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CONTENTS.

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No. 1. *January.*

MAPS.

No. 2. *February.*

MAPS.

No. 3. *March.*

MAP.

No. 4. *April.*

MAPS.

No. 5. *May.*

MAPS.

No. 6. *June.*

MAPS.

we are advancing not only toward the time when geographical environment will be recognized as one of the great fundamental factors in the evolution of human character, but toward the time when we shall be able to show the processes by which it plays its part. When that is accomplished a knowledge of geographical laws will be of primary importance in enabling us to discover how certain evil traits of character may be eradicated and good ones fostered in their stead. Geography will be so interwoven with history that the two will be inseparable.

DR. DE FILIPPI'S ASIATIC EXPEDITION.

DR. F. DE FILIPPI sends from Skardu, Baltistan, the winter quarters of the expedition, the following account of the scientific work done up to November 5.

The work of the expedition began with comparative observations taken at the Royal Hydrographical Institute at Genoa, which is to be the reference station for all gravimetrical mensurations. On August 22 the party landed at Bombay. Professor Dainelli, Lieut. Antilli, and Marchese Ginori, with the guide, Petigax, went straight up to Kashmir, while Dr. De Filippi paid a visit to Simla to obtain the co-operation of the Technical Departments of the Government of India in various researches, and Commander Alessio, with Professor Abetti, went to Dehra Dun, the seat of the Trigonometrical Survey of India. Here, between August 25 and September 4, they took a complete set of comparative pendulum and magnetic observations, and they made the first experiments of wireless transmission of time signals with Delhi, Simla, and Lahore, using the wireless receiving station of the expedition. By September 8 the whole party was again collected in Srinagar, Kashmir. Here, from the 12th to the 19th, Alessio and Abetti took the pendulum and the magnetic observations. Two days later the caravan journey was begun, and on the 26th the Zoji-La pass of the Himalaya was crossed (11,120 feet). From this point to Skardu the march was interrupted twice for gravimetrical and magnetic work. The first station was made in Dras (10,020 feet), a small village at the foot of the Zoji-La, the second in Tolti (about 8200 feet), a Balti village in the Indus valley. The observers have been able so far to surmount the difficulties of carrying on their work with the most rigorous scientific methods, notwithstanding the peculiar circumstances. So far the sky has been clear enough to allow to take regular astronomical observations, both in connection with the gravimetrical work and with the determination of the geographical co-ordinates of the stations.

Wherever a halt of some days has been made, Marchese Ginori has put

up the meteorological station; besides which, no opportunity has been missed to take comparative readings of the instruments. These may lead to interesting conclusions on the limits of accuracy of the various instruments, especially in regard to the determination of altitude.

These halts and the easy marches have afforded to the geologist, Professor Dainelli, the opportunity to make frequent excursions in Kashmir and in the Dras and Indus valleys, and to collect data which have led him to new and interesting views about the constitution and the geological history of this district. Abundant lithological material has also been collected. Lieut. Antilli, besides collaborating with Professor Dainelli in collecting photographic documentary evidence for geology, has lent to the topographers the valuable help of photography, and has busied himself with the general illustration of the country traversed.

The expedition reached Skardu on October 25, and established itself in two little bungalows, while the small dens of the neighbouring serai were turned into laboratories and store-rooms. Skardu, the capital of Baltistan, is 7700 feet above sea-level, and lies in a vast sandy plain, a widening of the otherwise narrow and precipitous Indus valley, where the Shigar and the Indus rivers meet.

A very interesting experiment was at once made. Having mounted the receiving wireless station, Alessio and Abetti were able, in the evenings of the 29th and the 30th, to receive very distinctly, and to register the wireless time signals transmitted by Lahore according to a prearranged plan. The possibility is thus established of adopting this method in the field, even among such natural obstacles as high ranges of mountains. The preliminary experiment will be followed by a series of transmissions of time-signals sent by the Lahore station and received simultaneously by the Dehra Dun station and by a station of the expedition. As long as the latter will be in the Indus valley, which is included in the triangulation of India, these wireless communications will permit determinations of differences of longitude sufficiently correct to calculate, when taken together with the determinations of latitude, the deviation of the plumb-line. Further on, these communications will be most useful to check the chronometers and determine the longitude of places in the unknown district which the expedition intends to explore next summer.

Marchese Ginori has begun to send off pilot balloons, followed in their course with the theodolite, simultaneously with identical observations done in various Indian observatories, according to a prearranged plan for the study of air-currents in the high atmosphere.

Finally, in the first days of November, an excursion was made up the valley leading to the Burji La and the Deosai plateau, and a place selected in it over 14,000 feet altitude, to which is now being conveyed the camp and the scientific equipment. It is hoped that, notwithstanding the advanced season, it will be possible to make here a station for pendulum and magnetic observations, for researches on the total solar radiation with

various pyrheliometers, for pilot balloon experiments, and for telephotographic work.

After the completion of this work, the members of the expedition will return to Skardu, which will in its turn become a station for gravimetrical and magnetic observations, followed by the determination of latitude and longitude (by the wireless method), for various topographical work and for researches in meteorology and aerology. Meanwhile, Dainelli will continue the geological excursions until prevented continuing his work by the winter snows.

The scientific equipment has suffered no damage in the long journey, and is in perfect order. All the members of the expedition have always enjoyed very good health.

Ever since its arrival in India the expedition has met with the greatest favour and the most cordial support in every quarter, from His Excellency the Viceroy and the various departments of the Government of India, down to the lambardar and the population of every Balti village which has lain on its way.

NOTTINGHAMSHIRE IN THE NINETEENTH CENTURY.

The Geographical Factors in the Growth of the Population.

By B. C. WALLIS.

Nottinghamshire is neither an agricultural county like Cambridgeshire nor so definitely an industrial county as Lancashire. The county lies tucked up against the south-eastern corner of the Southern Pennines and mainly north of the Trent, which is frequently considered as the southern boundary of the eastern portion of manufacturing England.

The survey of Nottinghamshire which is made in the following pages is intended to emphasize the geographical circumstances which have been mainly instrumental in causing the distribution of the population of the county as it exists at present. Such a survey must be to some degree numerical, if it aims at precision of statement; and the statistical matter upon which the conclusions are based is introduced solely from a geographical point of view. The complete investigation provides an example of an aspect of historical geography which has received but scant consideration in the past.

A preliminary conception of the development of the population within the county may be attempted in comparison with the changes which have taken place in an area which includes the neighbouring counties. This district is shown in the maps, Figs. 2–4, which indicate the distribution of the population in the groups of parishes which form the enumeration districts of the census officials. Nottingham county is composed of eight such districts: East Retford, Worksop, Mansfield, Basford, Nottingham, Southwell, Newark and Bingham (Fig. 1).

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THE EXPLORATION OF THE SIACHEN OR ROSE GLACIER, EASTERN KARAKORAM.*

By FANNY BULLOCK WORKMAN, F.R.G.S., Officier de l'Instruction Publique.

As previously stated in the *Geographical Journal*, near the end of our 1911 expedition Dr. Hunter Workman and I crossed to the Siachen or Rose glacier on August 20, making between that date and September 14 as much of a reconnaissance of its basin as the short days, variable weather, and glacial conditions of the advanced season would admit of.

In the time passed there I became fully alive to the obstacles which would beset one attempting, even with eight summer weeks at disposal, to explore its salient points and to carry out a fairly thorough survey of the main glacier and its affluents. Those who, like ourselves, have tried to investigate glaciers such as the Hispar and Baltoro, both of which may be ascended from their tongues, will appreciate the difficulty of visiting in its entirety a 46-mile-long glacier with a useless tongue. I say "useless tongue," because, as is known, the upper Nubra valley leading to that tongue is void of supplies for more than a handful of men, and, worse than this, the Siachen tongue cannot be reached at all between May and September 15, owing to the volume of water and to the presence of quicksands in the Nubra river, which render its traverse at different fording-points absolutely dangerous to life.

Hence, the exploration of the Rose glacier resolves itself at once into solving the problem of a last base at Goma in the Saltoro valley, which is

* Royal Geographical Society, November 24, 1913. A paper by Dr. Hunter Workman read at the same meeting will be published in a later number of the *Journal*. Map, p. 232.

separated from the Rose * by the 10-mile Ghyari nala, the 13-mile-long difficult Bilaphond glacier, the passage of the 18,400-foot Bilaphond La and the descent of the 7-mile-long Lolophond glacier.

When you have performed this little feat you are there and have tapped the Siachen at about 16,000 feet, where you may next make a new receiving base for the hundreds of maunds of flour, stores, sheep, and even wood required by a large contingent of men for several weeks. "No, I won't come again," I said as I sat snowed in in my tent for two days before crossing the Bilaphond La in September, 1911. But no sooner had I turned my back to the Rose and reached the top of the pass on that brilliant September morning, than my mountain ego re-asserted itself, saying *tant pis* to the obstacles, return you must.

And thus April, 1912, again found us in Srinagar. Through the kind assistance of Mr. E. A. Reeves, F.R.A.S., I had secured the services of Mr. C. Grant Peterkin, diploma-holder of the R.G.S., as surveyor. Col. S. G. Burrard, C.S.I., R.E., Surveyor-General of India, most kindly loaned me a native plane-tabler, Sarjan Singh of Party I. Indian Survey, to assist Mr. Peterkin. I have also to express my thanks to Col. Burrard for the loan of theodolite, plane-tables, chronometer watch, and other instruments, and to the Royal Geographical Society for the loan of plane-table and other instruments. Major Pirrie in charge of Party I. selected Surjan Singh for the work, saw that instruments were ready, and did all in his power to further the interests of the expedition. I have to thank Mr. Stuart Fraser, C.S.I., Resident in Kashmir, for assisting the expedition in every way he could. I took again T. Byramji of Srinagar as transport agent and collector of grain and coolies at Kapalu and Goma. Two reservist orderlies from the Indian Army, Pindi Division, assisted this work by accompanying coolie-caravans to and from the Goma base. Cyprien Savoye of Pré St. Didier accompanied Dr. Hunter Workman and myself as head guide, as well as three Italian porters, and a fourth porter was attached to Mr. Peterkin's party.

We left Sringaar June 5, Mr. Peterkin preceding us by about two weeks, for Baltistan. Kapalu is situated on the lower Shyok river, and has for its nominal ruler a jagadar or small Raja. Raja Shere Ali Khan, an intelligent, charming man who assisted us greatly in 1911, had died, and was succeeded by his nephew, Nasir Ali Khan. The Raja gave me our old headman, Wazir Abdul Karim, a hardy, amiable little man, who hung to our camp from start to finish, always working on our side, trying his best to lead the coolies and prevent their absconding in batches, which at times they elected to do. He was certainly the best of the Raja's retainers with whom we had to do.

Four marches from Kapalu brought us to Goma, the last village of the Saltoro valley. From Goma, July 2, we ascended the Ghyari nala to the

* I use both names, Rose and Siachen, for this glacier.

maidan at the tongue of the Bilaphond glacier. This glacier was first ascended for 6 miles by Vigne, in 1835, and again by Dr. Longstaff in 1909, in his search for the Saltoro pass. It is not well to attach too much importance to native names for glaciers given by coolies, and, as Sir Martin Conway said at one of our lectures before the Royal Geographical Society, "it is difficult indeed to place much reliance upon such names." This is particularly true when making rapid journeys through a region where one is forced to accept names given by any coolie who is at hand. But when one goes, as I did, with the idea of securing data for a map that would stand, it is necessary to inquire into the traditions of a name, and, so far as the meagre opportunities offer, get at the meaning it conveys to the zemindar's mind. As the nomenclature of this glacier and of the pass at its head is of no mean importance to the future geography of this region, I must expand somewhat on the two subjects.

When, in 1911, we inquired through our polyglot Parsee agent of the zemindars or coolies what they called this glacier, one and all said Bilapho, and spelled it without the "nd." They said the word was a Balti one, meaning a small bright-coloured butterfly. Not satisfied with this explanation, I told the agent in 1912 he must go further into the question of this name and consult the mullahs and oldest inhabitants. It happened that several intelligent native settlement officers, whose business it is to get at the meaning of local names, were in the Saltoro valley, and they and the Parsee went carefully into the matter, with the following conclusion—*i.e.* that Bilaphond so spelt, but the "d" not sounded, in Balti, means butterfly; that the reason for giving the glacier the name was, not because butterflies were seen on it, as had been said by the coolies, but that in former days this name was given because of the shape the glacier assumes at Naram, 6 miles from its tongue. The main glacier running south towards Ghyari and north towards the pass forming the trunk or body of the butterfly, and the branch entering east which descends from behind Peak 8 and the one entering west forming the wings, hence completing to the Eastern eye the image of a butterfly. This definition of the meaning of the name Bilaphond presupposes an intelligence and poetic imagination not to be found among Saltoro people of to-day. Perhaps in the old time, when, according to the "legend of the Siachen," the Ghyari nala was thickly populated to the foot of the glacier, a select few lived capable of such flights of imagination. At any rate, they have handed it down to their descendants, and it is pleasant to record such a poetic and also fitting reason for the naming of the Butterfly glacier.

Regarding the Saltoro pass, which Sir Francis Younghusband sought for from Chinese Turkestan, many miles north, and which Dr. Longstaff claims to have found when he stood on the Bilaphond La, in my humble opinion, this pass, if it exists, is still undiscovered. Dr. Longstaff says "tradition and usage have given the name Saltoro to the pass," but he admits that locally it is called Bilaphond La. Now the Bilaphond La is

separated from the Saltoro valley by the Ghyari nala and the Bilaphond glacier, and bears no relation to that valley. So far as I could learn from the so-called learned men of the region, who are possessed of whatever saga connected with it that has been handed down, it is, and always has been, called by the people Bilaphond La. In the legend, of which I shall speak elsewhere, old time Baltis referred to the Yarkandis crossing the Bilaphond La when they came to "loot" in the Ghyari nala. When Vigne, in 1835, ascended the Saltoro valley in search of a route to Nubra, he was told by the natives "that he would cross a pass, and descend, after crossing a glacier, upon the northern end of the Nubra valley." This he tried and failed to do. But nowhere that I can discover in his writings does he use the name "Saltoro pass." Neither have I been able to find in the writings of Thomson, Strachey, and Moorcroft, mention of the word "Saltoro" as applied to any pass. I cannot, therefore, agree with Dr. Longstaff that "usage and tradition" have given the name "Saltoro" to the pass at the head of the Bilaphond glacier. Thus, considering the name Bilaphond to be correct, both in local usage and as designating its geographical position, I have elected to have it so called on my map. The name chosen accords with the advice given explorers by the Royal Geographical Society to select, when naming glaciers or peaks, if possible, names known to natives of the region. It is not my habit to attempt to change either spelling or names existing on previous maps, but in this case I regard myself as quite justified in not adopting the word "Saltoro" as employed on Dr. Longstaff's sketch-map.

This being a historical and geographical narrative, I will not describe this glacier, but may remark *en passant*, that, judging from the appearance of its tongue, it was in both 1911 and 1912 advancing slightly. In both years, it was found a most tiresome glacier to negotiate from the condition of its huge jumble of rickety moraines which extend from side to side of its boundary walls. Locomotion by continual "moraine hopping," aptly so called by Major the Honble. C. G. Bruce, is continued to a mile beyond Naram, the first camping-ground 6 miles up the glacier. From here the ascent, by ice-bands running between median moraines, is easy to below Ali Bransa.

In 1911 we had no trouble in finding this last station before the pass, but the following July a heavy snowstorm overtook us, and it was difficult to spot the small moraine-ridge where it is situated, this being above an ascending area of crevasses which were not easy to handle in the blinding snow. It is at about 17,000 feet, and is separated enough from the high border-cliffs to be safe from falling stones. In 1911 eight native stone shelters were found there, which showed no signs of fires or of recent usage, and may have been standing in this protected place for a century. Neither Vigne nor Dr. Longstaff appear to have actually visited the place. The shelters have now been greatly demolished by the different parties of our expeditions, who constantly bivouacked here on their way to and from the

Siachen with supplies. For several reasons it clings to my memory as the most gruesome camp of my Rose glacier experiences, and, when we finally left it to cross to the Rose glacier in 1912, my mind was made up never to return thither could I find another road back. Coming directly from grass, the altitude is felt and the cold also in bad weather. We had a sixteen-hours snowstorm here, and, when it cleared, had to wait two days for a belated caravan of supplies. The minimum temperature on two nights was 16° Fahr. When the sun shines the heat is intense during the day; a black-bulb thermometer reading gave 197° Fahr. at 12.30 noon. After four nights, thinking to have shaken off Ali Bransa, we left on a cloudless day for the Bilaphond pass. An hour from camp, as the route was easy, I gave guide Savoye the order to cross the pass with the second guide and look up a route to a peak I wished to climb, and then rejoin us on the far side of the pass. Two porters remained with our caravan. Soon after, Cesare Chenoz, through his own carelessness, fell into a crevasse 80 feet deep. Although brought out alive and carried back to Ali Bransa, where every care was given him, he died the same night from the effects of cold and shock.

Three days later, after the burial of Chenoz, we again left Ali Bransa with a file of ninety coolies. The weather, as it had been for eight days, was glorious, when, for the third time in eleven months, we arrived on the summit of the Bilaphond La. This saddle was measured by Dr. Longstaff by aneroid at 18,200 feet. The mean of hypsometric readings taken by us in 1911 and 1912, and by Mr. Peterkin, give a height of 18,370 feet. The salient object of interest from the pass is the distant Rose glacier seen flowing southward, past the entrance of the large glacier which descends from the Bilaphond La and which we have named the Lolophond. Coolies coming and going from Goma arranged a camping-ground on the left moraine of this glacier which they called Lolophond. The width of the Siachen is $2\frac{3}{4}$ miles at entrance of the Lolophond, but, owing to foreshortening, such a width is not suspected from the pass. The largest Siachen east affluent is seen entering on its far side, curling gracefully around a bold rock promontory and continuing its way south-eastward with the Siachen, in tangled mazes of séracs and crevasses. To the east of the pass the Bilaphond peak rises, and to the west the summit of Peak 36, height 25,400 feet, towers above the mountains forming the Bilaphond wall. This latter peak, an object of great scenic effect elsewhere, here makes itself known only as a well-fixed survey point to aid the topographer.

A peak which I am about to mention, strikes the eye north, being one of the landmarks of the Bilaphond La. I had selected this mountain as offering a probable fine point of view in 1911, but the weather when we were in its vicinity was unfavourable for its ascent. If it were ever to be climbed this seemed to be the opportunity. The caravan was accordingly divided, the supply one continuing on to Lolophond. while we with a

smaller one, leaving the pass, descended north to a snow hollow, from which a steep, furrowed slope led us to a large plateau where camp was pitched in the snow at 19,000 feet. The next day more slopes were ascended to a rock ridge jutting out below the main peak. Here Dr. Hunter Workman set up his cameras and instruments and remained at 19,900 feet while I continued upward with three guides. It was a rather difficult climb, the middle part being decidedly precarious owing to the melting of the snow, through which we sank on to hard black ice, which necessitated constant step-cutting. On the last 200 feet the snow was deeper and more stable. The gradient was from 45° to 60°.

I saw many interesting things from this summit which aided me in the later work on the Rose glacier. Perhaps the finest was the double summitted Peak 35–36, which loomed directly south-west. This mountain was formerly called Karakoram No. 3 and 4 in 'Synoptical,' vol. 7, but at present its most up-to-date survey symbol is $\frac{\text{Pk. 35}}{25\text{A}}$ and $\frac{\text{Pk. 36}}{52\text{A}}$. I substantiated one special point also in connection with it. The snow-basin on the north side, much foreshortened in the photograph, is flanked by the unscalable boundary-wall rising between the Dong-Dong glacier, which lies directly behind, and the west Siachen affluent, which we have named Peak 36 glacier. We visited the Dong-Dong wall in 1911, and there exists no passage over the watershed between the Dong-Dong and the Siachen glacier affluent.

The most interesting peak I was able to secure with my small camera was probably the high one which we later discovered from the north-east Siachen source on the Turkestan side. The only Baltoro peak I could identify was the flat-topped Bride peak west of the Rose glacier. I named my new mountain the Tawiz peak, as it overlooks the Bilaphond La, where, according to the legend, in olden days the Baltis placed the Tawiz (magic) destined to bring about their revenge on the Yarkandis of the fabled city of Tarim Shehr. Its height measured by hypsometer is 21,000 feet. That night at camp on the plateau a minimum temperature of 3° Fahr. was noted. The next day we descended to the Rose glacier by the left Lolophond side, which we found both years to be the most feasible route.

The Siachen glacier is situated between lat. 35° 11′ 20″ and 35° 43′ 30″ N. and long. 76° 45′ and 77° 17′ 30″ E. It was first seen by Col. Henry Strachey, when, in October, 1848, he ascended it from its tongue for 2 miles. In 1909, Dr. Longstaff first crossed the Bilaphond La and discovered that the Siachen extended further north than had been supposed. It was thought by Thomson and Strachey, I believe, to end in a mountain wall about 20 miles from its tongue, and the Survey map gives it that length approximately. Dr. Longstaff visited its basin in 1909, remaining one day taking angles with clinometer to various peaks, and the same autumn ascended it from its tongue for about 10 miles. This was all that was known of the great glacier until 1911, when, as first stated, Dr. Workman

and I made a reconnaissance of its basin and explored two of its largest affluents. In 1912 my expedition first properly explored the glacier from end to end, discovered and ascended to its north and east sources, and established the relation of the eastern Karakoram-Indus watershed to that of Chinese Turkestan at those points. All of its chief affluents were examined and these and the main stream surveyed and mapped. Most of its important mountains also were triangulated. The glacier is 46 miles long, and its width for some 25 miles varies from $2\frac{1}{2}$ to $2\frac{3}{4}$ miles. It is without question the longest and largest valley glacier in Asia, probably in the world, excepting those of the Polar regions. According to Dr. Merzbacher, the Inyltchek, the longest glacier in the Tian Shan, has a length of 65 kilom. or 40 miles and a width of 2 to 4 kilom., $2\frac{1}{2}$ miles.

So far as I can learn after much inquiry, the meaning of Siachen is literally rose-bush. *Sia* is the Balti name for jungle rose, and *chen* means a collection of thorns. Such wild rose-bushes are prevalent in the nalas, and flourish in pink and white splendour to the tongues of the glaciers in this part of Baltistan. From Dr. Thomas, the Tibetan scholar, I learn that the Tibetan Se-ba-can means "having rose-bushes," so probably the Balti meaning is derived from the Tibetan. As is well known, Baltistan was subject to Tibet in the eighth century. Siachen, when correctly spoken, is guttural, and requires an effort to pronounce, and to my taste the English name Rose glacier is quite as appropriate. Its very incongruity as applied to this huge ice-sheet pleases the fancy. On many glaciers the jungle rose is found on mountain flanks well above the snouts, but on the lower Siachen flanks one is fortunate to find stunted edelweiss and other small Alpine flora, while on the route of its upper 30 miles only snow roses thrive. Ice formations resembling roses I noticed in some of its chasms.

In 1911 we made a base camp on the Tarim Shehr promontory. After the first 14 miles from the Siachen tongue, this is the only place in 33 miles where grass and burtsa for fuel are found. On Dr. Longstaff's sketch-map it is indicated as a nunatak, which perhaps it once was, but on near approach it is found to be a large granite and shale promontory descending from the slate peaks forming the barrier between the Rose and the east or Tarim Sehr affluent. The lowest point where it touches the Rose glacier is 15,670 feet, and directly overtopping it here is a slate peak, height 20,840 feet, which we climbed in 1911, and named Junction Peak. At the point where Junction Peak shades off into a gentle slope a good-sized offshoot of the Tarim Shehr glacier bears down upon the promontory in a tongue of white séracs. Below this are several acres of grass hillocks watered by glacier streams. Here any number of grass camps can be made in July and August, and here we found a stone circle 12 feet in diameter made at one time by natives. The stones, which were covered with lichens, had evidently lain untouched for years. No shelters such as were seen at Ali Bransa were found. Inside

the circle, large ibex horns attached to the skulls were piled up, certainly by human hands, and these were decayed and old, falling apart in shreds when touched. No carcasses were seen outside the circle, but the place was strewn with ibex horns, apparently from animals that had died or been killed by wolves or snow leopards. In other places the footprints of foxes and of some other animal which we failed to recognize, were observed. Large ram chikor flew out from the rocks when disturbed by footsteps, and there were a fair number of very small grey birds about in early September, which the guides called snow birds, being exactly like those found in the Italian Alps. Examples of bird-life are scarce on the high Siachen, and those existing seem to make their home here at the last grass.

