

## THE RANGES OF THE KARAKORAM.

By ARTHUR NEVE, F.R.C.S.E.

“EVEN the great Karakoram peaks themselves seem to follow two alignments.” So writes Colonel Burrard in his masterly monograph on the mountain ranges of Asia.

He points out that there are two Hindu Kush ranges, which are the westward continuation of the Karakoram mountains; and that there is in rear of the Karakorams a marked water-parting crossed on the west by the Shimshal and other passes and on the east by the Karakoram pass. Some of the explorations of the last year or two throw more light upon this problem, though one cannot consider it sufficient to permit of any dogmatism at the present time. The most striking new fact is that the great glacier from which the Nubra river flows, is some 45 miles in length, and lies in a geotectonic trough, with a very lofty range to its north, in which there are peaks over 25,000 feet in height, and one, Teram Kangri, probably over 27,000 feet.

There remains a terra incognita, of no great extent, to the west of this, and then there comes the now well-known Baltoro glacier, lying in a similar great trough. Looking at the map we see that where the Baltoro river bends south, the Biafo glacier occupies a broad valley passing north-west, beyond which is the great Hispar glacier. In short, there are these four great glaciers almost in a line stretching from Nubra to Hunza, a distance of nearly 200 miles. At no point would a straight line from the snout of the Siachen glacier of Nubra to Hunza be more than 20 miles from one or other of these four glaciers.

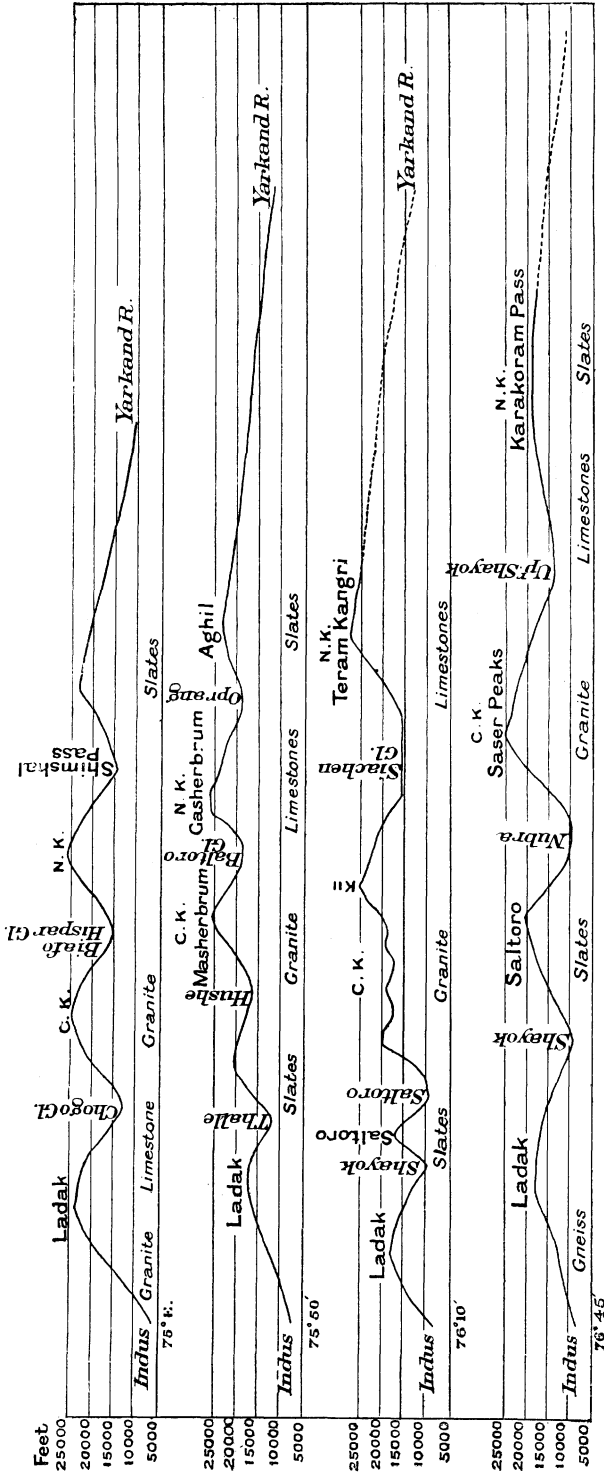
Another parallelism is to be noted further north where the Shimshal glacier of upper Hunza is almost in a line with the Oprang valley, of which the upper portion is in a direct line with the upper Siachen glacier. Beyond this, to the north, there is the great trough of the Yarkand river, bounded by the Kwenlun mountains; while to the south are the flanking valleys of the Saltoro Hushe, representing a minor trough, then the Shayok, and the Indus, the upper portion of which from Skardo is in a line with the Shigar, Basha, and Chogo Longmo. *These valleys correspond to recognizable mountain folds.*

