is none concerning which detailed information is more scanty than the eastern section of the great Karakoram range. Between Younghusband's Muztagh pass and the Karakoram pass on the Leh-Yarkand trade-route, a distance of 100 miles as the crow flies, we have no record of any passage across the main axis of elevation having ever been effected by a European. There are, however, traditions relating to an old route known as the Saltoro Pass, and it was the elucidation of this latter problem at which I aimed last year.

Concerning the country east of K₂, Burrard wrote in 1907: "There is no more likely spot than this for great undiscovered peaks to be existing" (Burrard and Hayden's 'Sketch of the Geography and Geology of the Himalaya Mountains and Tibet,' p. 100). So confident was I of the accuracy of this forecast by one of our greatest authorities on Himalayan problems, that I provided myself with an instrument for the special purpose of measuring these peaks, choosing on Mr. Reeves' recommendation the Indian Survey clinometer.

East of 77° E. and north of 35° 30' N. lies an area roughly measuring a degree in each direction into which no traveller has ever penetrated, and which has never been surveyed. We know that it is a region of snow-clad mountains, and that it is quite uninhabited. The known area may be regarded as limited on the south by the conscientious labours of the G.T.S. of India (*vide* quarter-sheets 44a south-west and south-east, which shows the head of the Nubra valley bounded by the main water-parting in the latitude of the Karakoram pass); on the east by the headwaters of the Yarkand river, explored by the intrepid Hayward under such exceptionally difficult circumstances in 1868 (*J.R.G.S.*, 1870, vol. 40, p. 52). On the north by Raskam, the scene of so many bloody raids by the Kanjutis; and on the west by Younghusband's discoveries around the glacier sources of the Oprang river in 1889 ('The Heart of a Continent,' chap. x.), of which more anon.

Two other travellers have knocked at these closed doors. In the year 1835 Vigne attempted to find the Saltoro pass, of the existence of which he had heard from the natives. He reached a point some 5 miles up the Saltoro or Bilafond glacier, but was forced to return owing to the inclemency of the weather, the lateness of the season, and the unwillingness of the Khapalu men to proceed (Vigne, 'Travels in Kashmir,' vol. 2, p. 382). In 1848, Henry Strachey visited the Siachen glacier, from which the Nubra river takes its rise, and forced his way

* Read at the Royal Geographical Society, April 18, 1910. Map, p. 744.

up it for 2 miles ('Physical Geography of Western Tibet,' p. 53; also *J.R.G.S.*, vol. 23, p. 53).

It was natural, therefore, that I made this region my goal last year, well assured that nowhere else could my alpine experience be turned to better use. Sir Francis Younghusband, then Resident in Kashmir, and to whose kindly assistance I am indebted far more than I can say, showed me the original field-books and maps containing the records of his explorations at the sources of the Oprang river in 1888. On this occasion he had been despatched on an important mission from which he turned aside for a short time to investigate the native reports as to the existence of a pass—the Saltoro pass—leading into Baltistan. His longitudes depended very largely on the identification of a high peak which he sketched. From the old survey maps with which he had been supplied, it was natural to suppose that this great peak was none other than K_2 . But H.R.H. the Duke of the Abruzzi had been able to demonstrate that it was probably Gusherbrum. The latitudes were quite beyond dispute, but in spite of this, we found that the compilers of the well-known 'Map to illustrate the Explorations of Captain Younghusband' had drawn his route much too far to the south in order to fill in the curious blank V-shaped patch south-east of K_2 . After a laborious three days' ascent of a glacier, named by him the Urdok glacier, Younghusband camped on the ice at an altitude of 15,355 feet. His latitude was $35^{\circ} 41' 20''$. Proceeding southward the next day, he saw a gap in the ridge about 3 miles distant. Through this gap he saw peaks rising to the south. His men believed this to be the Saltoro pass. But avalanches made further progress extremely dangerous; and, having ascertained what he wished to know—that there was no practicable route into Kashmir territory—he returned by the way he had come. Before I left he gave me a diagram showing where he considered the main water-parting really lay, and in the end it was found that his anticipations were in almost complete accordance with fact.

My party originally consisted of only Lieut. A. M. Slingsby and myself. At the last moment that well-known mountaineer, Dr. Arthur Neve, of Srinagar, found himself free to join us for a few weeks. I have to thank Colonel M. J. Tighe, D.S.O., 56th Rifles Frontier Force, for his kindness in obtaining special leave for Slingsby to join me, and also for allowing the latter to bring two sepoy, Gulab Khan and Attar Khan, with him. Let me say once for all that their services were quite invaluable. I have also to thank Colonel Longe, R.E., Surveyor-General of India, for his very considerate offer of the services of an Indian surveyor, an offer which I felt unable to accept because all his time would have been wasted had we been unable to cross the Saltoro pass.

We left Srinagar on May 20, and thanks to the excellent arrangements made for us by Captain D. G. Oliver, Assistant Resident and

British Joint Commissioner for Ladak, crossed the Zogi La (11,300 feet) on May 26 by the winter route, and reached Kharmang on the Indus on June 1. From Kharmang (8150 feet) Neve took the baggage down the Indus to its junction with the Shyok, the Northern Indus of earlier writers, where he ferried across the united streams. Then proceeding along the right bank of the Shyok he reached Khapalu after another exciting passage of the river on zaks.

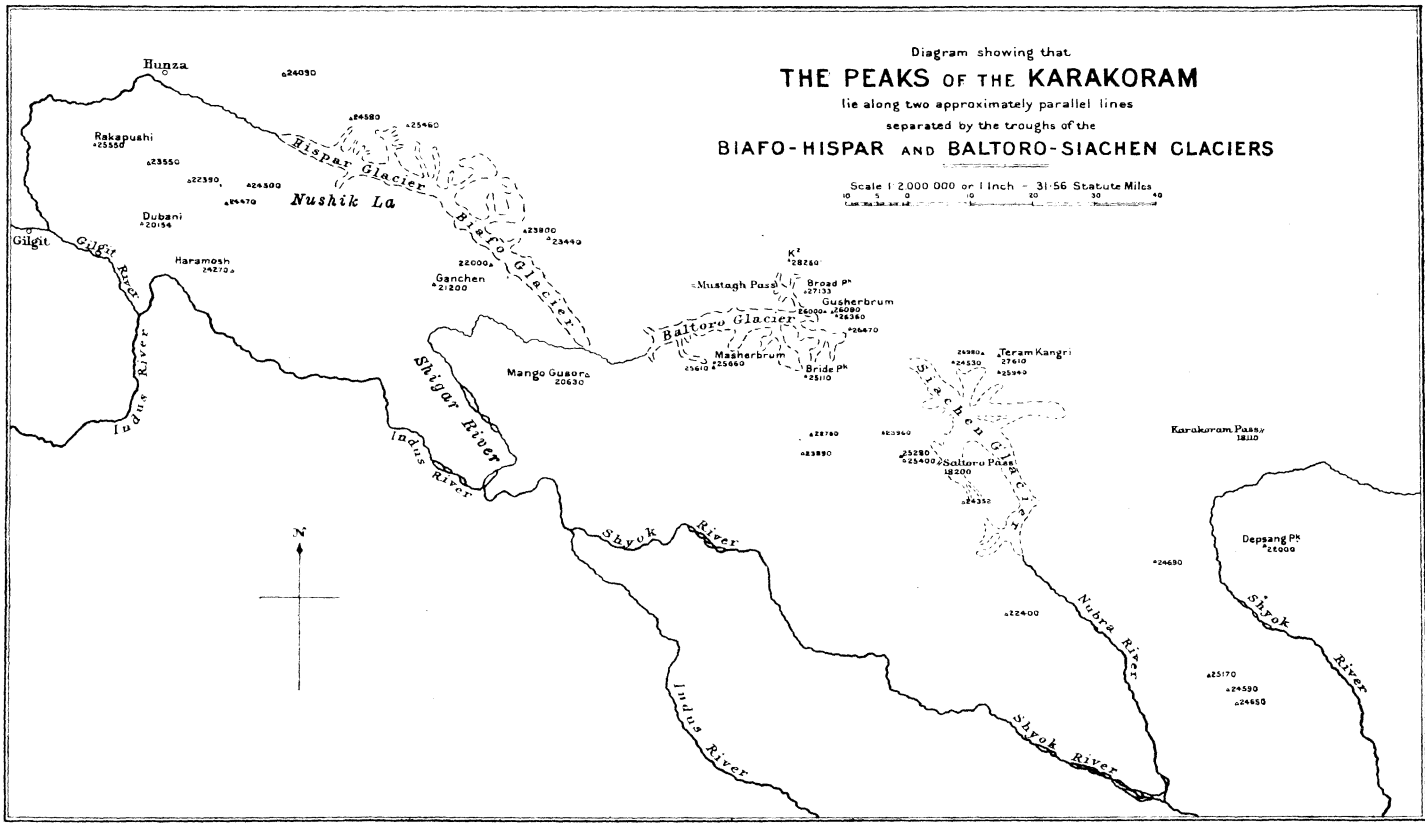
Slingsby and I crossed the Ganse La (17,100 feet) direct to Khapalu. We were told at Kharmang that the passage would not be possible "until the apricots were ripe." Scouting trouble, we took only four coolies, and when these struck work on the morning of the second day, we sent them home rejoicing, and carried our own loads over the pass, reaching Khapalu (8350 feet) on the third day. Slingsby's orderlies saved the situation. As usual, this lenient treatment of the local people aided us in our future dealings. A traveller gains far more by showing his own superiority over these people than by coercing them, and we never had any more trouble.

At Khapalu, thanks to a letter of introduction from Sir Francis Younghusband, we were most hospitably entertained by Rajah Shere Ali Khan and Rajah Nasr Ali Khan. Shere Ali Khan informed us that the Saltoro pass lay at the head of the Bilafond glacier, and that beyond it were two routes, one leading to Nubra and one to Yarkand. But we were too much obsessed with the ideas imbibed from the study of our maps to appreciate the full significance of this statement. The route was said to have been abandoned when the Leh-Yarkand trade-route *via* the Karakoram pass was rendered safe by the intervention of the British Raj. But the desuetude into which so many glacier passes across the ranges of High Asia have fallen in recent times is so frequent an occurrence that I cannot accept this explanation. I should rather look for changes in the glaciers themselves, but as I have previously pointed out (*G.J.*, vol. 31, p. 382) by no means necessarily an advance or increase of the ice. Dr. Stein could probably give us some information on this subject. Further, I find that in 1848, Thomson ('Travels in Tibet,' p. 463), in reference to Vigne's attempt, says that he has been unable to find any one who had crossed the Saltoro pass, and that in Nubra all knowledge of any road either to Khapalu or Yarkand was denied.

Neve rejoined us on June 5, and with the ever-ready assistance of Shere Ali Khan we started again for the Saltoro valley on June 7, Abdal Kerim, one of the rajah's wazirs, being sent with us to make arrangements for coolies and supplies. Crossing the spur behind Khapalu, we dropped down to the Shyok, and at Chogogron ferried across to the right bank on zaks. Our route now led us along the south (left) bank of the Saltoro river. Up to Dansam the valley is deep and wide, the river winding along over its flood plain in several

Diagram showing that
THE PEAKS OF THE KARAKORAM
 lie along two approximately parallel lines
 separated by the troughs of the
BIAFO-HISPAR AND BALTORO-SIACHEN GLACIERS

Scale 1 2000 000 or 1 inch = 31.56 Statute Miles
 0 5 10 20 30 40
 Kilometers



channels and sweeping round the bases of several large alluvial fans, each irrigated, and hence presenting a pleasant green contrast to the prevailing brown of the crags on either bank. Opposite Paro sheer spires of granite shoot straight up from the river to a height of 5000 feet or more, forming one of the most tremendous palisades I have ever seen—"one adamantine dominion and rigid authority of rock."

At Dansam the Kondus river from the north joins the main stream of the Saltoro, and there is a considerable rise in the level of the valley-floor, with a corresponding waterfall in the river. This is a constantly recurring feature in both the Karakoram and the Himalaya as the glacier region is approached, and I cannot help referring it to the conservative action of the glaciers which descended to these levels in recent geological times. I find it very difficult to believe that glaciers are capable of the degree of spade work claimed for them by most modern geologists. I cannot conceive that solid water is a more powerful denuding agent than liquid water. The etiology of the "tread and riser" formation seems to me to be more explicable on conservative grounds than by means of the elaborate laws evolved by the advanced supporters of the "plucking" theory. At Palit fragments of the old lateral moraines still cling in sheltered places to the valley walls 1000 feet above the level of the stream-bed. The rocks on the north side of the valley appear to consist exclusively of granites, but the high splintered crest on the south is of slate.

At Goma (10,800 feet), the highest village, we turned up the Ghyari nala towards the Saltoro pass. On the right side of the nala three steep narrow glaciers descend through deep gashes in the granite palisade, terminating among the shrubs of the valley floor. They are all actively advancing. The people say that this has been going on for ten or twelve years. As the snouts are approximately in the position shown on the G.T.S. map (1861), it is evident that there has also been at least one period of local retreat since that date. In this part of Baltistan the word *rüzu* was consistently employed to designate a glacier as apart from snow (*kha*).

The Saltoro valley splits at its head (Goma) into three main glens. The glaciers in these—the Bilafond-Chumik, the Rgyong, and in a lesser degree the Chulung—are of the valley type, which, with the doubtful exception of the Aletsch, is unknown in the Alps. They are dendritic, and in all cases secondary glaciers descend right down into the main valley below the present termination of the trunk-streams.

On June 11 we established our base camp in an extensive thicket a few hundred yards from the snout of the Bilafond glacier (12,400 feet). The place is known as Ghyari, and is annually visited by shepherds. A pair of ibis-billed curlew (*Ibidorhynchus struthersi*) frequented this spot. They were evidently nesting. We did not know that the eggs of this

rare bird had never been found, and so made no proper search for them. Eastern Baltistan and Ladak are relatively treeless countries, and the demand for fuel leads to great destruction of shrubs in the neighbourhood of villages, but it is usual to find a luxuriant growth of pencil cedar, *shukpa* (*Juniperus excelsa*), willow, and tamarisk, with broom, vetch, and borage, and sometimes wild-currant and rose bushes, near the snouts of the larger glaciers. This holds good as far east as the snout of the Siachen glacier in Nubra, but was not observed at the snout of the Remo glacier, where conditions are more completely Tibetan.

In September, 1885, Vigne camped at this spot. Next day he went 5 miles up the Bilafond to a spot he called Ali Bransa, and which is so marked on the G.T.S. map. He was compelled to turn back owing to bad weather. He speaks of there being two lofty ridges to cross, and two or three more nights to be spent on the ice "before the northern end of the Nubra valley is reached." He appears here to refer to the mountain wall which has always been supposed to close the Nubra valley on the north, 20 miles above the snout of the Siachen glacier.