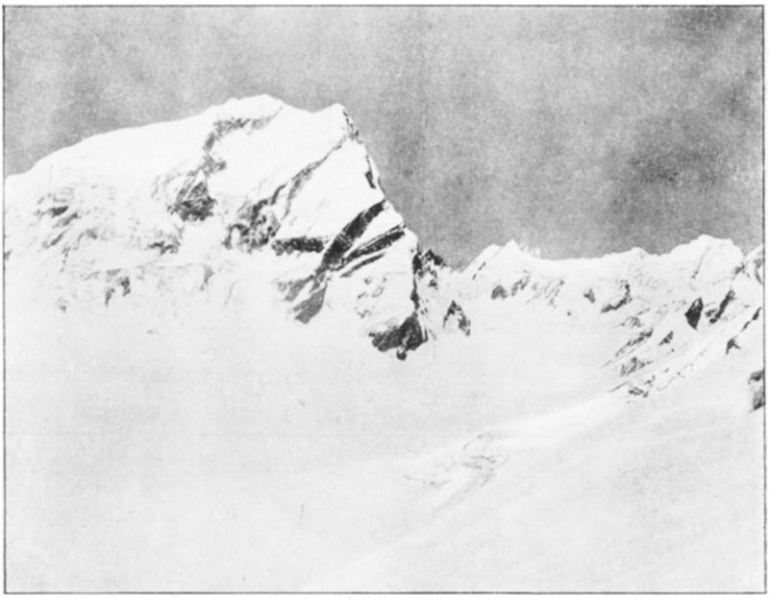
From the above-mentioned hillock-area a large torrent may be crossed and half a mile of slopes ascended to another rolling, much larger, grass-area, nestling in the hollows of which in 1911 we found two good-sized lakes. Here we made another camp in 1911 at 16,300 feet. Large ibex were seen daily here grazing. This part of the Tarim Shehr promontory is bounded on the north and south sides by bare shale and granite head-lands which rise abruptly from the glacier. Even on these rocky eminences rising to 800 feet above the second grass-area, tiny maidans for tents may be found now and again. This is a unique spot in the heart of this ice world, surrounded on all sides by miles of glaciers and ice-girt peaks, and may well be named Tarim Shehr, or "last oasis." Thus spelled Shehr in Persian means "city," and in the legend furnished me by the "learned men," there was supposed to be an ancient city here inhabited by Yarkandis. Here also the Baltis are said to have played polo with the Yarkandis, who from here went to the Ghyari nala to loot the cattle of the Balti villagers. Further, the legend explains why the ancient city was reduced to its present desolate and rock-strewn state.

On one occasion the Yarkandis kidnapped a Balti woman working in a field of a Ghyari village. An important Mullah, Hazrat Ameer, was in the village at the time, and he gave the enraged Baltis a Tawiz amulet, telling them to put it on the top of the Bilaphond pass, and to return to their village *viâ* Yarkand. The Baltis having done the first part, disobeyed the priest, and returned the same way, by the pass, home. However, soon after a great storm visited Tarim Shehr, "and the snow from the mountains slipped and fell upon the city," destroying it and its people, including those who had stolen the woman. Curiously, when first on the Rose glacier, the coolies never mentioned the place to us, and it was only when I spoke to my cook about going to the promontory that he said, "Oh yes; the coolies call that 'Teram Shehr,' and say it is a nice home with much grass." How they knew of it is one of those native mysteries one cannot solve. Dr. Longstaff did not visit the place, and, under all circumstances, it is hard to reach, owing to the broken condition of the Siachen for a

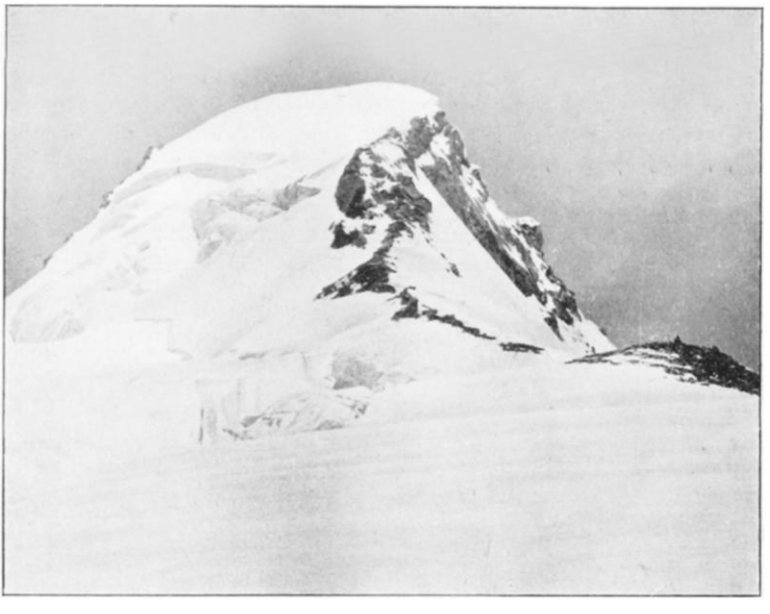
VIEW TAKEN FROM THE SILVER THRONE PLATEAU AT 20,600 FEET, SHOWING QUEEN MARY PEAK, MOUNT HARDINGE, AND THE PRECIPITOUS WALLS ENCLOSING HEAD OF NORTH-EAST KONDUS GLACIER.

THE SOURCE OF THE NORTH-EAST KONDUS GLACIER, THE GUSHERBRUMS, PEAK 23, AND ARÊTE OF QUEEN MARY PEAK IN BACKGROUND.

THE TERAM KANGRI FROM THE WEST SIDE OF THE ROSE GLACIER.



PEAKS 35 AND 36 AND RIDGE SEPARATING DONG DONG GLACIER FROM PEAK 36 GLACIER.



SUMMIT OF TAWIZ PEAK, 21,000 FEET, FIRST ASCENDED BY F. BULLOCK WORKMAN AND GUIDES IN 1912.

mile this side of it, and because of the numberless glacier-rivers to be forded. None of our coolies allowed that they had seen the place, and none certainly had been there before we led them to it, yet they had a name for it and said it was a good camping-ground. Beyond this, not a suggestion of a name for a spot above or below on the glacier was obtainable from our Baltis.

Regarding the term "Tarim," which I have adopted, I would say that neither experts in Tibetan, Persian, or Arabic, have been able to tell me of the existence of the word "Teram." The best informed persons of the Kapalu and Saltoro districts had no knowledge of such a word in the Balti language. As Tarim is used in Chinese Turkestan for cultivated area or oasis it is possible, as Sir Aurel Stein suggests, that the Baltis may have heard of it in connection with the Tarim basin or Yarkand as applied to the country beyond their frontier, and by usage easily have perverted it into Teram which they applied to Tarim Shehr. Anyhow, it seems best to adopt a term the meaning of which applies in a general way to the Tarim Shehr promontory, for that and the large east affluent, rather than to coin one for which no authority appears to exist. At Tarim Shehr three solid cairns marked B.W. in black were placed at different points, and one at our camp at 18,400 feet on Junction mountain.

On September 8, 1911, temperature 22° Fahr., we left the promontory to examine the Tarim Shehr glacier, striking it above the entrance into the Rose glacier. After five hours of easy slate and shale moraines came badly broken up granite ones, which so slackened the caravan's progress that camp had to be made on moraine at 17,500 feet. After a very cold night we continued up the glacier-surface, which in one hour became soft from the sun's heat. The whole route was dotted with snow-covered water-pools, into which to the knees one was constantly breaking. This zone ended, the gradient became much steeper. Seen from the Rose this glacier appears to rise gradually for miles, but in reality its higher part in 1911 was composed of three slopes broken by short snow terraces, and the whole area was distorted by transverse crevasses of a size and depth not met with on the Rose or its other large branches. A wide plateau was finally reached lying at over 18,000 feet. This white sea is riven with crevasses running in all directions. Leading the caravan cautiously in and out of this maze, we advanced until the guide said the risk was too great, as the caravan might at any moment become engulfed in this vortex of great bottomless chasms. From where we stood at 18,500 feet, the plateau imperceptibly rises to what looks like a snow depression on the north side of the east end. The passage, if there is one, would be by this narrow yoke. Should a descent on the further side be practicable, the head of one of the glaciers of the Remo system might be reached, and a route to the Shyok valley be found. We considered well before turning back here, but at last decided the risk was too great, of camping the caravan at 18,500 feet for two nights in the September cold, that year

very severe at night, particularly as the chance of our overcoming with the guide the 6 miles of crevasses leading to the col the next day was an uncertain quantity. The Tarim Shehr glacier is 17 miles long from its entrance into the Rose, and averages a width of 1½ to 2 miles before emerging into its reservoir basin. Peaks from 21,000 to 23,000 feet form its north and south boundary walls, and two of about 22,000 feet rise as isolated points from its reservoir-plateau.

In 1912 the Siachen sources first claimed our attention. When recalled from the lower Siachen my intention was to make a second attempt to reach the Tarim Shehr glacier source, but several reasons interfered. That glacier looked quite as impossible in its upper trend, as in the previous September. Provisions and coolie patience were at a low ebb, and ten days of fog came to hold us captive on the higher Rose. Finally, events worked together to make it a question of forcing a new passage at the Rose glacier west source-head or of attempting to reach the Tarim Shehr col, which, if reached, might be found to be a passage to some other glacier. Both could not be accomplished by my expedition that season. I had just the force of men and provisions necessary for returning by unknown ground to Baltistan, but not that needed to descend a new glacier east of Tarim Shehr, which it would be desirable to do if one existed, and wander down to somewhere in the Shyok valley, where most likely my caravan would find no supplies; and, as things turned out, I chose, wisely, I think, to do the former. If Dr. de Filippi's expedition explores the Remo glaciers to their heads, it will doubtless ascertain whether or not a pass leads from any of them to the Rose glacier.

I will next mention the Teram Kangri. This massif-like ridge culminating in several peaks rising from the Siachen basin and forming part of the east boundary wall, 18 miles from the north water-parting, was first seen by Dr. Longstaff from the Bilaphond La in 1909. During his day's visit to the Siachen he measured by clinometer three summits of the group, giving on his sketch-map later the height of 27,610 feet to the highest, called by him Teram Kangri. The apparent discovery of a very high peak in the eastern Karakoram created considerable interest in the geographical and Alpine world. In 1911 the Indian Survey sent Mr. Collins of the Survey to the Nubra valley, and from several high stations he triangulated the highest and lowest of the three summits with altitude results of 24,489 feet and 24,218 feet. That same season our topographer, Dr. C. Calciati, during a short visit to the Siachen triangulated the peak east of the one measured by the Indian Survey as the highest, for which he obtained a value of 24,793 feet, or 7559 metres. This he regarded as the highest summit.

In 1912 Mr. Grant Peterkin triangulated all three peaks of this group with results of 24,510 feet, 24,300 feet, and 24,240 feet being obtained for altitude. His observations show the middle peak to be the highest, corresponding thus with the result obtained by the Indian Survey, although

the value obtained for its height is somewhat greater. This ridge of peaks when seen from the Bilaphond La makes no extraordinary impression upon the observer, and I wonder that Dr. Longstaff should have selected these summits as being of unusual height. While prominent, the peaks of this ridge in their relation to the Rose glacier, are of quite secondary importance to the King George V. group at the source of this glacier and to Peaks 35 and 36 to the south-west. With the work done by the Survey and by my 1912 expedition, they may now be said to be triangulated fairly accurately for height.

Our visit to the Peak 36 glacier and ascent on Peak 36 itself to 20,000 feet, as well as some other points investigated, are on account of space omitted from this paper. As crossing the Rose to Tarim Shehr necessitated the fording of many glacier-rivers and finding a way through several intricate belts of séracs which might prove hazardous to coolies going and coming under native leaders, we gave it up in 1912 as a grain-base, using it only to procure burtsa for fuel and to harbour sheep. A higher base for collecting supplies was made on a Siachen moraine at 16,400 feet, and placed in care of a Srinagar babu. The gradient of the Siachen in a distance of 12 miles upward from Tarim Shehr is easy, showing a rise of 1442 feet, or one foot in 43. The best route is along the east side by bands of shaly median moraines. The camping is not much better than upon snow, for where the moraines do not rise in high, undulating hillocks, the surface-covering is sparse, and tents stand practically on thinly covered ice. These miles of moraines, strewn with blocks of marble and other *débris*, are very interesting, but do not come into the scope of this paper, and will be described elsewhere.

On July 18 we left one of these moraine camps at 17,000 feet for an attempt to reach the Siachen north source. Passing the last west affluent, which enters above the Peak 36 glacier, we continued up the Rose, which here takes on a sharper gradient and narrows somewhat. By 3 p.m crevasses and soft snow made advance so slow that camp had to be pitched in the middle of the glacier, 18,050 feet. The weather seemed uncertain at evening, and the next morning we found the tents laden with snow and a heavy storm in progress. When escape is possible there is no use waiting about under such conditions, so we packed up and descended in a dense mist for three hours with snow cutting our faces like a knife. Camp was made on snow-covered moraine at 17,200 feet. Luck was not yet ours, and that night the elements raged again and continued to do so for two days more. When the clouds broke a little the third day, but with a bad wind holding and four feet of new snow now lying on the higher glacier, as provisions were low we marched down to a mountain-*arête* to await favourable skies. From this perch at 16,770 feet for one day before the snow melted, the Siachen stretched above and below us like a great snow-sea, not a crevasse or rock being visible. Then the magic sea vanished and out cropped the crevasses, rocks, and

normal glacier-features, and with them came a change of wind which set us to hoping. Lastly, our three mascots appeared on the scene and began to caw loudly. I would mention that three crows had followed the camp from Ali Bransa, and continued to accompany us to the sources and to all camps to the Kondus tongue. They were not even distinguished by red beaks as are mountain choughs, but were well-nourished crows of good size, which took care to find a living off the camp, and did not suffer for five minutes from mountain lassitude even at over 20,000 feet.

After this delay, on July 25, a second start was made and we camped again on the end of a moraine at 17,200 feet. The next day we pushed on a good distance above the previous glacier-camp to a high shale ridge which juts into the glacier from the east side. About 200 feet above the glacier near the base of this ridge a small rocky spur was discovered for camp. Circling the base of the spur on all but one side was a deep blue lakelet encased in white ice-walls. Tent terraces were constructed amid the rock-chaos, and we thought ourselves fortunate to find such good quarters on soil near the Siachen head at 18,400 feet. A highly interesting find was made here—the lower layers or remains of two native stone cairns. They were nearly demolished, but it was quite plain that only human hands could have placed the rocks as we found them.

On July 27, temperature 15° Fahr., we left Spur camp and descended to the glacier. The ridge of the east wall, before spoken of, upon which the camp was located, projects into the glacier for some distance, thus causing a narrowing in of the Rose before it reaches its upper basin. After contouring this we ascended sharp, crevassed slopes for 1½ hours before reaching a large plateau. From this basin west rises a low snow mountain, and beyond it the high precipitous walls of the King George V. group which close the Rose glacier in an impenetrable barrier. Although high enough in themselves, these are really only lower walls of the group, which dominates in four high peaks the north-west head of the Rose glacier. Neither Peak 23 nor its satellites are seen from this point. From the east side of the plateau gentle slopes rose toward an apparent, but from here invisible, col. But this was not in that day's work, so we continued north over rising hillocks and slants which became most wearisome as the snow softened, letting us in to the knees at about every step. There was nothing to guide us, but after consultation we headed toward a snow peak of probably 22,000 feet, which apparently stood at the end of everything. On the west or left we passed the snow gap with a bergschrund at its base, that is seen for 30 miles down the glacier, which Dr. Longstaff noticed when he reached the Siachen, and which he says "he connected at once with the sketch of Younghusband's Saltoro pass," which he had seen in his report. This gap is what I suppose Dr. Longstaff refers to as Younghusband's saddle and designates by that name on his sketch-map. The gap is, however, no pass, and bears no relation to the real water-

parting ridge, which latter is not seen at all from any point of the Rose glacier. It is a narrow connecting link between some peaks of the intricate Siachen reservoir, merely an idiosyncrasy of nature, thrown in to mislead any one casually looking up from the middle Siachen. Beyond this false col is a deep snow-basin.

Leaving this point a mile or so behind, we came to a peak the east shoulder of which gave us a sharp bit of climbing. By this time we were well out of sight of the main Siachen reservoir, and after a descent continued along a previously unseen high snow-field. The whole *trajet* in the deep soft snow was exhausting, and we were relieved when upon contouring a reach of gaping crevasses the ridge was at last approached and distant peaks, rising from beyond a void, came into view. The guide, stepping ahead, called out, "Slowly, we must rope; it is a line of huge cornices." And so it was, not one, but rows of them, extending right across the ridge to the base of a sharp peak which forms the east boundary of this water-parting. We went as near the edge as possible, and saw these monsters curling over in great white hoods, fringed with massive pendants of ice. Below these fell a perpendicular snow-wall 5000 to 6000 feet to a basin. Bounding this basin was a long splintered rock-ridge which, as could be seen, formed a wall near one head of a large glacier flowing down north-north-east into the verdureless barren region of Chinese Turkestan. Besides the source above which we stood, this glacier had another, plainly seen, to the west on the flanks of the Gusherbrum range. From the latter, the glacier at first descends in chaotic ice-falls.

At the moment of arrival on the ridge we saw three tremendous rock-peaks piercing the clouds to the north-west, beyond doubt from position and appearance the Gusherbrums, but before the camera could be used their tips were lost in cloud. The continuing walls of the Gusherbrums, of which we saw all except a small corner, joins that of Peak 23. The rounded snow elevations seen at the west of the watershed col, running in intricate lines east and west, form a part of the very long but continuous east *arête* of Peak 23. Hence, the Rose glacier may be said to find its main source in the King George V. group, while the east *arête* of Peak 23 itself descends to the col and builds this part of the water-parting between the Indus and Chinese Turkestan. From here the watershed turns south-east and follows the north-east Siachen wall for 14 miles, beyond which we could not with certainty trace it, but it apparently is formed by the remainder of the wall extending to the head of the Tarim Shehr glacier.

A triangular mountain massif, the beginning of which is seen in the illustration, runs south-east from this Turkestan glacier and forms, from what we saw from the east col, the barrier wall between the glacier here spoken of and another large glacier which we discovered from the east col. The glacier here seen is different from those I have met with on the Karakoram side. As may be observed, grey moraines, and they are high ones,

descend through its middle, and they run thus a long way toward the tongue. The ice encasing the moraines on either side was composed of lines of tall pyramid and wedge-shaped white pinnacles, and nowhere were crevassed ice-bands to be detected. My impression was that the glacier could be ascended nearly to its source by a moraine route. From my own observations and after consultation with Sir Francis Younghusband, I judge this to be the Gusherbrum glacier, the tongue of which he visited in 1889. I am glad that we have been privileged to see and photograph it from above one of its sources, and to have aided Indian geography by definitely fixing this important Eastern Karakoram water-parting. The watershed-ridge measured by us with hypsometer works out for height at 20,860 feet after comparison with lower station readings taken three times daily at Skardu. I have named this ridge the Indira col. The only other explorers met with here were a dainty brown butterfly and a large sluggish wasp. The latter greeted us amicably and seemed content to sit for five minutes at a time on the point of my ice axe. There was a high wind blowing, which had perhaps wafted them up to meet us from Kashgar. The thermometer registered 50° Fahr. when we left to descend to our distant camp.

We next day investigated the east Rose source, returning first to the high plateau and then, turning east, ascended by easy slopes in two and a half hours to a snow saddle. This col lies at the base of a long shale mountain-*arête* upon which, if necessary, tents could be placed on rock. It was of interest to note that, on this most forbidding of glaciers for tent-nomads, at one of its heads a dry camping spot may be found. The saddle measured by hypsometer is 19,210 feet. The first thing that impresses the visitor here is the grand group of high peaks looming up as in the photograph, a little to the south behind the east Siachen wall, on the Turkestan side. They are lofty, wild, and complex, rising from intricate snow valleys and elevated plateaux. They have not been placed on any previous map, and were evidently here seen for the first time. The col we stood on, seen in the view, forms a semicircle and ends in the bergschrund-festooned wall visible in foreground of the peaks. Directly below the col a sharp drop occurs, of say 2000 feet. Below, this wall shades off into a short crevassed glacier, which, as an affluent, joins a wide trunk-glacier flowing north-west towards its tongue. We saw well only the upper part rising south-east towards its source behind the group of peaks above mentioned. From the edge of the col the end of the triangular mountain-mass discovered from the Indira col was seen, and the main glacier appeared to take its downward direction along the base of these mountains.

It is probable that this large glacier flowing north-west joins the Gusherbrum stream seen from the Indira col beyond the triangular mountain range, or that both end in the same valley near together. The lat. 35° 41′ 20″ of the point reached by Sir F. Younghusband on the

Urdok glacier would about correspond with that of this col. After consultation with him there appears to be but one conclusion possible—that this is the glacier he ascended in 1889 in search of the Saltoro pass and named the Urdok. The col he saw culminating the Urdok is probably a ridge of the mountain group seen by us from the east Siachen col. This "Younghusband saddle" at head of the Urdok glacier could not lead to the Siachen, as on the east Siachen wall above Tarim Shehr there is no break or possible pass. This east col, therefore, is another and more easterly point on the watershed-ridge towards the Turkestan side, which, with the north one, makes two, which I think I may, with my *confrère* in exploration, justly claim to have discovered and first visited. I have called it the Turkestan La on the map, because under proper European leadership it could be crossed with difficulty by coolies up to August 1 in ordinary seasons. But, in my opinion, it could never have been employed as a passage by Kashgar people to Baltistan or Nubra for two reasons. First, it would be fraught by too many mountaineering obstacles to be used as a caravan route by natives of Turkestan. Second, not being the culmination of a main artery, it would be observed by them only as a ridge at the top of a branch of the Urdok, which it would not occur to them to explore. Here, there is no obvious route such as exists from Nagar over the Hispar pass to Baltistan, for example. In some isolated case a party may have been driven by circumstances from Baltistan or Nubra to seek a way out to Turkestan, and on ascending to the Siachen reservoir found an exit here. This, if accomplished only once, would account for the cairn remains found at Spur camp.

Another explanation of the Spur camp cairns may be sought in the possibility of Nubra or Goma people having penetrated that far up glacier in search of a pass, and, not liking the appearance of the snow-wastes above, having returned down the Siachen. This might also account for the stone circle at Tarim Shehr. But I fear no light can be shed on the matter, certainly not in the Saltoro valley, and, from what I have heard from persons who have inquired in Nubra, the people there appear to have no knowledge of the Rose glacier.

One may weave what romance one will about the cairn-remains near the Rose glacier source, but I think what we saw at the north and east points of the water-parting demonstrates pretty conclusively that no caravan route for either laden animals or men has ever existed there. Sir F. Younghusband tells me that a sportsman with a few natives of Kashgar thinks he crossed the water-parting somewhere in this region ten years ago. He could not, however, remember being on a large glacier during his journey, nor give any details pointing to the route traversed, and only recalled Kiris in the Shyok valley as the first village he reached. At any rate, it is quite certain that he did not cross by the north, north-east, or west Siachen sources.

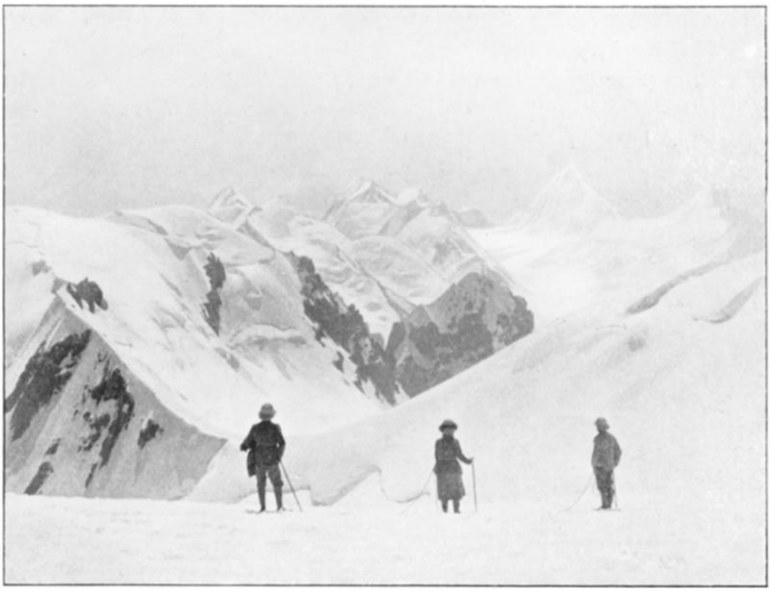
During these days a white mist hung over the mountains and about

the Siachen, which proved disastrous to photography. It was cold at night and very hot after 11 a.m. On the col described, the glass stood at 32° Fahr. at 9 a.m., and at noon a black-bulb thermometer reading of 200° Fahr. was noted. The weather still holding fair, we at once started for the west Siachen head lying above the last west affluent. Before leaving Spur camp a large cairn was built and marked B.W. in black with the date. Descending the Rose glacier by the same route for a time, we crossed later to the west side just above the entrance of the upper west affluent. Here the glacier from melting was turned into a series of slush-covered lakes which were best crossed on hands and knees. The broad west branch enters the Rose at over 17,000 feet. It is a snow expanse from one containing wall to the other. Crevasses, which are legion in the lower part, remain mostly snow-covered, and therefore doubly dangerous, until August. After the first quarter-mile the gradient is a steadily-ascending one, to where in its upper portion it assumes the appearance of a slowly rising plateau. From here its source, still distant, may be seen, backed by two beautiful snow cones, which we called the Silver Throne, probably about 23,000 feet high, and Lower Silver Throne. We climbed beyond the crevassed zone and camped near the centre of the glacier at 18,700 feet. This camp, where we passed three nights, was a source of many lamentations from the coolies, because of the absence of rocks and of lakelets so abundant on the Rose glacier.

