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OCTOBER, 1911.

VOL. XXXVIII.

JOURNEYS IN THE HIMALAYAS AND SOME FACTORS OF HIMALAYAN EROSION.*

By Dr. ARTHUR NEVE.

THE barren regions of little Tibet are a school of mountain anatomy and pathology. One is reminded of those strange anatomical diagrams of humanity erect and gazing, but deprived of its skin, where are depicted the various muscles and structures of the body. After some weeks of travel in Ladak and Baltistan one gets accustomed to the sight of tilted strata of various tints, stripes of pink and brown in wavy lines, with green slate, light pink granites, and grey limestones harmonized by a soft blue atmosphere, but always attracting the eye to study the relations of the freely revealed structure, and to reflect on the processes of erosion still in such activity. It is well that all men do not gaze with doctors' eyes, seeing through all the outer drapery to the shapes of hidden structures; yet who can so truly appreciate the truest balance of pose or the symmetry of the figure as one who is an anatomist? and so it is that the knowledge gained of mountain structure in those soil-less, flayed rock ranges gives fresh life and meaning to the softer curves of wooded slopes, or to the grassy terraces and the green knolls of the outer Himalayas.

The great variety of the scenery from the vast undulating plateau of Western Tibet to the forested ridges of the Pir Panjal does not depend merely upon the present climatic conditions, but upon the different stages of the processes of erosion. Thus, for example, in Ladak we see a country in most of which erosion is at a minimum, although disintegration is active. There are wide valleys of gentle gradient and with comparatively easy slopes above, and with peaks of relatively no great height—that is, as compared with Baltistan or Gilgit. Doubtless aërial erosion does go

* Royal Geographical Society, June 12, 1911. Map, p. 456.

on, but the valleys seem in a balanced state, neither eroding nor depositing. Yet at one time the erosion must have been very great, and for ages there has been a pendulum swing of erosion and deposit, but chiefly the latter.

Very different is the condition of lower Baltistan and Gilgit. A traveller would at first sight notice the general resemblance to Ladak, with its barren hills and picturesque shapes and colours; but he will soon see that the mountain-sides are much steeper, and that the rivers flow deep in gorges cut through great boulder terraces, so that the paths are constantly dropping from the level of terraces hundreds of feet above the main river down to the side streams which have cut their way deeply through each side fan. The age of extensive deposit is here past, and erosion is very active, for the rivers continue to over-deepen their channels. There is indeed but little rain, but the soil is unprotected, and the old deposits have but little cohesion, so that the loose boulders or pebble beds seem constantly in motion. Even in one of the driest months of the year (October) there was scarcely a day in Hunza when loud rattling noises and a cloud of dust rising from the ravines did not indicate portions of the cliff breaking away. So steep and so unstable is the soil that goats or ibex send showers of falling stones. I remember levering a big boulder over the edge of a plateau near Nanga Parbat, down a slope of perhaps 75° , and in doing so started an avalanche of stones and boulders of all sizes, and clouds of dust filled the ravine for five minutes.

Where the natives have of recent years brought abundant water-supply on to such terraces they have often started considerable landslips, for the angle of stability in dry, loose deposits is high, but in wet soil very low. Rough moraine material accumulated under pressure may even show vertical banks of great height if fairly dry, but if water percolates to any extent they will subside; and so it is that in Astor and Gilgit mud avalanches, such as Sir Martin Conway has so vividly described, are of frequent occurrence in early summer when the snows are melting. I quite agree with him as to the prominent share to be allotted to such landslips and mud avalanches in that region, for I have personally witnessed several such. My object is to speak of the processes which have so conspicuously forced themselves upon my notice.

When camped near Nanga Parbat many years ago, I photographed a bold cliff in the foreground jutting out against the glorious background of the glaciated cirque above Tarshing. Some years later I camped at the same spot, but the cliff had lost its bold outline, although there were still some projecting rocks at half the original height, which I sketched one morning; but later the same day a landslip took place, owing to percolation, and the *débris* piled up 200 feet below over an area of 2 or 3 acres, and the conspicuous rocks sketched in the morning had gone.

I saw a village partly buried under a mud-slide in the Astor valley ; a terrace with apricot orchards and cornfields became covered in the course of a few hours with 2 or 3 feet or more of liquid mud, which flowed down carrying with it boulders of all sizes up to irregular cubes of 6 or 8 feet in diameter.

The great rivers of that district are almost overhung by ancient riverine or glacial deposits, which remain at a steep angle up to 2000 or 3000 feet above the bottom of the ravine. It is not unusual for landslips of large extent to occur. One has been in process for many years at Doyen on the Gilgit road. The slope is not more than 40°, but the whole hillside for some 2000 feet is cracked and crinkled, and is very gradually settling down towards the river ; but possibly the attention now paid to the drainage, owing to the Gilgit road crossing the upper part, may gradually arrest or delay its further subsidence.

Another vast slip, one of the biggest on record, took place in that region some sixty-nine years ago, and blocked the Indus river below Bunji, submerging the valleys according to one account for a distance of 36 miles. There is a curious conflict of evidence on some points with regard to the flood which followed, and which Cunningham attributed to the Shyok glaciers ; but I follow Drew, who had examined the site of the landslide near Gor, below Bunji, and also Major Beecher, who was on political duty in Kashmir in 1857.

It must have been of some such region that Shelley wrote—

“Lo, where the pass expands its stony jaws
The abrupt mountain breaks,
And seems with its accumulated crags
To overhang the world.”

There is, then, no difficulty in accounting for the vast accumulation of mountain ruin which fills some of the wider valleys to a depth estimated at possibly 4000 feet (Sir Martin Conway, *re* Bunji plain) even under present conditions, but, as I shall show later, these processes must have been at times immensely greater.

As I have said above, Ladak may seem to be in an almost balanced state as regards valley erosion ; and so too is the Kashmir province, between the Central Himalayas and the Pir Panjal range. The forested and grassy slopes are not usually very steep, and the hillsides seem to be at an angle of relative stability ; where of solid rock they may be precipitous, but where of softer material, or of *débris*, or of clay, they have long consolidated at an easy slope. The great alluvial plateaus or karewas are only 5° to 7° above the horizontal. The agencies now at work are as insufficient to account for the vast riverine and lacustrine deposits as for the great erosion of the past.

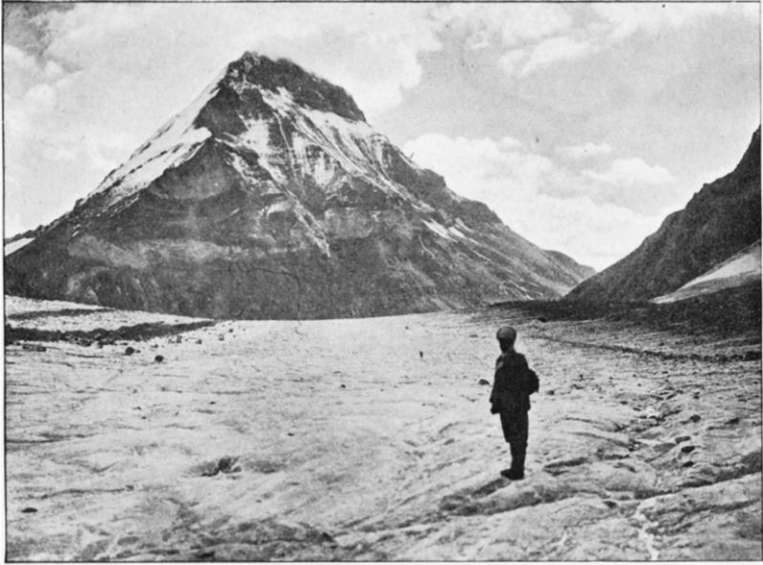
But on the south side of the same range, the Pir Panjal and Dauladhar mountains, there is a different condition ; the valleys are overdeepened, and the hillsides are exceedingly steep. These hills are scarred with

recent landslips, and although protected with rich vegetation and forests, these cannot hold the soil on the rocks where they dip at a steep angle; *e.g.* at Chakoti (on the Murree-Kashmir road), a hillside miles in area has been in movement for years, and the roadway and bridges for half a mile have needed yearly renewal at great expense. The rainfall is always rather heavy, over 70 inches a year; but if any large portion of this, say 10 inches, falls in a week the destructive effect on the hillside is tremendous: roads disappear, bridges are carried away, sometimes with the banks on which the abutments rested, and the reddish-chocolate floods grumble like distant cannonading with the big boulders being swept down the rocky bed.