If a section be taken from a point  $76^{\circ} 10' E.$ ,  $35^{\circ} N.$  to the north-east (see No. 3), it first cuts the Ladak range, then a lower range between the Shayok river and the Saltoro, then comes a mass of granite mountains, through which the main streams cut their way in very deep narrow gorges. This range was formerly regarded as the water-parting of the Indus, and marked as the frontier; but beyond it is the broad trough of the Siachen glacier, and then the great ridge of which Teram Kangri is the culminating peak; beyond which is the basin of the Yarkand river. So that on this line I recognize four definite crustal folds, emphasized by structural differences.

That to the north is the true Karakoram going beyond the Karakoram pass far to the east into Tibet (Hedin). To the west, from Teram Kangri it passes to Gasherbrum with a dip to about 20,000 feet between the Siachen glacier and the head of the Oprang valley at the point marked Young-husband's Saddle in Longstaff's map. From Gasherbrum the range proceeds north-west to K<sup>2</sup>, and the next dip is at the Mustagh pass, 18,000 feet, after which it is again a very lofty range, with the Biafo and Hispar glaciers to the south, and the Shimshal on the north. But a bifurcation of the range goes more north, and then west, where it is crossed by the Shimshal Mintaka and other passes. The Hunza river flows in a tremendous gorge, a few miles north of Hunza on the path to Gulmit, and the snowy range appears again on the west side of the gorge, continuing towards Daspur mountain in Yasin and then sweeping round to the south-west.

It may be asked whether the Aghil range (Younghusband) may not be in stratigraphical relation with the Shimshal Mintaka section of the northern Karakorams above mentioned? It seems likely, but no definite answer can yet be given on this point, nor upon the eastward continuation of the Aghils, which may be a bifurcation of the main range.

I wish to draw attention to the somewhat "herring-bone" arrangement of the transverse river valleys on either side of the Karakorams; for while the main rivers, the Indus, Shayok, and Yarkand, flow south-east to north-west, the rivers on the north flow north-west and those to the south south-east, on both sides tending to make an acute angle with the main river they join. This may be due either to the original transverse mountain folds not having been at right angles to the general axis of the Karakorams, or possibly to the early channels having been cut in Tertiary or pre-Tertiary times when the Indus and Yarkand river may have flowed south-east to the Tibetan ocean. It has to be remembered that the central range of the Karakorams is chiefly granite, and was probably raised ages before the northern Karakoram, which are largely limestones, emerged from the sea. Lydekker's geological map indicates a considerable area of Carboniferous and Jurassic limestones in the Changchenmo and Dipsang regions, extending north-west and crossing the Shayok in the direction of the northern Saser peak, No. 52. It is probably this belt which is to be traced across the head of the Remo glacier to Teram Kangri. My observations show that the strike of limestone crosses the upper Siachen almost from east to west, and that the moraines from Cornice peak are of white and grey marble. The Duke of the Abruzzi's expedition also showed that Gasherbrum and Hidden peak are limestone masses, which are almost certainly of the same series. *There are then stratigraphical as well as orographical grounds for differentiating the northern Karakoram from the great central granite mass which extends from the Saser peaks, Nos. 41, 55, 57 on the east, to Rakaposhi mountain in Hunza, on the west. This great mass is of considerable width, as well as of great height, and needs more detailed mention.*



LADAK RANGE, SALTORO, CENTRAL KARAKORAM, NORTH KARAKORAM.  
*Gneiss Slates etc Granite Slates, Limestones.*

DIAGRAM OF SECTIONS FROM S.W. TO N.E THROUGH THE FOUR RANGES  
 BY ARTHUR NEVE F.R.C.S.E.