The next day in a strong wind, temperature 14° Fahr., we continued on due west toward a depression between the Lower Silver Throne and the north border-peaks of the glacier. On near approach a reach of large open crevasses was found to stretch across the glacier, and to get around these we should have to traverse the glacier and climb up the mountain flanks to look over the dip now seen to exist beyond. As geographical information from a high point was our object, it was clear that that was not the place to find it. The guide insisted that, did we go, we should see only a precipice instead of a pass. I decided that the depression must, however, later be examined, as it might prove to be a real west source passage to another region. A high col connected the higher and lower Silver Throne peaks, so we climbed the slopes a little south leading over the lower peak flanks, and in two and a half hours reached the snow yoke.

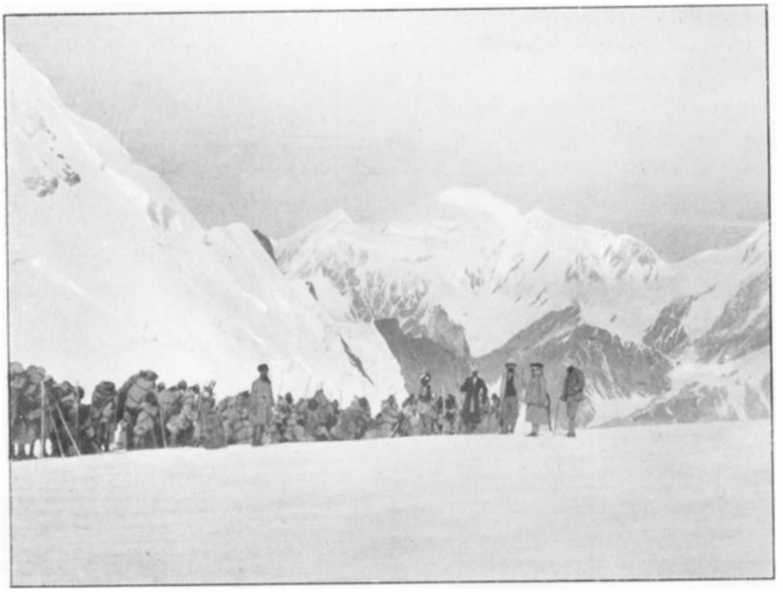
Here an interesting scene lay before us. A large glacier, the visible source of which was walled in by high rock-cliffs, lay 4000 feet below. Long moraines extended nearly to its reservoir, evidencing that this lay at not much over 16,000 feet. It seemed probable that the Kondus glacier backed against the Siachen west tributaries, further east near the Sherpigang wall, and so we put aside the thought of its being the Kondus. It did not appear wide enough or far enough north to be the Baltoro. Awaiting further developments, photographs were taken of a peak facing the Silver Throne on the opposite side of the new glacier. This proved to be a

TARIM SHEHR PROMONTORY TAKEN FROM 18,400 FEET, SHOWING JUNCTION OF TARIM SHEHR BRANCH WITH THE UPPER ROSE GLACIER.



ON THE TURKESTAN LA OR NORTH-EAST SIACHEN WATER-PARTING, 19,610 FEET. GROUP OF PEAKS TO THE SOUTH FIRST SEEN FROM THIS POINT.

PEAK 8, PHOTOGRAPHED FROM JUNCTION PEAK AT 18,400 FEET.



ON THE SIA LA, 18,000 FEET. BRIDE PEAK IN BACKGROUND.

lower peak of the Golden Throne, the highest being behind further north. We faced an unknown, unmapped area, being confronted by four or five first-order Himalayan giants, the tortuous ridges, intricate valleys, and lesser peaks of which were hurled into a stupendous mountain ensemble, not to be accounted for with precision at first glance. I shall return to these peaks, which are seen to greater advantage from the high Silver Throne plateau. This saddle, 19,600 feet, can be crossed by mountaineers, but is not feasible for a coolie caravan.

With weather still fine the next day, facing a still more glacial wind than on the previous one, we retraced our steps toward the source. This time, by ascending on the flank of the north containing glacier-ridge, a view over the gap was obtained. Here, as I had surmised, the real outlet to the west Rose source was seen. From the ridge connecting the lower Silver Throne with the opposite mountain *arête* a long snow defile ran downward to the new glacier, a bit of which could be detected in the distance. Being satisfied on that point, we turned south again, and, climbing beyond the col previously visited, over rising schrund-gashed hillocks, headed toward what appeared to be a still higher ridge south of the main Silver Throne peak. Finally surmounting a snow wall, we reached a large plateau not before supposed to exist, stretching south. A ridge at its end was climbed which overhung the glacier discovered the day before. The plateau at its lowest point is at 20,450 feet, and at its highest 21,000 feet altitude. From here the lower Silver Throne was overlooked, and a grand view of the Gusherbrums and the King George V. group obtained.

Peak 23, or Hidden peak, elusive and well named, no doubt, by Conway so far as its relation to the Baltoro glacier goes, assumes another aspect in connection with the Rose glacier. It is seen 30 miles down the glacier as its *motif majeur*. As I said before, its great east *arête* forms the north water-parting ridge, and its east and south flanks throw off the snows that produce the reservoir and upper *névé* of this glacier. Its high satellite-peaks again drain to and form much of the snow supply of the upper west Rose affluent, so that this group may truly be called the originator and large supplier of the Rose glacier. Peak 23 is also called by the Indian Survey Gusherbrum I., but it is a higher, more impressive peak than the others of that name, and stands at some distance removed from them. This mountain, with the three high peaks south-east of it on the same ridge, builds a group of its own 11 miles long distinct from the peaks to the north, and I have the honour, with the gracious permission of His Majesty, to call it on my map the King George V. group. Particularly impressive from the Silver Throne plateau were the two second highest mountains of the group which were first discovered and triangulated by this expedition. The highest of these, seen in the photograph taken at 21,000 feet, I have with the permission of Her Majesty named Queen Mary peak. Its height is 24,350 feet. The second peak,

23,270 feet, I have pleasure in naming Mount Hardinge, after H.E. the Viceroy of India.

It may be noted I have named no peaks already triangulated and numbered by the Indian Survey, and I entirely agree with the policy of the Survey in keeping Government maps of Asia free from personal names. *Re* Himalayan nomenclature, I quote the greatest authority. Col. Burrard says, "The numerous peaks which have no native names, have been numbered in a scientific way, after the astronomical system." As the present system of nomenclature has extended throughout Southern Asia, the new Survey symbols placed on my map seem likely to become permanent ones. This in no way affects the nomenclature adopted by explorers for new peaks shown on their private maps, and it seems to me appropriate that illustrious British names should adorn the first detailed and fairly accurate map made of Asia's greatest glacier.

Our high plateau was of particular geographical interest, as from it could conclusively be proved that the King George V. group with its formidable precipices prohibits both at the north and west Siachen sources all passage from the Siachen to the Baltoro glacier, which is not a complement of, nor has it any relation to, the Siachen. Behind the sheer snow-painted ridge seen in the foreground of the King George V. group in illustration a snow valley runs to a col climbed by Mr. Peterkin, who saw a distant snow ridge below the Golden Throne probably lying above the Baltoro glacier, in which direction he was looking, but near the col the snow expanse he overlooked ends in a rock precipice falling to the main Kondus source that we examined later and found to be an impassable wall. The mountain ridge alluded to in the view separates the valley and col visited by Mr. Peterkin from the pass crossed by us to the Kondus and runs nearly parallel to it in direction.

While on the Silver Throne plateau clouds rising from the south swirled over our heads, dropping occasional snow-flakes as a warning for us to depart. We had gleaned most of the secrets of the Siachen, and could not complain if the weather-god now turned his attention to fulfilling the prayers for storm contained in the Tawiz of the coolies. Contouring chasms and plunging to above the knees over the sodden snow-hillocks, we returned to camp, and, after a night of blustering wind and snow, descended to the Siachen in a blinding storm. I was, however, convinced that in order to complete the exploration of the Siachen basin and sources, a return must be made to the icy west head, and our exit carried out by the lately-found passage there. We next descended the Rose glacier to the great bend, a short distance above the point reached by Dr. Longstaff from Nubra. Here, owing to delinquencies on the part of a headman, we were forced to return to the high Rose.

Mr. Peterkin thoroughly carried out the mapwork on the lowest Siachen to the Nubra river. In spite of careful observation, nothing was seen of

Dr. Longstaff's cairn at the point indicated on his sketch-map. In some unknown way it has doubtless been demolished.

Above Tarim Shehr on the return, a camp was pitched at 16,600 feet on moraine-strewn ice, where supply and transport exigencies, abetted by continual fog and storm, kept us prisoners for ten days. The minimum temperatures at this camp were 10° and 15° Fahr. only, but with no sun by day and high winds at night we felt the cold more than at dry, cold, higher camps where the thermometer fell to near zero. Tinned provisions disappeared slowly, for even the guides had long since arrived at caring for little beyond soup and light food. They attributed this to *ennui* at the long detention, but I think it was the effect of altitude. We had been four weeks, with the exception of three days, always above 16,600 feet, and most of that time above 17,000 feet, and I noticed that all our Europeans ate steadily less as time elapsed. I have often observed this effect upon the appetites of our Europeans, after any stay above 16,000 feet. I still maintain, H.R.H. the Duke of the Abruzzi's experiences to the contrary, that Europeans do suffer from insomnia at camps above 20,000 feet, for I have seen these facts borne out, not only upon ourselves, but very decidedly upon our numerous hardy young guides and porters during seven different Himalayan expeditions.

On August 20, our caravan of sixty-six left Boulder camp and marched up to the end of the east latero-median moraine. Here the final preparations of coolie food for twelve days were made, although the weather was uncertain and the sky leaden. The next day, under a threatening sky, we crossed the Rose, the three crows gaily leading, and ascended toward the old snow camp. The snow was at its worst and the coolies lagged badly, notwithstanding half of them wore nailed boots. We camped not far from the col in a freezing temperature and snowstorm at 3 p.m. It cleared about six, and after a cold, still night, minimum temperature 3° Fahr., we continued on to the ridge, Nature for the first time in many days smiling radiantly upon us. A somewhat long descent occurring before the final climb to the col places the actual saddle measured by boiling-point at the same height as the camp, 18,700 feet. This Siachen-Kondus water-parting-col I have named the Sia-La. Here the caravan was photographed against a background of the lower Silver Throne *arêtes*, with Bride peak looming grandly into the deep blue vault above.

The descent to the Kondus glacier is of about 2600 feet. The gradient of the upper third was sharp. At about the halfway point the surface became greatly broken by huge chasms and fissured by wide crevasses running from side to side, which necessitated long *détours*. Fortunately, a good route on the right side was chosen, for by August 20 the left side is so riven it cannot be traversed at all. A moraine ridge below was reached by noon, where we lunched in full view of the large glacier streaked by black and grey moraines and of the precipitous grim walls at

its head. These walls were thoroughly examined, as we were now quite certain that we were on the upper Kaberi,* or Kondus glacier. The Sia La descends to the Kondus not at its head, but from the east, and its existence would not be suspected by persons ascending even the upper part of the glacier. Near the source, behind the Silver Throne *arêtes* and on the true left side, the glacier leading up to the pass is first seen. Hence the topography is as follows: Bride peak, seen apparently nearly over the Kondus from the pass, really lies some miles west—so far west that it is actually beyond and west of the second Kondus north-west branch seen on the map, and of which I shall soon speak.

A lower peak of the Golden Throne rises above the Kondus source north, and the King George V. group lies behind the Kondus head also north. Peak 23 itself lies some 8 miles north of the Kondus reservoir, and its snows on this side do not drain to that source. Those of a part of Queen Mary peak do fall to the shelf above the Kondus precipices. The deductions made by the Abruzzi expedition, that a probable pass exists from the Kondus head to the Oprang basin and Urdok valley, are quite awry, but the opinion of Signor Novarese that the westernmost extremity of the Siachen communicates with the Kondus exact, so far as it goes. But he is wrong in his supposition that the Kondus head intervenes between the Siachen and the Urdok glacier. The Kondus head lies further west and south than he supposes, and between that head and the north Siachen water-parting, which overlooks the Gusherbrum glacier, the broad 11-mile-long King George V. group intervenes.

Overtopping the Kondus reservoir is a high granite and shale wall broken at one point by a projecting *arête*, between which and the main glacier a short glacier descends to the reservoir. The *arête* of the lower Golden Throne builds a part of the Kondus wall, and above, far behind, lies what on Conway's map is called "Probable Saddle." Here may be a col overlooking the Baltoro, but there is no pass from it to the Kondus glacier.

South-west of the Golden Throne massif, at point on Conway's map marked "Kondus Saddle," is in reality a sheer snow wall, which does away with that saddle altogether. Thus these two saddles as passes are non-existent. The Kondus basin is entirely closed so far as any communication with the Baltoro glacier is concerned, and has but one outlet, which is to the Rose glacier west affluent. The mountain topography here is complicated, and can only be unravelled by overlooking the Kondus source and its outlying great mountains from elevated points and by visiting the source itself. We were fortunate to do this in clear weather, and I think my report of the connection, geographical position, and

* To natives of the Kondus valley the Kondus glacier is known only by the name Kaberi.

conditions here will be found in the main to be correct by future explorers.

Following the Kondus down southward, numerous affluents are seen entering from the right side, descending from the precipitous narrow ridge which divides the main north-east from the second north-west branch. At about 10 miles down, the chief stream, with which we are dealing, makes a distinct bend south-west, and below the bend the north-west affluent enters, the two streams uniting and forming one, which continues south to its tongue in the Kaberi nala. Any one ascending the Kondus from the tongue, in 10 miles would see nothing of the main north-east branch, and even where the bend occurs, nothing is seen of it until an opening is discovered between gigantic border-cliffs. It is the most hidden of hidden glaciers. No Survey man nor any one else having gone more than a mile above the tongue before our 1911 expedition, accounts for the mistake on the Survey map, which shows one main glacier running to the base of Peak 23.

To return to the north-west affluent. This is shorter than the north-east, and is separated from it by a narrow barrier-ridge, which in its upper part we overlooked from the Silver Throne col. We saw also from there a part of the sharp wall rising above the north-west Kondus head. We ascended this branch far enough to see that Bride peak lay west of its source, and that the reservoir was like the main north-east Kondus, walled in by high cliffs, which afford no pass to the so-called Chogolisa saddle existing on Conway's and the Abruzzi maps. In 'Karakoram and Western Himalaya,' Dr. de Filippi says that "The southern wall of Chogolisa is very steep, and that the Kondus was not visible from the Duke's point of observation." This I can believe, and it serves only to confirm my own observations. Had H.R.H. the Duke of the Abruzzi been aware that there are two upper Kondus glaciers, when he stood on "Chogolisa," he would have realized that the "large valley running between two parallel chains of high mountains on the other side of the Kondus basin" was not the Siachen, but probably the north-east Kondus glacier. He was above the north-west Kondus basin, and doubtless could not see the reservoir of the north-east Kondus. Further, there is no pass from the north-west Kondus to the Chogolisa glacier next west of the Kondus, for we found on examination in 1911 an impenetrable mountain chain on that side of the Chogolisa glacier head. Dr. Calciati states that he thinks one of his older coolies said that he in his youth had crossed from the Kondus to Hushe. It is not likely that such a passage was ever made by natives from anywhere on the Kondus, but at any rate no passage exists at the north-west Kondus head to the Hushe glaciers.

As obviously no pass exists from the Kondus to the Baltoro or the Chogolisa glaciers, the name Chogolisa saddle in the sense of pass should not be inserted on future maps. As a euphonious native name there is

no objection to it, but, as the glacier bearing the same name does exist and claims no relation to the so-called saddle, it is, to say the least, an irrelevant and misleading term.

As stated in my preliminary report the Kondus is the most tiresome glacier we have met with in the Karakoram to travel upon. After three miles from its source, it descends in hillock-moraines in places 200 to 300 feet high. These extend from one containing wall to the other, and I recall only two small stretches of a quarter-mile, where it was safe to proceed in a narrow sand-ravine existing between these hillocks and the cliffs of the perpendicular rock-peaks which border the glacier. At a point 6 miles from the tongue, on the left orographical border cliffs we painted the letters F.B.W. with date, in black, and built a cairn on a ridge under the rock face.

As to climatology, I have a few facts to add. In 1911, between August 20 and September 15, and in 1912, during July and August, we found, as a whole, better weather-conditions on the Rose glacier than we have ever noted in the Western Karakoram. The south-west wind brought mist or storms, and there were plenty of them, but the north and north-east winds brought fine weather which lasted for longer periods than we have experienced on the Biafo, Chogo Lugma, or Hispar glaciers. Dr. Longstaff thinks June the best month for high climbing in the Eastern Karakoram, but in 1912, July was a better month for high work than June. In both these years the south-west monsoon was light in India, and the whole vale of Kashmir suffered much from drought. In the Kapalu district almost no rain fell in July and August of either years. These facts doubtless counted much in our favour on the glaciers. Certainly 1911 and 1912 were favourable weather years for snow work in the Eastern Karakoram, but they offer no basis for claiming better or worse climatic conditions in general for the Eastern over the Western Karakoram.

No Tawiz amulet was worn to bring us luck, and fair skies were needed to carry out the work planned. Certainly what measure of accomplishment in that line was ours came through persistent endeavour and the aid of the weather-god, who on special and critical occasions favoured us, and to him are due my deep salaams.

APPENDIX.

Notes of the Rose Glacier having been an Old Time Route to Nubra or Chinese Turkestan.

Regarding the eight stone shelters, one stone circle, and two cairns, found by my expedition at Ali Bransa, Tarim Shehr and the North Spur camp, and their bearings on the question of the Bilaphond and Rose glacier having been once used by natives as routes to Turkestan and Nubra, I have a few words to say.

In the *Geographical Journal* of June, 1910, Col. Godwin-Austen says that "after looking at the map," it appears to him that this pass, referring to the "Saltoro," "was in all probability a way by which the people of Baltistan got into Yarkand." This remark was made after Dr. Longstaff's short visit to the Rose glacier, when nothing was really known as to the water-partings on that glacier, and when all that could be said was mere supposition.

From what I have seen of them, I do not hesitate to negative the idea of either the Bilaphond La or the Rose glacier having been at one time a route from Baltistan to Chinese Turkestan.

The two remaining points of exit are those by the east Tarim Shehr affluent and by the Lower Siachen to the Nubra valley.

The passage, should it exist, from the head of the Tarim Shehr glacier, could only lead to the Remo or an adjacent glacier draining to the Shyok valley, and that would be, apart from the prohibitive ice-conditions, a circuitous route. No shelter-huts were found on any part of the promontory at entrance of the Tarim Shehr glacier into the Rose, only one stone circle, and on the 17 miles of glacier to the source no vestiges were seen. It has been said, I know, that, when driven by stress of circumstances, natives will find a way out over most arduous routes, yet even allowing for this, it is most unlikely that people either from Nubra or from Baltistan would attempt passing by the east Siachen affluent.

The suggestion by Dr. Longstaff that the Bilaphond La was once "used as a short cut from Baltistan to Nubra," appears fairly plausible, although no records of this passage having been employed are available. No signs of former human birds of passage were found by my expedition between Tarim Shehr and the Siachen tongue, but the fact remains that Ali Bransa was by previous generations occupied as a bivouac and most likely more than once.

What tells most against the idea of this having been a usual route to Nubra, are the very difficult physical conditions of the Rose glacier the whole 23 miles to its tongue, the unfordability from May to September 15 of the Nubra river, and the sparsely inhabited and supplyless area encountered in the Nubra valley before Pananik village is reached.

Whether like serious obstacles were less in evidence in former times, must be answered by one competent to solve these problems, which I confess I am not. So far as the present-day Baltis are concerned, I feel sure they would proceed by the Chorbat, or any other remote road, rather than thread the mazes of the Rose glacier and face the Nubra water-crossings.

A route to Nubra by the Rgyong La, since on its summit Dr. Longstaff found a cairn, would, it seems to me, have been chosen by natives, rather than the one over the Bilaphond La, but that does not bear upon the point here at issue, which hinges on the presence of the shelters at Ali Bransa. Again, perhaps the Baltis previously said to inhabit the Ghyari valley, on occasion climbed to the Rose glacier, carrying their investigations as far as the opposite Tarim Shehr grass-area and then returned over the pass home.

This suggestion credits the old-time Baltis with exploring proclivities which certainly those of to-day are not guilty of possessing.

These questions in human geography, if I may so call them, are interesting, pertaining as they do to the Rose glacier, a vast intricate snow expanse, stretching its long snowy affluents, ice-bound water-parting ridges, and formidable crevasse-riven tongue, as defiant bulwarks toward Baltistan, Chinese Turkestan, and Nubra. But, like those queries arising daily in other sciences, they must, I fear, abide their time and await a solution that may or may not be forthcoming.

Note on the Construction of the Map of the Siachen Glacier, by C. Grant Peterkin.

The map is an extension from, and is based on the fixed points of, the G.T.S. of India. During the survey five of these fixed points were observed to, namely, $\frac{\text{Pk. 8}}{52\text{ E}}$ $\frac{\text{Pk. 36}}{52\text{ A}}$, $\frac{\text{Pk 35}}{52\text{ A}}$, $\frac{\text{Pk. 33}}{52\text{ A}}$, and $\frac{\text{Pk. 23}}{52\text{ A}}$. The area covered by this survey, about 600 square miles, is given on the G.T.S. atlas sheets 44A S.W. and S.E. The topography there shown had been altered by the explorations of Dr. T. G. Longstaff's expedition (*Geographical Journal*, vol. 35, p. 622). An outline map, on the scale of 4 miles to 1 inch, was issued at Dehra Dun, showing alterations made by that expedition, and this was embodied in the R.G.S. map published as above. These were the existing maps at the time of this expedition.

The Survey of India now publish degree sheets, which are to supersede the old atlas sheets. The nomenclature of fixed points according to these sheets is shown.

The survey party was working on the glacier about nine weeks, having crossed the Bilaphond La on June 24, and recrossed on August 27. The season was an excellent one, at least 80 per cent. of the days being suitable for observation to high peaks. As is already known, the peculiarity of this glacier is its inaccessibility from the region of the tongue, except for a few weeks in the late season. This makes little or no difference for survey work, as in the central area good views are generally to be obtained of the fixed points which are available for interpolation, while the upper Nubra valley is narrow and much enclosed by high mountain walls, which would make the extension of triangles from any base measured there very inconvenient.

Surveyor Surjan Singh, of No. 1 party, Survey of India, made a very good plane-table sketch on the scale of 2 miles to 1 inch. All plane-table accessories were lent by the Survey of India. I also had one of Reeves's telescopic alidades with parallel bar attachment, a useful instrument in such country. I took with me a tacheometer of the form usually known as the Indian Survey subtense instrument; but with large distances and the difficulty of access to points it did not prove useful, and I relied on the plane-table for whatever detail was required.

My initial plans were dependent on the possibility of measuring a suitable base. On getting on to the surface of the glacier, I decided that no base of sufficient length, even for extension, could be measured without spending a great deal of time, and even then its accuracy would be doubtful owing to the peculiar unevenness of such a surface and its liability to quick change. I therefore crossed the glacier at once to the Terim Shehr promontory, being a central position from where to make a rough reconnaissance.

The triangulation was carried out with a 5-inch transit theodolite fitted with verniers reading to 30″, which was lent by the Survey of India. In countries where transport is a consideration, surveyors will probably find one of the light and compact 4-inch instruments, now so well made, to be as useful as the larger ones.

The first station was made on a low spur of Junction peak, from which position there was an excellent view of several high peaks to the west, two of which were the survey points, $\frac{\text{Pk. 8}}{52\text{ E}}$ and the twin peak, $\frac{\text{Pk. 35 and 36}}{52\text{ A}}$

A base was deduced from the two known sides, $\frac{\text{Pk. 8}}{52\text{ E}}$ $\frac{\text{Pk. 36}}{52\text{ A}}$, and $\frac{\text{Pk. 8}}{52\text{ E}}$, $\frac{\text{Pk. 35}}{52\text{ A}}$. Colonel Renny Tailyour's solution from two fixed points was used ('Auxiliary Tables' (4th edit.), p. 85). The two values obtained for the side AB were 7400·8 and 7405·1 feet. After leaving Tarim Shehr the survey was carried northward up the main stream of the glacier. From stations P and Q observations were again taken to the fixed points $\frac{\text{Pk. 8}}{52\text{ E}}$ and $\frac{\text{Pk. 36}}{52\text{ A}}$. The value obtained for the side PQ, when working from the base AB, was 12,098 feet, while the direct reduction from the fixed points gave a value of 12,118 feet.

In the brief season on these high glaciers no preliminary reconnaissance survey can be done by a small party such as we were, if it is proposed to cover any considerable area. The constant moving of camp and keeping up the necessary supply of ata kept our few coolies always busy. The building up of firm platforms for observing was a constant difficulty, which, in the case of stations on the moraine, was added to by the rapid melting which takes place in the middle of the day. At the head of the glacier there was no possibility of building stations, and the theodolite had to be set up on the snow-field. It was hoped that the triangulation could be carried to some station in the Nubra valley; however, owing to time and the untoward failure of the commissariat arrangements for the coolies, most of the southern part had to be abandoned. Owing to bad weather at the end of the season, triangulation was not carried up the Lolophond glacier to the pass.