The traveller who only sees Nature in her mild moods is apt to underestimate the awful forces at her disposal. This year (March, 1911) I was in Chamba during an unusually heavy rain of five days. On the first day the old landslips, saturated with water, began to move; and on the main road near the capital we had to rush across the boulders and muddy *débris* between the showers of boulders falling from a height of 900 feet. Five days later the road was blocked in fifty places in 15 miles by liquid mud and huge boulders, and in some places the path had subsided down the cliff. The flume for the electric power had also been carried away.

The effect of excessive rain is familiar enough, but I desire to emphasize that the word "excessive" is a relative term; that if 75 inches fell in Kashmir as well as on the outer ranges, the processes of denudation and erosion would spring into intense activity, landslips and floods would be the order of the day. But it would not in itself constitute an extraordinary amount. We know of many places in Assam and the western Ghats where 200 inches is annually registered; and according to Huntington in his 'Pulse of Asia,' the rainfall in Central Asia has varied to a great extent in past ages, not beyond the scope of history. According to him, there was one such wet and cold epoch about the beginning of the Christian era, and at least one other since. Without committing myself as regards the application of this theory, or perhaps I should call it scientific deduction, as applied to Kashmir history, yet there seems to be cumulative and converging evidence as regards both Western and Central Asia.* Perhaps Dr. Stein will tell us how far his explorations and historical researches corroborate the view as regards either Kashmir or Kashgaria. If correct, then such wet periods must have been times of phenomenal erosion in the regions I have been speaking of. For Gilgit and Astor now have but 8 or 10 inches of rain a year. If this were increased to 30 or 40 inches, the loose bouldery plateaux and very steep talus slopes would all be on the move. A dry talus slope may be fairly settled at 40°, but a wet one will spread out at its base to 15° or less, and where the toe is washed away by mountain torrents and rivers

* I doubt if there has been any considerable variation during the historical period



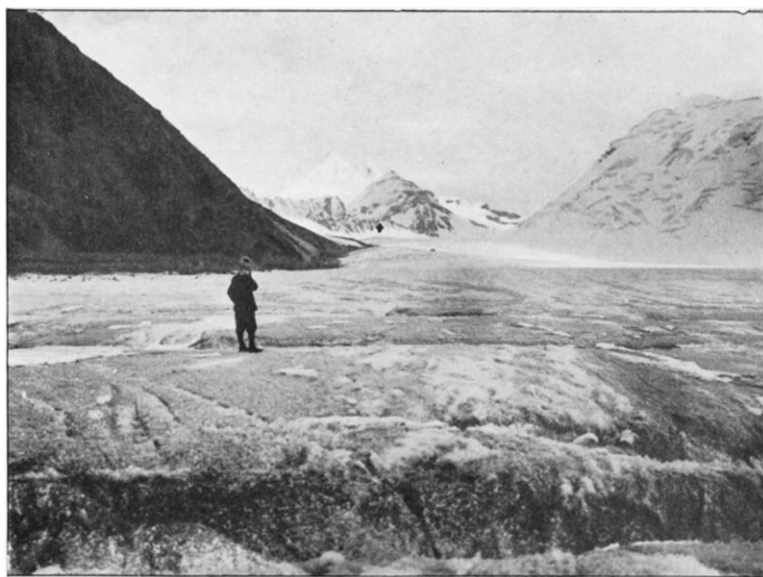
ON THE BARMAL GLACIER, LOOKING EAST AT NO. 10.



THE BHOT KOL PASS FROM THE BARMAL GLACIER, LOOKING NORTH-EAST.



THE ICE-FALL OF THE BARMAL GLACIER, FROM CORNER OF NO. 10,
LOOKING SOUTH-WEST.



FROM ABOVE ICE-FALL, LOOKING EAST. THE BARMAL PEAK D 41 IS CENTRAL;
6 MILES OFF, MOUNT NUN IS SEEN BEHIND.

then no stability can be attained; the slip remains in constant activity, as I have observed on a small scale in the Murree hills. Active engineering and revetment walls may check it, and this is one reason why in Switzerland the slips are held in some degree of control.

Let us apply the same suggestion to Ladak, where at present the annual rainfall (at Leh) is only 4 inches. Were this to be increased to 25 inches, the erosion of the hills and shallow valleys would be enormous. The rocks disintegrate under a scorching sun by day and sharp frosts by night into a loose congeries of fragments set in sand, with scarcely any binding material. One August I saw light rain at intervals for three days, which did much damage to the terraced fields, and also to the buildings old and new, which are constructed chiefly of rubble masonry and sun-dried bricks. With such construction it is not surprising that uninhabited buildings, such as monasteries, fall into ruinous decay within a century. It is difficult to find reliable data as to the age of the chief old buildings. The castle at Khalatse, on the black rock, is certainly getting on for a thousand years old, according to Rev. H. Francke, the chief authority on Western Tibetan history and archæology. These materials do not enable one to check Mr. Huntington's views; though one would think that during a cold wet period the Ladakis would have adopted a more secure and durable style of building, and that some specimens of it might have been adduced. But I ought to acknowledge that there was in olden days a more extended use of wood, and that portions of the old monasteries may be of really great age. Having considered briefly the question of climate pulsation as regards Himalayan erosion, I venture to mention two other factors, both somewhat rare, but of both I have seen very notable effects in my short span of experience. The first is that of water dammed up by landslips or by glaciers, and then breaking away in cataclysms.

One example occurred in the Suru valley, above Sankho, in 1896; and it has never to my knowledge been published. I saw its effects 40 miles lower down the valley a few days afterwards; and a few years afterwards visited the actual site. The glacier which caused it is in a hanging valley 3000 feet above the Suru valley. Its drainage became blocked, and then it burst, bringing down a vast quantity of rocks and mud which spread out over a square mile of land below and completely obstructed the whole Suru river for about two days; it then burst the barrier and swept down the valley, devastating the lower-lying terraces and fields of Sankho, Kartse, and other villages for 40 miles down. Similarly, floods have from time to time swept down from the upper Shyok, where the Kichik Kumdan glacier has occasionally blocked the whole river, as described by Cunningham, and examined recently by Captain D. G. Oliver, and others.

I have endeavoured to trace the history of the floods of 1841 and 1843 as low down as Khapalu, and Kiris; and I doubt whether the magnitude or destruction of those floods was at all as great as Cunningham

seems to imply. At any rate, the "oldest inhabitants" of one or two villages in the narrow gorge of the Shyok before its junction with the Indus seemed to have no tradition of any loss in their lowlying villages. But the evidence is ample as regards the upper Shyok valley as far down as Puiyan (or Chorbat). Another glacier which gets blocked and from time to time causes floods is the Shimshal in upper Hunza; the Gilgit engineers watch it closely, as the important bridges have been once and again carried away; but the village terraces are high above the river and suffer no loss. On the other hand, we have to consider the extraordinary effect upon the loose rubble cliffs and sandy banks of such a mass of water sweeping by, at a height of perhaps 40 or 50 feet above the ordinary summer level, carrying on its foaming crest the floating *débris* of tamarisk scrub, and hurling huge rocks along its bed as if it were a bowling alley.

Another glacier about which I obtained special reports and photographs was that at Tarshing, below Nanga Parbat. It has always in the memory of man crossed over the Rupal valley and rests against the opposite cliffs, while the big river which drains that extensive valley where there are three other large glaciers has to escape by means of a tunnel half a mile long and 300 feet below the present surface of the glacier. I examined it in 1886 and again in 1907. Drew describes how a flood once occurred in the forties. The same thing happened two years ago, and considerable damage was done for 60 miles down the Astor valley, not only to bridges, but also to lowlying terraces, while landslips also followed. Apparently the tunnel became blocked during the winter; then the dammed-up water formed a lake, which finally burst out partly over the top and reopened the tunnel. When seen late that summer by a friend, who photographed it and reported to me, the glacier was higher than ever, and had advanced slightly towards the direction of its outlet.

The last of these irregular factors in erosion which I must now mention are earthquakes.

After the great Kashmir earthquake of 1885, small hill torrents, usually fairly clear, became for some weeks thickly laden with silt and stones. The soil of the hillsides and upper plateau had been split and cracked, in places like crevasses, and many landslips big and small had happened, so that drainage was diverted or blocked, and the streams burst out later with tenfold force, carrying with them the loosened *débris*; and later on one saw how the streams had altered their courses, and how they had deposited new banks of mud and boulders, like tiny lateral moraines. A point I wish to clearly state is, that whatever may be the ordinary action of aerial, aqueous, or glacial denudation, these exceptional forces of earthquake, of landslips, of glacial cataclysm, and torrential rains have, in my personal observation, wrought far more remarkable changes.