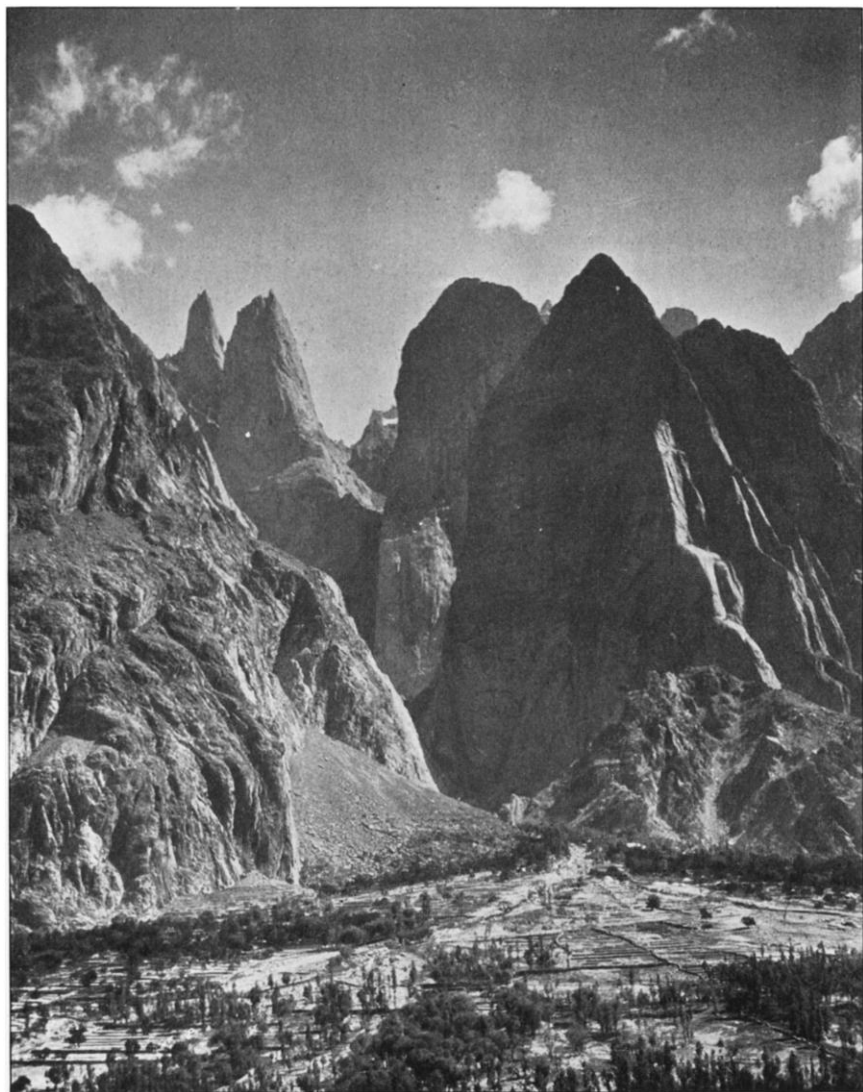
The Bilafond glacier is the most northerly and largest of the three glacier systems from which the Saltoro river heads, and had it not already a well-accepted local name, might well be termed the Saltoro glacier, for tradition and usage have given the name of Saltoro to the pass we had set out to explore, and it was so used in conversation by the Rajahs of Khapalu. But locally the pass is called the Bilafond La. The Chumik glacier has united with the Bilafond, and the ice now definitely enters the main Ghyari nala. This advance has been a matter of local interest and comment for the last ten years or so. The Chumik glacier was said to have joined the Bilafond about fifteen years ago. Comparison with the old survey indicates an advance of about 2 miles of the combined trunk stream. The advancing ice has actually involved the thickets of alder and juniper on its left bank, and has flowed over the sheep-track which led to the little pasture situated there. The glacier appears to be over-topping its lateral moraine, but there was no observed advance of the snout between June 11 and June 27.

After a day's work with the plane-table from a spur (14,900 feet) above camp, we set out on June 13 up the Bilafond glacier. We had eighteen laden coolies carrying tents, provisions, and wood for our party of twenty-five all told. Our headman was Mullah Halim, of Goma, a very fine fellow. Keeping as close as possible to the right bank, we made our way over horribly unstable moraine. Well disposed glaciers leave a road between themselves and their containing wall, but the Bilafond is an overbearing monster, full to the brim, and steadily advancing, piling its moraines in fearful confusion against the very bases of its confining cliffs. After seven hours' grind, having covered 6 miles, we got off the ice on to the steep grassy slopes of the right bank, and camped about the spot marked "Ali Bransa" on the G.T.S. map,

probably after Vigne. The real Ali Bransa is some 6 miles further on. Our camping-place appeared to be known as Naram (14,400 feet) : there was a clear sight back to my last station.

One word as to the old survey. In reference to the Saltoro region, the Report ('Synopsis of Results, G.T.S.,' vol. 7, p. xxxiii.) states that "Mr. Ryall made a rapid sketch of the country, but with sufficient precision to give a good general idea of its physical formation." This is a thoroughly accurate description of what was done in 1861. No claim is made to a detailed topographical survey. The whole basin of the Kondus and Saltoro rivers was under examination, and it was quite impossible that the glaciers should be explored. The triangulation of the high peaks, on which my map is based, was a very different affair, having been effected several years previously by Montgomerie's assistants with the greatest precision. But none of these points are represented as being on the line of the water-parting; they are all correctly shown to the south or west of it. It should not be necessary to point out that, while a mountain range can only be accurately mapped by means of a theodolite triangulation, it is quite impossible to lay down the actual line of water-parting except by supplemental topographical methods. For the latter class of work the great glaciers of the Kondus valley still remain an almost virgin field.

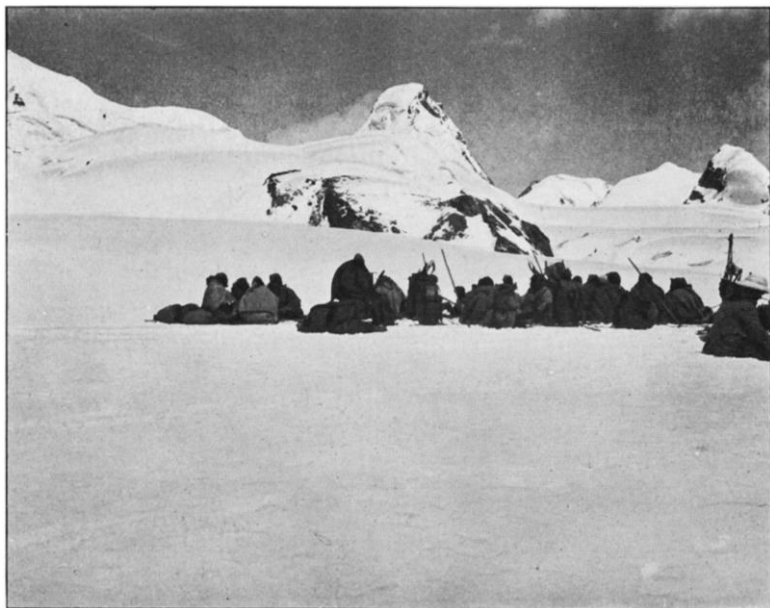
On June 14 we continued on up the glacier. The going was much better, there being a choice of either the well-made moraines or the clear alleys of ice between them, for, owing to the numerous large secondary glaciers which join the Bilafond, the medial moraines are multiple. About the junction of the middle and upper thirds of this glacier these moraines are four in number, and each about 50 feet above the level of the rest of the glacier. This height is not due to the actual depth of moraine stuff, for melting is here greatly retarded, so that the ice is really raised underneath the protecting covering of stones. The ice of these moraine-weals is a clear blue or green, while on the bare surface of the glacier the ice is white and finely honeycombed. Besides the Chumik, two large glaciers enter on the left bank. On the right they are more numerous but smaller. Glacier tables of large size are common, being situated usually beside the raised moraines, from the summits of which they had originally fallen. On the right bank of the main glacier, jutting out from two salient angles, are a gigantic pillar of rock, and about a mile further on an almost equally extraordinary pointed tower. The moraines, and, so far as I could see, the two confining ridges also, consist entirely of granite, and on the right bank the former present an almost continuous palisade of gothic spires. If these were ever covered by an ice-cap, that ice-cap has singularly failed in leaving its mark upon them. It is inconceivable that any re-weathering can have produced forms so abrupt and on so gigantic a scale.



SALTORO SPIRES.
(All photos by T. G. Longstaff.)



THE BILAFOND GLACIER.



SUMMIT OF THE SALTORO PASS.

As we proceeded the moraines diminished, and crevasses, often covered by sodden snow, became more troublesome, so that we had recourse to the rope. This, of course, delayed the coolies, and it took seven hours from Naram camp to reach the spur on the left bank of the glacier where Ali Bransa was reputed to be. None of our men could exactly locate the old halting-place. In consequence we climbed up a steep slope, and camped in a most uncomfortable and exposed spot (16,700 feet). There were several snow and hail storms, with tempestuous wind all night.

On June 15 we started at 7 a.m. Snow was lying on the ground, and the going was very bad. Regaining the glacier, we soon came to the real Ali Bransa, consisting of three low stone walls (*bransa*) on a strip of solid moraine tucked away under a cliff. The *bransa* yielded not the slightest trace of human occupation. I think it is certain that it had not been visited for at least a generation, for our men could have made themselves fairly comfortable here, instead of passing a wretched night on the exposed spur. Our last camp had involved great labour in building platforms for the shelter tents with which we had provided them. We had constant difficulties with concealed crevasses, but of course were roped together in suitable parties. At 9.30 a.m. we reached the foot of the steep slope leading up to the pass, and the coolies going very well, reached the summit (18,200 feet) at 10.50.

The summit of the pass consists of a level snowfield with a very gentle slope towards the north-east, succeeded by a steeper drop. There was thus a good deal of dead ground on either side of us, which, added to the clouds already covering the highest peaks, considerably detracted from the results obtained by camera and plane-table. We could see that from our pass a broad glacier led gently downwards in a north-easterly direction, and joined a still larger glacier at right angles, which at first seemed to us to flow northwards, we supposed into the Oprang valley through some gap in Younghusband's wall. But that same afternoon we approached sufficiently near to see that the main glacier was flowing to the south. Beyond this was a wall of very lofty peaks, their summits hidden by cloud, which we assumed formed part of the Aghil range. We very naturally believed that we had crossed the main divide of the Karakoram, and that therefore this huge ice-stream must curve round to the east and discharge into the Yarkand river. At 11.50 we began the descent. The snow was appallingly soft, and the leader sank to the waist at every step. Crawling on hands and knees scarcely relieved the labour, and even when some sort of a track was broken it was grinding work for our laden coolies, who wished to camp on the snowfield until the night frost hardened the crust. However, they persevered manfully, and at 4.30 we camped (16,900 feet) on bare ice close to the birthplace of the right lateral moraine. The creaks and groans emitted by the slowly moving ice so

frightened our men that, in spite of the cold, they left their tents and passed the night huddled up in the open.

Next day we made only a short march. It was impossible to get off the ice on to the right bank, owing to a confusion of huge seracs and impassable crevasses. We eventually camped at the spot where the left lateral moraine of our glacier effected a junction with the right lateral moraine of the main ice-stream (15,875 feet). Here there was a depression in the glacier-level, and an inexhaustible supply of stones to lay on the ice under our tents. Water was obtainable from surface pools close at hand. Two coolies told us that they had heard of this glacier, and that it was called Tērām (or Terām). They said that it would lead eventually to "Chang Thang," by which I concluded they meant the country north of the Karakoram pass. We naturally christened our glacier "Teram glacier," being quite unaware of the fact that it was really the undiscovered upper portion of the Siachen glacier of Nubra.

From our camp we now saw that we were upon an enormous glacier, fully 3 miles in breadth, and by far the biggest any of us had ever seen. It was flowing from north-west to south-east, or approximately from the direction of Conway's "Hidden peak." Near its head and distant about 15 miles was a gap, which I at once connected with the sketch of Younghusband's "Saltoro pass" which I had seen in his report. It is possible that in former times there was a route from the Oprang valley over Younghusband's saddle, and either down the upper Siachen into Nubra, or into Baltistan over the true Saltoro pass, or by some other pass over the Kondus ridge. But I cannot believe that natives would ever have undertaken so dangerous and arduous an enterprise; for we had been told that animals had never crossed the Saltoro pass, and thus travellers from the Oprang side would have had to carry their own food and fuel on their backs, possibly from Raskam. Under the best conditions, the passage of the glaciers alone could not have occupied less than a week. I believe that the Saltoro pass was never used except as a short cut from Baltistan into Nubra. If a direct pass from Nubra to the Pamir formerly existed, it is almost inconceivable that Muhammed Haidar should not have crossed it in 1535, when the treachery of Rashid Sultan compelled him to seek safety in Badakshan, and when, in fact, he fled from Ladak by way of the Karakoram pass and Raskam. It should be noted that both Hayward and Gordon refer to an old pass leading from the head of the Kufelung glen into Nubra, necessarily *via* the Siachen glacier. On our side a great secondary glacier swept gently down from this very direction.

None of the trigonometrically fixed peaks of the G.T.S. were visible, and although I had carried my plane-table sketch down to this camp, so sceptical was I of its accuracy, owing to the many difficulties I had had to contend with, that I decided to start afresh with a new base-line on the approximately level surface of the main ice-stream. This was

accomplished on June 17 with the indispensable assistance of Neve and Slingsby. From the two ends of this base I roughly sketched in the topography of the 25 miles of glacier in view, and took altitudes to the principal peaks. Meanwhile Slingsby despatched Gulab Khan with our two best Baltis down the glacier. They were absent over 13 hours. On their return Gulab Khan reported that they had descended for 7 or 8 miles, but had seen no indication of the termination of the glacier, and further that it showed no intention of turning to the east, but even turned still more to the south. They brought back a primula, a sedum, and a saxifrage, and reported having seen ibex on the east bank. They also said that the main surface stream was quite impassable a few miles below our camp.

Pyramidal ice-pinnacles as much as 3 feet high are a great feature of this glacier. The surface of the ice was also honeycombed to an extent I have never seen in any other mountain region. The hollows were round or oval, having a level bottom, floored with a sprinkling of stone fragments, varying in size from slaty slabs about 6 inches in diameter to fine grit, and covered by 1 to 6 inches of water. The edges rose steeply from the bottom in beautiful fluted cones to a height of from 6 to 18 inches. A spirited attempt has recently been made to classify as *nieves penitentes* all sorts of varieties of ice and snow pinnacles prevalent in the Karakoram, including even "glacier tables." I hardly think the position is tenable, because the genesis and composition of so many of these structures are so different to those of the well-known Andean formation. Hooker, in 1848, appears to have been the first to notice these cones in the Himalaya (*Himalayan Journals*, vol. 1, p. 252).

Owing to the numerous large secondary glaciers which join the trunk-stream on either hand, there are four moraines (possibly five) which may be termed medial moraines. Those on the right half of the glacier appeared to consist entirely of various granites, and are of a uniform light grey or brown colour. This was in accordance with our observations of the petrological character of that range of the Karakoram across which we had passed. But from the moraines on the left half of the glacier we obtained specimens of hornblende schist, mica schist, dark slate, and white or grey marbles of various kinds, some of the latter being of exceptionally good quality. Gulab Khan also brought back a beautiful fragment of alabaster from near the left edge of the glacier. Thus in marked contrast to the light greys and browns of the right moraines, those on the left presented a much darker hue, appearing almost black in contrast to the blocks of white marble scattered on the surface. The latter appear to be derived from the upper section of the central peaks, while the lower strata of the range appears to be of slate and dark schists. Altogether we seem justified in assuming that the valley is a tectonic one.