The northern limit in the Saser group may be taken as probably close beyond No. 52, which I have personally observed to be of light grey and pink granite. The southern is represented by the peaks Nos. 41, 55, 57 (see section No. 4). This gives a width of over 50 miles. At the Bilaphond the limit is most definite. On the south side of the upper Saltoro valley are Palæozoics, continuing up the Chulung, and the south side of the Rgyong towards Nubra; while on the north side the granite is continuous to the Siachen, an approximate width of 30 miles. At the junction of the Saltoro and the Hushe there is the same sharp demarcation at once of the granite and of the mountain mass. On the north, Masherbrum is granite, so there again is a width of about 30 miles. These great rivers cut right through this central Karakoram, or to define it by a name as suggested by Colonel Burrard, this Masherbrum range. At  $78^{\circ} 15' E.$  it is marked off by the sharp angle of the Shayok river, beyond which it may be traced to the north of the Pangory lake, where it becomes the Kailas range.\*

The Nubra river cuts diagonally through the entire breadth of the range, in a gorge which, from Aranu to Siachen, is about 6000 feet deep, with peaks over 23,000 feet high, only 10 miles distant on either side ( $34^{\circ} 50' N.$  to  $35^{\circ} 20' N.$ ). The Bilafond trough sections the range from  $35^{\circ} 10' N.$  to the Saltoro pass,  $35^{\circ} 23' N., 76^{\circ} 50' E.$ , overhung on either side by  $K^{11}, K^2, K^{13}$ , of which the highest is over 25,000 feet.

The Kondus gorge,  $76^{\circ} 35' E., 35^{\circ} 12' N.$ , is even more striking, its portals guarded by the Saltoro spires, vast, smooth-faced granite slabs rising sheer 10,000 feet from the river at Dumsum, and culminating in stupendous pinnacles and peaks from 21,000 to 23,000 feet high. This valley requires glacial exploration, as the topography is certainly incorrect as regards the relation of the Dong-Dong glacier to  $K^{10-11}$ .

On theoretical grounds I am very doubtful if the main Kondus glacier originates as mapped so far north as  $35^{\circ} 42'$ : it appears to me more likely that the crest line of the Masherbrum range runs nearly due east towards Bride peak, and then curves to the S.E. to  $K^9$  and  $K^{10-11}$ , and that the area  $35^{\circ} 35'$  to  $35^{\circ} 40' N.$  and  $76^{\circ} 43'$  to  $76^{\circ} 53' E.$  is really at the head of the Siachen glacier. This remains to be seen. In any case, there may be some dips in the crest similar to the Saltoro pass, at the head of Kondus or Sher-pi-gan.