Every year supplies its quota of earthquakes. Glacial changes, and in some places like Hunza-Nagyr, glacial advances, have been extraordinary. Cloud-bursts and floods from rains occur from time to time; so that if we speak of the general uniformity of Nature we must do so in a wide sense, remembering the wide epochs, it may be, of thousands of years, which represent but as it were one or two footsteps in the progress of Nature, which is the self-revelation of Him with whom a thousand years is as one day.

My object in my first Karakoram trip (1896) was to examine the "massif" of the Saser peaks, and ascertain the possibility of a high ascent on one of them. Only a brief account of this can be given; at Panamik a large glacial river not marked in the map claimed our attention. It is a series of cataracts for the lower 3000 feet, and the steep path of very loose sliding talus ascended the spur on one side and skirted the top of the cliff. About 4 miles on we came to a hanging valley, with goat tracks, and grazing ground; and gradually ascended the easy slope to the little lakes, beyond which glaciers were seen. This valley was previously unexplored, and indeed the survey-map marked a mountain ridge on the spot. We pitched our camp by the lake at approximately 17,000 feet for thirty-six hours, acclimatizing ourselves, though none of us suffered. I carried out certain physiological observations, on the circulation and respiration under conditions of rest, and also of violent exertion, such as running 100 yards, and running uphill for 100 feet. The account of this expedition may be found in my book "Picturesque Kashmir," now out of print, and only available in libraries.

The general size and position of this glacial valley are shown in the map published by Dr. Longstaff, for which I supplied some material. Our highest point, 21,000 feet, which we called Panamik peak, was cut off from the Saser peaks, 25,170 and 24,590 feet, by the upper glaciers of the Chamshing, which bend round and form a very large remarkable snow basin to the south-west of those three great giants. Two years ago, at my suggestion, Dr. Longstaff examined the upper Popache valley, but bad weather prevented him accomplishing anything new in the few days at his disposal. The upper Chamshing valley requires surveying, as it is practically unknown save for what we saw of it.

From Panamik peak there was a splendid prospect to the north, and the view we got of the glacier marked Murgisthang in the map, induced me to visit that in 1908, after an abortive attempt to penetrate the Siachen, which proved to be unget-at-able during the summer months on account of the broad swift waters of the Nubra river which sweep from side to side of the valley north of Gonpo, with vast precipices overhanging its banks on either side. Captain Oliver (Joint-Commissioner of Ladak) and I had intended, in 1908, ascending the Siachen, making a pass, and trying to get round to the Saltoro. The rivers stopped us, and showed that the Saltoro route would be the better, which Dr.

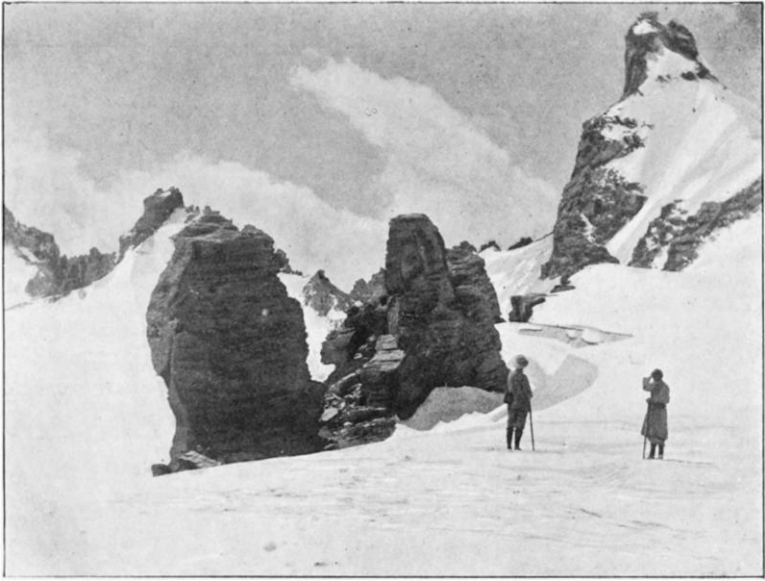
Longstaff, Lieut. Slingsby, and I proved to be the case the following year. When blocked by the river, Captain Oliver and I decided to investigate the so-called Murgisthang glacier, as it seemed a possible route to the main ridge of the Karakoram.

As far as Tutialik (15,000 feet) we were on the ordinary Saser route to Yarkand. There we turned off; and made a four days' exploration of the big glacier, which our local Nubra porters called Monzthang. Of this I sent a detailed report to the Geological Survey of India, which is taking up the subject of glaciers, and I need not repeat it here.

We camped on the second day at 17,700 feet at a rocky corner where three great snowfields meet. One from the north-east originates in a basin 1 mile in diameter immediately south-west of the towering pale-pink granite cliffs of K 32. This most precipitous peak rises to 24,690 feet, and stands out 4000 feet above the jagged ridges on either side.

The glacier from the west is much more extensive than appears in the map, probably 4 or 5 miles more to the north-west, and starts from an unmarked snow-dome about 23,000 feet high, in a line with the crest of K 32, and with a general north-west strike, about 3 miles to the west of it. We ascended the middle glacier, which comes from the north, from the ridge uniting these two peaks, and, after a steep icy ascent, we gained a ridge at the height (hypsoneter and aneroid) of 20,100 feet. The view to the north and west showed many lofty peaks of 23,000 or more, most of them still untriangulated. One peak I feel able to identify, with some degree of assurance, as being Teram Kangri. But what our view chiefly established was that the large glacial basins near us to the north belonged to the upper Shyok system, probably to the Remo glacier, which must therefore be of great size, over 20 miles in length. There remains an extensive glaciated region to be mapped in detail at the sources of the Shyok; in which some surprises may await future explorers. There are some features on the map which excite mistrust, including the alignment of the water-parting west of the Karakoram pass. And I would mention that there are certainly some very high peaks east of Teram Kangri in the same range.

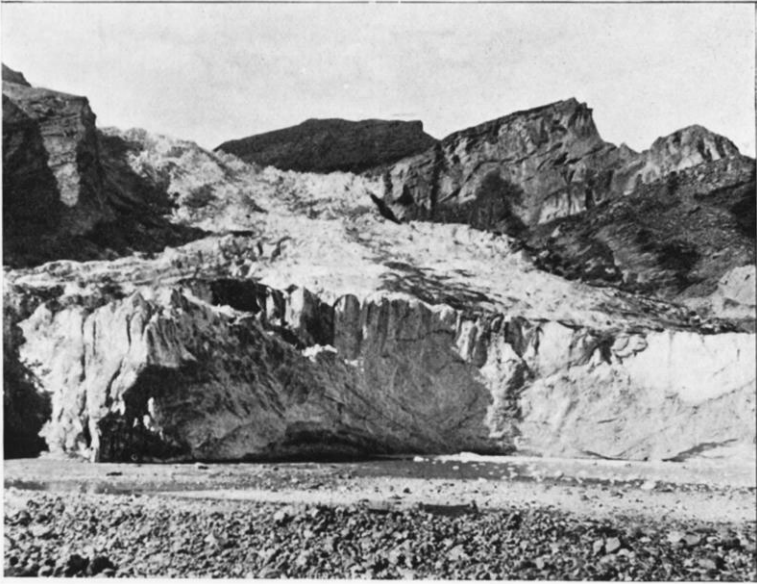
Before quitting the subject of Karakoram exploration, let me point out that the Baltoro glacier with the series of well-equipped mountain parties, attaining their climax in H.R.H. the Duke of the Abruzzi's successful ascent to the record height, has received somewhat more than its share of attention. The great glaciers of the Hushé and the Konduz are scarcely known even to sportsmen. Is there no pass at the head of the Sher-pi-gan to the north? Is the water parting even approximately mapped? Then for an expedition with say a fortnight's supplies on the north side of the Saltoro pass, how much country remains to conquer, and as far as we could see the upper Siachen glacier basin would in good weather present no special difficulties, and a way should be found to the Oprang valley.



NORTH OF THE SENTIK PASS, LOOKING SOUTH.



NUN AND D 41 (ON THE RIGHT) FROM NEAR THE SENTIK PASS, LOOKING EAST.



ICE-CLIFFS OF THE NORTH GLACIER, NUN KUN, WASHED BY THE SURU RIVER.