The huge wall of peaks * to the north-east was obviously of very great altitude, as Burrard had predicted. But it has been very truly said that the discovery of a new peak is of little interest or importance unless its actual height is ascertained, and I must therefore anticipate somewhat by giving the results of my measurements of the highest point in this new cluster, which I have named Teram Kangri. I got a good sight of it from the west end of my base-line, but by the time I got to work with the clinometer at the east end, the highest peak was in the clouds. I got another sight from the Saltoro pass on my return. I estimated it at the time as being over 25,000 feet; but when my observations were worked out at Dehra Dun, its altitude appeared to exceed that of Everest. This was too much for Colonel Burrard, in spite of his own prophecy. The angles which the peak subtended could not well be called in question, for the Indian Survey clinometer is a very simple instrument and quite easy to use. I tested it at Dehra Dun, observing to the neighbouring hills against another observer with a theodolite. But the determination of the exact location of the peak really depended on two rays only—those from the two ends of my 1000-yards base-line; for the third ray from the Saltoro pass was of little or no additional value. My distance from the peak was, therefore, quite likely to be in error, and, after consultation, I moved the highest peak 2 miles and the second highest 1 mile nearer to my observing-station. The result of this manœuvre may be tabulated as follows:—

Angle from station.	Distance from peak.	Altitude above station.	Altitude of observing station.	Observed altitude of peak.
10° 50'	12 miles	12,200 feet	16,000 feet	28,200 feet
4° 50'	20 „	9,150 „	18,200 „	27,350 „

It is to be noted that the value 18,200 feet given for the Saltoro pass is deduced from Watkin aneroid observations (*v. post*). The angle by clinometer from my base station gave to the pass a height of 18,780 feet. If the latter value be accepted, the value for the second observation would work out at 27,940 feet. On July 2, from the summit of the Rgyong La (18,700 feet), Slingsby and I saw to the northward a group of very lofty peaks, far overtopping the general level of the snowy ranges spread before us, which we identified as the Teram group. Owing to the anticipation of greater difficulties than we actually experienced, we had taken no coolies with us, and I had shirked carrying up either my large clinometer or my plane-table. Nor did I, indeed, expect to see these peaks, for I had not realized the probability of their extreme height. I had with me a small geological clinometer, with a swinging arm. For greater accuracy I rested this along the straight edge of my ice-axe, while Slingsby read the dial half a dozen times.

* The dip appeared to be towards the north-north-east.

We made the angle about $3^{\circ} 40'$. The Rgyong La is 33 miles from the peak according to my map. Were these figures correct, the peak would work out at something like 30,000 feet. But with such rough methods the probability of error becomes a certainty. Yet this observation, crude though it be, combined with the photograph of the group taken from the same spot and which I have shown on the screen this evening, tends to confirm my previous results. After full allowance has been made for a slight downward tilting of the camera (f.l. 118 mm.), the highest peak still appears to rise at an angle of at least 3° above the horizontal. This is equivalent to an altitude of about 27,700 feet. But considering that the discrepancies between the different observations are very considerable, I wished at first, for obvious reasons, to suppress the actual figures I obtained, and to content myself with saying that the peak was a very lofty one. I was subsequently advised to publish the figures for what they are worth, and to give the nominal value 27,610 feet to the peak; but it must be distinctly understood that the Survey can take no responsibility for this or any other of the results I am putting before you. They have, however, accepted my nomenclature, which is in conformity with the advice officially tendered to travellers by this Society. The Tibetan form Kangri, instead of the more correct Ladaki form Gangri, has been adopted for the sake of uniformity with modern usage, as in the case of Aling Kangri, Kulha Kangri, and so on.

I have thought it well to deal fully with my reasons for attributing so great a height to an unknown peak. Not since 1858 has a peak approaching this height been discovered. It is to be noted that, until last year *all* those mountains known to exceed 27,000 feet have been brought to light by the scientific operations of the Survey of India. If Teram Kangri attains such a height, it seems to me incredible that it can have eluded the theodolites of Montgomerie's surveyors. Yet at its feet winds one of the greatest glaciers in High Asia, unsuspected until last year. That Teram Kangri has been seen before, probably by Neve and Oliver from the Murgisthang saddle, and possibly by Ryall, I cannot doubt.* Hayward must have seen it from the north (*op. cit.*, p. 57). But its remote inaccessibility and the screen of high peaks west and south of it appear to have prevented its identification, though its existence was obviously suspected by Burrard.

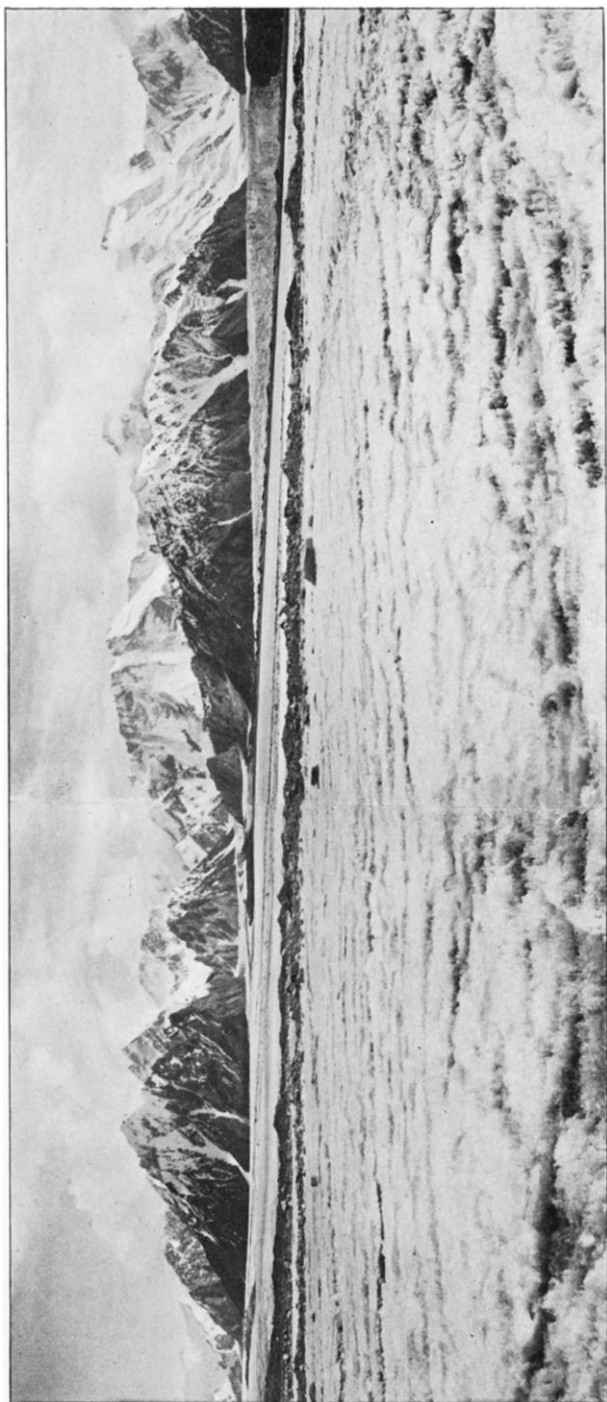
When I had first planned this expedition, my idea had been to force a pass over the range which has always been shown at the head of the Siachen glacier, from upper Nubra into the head of the Oprang valley, and endeavour to return from thence by the Saltoro pass. But Neve and Oliver had already attempted to reach the Siachen glacier, and they entertained the project of renewing their explorations there in the autumn of 1909. Though they offered to waive their prior claims in my

* Apparently also by Sir Martin Conway and Major the Hon. C. G. Bruce from Pioneer Peak.

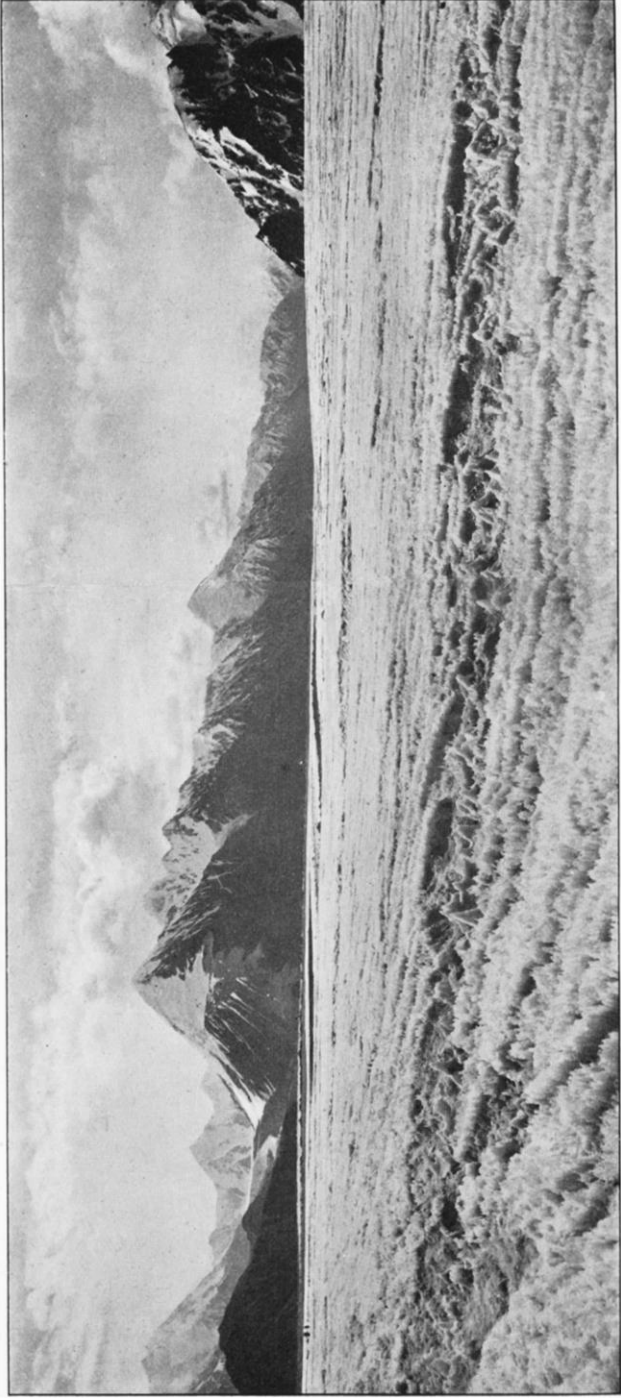
favour, I accepted their suggestion that Slingsby and I should attempt the Saltoro pass first. We hoped by this means to effect a practical junction of our routes, even if both parties were compelled merely to retrace their steps on the return journey. Neve and Oliver accepted the Survey map as essentially correct, regarding the Siachen basin. It will thus be seen that we were all thoroughly obsessed with the idea that there was a mountain barrier between our "Teram" glacier and the Siachen, and believed that, in spite of all appearances to the contrary, the outlet of our glacier must be towards Kufelung and the Yarkand river, an uninhabited region quite destitute of supplies. Under such circumstances, it seemed unfair to compel the coolies, already becoming alarmed, to continue down the glacier, and we decided, wrongly as it turned out, to recross the Saltoro pass back into Baltistan. Remembering our former difficulties, we realized that a heavy fall of snow would cut off our retreat, or at least retard it for more days than our supplies would hold out. So as the night of June 17-18 was clear and frosty, we decided to rush the pass while all was well, and at 5.20 a.m. on the 18th we started back, roping up before we left camp. The coolies went very well now that their faces were turned towards home, and, taking a much better line on the glacier, we regained the Saltoro pass at 10 a.m., having come very fast all the way. I set up the plane-table and clinometer again, but had no time for photography. Luckily, my head was aching sufficiently to enable me to dispense with lunch! On the far side the snow was already in bad condition, and the weather threatened a storm; but, by forcing the pace, we had the satisfaction of reaching our old camp at Naram in twelve hours from the start, where we much appreciated sleeping once more on solid earth. On the 19th we gave the coolies a day's rest at Naram. Neve botanized; Slingsby went off after a herd of ibex; and I went a few miles up the large secondary glacier, which joins the Bilafond opposite Naram and appears to rise in the snowfields of K_{12} , an elusive peak which I was never able to identify to my entire satisfaction. It snowed most of that afternoon and all the following night, rendering the descent of the moraines to Ghyari more exasperating than ever, and we felt we were well out of what might have been an awkward fix.

The task we now set ourselves was to find a pass over the head of one or other of the Saltoro group of glaciers which would lead us down directly into upper Nubra. The only known way into that valley would lead us back to Khapulu and up along the Shyok to its junction with the Nubra river, a very trying route at this time of year.

On June 23 we set out up the Chumik ("water-eye" = spring) glacier, camping at 15,500 feet. Its southern boundary is formed by a serrated wall of unscaleable peaks draped with traceries of fluted snow of indescribable beauty, but literally raining avalanches on to the glacier below. The rocks were composed of various granites, but



TERAM KANGRI ACROSS THE UPPER SIACHEN GLACIER.



LOOKING DOWN THE UPPER SIACHEN GLACIER.

from the middle moraine I obtained specimens of actinolite schist and a badly weathered dyke rock (? minette).

The character of the Chumik glacier was in general very similar to that of the Bilafond. The pass at its head was obviously much too steep for coolies, and greatly to Slingsby's disappointment we did not attempt it, but contented ourselves with mapping and photography. On our return journey to Ghyari (June 25), Slingsby and I reached a height of 17,150 feet on the steep ice-fall of the upper Chumik glacier north of our last camp. The danger of avalanches from the peaks above prevented our reaching its highest *névé*, but I have ventured to reduce its area very considerably on my map. Neve had now to return to Srinagar, and we parted at Goma on June 27 with mutual regrets. The influence of his reputation as a healer had been of the greatest use to us in our dealings with the Baltis. His skill in the operation for cataract, which he performs by the roadside with the greatest success, is an inestimable boon to these people. It was an honour to be associated with him in such work, in however slight a degree.

At Goma we heard that there was a tradition of a route into Chorbat (Shyok valley) over the head of the Chulung nala. But we decided first to thoroughly explore the Rgyong valley. We accordingly left Goma on June 29, and crossing the Saltoro river by a temporary and extremely rickety bridge, entered a peculiarly narrow and steep-sided defile, and ascended beside a series of waterfalls and cataracts. The gorge, as usual, opened out higher up, and the river wound broad and shallow over a gravel flood plain, cutting the bases of several *débris* fans.

Our camp (13,250 feet) was pitched among stunted willow, birch, and pencil cedar, below the first large glacier descending from the north. On later examination this proved to be in a state of active advance. It terminates in a perpendicular wall of ice, finely castellated at the two sides, and from which great blocks of ice constantly roll down into the scrub jungle at its foot. On June 30 we continued up the valley, reaching the main glacier after about an hour's walking. We found the snout about a mile below the point marked on the Survey. It had all the characteristics of active advance, but there was no observed advance of the snout between June 30 and July 3. We kept along the right edge of the glacier, making use of the lateral moraine as much as possible. As a rule, the glacier filled the nala from edge to edge, but occasionally we could travel in the hollow between the moraine and the valley wall. On one such spot (15,000 feet) we camped early in the afternoon to take shelter from an impending storm. We had had light snow squalls all day long. On July 1 we soon reached bare ice, where the going was easier. In two hours we reached the point (15,850 feet), where the glacier divides into two great arms. One flows from the two Survey peaks, 21,720 feet and 20,960 feet, to the south; and the other swept down from an invisible saddle to the

north-east. The latter was obviously our goal, and we camped on the highest available spot (16,700 feet) on the right bank. Just above us we noticed an old native cairn. It was the highest spot on this trip at which we saw the little mouse-hare, a friendly beast, very aptly named *shippi*—"the whisperer."