The heights obtained from theodolite vertical angles are dependent on those of the G.T.S. fixed points from which they were initially deduced. From stations A and B the heights were carried up the glacier, being checked at stations where fixed points were observed to, and from station I. the height of Hidden peak was deduced. This gave a value of 26,491 feet. The G.T.S. value is 26,470 feet. The coefficient of refraction used was 0·055; this was tested by the observation of reciprocal angles. Hypsometrical readings were also taken. Arrangements were made by Mrs. Bullock Workman for lower station readings to be taken at Skardu three times daily while the expedition was in the field. Three hypsometrical readings were taken on different dates at the Bilaphond La, giving heights of 18,328, 18,365, and 18,428 feet. The mean value was taken. Hypsometrical readings at D station gave a height of 16,666 feet. The trigonometrical height, which at this station was deduced from direct rays to G.T.S. points, was 16,395 feet.

The Survey of India report, that hypsometrical heights taken by them have been found to be as much as 600 feet in excess at trig. stations (*Geographical Journal*, vol. 41, p. 155).

The survey party carried two aneroids graduated to 25,000 feet, which had been made for Mrs. Bullock Workman by Hicks. One was fitted with Watkin's patent; both gave steady readings up to 16,000 feet, but above that the Watkin became erratic. The patent action was not used at all. Photographs were taken at several theodolite stations, and were used in plotting detail.

A sketch of the Kondus glacier basin is shown on this map. The details of its construction are given in the note with the map. There has been a little difficulty in getting a satisfactory junction, especially in the lower part.

SIACHEN GLACIER SURVEY.

THEODOLITE STATIONS.

Station.	Latitude N.	Longitude E.	Height.
			feet
A	35° 28′ 02″	77° 05′ 08″	15993
B	35 29 07	77 04 26	17003
C	35 29 01	77 05 48	16946
D	35 29 21	77 02 37	16395
E	35 29 41	76 58 56	16314
F	35 30 45	77 01 27	16364
G	35 31 20	76 56 25	16765
H	35 33 13	76 55 22	17058
I	35 36 17	76 53 22	17450
J	35 38 17	76 50 05	17978
K	35 35 20	76 49 22	18222
L	35 35 43	76 48 43	18439
M	35 36 26	76 47 33	18780
N	35 38 06	76 45 43	20128
O	35 35 37	76 54 54	—
P	35 35 11	76 55 52	16980
Q	35 33 38	76 57 26	16736
R	35 32 19	76 58 09	16594
S	35 32 01	76 58 22	16559
T	35 29 51	77 00 57	16194
U	35 28 50	77 01 49	16002
V	35 26 59	77 05 01	15660
W	35 25 46	77 06 13	15503
X	35 29 57	77 12 13	17590
Y	35 29 58	77 09 05	17215
Z	35 20 20	77 11 38	14706

INTERSECTED POINTS.

			feet	
SIACHEN No. 1	35° 25′ 32″	77° 02′ 26″	19360	
,, 2	35 26 05	77 01 18	19460	
,, 3	35 23 04	76 57 26	20430	
,, 4	35 27 19	76 58 14	19620	
,, 5	35 28 08	76 59 48	16900	
,, 6	35 28 49	76 57 49	19560	
,, 7	35 29 41	76 52 59	21610	
,, 8	35 31 06	76 48 07	24280	Mt. Ghent
,, 9	35 31 44	76 48 33	24090	
,, 10	35 32 58	76 52 10	22160	The Hawk
,, 11	35 34 07	76 53 19	19960	
,, 12	35 34 31	76 50 44	19790	
,, 13	35 33 47	76 45 36	—	Silver Throne
,, 14	35 34 55	76 46 38	20230	Lower Silver Throne
,, 15	35 36 36	76 50 08	21440	
,, 16	35 37 59	76 47 29	23270	Mt. Hardinge
,, 17	35 39 51	76 45 43	24350	Queen Mary Peak
,, 18	35 39 55	76 50 33	21410	
,, 19	35 37 09	76 54 04	20770	
,, 20	35 35 47	76 57 32	22360	
,, 21	35 35 56	76 59 05	23630	Mt. Rose
,, 22	35 32 36	76 59 23	20300	
,, 23	35 36 02	77 03 00	24240	
,, 24	35 34 43	77 04 54	24510	Teram Kangri
,, 25	35 34 11	77 05 25	24300	
,, 26	35 33 08	77 08 16	22530	
,, 27	35 32 22	77 09 01	23770	
,, 28	35 31 57	77 08 40	23350	
,, 29	35 31 05	77 11 21	23010	
,, 30	35 29 48	77 14 39	22480	
,, 31	35 27 36	77 10 49	22910	Mt. Lakshmi
,, 32	35 27 29	77 07 55	21860	
,, 33	35 24 39	77 11 30	21580	
,, 34	35 20 33	77 08 14	20180	
,, 35	35 22 11	77 06 45	19530	
,, 36	35 22 04	77 04 47	20460	

GREAT TRIGONOMETRICAL SURVEY OF INDIA POINTS.

			feet
Pk. 23 / 52A	35° 43′ 30″	76° 41′ 48″	26470
Pk. 25 / 52A	35 36 44	76 34 23	25110
Pk. 26 / 52A	35 27 45	76 34 44	22750
Pk. 27 / 52A	35 25 08	76 33 12	23890
Pk. 33 / 52A	35 27 54	76 47 07	23960
Pk. 35 / 52A	35 24 24	76 50 50	25280
Pk. 36 / 52A	35 24 01	76 50 55	25400
Pk. 38 / 52A	35 12 12	76 45 41	21870
Pk. 8 / 52C	35 17 46	77 01 23	24370

NOTE.

The Siachen glacier and tributaries is from a trigonometrical survey by Mr. C. Grant Peterkin, surveyor of the expedition, assisted by Surjan Singh of the Survey of India, as plane-tabler.

The triangulation was carried out by Mr. Peterkin with a 5-inch transit theodolite, and is an extension of the fixed points of the Survey of India, checked by two bases deduced from the common side K[10] K[12] (Pk 25 / 52A — Pk 26 / 52A). The methods by which the heights have been determined are stated in the reference. Topographical detail was filled in with the plane-table and from photographs taken at known points.

The northern slopes of Bride Peak, Golden Throne and Hidden Peak are from Sir Martin Conway's and the Duke of the Abruzzi's Surveys, 1892 & 1909.

The positions of Indira Col, Turkestan La and the watershed between Hidden Peak and Siachen, No. 18 Peak, are from observations and photographs by Mrs. F. Bullock Workman.

The Kondus glacier and tributaries is from Sheet 44a S.W. of the Atlas of India, with additions from personal observations of the leaders of the expedition, supplemented by compass bearings and photographs. The lower half of the Kaberi glacier and nala is from a sketch by Dr. Calciati. This section of the map is shown faintly, as the topographical material from which it is constructed can only be considered approximate.

The whole area of the map lies within the Survey of India degree Sheets 52A and 52E, and the numbers of the G.T.S. fixed points are taken from these sheets.

The responsibility for the nomenclature used on this map rests, in so far as it is new, with the author of the paper.

For further information concerning the construction of this Map, see Mr. Peterkin's note, at the end of author's paper, published in the Geographical Journal, February, 1914.

Reference.

- Route of Bullock-Workman expedition
- ,, ,, Mr. Grant Peterkin's survey party
- ▲ 21870 Great Trigonometrical Survey of India points
- △ 23350 Heights in feet based on triangulation
- · 16710c ,, ,, ,, ,, ,, Indian Clinometer angles
- · 16730h ,, ,, ,, ,, ,, Hypsometer readings
- o Camps

THE SIACHEN OR ROSE GLACIER
AND TRIBUTARIES
in the
EASTERN KARAKORAM
Explored by the
FANNY BULLOCK-WORKMAN EXPEDITION
1912.

Scale 1: 175.000 or 1 Inch = 2·76 Stat. Miles.

Published by the Royal Geographical Society.

EASTERN KARAKORAM.
Bullock-Workman.

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,, 20	35 35 47	76 57 32	22360	
,, 21	35 35 56	76 59 05	23630	Mt. Rose
,, 22	35 32 36	76 59 23	20300	
,, 23	35 36 02	77 03 00	24240	
,, 24	35 34 43	77 04 54	24510	Teram Kangri
,, 25	35 34 11	77 05 25	24300	
,, 26	35 33 08	77 08 16	22530	
,, 27	35 32 22	77 09 01	23770	
,, 28	35 31 57	77 08 40	23350	
,, 29	35 31 05	77 11 21	23010	


76°40′
76°50′
pk 23
Hidden Pk
26470
Kinbo Glacier
Indira Col
20860h
Queen Mary Pk
24350
Golden Throne
Mt Hardinge
23270
Bride Pk
25110
Sia La
18705h
Lower
Silver Throne
Silver Throne Col
West Source Glacier
Silver Throne
Silver Throne
Plateau
The Hawk
22160
Mt Ghent
Kaberi or Kondus Glacier
Kaberi Glacier
22750
pk26
23890
pk27
23960
pk33
25280
pk35
25400
pk36
Dong Dong Glacier
Gang Glacier


76° 50′
77°
NOTE.
The Siachen glacier and tributaries is from a trigonometrical survey by Mr. C. Grant Peterkin, surveyor of the expedition, assisted by Surjan Singh of the Survey of India, as plane-tabler.
The triangulation was carried out by Mr. Peterkin with a 5-inch transit theodolite, and is an extension of the fixed points of the Survey of India, checked by two bases deduced from the common side K10 K12 (Pk 36/52A Pk 8/52E) The methods by which the heights have been determined are stated in the reference. Topographical detail was filled in with the plane-table and from photographs taken at known points.
The northern slopes of Bride Peak, Golden Throne and Hidden Peak are from Sir Martin Conway's and the Duke of the Abruzzi's Surveys, 1892 & 1909.
The positions of Indira Col, Turkestan La and the watershed between Hidden Peak and Siachen, No. 18 Peak, are from observations and photographs by Mrs. F. Bullock Workman.
The Kondus glacier and tributaries is from Sheet 44a S.W. of the Atlas of India, with additions from personal observations of the leaders of the expedition, supplemented by compass bearings and photographs. The lower half of the Kaberi glacier and nala is from a sketch by Dr. Calciati. This section of the map is shown faintly, as the topographical material from which it is constructed can only be considered approximate.
The whole area of the map lies within the Survey of India degree Sheets 52A and 52E, and the numbers of the G.T.S. fixed points are taken from these sheets.
The responsibility for the nomenclature used on this map rests, in so far as it is new, with the author of the paper.
For further information concerning the construction of this Map, see Mr. Peterkin's note, at the end of author's paper, published in the Geographical Journal, February, 1914.
Urdok Glacier
Indira Col
Turkestan La
Mt Hardinge
Sia La
West Source Glacier
Siachen
Mt Rose
Teram Kangri
The Hawk
Mt Ghent
Tarim Shehr
Peak 36 Glacier
Tawiz Pk
Lolophond Glacier
Bilaphond La
Ali Bransa
Dong Dong Glacier
Rose

NOTE.

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or of the expedition, assisted by Surjan Singh
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ied out by Mr. Peterkin with a 5-inch transit
of the fixed points of the Survey of India,
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hts have been determined are stated in the
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le Peak, Golden Throne and Hidden Peak are
e Duke of the Abruzzi's Surveys, 1892 & 1909.
l, Turkestan La and the watershed between
Peak, are from observations and photographs

butaries is from Sheet 44a S.W. of the Atlas
personal observations of the leaders of the
mpass bearings and photographs. The lower
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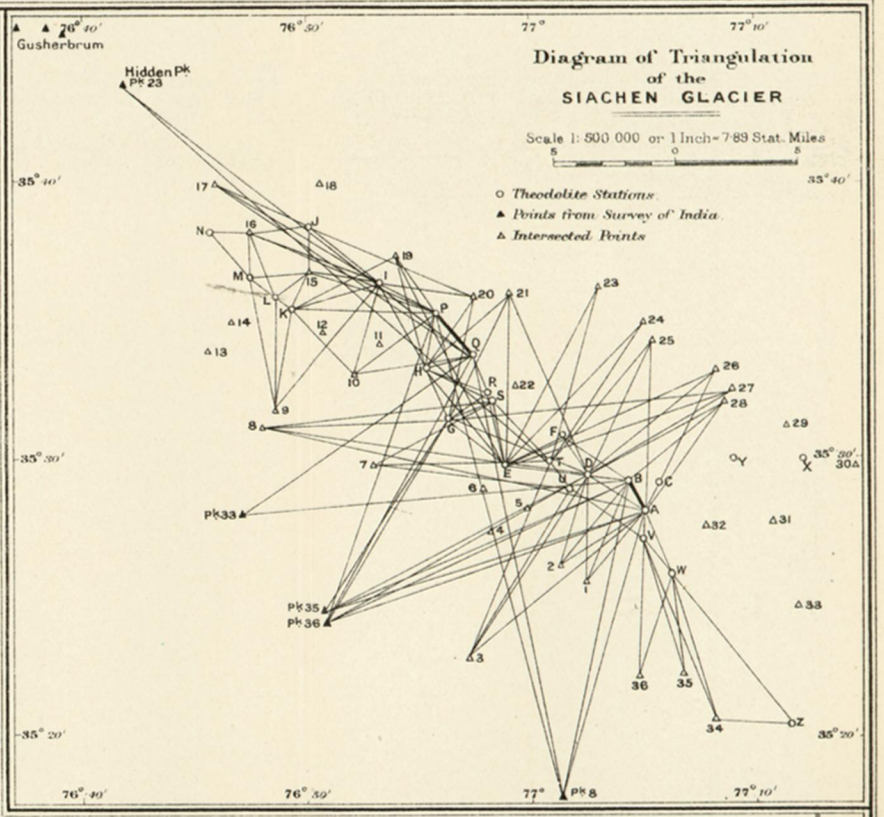
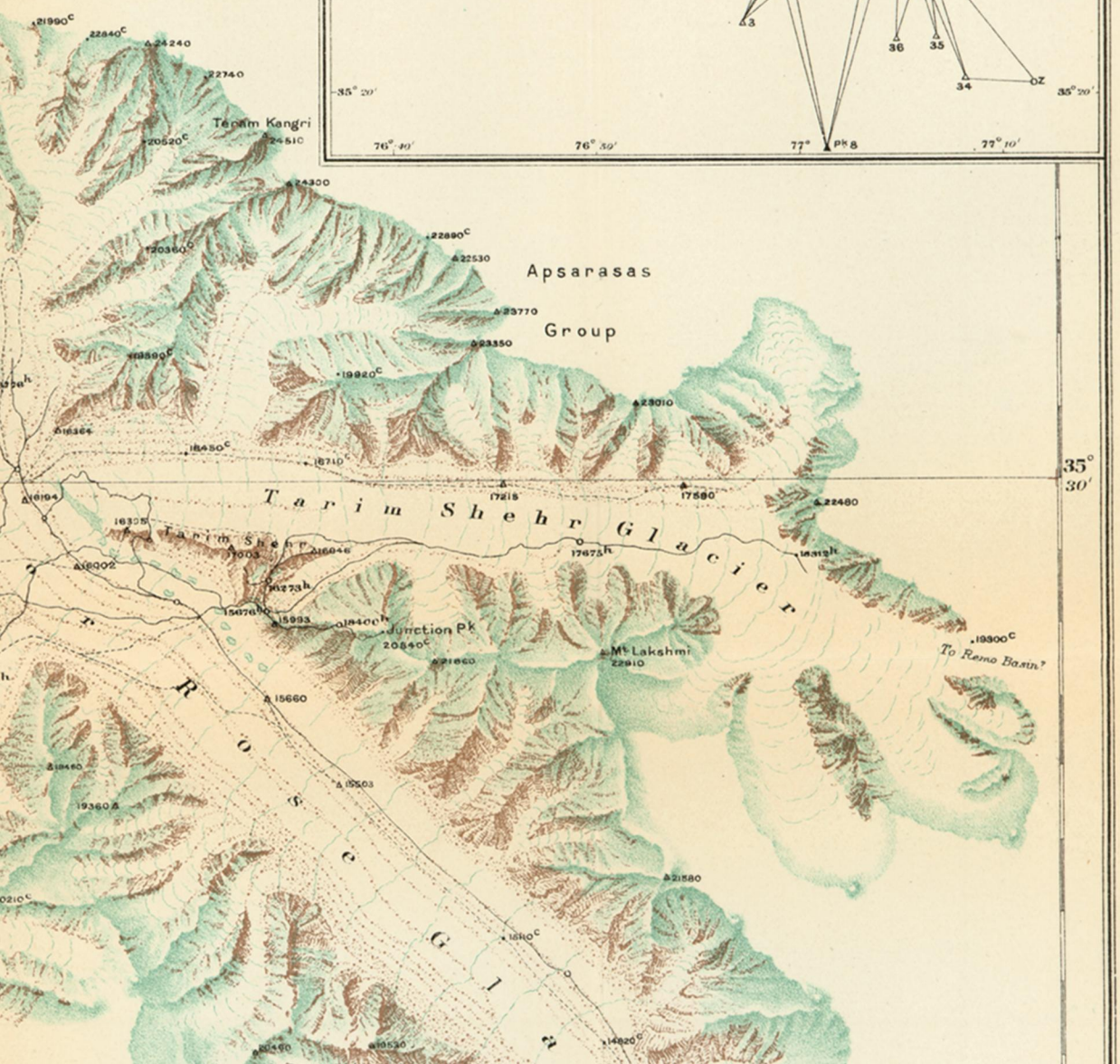
end of author's paper, published in the
, 1914.

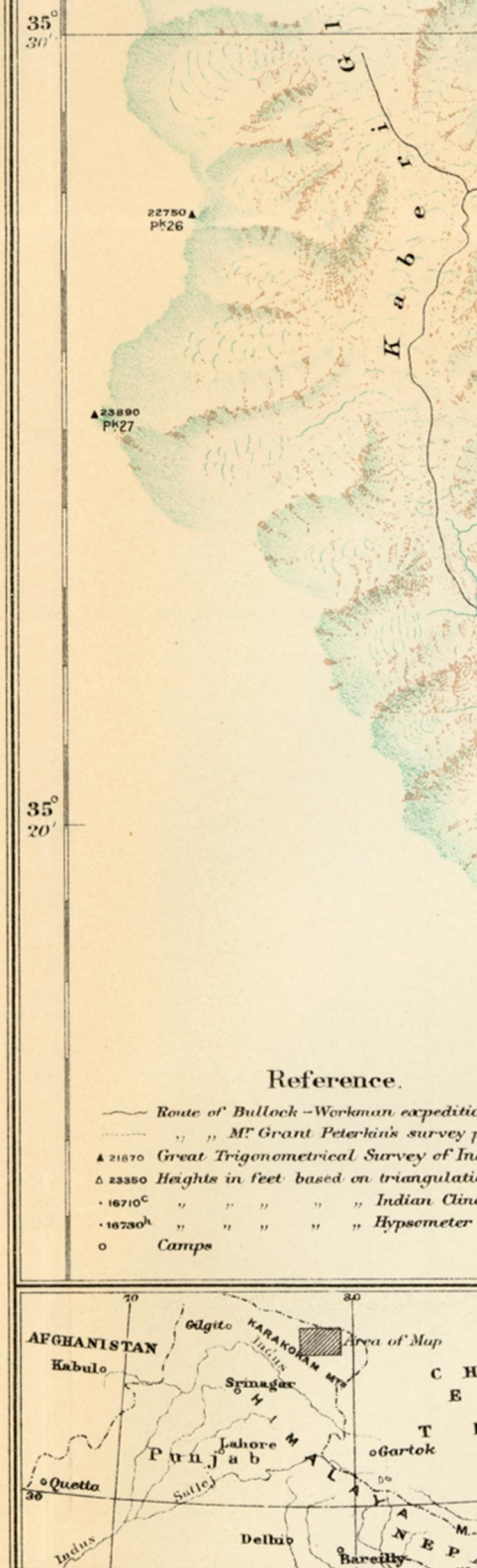


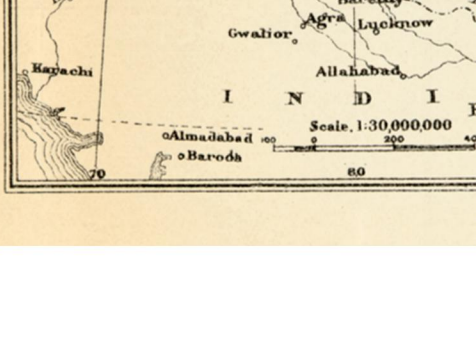


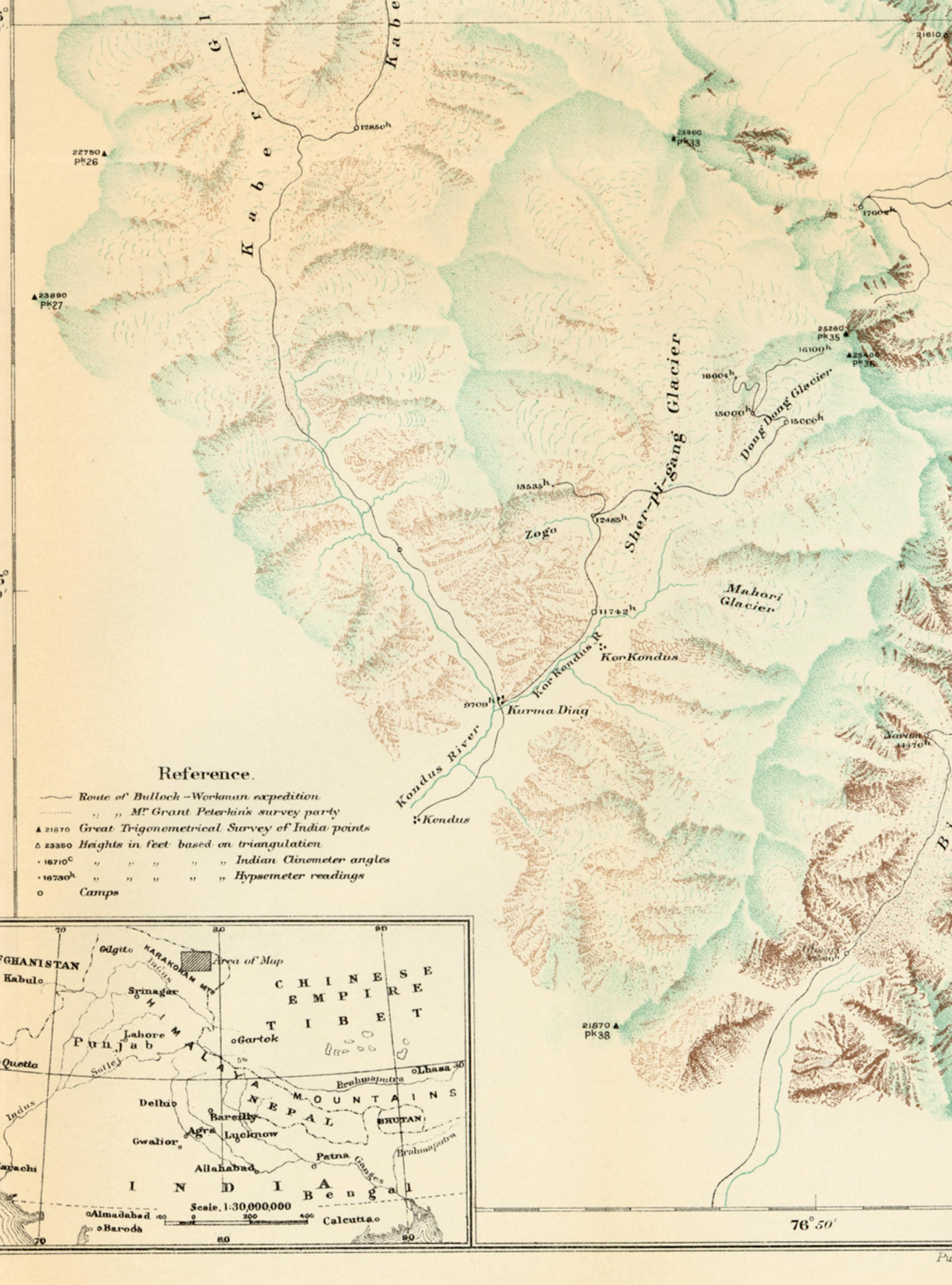
,,	3	35 23 04	76 57 26	20430
,,	4	35 27 19	76 58 14	19620
,,	5	35 28 08	76 59 48	16900
,,	6	35 28 49	76 57 49	19560
,,	7	35 29 41	76 52 59	21610
,,	8	35 31 06	76 48 07	24280 Mt. Ghent
,,	9	35 31 44	76 48 33	24090
,,	10	35 32 58	76 52 10	22160 The Hawk
,,	11	35 34 07	76 53 19	19960
,,	12	35 34 31	76 50 44	19790
,,	13	35 33 47	76 45 36	— Silver Throne
,,	14	35 34 55	76 46 38	20230 Lower Silver Throne
,,	15	35 36 36	76 50 08	21440
,,	16	35 37 59	76 47 29	23270 Mt. Hardinge
,,	17	35 39 51	76 45 43	24350 Queen Mary Peak
,,	18	35 39 55	76 50 33	21410
,,	19	35 37 09	76 54 04	20770
,,	20	35 35 47	76 57 32	22360
,,	21	35 35 56	76 59 05	23630 Mt. Rose
,,	22	35 32 36	76 59 23	20300
,,	23	35 36 02	77 03 00	24240
,,	24	35 34 43	77 04 54	24510 Teram Kangri
,,	25	35 34 11	77 05 25	24300
,,	26	35 33 08	77 08 16	22530
,,	27	35 32 22	77 09 01	23770
,,	28	35 31 57	77 08 40	23350
,,	29	35 31 05	77 11 21	23010
,,	30	35 29 48	77 14 39	22480
,,	31	35 27 36	77 10 49	22910 Mt. Lakshmi
,,	32	35 27 29	77 07 55	21860
,,	33	35 24 39	77 11 30	21580
,,	34	35 20 33	77 08 14	20180
,,	35	35 22 11	77 06 45	19530
,,	36	35 22 04	77 04 47	20460