KUN AND PINNACLE PEAK FROM CHILONG, WEST OF SURU,

But I must pass from this subject to speak of some points in connection with the geography of Nun Kun in the Central Himalayas. In the autumn of 1910, accompanied by the Lord Bishop of Lahore, and the Rev. M. E. Wigram, I paid my third visit to the Nun Kun group, with the view of settling finally the doubts thrown by Dr. Hunter Workman (p. 148, *op. cit.*) upon my description of the Barmal glacier as first published in the *Alpine Journal*, 1902, and also given in my Guide-book to Kashmir and Ladak. He denied categorically that the Barmal glacier drains almost due west into the Bhot Kol and Upper Wardwan valley, stating that he has traversed the Bhot Kol glacier from beginning to end; and the map he publishes of the Nun Kun group shows some startling features, and changes from the survey map.

There were three chief errors in the survey map which I corrected in my map published in *Alpine Journal* which is substantially correct. One is that a glacier of considerable size is depicted on the east flank of No. 10 draining north-east, in the position where there is in reality a low ridge connecting that mountain with D 42. The second is that a single range is shown proceeding west from Nun peak, whereas there are two, the southern being a ridge connecting Mount Nieve Penitente with the hills on the left bank of the Wardwan. One conspicuous point is about 4 miles west of Nieve Penitente, and might be called South Barmal peak, approximately 18,000 feet high; another is what I call Knuckle peak, at the great bend of the glacier, south-west of No. 10. The third error in the survey map is that No. 10 is made to connect with Knuckle peak by a low ridge.

Dr. Hunter Workman has fallen into the same mistake, and supports it by a photo on page 148 of his book, where the subscribed legend is that the range seen above the ice-fall is erased by Dr. Neve. (The photo happens to be an old one, taken many years before by Dr. Workman on his first Ladak trip, before the existence of the Barmal glacier was suspected.)

The ridge there seen is on the south side of the glacier, and connects South Barmal peak with Knuckle peak; and by a strange irony it is this very ridge at its south-west extremity which would need erasing to substantiate Dr. H. Workman's map, in which the Barmal glacier is shown draining south-west into the Zag Nai valley. Having myself traversed that valley in 1902, I knew that could not be the case, and before the publication of the beautifully illustrated book on Nun Kun by Dr. H. and Mrs. Bullock Workman, I assured him of that fact, and told him of Major the Hon. C. G. Bruce's account in the *Alpine Journal*. The most inexplicable feature in Dr. Workman's map is the displacement of such trigonometrically determined points as No. 10, and D 42 by some miles. The photos I now show trace the glacier upwards. One, taken 3 miles from the present snout, looking due east, shows the splendid pyramid of No. 10, with the dip to the Bhot Kol pass on its left, and the ice-filled valley on its right.

The next taken $1\frac{1}{2}$ miles further up, and looking north-east, shows the southern slopes of that pass, devoid of any ice, with merely some insignificant beds of *nevê*. This demonstrates the fallacy of the name *Bhot Kol* glacier. The survey map is again in error on this point, and Dr. Hunter Workman repeats it, showing a glacier coming off the pass. There is a large glacier on the north side, but none on the south.

The next photo taken from near the same point, but looking south-east, shows the great icefall, but also the gap between the south arrête of No. 10, and the snowy ridge which I call South Barmal peak.

To obtain the next photos Rev. M. E. Wigram and I climbed the icefall. He had been up it before in 1908 alone from the south arrête of No. 10. I took this photo looking south-west across the upper icefall, with Knuckle peak in front (compare the photo on p. 144 of *Nun Kun* by Dr. H. Workman).

The width of the glacier at this point, north-east to south-west, is not less than 2000 yards, with ill-defined ice and snow slopes on the south, but no bifurcation. Rounding the first spur, we took our next photo due east to the great peak of Nun, which did not clear properly; in fact, a snowstorm set in and hindered our operations somewhat. We roughly measured a base, and took the bearings with a prismatic compass on a stand to the points previously familiar to me, D 42, D 41, Mount Niève Penitente and South Barmal peak. From our second glacier station 500 yards south the peak Kun came very clearly in sight, and the very wide almost level glacial basin facilitated the work. The Sentik pass was plainly in sight about 5 miles east. We decided to take our Kashmir porters to Sur, and obtain local men, with whom two days later we established a high base camp on the north side of the Sentik, in a charming sub-glacial grassy hollow where fuel can be obtained. The day following we reached the Sentik pass in three hours, and placed our Whymper tent at the extreme upper basin of the Barmal glacier at a height of approximately 17,000 feet. The heavy snowstorms three or four days previous increased the labour, and marked the onset of autumn. Even with a hot sun there was not a drop of water on the glacier, and we had to carry all we needed for miles, and sent down all our porters to take refuge under the rocks on the Sentik.

Next day we started at dawn and ascended D 41, following my previous route. We were roped and wore crampons, which almost entirely obviated the necessity for step-cutting. It was a brilliant day, and the sun soon softened the surface and we broke through the thin crust in a fatiguing way. Ahmdu, the Kashmir porter, bore his full share of this labour. At 10.30 a.m. we crowned the last steep cone to the little cairn built by the Workmans' guides, and faced a cloudless panorama of surpassing extent and clearness; from our height of 20,570 feet we over-looked everything except Nun Kun. Distance seemed annihilated, peaks in Hunza Nagy, 150 miles north-west, were absolutely clearly detailed.

All the great peaks of the Karakorams, some twenty-five summits over 24,000 feet, stretched along the northern horizon, subtending an angle of 45° . All from K^2 to K^{12} , with No. 32, and others of the Nubra-Saser range. Through the intervals I saw some of the more distant northern range in which stands Mount Teram Kangri. There appeared to be one very lofty peak in the same range a few miles east of Teram Kangri, which the survey officers should look for this year, when they are trying to fix the position and obtain the actual height of Teram Kangri.

We spent half an hour on top taking observations, and then descended rapidly, rejoined our porters, and at dusk camped over 9000 feet lower in the village of Tongul, near the gorge where the whole Suru river flows for 100 yards in a narrow tunnelled gorge, roofed in by boulders and debris, doubtless deposited when the Tongul glacier blocked the valley in past ages. At two points of our route near Suru I obtained careful clinometer observations of Nun Kun and the adjacent Pinnacle peak, which Mrs. Bullock Workman climbed, and for which it was claimed that it was higher than Kun, which is 23,264 feet (Survey). Each observation I repeated three times.