Next morning, taking only two men with us, we started at 5.45 for the Rgyong La, as we named our hypothetical pass. We expected considerable difficulties, but except for some fatiguing step-cutting we raced up without a hitch, and reached the pass (18,700 feet) in very good time, at 8.40. The rocks of the crest are granite. To my great surprise we found the remains of a cairn on the summit, so that probably the pass has been crossed by natives. We looked down on to a feeder of the Siachen glacier of Nubra, but the descent is extremely steep, and we were not willing to risk the lives of our coolies by making them carry our heavy baggage down it. The panorama spread before us was a magnificent one. To the west we looked back over the mazes of the Rgyong glacier. To the south was a sea of magnificent peaks separating us from the Shyok valley. But it was a vista of distant snows, through a break in the hills to the north, that held our attention. There a group of four peaks far over-topped everything else in sight. We had no doubt that this was the massif north-east of our "Teram" glacier, but until this moment we had no idea of their commanding altitude. I took bearings to these peaks, and also to K₁₉ and K₃₂ of the Survey map. Presuming that these two latter identifications were correct, the observed position of Teram Kangri agrees with that shown on my map. It is extremely unlikely, for many reasons, that the high peaks we saw were any others than the Teram Kangri cluster. I have already detailed my attempt to measure the highest peak.

After spending an hour and three-quarters on the pass, we descended rapidly to our last camp, and striking it at once, the whole party started back down the glacier, reaching our first glacier camp (15,000 feet) easily by 5 p.m. On the way down we witnessed a fine glacier burst. It was heralded by a loud and prolonged roaring sound, quite unlike anything I have ever heard. We soon located it, bursting from a side glacier in a ravine high above the right bank of the main ice-stream. The whole hillside seemed to be moving, as a torrent of black muddy water rolled great masses of ice and rock down its bare slopes. We found our camping-place, a low sheltered spot beside the glacier, had been very nearly flooded by the torrent thus set loose. Next day we ascended a prominent spur (16,070 feet) to examine the great secondary glacier marked on the survey map as discharging into the Rgyong Valley on the north-east. But again, as with the corresponding branch of the Chumik, I was constrained to reduce its area very greatly. We marked our station with a large cairn, visible from the valley below. On July 4 we again reached Goma village.

The Chulung ("water-valley," or valley of streams) was now the only remaining terminal of the Saltoro valley system to be explored. We left Goma for the last time on July 6. There was the usual steep rise beside a waterfall from the level of the Saltoro river into the Chulung gorge, where the Chulung river has cut out a fine cañon. The right bank of the cañon is of granite, and the left of slaty schists, and lying beside the torrent are boulders of beautiful green serpentinous and mica schists. The latter probably came from the ridges to the south-west, and are no doubt ice-borne. Several secondary glaciers are visible in ravines on either side.

The magnificent granite spire of Gharkun (17,060 feet) was constantly in view as we ascended the valley. A second steep rise brought us into the open upper valley. We camped at Malla Mani, the highest hamlet (13,400 feet). It is, of course, only occupied during the summer. The grazing is good, but there are no shrubs at this altitude, and fuel has to be fetched up from lower down the valley. Marmots and ibex are numerous.

After three days' rain the weather cleared, and we started on up the nala with 28 coolies. The Bawoni glacier, advancing from the south-west, has descended right into the valley, and abuts against the right bank of the nala a little below the Beltus glacier, where a bed of phyllite underlies the prevalent granites. At no other spot did we see such a profusion of flowers—acres of ground were completely carpeted with eidelweiss, over which flew flocks of buntings. We next passed along the edge of an old lake-bed through which the stream wound in several channels to force its way eventually under the ice-barrier of the Bawoni glacier. Snow fell heavily, and we camped at noon (14,300 feet) below the granite walls of Gharkun. Opposite our camp a small but very beautiful glacier descended almost to the valley floor, ending in green cliffs of ice.

Slingsby discovered a fine glacier pass at the head of the main Chulung glacier which would obviously lead us over into Chorbit, and on July 10 led me and his two orderlies from our camp to the summit (18,300 feet) in 5 hours 40 minutes. From the pass a small portion of the Teram Kangri group was visible to the north, but at this distance (45 miles), and with so limited a view of the range, I was unable to identify the actual peaks in sight. To the south we looked across to the ranges beyond the Shyok river, and beyond these thought we recognized the two great peaks of Nun Kun. The descent on the south side of the pass, which we named the Chulung La, led over steep rolling *névés* and seemed practicable for laden coolies. We therefore decided to attempt its passage with our entire caravan. While waiting for fine weather and to collect food for the coolies, I worked a good deal at my map, and find a note in my diary under July 11, to the effect that our Teram glacier seems likely to turn out to be the Siachen.

On July 12 we got under way at 7 a.m. with thirty coolies led by Abdal Kerim, secretly hoping to cross the pass that day. As usual the coolies lost a lot of time by sticking to the lateral moraines instead of taking to bare ice. By noon we reached the highest possible camping-place, which looked so desolate and forbidding that the coolies were easily persuaded to try the pass that day. I went on ahead with Ahmedu, the only decent Kashmiri of this class we had encountered, in the hope of doing some more plane-tabling, but I did not reach the pass till 2.45 p.m., by which time clouds greatly interfered with my work.

On Slingsby and his two orderlies, ably supported by Abdal Kerim, fell the trying task of assisting and persuading the coolies to face the steep snow-slopes, now softened by the heat of the day. I think very few men would have succeeded as he did. By 4 p.m. all five parties were close to the pass, and I started down to mark the route for the descent. The snow was very soft, and the glacier soon degenerated into a maze of crevasses concealed by a most deceptive covering of new snow, through which the heavily laden coolies were constantly breaking. I quite expected that we should have to spend the night upon the Korisa glacier, but just as it got dark Slingsby found a way off the ice through the difficult seracs on the right bank. We ourselves waited till the last coolie had reached solid ground, and quitted the ice at 8.45 p.m. (16,100 feet).

Our arrival at the hamlet of Korisa next morning created great surprise among the shepherds there. The men are of the Ladaki type, but Mussulman and not Bhuddist. After a long walk we dropped down a deep descent into Chulunka village (9350 feet) on the Shyok river, along the right bank of which we were to travel 50 miles. Between Siksa of Chorbat, and Thirit of Nubra, a distance of 80 miles, the Shyok is unbridged, but it is possible to cross on zaks where the latter opens out opposite Deskit, just below the entrance of the Nubra river.

The track is extremely bad between Chulunka and Biagdangdo, and the coolies were unable to carry their loads across one particularly awkward parri. Here we took two hours to make 300 yards, and nearly lost a coolie, who was hit on the head by a falling stone. Attar Khan caught him as he fell, or he would have dropped straight into the Shyok, roaring in full flood below. The chief villages are all on the northern bank, where alluvial fans are irrigated by means of the lateral streams descending from the glaciers to the north. Barley, buckwheat, and apricots are the chief produce.

At Biagdangdo we left the river-bank to visit Waris, reaching the first Buddhists at the farm and chorten of Zdongpolas, 12,494 feet, for we now enter Lower Nubra. Here we saw shapu (*Ovis vignei*); this is possibly the first record of its occurrence north of the Shyok; their ancestors probably crossed during some very hard winter. Continued bad weather prevented us from attempting to find a pass from the Thusa

glaciers into Upper Nubra, and on July 20 we descended again into the Shyok valley. On this day our route lay along the Chunik La ridge past the "La Chunik Pole, 13,470 feet" of the Survey. From this point the view up and down the wild Shyok river hemmed in on either side by mile after mile of gaunt brown crag, is indescribably grand, its unrelieved and elemental savagery producing in an unusual degree a feeling of exaltation and intense remoteness from humanity.

Beside the Pastan stream we encountered deposits of boulders and gravel cemented together with fine hard silicious mud. These beds were obviously quite different to the fluvial deposits we had seen high above the Indus when approaching Kharmang. The larger boulders are angular or faceted. Some of the largest capping typical earth-pillars. The commonest rocks represented are hornblende and other granites, but I also found conglomerate, calcareous schists, quartz with chrysocolla, calcite with a little malachite, and red jasper. A careful search yielded no trace of shells or other organic remains. The bed rock forming the sides of the nala turned out to be metamorphic, a highly silicious greenish limestone. These beds must be of glacial origin. We passed other deposits, apparently quite similar, further up the Shyok valley. In the Nubra valley they are never out of sight. They are seen hanging like martins' nests in sheltered spots to the bare rocks of the slopes above the river, and about 1000 feet above its present level. In the Upper Nubra valley itself they were occasionally so continuous on both sides of the nala as to make me think they were the actual remnants of the lateral moraines of the glacier which formerly filled that valley.

We struck the Shyok river again just as it gathers itself together to dash through a very precipitous defile cut in the living rock. The narrowed waters sweep over an obstructing ledge, a portion of which, even at this time of flood, formed an islet in mid-stream. From this point onwards to the junction of the Nubra with the Shyok the valley gradually widens out, until at Deskit the river-channels spread themselves over a breadth of 2 miles. Horizontal beds of fine gravel and sand, especially on the south bank of the river, appeared to point to a former lake-like expansion of the river before the defile was sufficiently deeply eroded to carry off the full volume of water. Several curved bays in the wide flood-plain were covered with sand-dunes on which a scanty growth of tamarisk maintained a precarious foothold. Beyond Mondari the valley presents a wide open prospect which was most pleasing to us after the confined granite trenches of the Saltoro region. Great bushes of wild lavender, with a constant succession of Buddhist chortens and mendongs, added to the picturesqueness of the scene. The banks are quite arid, except where irrigation is possible; but beside the river are dense jungles of amber-berried hippophæ full of small birds, chakor, and hares.

On July 22 we made a twelve-hour march from Mondari to Charasa, rounding the bold rocky promontory, at the foot of which the Nubra river enters the Shyok at an unusually acute angle. Taking the average courses of these two rivers, the general angle of junction is 50° . The angle at the great south-to-west bend of the Shyok, 50 miles further upstream, is also acute, being about 60° . It is evident that the valleys of the Nubra and the Shyok, like the Indus valley, are tectonic. Drew observes that the rocks on the east side of the Nubra are of light brown granite, while those on the west are of a different and much darker crystalline rock. Glaciers have left their marks in these valleys, but the rivers were antecedent.

As we approached the Nubra-Shyok junction at the steep corner mentioned above, we continually passed beds of relatively recent moraine stuff with perched blocks. The solid rock for hundreds of feet above the river was polished, rounded, and scratched at this point of pressure. But the very convexity of their form shows how relatively slight has been the erosion. The striæ showed that the glacier had swung round the corner into the Shyok valley without any alteration of level, just as the river does now. This more than confirms Drew's surmise that the great Nubra glacier must have extended as far as the Shyok valley. On the floor of the Nubra valley itself are many islands of hard rock ("metamorphosed slate," Drew) perfectly worn into polished *roches moutonnées*, which have resisted through unknown ages the passage over them of a glacier at least 1000 feet in depth. Whymper pointed out long ago that *roches moutonnées* cannot be signs of great erosion, for *flat* and not convex forms are thereby produced. Drew gives the glacier a depth of 4000 feet, but I think some of his arguments can be accounted for by the action of the very large secondary glaciers which must have joined the trunk-stream from the lofty ranges on either side of the valley. The chief lateral glens which I saw or visited may all be described as hanging valleys, their lowest sections having been cut down by water now given a free hand by the retreat of the ice. As a result, the mouths of great lateral valleys such as Chamshing, Popache, and Thalambuti appear quite insignificant when seen from the main valley.

Charasa is situated on one of the ice-worn rock islands I have just mentioned. It is the ancient capital of Nubra, and probably that "Mutadar" which Muhammad Haidar captured with some difficulty from Bur Kapa (? Bagra Mir-Francke) in 1532. Here we unsuccessfully attempted to ford the Nubra river. Its very size might have led us to expect that the Siachen glacier was much larger than is shown on the Survey map. For though the Nubra river has a course of only 45 miles, and receives no tributaries of any importance, the water was sweeping down with a very rapid current through numerous channels covering about a mile in width, and in some of these with a minimum



TERAM KANGRI FROM THE RGYONG LA.



LOOKING UP THE LOWER SIACHEN GLACIER.



AKTASH GLACIER LYING ACROSS ROAD.



GENERAL VIEW OF AKTASH GLACIERS FROM SOUTH.

depth of over 4 feet. It was the strength of the current that really stopped us. However, we managed to cross the river just below Kubet on July 25. Fortunately for us some fifty ponies and yaks belonging to the Nubra people were waiting to cross to Panamik, the highest village of any importance in the valley, where they would be hired out to the Yarkandi and Khotani merchants. We entered the river at noon, and the passage of the different channels occupied three hours. We reached the eastern bank just below the village of Panamik, and about 2 miles lower down than the spot where we first took to the water. One pony was swept away, but managed to make the western bank a mile or so lower down. We were most ably led by the Trampa of Kubet, and a most resolute lama, against whose spells the demons of the waters were powerless. Oliver had most kindly sent news from Leh that we were coming from the west, and had given orders that we were to receive all possible assistance.

The upper Nubra valley was visited in 1821 by Moorcroft, that extraordinary man whose end is still shrouded in mystery; by Vigne about 1835; by Thomson, the first European to reach the Karakoram pass, and by Henry Strachey, in 1848; and later by Drew, whose general description of the valley has never since been improved upon. I will, therefore, only refer to one excursion that we made from Panamik. This was to the glaciers under the great Nubra-Shyok peak 25,170 of the Survey, the Changlung Gipfel of Hermann Schlagintweit. We left most of our baggage at Panamik, and on July 28 entered the Pokachu ravine, or Popache lungma as it is locally called. As usual, the comparatively broad open upper valley is reached through a deeply cut rocky gorge, through which the glacier torrent tumbles in a series of tumultuous cascades. This defile is quite impassable for baggage animals; indeed, it is only just practicable for laden coolies. Instead of a more or less even valley-slope from the water-parting to the Nubra river, we have a hanging valley with a step-like descent, each step representing, as I take it, different levels, and possibly different cycles of glaciation. The head of the valley is divided into two main branches, each holding a large glacier; these sweep round a salient spur, behind which, and at the foot of the culminating peak of the range, their névés are almost in contact, the result being a nunatak. Unfortunately, I selected the northerly of these two glens, and beside its glacier (16,500 feet) we camped on July 29. Continuing up the glacier next day, we camped on bare moraine at 18,200 feet. Here the weather stepped in, snow falling steadily for twenty-four hours, and we were finally compelled to beat a retreat to Panamik on August 1. The highest peaks, best approached from the south-west, presented some steep faces of exposed rock. This was very light in colour, and possibly composed of calcite or marble. On the moraines of the southern glacier I collected specimens of white and green

marble, very similar to the specimens obtained from the upper Siachen ("Teram") glacier. The valley visited by Neve, Millais, and Tynedale-Biscoe in 1899, from the uncharted glacier at the head of which they ascended Panamik peak, 21,000 feet, lies between the Popache and Chamshing ravines directly behind the village of Panamik (Neve's 'Picturesque Kashmir,' p. 140). I have indicated this glacier on my map.

The weather had been most disappointing. Nubra has often been indicated as a suitable field for high mountaineering, owing to its scanty rainfall. This may be relatively true, but from July 24 to September 12 rain fell almost every day at Panamik, and, since fresh snow was visible on the lower hills almost daily, the snowfall above the line of permanent snow must have been considerable. We were first told that this was unprecedented, and then that it had occurred only during the last fifteen years. But the same story was told to Moorcroft in 1821. I feel certain that the weather between mid-July and mid-September is just as bad as in the western Karakoram, and that June is the most suitable month for high mountaineering. Miss Duncan notes that in 1904 rain fell at Khapalu throughout August.