GREAT TRIGONOMETRICAL SURVEY OF INDIA POINTS.

			feet
Pk. 23 / 52A	...	35° 43′ 30″	76° 41′ 48″	26470
Pk. 25 / 52A	...	35 36 44	76 34 23	25110
Pk. 26 / 52A	...	35 27 45	76 34 44	22750
Pk. 27 / 52A	...	35 25 08	76 33 12	23890
Pk. 33 / 52A	...	35 27 54	76 47 07	23960
Pk. 35 / 52A	...	35 24 24	76 50 50	25280
Pk. 36 / 52A	...	35 24 01	76 50 55	25400
Pk. 38 / 52A	...	35 12 12	76 45 41	21870
Pk. 8 / 52E	..	35 17 46	77 01 23	24370

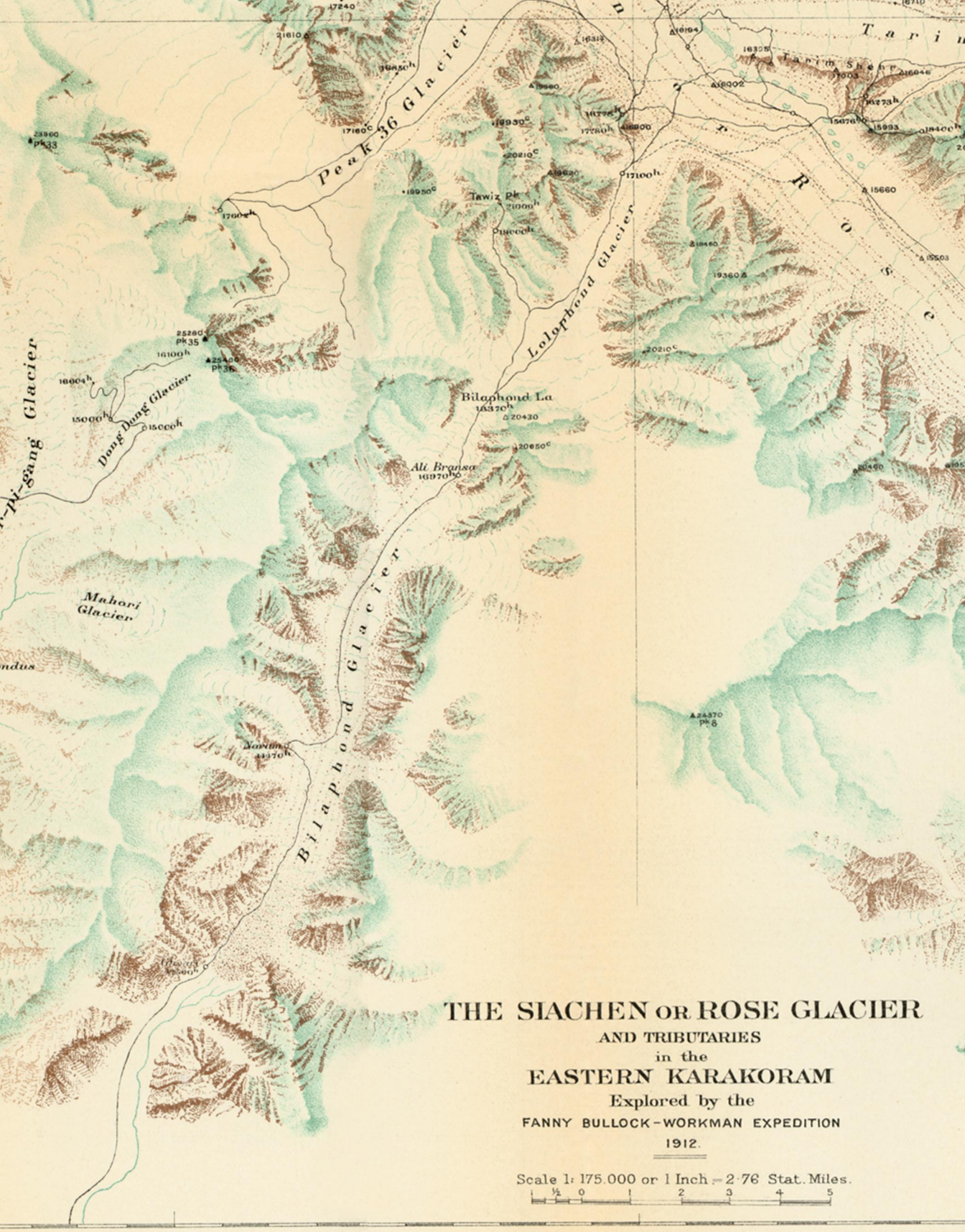






Reference.

- Route of Bullock-Workman expedition
- ,, ,, Mr Grant Peterkin's survey party
- ▲ 21870 Great Trigonometrical Survey of India points
- △ 23350 Heights in feet based on triangulation
- · 16710c ,, ,, ,, ,, ,, Indian Clinometer angles
- · 16730h ,, ,, ,, ,, ,, Hypsometer readings
- o Camps



THE SIACHEN OR ROSE GLACIER

AND TRIBUTARIES

in the

EASTERN KARAKORAM

Explored by the

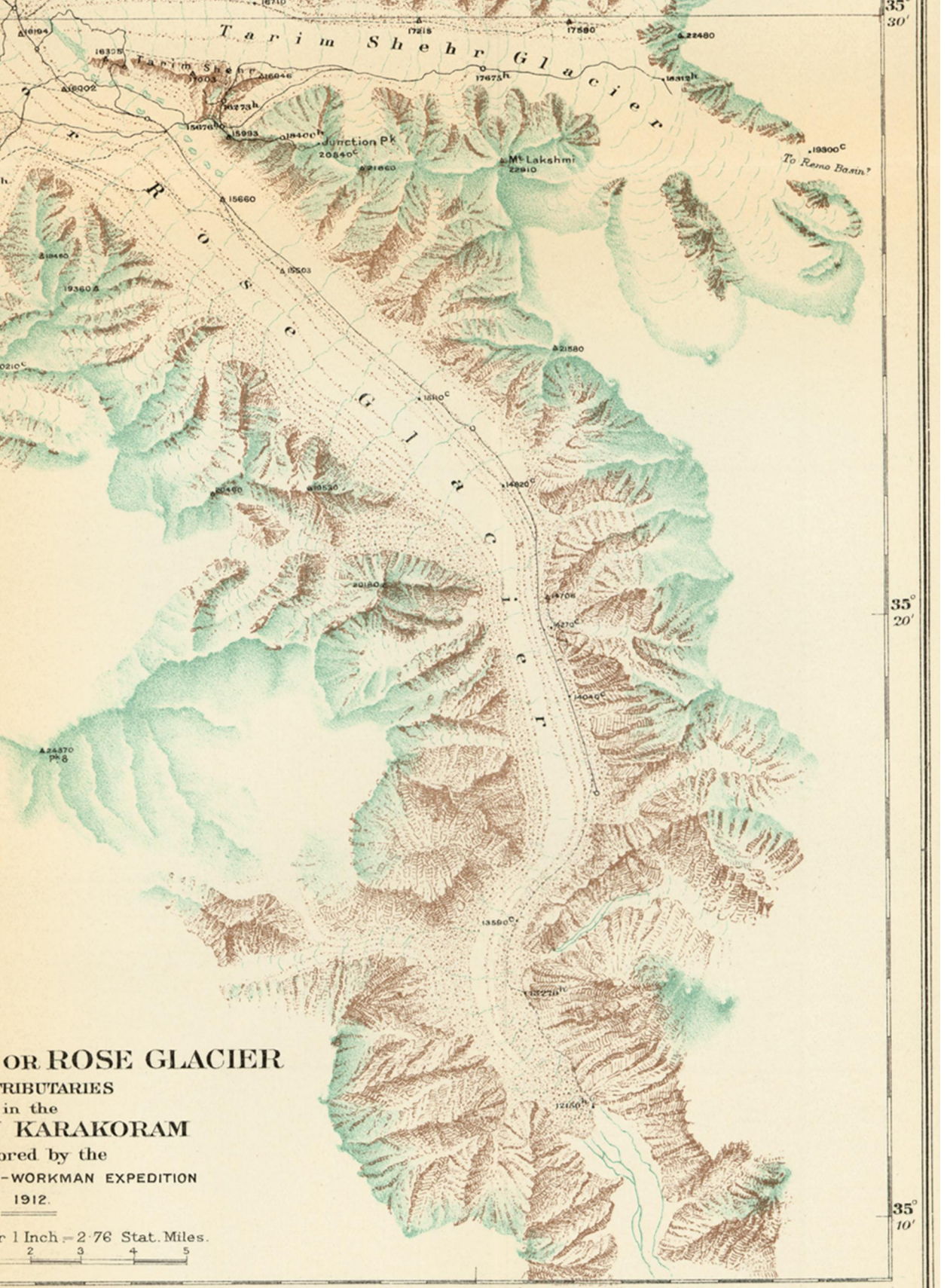
FANNY BULLOCK-WORKMAN EXPEDITION

1912.

Scale 1: 175.000 or 1 Inch = 2·76 Stat. Miles.

½ 0 1 2 3 4 5

Published by the Royal Geographical Society



OR ROSE GLACIER

TRIBUTARIES

in the

KARAKORAM

ored by the

-WORKMAN EXPEDITION

1912.

r 1 Inch = 2·76 Stat. Miles.

2 3 4 5

EASTERN KARAKORAM.

Bullock-Workman.

The PRESIDENT (before the paper): I am glad to see so large an audience assembled to give a welcome to our old friends, Mrs. Bullock Workman and her husband, Dr. Hunter Workman.* I say they are old friends of ours, because not merely are we familiar with their work from the written accounts of it, but they have both lectured to us on several occasions; exactly four years ago they paid us the compliment, for the first time, of lecturing together, as they are about to do to-night. It is quite fifteen years since Dr. and Mrs. Workman commenced their work in the region of the Himalayas. Since then they have carried out expedition after expedition with marked success and with scientific results of high value. It is a little more than three years since Mrs. Workman gave her last lecture before the Society on the subject of the Hispar glacier. Since then, she and her husband have been busy in a difficult and complicated region of the Eastern Karakoram, and it is with the results of these last expeditions that they are going to favour us to-night.

Sir FRANCIS YOUNGHUSBAND (after the paper): I think even those of you who have never been in those parts must have realized, from the magnificent photographs which Mrs. Bullock Workman and Dr. Hunter Workman have brought back, the terrible obstacles which they have had to overcome in order to accomplish what they did, and certainly those of us who have been there and know what the difficulties really are, can say that it is only by the greatest perseverance, pluck, and determination that such obstacles could have been overcome. I think that probably the part which I should most advantageously speak to you is in regard to this mysterious Soltoro pass, which Mrs. Workman has referred to. She was in doubt why it was called the Soltoro pass, but I think we simply called it the Soltoro pass because we did not know any other name to give it, just as mathematicians use the expression "x" to denote an unknown quantity. All that was known to us was a rumour that a pass did exist from Chinese Turkestan in the north into the Soltoro district of Baltistan on the south. There had been such reports for many years, and in 1889, when I was deputed by the Government of India to explore the passes into Hunza, I was asked on the way to try and find this mysterious Soltoro pass. I had crossed the watershed in 1887 by the Mustagh pass, and I imagined the Soltoro must be somewhere about the limit where Dr. and Mrs. Workman reached in 1912 expedition. I explored up that Urdok glacier, which is marked on the extreme north-western corner of the map, and at the top of the glacier I saw what I thought must be a pass, and ascended it about halfway when I was deterred from going any further by two avalanches very similar to that depicted in the slide which Dr. Workman has shown. I was just able to see that, at any rate, there was no practical route from Turkestan down to Baltistan by that way. But the curious thing is that this summer, quite unexpectedly, we heard of an officer from India who had come across the range by some way which he himself cannot define accurately on the map, from Turkestan down to Baltistan. He had gone up into Kashgar territory on the north by the Karakoram pass on the extreme east of these maps, and when in Turkestan, his hunter had told him that there was a more direct way down to India, by a pass to the west of the Karakoram pass, and ten years ago he came down by this same way west of the Karakoram pass, and certainly east of the Mustagh pass, and came out at Skardu in Baltistan. How he did it —whether he came over this glacier, which Mrs. Workman has so vividly described this evening, or by some other way, it is difficult to say. He assumed at the time that the route was known, and as he had no surveying instruments with

* Dr. Hunter Workman's paper will be published later.

him, for he was simply on a shooting expedition, he was unable to say exactly how he came. I hope this point will be finally cleared up by the expedition which Dr. de Filippi has organized, which is now at work in that region. Dr. Longstaff, in 1899, was, I think, the first to establish the interesting point that this Siachen glacier was really one of the great glaciers of Asia. Its mouth, as Mrs. Workman has said, was first seen by Henry Strachey many years ago, but it was then supposed to be quite an ordinary glacier—that is, ordinary for those regions, and it was reserved for Dr. Longstaff, when he crossed the Bilaphon-la, which he then thought must be the Saltoro pass, to first establish the magnitude of this glacier which Dr. and Mrs. Workman have now explored to its extremities, and mapped scientifically and accurately, so that we now have a full and detailed description of this remarkable glacier. Another point I was interested in in Mrs. Workman's account, was what she said about having seen a little brown butterfly. Some years ago I met a gentleman travelling in that region, who asked me whether, when I was crossing high passes, I had seen any butterflies ? I said, "No, certainly not; high passes are not the places where you see butterflies." He said there was, some years ago, a brown butterfly caught by the Forsyth Mission of 1873 on the Karakoram pass, and he had been offered £400 to secure another specimen of the same butterfly. I hope Mrs. Bullock Workman will get £400 for her specimen. I desire to congratulate Mrs. and Dr. Hunter Workman on the very fine work they have accomplished, and on the highly valuable scientific results they have attained, and which could not have been accomplished without great care of organization before they started, without extreme persistence and pluck while on the journey, and without further elaborate working out when they came back.

Dr. T. G. LONGSTAFF: I have listened with great interest to the paper this evening. In 1909 I spent four months in this region, though only seven days and five nights were passed on the Siachen glacier. I was accompanied by Lieut. Morris Slingsby, 56th Rifles, F.F., for the first half of the trip, and Dr. Arthur Neve, of Srinagar, joined us for the Saltoro pass; his assistance was of very great value. For the last two months I had the good fortune to travel with Captain D. G. Oliver, at that time British Joint Commissioner for Ladak. My paper appeared in our *Journal* for June, 1910. I have had a series of maps, including my own sketch-map, put up in the next room. Neve wrote an account of the first part of our trip for the *Times of India*, September 2, 1909, which is of particular interest, because it was written before the identity of the upper Siachen glacier had been discovered: a *résumé* of this article appeared in our *Journal* for November, 1909. His 'Thirty Years in Kashmir,' just published, contains a great deal of valuable and most reliable information on this and the neighbouring districts. His great influence with the natives give him advantages altogether denied to the ordinary traveller.

It is satisfactory to find that the Siachen and Teram glaciers each obtain a mile more length than I credited them with, though I note with regret that the former loses one-twelfth in extreme breadth. It is also satisfactory to find that our location of Younghusband's saddle was substantially correct. We are even agreed as to the mistake I made in attributing so great a height to Teram Kangri, a mistake I endeavoured to rectify by communicating Colonel Burrard's letter to our *Journal* (vol. **39**, p. 71) two years ago, and by publishing in the *Alpine Journal* (vol. **26**, p. 307) an account of the remarkable mountaineering achievements of Mr. V. W. B. Collins of the Survey of India, who successfully triangulated the peak in 1911 (compare also *Geogr. Journ.*, vol. **37**, pp. 28–29). In the use of those points actually visited by us in 1909 and determined barometrically

I see that on the new map there is invariably an increase of altitude shown, averaging 270 feet in the nine comparable instances.

We have to thank the lecturers for giving us, by their enterprise, Mr. Grant Peterkin's really first-rate survey of the Siachen glacier. I showed him all my photographs and data before he started, and since he returned I have seen his and have watched his map growing at our quarters. I am certain that there will be no corrections of any importance for subsequent travellers to make in it. Of course, when we get beyond the limits of his own survey on to some of the outlying snow basins and on to the Kondus, the map becomes once more a sketch-map, just as mine was. That he did not see my cairn above the great bend is only to be expected, since he passed nearly 1000 feet below it and at a distance of at least a mile away from it.

I feel that the Italian expedition has hardly been treated fairly. It is true that they believed that Younghusband's saddle would be found further west than is shown on my map and where the lecturers have now placed it. But I really must point out that apart from this—only advanced as a supposition—there is no essential difference in the geographical relations between the Baltoro and the upper Siachen, as described by the Italians and by the lecturers. The great height (21,000 feet) of their camp on Chogolisa saddle gave the Italians a most commanding view. The quotation cited by the lecturer from page 315 of de Filippi's book makes it appear that they did not see the Kondus basin. Yet they say (de Filippi, 'Karakoram,' etc., pp. 441–2) that the Kondus glacier "was seen to intervene between the Baltoro and the recently discovered upper Siachen." "The westernmost extremity of the Siachen valley will not communicate directly with the Urdok, but only with the Kondus": this has been proved by the discovery and passage of the Sia La by the lecturers. Again, "Hidden peak is not the most easterly peak of the Gusherbrum group, for eastwards of Hidden peak rises another"—evidently that named after Her Majesty by the lecturers. This is all just as the lecturers have demonstrated this evening. Undoubtedly, Dr. and Mrs. Workman are the first Europeans actually to traverse the Kondus glacier, and they have very materially increased our knowledge of it. They have also visited the Sher-pi-gang for the first time, and of course they are the first to explore the highest reaches of the Siachen glacier itself.

With regard to the suggestion that because there are no practicable passes there, the names Kondus saddle and Chogolisa saddle of Conway's and the Italian maps should be abolished for the future—this is based on a misunderstanding of the rules of mountain nomenclature by the lecturer. They are called saddles *because* they are not passes. Compare the Agassiz *Joch* and the Hugi *Sattel* on the Finsteraarhorn. The Italians themselves indicate that they are not passes, but that is no reason for the abolition of two names of historical interest.

I fear that the constant changing of geographical names will lead in the future to as much confusion as has fallen upon biologists from the same cause. The name Saltoro pass has already been accepted by the Survey of India. It was recognized by Shere Ali Khan of Khapalu when we were getting information from him in 1909. It is used in the official 'Sketch of the Geography and Geology of the Himalaya Mountains and Tibet' (Chart 20). It also appears on the official map to illustrate Younghusband's explorations.

But apart from any of these precedents it is unquestionably the most important high pass leading directly into the Saltoro valley—from anywhere. The study of these native names is fascinating, but beset with difficulties. Lolophond sounds rather familiar to me. It is the name of a camping-place,

apparently our second camp beyond the Saltoro pass. To such the natives not infrequently attach the name of some person who has been there. For instance, Doulatbeguldi—"the place where Doulat Beg died." Now, *Loloff* was about the nearest the Baltis could get to my name, though Ladakis and Tibetans can get much nearer to Longstaff. It is quite an unexpected compliment for which I am duly grateful. The suggested change of the name Teram (properly Term, pronounced Térram) to Tarim (pronounced Tarreem) is unfortunate. We obtained this name Term from our coolies: it was the only name connected with the upper Siachen glacier which we could extract from them. Tarim must be either Persian or Turki. It is as if we altered an English place-name into a somewhat similar-sounding French one: as, for example, Cambridge into Cambrai. And again, surely Siachen should stand unchallenged as the name of the greatest glacier in Asia. Both these names also have been accepted by the Indian Survey. The lecturer seems to infer that the Baltis supplied the name Siachen. Possibly its identity may have penetrated to the Saltoro valley in consequence of our discoveries. But I must remind you that when we stood on the Saltoro pass in 1909 and saw this great glacier before us, no one knew what glacier it was nor whither it flowed; according to all previous notions we already stood on the Turkestan water-parting. Its origin was obviously in the neighbourhood of Hidden peak (*Geogr. Journ.*, vol. **35**, p. 630) and the main interest was to find out where it went to, a riddle only solved with Captain Oliver's help three months later, when it was found that we had added some 500 square miles to the Indus basin. I understand the lecturer to say further that the name Siachen is not known to the people of the Nubra. Yet it is a Ladaki name, and was obtained directly from the upper Nubra villages. Neve also obtained this form of the name some years earlier: the Nubra people further told him that three marches up the glacier was a pass to the Remo ('Thirty Years in Kashmir,' p. 293). Therefore I ventured in this one instance to change the old Survey spelling Saichar to Siachen, giving the derivation practically adopted by the lecturer. The "ch" is pronounced soft as in *chenmo*. All the names on my map, published by our Society, had been decided upon in consultation with the Indian Survey at Dehra Dun, and were actually printed by them on the outline sketch-map, which they so kindly drew from my material. I welcome the new name "The Hawk" (22,200 feet on the Workman's map) as a most appropriate one for this beautiful mountain, and should like to withdraw our temporary name "Cornice peak" (22,140 feet on my map) as not good enough. None of these temporary names were printed on my map, but were used in my text.

Now as to the historical evidence for the former existence of a direct route over the Turkestan water-parting to Yarkand, used in combination with the Saltoro pass. In my paper I hastily assumed the negative view, attributing the stone shelters which we found at Ali Bransa (*Geogr. Journ.*, vol. **35**, p. 629) to a route to Nubra only. Further reading had convinced me that the historical evidence is distinctly in favour of the positive view, and now the stone circle on the Teram peninsula and the cairns at Spur camp, discovered by the lecturers, definitely prove to my mind that such a route was formerly in use. The study of glaciers is of very recent growth. Changes may occur far more rapidly than has usually been expected. Remember that the Mustagh pass was in use so late as the time of Ahmed Shah—some eighty years ago. When Younghusband forced it, it had been completely abandoned.

The lecturers themselves have indicated a practicable route from the Oprang valley, though we cannot make absolutely certain that they saw the Urdok glacier till that region is definitely surveyed. Hayward (*J.R.G.S.*, vol. **40**,

p. 59) refers very circumstantially to an old route from Khufelung, leading both directly to Nubra and to Chorbat: in the latter case, the Saltoro pass would also have to be crossed. (Cf. Sir Henry Trotter, *J.R.G.S.*, vol. **48**, p. 177, and Sir T. E. Gordan 'The Roof of the World,' p. 15). That it is necessary to cross *two* passes by this route between Turkestan and Baltistan was indicated by what Shere Ali Khan told us in 1909 (*Geogr. Journ.*, vol. **35**, p. 624). Again, Vigne (vol. **2**, p. 387), when weather-bound on the Bilafond glacier, wrote that "two lofty and difficult ridges were to be crossed on the way." On his map, which I am showing this evening, is printed "Way over glacier by Ali Bransa to Yarkand." I find also a curious association between the names Khapalu, at the mouth of the Saltoro valley, and Khufelung, a camping-place near the head of the Yarkand river, on what I believe to be the old route. Strachey's map marks the latter actually as "Khapalu Agze," while Shaw prints it "Kapaloong." Moorcroft even writes Khapalu as "Kafulun"; of course, in this part of the world, *f* and *p* are often confused. Until de Filippi is able to explore both the Remu and the Khufelung valleys, it is impossible to get at the truth of these traditions, for no part of the main water-parting between the Karakoram pass and the point reached by the Workmans has yet been explored. But I have a strong suspicion that the officers alluded to by Sir Frank Younghusband really crossed the pass we have all been looking for, and preceded our party on the upper Siachen.

There is another interesting problem in this region for de Filippi to solve. As I have often said, none of us ever thought that Teram Kangri was particularly high until Slingsby and I reached the Rgyong La, nearly 19,000 feet. From there we saw and photographed a very imposing group of mountains which I thought was Teram Kangri (*Geogr. Journ.*, vol. **35**, plate 1, opp. p. 640; *Alpine Journ.*, vol. **25**, plate 1, opp. p. 485, and vol. **26**, p. 313). But a comparison of the altitudes of the different peaks of the Teram Kangri group obtained by Mr. Collins for the Survey of India and of the more complete data obtained by Mr. Grant Peterkin for the Workmans' map, with the outline of the peaks shown in my photograph, appears to me to disprove my assumption. In this case, these peaks must constitute another unknown and very lofty mountain group somewhere to the north-east of Teram Kangri, probably in the Remu area, as indeed I might have inferred from a letter I received (March 28, 1910) from Colonel Godwin Austen. Extreme difficulties of access have so far kept the geographical secrets of this north-eastern region of the Karakoram hidden from our view, but if any one can unveil them it is de Filippi and his very talented companions who are even now wintering in Baltistan.