The results (checked by the Survey Department) are as follows:—

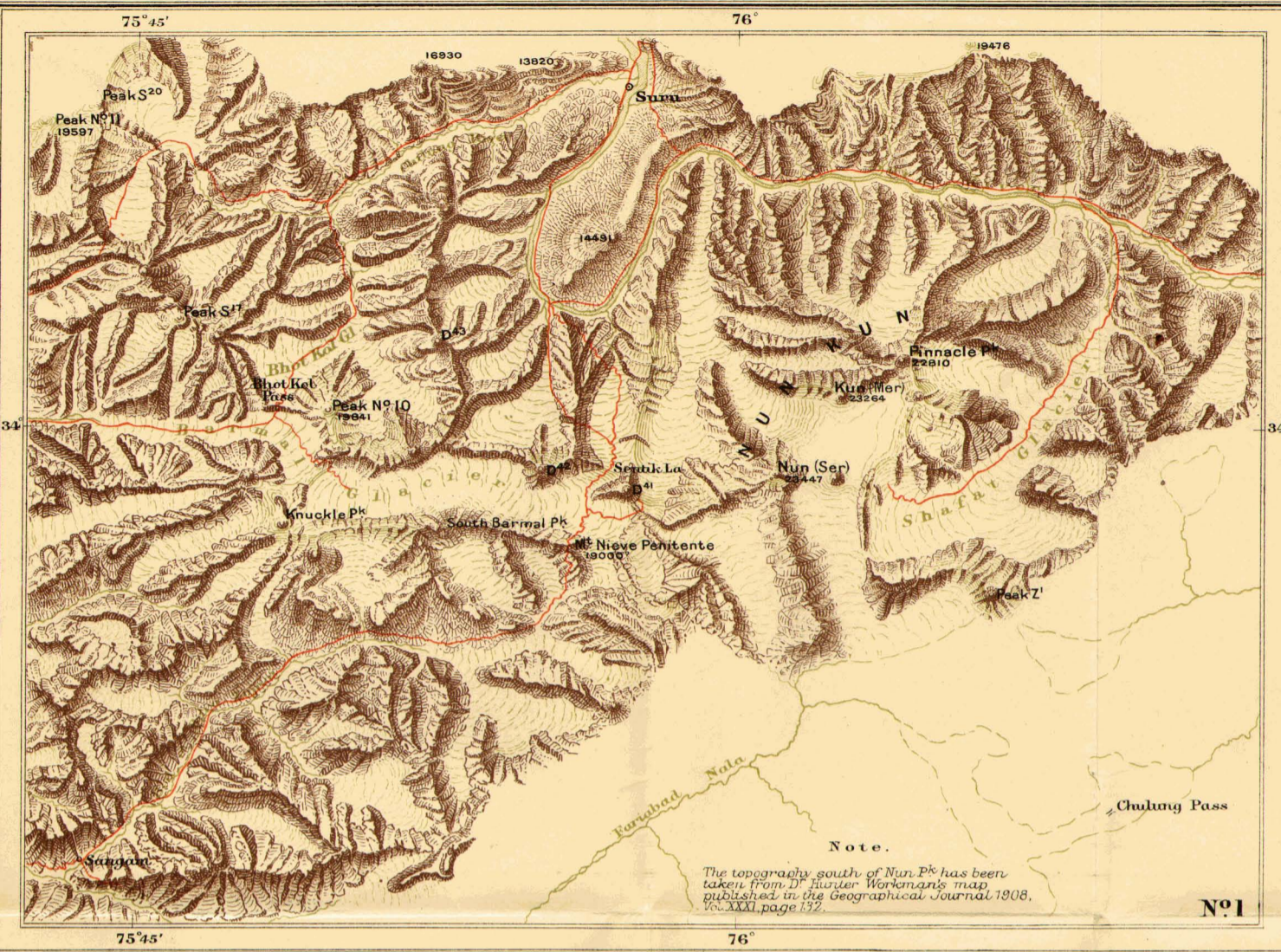
(1) From observations at Suru bridge Kun is 419 feet higher than Pinnacle peak, or, after applying refraction and curvature correction, 415 feet higher.

(2) From observations at Chilung, Kun is 559 feet higher than Pinnacle peak, or, after refraction and curvature corrections, 551 feet higher.

The height for Kun (*i.e.* syn. Mer) was obtained as 23,276 feet and 23,253 feet by two deductions, the mean was 23,264 feet, but the height adopted in the Synoptical Volume VII. is 23,250 feet.

The survey height for Pinnacle peak is 22,810 feet, this is probably more reliable than my observations, which make it 22,767 feet, agreeing with the survey within 43 feet. In any case the re-survey now in process will finally settle any remaining doubt.

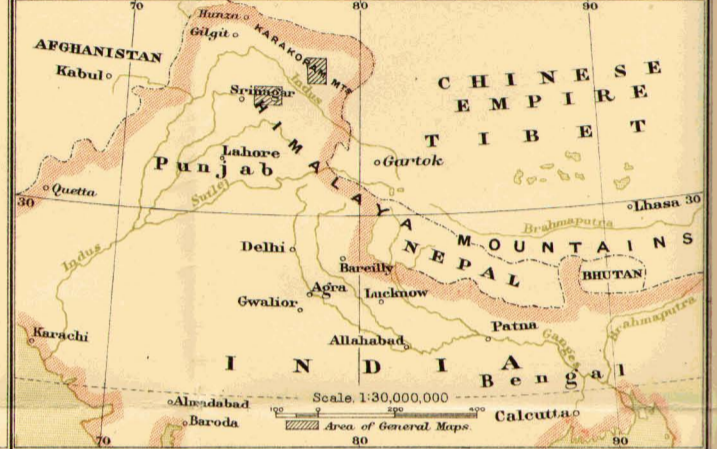
The PRESIDENT (before the paper) : The reader of our paper this evening bears a name, no doubt, very familiar to many of you here present, who are acquainted with geographical work in Kashmir, but a name still more familiar and even more honoured in Kashmir itself. I do not suppose there is any Englishman who is better known in Kashmir, who has rendered greater services to all classes of people in that country for the space of thirty years, than Dr. Arthur Neve. Going out there as a medical missionary in connection with the Church Missionary Society, he has devoted himself assiduously throughout that period to the welfare of the people, and it is one of my happiest reminiscences that, a special decoration having been founded by the late Queen Victoria, when I was in India, for the reward of unostentatious but beneficent service of any character in the public interest, one of the first recipients of that

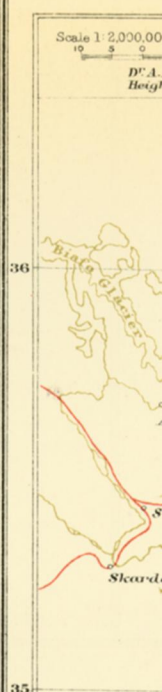
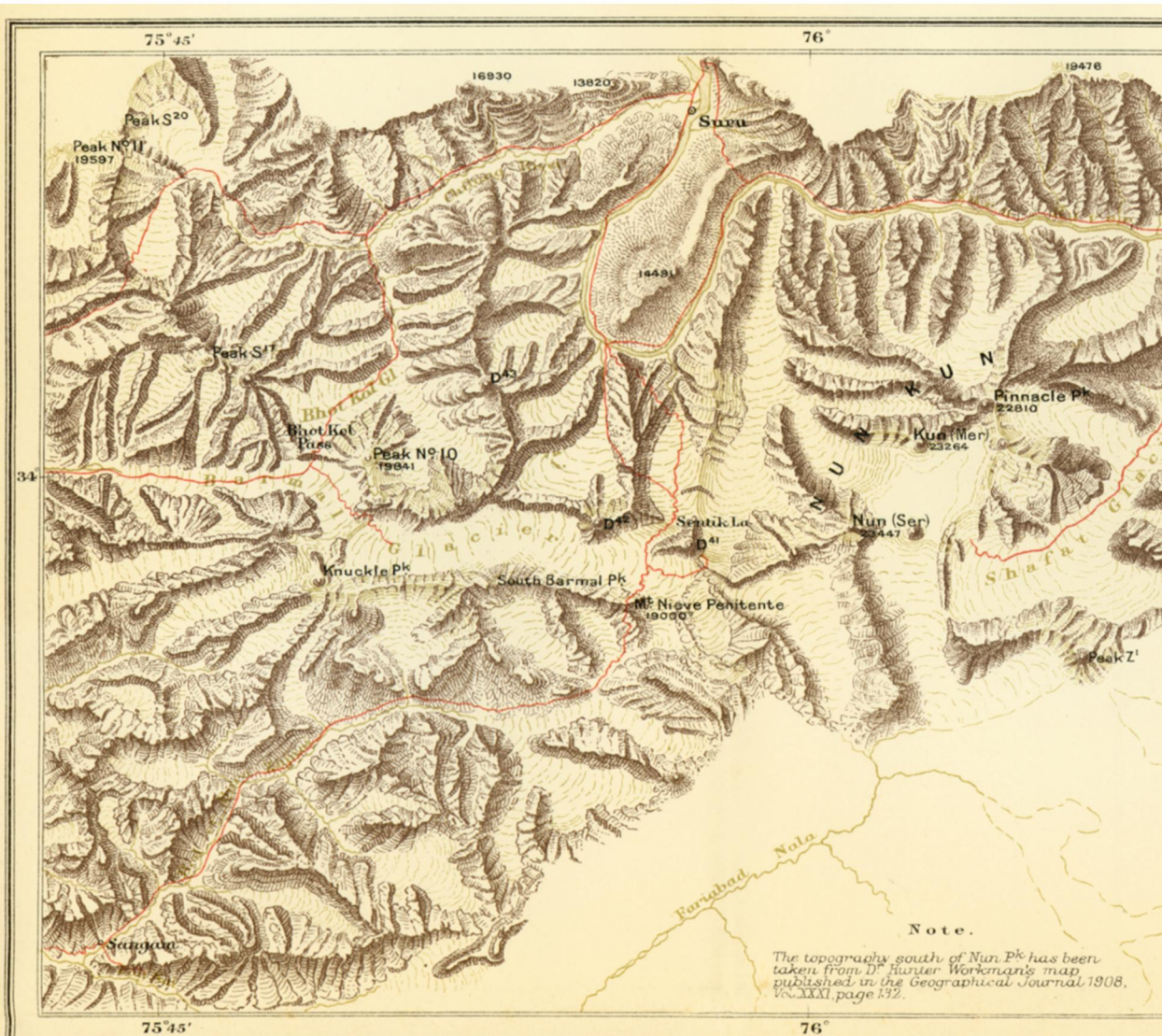