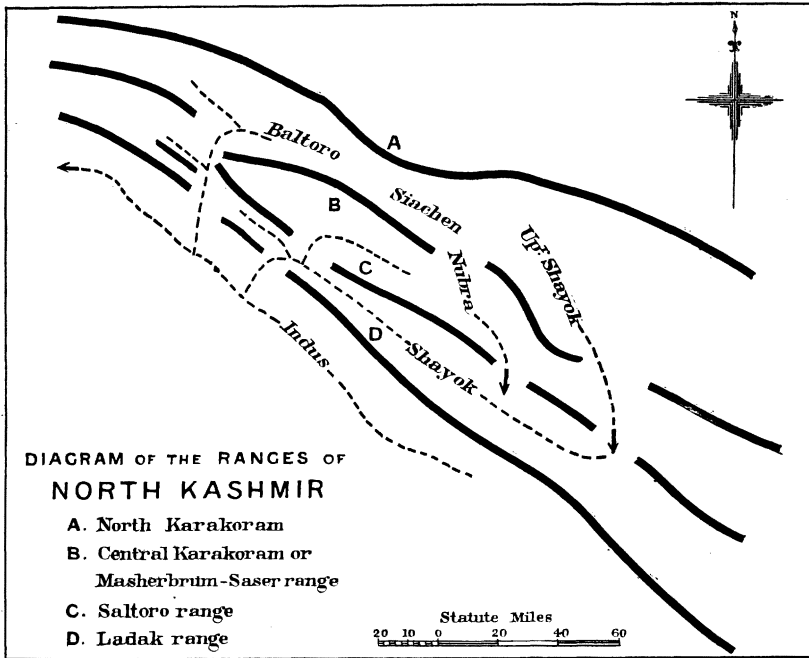
The next great gap in the range is at the gorge of the Baltoro river below Askole, beyond which on the south of the Biafo-Hispar glacier the mountains again attain great heights at Rakaposhi near Gilgit. But while the crest line preserves a great altitude from the Nubra to the Baltoro valley, the minor valleys cut the wide lofty granite mass into blocks containing very many peaks, literally scores, over 20,000 feet high, few of which have been trigonometrically fixed. Those few are mainly, as would be expected, along the southern border of the range, and one who only

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\* Burrard, Hayden, p. 94.

knew the country from the map might be tempted to unite these summits by a line tending S.E. by N.W., and thus to define another mountain fold.

The *third fold* or range is almost insignificant in comparison with the other three; but it can be clearly seen whether on the spot or in the map stretching along the north of the Shayok, from the Nubra junction and right on across the mouth of the Hushe to the Thalle La. It is of *palaeozoic rocks*, schists and slates, vari-coloured, with some trap. It might be called the *Saltoro range*. The same strata may be seen on the east of the Nubra valley at Tagur, but are more in evidence on the south side of the upper Shayok, there blending with the Ladak range.



The fourth range is the Ladak range. I do not personally know this east of Leh, and in any case it has been well described by Burrard (Burrard and Hayden, *op. cit.*, pp. 92-94). The noteworthy point is its relation to the Indus river. "For the first 180 miles from its source the Indus flows along the trough north of the Ladak range and parallel to it. Near Thangra north of Haule it bends at right angles, cuts across the range . . . and now flows for 300 miles along the south flank of the Ladak range." But the authors go on to state, on the very high authority of Godwin-Austen, that "shortly before its junction with the Shayok, the river passes back across the range to its original side," and a footnote on p. 171 states that "the gorge near Skardo where the Indus breaks across the Ladak range, is said to run between precipices 14,000 feet sheer: see article 'Indian Imperial

Gazetteer, 'first edition'' (probably Cuningham). On a journey last year along the Indus valley, I devoted special attention to these two statements, and am forced to challenge them. Between the junction of the Suru river and Skardo, the ranges on either side seldom exceed 18,000 feet, and few peaks within 5 miles of the Indus attain over 16,000 feet, so that the gorge is, at the utmost, 8000 feet in depth (the Indus being 8000 feet above the sea). It is only below Rondu towards the great knee above Bimji that such a gorge as 14,000 feet is possible (*i.e.* about  $35^{\circ} 30'$  N. and  $75^{\circ}$  E.). And there it is even exceeded, for the river is 5000 feet, and eight miles to the north towers Mount Haramosh to a height of 24,270 feet, while there are peaks of 18,000 and 19,000 feet on the south side. This gorge is indeed colossal, but it is 60 miles west of the alleged gorge above Skardo. The other question, that of the Indus river cutting through the range, is not so simply settled. Undoubtedly it does cut through from north to south at  $78^{\circ} 50'$  E., above the junction of the Haule river, but at no point to the west of this does it do more than cut through the flanks of the Ladak range, which is mainly a granitic fold, with an average height of nearly 10,000 feet *above the river*. At  $77^{\circ} 25'$  E. the Indus comes into close relation with the north Zanskar range on its left bank, and for a considerable distance *much of its trough may be regarded as cut into the flanks of that range*. Indeed, it seems possible that previously the Indus may have flowed on the northern side of the somewhat isolated hillocks which now fringe its banks, and that the great plateau deposits of Phyang, Bazgu and Timisgam have filled in its former bed. Anyhow it is noteworthy that about  $77^{\circ} 10'$  E. the strike of palæozoics is diagonally from S.E. to N.W. across the river-bed; and it is these slates and schists, with some palæozoic limestone, which are found at  $76^{\circ} 15'$  E., near Tarkutta, re-crossing the Indus from right to left, *i.e.* from E. to W., as the river there turns north. It is true also that for nearly ten miles to Khartaksho the strike is similar, but at each bend of the river to the west the strike is again diagonally towards the right bank. No great portion of the Ladak range appears to cross, but it continues to the wild tumultuous gorge through which the Shayok cuts its way between Dowani and Kuru ( $76^{\circ}$  E.). Beyond this the features of the range are indistinct; it blends partly with the Saltoro range at the Thalle La (the Kashomal mountain is partly limestone); but again, beyond the Shigar river, the fold is well defined, and reaches a culminating point at Mount Haramoush  $75^{\circ}$  E.