With regard to Dr. Workman's paper; as to the hypothesis which I suggested with regard to the physiographical relations between the Gusherbrum range and the Teram Kangri group, though such a high authority as Professor Novarese has already enunciated (de Filippi's 'Karakoram,' p. 443) the views now brought forward by Dr. Workman, yet no less an authority than Dr. Oldham appears to favour (*ibid.*, p. 447) my own theory. The gaps between Teram Kangri and the Gusherbrums and between the Gusherbrums and K_2 do not necessarily affect the structural unity of the range, and Dr. Oldham considers that they are probably "part of the same general area of special, recent, uplift." My view that the Siachen may turn out to be a homologue of the Baltoro gains very strong support from a photograph shown me by Mr. Grant Peterkin taken from the northern branch of the western Siachen source, not visited I understand by Dr. Workman. In this photograph I recognized, to my astonishment, the Mustagh tower far down the Baltoro, showing that despite the intervening Kondus basin (which I

indicated on my map) the main valleys of the Baltoro and Siachen do form a continuous line of depression. I think that any one reading Novarese and Oldham's Appendix to de Filippi's 'Karakoram' must agree that the Italians are justified in their geological deductions. Furthermore, I see no reason to change mine with regard to the Siachen. Certainly it is impossible for any one to be positive about the succession of the rocks until they have been thoroughly examined *in situ*, and this still remains to be done.

Sir MARTIN CONWAY: It is just over twenty-one years since I returned from the region which is on the extreme edge of this map, and it is, therefore, with some diffidence that I venture to speak on the question at all, because one's memory of detail naturally grows feeble in that time. One thing, however, I may say, which touches in no manner on geographical detail, and that is, that if there did exist any ill-tempered critic desirous to make the worst that he could of the work in the mountains of the Karakorams of Dr. and Mrs. Workman, he would, after saying his worst, have to make certain omissions. He would be compelled to allow that, during the best part of fifteen years, they had devoted a great portion of their time to the serious study of this enormous mountain region. He would be obliged to say that they had undertaken expedition after expedition of the most arduous kind; that they had carried those expeditions through with ever-increasing ability, increasing elaboration, and with the increasing success which comes from accumulated experience. He would be obliged to say that the map of this part which was in an unsatisfactory state, over a considerable portion of it, has, since their visits, been filled out with detail which is obviously truthful; that they have added, therefore, enormously to our knowledge of the greatest knot or group of mountains on the face of the Earth; and that as a matter of fact they have "hitched their chariot," as it were if not to a star, at all events to a great mountain group, and as long as those mountains continue to attract the attention and the admiration of people who take an interest in such matters, their name must be indissolubly associated with them. Dr. Workman has referred to a set of glacial phenomena, which he has classified and in which he has taken a great interest. I have before broken a lance with him as to the use that he makes in relation to them of the term "nieves penitentes," because I think he stretches that term to cover certain phenomena which it ought not to be used to cover. The term "nieves penitentes" is a South American name for a particular thing, and I doubt if South Americans would recognize that object in some of the phenomena to which Dr. Workman applies the term. That, however, is not a matter of great importance. He referred to a particular set of forms of glacier-ice on the Baltoro glacier, which he had not seen, but which have been seen now by three or four parties—I mean the blades of white ice that jut up out of the surface of the glacier to considerable heights—30 or 40 feet, and that follow one another down the glacier in a long succession. I looked in his photographs for any examples of the same formation, and though there were some that distantly resembled them, there were none of identical form or nature.

I have no doubt that the explanation he gives of them is correct. These blades of ice are denuded pressure ridges; where the ice has been most compressed there it melts the least readily, and consequently these blades of ice stick up above the rest of the surface of the glacier. What, however, I principally noticed as the general outcome of looking at the photographs they showed us, was that in the Siachen district we come into a mountain area altogether different in kind from that which surrounds the basins of the Baltoro and Hispar glaciers, which I myself traversed. In that other region the mountains are, for the most

part, unclimbable mountains. They are, for instance, such needles as that first view Dr. Workman showed; peaks overwhelming in altitude, precipitancy, and every quality that is least favourable for a climber. On the other hand, this group of mountains we have been taken to to-night is one that suggests possibilities of ascent, and, if I was not far beyond ever thinking of going off the level ground now, I should feel tempted to have a try at them myself. I feel no doubt that in the future we, as a Society, shall have the opportunity of making the acquaintance of some of these great peaks in detail, when the story of their further exploration is related before us, and then we shall be able to congratulate whoever it may be that returns in triumph from some great ascent, as warmly as I congratulate Dr. and Mrs. Workman on the renewed success they have attained in one more great expedition.

The PRESIDENT: I should like on your behalf, and as President of the Society, to associate myself with the words that have fallen from the speakers this evening —all of them experts of the highest authority—as to the interest and value of the two papers to which we have listened. I shall not presume to add anything to what has fallen from their lips, but I am expressing your feelings as well as my own when I say that we have never here listened to two papers of higher scientific interest, illustrated by more beautiful slides.

IS THE EARTH DRYING UP?*

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

1. The Reported Desiccation of the World and its Effects.

Underlying the irregular and apparently capricious variations of the weather, a regular cycle of change has been recognized by the study of long continued observations. This cycle appears to be only a secondary movement on a still greater cycle, and it, according to some geographers, is in turn controlled by variations the length of which can only be measured in geologic ages, while glacial deserts were being changed into torrid wastes. In recent years we have been often warned that one of these great climatic changes is now carrying the world, slowly and irresistibly, toward world-wide drought. The view that the Earth is becoming steadily

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* Royal Geographical Society, December 8, 1913. Map, p. 232.

permanent office in England. On her part, Great Britain will cordially welcome the responsibilities entailed by this honourable outcome of her initiative in calling the conference of London.

The sometimes severe labours of the Conference of Paris were lightened by the traditional splendid hospitality of the French Government, of the City of Paris, and of many unofficial hosts. The delegates had the honour of being received by the President of the Republic ; they were entertained magnificently at the Opera, and at a final banquet. The arrangements for their comfort made by the staff of the *Service Géographique* lacked nothing which forethought could supply ; and the generous breadth of view which distinguished the conduct of General Bourgeois in the presidential chair was happily reflected in the cordial sympathy established between the representatives of France and of all other nations.

THE ALAI-PAMIRS EXPEDITION OF THE GERMAN AND AUSTRIAN ALPENVEREIN.

Mr. W. R. Rickmers, the leader of this expedition, has just returned home, thus closing a successful journey under the auspices of the German and Austrian Alpine Association, which supplied one-half of the funds ; the total expenditure was £1350, for a party of eight people and a journey of seven months, including outfit. The members of the expedition were Dr. W. Deimler (astronomy and topography), Prof. H. v. Ficker (meteorology), Dr. R. v. Klebelsberg (geology), Dr. R. Kaltenbach (natural history), Frau Kaltenbach (portrait painting), Herr E. Kuhlmann and Mrs. Rickmers. From the account of the earlier part of the expedition given in the *Journal* for December (p. 570), it will be remembered that the explorers had reached a point a little above Garm, in the valley of the Vaksh or Surkhab (in Karateghin), whence an ascent of Sagunaki and other mountains of the Peter the Great range had been made.* The party afterwards proceeded to Tupchek, a little higher up the same valley, making this also a base camp for the thorough examination of the neighbouring mountains, with their glaciers and moraines. Ascents were made up to 5400 metres (17,717 feet), as well as side excursions up the Muksu valley and down to the Surkhab junction, where vast moraines were examined. The further march led by Little Tupchek and across the Gardani Kaftar pass to Kalai-Lojirk, in the valley of the Khingob, on the south side of the Peter the Great range. After various excursions and glacier studies the expedition went by Vanj to the valley of the Panj (upper Oxus), returning to Kalai-Lojirk by another route. The party then divided, one half returning to Samarkand by way of the lower

* The height of Sagunaki is now given by Mr. Rickmers as 4900 metres (16,076 feet), instead of 5100 metres.

Khingob, Diushambe, etc.; the other going south-west by Muminabad to Kabadian, and continuing by the usual route *viâ* the Irongate to Bokhara city.*

The plains and valleys of this region are well known, though still offering many curious problems. The Russian 5-verst map (1 : 142,000) is good, as far as situation and communications are concerned, but the high mountain topography is practically (and probably intentionally, for want of time) neglected. In this respect the expedition found an extensive field of action, the main result being a photogrammetric survey of the glaciated ranges between the Surkhab and Khingob rivers. A detailed photographic survey of the whole of the Borolmas moraines (old and recent) was also made, while about thirty full-plate panoramas will show the morphological and orographical detail of various landscapes along the route. Many new glaciers were discovered, and an entrance effected into the mysterious Daraigharmo or valley of the upper Khingob, where the travellers ascended a mighty glacier close up to the foot of Mount Sandal. The heights of peaks west of Altin-mazar were found to have been overestimated by previous explorers, but Mount Sandal (7000 metres, or 22,960 feet, by triangulation from a base determined by boiling point and by reference to previous points) and its neighbours made good their earlier claims. Over thirty summits were climbed, ranging from 2200 to 5200 metres (7220 to 17,060 feet), chiefly for topographical purposes. Attempts at fixing longitude by occultations may be expected to give correct results after final calculation.

The geological results are rich and manifold. Among items of general interest may be mentioned an important fault which coincides with the Surkhab valley along a great part of its length, and which evidently has some connection with the earthquake region between Andizhan and Karatagh. Many valuable profiles were obtained. As to glaciology, one may confidently state that the expedition has obtained one of the most instructive additions, of latter times, to general and climatic glaciology. An unexpectedly low level of former ice-periods was established beyond a doubt. The larger glaciers are characterized by long "dead" snouts, and the old moraines (mostly rather recent, *i.e.* later than the Würm period) are very beautiful.

Among other items may be mentioned the discovery of a cave (known to the natives) with historic, archæological, and possibly prehistoric remains. Mountain insects (chiefly butterflies). ibex horns, etc., were collected, and the occurrence of a kind of markhor was established on the right bank of the Oxus. A series of colour photographs were taken by Herr Kuhlmann (who died a fortnight after his return home from a dangerous, and, it appears, undefinable disease, a complication of jaundice and typhoid with malarial symptoms). Many types of men and especially

* The route may be followed approximately in Mr. Rickmers' map, *Journal*, vol. **30**, p. 468.

women were drawn by the painter. Meteorological results were as good as the short and broken records of such a journey will allow, but the skill of such a trained observer as Prof. Ficker will admit of many interesting conclusions.

The expedition was devoid of sensational incident or exciting discoveries, but produced a rich harvest of scientific data. The Russian Government and the Amir of Bokhara gave most hospitable assistance, and the leader is also indebted to the Grand Duke of Oldenburg and Prince Oldenburg for most valuable introductions.

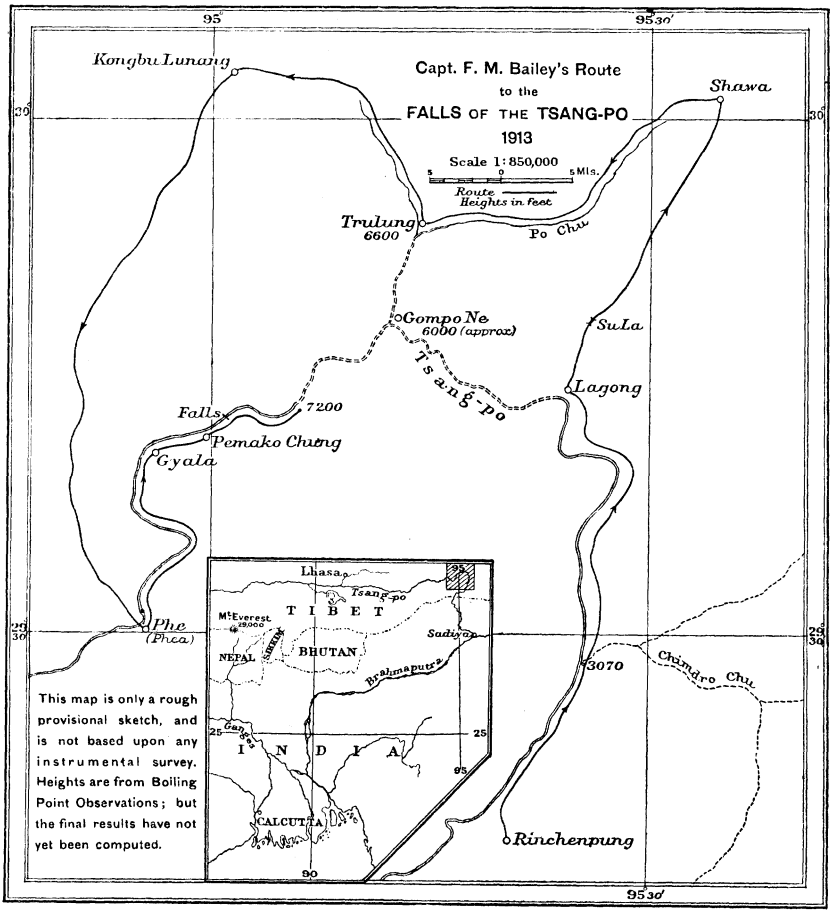
NOTE ON THE EXPLORATION OF THE TSANG-PO.

By Captain F. M. BAILEY.

[CAPTAIN BAILEY sends us the following short account of his recent journey with Captain Morshead to explore the hitherto unknown portion of the Tsang-po where it breaks through the main range of the Himalayas. He says nothing here of the route by which he reached Rinchenpung (a village with a monastery visited by Kinthup and shown on the map accompanying his report), but from his former letter quoted in the *Journal* for November last (vol. 42, p. 491), it appears that he and his companion had crossed the mountains from the upper valley of the Dibong. Rinchenpung is considerably higher up the Dihong valley than the furthest point reached during the Abor expedition (roughly 29° N.; see Mr. Bentinck's map in *Journal*, vol. 41, p. 200), but it is known that surveys have since been continued by various parties, and the monastery may have been reached by some of these. The accompanying map has been compiled from the scanty material hitherto existing, in order to help to an understanding of Captain Bailey's text, but it must be regarded as merely provisional. Some of the places named have appeared in no previous map, though several were mentioned by Kinthup, whose route it should now be possible to follow with more precision than hitherto. One result of the recent explorations is to show that the confluence of the Nagong (or Po) Chu (the source of which was touched by A-K during his journey of 1879–82) is much further north than was once supposed. It will be noticed that about 45 miles of the course of the Tsang-po remain unvisited, but the result of Captain Bailey's inquiries seems to leave little doubt as to its general character even here. Captain Bailey writes:]

We followed the Tsang-po valley from Rinchenpung up to the village of Lagong, but no altitude in the river-bed was obtained higher up-stream than the confluence of the Chimdro Chu with the Tsang-po, a point some 40 miles by road below Lagong; the altitude of the river by hypsometer at this point was 3070 feet. At Lagong we left the Tsang-po, and, crossing a pass, the Sula, entered the valley of the Nagong Chu, here called the

Po Chu. This river was followed from Showa down to Trulung (Kinthup's "Poh-toi-lung"). The altitude of the river at Trulung was 6600 by hypsometer. We wished to follow this river down to its junction with the Tsang-po at Gompo Ne, but were prevented, as the rope bridge had been carried away; the height of the Tsang-po at Gompe Ne must be about 6000 feet, or some 600 feet below Trulung. From Trulung we



followed Kinthup's road as far as Kongbu Lunang, from which place we took a more direct route to Phe (Phea) than that followed by Kinthup. We then went down to Gyala, opposite which is a waterfall on a small tributary, in which a god, Sinji Chogye, is carved on the rock behind the cascade.* The god is only visible in winter when the stream is small.

* These falls would almost seem to be responsible for the reports of falls on the Tsang-po itself—both those described to Colonel Waddell, of which a native drawing was reproduced in the *Journal*, vol. 5, p. 259, and those mentioned by Kinthup. The drawing showed the "god" carved on the rock, and Kinthup spoke of the cliff as Sinji Chogyal.—[Ed.]

From Gyala we went down to Pemako Chung, a small lamasery which was visited by Kinthup. Near this are the falls which he described. The river nearly the whole way from Gyala to this point is a foaming rapid, though in one or two places it flows quietly. At Kinthup's falls the rapid develops into a fall of about 30 feet; here rainbows were seen. We succeeded in pushing about 12 miles below Pemako Chung. Our lowest hypsometer observation, taken about 2 miles above the lowest point mapped, gave an altitude of 7200. The gap in the river which is unmapped we estimate at 45 miles, *i.e.* from the lowest point reached below Pemako Chung to Lagong. The gap between the two boiling point observations (below Pemako Chung, and at the confluence of the Chimdro Chu and the Tsang-po) is, however, about 90 miles. In the 45 miles that are unmapped we have the estimated height of 6000 feet of the Po Chu-Tsang-po confluence at Gompo Ne, which cannot be much in excess. The road down from Gompo Ne to Lagong is used a great deal in winter, as when the Su La is closed by snow, it is the only road from the Po Chu valley to the lower Tsang-po valley. We met a great many people who had seen this part of the river, all of whom agreed that there was nothing in the way of falls on it, though at the confluence of the rivers at Gompo Ne there are remarkable rapids and whirlpools. As regards the portion between Pemako Chung and Gompo Ne it was more difficult to collect information, as there is no road, but the distance can only be about 15 miles, and we met people who had hunted in the jungles in the neighbourhood who all said that there was no big waterfall on that section of the river, though the rapids must be extraordinarily steep.

The heights mentioned are liable to revision.

THE RIVERS OF FRANCE AND THE SUPPLY OF WATER POWER.*

By a decree of March 25, 1903, the French Ministry of Agriculture constituted a *Service d'Etudes des Grandes Forces Hydrauliques*, the purpose of which was to examine the resources of the country in respect of supply of water and water power from rivers, and to inquire into the best methods to be adopted for their development. Two regions were attacked at once—that of the Alps south and east of the Rhone, and that of the south-west draining by the Garonne, Adour, and other rivers from the Pyrenees. In the first the work was placed in charge of MM. R. Tavernier and R. de la Brosse, Ingénieurs en Chef des Ponts et Chaussées. The south-western district was organized at first on a smaller scale with the existing staff of the *Service Hydraulique*, but in 1909 it was brought into line with the Alpine district and put under the control of M. Tavernier.

The programme originally drawn up set forth two main divisions of work: (1) the purely physical study, from the geographical, meteorological, and

* 'Ministère de l'Agriculture. Direction de l'hydraulique, etc.' [*in later issues*, Direction-générale des Eaux et Forêts]. Service (d'études) des grands forces hydrauliques (dans la) région des Alpes. Tomes 1–6, and Annexe du Tome 6. The same. Région du Sud-Ouest. Tomes 1–2. Paris, 1905–1913. *Maps and Illustrations.*

the globe. It only shows what can be accomplished with perseverance and first-rate organization. The mountain men apparently subsist entirely upon their plantations; but how they originally reached the district they are now in, unless their antiquity is immense, is a mystery. That they are acquainted with the Tapiro pygmies, discovered by the Mimika Expedition, is clear by the similarity of dress, ornaments, architecture, and weapons of the chase, and still more so by the fact that they can count up to ten—a feat of arithmetic far beyond the powers of the plainsmen. Since the two tribes are so alike in these points, I think we may presume that the women of the Tapiro pygmies, of whom we failed to obtain a glimpse, are in like manner clothed in a girdle of leaves. Their bodily characteristics, however, are so dissimilar that it will not be easy for anthropologists to connect the two, and it raises one more conundrum which scientific men will find it hard to solve. I am glad that Mr. Wollaston has been able to bring forward further evidence of the terrific steepness and immensity of the southern face of the main range, and, in addition, has been able to obtain a telephoto of the precipice to the south of Mount Leonard Darwin. Mr. Wollaston still considers it possible that mountains of even greater altitude lie to the north of Mount Carstensz, and we must all sympathize with him in his disappointment at being baulked of his wish at the last moment; but in my own mind I am more convinced than ever, now that I have seen the photographs and have looked into the strata of the rocks, that the country to the north consists of great parallel ranges, steadily dwindling in altitude and with no peak surpassing Mount Carstensz in height.

PHYSICAL CHARACTERISTICS OF THE SIACHEN BASIN AND GLACIER-SYSTEM.*

By WILLIAM HUNTER WORKMAN, M.A., M.D., F.R.G.S.

THE term "glacier" is not sufficiently comprehensive to designate accurately the immense and, in arrangement, complicated bodies of snow, *névé*, and ice collected in the great rock-basin extending north-west from the source of the Nubra river to Peak 23 (Hidden peak), 78·4 kilom. (49 miles), with an east and west average width for a considerable distance of 32 kilom. (20 miles), and having an area, approximately, of 2400 sq. kilom. (over 900 square miles).

The basin is crossed in various directions by many glaciers of the first order and innumerable lesser ones, fed by snow precipitated upon the mountains and slopes of its watershed, all converging on a great central trunk averaging 4 kilom. (2·5 miles) in width, that stretches the length of the basin in a north-west by south-east direction and discharges from its tongue water derived from the snow collected in all parts of this extensive region to give birth to the Nubra river. This central trunk with its multitude of affluents resembling a river-system is more fittingly styled the Siachen glacier-system. The four other great Karakoram glaciers, as well as many smaller but by no means insignificant ones, are fashioned on the

* Royal Geographical Society, November 24, 1913. Map, p. 232. Read after the paper on the same date by Mrs. Bullock Workman. For discussion, see p. 142.

same plan. This type is peculiar to the Karakoram, being conditioned on the configuration of its valleys and the arrangement of its peaks. For this reason, as well as on account of certain structural features referable to existing conditions, all these glaciers merit the designation of glacier-systems or glaciers of the Karakoram type.

The Siachen basin is separated by its enclosing walls, on the east, from an unexplored region containing the Remo basin, with which the Siachen probably communicates by an ice-covered pass, possibly two, leading from the head of the Tarim Shehr affluent, and further north a group of snow mountains discovered by us from the east Siachen head that give rise to a large glacier, apparently the Urdok, running north-west into Chinese Turkestan; at the north end, from a glacier-basin leading north-east from the Gasherbrum massif; and on the west from the Baltoro, Kabery (Kondus), Sher-pi-gang, Dong Dong, Bilaphond, and Chumik basins, with glacier-passes connecting with the Bilaphond and Kabery, the last first discovered and crossed by our expedition in 1912.

The enclosing barriers of the Siachen consist of granite, gneiss, crystalline schists, slates and shales, sandstones, amorphous and crystalline limestones, and conglomerates, with some igneous intrusions. These rocks alternate with one another at short intervals, and are in places intimately intermingled and interfolded. They are extensively foliated, friable, and easily disintegrated by frost and weathering. Even the granites, largely of the biotite variety, are divided into small sections by joints crossing one another, and intersected by bands of quartz, feldspar, schists, and shales, in consequence of which they split up easily into fragments. The physical condition of the gneiss and crystalline schists would suggest to the ordinary observer that they were formed largely by metamorphosis of sedimentary deposits. But whether this be the fact, or whether it be that they originated as primary granites and were afterwards metamorphosed by folding, they are brittle, and present in the one case an immature appearance as if incompletely developed, or in the other a decadent one, as if the original structure had been overwrought and disorganized by strain and violence in the upheaval of the great ranges of which they form constituents.

This fragile condition of the rocks accounts for the irregular, jagged outlines of the mountains of the region, especially of the granite peaks, many of which are greatly serrated, and for the vast detritus-deposits that load the glaciers and play an important rôle in the development of their structural features. Owing to the amount of snow covering the mountains and the staining and weathering of the visible rock-surfaces, it is often difficult, even from a short distance, to distinguish the character of the rocks composing a mountain, so that the observer, particularly if he is not a trained geologist, may well be in doubt as to what formation lies before him. The shales and slates, the latter largely of very dark colour, are the most easily distinguished.

The north-east wall of the Siachen trunk resembles in structure and extent that which, with an unbroken length of 63 kilom. (39 miles), forms the upper portions of the southern Hispar and western Biafo barriers.* Starting at the north-east head, it extends west 4·8 kilom. (3 miles), then turns south-east and continues on 22 kilom. (14 miles) to the Tarim Shehr affluent. Here it turns east and forms the north wall of the Tarim Shehr for 27 kilom. (17 miles) to its sources, making a continuous, unbroken wall 53 kilom. (33 miles) long. The upper 20 kilom. (12 miles) of this wall is, and the remainder appears to be, a part of the main watershed between Turkestan and the Indus, and as such it probably continues on from the head of Tarim Shehr tributary to the Karakoram pass.

A second portion continuing around as the south wall of the Tarim Shehr glacier and extending west to the Tarim Shehr promontory there turns south-east and forms the remaining portion of the north-east wall of the trunk to its end, having a length of 53 kilom. (33 miles). Stated in another way, the north-east Siachen wall stretches from the north head of the trunk south-east in a nearly straight line for some 72 kilom. (45 miles), being pierced only by one small and two large affluents.

The south-west boundary of the upper half of the trunk can scarcely be called a wall. It consists of numerous mountains of irregular outlines, scattered about in an irregular manner, enclosing vast reservoirs of snow and ice that communicate with the main glacier by large secondary glaciers, the whole forming an ice-bound labyrinth that defies description. Still, the mountains and affluents stand in such relation to the main glacier that lines drawn from one headland to another suffice to mark the limits of its bed with sufficient accuracy. From the Peak 36 tributary to the tongue, a fairly continuous wall exists which is pierced by several large affluents.