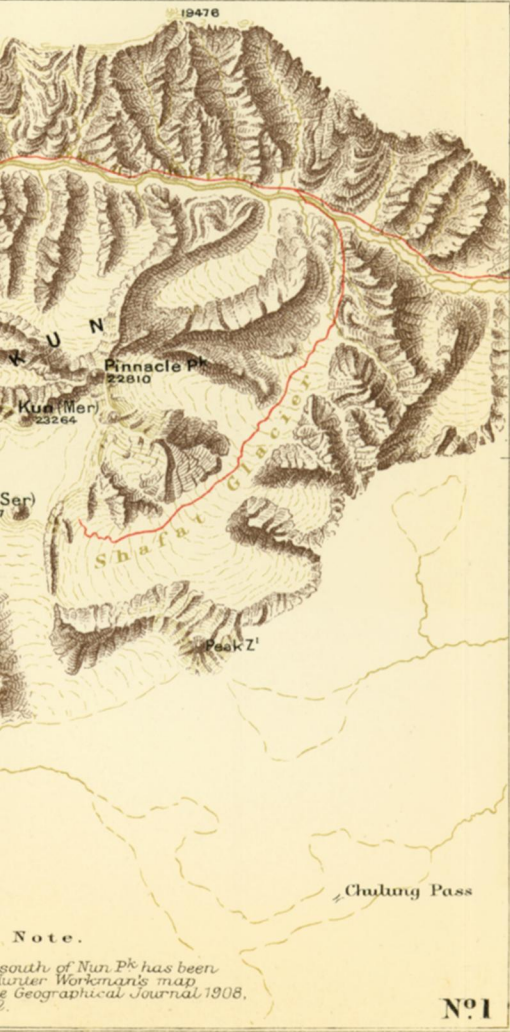
KASHMIR
 Sketch Maps
 to illustrate the explorations of
 DR. A. NEVE
 in the
HIMALAYAS
 1896 - 1910.

Scale, 1:250,000 or 1 Inch = 3.94 Statute Miles.

Heights in feet
 Route



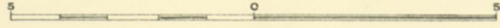




KASHMIR

Sketch Maps
to illustrate the explorations of
DR. A. NEVE
in the
HIMALAYAS
1896-1910.

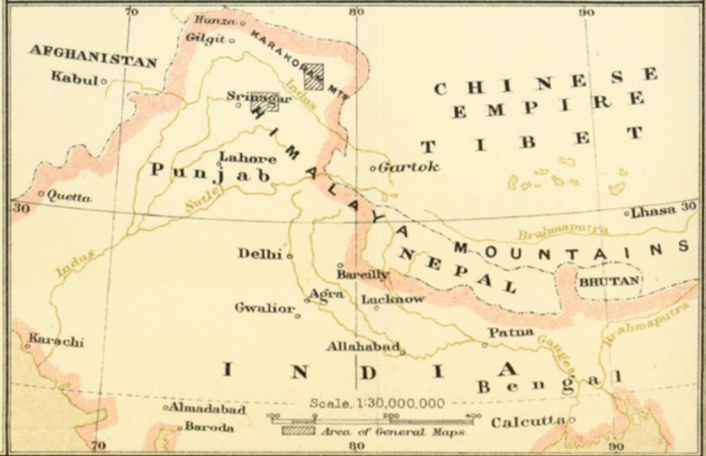
Scale, 1:250,000 or 1 Inch = 3.94 Statute Miles.



Heights in feet
Route ———

Note.
south of Nun Pt. has been
after Workman's map
Geographical Journal 1908.

No 1



Scale, 1:30,000,000

Area of General Maps

77

78



Scale 1:2,000,000 or 1 Inch = 31.56 Stat Miles

Dr. A. Neve's route
Heights in feet

36

36

35

35





Fortabad Nola

Note.

The topography south of Nun Pk has been taken from Dr Hunter Workman's map published in the Geographical Journal 1908, Vol. XXXI page 132.

75°45'

76°

77°30'

77°45'



35°

35°

35°

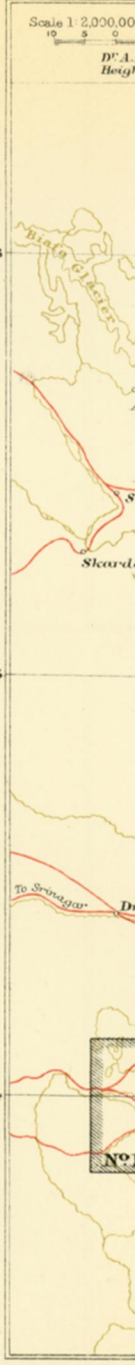
35°

34°

N° II

77°30'

77°45'



Note.

south of Nun Pk has been
after Workman's map
in Geographical Journal 1908.

No 1



Scale 1:2,000,000 or 1 Inch = 31.56 Stat Miles

D.F.A. Neve's route
Heights in feet



medal whom I had the good fortune to select was Dr. Arthur Neve. To-night, however, we see him here, not in the capacity of a universal benefactor of the species, but as a student of that science to which we are devoted. In the intervals of his work he has effected very valuable results in his exploration of the mountains of the Himalayan range. It is the results of some of these expeditions and labours that he is about to lay before us this evening, and I commend him to you as an admirable example of a man who combines devotion to the duties of his profession, and an active and unsleeping love for the people of the country in which he resides, with an eager pursuit of the science which he has at heart. Such is the character of the man who will address us, and I feel sure we shall have no more interesting paper in recent times than that to which we are about to listen.

The PRESIDENT (after the paper): We are fortunate in having to-night quite an unusual number of experts present, and I hope that their natural modesty may be overcome, and that they will give us the benefit of their experience. The first of these upon whom I propose to call is Sir Walter Lawrence, whose name is familiar to all of you, even although you perhaps have not been brought into as close association with him as I had the good fortune to be in India. Long before that date he had spent many years of his life in Kashmir, where his work is embodied in one of the best books ever written upon the country. No man knows more about Kashmir than he does, and I am sure we shall listen with gratification to anything he may be willing to say to us.

Sir WALTER LAWRENCE: I was quite unprepared for this call. All I can say is that if I had had the privilege of listening to Dr. Neve before I attempted to write my poor chapter on Physical History in 'The Valley of Kashmir,' I should have been able to write with much greater effect. From what I have seen myself, I can testify to the great accuracy of Dr. Neve's account. I should prefer this evening to speak rather upon a point to which our President has alluded. I think this is a good opportunity, before this great audience, for letting you know what the work of the Medical Mission in Kashmir is doing. I lived six years in that country, and know the road from Kashmir to Gilgit and Ladak. Wherever I went there was only one question. The people did not want to see me, but they wanted to know when Neve "Sahib" was coming—Neve Sahib, who brought comfort and healing wherever he went. Working with very little help, working in a very small way against every hindrance, against the Brahman influence, the two Neves have won everything to them, and now they have a grand hospital in Srinagar, and when the Neves are not going into the villages, the villagers are coming into the Neves. I was not prepared for the great compliment of being called upon to-night. I can only say that so far as my recollection of the journey to Gilgit and Ladak goes, every word of Dr. Neve brings back familiar and most charming recollections to me.

The PRESIDENT: We have present among us to-night that great explorer, Dr. Sven Hedin, to whom, as we all know, the Himalayas, the Karakoram, and those parts of the world are as familiar as Piccadilly and Pall Mall are to us.

Sir SVEN HEDIN: I regard it as a great privilege to be called upon by our noble President to say a few words on such an occasion as this, and it has been a very great pleasure to me to be present to-night, and to listen to such an important paper as the one just read by Dr. Arthur Neve.

I am not a stranger to him. He is one of the men whom I remember with

special pleasure, sympathy, and gratitude. He almost saved the life of one of my Cossacks when I came down to Srinagar in 1902; and when I started on my last expedition, he found for me an excellent assistant in a young Eurasian, Alexander Robert, who was most useful to me in Tibet.

There will be several persons in this hall to-night who have heard of the glorious work of charity and philanthropy carried out by Dr. Neve during his long years in Kashmir. But this is not the place to sing panegyrical songs in the honour of one of the most noble Christian missionaries who ever lived. I rather choose to congratulate the R.G.S. most heartily for possessing in Dr. Neve a very able, a very conscientious, and a very thorough workman in the field, and a member who, whenever he contributes a paper to the *Geographical Journal*, has a new and striking discovery to tell to the world. For he is one of the men who have penetrated *con amore* into the very heart of the Karakoram, and he has lifted away a good deal of the veil which has hidden the mysteries of those magnificent mountains.