On August 4, Slingsby left me to rejoin his regiment. My debts to him during our joint expedition are quite beyond acknowledgment. I parted with Gulab Khan and Attar Khan with feelings of sincere regret. It must be the strong element of personal government which lies at the root of all military organization, which makes the Indian sepoy so very satisfactory to deal with.

I had obtained leave to cross the Karakoram pass and search in the direction of Kufelang for the lower end of the "Teram" glacier. But at Panamik I received letters both from Sir Francis Younghusband and Colonel Burrard, each independently assuring me that it must have been some upper reach of the Siachen glacier which we had found on the further side of the Salto pass. Appreciating the weight of advice from such sources, advice for which I can never be sufficiently grateful, I decided to attempt to prove or disprove the theory before starting on what might have been, and in the circumstances would have been, an expensive wild-goose chase.

On August 12 I was joined by Captain D. G. Oliver, British Joint Commissioner for Ladak. In 1908, in company with Arthur Neve, he had attempted to reach the Siachen glacier at the head of the Nubra valley. But they had been defeated by the size of the river. He considered that the water was too high for us at the present time, and I therefore spent a month with him in working out some problems connected with the trade-route to Yarkand, which was under his control. I hope to deal with his journey across the Kumdan glaciers to the source of the Shyok in a future number of our *Journal*.

On our return to Panamik in September, Oliver considered that the Nubra river had fallen sufficiently to enable us to reach the Siachen

glacier. Owing to the steep cliffs of granite that hem it in on either bank, and against the foot of which it sweeps at several points, the Nubra river has to be forded several times. We left on September 13 with a small pony-caravan. Tsering Spalzung, the headman of Panamik, and the most water-wise man in the valley, was our leader; Satan was the name of his most able assistant. At every doubtful point, and especially where quicksands were feared, we all awaited their verdict before trying a ford. We first crossed the river from Takshay on the east to Ayi on the west bank. The mendongs by the roadside now consist largely of waterworn slabs of white marble. A few miles above Aranu, and marking a just perceptible step in the old valley floor, we passed over the remnants of a recent moraine. It was formed around and beside the snout of the Siachen glacier during a temporary cessation of retreat opposite the Thalam-buti spur. We reached Gonpo (gom-pa—a monastery—10,900 feet) on September 14. Here there is a red-cap monastery belonging to Himis. High above the monastery to the south-west, suspended above magnificent cliffs of granite, towers a spire of perfect snow—Shelma, "The Crystal One" (Francke)—an object of veneration to these humble folk. The monks turned out to receive Oliver, and we entered camp to the impressive deep rolling boom of their drums, the long rending blare of six-foot trumpets, and the clashing of cymbals, a music perfectly harmonizing with the wild setting of the scene.

Beyond Gonpo the valley is uninhabited, though a plot of ground at Warshi is cultivated by the lamas every three years. A mile above the monastery the river sweeps into the base of the cliffs on the right bank, and it is necessary to ford across to the left bank. It was here that Oliver and Neve were stopped in 1908, but we found it only up to our girths on the morning of September 15. The Shosholing glacier tumbles down a narrow, wedge-shaped ravine to within 1 mile of the Nubra river, and we were told by the lamas that it had advanced rapidly during the last three years.

On September 16 we again forded the river, the water coming up to our saddle-flaps, and the current very strong. That afternoon we reached the foot of the Siachen glacier, camping beside a small jungle of autumn tinted willow trees and red dog-roses. I make the height of our camp, which was level with the snout of the glacier, 11,600 feet. The official Gazetteer of Ladak gives 11,700 feet for the snout of the glacier. If these two figures are accurate, they would represent an advance of the ice (since 1862) about commensurate with that which I have shown on my map.

Though this spot has certainly been reached by sportsmen, the glacier, so far as I can ascertain, has been previously visited only by Henry Strachey. In October, 1848, he ascended the glacier for two miles; he was unable to see the head of either of the two branches into which it divides about 5 miles from the snout. He remarks upon the

even level maintained by the glacier, the abrupt contact of the ice with its confining walls of granite, the unusually large amount of bare ice exposed by the moraines, and the excessive crevassation of the glacier, rendering its passage very difficult and toilsome. He concludes a description, upon which I cannot improve, with the characteristically modest remark that the understanding of glacial phenomena requires much time, study, and experience (*op. cit.*)* The survey name, Saichar, is more properly written Sia-chen (rose-place). It is said to be derived from the clumps of rose-bushes below a patch of grazing-ground on the right bank of the glacier, which have now been destroyed by advance of the ice.

We started up the glacier on September 17, taking thirteen coolies with us. We kept to the left side of the glacier, making very slow progress, as we were unable to leave the ice, and had often to cut steps up and down awkward seracs between the numerous crevasses. The first feeder on the western side might easily be passed unnoticed, for it is so smooth and is covered with such finely divided moraine stuff, that only strong glasses revealed the ice beneath. In the centre of the main glacier are numerous ice-cones, brilliantly white, and of such size and symmetry as I have only seen on the Kumdan glaciers of the upper Shyok. After about five hours we came to a deep steep-sided level-floored nala entering from the north-west. I estimated that its bed was about 400 feet below the level of the ice on which we stood.

There was a small milky stream winding along its sandy bed; it was a typical "glacial trench," but no glacier was visible in the 4 or 5 miles we could see of it. The Siachen glacier had literally overflowed or bulged into its mouth, presenting a most unusual appearance, for the floor of the glen is so level, that when facing up it we could easily imagine that we were standing on the snout of a glacier which terminated here in the usual manner. I imagine that a small catchment area, combined with the south-west aspect of its enormous granite walls, render the maintenance of a glacier impossible in this glen under present conditions, but the absence of *débris* fans showed that it had only recently been evacuated. The fact that its floor was on a level with that of the main valley shows that the huge trunk-stream of the great Siachen glacier had effected no "over-deepening" of its own bed. Owing to the chaotic jumble of seracs at this point, it was impossible to reach the valley floor for closer examination, and indeed it was some time before we found a route by which we could continue our way up the main Siachen glacier.

We eventually camped on a small grassy slope on the left bank of the glacier (13,000 feet), having come about 6 miles up the glacier in

* I have since had the privilege of discussing this expedition with Colonel Henry Strachey, whose memory, at ninety-five years of age, is happily still quite clear, and whose interest in exploration is still as keen as when he solved the problem of Mansarowar in 1846.

seven hours' actual walking. This is the best place for a first camp for any one proceeding up the glacier. Water is hard to get, but there is plenty of dead juniper for fuel. Unfortunately, Oliver had received an official message which compelled him to turn back at once, and he left early the following morning. It was very hard lines, as he had made the whole of the arrangements for this trip, and indeed, without his assistance, it is improbable that I should have been able to get any transport to follow me beyond Gonpo.

On September 18 I started on alone with Ahmadu, prepared to sleep out if necessary. The right moraines were pale grey, obviously of granite, while the left moraines consisted of black schists with slate, limestones, and various marbles. I now felt practically certain that it was the upper portion of this, the Siachen glacier, which we had reached after crossing the Salto pass in June. After two hours' hard walking I reached the point where the glacier makes its second great bend, sweeping down from the north-east through a steep-sided gorge about a mile in breadth, distinctly narrower than at any other part of its length. This gorge is quite invisible from below, and the idea that the Siachen glacier was bounded by a great mountain wall at this point, as shown on the Survey, on Thomson's, and on Strachey's maps, was quite a natural supposition under the circumstances.

With some difficulty I got off the glacier on to solid ground on its left bank. The ice rose 200 to 300 feet above me as I stood in the trough at its side. A steep climb of 1000 feet landed me at 12.15 on a narrow ridge (14,300 feet), from whence I had a magnificent view up the glacier. This point is about 10 miles from the snout of the Siachen glacier, and on it we erected a cairn which is visible from the glacier below. Directly on the further side of the ridge was the peculiar empty glen I have already described. Up to this point the cliffs of the left bank appeared to consist exclusively of granite; further up the glacier, but only on the left bank, I could see what I took for beds of black schist. Though I could not, of course, see the broad upper reach of the glacier on which I had camped with Neve and Slingsby three months previously, I think I can safely say that their continuity is established. It will be seen that the identical peaks on the true right bank of the glacier occur in both the last photograph taken looking down the "Teram" glacier, and in that taken from my last point of observation looking up the lower Siachen glacier.

This glacier appears to be not less than 45 miles in length, and according to Burrard and Hayden (*op. cit.*, p. 194), is the largest in the Himalaya or Karakoram systems, if not in the world, the polar and sub-polar regions excepted. Just as the Biafo glacier may be regarded as the complement of the Hispar, so may the Siachen be represented as the complement of the Baltoro. That it has escaped detection for so long is due to the difficulties of access, difficulties which must be my

excuse for the numerous imperfections of the preliminary survey which I have presented to you. Whatever the real height of Teram Kangri may be, my observations fulfil Burrard's remarkable prophecy, while Younghusband's views as to the northward extension of the Indo-Turkestan water-parting have been definitely established. H.R.H. the Duke of the Abruzzi has made the startling discovery that Conway's Broad peak attains an altitude of 27,132 feet. Also that both this peak and the four Gusherbrums are composed of marbles and conglomerates. The massif of Teram Kangri is a continuation of this range; its base appears to consist of schists and slates, and its peaks of marbles and calcites. There are indications that the same formation occurs in the Nubra-Shyok peaks; certainly the high peaks in the range south of the Depsang plains, which continues south-eastwards for an unknown distance some few miles back from the left bank of the Shyok river, consist chiefly of calcite. It would, therefore, appear that at least half of the main line of elevation of the Karakoram, the second highest range in the world, must be coincident with an axis of limestone.

NOTE.

The words "right" and "left" are always used in their strict orographical sense in this paper.

The map is based on the fixed points of the Survey of India. Much of the southern and eastern portions of it must be regarded merely as a route-sketch based directly upon the G.T.S. atlas sheets. The Bilafond-Chumik and Rgyari basins are from a plane-table sketch, on the scale of 2 miles to 1 inch. The depth and narrowness of the glacier valleys rendered the identification of the trigonometrical points a matter of great difficulty. When possible, I oriented my table by cutting in from three such points, but had frequently to fall back on secondary points or stations which I had fixed myself, and was sometimes compelled to rely on the box compass. Occasionally I made use of a prismatic compass. The sketch of the upper Siachen basin, and the position of the peaks around it depend on a base of 1000 yards measured on the level glacier. This was effected by means of carefully measured lengths of alpine rope, checked occasionally by a 50-foot steel tape. An allowance of 2 per cent. was made for sagging. The measurement is, of course, a rough one, but was made as carefully as possible under the circumstances. From the two ends of this base the peaks given in the opposite table were fixed.

A fairly good junction of the different sheets was effected at the Saltoro pass (N. $35^{\circ} 23' 30''$, E. $76^{\circ} 56' 30''$) and on the lower Siachen glacier. On the north-west my work, so far as it goes, is in full accord with Younghusband's. Colonel Burrard very kindly had an outline map on the scale of 4 miles to 1 inch made from my material. I have worked this up with the help of photographs, and it forms the basis of the map accompanying this paper. Sir Francis Younghusband's route on the Oprang glaciers has been re-plotted from his field-books. His route from Raskam by the Aghil pass is from published maps. Hayward's route is taken from his map in *J.R.G.S.*, vol. 40. The area thus enclosed has never been surveyed, and its delineation is therefore hypothetical. The line of peaks on the water-parting at the head of the Baltoro glacier is taken by permission from the new map by H.R.H. the Duke of the Abruzzi.

The heights of passes and camps placed in brackets in the text have been fixed from Watkin aneroid and hypsometer observations calculated from Leh Observatory.

These have been deduced by the Indian Meteorological Department by the kindness of Dr. Gilbert Walker, F.R.S. They are unusually consistent, but I found that the aneroid gave results from 350 feet to 720 feet (average, 530 feet) below those obtained by the hypsometer. This difference I have halved, and the responsibility for the actual figures given is mine. The heights of the passes, deduced only from aneroid observations, are probably too low.

Temporary sign and name.	Observed alt.	No. of rays for position.	No. of rays for alt.	Lat. N. approximate.			Long. E. approximate.		
				°	'	"	°	'	"
L ₁ Bilafond peak ...	22,200	2*	2	35	22	0	76	56	30
L ₂ "Tent peak" ...	—	2*	0	27	0		57	40	
L ₃ "Cornice peak" ...	22,140	2	2	34	0		53	30	
L ₄	22,400	2	1	38	10		49	35	
L ₅ "Spire" ...	21,030	2	2	38	40		55	0	
L ₆ "Slate peak" ...	24,530	2	1	38	10		77	1	0
L ₇	26,980	2	1	39	30		5	0	
L ₈ Teram Kangri ...	27,610	2*	1†	38	30		7	30	
L ₉	25,940	2*	2†	36	30		7	50	
L ₁₁	—	2	0	31	25		20	0	
L ₁₂ "Cone" ...	—	2	0	28	0		15	0	
L ₁₃ "Snow dome" ...	—	2	0	21	0		12	0	
L ₁₄	21,010	2	1	26	0		2	0	

The rock specimens are in the museum of the Geological Survey at Calcutta, and have been very kindly identified for me by the Curator, as I have no knowledge of petrology.

APPENDIX.

NOTES ON THE GLACIERS OF THE UPPER SHYOK VALLEY.

CARAVANS travelling from Leh to the Karakoram pass have a choice of two possible routes. They may cross the Khardong pass directly behind Leh, and travelling up the valley of Upper Nubra, cross the Sasir pass into the highest reach of the Shyok valley; this is the present summer route, and along it, at great labour and expense, a pony track has been constructed by the Government of India. Or they may cross the Digar pass east of Leh, and march direct up the whole of the Upper Shyok valley; although no road has been constructed along this route, it is still used during the winter months, when the water of the Shyok river is sufficiently low to permit of its being forded without danger.

Both routes will approximately meet below the eastern foot of the Sasir pass. Here, again, there may be a choice of routes. The present road leads eastward to Murgo, and then northward by the difficult gorges of the Kizil Su to the Depsang plains and so to the Karakoram pass. But the natural route continues straight on beside the Shyok river to the small plain of Yapchan below the great Remo glaciers, where the Shyok river is left for the Chipchak or Tsaka ("salty") Chu which leads eastward over easy ground to the Karakoram pass. This last section of the Shyok valley, which would otherwise be the natural route, is now closed by the advance of the Kumdan glaciers, which, rising in the neighbourhood of peak K₃₂ of the G.T.S. sheet 44A South-East, flow into the main valley at right angles to its course.

These glaciers have been named from Turki sources by Captain D. G. Oliver, the present British Joint Commissioner for Ladak, whose nomenclature is followed in these notes. The first is the Kichik (little) Aktash; the second is the Aktash

* Third rays from Saltoro pass; good for L₁ and L₂; no additional value for L₈ or L₉.

† Additional ray from Saltoro pass.

(white rock), so named from an outcrop of marble near its snout; the third is the Kichik Kumdan; and the fourth the Chong (great) Kumdan.

During their minor cycles of advance, one or more of these glaciers have on different occasions thrust their snouts right across the course of the Shyok river, only to be stopped by the great cliffs on its left bank. By the making and breaking of these dams of living ice, the Shyok valley has been the scene of many disastrous inundations, the suddenness of such cataclysms entailing much loss of life in the riverine villages of Lower Nubra and Chorbat.

The great Indus floods of 1841, 1858, and 1865 have been frequently attributed to this cause; but it is now well known that the first was caused by a landslip at Gor, below Bunji, that the second originated near Hunza, and the third near Gilgit.