It appears to me that it is the north Zanskar range which, throughout this 300 miles, forms the left bank of the Indus. Enough is not known of the ranges west of the great bend of the Indus in Darel and Upper Swat to attempt to trace the relation of the Zanskar and Ladak ranges beyond this point, where there are intricate orographical problems to be solved.

In conclusion, I should like to express my great debt to Colonel Burrard's most suggestive and masterly treatment of the subject. It is remarkable that he should have indicated with such foresight the probability of peaks

of the first magnitude being found in the region of the Siachen. I have followed him to some extent in treating of the way the great rivers Shayok, Nubra and Baltoro cut the Karakorams into blocks. To some it may seem doctrinaire to mark off the Nubra-Saser range from the N. Karakoram. A traveller to whom the whole region is familiar usually travels along the valleys, and is apt to think of the main ranges as running parallel to and between the valleys, just as the cartographer is apt to let the rivers dominate the shading. But the climber who sees vast districts spread out below him, and whose attention is naturally specially directed to the great heights, noticing the general direction and the class of rocks while endeavouring to trace lines of approach to the ridges and peaks which have baffled his predecessors, gets a wider outlook, which, in its turn, needs to be corrected by the more precise working of a scientific geologist. It needs a highly trained geologist to interpret the complexities of the often inverted folds of these great wrinkles of the Earth's crust, rendered still more intricate by intrusions of gneiss and trap. The amateur can, nevertheless, render some assistance by careful observation. If the range classification I have adopted seems too schematic, I can only plead that it is a working hypothesis founded on some personal knowledge of the districts from Hunza to Nubra. I have crossed the Nushik pass, the Thalle La, the Chorbut and the Saltoro-Bilaphond, and have twice climbed to over 20,000 feet in the Nubra-Saser range. A photograph taken by me in 1908 at the head of the Manzathang glacier actually shows the lofty peak Teram Kangri, which Captain Oliver and I then assumed might be Gasherbrum. We see what we expect to see, and it is these mental pre-suppositions which too often hinder our discovering that which lies before our eyes. I join with others in my tribute to the work done by Messrs. Johnson and Ryall and Colonel Godwin-Austen of the Survey fifty years ago, which has been the basis of the work of all subsequent explorers in the Karakorams; and I wish to express my indebtedness to my friend Dr. Longstaff, to travel with whom is an education in clear-headed conception of mountain problems.

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### THE ISACHSEN SPITSBERGEN EXPEDITION.\*

THE Norwegian expedition under Captain Gunnar Isachsen returned on September 18 last to Christiania. The expedition consisted of fifteen members and worked in five parties, the leaders being, besides the chief of the expedition, Captain Isachsen—Messrs. Hoel and Holtedahl, geologists; Lieut. Staxrud and engineer Koller, topographers. The Norwegian Government placed the navy transport vessel *Farm*, Captain Hermansen, at the disposal of the expedition.

The expedition left Hammerfest on June 22. The 24th of the same month was spent on the east side of Bear island, where a new bay was

\* Communicated by Captain Gunnar Isachsen.