The structure of these walls may be stated in general terms as follows †: The mountains enclosing the Indira Col and the north-east col, at the northern extremity, are composed of slates and shales, light and dark in colour with, possibly, some limestones. Thence down the north-east wall to within about 6 kilom. (4 miles) of the Tarim Shehr opening mostly of light coloured limestones and shales with some conglomerates and at least one igneous intrusion. The limestones are strongly in evidence in the moraines fed by this section. The rocks are soft and the peaks and ridges broken and jagged in outline. From a point shortly north-west of Teram Kangri, the wall and its peaks, including that summit, quite to their tops, forming the north barrier of Tarim Shehr glacier to its end, appear to be almost wholly made up of black slate with here and there foothills of lighter-coloured shale or limestone.

* Vide *Geographical Journal*, February, 1910, p. 117.

† It is obvious that not more than a general outline of rock distribution could be obtained amid the exigencies of an expedition of limited duration, with opportunities for investigation restricted by snow and weather-conditions, in an unexplored region of such character and extent as the Siachen basin, where one can come into actual contact with the rocks *in situ* at comparatively few points.

The same is true of the visible rocks on the south side of Tarim Shehr glacier, though some of the ice-covered peaks at its upper end must contain granite and gneiss, as much *débris* of this character appears in the moraines of that side. On the extremity of Tarim Shehr promontory, most of which is composed of brown shale, granite crops out over a considerable area. Thence, beginning with Junction mountain, 6353 metres (20,840 feet), rising above the promontory, ascended by us in 1911, down to the great bend, some 25 kilom. (16 miles), the mountains are of dark brown and black slate with occasional sections of lighter colour broken into jagged points and cleft by deep, ragged ravines. The only granite noticed *in situ* in the whole length of this wall was at Tarim Shehr promontory.

From our camps on moraines opposite this wall, the view toward it was most forbidding. The foreground was occupied by the huge black hillock-moraine coming from the Tarim Shehr affluent, the towering hillocks of which, resembling vast heaps of coal piled up at random in a Cyclopean coalyard, shut out from sight the white ice of the glacier beyond, while the background was formed by the succession of black peaks hard in outline and destitute of grace, rendered more desolate by contrast with the snow capping their tops, the whole constituting as sombre and depressing a landscape as could well be imagined, far eclipsing the most fantastic conceptions of Boecklin and casting an uncanny shadow over the soul.

On the south-west side of the trunk a similar variety of formation occurs, but granite is more and limestone less in evidence. The last three peaks of the King George V. group ending the massive mountain-tongue, interposed between the heads of the Baltoro and Siachen glaciers, which form 11 kilom. (7 miles) of the upper south-west Siachen wall, appear to be mainly composed of granite and gneiss, though on an eastern spur and near its south-east extremity the granite passes over suddenly without discontinuity of outline into black slate.

South of this tongue at the entrance of the upper western tributary into the Siachen, the Hawk, a graceful pointed spire of granite, soars from a circle of black slate peaks and ridges to an altitude of 6768 metres (22,200 feet). From this peak downward for 35 kilom. (22 miles) to the great bend, the south-west wall is largely, if not wholly, composed of sedimentary rocks, prominent among which are black slates. Just at the bend, two elevations, the ends of spurs descending from Peak 8, have the appearance of granite. The greater part of the south-west wall, as we observed it, does not, therefore, conform to the granite structure assigned to it by Dr. Longstaff.

Sixteen kilometres (10 miles) west of the trunk the impressive granite massif of the twin Peaks 35 and 36, 7743 and 7707 metres (25,400 and 25,280 feet) overtopping all mountains of the region south of Peak 23 and forming a salient landmark, gives off the large Peak 36 affluent to the Siachen on the east and the Dong Dong glacier on the west. Granite and

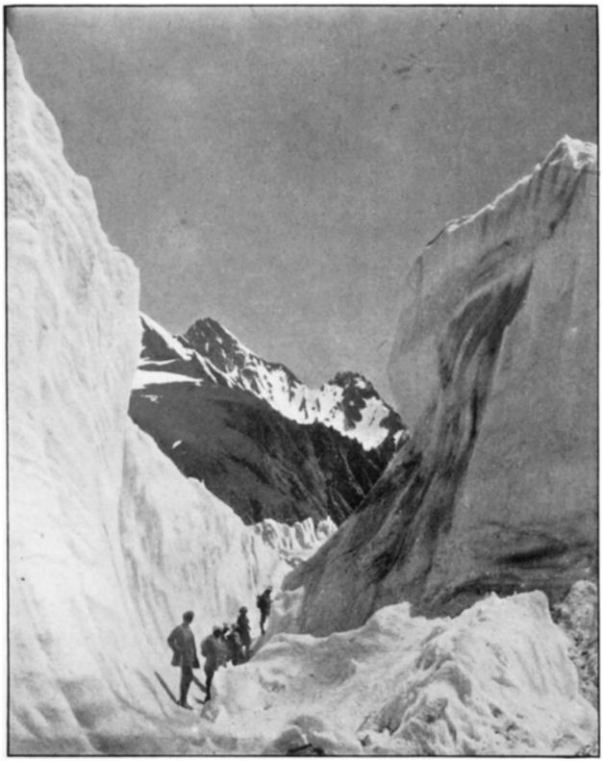


FIG. 3.—TWO GIGANTIC SERACS AND PASSAGE BETWEEN THEM ON SIACHEN. LARGE AREA OF SIACHEN SURFACE AT AND BELOW TARIM SHEHR JUNCTION BROKEN UP BY PRESSURE IN THIS MANNER.

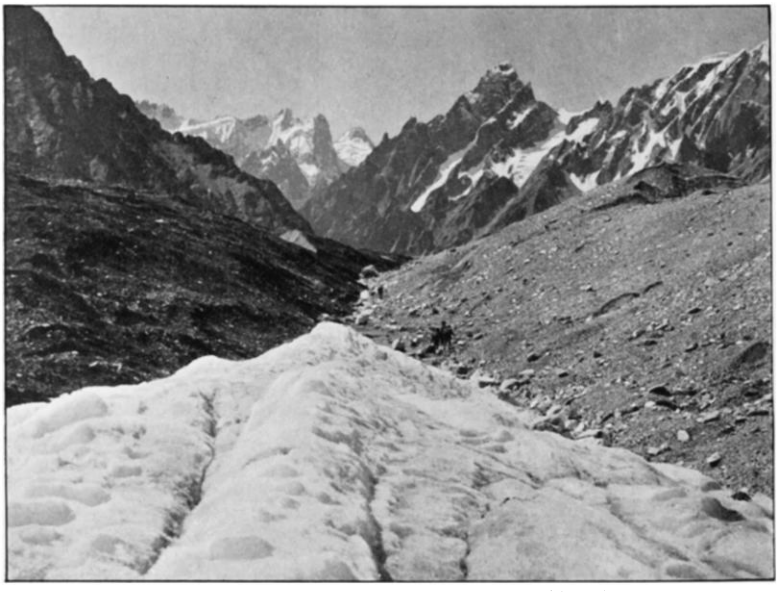


FIG. 4.—CONVERGING BLACK AND GREY MORAINE STREAMS COMING TOGETHER AND STRANGLING IN THEIR GRIP ATTENUATED EXTREMITY OF WHITE STREAM. PROPORTIONS OF LAST DISTORTED BY POSITION OF CAMERA. WIDTH IN FOREGROUND, 10 METRES (32·8 FEET). LENGTH TO APEX, 60 METRES (ABOUT 200 FEET). NOTE THAT MORAINE-STREAMS CONTINUE ON WITHOUT INTERMINGLING.

FIG. 1.—BIRD'S-EYE VIEW OF 48 KILOMETRES (30 MILES) OF TRUNK OF SIACHEN GLACIER, SHOWING WHITE AND MORAINE STREAMS, THE NARROWING OF FORMER AND INCREASE IN SIZE OF LATTER AS THEY DESCEND, AND DEFLECTION OF BOTH BY AFFLUENT PRESSURE. AT LOWER RIGHT-HAND CORNER TARIM SHEHR AFFLUENT ENTERS, TURNING THROUGH ANGLE OF 140° AROUND POINT OF ROCK PROMONTORY, FLANKED BY MARGINAL BLACK SLATE MORAINE, WHICH, BENDING AROUND IN SYMMETRICAL CURVE TOWARDS CENTRE OF SIACHEN, DESCENDS AS MEDIAN MORAINE.

FIG. 2.—SECTION OF BLACK SLATE HILLOCK-MORAINE WHICH, DESCENDING TARIM SHEHR GLACIER AS MARGINAL MORAINE, CONTINUES ON DOWN SIACHEN AS MEDIAN MORAINE, HAVING TOTAL LENGTH OF SOME 50 KILOMETRES (31 MILES). ITS HILLOCKS, SEVERAL ABREAST, RISE 100 TO 150 METRES (328 TO 392 FEET) ABOVE DEPRESSIONS AT THEIR BASES. WIDTH APPROACHES HALF KILOMETRE (ABOUT 1600 FEET).

FIG. 7.—PYRAMIDAL ICE-PINNACLES, LAST REMNANTS OF EXTINCT WHITE STREAM, FORMED BY MELTING AWAY OF SOFTER PARTS OF HIGH ICE-RIDGE CROWDED UP BY PRESSURE, AND CUTTING DOWN THROUGH RIDGE OF THIN DÉBRIS-DEPOSITS HEATED BY SUN. DÉBRIS-COVERED SURFACE AROUND PINNACLES FREE FROM CREVASSES. HEIGHT OF HIGHEST PYRAMIDS 11 METRES (36 FEET).

gneissoid rocks crop out, doubtless, at various other points of the Siachen basin that were not within range of observation. No conglomerates *in situ* were noticed.

Thus it will be seen that, while slates and shales constitute, perhaps, the greater part of the rocks of this region, they have mingled with them a very considerable proportion of limestones and conglomerates appearing in the moraines, and also of granite, gneiss, and crystalline schists. No single formation continues uninterrupted for any great distance. One mountain may be of granite and the next of shale or limestone, or the same mountain may consist of two or more rock-varieties more or less intimately mingled. This composite arrangement, as I have had opportunity to observe in an almost continuous line from the Siachen to Hunza, exists throughout the Karakoram. The opposing walls of its valleys, large and small, both those running east and west and those north and south, are often composed of different varieties of rocks, perhaps granite on one side and shale or other sedimentary rock on the other, or a given wall may vary at different points in the same manner. The various rock-formations not only of the Siachen region, but also everywhere that I have been in the Karakoram, are so distributed and intermingled that it does not appear to me possible to draw any reliable inference from them as to the existence of parallel ranges of dissimilar structure.

In the June, 1910, *Geographical Journal*, p. 646, Dr. Longstaff states that the Duke of the Abruzzi's expedition discovered that "this (Broad peak) and the four Gasherbrums are composed of marbles and conglomerates." He adds, "The massif of Teram Kangri is a continuation of this (Gasherbrum) range; its base appears to consist of schists and slates and its peaks of marbles and calcites." After careful study of the published accounts of the expedition referred to, I have been unable to find any authorization for the statement that Broad peak and "the four Gasherbrums are composed of marbles and conglomerates." In the December, 1910, *Alpine Journal*, p. 344, Dr. de Filippi states that moraines seen on the Baltoro "consist of beautiful polychrome marbles and conglomerates, originating from Hidden peak and the Golden Throne," but this is far from "discovering" that Hidden peak, as a mass, and still less the other three Gasherbrums are composed of such rocks.

As already stated, the last three high mountains of the King George V. group, ending the spur and interposed in direct line between the Gasherbrums and Teram Kangri, appear to consist mainly of granite and gneissoid rocks. We passed directly beneath and camped almost in the shadow of the high vertical precipices of their eastern and southern flanks, of which we had a near view. Also the upper portions of the Gasherbrum peaks, as seen from the high Silver Throne plateau to the south-east, appeared to have the shape and general aspect of granite peaks, though we were not sufficiently near them to distinguish their structure. However this may be, we saw nothing in their appearance to suggest marbles.

Regarding the massif of Teram Kangri, having passed three weeks altogether at various points near and in front of it during late summer, both in 1911 and 1912, when the snow was largely melted away, we had considerable opportunity to study it. As we saw it, it appeared to consist of black slate quite to its top, and no evidence of the existence on it or any of the adjoining peaks of "marbles and calcites" could be detected with a powerful field glass. Further, no calcite or marble was found on moraines the origin of which could be traced to Teram Kangri, which does, however, throw off an immense quantity of black *débris* upon the glacier. Therefore the argument based on similarity of structure in support of the view that the massif of Teram Kangri is a continuation of the Gasherbrum "range," so far as can be judged from our observation, falls to the ground.

The topographical objection to this view is quite as strong, if trend and continuity of elevation are criteria, in determining whether two mountain sections are parts of the same range. The Gasherbrum "range," if the comparatively short south-east spur from which Broad peak, the Gasherbrums, and the three last peaks rise can be called a range, ends abruptly in the icefields of the upper Siachen, and has no connection above the ice with the north-east Siachen wall, of which Teram Kangri forms a point, being separated from it at every part by the whole width of the glacier.

On the contrary, the north-east wall continues on directly over the Indira Col at the north Siachen head into Turkestan, with a precipitous drop of *circa* 2000 metres (6562 feet) at the col, running thence north-east as a line of pointed, ragged, dark, slaty peaks, which form the south-east wall of the Gasherbrum glacier issuing from the Gasherbrum peaks. This wall, taken as a whole, constitutes the eastern barrier of an Oprang-Nubra depression, of which the highest point occurs at the Siachen head on the watershed between the Indus and Turkestan, whence the gradient drops north-east toward the Oprang and south-east to Nubra.

The discussion by Dr. de Filippi in "Karakoram and Western Himalaya" of the structure of Broad peak and the Gasherbrums involves the, geologically, interesting and important question touched upon in the preceding pages of the distribution of rocks in this region. On page 227, he says, "From an examination of the moraines that have their origin in the various mountains, we were able to ascertain that the whole chain of Broad peak and the Gasherbrums, including Hidden peak and the Golden Throne as well, is a sedimentary formation."

Not having seen Broad peak or the western faces of the three northern Gasherbrums, which rise from the spur extending south-east from the north Baltoro wall and ending among the upper reservoirs of the Siachen, I would not venture to assert that Dr. de Filippi's inference regarding their structure is not correct, but analysis of the evidence on which it is based does not appear to me to warrant so positive a statement as he makes.

With due deference to the interesting and able treatment by Ing. Novarese of the material supplied by the expedition, although some of the geographical deductions based on it were shown by our later Siachen expedition to disagree with actual conformation, I would ask geological experts, whether a definite conclusion as to the structure of the great inaccessible peaks far removed from direct inspection forming the central and highest portions of the mountains mentioned could be drawn from moraine material lying at a distance on the Baltoro? Might not the sedimentary *débris* here found originate largely or wholly in the lower, outer buttresses of the massifs, or in the outlying mountains between them and the Baltoro forming the immediate walls of the latter? Because such *débris* existed in moraines extending out from these peripheral elevations, does it follow that granite or gneissoid rocks can be excluded as components of the high central uplifts beyond?

My reasons for asking these questions are the following:—

(1) It is a fact which may be observed almost anywhere in the Karakoram, and nowhere more than in this region, that a mountain may be composed of different varieties of rock, the central portions being, perhaps, of one variety and the peripheral of another or several varieties. This is well illustrated in the very spur in question by Queen Mary peak, Mount Hardinge, and the last peak ending it, which consist, apparently, chiefly of granite and gneiss with outlying sections of black slate; by the marble peak on the Baltoro opposite Broad peak, mentioned by Dr. de Filippi as rising from a mass of black rock in the midst of a granite region; and again a short distance south-east on the Siachen by the sharp, grey granite crest of the Hawk towering above a surrounding mass of black slate mountains.

(2) It is also a fact, which I have noticed in various Karakoram localities, that a large surface-moraine may originate in a rock-shoulder or section intercalated in a formation of wholly different character, so that an opinion based on the *débris* found in the moraine might assign to a large massif a formation entirely foreign to that of its greater part and thus be wide of the truth. Moraine *débris*, as such, demonstrates the existence of given rocks without indicating their location or extent. It can only have a positive value in determining the distribution of those rocks when traced to the sources from which it springs. The sedimentary *débris*, found by Dr. de Filippi on the Baltoro moraines, shows that sedimentary rocks exist in the mountains at the head of the glacier, but it does not indicate their exact location or limits, nor does it exclude the presence in these mountains of other rocks. His account does not make it clear whether these moraines do not contain also granitic *débris*, as would appear probable from Conway's earlier observations. The sources of these moraines seem to have been judged of, chiefly, by their trend towards the bases of certain mountains, but it is evident that the *debris* on them was not and could not be traced to an origin in the central highest peaks far

behind. Further, in the above quotation he includes among the peaks, the structure of which he "ascertained" from examination of these moraines, Gasherbrum II. and III., which, according to the map published with his book as well as those of Sir Martin Conway and the Indian Survey, have no direct connection with the Baltoro, and from which, therefore, no *débris* of any description can reach the Baltoro moraines.

(3) Dr. de Filippi mentions the grey colour of the higher parts of Broad peak and the Gasherbrums as distinctive of limestone. The colour of the three last granite or gneissoid peaks of this spur is also grey. This colour, in the presence of Himalayan weathering, is at least as characteristic of granite as of limestone.

(4) Also the broad strata of Broad peak, cited as distinctive of sedimentary rocks, are very commonly seen in Himalayan granite, gneiss, and crystalline schists. The face of K2 asserted to be a granite massif presents in panorama E. of "K. and W. Himalaya," an appearance very like that of a banded formation.

(5) Likewise the forms of the compact pyramids or obtuse cones with smooth outlines of Peak 23, and the other three Gasherbrums strongly resembling those of granite spires in the Bilaphond, Kabery, and Saltoro regions, suggest granite quite as much as sedimentary formations, as do also the rounded summits of Broad peak as seen in the Sella panoramas. The summits of Broad peak parallel closely in shape those shown of its next northern neighbour, Staircase peak, stated by Dr. de Filippi to be granite, *cf.* panoramas C and G. As granite appears to form the mass of the three south-east peaks of the same spur on the other side, according to Dr. de Filippi's inference Broad peak and the Gasherbrums are a *high sedimentary group* flanked on either side by *lower granite mountains*, the first exception, I believe, reported to the rule enunciated by the Indian Geological Survey that the upper portions of very high Himalayan peaks are of granite. Can this inference as to structure be accepted on the evidence given ?

From these considerations, without expressing a positive opinion, I would suggest as an alternative proposition for investigation by future explorers, particularly geologists, who may have opportunity to examine this region more carefully, that the whole spur heading the Baltoro on the east from Staircase peak, so called, to its termination in the snows of the Siachen consists of a lofty central vertebra of granite and gneissoid rocks flanked on both sides by lower sedimentary slates and limestones, which last form the source of the limestone *débris* found by Dr. de Filippi in the Baltoro moraines and of similar *débris* observed by our expedition in 1912 on the Kabery glacier moraines south of the Golden Throne.

The great altitude of the mountains and ridges surrounding the heads of the Siachen, and spread over the region west of it almost to the extremity of its tongue, ensures the accumulation of enormous quantities of snow upon them and in the labyrinthine recesses between. The whole region

for many kilometres back from the main glacier constitutes a great reservoir, that sends forth its icy contents by affluent after affluent to build one large central trunk. The north-east wall, much less ice-clad than the south Hispar wall, contributes a relatively small quantity of ice to the trunk, but the ice-streams from it are loaded with a vast amount of rock-detritus from its crumbling crags, which deposited upon the glacier exercises an important influence on the glacier-economy. Through this wall, about midway between its ends, enters from the east the largest affluent, the Tarim Shehr, contributing to the main glacier ice from a wide eastern area.

The ice thus poured into the main trunk is sufficient to keep it at a maximum volume so as to cover completely the floor of the valley it occupies, leaving no free space between it and the valley-walls. No passage exists by the side of the glacier or over the precipitous valley-walls. The explorer is obliged to find his way over the glacier itself, an undertaking as arduous and dangerous as the ascent of high snow-clad mountains, the nature of which is not appreciated by those unacquainted with Himalayan glaciers. In this respect the Siachen resembles the Kondus system of glaciers, but differs from the Biafo and Chogo Lungma, which do not fill their valleys. These last can be penetrated for long distances by the sides of the glaciers upon lateral moraines or over maidans and slopes covered with grasses and flowers.

A bird's-eye view of the Siachen trunk from Junction mountain above Tarim Shehr, 6353 metres (20,840 feet), shows it to be composed of a number of sharply defined, parallel, longitudinal sections of streams, some consisting of white ice, others covered with moraine material, running side by side for many kilometres, the largest for above 50 (30 miles) without intermingling. These I will distinguish from one another in this paper by the names white and moraine-streams from their surface appearance, and I will also apply the term "white ice" to those parts of the glacier which were comparatively free from detritus without regard to the physical distinction between surface white ice and the blue or black ice of the glacier-body beneath.

These streams, which can be traced upward toward the ultimate sources of the trunk and affluents, are seen to represent the ice-masses contributed by the initial reservoirs compressed and narrowed into ribbon-like bands by the tremendous lateral pressure developed by the crowding of vast bodies of ice coming from different directions into the comparatively small space between the mountain walls occupied by the trunk.

This lateral pressure is increased by the entrance of each successive affluent. Any affluent sufficiently large and powerful to add its own streams to those already existing in the trunk must do so by crowding the trunk out of its path over toward the opposite side of the glacier-bed and by inserting its own streams into the side-space thus created. This yielding of the trunk, which previously to the entrance of the affluent completely

filled its bed, is an indication of an increase of lateral pressure proportioned to the size of the affluent, which must result in a further compression and narrowing of the trunk-streams. This is seen in the bird's-eye view to be exactly what happens to the Siachen streams, especially the white streams, which, broad and greatly exceeding the moraine-streams in width in the upper parts of the trunk, gradually become narrowed under lateral pressure until they finally die out and disappear at various distances from their sources.

Pressure is not, however, the only factor involved in this result. Descending to the glacier and crossing it at points above the Tarim Shehr junction, where its surface is fairly smooth, one finds the centres of its white streams in transverse section elevated considerably above their edges, and the streams themselves symmetrically arched or crowned so as to resemble a series of perfectly constructed, metalled, and crowned roadways placed side by side. So high is this crowning that, standing on moraine-ridges in the centre of the trunk, 6 to 10 metres (20 to 33 feet) above the adjoining white ice, I could not see the edges of the glacier on the sides nor, perhaps, halfway to them.

This crowning is connected with the thinning and disappearance of white streams. Its presence indicates that the pressure which diminishes their width also crowds them upward without disorganizing their structure or causing them to mingle with one another, and that, the lateral pressure being applied on both sides, their ice yields most along the central line, which is thus crowded highest. Rapid ablation of the raised portions occurs through melting, which, on this glacier, is very marked in the course of a summer. Ten metres is probably a conservative estimate of its amount. This diminishes the depth and volume of the stream, with the result that it becomes constantly less resistant to pressure and more easily compressed and elevated. The interplay of lateral pressure and ablation, finally, so reduces the size of the stream that it is unable to offer further resistance, and is strangled in the grasp of its more powerful neighbours (moraine-streams), disappearing henceforth from view.*

As the streams become thinner and weaker they are pressed up higher with more abrupt sides, and their tops are broken into superficial séracs, as occurs on the Tarim Shehr and lower portion of the Siachen. Symmetrical crowning here disappears. Crowning can, on the contrary, be traced upward into the reservoirs, where I observed it among the vast snow and ice expanses at altitudes of 6400 metres (21,000 feet). The greater the width and volume of streams and reservoirs the more generally are the effects of pressure diffused throughout the mass and the more gradual are the resulting curves. In the reservoirs, crowning displayed itself in wide elevated ridges sloping gently away to lower levels, orienting

* For a detailed consideration of pressure-effects *vide* "Features of Karakoram Glaciers connected with Pressure," Workman, *Zeitschrift für Gletscherkunde*, Dec., 1913.

at right angles to the direction of pressure. It is easy to understand how here vast masses of snow and ice descending the steep opposite sides of a narrow valley and meeting at the central line would crown upward.

With moraine-streams the case is quite different. They, usually, first appear as small accumulations of *débris* at places where *névé* has melted mostly or wholly away, but they increase in size and height as they move down a glacier, till at length they exceed in volume the white streams between them. Those occupying the glacier-edges constitute latero-median or marginal moraines, but when, after coming in contact with affluents, they are pushed away from the edges toward the centre they become median moraines, affluent streams being interposed between them and the sides of the glacier-bed. They increase in size not only through their mass below the surface, being crowded higher by increasing lateral pressure, but also through union with them of marginal moraines of incoming affluents.