I believe there is no other minor problem connected with the ranges of High Asia concerning which a greater confusion of ideas has prevailed in the past, and even, I dare say, at the present time. The fact that early writers of the time of Moorcroft and Vigne invariably write of the *Shyok* river as rising in a lake which they name the *Nubra Tso*, but which they correctly place on their maps in the neighbourhood of Yapchan, has, I believe, been a stumbling-block to later writers. Again, the closing of the first or lower portion of the Shyok valley route by the normal summer flood has been confounded with the blocking of the second or Kumdan section of that route by glacier advance. This advance again, instead of being attributed to normal periodic variations, has been accounted for by the wildest theories. The glaciers have been said to have broken their backs and suddenly slid down their respective valleys into the river, no particular cause being assigned for such extraordinary behaviour. Even the rapid advance of the Upper Aktash glacier during the winter of 1902-3 is paralleled, if not exceeded, by the advance of such glaciers as the Yengutsa and Hassanabad glaciers of Hunza ('Records Geological Survey of India,' vol. 35, p. 134).

I have endeavoured to sift the historical evidence supplied by writers of last century. The chief authorities are: Elphinstone's 'Kingdom of Cabul' (see under Mir Izzet Ullah); Vigne's 'Travels in Kashmir' (vol. 2, p. 362); Cunningham's 'Ladak' (p. 154); Thomson's 'Travels in Tibet' (pp. 200, 438); Henry Strachey's 'Physical Geography of Western Tibet' (p. 55); Shaw's 'High Tartary' (p. 432); Drew's 'Jummoo and Kashmir' (p. 414); Gordon's 'Roof of the World' (chap. ii. and five illustrations); Bellew's 'Kashmir and Kashgar' (p. 161). Strachey obtained evidence of a big flood about 1780. In 1812, and probably earlier, the Kumdan route was open and remained so till about 1824, some time after which date it was closed by glacier advance. In 1835 a most disastrous flood occurred, followed by smaller ones in 1839 and 1842. In August, 1848, Thomson found the snouts of the Aktash and Kichik Kumdan extending into, and even partly across, the river, his onward path being thereby completely barred. He crossed the Aktash glacier a long way above its snout on this occasion. He either did not see or more probably did not recognize, the Chong Kumdan glacier. It is more covered by moraine than any of the others. This region appears to have been surveyed by E. C. Ryall in 1862; the Aktash glacier is marked one mile, and the Kichik Kumdan half a mile, back from the river. The Chong Kumdan is shown, and labelled as closing the road; but this is probably a later addition to the map, for W. H. Johnson returned from Ilchi by this route in 1865, and in July, 1869, on his return from Kashgaria, Shaw also followed it. The projecting snout of the Chong Kumdan glacier compelled the latter traveller to ford the Shyok, and at this point he nearly lost two of his horses in a quicksand. Lower down he found that the Kichik Kumdan had completely blocked the road, though one of his guides had passed that way only three months before. The glacier had advanced right

up to the cliffs, the river forcing its way through a tunnel in the ice. He had to abandon his baggage, and, sending his horses back to make the round by the Depsang plains and Murgo, he crossed the glacier on foot with two men. On the further side he had a narrow escape from drowning at another ford. On the third day he forced his way over the Sasir pass, reaching Upper Nubra in an exhausted condition. In October, 1873, Gordon and other members of the Kashgar Mission easily made their way round the snouts of the Kichik and Chong Kumdan glaciers. He gives pictures of both. He does not mention the Aktash glaciers, which presumably had not approached the river-bed. A short time afterwards W. H. Johnson, then Governor of Ladak, returned down this route to see if a road could be constructed along it. It was considered too expensive, but it appears that the ice was not too far advanced to render such a project by any means impossible.

Captain Oliver has supplied me with the following more recent information. Probably the last European caravan to traverse this route was that of Messrs. Church and Phelps, about 1894. About 1899 the then Joint Commissioner commenced building a road along this route; it was carried beyond the present site of the Aktash glacier, but progress was subsequently arrested by the advance of the Kichik Kumdan. Until the winter of 1902-3 traders continued to make use of the Kumdan route during the cold weather, passing round the snouts of the two Kumdan glaciers by wading or fording when necessary. In the winter of 1902-3 the Kichik Kumdan advanced rapidly, and completely blocked the route. How rapid this advance was we do not know. Oliver was told that the glacier advanced several miles during that winter. Native testimony cannot be absolutely trusted on such a subject, but it should be remembered that a similar transverse glacier in Hunza, the Hassanabad, appears to have recently advanced 6 miles in two and a half months. In 1903 a bad flood occurred, which Oliver attributes to the bursting of the Kichik Kumdan dam. There are still traces of the former existence of a lake or lakes in the broad flood-plain between the Kichik and Chong Kumdan glaciers. In 1905 the Aktash glacier advanced across the river-bed, but the river forced a passage under the ice, and no lake formed behind the dam. At the present time the route is blocked by all three glaciers.

It is probable that the explanation of such periodic glacier variations as I have described must be sought in the periodic variations of rainfall. But in attempting to correlate such variations we are met at the outset by the difficulty that hardly any two glaciers have equal feeding-grounds, aspects, lengths, or slopes of bed. Hence, by the time the effect of such a general cause reaches the snouts of different glaciers we must not expect any universal coincidence of date. In the present instance none of the glaciers under discussion have been surveyed in detail. So far as it goes, the evidence points to advance of the two larger Kumdan glaciers being by no means synchronous with that of the two smaller Aktash glaciers, and hence we can form but a rough idea of their periodicity of advance and retreat. Flood-periods occurred in 1780, 1833-1842, and 1903—that is, at intervals of between fifty and sixty years. The Kumdan route was probably open before 1800. It was closed from about 1825 until about 1860. It was again usually open between 1865 and 1902. The "open" periods seem to last for about thirty-five years, and the only complete "closed" period that we know of also lasted about thirty-five years. I have already indicated that this curious agreement with Brückner cycles must be regarded as largely a matter of accident. I have recorded the recent advance of the Saltoro glaciers, and of the great Siachen glacier of Nubra, in my previous paper.

In August, 1908, Captain Oliver visited and photographed the Kichik Aktash and the Aktash glaciers. The latter he attempted to cross, but failed owing to

want of proper appliances. When, in the following year, he met me at Panamik in Upper Nubra, he decided to repeat the attempt. We therefore crossed the Sasir pass (17,600 feet), perhaps the strangest pass in constant use. The summit glacier, some 3 miles in length, is saddle-shaped. The pommel points north; the cantle is represented by ice-fields flowing down to the pass from the south; one saddle-flap leads up to the pass from the west, or Nubra side; the right saddle-flap slopes down into the Shyok valley towards the east. We camped on August 17 at the halting-place known as Sasir, on the right bank of the Shyok. Looking up the valley, we saw the river flowing in a narrow flood-plain. Continuous steep cliffs shot straight up from its left bank, but the right side of the valley was of a much gentler slope. Snow-capped spurs swept down in great curves to a broad sloping valley-shelf, down which streamed several glaciers. Their surface was moulded into the most fantastic cones and spires, and very little moraine stuff was visible.

We started up the valley on August 18, following the old bridle path. The first glacier, a small nameless one, is soon passed. It descends to within a few hundred yards of the track, which here lies about half a mile back from the river. It lies on the top of beds of gravel and scree which cover the sloping valley-shelf, without having cut out a bed for itself or ploughed up the ground in front of it, although it is actively advancing. A glacier is not a steam-plough: it does not slide downwards as a whole; its different layers, so obvious as "bands," glide smoothly one over another. Hence in spite of more rapid melting of the upper layers, an actively advancing glacier usually presents a vertical terminal face as opposed to the receding forehead prevalent during the stationary or decadent phases.

The Kichik Aktash ends in a cliff of ice about 30 feet high just above the brink of the river-bed, so that we had to descend into the flood-plain, on to the edge of which blocks of ice are occasionally discharged. Oliver decided, from the evidence of his own photographs, that the glacier had advanced a few yards since his previous visit.

Along the edge of the river and over the dry flood-plain masses of white glacier ice had been stranded. We scrambled over outcrops of black slate towards the "White Rock," a bed of white marble which gives its name to the Aktash glacier. Just before this glacier is reached, an island of rock divides the Shyok river into two branches. The current was rapid, and the water full of blocks of ice. These greatly increase the danger of the ford between Sasir and Murgo. We found the snout of the Aktash glacier projecting into deep water; it terminated in a sheer wall of ice, round which we were quite unable to pass, and from which great blocks of ice fell into the river as we watched. Oliver said that the ice had not retreated since his previous visit. Therefore at this point the glacier is actively advancing, but the river at present is able to keep its channel clear by undercutting the ice.

The lower part of this glacier lies upon the valley shelf without cutting out a bed for itself to any appreciable extent. The ice has crossed the pony-track commenced about ten years ago. The path, showing hardly a sign of dislocation, is abruptly terminated by the steep face of ice presented by the edge of the glacier. We had no time, subsequently, to search for its point of emergence on the other side. We ascended the valley-shelf for about 2 miles. A gradually developing lateral moraine is piled beside the glacier, and soon conceals from view the rows of ice-cones which form such a feature from more distant view points. Thus seen from the moraine, the glacier appears to be embedded in a trough; but at a little distance the appearance is quite reversed, the moraines resembling high canal banks raised well above the level of the valley-shelf.

We camped about 1000 feet above the river, and at once proceeded to look for a

practicable route across the glacier. The lateral moraine here presents a steep face of hard silicious moraine-stuff towards the glacier, so that it is necessary to climb down into a deep trench, and climb up on to the glacier through steep seracs. Both operations were difficult at the time of our visit, and some of the crevasses delayed us considerably. Eventually a way was found through a great valley of ice, probably representing a closed crevasse, and in $1\frac{1}{2}$ hour we reached the further bank. We had cairned our route, and the return occupied only an hour, the distance exceeding half a mile. Our camp had been pitched beside the glacier, and we reached it at 8 p.m.

On August 19 Oliver despatched Rasul Gulwan with the caravan back to Sasir camp, with orders to proceed *viâ* Murgo and across the Depsang plains to meet us at the old camping-ground of Yapchan, near the source of the Shyok river. Oliver took only twelve coolies and his Ladaki shikari, with my man Ahmedu, now a fairly expert ice-man, as cook. We did not leave camp till 1.45 p.m. In half an hour we reached the glacier. The whole party was supplied with crampons, and roped together until the difficulties were passed. We crossed in $1\frac{1}{2}$ hour—good time under the circumstances. We saw that the Aktash glacier expanded somewhat at its snout, some huge masses of ice resting on the farther bank at the foot of high limestone cliffs, which weather to a warm red colour. On September 8 Oliver again crossed this glacier, and found that all our cairns had been destroyed by the normal activity of the onward flow of the ice. The Aktash glacier flows down through a fine steep-sided glen from the direction of K_{32} , but, owing to bad weather, we could not see its upper reaches. We camped at 5.15 near a small tarn beside the Kichik Kumdan glacier, and about $1\frac{1}{2}$ mile from the river.

From our camp we could see the snout of the Kichik Kumdan glacier. It appeared to be quite impassable from the river-bed. On August 20 we crossed the glacier in one and a half hour. It was less difficult than the Aktash, but without crampons our coolies could hardly have crossed in safety. We saw that the snout expanded into a sort of ice-foot, this form, no doubt, being due to the force of its impact against the cliffs of the left bank. Great masses of dead glacier-ice were lying at the foot of the cliffs across the river. Between these and the living glacier the river had cut a channel. Probably this channel is not a continuous one. The middle section of the snout appeared to bridge the river, which must flow in an ice-tunnel beneath it. Where we crossed the ice, the glacier was nearly a mile broad. I estimated the greatest breadth of its expanded snout at about 2 miles. This is the identical condition described by Gordon in 1873.

After quitting the glacier we continued a short way along the valley-shelf, and then descended steep slopes of scree to the level of the river, whose broad bed here resembled a lacustrine plain. Straight ahead the lower portion of the great Kumdan glacier was visible, its last mile almost covered by moraine, though a few huge white ice-cones are thrust up through it. We struck the glacier at 2.30, at a point about 5 miles above the snout of the Kichik Kumdan glacier. The walking was tiring, but much easier than on either of the others. The glacier is nearly 2 miles broad where we crossed it (in $2\frac{1}{2}$ hours). A long way up the valley we saw a high snow-peak, which I believe was K_{32} itself. We had great difficulty in getting off the glacier. A very steep slope of ice has to be negotiated, and this is constantly raked by stones falling from the moraine heaps at its edge. Steps were cut down this slope, and the coolies descended safely. Oliver waited above with a rope until the last man had got safely down. While he was descending the ice-steps an avalanche of boulders caught him, carrying him off his feet and hurling him down the slope. We thought he must be killed, but he escaped with some bad cuts and bruises. It was now 5 p.m., and the lateral glacier-torrent

which emerges from the side of the glacier about half a mile higher up presented a serious obstacle. We were in a dangerous spot, and had to ford it at once; we camped on a soft bed of fine shingle beside the main river. The snout of the Chong Kumdan projected far into the river, but owing to a sharp bend in its course we were unable to see whether any part of it reached the farther bank. If any road is made it must follow the left bank of the river, and at this corner must be blasted out of the solid rock.

On August 21 we had a very tiring march up the Shyok. Between 8.30 a.m. and 4 p.m. we covered only about 4 miles, having constantly to climb up and down the cliffs of the right bank, in one place mounting more than 1000 feet, only to be forced back to the river-bed a short way further on. The rocks were of limestone and grey calcite, weathering to a beautiful red, which was very remarkable on the high peaks to the east across the river. The main valley now widens out very markedly and the river flows in several channels over a wide flood-plain. If the river were blocked this flood-plain alone would form a lake from half to a mile broad, and extending to the foot of the Remo glacier. Next day we moved our camp up to the old stage (15,700 feet), known as Yapchan (= a woody plant). Fire-blackened stones and horses' skeletons indicated considerable previous occupation. Just above Yapchan the Shyok makes a sharp turn; flowing east from the Remo glacier it bends suddenly due south. This angle is filled by a rolling, somewhat waterlogged plain, much of which is covered by tufts of grass and small woody plants, providing both fodder and fuel. Large numbers of female antelope (*Pantholops hodgsoni*), attended by a few wolves, pick up a living on these plains, and I shot a couple of the former for our coolies, who were now on rather short commons.

On the evening of August 22 Rasul Gulwan turned up with the caravan, having come round from Sasir in three days, a very remarkable performance. Rasul the Horse Thief belies his name. He has travelled with Littledale, Barrett, Phelps, and Church, and has always been spoken of very highly by his employers.

On August 23 we noticed the first signs of winter, the pools beside the Shyok being frozen at their edges. At 8.45 I rode off with Oliver to look at the Remo glacier. The ground was full of the burrows of a large ochotona which was new to me. It was about the size of a small rabbit, and had a low whistling note, much stronger than the "whisper" of *shippi*. The ordinary white-capped black redstart of Ladak (*Chimarrhornis leucocephala*) is replaced by another very similar bird, but with white patches on its wings (probably *Ruticilla erythrogaster*). Most of the hollows are impassable bogs, due to infiltration from the glaciers to the west. Many are encrusted with an efflorescence of saltpetre. We passed a kidney-shaped lake, about 300 yards long, lying in a rock basin, which was most obviously *not* due to glacial erosion. Beyond it, three hours from camp, we reached a rocky knoll of limestone, and the glorious expanse of the Remo glacier was before us, a sight which Shaw described as being in itself worth a journey from Europe to see.