I remember a paper written by Dr. Neve and published a few months ago. He there proved the existence of three parallel ranges in the far west of the system of the Karakoram. Beyond doubt two of them belong to the most gigantic systems on the Earth's surface. On the northern limestone prevails, whereas archaic rocks, granites, gneisses, syenites, and crystalline schists crop up in the southern system. Since 1904 I have always felt pretty certain that this northern Karakoram system was the same as the Tang-la of classic fame. And since the specimens of rock which I brought home from my last journey were macroscopically determined by Dr. Hennig in Lund (they will be microscopically studied later on), it has been proved that the whole of the system north of the upper Tsang-po, which I have called Trans-himalaya, consists of archaic rocks, granites, gneisses, porphyrites, crystalline schists, etc., so without doubt I may maintain that the Trans-himalaya is the eastern continuation of and belongs to the same tremendous mountain fold as the southern Karakoram.

Only by studying the geology of such a country as Tibet you will be able to understand its building, its original architecture, and its present orographical plastic. When I found in the regions north of the Trans-himalaya *Orbitolina conoidea* and *Orbitolina discoidea*, it could be proved by Dr. Hennig that the rocks in which those fossils had found their resting-place were Cretaceous. And we also know that one of the pundits brought home to Sir Henry Trotter specimens from Tengri-nor, the fossil invertebrates of which also proved to belong to the Cretaceous horizon. Then, for instance, we have two localities of Cretaceous limestone, both on almost the same latitude, both north of the Trans-himalaya, both certainly on the eastern continuation of the mountain fold to which the northern, the limestone Karakoram belongs.

Since I last had the honour to deliver a lecture in this famous and world-known Society, I have been working hard on the scientific results of my last journey. I have tried to trace all the sources in the history of exploration in Tibet, and I have been surprised to find how extremely little has been known of this country. Several able men have been working hard in Tibet and its borderlands. To them belongs the lecturer of this evening. To them belong the Jesuit lamas of Kang-hi and the Capuchin missionaries in Lhasa. But until the present day everything has been pioneer work. Only Hayden and Ryder, of the British mission to Tibet, have done detailed work. We shall not be able to say we *know* Tibet until we have penetrated to its very soul—its geological building. And there is work enough for the explorers of centuries.

There are a lot of interesting problems in connection with Dr. Neve's paper. But it would require another lecture to deal with them at some length. I should have liked to touch the question of precipitation, and the fact that the modern exploration in Tibet has proved that the monsoon rains go much further into the interior of that country than ever Blanford believed. I should have liked to dwell upon the beautiful discoveries Lord Curzon made during his memorable journey in the Pamirs, during which he proved that the Oxus begins from glaciers and not from a poor little lake, and I should have shown that the same is the case with the Brahmaputra, which by no means starts from mere passes and valley thresholds, but from gigantic glaciers. Dr. Neve has mentioned the Remo glacier as the real source of the Shyok. There is another example of the fact that great rivers have their sources in glaciers.

I should have wished to say that I do not at all believe in theories which search for arguments in history to prove the periodical changes of climate. Of course, we know that the post-glacial desiccation is continuously going on, and that occasionally wet and dry periods are occurring. But judging from the chronicles of the early Han dynasty in China, the climate of Lop-nor must have been practically the same as nowadays, as has been beautifully shown by Dr. Hermann, of Hanover.

And finally I should have wished to return once more to a glacier mentioned by Dr. Neve, the Kichik Kumdan. By tracing the periods of advance and retreat of its snout, you will arrive at very interesting results; or I would rather turn the problem in the following way: If you collect from all existing material the records of Mansarowar and Rakas-tal, you will find that during periods when Mansarowar had an affluent to the Rakas-tal, and when the superfluous water went out of the Rakas-tal through the bed of the Sutlej, or, in other words, when there was a great amount of water in the lakes, there was also a rather energetic advance of the Karakoram glaciers, and particularly of the Kichik Kumdan. I have compared all this material as far as possible, and in due time it will all be published in my next scientific work.

Dr. Neve has told us that even in the west, where Thomson, Drew, Henderson, Cunningham, Hayward, Shaw, the Schlagintweits, Forsyth, Trotter, Stoliczka, Gordon, and all the modern travellers have been, there still remain vast glaciated regions in the Karakorams which are absolutely unknown. And how much more will this be the case further east, in the central parts of the Trans-himalaya!

But you will forgive me if I do not enter upon all these important problems now. I will only once more express my admiration for the work done by Dr. Arthur Neve, a hard, dangerous, and arduous work carried out during his holidays, when other people take a regular rest. And I hope that in future he will get opportunities to continue this important work, not only as a medical missionary, but also as a geographer, and to make us more and more familiar with one of the most attractive, most difficult, and most glorious parts of the Earth.

Dr. STEIN: It is a great honour for me to be called upon to offer my humble tribute to the fascinating paper we have heard from Dr. Neve. I confess that it is a difficult task, in the few minutes which are all I can now claim, to state the many topics which have closely interested me, and upon which I should like to express a view. It has been my good fortune to know Kashmir for the last twenty-three years, and to date the greatest part of my scientific labours in India from the ten summers I spent there. With regard to

Dr. Neve's personal services to Kashmir, I need only say that from there to beyond the Karakorams, if a European's name is known, it is that of Dr. Neve. I have, in fact, heard eager inquiries about his coming to help and heal even among the Kirghiz, beyond the Karakoram. Dr. Neve has done me the honour of referring to me for an opinion in regard to desiccation. The subject interests me deeply. But I confess it seems somewhat trying that I should thus be appealed to just in connection with that Kashmir where I have always been most happy to forget that there could be such a thing as desiccation. For I associate Kashmir with abundant verdure and beautiful mountain scenery on a larger scale than one can find perhaps anywhere else. Protracted archæological researches in Central Asia have convinced me of changes due to desiccation having taken place there during historical times, but not on such a large scale as would be implied by the hypothetical remarks we have heard about a rainfall of 4 inches being increased to 25 inches, etc. In the Tarim basin, that portion of Central Asia with which I am most familiar, the work of human factors, as far as we can trace it back, has always been bound up with so severe a struggle for water that even a slight difference in climatic conditions would result in visible changes. I mean, a country which manages to do its cultivation on a rainfall say of 2 or 3 inches per annum would feel it very much if that trifling amount of moisture were reduced even by 20 per cent. I believe to have proved, by exact measurements as it were, that at those ancient sites which I investigated in the Taklamakan desert and further east, irrigation water could now not be brought as far as it was brought in the third century A.D.

But I do not believe that the climatic change which has taken place there was sufficiently great to allow us to recognize historical evidence of desiccation in Kashmir also. According to a suggestion made by Mr. Huntington in the stimulating book to which Dr. Neve and Dr. Sven Hedin have referred, every period of reduced moisture, which would spell, as it were, a general drying up and reduction in the cultivated area of Turkestan, would be accompanied by specially flourishing conditions in Kashmir. In the reverse way it was argued that during the period when Turkestan enjoyed a somewhat larger rainfall and consequently more extended irrigation, Kashmir must have been suffering from an excess of snowfall which would have impeded cultivation or rendered it altogether impossible. The fluvial and interfluvial periods assumed in that book happen to fall within time limits for which we possess sufficient historical data in Kashmir, and as it was my task for many years to investigate the Kashmir chronicles in detail, I can speak on that subject with some special knowledge. According to the theory just alluded to, the last centuries before and the first few after Christ are supposed to have been a fluvial period, and thus a time when Turkestan had more ample moisture, with cultivation extending further into the desert. Mr. Huntington was inclined to refer to that fluvial period the old popular legend about a time when Kashmir used to be so deeply buried under snow that the country could be inhabited only during the summer months. But in reality we have got quite reliable historical evidence to show that Kashmir was a highly civilized and cultivated country long before that period, as is, *e.g.*, indicated by the extension of King Asoka's rule (third century B.C.) to Kashmir, and by the Council of the Buddhist Church, which was held there under the Emperor Kanishka in the first century A.D.