I have not been able to find any mention of the Remo glacier prior to Johnson's survey season of 1864, nor can I find any definite statement in the G.T.S. Reports as to who sketched its topography. The present condition of the Remo glacier is now identical with that shown in Gordon's picture of it taken in 1873 (*op. cit.*, p. 19). Rasul Gulwan was of opinion that it had advanced somewhat during the ten years which had elapsed since he had last seen it. But such advance must necessarily, owing to the great breadth of the ice-foot, be a very gradual affair. I am rather doubtful whether its delineation on the Survey map (44A south-east) can be accepted as true of the date (about 1864) which it must represent. For if it was correct the Remo glacier and the two large glaciers in the valleys to the north and

south of it must each have advanced 8 miles or more, and united to form a huge expanded ice-foot at least 2 miles wide at their point of junction; all this in the course of one decade at the outside, and during a period not signalized by active advance of the Kumdan and Aktash glaciers. It appears certain that no one has ever crossed the Remo ice-foot. Has any one actually travelled up the northernmost of the Remo valleys which is represented as originating just west of the Karakoram pass, and running west and then south for 30 miles, till it reaches the present site of the Remo ice-foot? If this valley exists as shown, there must be a very big lake in it, for the Remo dams it completely. But judging merely from what I saw later, on my way to the Karakoram pass, I cannot help thinking that a mistake has been made, and that the source of the Shyok is really the Remo glacier, and not a small rivulet visible from near the foot of the Karakoram pass. I suspect that this westward flowing rivulet eventually drains towards Shahidula, and that the northerly Remo glen is closed by a mountain wall about 15 miles from the snout of the glacier.

This huge ice-foot presents a truly magnificent sight. Although four large glaciers unite to form it, only one medial moraine is visible, which is slightly expanded at the snout. The rest of the surface is split up into beautiful cones and spires of ice, brilliantly white, and all of an even height, so that, at a distance, the glacier resembles some great white lake whose storm-tossed waves have suddenly been struck motionless. None of the snow-peaks visible up the different valleys seemed to be of remarkable altitude, though, as our station was very little above the level of the glacier, this is hardly surprising. But it is certain that such great ice-streams must derive their stores of ice from some very lofty group; it does not seem possible that they can be directly derived from Teram Kangri. These glaciers would undoubtedly afford a most interesting and profitable field for exploration, for their aggregate area must rival that of any of the four great primary glaciers of the Karakoram range.

After visiting Dalglish's cairn just across the Karakoram pass, Oliver spent some time in trying to find a way from the Shyok valley, below Kataklik, over on to the Changchenmo. It is a very wild region of snow-clad limestone hills and deep defiles. At our farthest point we came across the remains of an old fireplace. Our Ladakis instantly referred this to Johnson, who is remembered by the natives as the most resolute of all the explorers of this desolate region.

I have to thank General Sir T. E. Gordon for kindly looking over these notes, and for giving me the opportunity of examining the sketches of the Kumdan and Remo glaciers which he made in 1873.

The PRESIDENT (before the paper): Dr. Longstaff is so well known to us all that I really think hardly anything need be said by me on this occasion. He had already done excellent mountaineering work both in the Alps, in the Caucasus, and in the Himalaya, when he made his first expedition to Asia, a political mission in Western Tibet. Perhaps the most noteworthy feat he had yet accomplished was the ascent of Mount Trisul, a mountain over 23,000 feet high. The present expedition, which he is going to describe to us to-night, deals with a little-known part of the Karakoram range. Dr. Longstaff is one of those explorers who always takes great pains before he visits a place to make himself thoroughly acquainted with all that other explorers have done, and he never makes any claim whatever to have done a thing until that claim can be absolutely established.

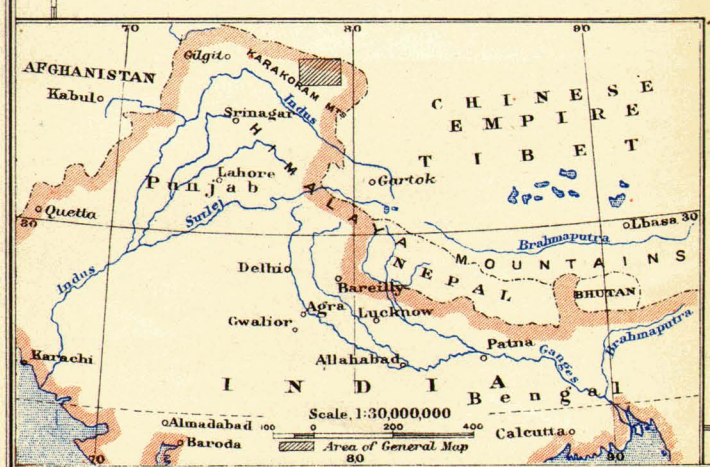
Lieut.-Colonel GODWIN-AUSTEN: I must first congratulate Dr. Longstaff on the excellent piece of exploring work which he did last summer. He has added a very valuable addition to the topography of the Himalayas, especially of that portion of

EXPLORATIONS in the EASTERN KARAKORAM by T. G. LONGSTAFF, M.A., M.D. 1909.

Scale 1:500,000 or 1 Inch=7.89 Stat. Miles.

Reference

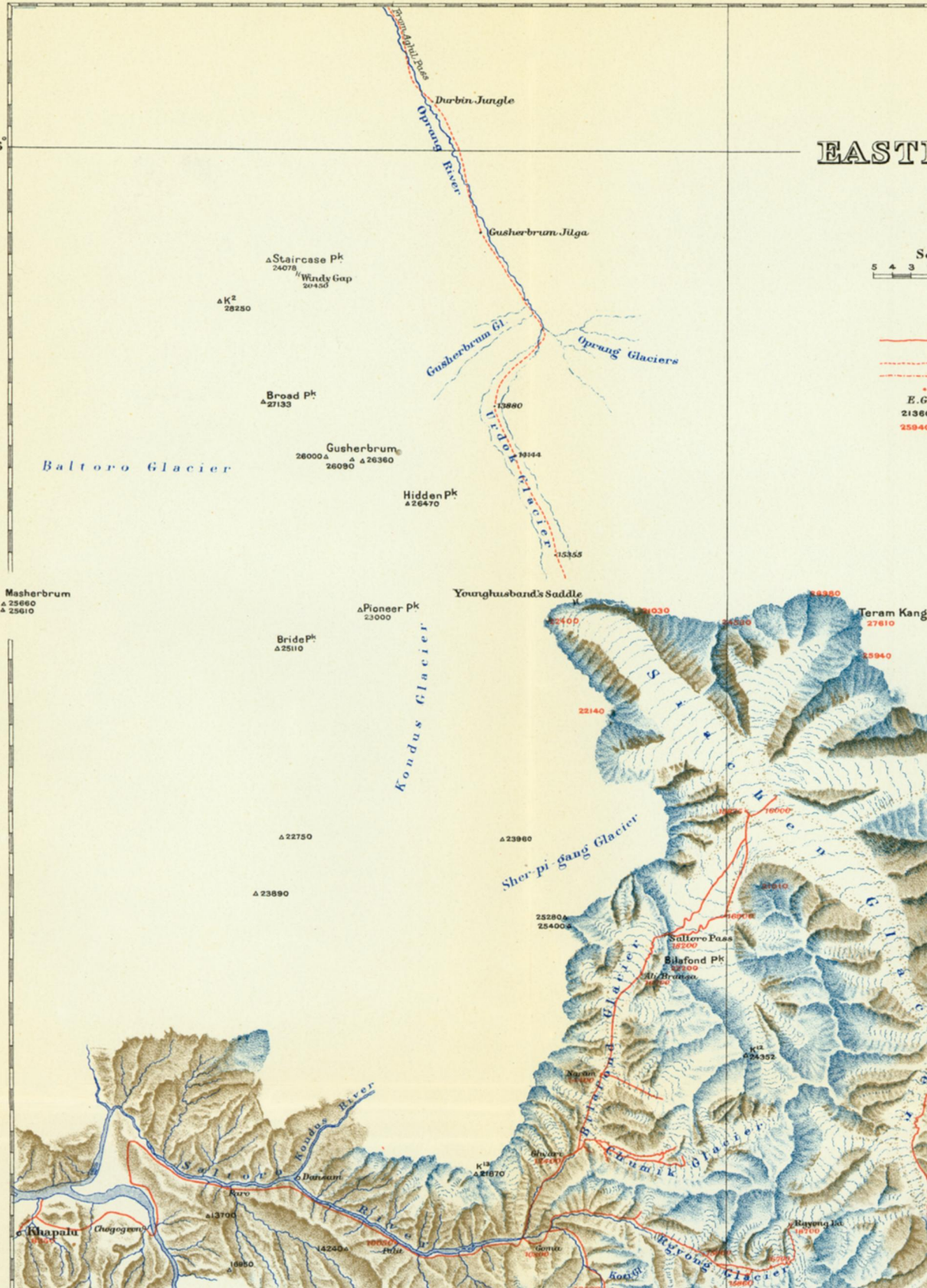
- Routes traversed by Dr. T. G. Longstaff, and in parts by Lt. A. M. Slogby, Dr. A. Neve, and Capt. D. G. Oliver
- - - Routes traversed by Sir F. E. Younghusband K.C.I.E. in 1863
- - - " " " Dr. A. Neve
- Camps
- Encamping grounds
- Heights in feet from Survey of India.
- " " " determined by Dr. T. G. Longstaff from aneroid, barometrical, and hypsometrical observations.

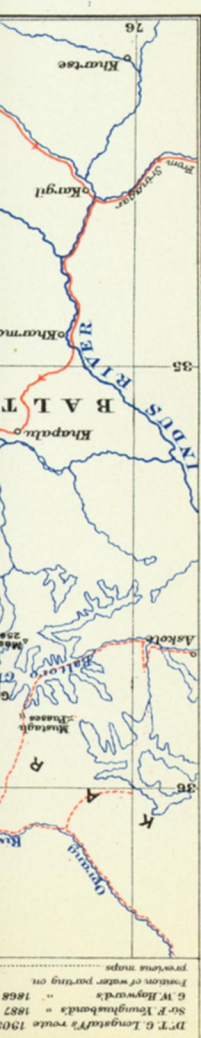


77°

36°

EAST





EXPLORATIONS
 in the
EASTERN KARAKORAM
 by
T. G. LONGSTAFF, M.A., M.D.
 1909.

Scale 1:500,000 or 1 Inch = 7.89 Stat. Miles.
 15 10 5 0 1 2 3 4 5

Reference
 Routes traversed by Dr T. G. Longstaff, and in parts
 by Lt A. M. Stungby, Dr A. Nave, and Capt. D. G. Oliver.
 Route traversed by Sir R. E. K. Youngblood and K. C. I. E. in 1859
 " " " Dr A. Nave.
 Camps
 Encamping grounds
 Heights in feet from Survey of India
 21360 " " " determined by Dr T. G. Longstaff from
 25940 chronometer, barometer, aneroid, and hypsometrical observations.

Dr T. G. Longstaff's route 1901
 Sir R. E. Youngblood's " 1859
 G. W. Hayward's " 1868
 Positions of water parting on
 previous maps

EASTERN KARAKORAM

Longstaff.

THE GEOGRAPHICAL JOURNAL 1910.

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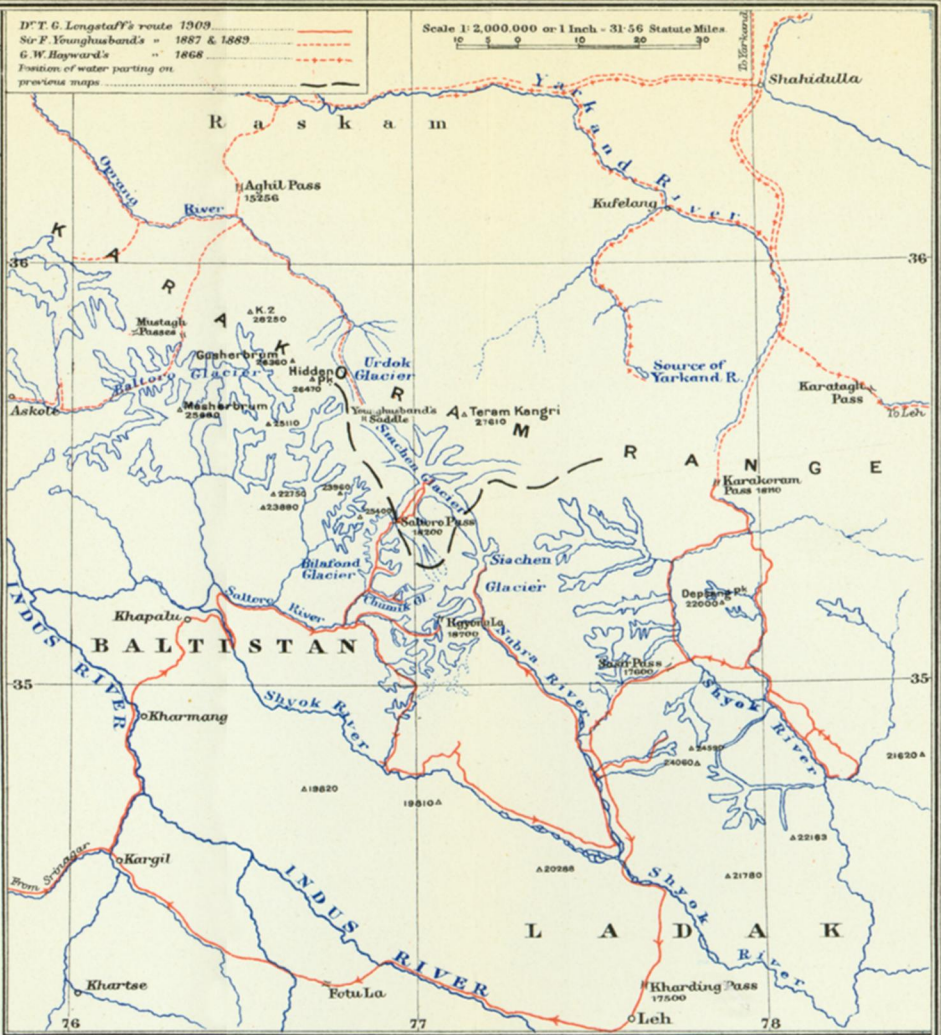
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D.T.C. Longstaff's route 1909
 Sir F. Younghusband's " 1867 & 1889
 G.W. Hayward's " 1868
 Position of water parting on
 previous maps

Scale 1" = 2,000,000 or 1 Inch = 31.56 Statute Miles





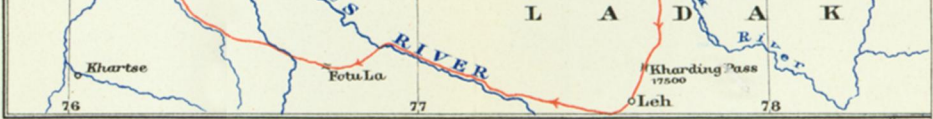
NOTE.

The map is based on the fixed points of the Survey of India. The western and eastern portions of it must be regarded merely as a route-sketch the G.T.S. atlas sheets, from which areas unvisited by me can be filled. Chumik and Rgyari basins are from a plane-table sketch, on the scale of



NOTE.

The map is based on the fixed points of the Survey of India. Much of the southern and eastern portions of it must be regarded merely as a route-sketch based directly upon the G.T.S. atlas sheets, from which areas unvisited by me can be filled in. The Billafond-Chumik and Rgyari basins are from a plane-table sketch, on the scale of 2 miles to 1 inch.