I should be greatly tempted to refer to a few other regions close by, like Gilgit, for example. There again we have distinct historical evidence that

conditions about the middle of the eighth century A.D. could not have been very different from our times. We know from the Chinese Imperial annals that in 749 A.D. the Chinese sent an expedition across the Pamirs into Gilgit to turn out the Tibetans, one of the most remarkable military exploits ever done in these regions. We also know from the same reliable records that after a year or two the Chinese administration found the utmost difficulty in maintaining there a garrison of three thousand men. Their supplies had to be brought from Kashmir exactly as for those three thousand Imperial Service troops which were kept in Gilgit for some years before your President assumed the Viceregal office in India.

I am afraid I have no time left to speak about the mountains. I can only express the hope that a lecture like the one we have heard will encourage others to try and do mountaineering work in that fascinating region beyond the southern range of the Karakoram. I believe that well-organized expeditions supported from the Turkestan side would solve most of the interesting problems to which Dr. Neve has referred. Let me add the hope that whenever travellers use a summer holiday for exploration there, they will not fail to apply to that admirable body, the Survey of India, for a competent native surveyor to help them in topographical work. I am convinced that there is no peak to which a European traveller can ascend where a native surveyor cannot take his plane-table. Going to such places is not an easy affair, as I know by experience. Hence, a proper division of labour is an essential point in the arrangements, and the presence of a qualified helper for the topographical side of the work would greatly add to the results. I can only conclude with my heartiest thanks to Dr. Neve for the excellent slides he has shown us here, and express the hope that geographical research in Kashmir and the regions beyond will profit for many years yet by his devotion, just as much as humanitarian and scientific interests have already profited by it in the past.

Prof. NORMAN COLLIE: I also have visited that part of the Himalayas which Dr. Neve talked about, though only for a short time, and I have listened with the very greatest interest to all he has said. There are just two points I should like to speak about. The first is about the great erosion going on there. I was under Nanga Parbat in the Indus valley, and I saw what I concluded to be probably one side of that great earth-slip which blocked up the Indus and held it back for several months seventy years ago. It must have been a terrific flood that followed the bursting of this dam, for the dam was at least, I should think, 1000 feet high. The valley which was blocked is, perhaps, one of the most savage and deepest valleys in the world—at any rate, one side of it is much larger than anything else, that is the south side. If you ascend the north side you are standing at perhaps 15,000 feet above sea-level. You see the river 12,000 feet below you. You look up and see the top of Nanga Parbat 12,000 feet above you. There is no other place in the world where you can see nearly 24,000 feet straight on end. It was this valley that was blocked by that great fall. The great lake that was formed behind it must have been immense. The Indus is nearly 1000 miles from its source there. The great Shayok river is only a small tributary. There is the Gilgit river, which is a big river; also the Suru, the Zanskar rivers, and many others. All the waters of these rivers were held back for months, and then that dam burst! Between that and the plains where the river Indus comes out from the mountains there are most terrific gorges. The river there must have been hundreds of feet high. At Attock an entire Sikh army was washed away. The native description of it was, "As a woman with a towel sweeps away a legion of

ants, so the river blotted out the army of the Rajah." That was what could be done by one of these great cataclysms in the Hinnalayas. There are many other floods that have taken place. There is one other point Dr. Neve has mentioned, that is the discrepancy about the Barmal and the Bhot Kol glaciers. Dr. Neve naturally, with his tremendous knowledge of Kashmir and of the mountains beyond, was not wrong. He knows that country, I should say, far better than any other European or than any other native. The Bhot Kol glacier naturally must connect up with the Barmal glacier, because, in 1898, Major Bruce, with his Ghurkas and coolies, crossed the Sentik La to the head of the Barmal glacier; he then proceeded to take his coolies down that glacier over those ice-falls you saw; he then brought them back by the Bhot Kol pass to the Suru valley. According to the map of Dr. Hunter Workman, they would have had to have gone right through a whole range of mountains three or four thousand feet high instead of merely descending the glacier. As Major Bruce had been down the glacier, that surely was sufficient to convince any ordinary person that the Bharmal glacier went down to the Bhot Kol glacier. Now it has remained for Dr. Neve to prove beyond doubt that his statements about these glaciers were correct. I can only congratulate him again on the extremely interesting paper he has given us this evening.

Sir THOMAS HOLDICH: I have no wish at all to add to your troubles to-night, for I think you will have had enough scientific information to give you nightmare for a fortnight; nor can I claim, like Dr. Sven Hedin, to be as intimately acquainted with the Karakoram as I am with Piccadilly and Regent Street. Nevertheless, as those beautiful views which Dr. Neve has shown us passed on the screen, a good many very pleasing reminiscences of times gone by came back to me. There was much, indeed, that reminded me of pleasant travel and geographical work safely accomplished. There is one point I should like to refer to in Dr. Neve's very able lecture which I think does require a little consideration. I do not think that the actual rainfall which descends over any particular area can be accepted as the criterion for the amount of change that takes place in the physical features of that area. It is not the amount of rain so much as the manner of its descent which makes the difference. I will remind you that in the somewhat arid region of Baluchistan, some time ago now, we had a line of railway connecting the plains with the plateau which passed by way of the Bolan river. Now, there came a local storm of no very great extent, but of very great power within a very limited area, the result of which was a flood down the Bolan pass which wiped that railway out of existence. There was probably no very great amount of rain. It was impossible to measure it, of course, but it fell in a small restricted and rocky area, from which every single drop of water descended down the pass. Once, again, I had the experience of making my way up to the top of a hill, apparently dry, covered with grass and flowers, what looked as if it had long existed exactly as I found it. I had to descend very hastily indeed, because a cloud burst just over me and my surveying instruments, and before I reached the bottom I was knee-deep in mud. Luckily there were no rocks or boulders, but I take it that for at least ten years that hill had been undisturbed by any such downfall as that which I experienced. It was an isolated hill in the midst of a vast plain.

I would like to take this opportunity of asking you to recognize to-night the enormous amount of assistance to geographical inquiry which is due, not only to Dr. Neve, but to the whole of the great fraternity of missionaries. Right from the very beginning of history these are the men who have taken their

lives in their hands and gone to the dark places of the world, full at first, no doubt, of the energy of their great mission, but still reserving time to observe the natural features of the country, and to bring them home to us in the form of our first and earliest maps. Such maps were a little sketchy, perhaps, but such knowledge as we had for many years of Central Asian topography was entirely derived from these missionary efforts. One can easily recall the names of many of these men. We remember first amongst the missionaries in Tibet and Western China the historical name of d'Orville; next that remarkable geographer (and I am afraid something of a story-teller) the Abbé Huc, with Gabet, Desgodins, and Della Penna, until in modern times and in other fields we all revere the name of Livingstone. In the present day we are still indebted to missionaries for much of the best work we assimilate into our geographical records. I would only mention one more name—that of Mr. Fergusson. He is not exactly a missionary, but simply a Bible distributor, who has quite recently given us some of the best mapping of Western China that it has ever been my pleasure to examine. Soldiers, sailors, commercial travellers, people of all classes, no doubt, have added to our geographical knowledge, but above all, I think (especially if we include Buddhist and Mohammedan missions), we owe the greater part of our geographical knowledge in early days, and very much of it still, to the efforts of missionaries.

The PRESIDENT: I am sure it will be your pleasure that I should express on behalf of this meeting our sincere thanks to Dr. Neve, not merely for his paper, but for the very interesting discussion provoked by it, culminating in that tribute to the work of missionaries, not only in Kashmir, but in many parts of the world, which we heard just now emanating with equal authority and truth from the lips of Sir Thomas Holdich. I listened with very great pleasure to the paper myself, and in many of the pictures thrown upon the screen I recalled scenes that I have been so fortunate as to witness. Even had I felt tempted, however, to talk about what I have seen myself, I should have been abruptly pulled up by the very apposite remarks as to the influence of Coronation year which fell from one of the speakers, supplemented as they have been by the obvious symptoms of restlessness which I noticed on the part of some of the audience. I think, therefore, I shall be best performing my Presidential functions if I now merely tender your thanks to the reader of the paper this evening.

GEOGRAPHICAL CONDITIONS AFFECTING THE DEVELOPMENT OF CANADA.*

By W. L. GRANT, M.A., Professor of Colonial History, Queen's University,
Kingston, Canada.

A PLATITUDE is that which every one admits and no one remembers; give it an adequate place in your thoughts, and it becomes a great truth. The platitude with which I begin is that Canada is a large country; made the basis of all our thinking about her, and followed out to its consequences, it becomes a great truth.

Canada is a large country. Her most southerly point is in 41° 41', further south than Rome; her northern boundary is hundreds of miles to

* Royal Geographical Society, May 29, 1911.