35°

78°

Kashmir territory. A very large portion of the area on the north of that part of the Kashmir was necessarily done in a very superficial way. The trigonometrical stations were very few; the assistants in the survey were expected to bring in very large areas of country mapped during the summer months, and it was impossible to sketch the mountains in anything like accurate detail. In many instances all that could be done was to map in the end of the glaciers; some of the larger ones we were able to go up, but the area brought before you to-night was some way to the east of where I was working myself in 1862. Mr. Ryall did the portion that we have had shown on the screen, and I think that his work was really more difficult than what I had to do. The upper Shayok is a most wonderful mountain system; it is unlike any other portion that I know of in the Himalayas, in the extraordinary structure and altitude of the peaks. I had, from near a peak called Shyok No. 2, which is 21,073 feet, upon the edge of the Changchenmo, a very magnificent view over all the Shyok mountains opposite, and it was one of the most wonderful scenes I think I have ever seen. My work then lay further to the east, so that I was never on the upper Shyok itself. The work that Dr. Longstaff has brought before us has cleared up the true position of that great glacier, the Saichar (Sia-chen), which was first seen by Henry Strachey, the first Englishman who went up into Ladak and began a rough survey of the country. There are many points connected with the lecture this evening, but I think there was one I will touch upon. It appears now, and from what we know of the Saltoro pass, that Vigne made two attempts to cross it; that was in 1835, when Ahmed Shah was the Raja of Skardo. At that time the Saltoro pass was evidently well known, and looking at the map now, and what Dr. Longstaff has done, it appears to me that this pass was in all probability a way by which the people of Baltistan got into Yarkund. They are particularly good mountaineers, and in their own interests they do not mind these glaciers in the least, and from the Shyok valley, where there are very populous villages, it strikes me it was one of the most feasible, probably a more feasible, route than going by Skardo and the Braldo river, and across the Mustagh pass, the route at present used; and looking at the map and the trend of the Saichar glacier, I think it is very probable that it was really at one time in constant use. There are many other points, of course, connected with the glaciers of this region. They are vast, and a great number of them have yet to be explored. I only hope that at some early date a really scientific expedition will go up into that part of the world to examine the glaciers and their action more thoroughly, like Forbes did the Mer de Glace. There is a very vast amount of work to be done in that direction. Some of the country to the north of the Remo glacier, which you saw shown on the screen, is very doubtful topography indeed, Dr. Longstaff in his paper refers to it, and has been unable to find out who did it. My opinion is that it was done by W. H. Johnson, who at the time he went to Ilchi travelled over the great extent of intervening country very rapidly, and brought back very rough plane-table sketches indeed of the country, which were partly utilized in compiling the final maps.

Sir FRANCIS YOUNGHUSBAND: It was a source of peculiar interest to me that on my last summer in Kashmir two such fine expeditions should have come into the country to explore the northern frontier of Kashmir, in which I had myself twenty years ago been exploring. The first of those expeditions was headed by the Duke of the Abruzzi, and the second was one of which we have heard to-night—Dr. Longstaff's. They were each of them good in its own particular way, and typical of the nationalities to which they belonged. The Duke of the Abruzzi's was magnificently organized, it was soundly equipped, and it did its work thoroughly well, and achieved, I think, its main object. Although the Duke did not actually reach the summit of K₂, he, at any rate, attained a greater height than any other human being

has yet reached. The second expedition was what we may call a rough-and-ready pioneer expedition. Dr. Longstaff had with him Dr. Neve, a man thoroughly well known in Kashmir, and one of the most highly respected men in the country. Dr. Longstaff has one qualification to which the President has referred, that is of giving thorough credit to those who have gone before. That is a qualification which is not always met with, and it is most highly appreciated by us unfortunate men who have done our explorations early in life, and have to suffer all the rest of our lives from seeing later explorers criticizing what we ourselves have done under perhaps more trying circumstances. Dr. Longstaff's main object, I understand, was to discover this fabulous Saltoro pass, whose existence had been known for years, but whose exact whereabouts no one had hitherto been able to ascertain. Neither Colonel Godwin Austen, who was exploring in those regions before either Dr. Longstaff or myself were born, nor his collaborators had been able to exactly fix the Saltoro pass. In 1889, when I was sent by the Government of India to explore that northern frontier, and to find any practical routes there might be across it, I was asked, on my way, if I could, to ascertain where this pass was, and to find out if it was at all a practicable route. From the north side I did my best to find where this pass was, and ascended a saddle on the main watershed, but that did not prove to be the actual pass, although at the time I thought it might be. Dr. Longstaff has not only this summer found out the pass and crossed it, but has achieved three other results, of which he made very little himself, but which I think ought to be emphasized because they are of great importance. He has fixed the exact position at that particular part of what is really the greatest watershed in Asia—the watershed which divides the rivers flowing to Central Asia from those which flow down to India. Hitherto it has not been placed accurately on our maps, and it is to Dr. Longstaff's credit that he has now for the first time fixed its true position. That, I think, is one result of great geographical importance. Then, again, on the far side of the Saltoro pass, he found a glacier which he at the time naturally thought must flow north. When crossing a pass like the Saltoro, which has hitherto been supposed to be on the main watershed, and you get on the other side you naturally suppose the glacier there will flow north into Central Asia, but he discovered that it trended south, and came into the Nubra valley, and was, in fact, nothing else but the Siachen glacier. That is a second result of great importance, because it proves that the glacier on the far side of the Saltoro pass and the Siachen glacier are one and the same, and therefore the greatest glacier in Asia. But besides that, on the far side of the glacier, he saw this wonderful mountain of which he modestly puts the height at 27,000 feet. That may prove to be another discovery of the very highest geographical interest, because it is possible that he is erring on the low side; we cannot say for certain that it is merely 27,000 feet, it is quite possible it is 28,000 or 29,000. It had always been expected, as Colonel Burrard said, that there must be a large peak on the far side, and there is no reason why this peak should be not 27,000 feet, but possibly something greater. On all this, we must take into consideration Dr. Longstaff's well-known modesty, and be sure in these matters he has erred on the low side.

There is one final remark I should like to make, and that is regarding a casual observation that he made, that this peak was composed of limestone. We must think to ourselves what that really means. Limestone is a rock which must at one time have been formed beneath the surface of the ocean. You saw that enormous new mountain; you saw those other mountains of scarcely less magnitude, you must recollect that all of them are more than 1000 miles from the sea, and reflect on this, that those great mountains at that immense distance from the sea at one time have lain at the bottom of the ocean. Finally, I should like to congratulate Dr.

Longstaff most sincerely on his magnificent achievement, and to thank him for having caused us in Kashmir so very little trouble and given us such a large amount of pleasure.

Mr. DOUGLAS FRESHFIELD: I have no acquaintance with the region that is the subject of Dr. Longstaff's paper, but as an Himalayan traveller and an old climber I may perhaps venture to comment on some of the points raised by it. In the first place, I would congratulate Dr. Longstaff on his discovery of new peaks of over 27,500 feet, and possibly much more. If the botanist glories in a new lichen, and the entomologist in a new beetle, how much more glorious is it to add to the number of the noblest objects in creation!

No one, I think, who, like myself, has watched and shared in the progress of mountaineering for the last half-century can fail to appreciate the great advance that has been made in extending the limits attainable by human energy and endurance, and, consequently, in exploring the highest regions of the Earth's surface. It is but a few years ago that many persons, otherwise quite rational, thought it ridiculous to pretend that human beings could sleep at 20,000 feet, or climb to 24,000 feet. Now by the feats of Dr. Longstaff, the Duke of the Abruzzi, and their predecessors, Sir M. Conway, the Workmans, the Anglo-Swiss party who camped for seven weeks under K₂, the young Norsemen who climbed Kabru, and others, the "manlevel"—if I may coin a phrase—has been definitely lifted to 25,000 feet. Mountain sickness has been found to be no insuperable obstacle. We know much more about it. It has been ascertained that it is most formidable as a cumulative diminishment of energy, physical and moral, consequent on prolonged stays at high levels, as in sporting language a variety of "slackness." Consequently, the forlorn hopes which will attack the loftiest summits of our globe should, as far as possible, rush their peaks. They should have pioneers to prepare their way to their highest bivouacs. This may seem a contradiction to some of your preconceived ideas; but you will find it prove true—I speak with high medical authority behind me. There is not, in my mind, the smallest doubt that when a reasonably accessible mountain of 28,000 or 29,000 feet can be found in the British dominions, it will be climbed as soon as any one is ready to spend for the purpose a quarter of the money that has been spent on many single expeditions to get near that floating nonentity the North Pole.

Unfortunately, all the highest peaks hitherto discovered have been either excessively arduous, or are in territory barred to British explorers. Their would-be conqueror has either to evade avalanches or to get round Lord Morley, and I know not which is the more awkward obstacle. Till the Chinese Government, which, according to Dr. Stein's account, is sympathetic to research, is ready to grant passports to Tibet we must abandon all hope of Mount Everest.

In physical science Dr. Longstaff has touched on more than one question of interest. His observations tend to support the theory of the conservative, or protective, action of ice, which I ventured to maintain many years ago, in 1888, in our *Journal*. It is held to-day by several most eminent British and Swiss geologists. But it is also contested by Germans, and following the German lead by Americans. For instance, I find in our *Journal* Prof. Hobbs, of Michigan, asserting as axioms views which are, to say the least, no more than doubtful hypotheses—I refer to the supposed excavation of main valleys by glaciers and the production of cirques by snowy *névés* working backwards, to my mind a most fantastic doctrine. But this is not the place to argue on these matters. I desire simply to warn unscientific readers of our *Journal* against being unduly biased by dogmatic and unqualified statements on moot points.

With regard to two other matters, the rate of advance of glacial snouts and the

general periodic oscillations of the glaciers, Dr. Longstaff has some new facts to bring forward which are particularly interesting to me as the English member of the International Society for the Observation of Glacial Movements. He tells us of one glacier which did 6 miles in two months and a half, which, if I have not forgotten my arithmetic, means nearly 6 yards an hour! Mark Twain was, after all, not so very unreasonable when he sat down in the middle of the Gorner glacier in the hope it would take him to Zermatt in time for the *table d'hôte*! Again, Dr. Longstaff notes an apparent correspondence in the period of the greatest oscillations of advance and retreat with that observed in Europe. In the Alps the maxima and minima of the glaciers seem to be roughly 50 years apart. I saw the Bernese and Chamonix glaciers at their maximum in 1855, and in 1905 they were, as we all know, deplorably diminished. It might be interesting, did time allow, to compare in detail the physical aspect—the scenery—of the different parts of the Himalaya that have been lately opened up by travellers, and, in particular, to compare the Karakoram and the mountains of Sikhim. Such a comparison is suggested by Signor Sella's magnificent photographs, and by the fine views we have seen to-night. On the one hand, in the Karakoram, we have absolute solitudes, grim towers, and spires and obelisks of naked granite, leading in gigantic avenues 40 miles long to the hidden storehouses of the snow. The valleys are choked by the greatest glaciers outside the polar regions; the ice is hidden under hideous piles and banks of fallen rubbish; there are no trees, and few high pastures—only interminable desolation, the appalling sublimity of a region where man comes as an intruder into a dead, or unborn, world, where the only voices are the groans and creaks of the crawling ice-streams, or the thunder of the avalanche. In Sikhim, on the other hand, the traveller finds himself in an earthly paradise. Deep-cut valleys, whose sides are clothed in the luxuriance of sub-tropical ferns and forests lead up to the broad pastures of the yak, above which elegant, or majestic, snow-peaks group themselves in ever-varying combinations, while over all towers the great white throne of Kangchenjunga, a vision not to be described except by a Shelley. The landscape combines the sublime and the romantic carried to their highest powers. It is as wonderful as a poet's dream, or a child's first pantomime.

I have tried to distinguish between these two regions because, though they are some 900 miles apart, the public does not always do so—nor, I regret to have to add, does our Press assist it in the endeavour. I saw, as I came up, at a railway bookstall, in the last number of an illustrated newspaper called the *Sphere*, the splendid—and to me familiar—plate here exhibited with the superscription in large letters, "The Virgin White Peak of the Himalaya: the Duke of the Abruzzi's Record Climb." Below were the words "taken by Signor V. Sella of the Duke of the Abruzzi's expedition." It is true "this view represents Jannu in the Nepal Himalaya" was added. But how many readers will understand that this picture has nothing to do with the Duke of the Abruzzi's expedition; that it represents a peak 900 miles from the scene of his exploits, as far as Biarritz is from Vienna, and that it is an enlargement from a plate taken by S. Sella when with me in Sikhim ten years ago, and used as an illustration to my book 'Round Kangchenjunga'?

The PRESIDENT: I am sure that every one here present feels we have heard an account of an excellent bit of exploratory work. It is excellent from every point of view. It has increased our knowledge of a very wild and desolate region about which little was known before: it has, as Sir Francis Younghusband has said, solved a number of very important problems; and the author has dealt with the question of glaciation in a most interesting way. No doubt the most interesting bit of news he has given us is as to the possible existence of a mountain, Teram

Kangri, previously unknown, which may make the proud position of Mount Everest no longer tenable. He has told us in his paper how he manipulated his observations in order to make that mountain appear lower than it would otherwise appear, a proceeding probably unique in mountaineering records. The result is, that Mount Everest still occupies her royal position, though her sovereignty must remain doubtful. If I may say so, Dr. Longstaff has been very wise in the attitude he has adopted. If in the end his first calculations are proved to be accurate, and Teram Kangri is, in fact, the highest mountain in the world, he will still have the satisfaction of having his name associated with its discovery. On the other hand, he will have nothing to retract if his more modest figures are substantiated; whilst, in any case, this journey will always be remembered as a most admirable and conscientious bit of work.

Dr. LONGSTAFF: All the gentlemen who have been so kind as to take part in the discussion have been so complimentary that there is hardly any point which calls for an answer. I should, however, like to protect myself from the incredulity of Mr. Freshfield concerning the glacier reported to have advanced at the alarming rate of several yards an hour. Following the example of Herodotus, I sheltered myself behind my authority. I referred, of course, to the Hassanabad glacier in Hunza, which I have never visited, and was quoting from the 'Records of the Geological Survey of India.'

THE GEOGRAPHICAL FACTORS THAT CONTROL THE DEVELOPMENT OF AUSTRALIA.*

By Prof. J. W. GREGORY, F.R.S.

I. THE MAIN FACTORS.

IN those remote times when the primæval forests that produced our coal were growing on the British area, a wide continent extended across two-thirds of the southern hemisphere. It included the highlands of Brazil on the west, the peninsula of India on the north, and probably most of Australia on the east. That vast continent, Gondwanaland, is now represented by some scattered remnants, most of which have been merged in continents of later growth; thus, its most western fragment is part of America; India has become an Asiatic peninsula; and Africa has grown northward and united with an area that is essentially European. Australia, however, although the Malay archipelago, like giant stepping-stones, links it to Southern Asia, has been left isolated in the far Southern seas.

The first fundamental factor in the geography of Australia is then its isolation. It was the last of the inhabited continents, as far as existing evidence goes, to be reached by man, and the last to be discovered and colonized from Europe. It stands apart, almost as distant as any great land-area can be, from the region that contains the chief centres of modern progress. Nevertheless, in spite of its isolation and recent occupation, Australia has already become the greatest White Man's

* Royal Geographical Society, February 7, 1910. Map, p. 744.