Relatively to the white streams, their visible portion becomes also constantly greater from the fact that, being heavily covered with *débris*, ablation of their substance through melting is reduced to a very small amount, so that they, practically, retain the elevation and bulk they receive through pressure, while the rapid lowering of the surface and diminution in volume of the adjoining white streams through melting expose a still greater extent of their sides and actually add to the difference in height between the two. As a result, the moraine-streams, which at their points of emergence in the upper parts of a glacier may be on a level with the white, soon acquire a decided elevation above them, which, lower down on the glacier, may become as great as 100 metres (328 feet) or over. Further, as the glacier-bed narrows, the moraine-streams under the influence of lateral pressure thus occasioned converge upon one another, occupying the space left vacant by the wasting white streams, till they come together and swallow up the attenuated remnants of the latter.

Where the last white streams finally disappear the orderly arrangement, which up to this point usually characterizes the moraine-streams, may cease, and the latter, crowded directly against one another, may mingle together, becoming converted into a confused mass of elevations and depressions, with which condition of its surface the glacier-tongue moves on to its extinction. The final disappearance of white streams occurs on different glaciers at different distances from the extremity of the tongue. According to my observation, the last white stream of the Chogo Lungma was blotted out at 14·4 kilom. (9 miles), of the Hispar at 16 kilom. (10 miles), of the Kabery, first descended by our expedition in 1912, at 18 kilom. (11·25 miles), of the Biafo at about 5 kilom. (3 miles), whilst on the Siachen the central white stream persisted to within 2·4 kilom. (1·5 miles) of the end of the tongue.

A peculiar feature of the effect of lateral pressure on moraine-streams is that it often presses them up into a series of rounded or angular elevations

or hillocks covered with *débris*. These have a size varying according to the pressure and amount of ablation of exposed ice from a few to over 100 metres in height, and once produced they persist for a long time. This subject was mentioned in a paper read by myself before this Society on December 6, 1909, and printed in the *Geographical Journal*, February 10, 1910, *vide* pp. 117, 121.* To moraines exhibiting this formation I have given the name *hillock moraines*. All the above characteristics and others besides are exemplified in the moraine-streams of the Siachen, which are remarkable in size, perfection of structure, and arrangement, and constitute by no means its least interesting feature. Its trunk is banded by numerous streams of this kind, eight to ten at any point below Tarim Shehr, most of which originate in affluents, though some crop out near its centre, and one of the largest springs from the north-east wall. Among these the three largest deserve special mention.

(1) The black hillock-moraine.

This, the most prominent moraine of the glacier, is an enormous hillock-moraine covered with black slate *débris*, coming from the Tarim Shehr affluent. Gathering into its embrace detritus shed off, principally, from the northern black slate barrier, though with some additions from the centre, and transformed well up the glacier into a hillock-moraine, it finally descends along the northern edge of the Tarim Shehr as a marginal moraine, turns with this affluent into the bed of the Siachen trunk, and, crowded by the enormous pressure well over towards the centre of the latter, with the Tarim Shehr white streams between it and the north-east Siachen wall, passes down the Siachen as its largest median moraine almost to its end. Its total length is over 50 kilom. (32 miles).

At its line of first contact with the Siachen, its bulk is increased by the addition of a large, black slate-moraine and a smaller one issuing from gorges at the base of Teram Kangri. Below its junction with the Siachen, its width exceeds half a kilometre, and its hillocks, three and four abreast, reach huge proportions, rising over 100 metres (328 feet) above the depressions at their bases. I saw a number the height of which appeared to be nearly if not quite 150 metres (492 feet). Seen from the ice outside it, this moraine resembles a range of large black hills stretching down the centre of the glacier. Many of its depressions are occupied by lakes. It is the largest moraine I have met with in the Karakoram, and it does not appear likely that its equal can be found anywhere else on a valley glacier.

(2) The great limestone moraine.

Beneath some orange-coloured peaks of the north-east wall, shortly below the extremity of the King George V. ridge, where the *névé* of the north Siachen reservoir disappears in late summer, a mass of small rock-fragments presented itself to view, covering the ice for some distance from the mountain-wall. Part of this is, doubtless, brought down by the ice

* *Vide* also *op. cit.*

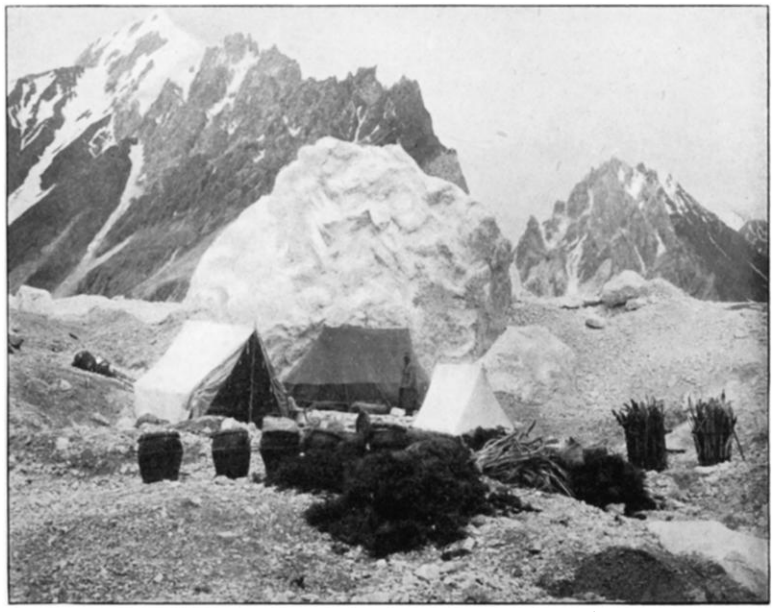


FIG. 5.—CAMP AT ABOUT 3800 METRES (16,300 FEET) ON GREY LIMESTONE MORAINE AT BASE OF LIMESTONE BOULDER: SIZE OF BOULDER CAN BE SOMEWHAT ESTIMATED BY COMPARISON WITH TENTS.

FIG. 6.—END OF ROCK-PROMONTORY PROJECTING INTO EDGE OF PEAK 36 GLACIER AT ALTITUDE OF 5366 METRES (17,600 FEET), WITH LAKE AND STEEP CURVING ICE-WALL FORMED BY MELTING OF ICE BY HEAT REFLECTED FROM ROCK-PROMONTORY.

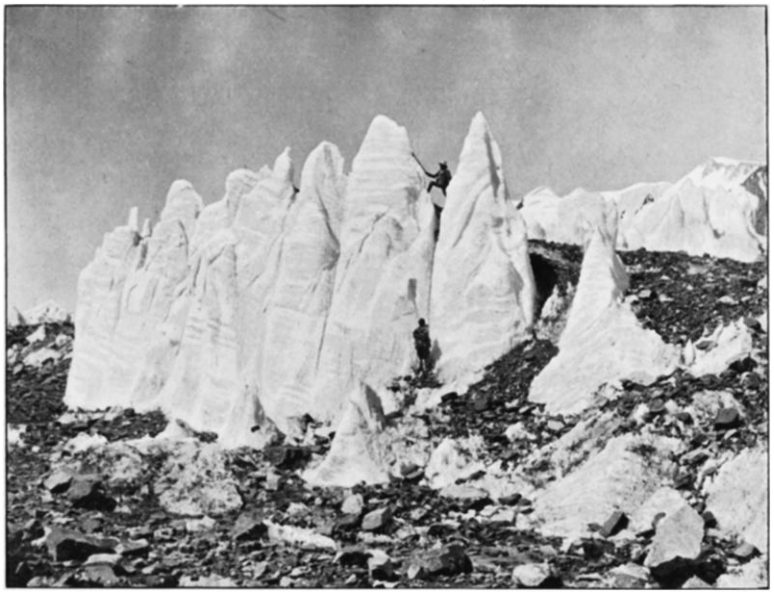


FIG. 8.—LINE OF PRESSURE-SERACS SHARPENED OFF BY MELTING INTO POINTED PINNACLES (SERAC-PENITENTE) ON TARIM SHEHR GLACIER. HIGHEST, 11·5 METRES (36 FEET).

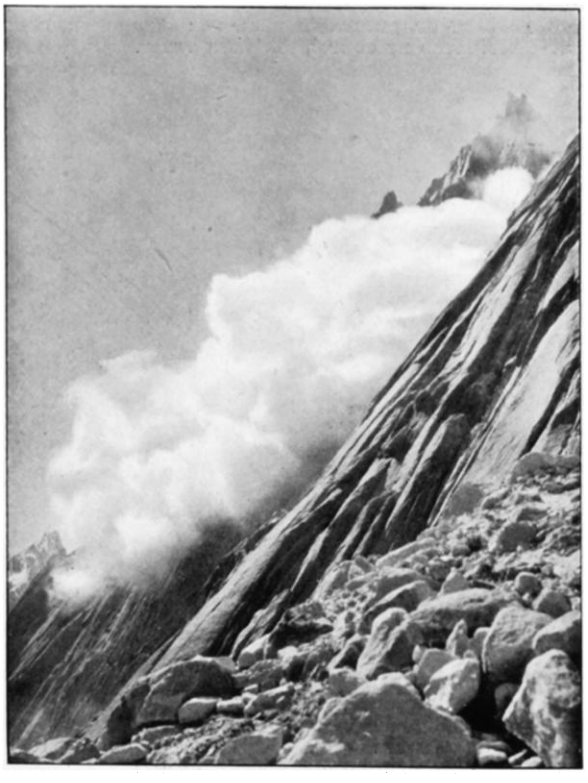


FIG. 9.—CLOUD FROM AVALANCHE FALLING IN COULOIR BETWEEN TWO GRANITE PEAKS ON BILAPHOND GLACIER. BROKEN ROCK-SURFACES HERE SEEN CHARACTERISTIC OF THE GRANITES OF THIS REGION.

from the glacier higher up, and part is derived from the wall directly above. This, as it moves down with the ice, soon takes the form of an elevated moraine, which, under the pressure of the large West Head or first western affluent entering opposite, is converted next the wall into a hillock-moraine and on its glacier-side into a raised moraine-shelf.

Receiving constant accessions of *débris* from small tributaries from the north-east wall, it gradually spreads out from the edge until it attains a width of some 400 metres (·25 mile). This moraine is composed of small fragments of limestones, marbles, and breccias of various colours, some calcite, different-coloured shales, and conglomerates. Granite, if present, is very scantily represented. I find in my notes no mention of any having been noticed in the 43 kilometres (27 miles) we followed its course. Comparatively few *débris*-masses were seen on it worthy of the name of boulders. The general colour of the moraine is grey.

Many limestone fragments contain markings in white resembling ribs with articulating heads, and vertical sections of heart shape resembling two ribs joined by a vertebra enclosing a dark centre as of some animal like a serpent or reptile. They probably represent the remains of some bivalve mollusc. They have diameters averaging 15 cm. (6 inches). They are intimately associated with the limestone and cannot be separated from it as fossils, and were only seen in transverse section. No actual fossils were found.

This moraine descends along the eastern edge of the trunk some 13 kilom. (8 miles) to the entrance of the Tarim Shehr affluent, by the pressure of which it is then deflected westward nearly to the centre of the trunk-bed and henceforth becomes a median moraine. As it turns west, its volume is increased by the accession of a moraine of considerable size, elevated 6 or more metres (20 feet) at its centre, issuing from a nala lying behind a projecting shale ridge of the north-east wall shortly above the base of Teram Kangri. This moraine consists wholly of a soft, grey limestone of a texture not sufficiently firm to merit the name of marble, mottled with black masses suggestive of fossil remains, though distinct forms are not evident. Its central ridge is crowned by a succession of immense boulders of the same limestone.

At the Tarim Shehr-Siachen junction, the main moraine meets the gigantic black hillock-moraine of the former, the two crushing out of sight a good-sized white stream caught between them, and descends side by side with it without intermingling to within a short distance of the glacier-end. Below the junction its hillocks increase in size till they rival those of the black moraine.

(3) The granite moraine.

The third large moraine first appears high up on the south side of the Peak 36 affluent, in front of the granite massif of that name, at the junction with it of a secondary affluent, as a line of discrete, oblong hillocks 4 to 8

metres high, their bases separated by ice-surfaces. As these move downward towards the Siachen trunk, they are crowded up higher by the increased pressure of other affluents till their bases unite and they form a continuous hillock-moraine, which descends as a median moraine to the Siachen, where it is amalgamated by pressure with a marginal moraine, which has descended alongside it.

Still farther reinforced by contributions from the south-west wall, it acquires a width of nearly 500 metres (1640 feet), and for the next 5 kilometres (3 miles) occupies the edge of the Siachen trunk. On meeting the Lolophond affluent descending from the Bilaphond La, its size is further augmented by junction with it of the north marginal moraine of that glacier, by which it is pushed strongly over eastward into the Siachen bed. From this point it passes far down the Siachen as a median moraine.

This moraine is composed largely of granite and crystalline *débris* mixed with shale. On its eastern edge great blocks of striped and variegated limestone were scattered about, the source of which was not evident. This was also the case with a smaller shaly moraine striking over from the centre of the glacier and joining it.

In the upper reservoirs and higher portions of trunk and affluents covered by *névé*, no signs of moraines are visible. One may walk over these for many kilometres where the virgin white expanse is unmarred by the presence of a single boulder or rock-fragment. This fact does not preclude the possibility of the existence of large quantities of rock-*débris* in the deeper portions of the ice, or the probability that the marginal portions are packed with detritus that comes to light in the moraines lower down.

As the Siachen fills its bed so completely and its enclosing walls rise from it so abruptly, there is little room for lateral moraines to be deposited, and they are only found here and there for short distances. Just above the Lolophond affluent, on west edge of glacier-bed, a huge one exists, but only for a few hundred metres.

The larger Siachen affluents join the trunk at accordant grade at angles of 90° or over with its axis in the usual manner; but the junction of the great eastern affluent, the Tarim Shehr, involves phenomena especially noteworthy. Here probably the largest existing valley tributary outside the Polar regions unites with the largest known valley glacier. The Siachen just above the junction has a width of 4·4 kilom. (2·75 miles) and completely fills its bed. The Tarim Shehr, with a width of 3·2 kilom, (2 miles) and a length of over 27 kilom. (17 miles), and falling nearly 1000 metres (3281 feet) from an altitude of 5883 metres (19,300 feet), impinges on the Siachen at an angle of 40° with its course with a shock so great that the Siachen trunk is compressed and driven over toward the opposite side, to an extent, that permits the Tarim Shehr to turn around the pointed extremity of the granite and shale Tarim Shehr promontory through an arc of 140° and take its place as a constituent part of the trunk.

The width of the glacier-bed just below the junction is again 4·4 kilom. (2·75 miles). The amount of pressure exerted by the oncoming Tarim Shehr on the Siachen may be gauged by the fact that two immense ice-bodies of unknown depth, together 7·6 kilom. (4·75 miles) wide, are crowded into a space only 4·4 kilom. (2·75 miles) wide. The plasticity of ice could not be better illustrated than by this result. The severity of the struggle incident to its accomplishment may be seen not only in the displacement of the vast Siachen ice-mass and its compression to less than three-fifths its former width, but also by the disturbance of structure in the affluent, the surface of which, as it turns around the pivotal promontory, is broken into a long line of gigantic séracs, and elsewhere rent asunder and twisted into a tortuous labyrinth of huge ridges and elevations surrounded by profound depressions, some of them occupied by large lakes. One wishing to acquire a knowledge of the difficulties and dangers of glacier-exploration could nowhere find a better opportunity than here in crossing the black hillock-moraine and pushing a couple of kilometres (1·25 miles) up the Tarim Shehr.

The periphery of the arc described by the Tarim Shehr in its change of direction is formed by its great, black hillock-moraine, that, as seen from Junction mountain above, sweeps around in a magnificent, symmetrical curve interposing a broad, black, billowy belt between the white streams on either side, from which it stands out in striking contrast. The view it presents fascinates the eye and excites the imagination, marking as it does the extent of the battleground covered in the struggle for supremacy between these two monster glaciers.

An anomalous and most interesting formation, such as in a wide experience in glacier-exploration I have nowhere else seen, occurs at Tarim Shehr promontory. About 6 kilom. (4 miles) above its extremity, a sharp shale shoulder projects like a ploughshare into the Tarim Shehr glacier. This shoulder intercepts the moraine-covered glacier-edge and part of an adjacent white stream and turns them aside over the base of the promontory as an offshoot or ***true branch*** some 0·53 kilom. (0·33 mile) wide, which descends towards the Siachen across the foot of Junction mountain.

As a rule, from the conditions of its existence, a glacier-trunk occupies the lowest line of drainage or flow in a valley, and ice gravitates toward and not away from it. In this case, the tremendous pressure of the great affluent forces the two ice-streams intercepted by the shoulder to overleap their natural lateral barrier and separate themselves from the main body. So great is the force exerted that the whole mass of the white stream, which impinges directly on the shoulder, is split up into séracs which, pointed off by melting, descend the declivity of the promontory as a cascade of glistening white pinnacles (sérac-penitente), forming one lateral half of the detached offshoot or branch. The other lateral half consists of the marginal moraine-stream having a smooth, dark, *débris*-covered surface.

This branch at some former period crossed the entire base of the promontory and joined the Siachen, thus making a nunatak of the promontory; but it has receded 500 to 600 metres (1640 to 1969 feet) up the slope, leaving a large amphitheatre streaked by old moraines, dotted with weathered and lichen-covered boulders, and clad with grasses, burtsa, and flowering plants, a resort of ibex of gigantic size and other animals. This is the only vegetation-clad oasis in a wilderness of ice and rock extending for scores of kilometres in every direction, and, as affording a refuge to the wanderer from the rigours of the savage expanse around, it merits the name of Tarim Shehr (Oasis-City) bestowed on it by the natives.

At various places along the course of the trunk and affluents where rock-promontories project into the glacier-bed, the glacier-edge opposite these consists of a smooth, vertical or steeply slanting wall curving around to correspond to the shape of the promontory-end, and removed from it by an interval of 20 to 40 metres (66 to 131 feet). The interval is occupied by a lake. This formation only occurs in connection with such promontories. It is caused, apparently, by the melting away of the glacier-edge by the heat radiated from the rock surfaces, and the ice melts back until a high, smooth or fluted wall is formed, and downward until a deep basin is excavated, which receives and retains the resulting water.

Such formations were found near the head of Peak 36 affluent, and of the main trunk at altitudes as high as 5365 metres (17,602 feet) and 5601 metres (18,372 feet) respectively. We were able to utilize three promontories giving rise to these for camps, in each case only after the coolies had worked two to three hours under our direction in building, with rock-fragments, retaining walls and terraces to support the tents. Although these promontories afforded but little elbow-room outside the tents, they served as most welcome situations for camps in regions otherwise deeply covered with ice and snow. Access to them was not easy. They could not be reached from the front on account of the steep, treacherous ice-walls and lakes. The only approach was by dangerous ice-slants some distance above their ends sloping sharply down to the lakes, where a mis-step would precipitate one into an icy bath, that would speedily prove fatal unless one could be immediately rescued, which might not always be possible. In one such instance, prompt assistance undoubtedly saved a coolie's life. It was not safe to approach the edges of the ice-walls at any point, as during the day they became soft, and being often undermined they broke away and slid into the lake below.

The following table shows the lengths of the five great Karakoram glacier-systems, the altitudes of the col, initial bergschrund, or highest glacier-surface, that may be considered to form their heads, altitudes of extremities of tongues, their total and average fall in metres and feet omitting fractions :—

	Length.		Head.	Tongue.	Total fall.	Average fall.
	kilom.	miles.	metres. feet.	metres. feet.	metres. feet.	
Siachen	72*	(45)	6400 (20,998)	3713 (12,182)	2687 (8816)	1 to 26
Chogo Lungma	48	(30)	5800 (19,029)	2896 (9,502)	2902 (9521)	1 to 16
Biafo	59	(37)	5333 (17,497)	3201 (10,502)	2132 (6995)	1 to 36
Hispar	58·5	(36·4)	5333 (17,497)	3209 (10,528)	2043 (6703)	1 to 28
Baltoro	57·6	(35·8)	5072 (16,641)	3352 (10,998)	1708 (5604)	1 to 37

From this it will be seen that the Siachen trunk lies at a considerably higher level than those of the other four systems, and that the average gradient of the Chogo Lungma is the sharpest. The gradients of all the trunks vary greatly in different portions, being steepest in the first few kilometres from their origin, comparatively slight for the greater portion of their course, and on some stretches of several kilometres practically level. It is scarcely necessary to add, that all the trunks are fed from reservoirs lying at considerably greater altitudes than those assigned to their heads.

The gradient of the Siachen trunk and of most of its largest affluents below their sources is gentle and remarkably even. Their surfaces are not disturbed by ice-falls, certainly not by such as split up the Choge Lungma in its upper third, extending across its whole width. The few ice-falls that exist are of small extent. On the contrary, crevasses in the upper parts are frequent and dangerous, being concealed by snow until late in the summer. The upper Tarim Shehr plateau, for some 8 kilom., is seamed in every direction with great crevasses and openings, which were found so dangerous that we did not feel justified in attempting to penetrate it with coolies.

The amount of ablation of the white ice through melting during a summer is great. This is made evident by the large quantity of water bathing the surface. In the upper portions, where its free movement is hindered by the presence of *névé*, it lies in great sheets, as we also found it on the Biafo and Kanibasar glaciers. Its surface freezes at night into a slushy sodden ice, that furnishes a treacherous bridging to those compelled to cross such water-areas. They were mostly negotiated by crawling on hands and knees, but this apology for ice often proving too weak to support the weight of a man even in this position, we were obliged to make *détours* to get around them.

Lower down where water can flow unhindered it courses over the surface in rivulets hurrying to escape by the lowest passages. Owing to the crowning of the white streams, the rivulets run off transversely from their centres towards the sides, ever increasing in size by coalescence with

* The length of the Siachen is somewhat difficult to define. If, as in this table, the Indira Col be taken as its head its length may be called 72 kilom. It, however, extends upward on the flank of Peak 23 some 3 or 4 kilom. farther in a great ascending snow basin.

others, till they reach the lowest line of the longitudinal angular depressions formed by the apposed edges of contiguous ice-streams. The water accumulated here from the combined rivulets forms powerful torrents which, cutting channels 2 to 10 metres (6·5 to 33 feet) wide and often over 10 metres (33 feet) deep along the lowest levels of the furrows between the ice-streams, rush seething downward to perform their mission in the scheme of glacier-evolution.

Torrents of this kind are a feature of the Siachen, and are met with in nearly all the longitudinal furrows mentioned. Some eight to twelve have to be passed in crossing the central portions of the trunk, which, as they are often impassable except where covered with *névé*-bridges or at points where the channel-walls approach sufficiently near each other to permit of leaping over them, offer a serious obstacle to the exploration of the glacier. One coolie lost his life and several others were injured by falling into them in 1912.

Séracs are a common feature of the steeper parts of most large glaciers, being usually associated with ice-falls. They are, in most cases, due to the splitting asunder of the ice under tension caused by the bending of a glacier over sharp increases of gradient in its bed. The resulting projecting ice-masses whitened by exposure to heat give the surface the appearance of ice-cascades.

Only a few unimportant sérac-areas due to this cause exist on the Siachen and its larger affluents. There are, however, extensive sérac-areas on the Tarim Shehr and on the Siachen trunk above and below their confluence, that are formed under entirely different and exceptional circumstances, where the glacier-bed is smooth and the gradient gentle. The cause of these is the enormous pressure developed around the junction, which forces the white ice-streams strongly upward and fractures their surfaces into large fragments or sérac-masses 10 to 30 metres (33 to 98 feet) high separated by intervals of greater or less width. These intervals which take the forms of crevasses and gullies are superficial, extending only to the bases of the séracs, the deeper portions of the glacier remaining in solid contact, thus differing from intervals between tension-séracs which usually penetrate the glacier-substance below what may be termed the sérac-bodies. Large numbers of these séracs are sharpened by melting into pointed pinnacles, constituting what I have classified as sérac-penitente, of which they form beautiful examples.

Another variety of pinnacle analogous to the last, which, from the fact that its final shape is chiefly determined by melting, may be regarded as a gigantic form of ice-penitente, is seen at places, usually at the central and lower parts of glaciers as well as also in the upper portions of low-lying glaciers, where moraine-streams greatly overbalance the white, and where the latter, having become much attenuated, are about to disappear. At these places, pinnacles 5 to 12 or more metres (16 to 39 feet) high of white ice having the form of pyramids, wedges, or crested combs, with

steep sides, and standing almost touching one another or some distance apart, project upward in lines from smooth, moraine-covered surfaces free from crevasses, their glistening, white forms contrasting strongly with the dark moraine-surfaces around them.

They appear to be developed as follows. The lateral pressure, which farther up the glacier where the white streams have greater volume only causes them to crown up in the centre, here where they have become reduced by pressure and ablation to slender filaments, crowds them up between the converging moraine-streams as high, narrow, white ridges with more or less broken summits and vertical or steeply slanting sides. Melting then causes the softer and thinner portion to disappear, leaving the more massive and resisting ones standing detached from one another as the ice-pinnacles in question. Sometimes these pinnacles are at such distance apart that relationship between them is not obvious at first sight. In other words, resisting centres being present in the elevated ice-ridges, the formation of pinnacles or gigantic ice-penitente from these occurs on exactly the same lines as that of penitente-pinnacles of any other variety. The presence at various points on the surface of the ridges of thin *débris*-deposits, which rapidly melt their way downward through the ice, accounts for a great deal of the segmentation that divides the ridges into detached pinnacles. This *débris* is usually seen covering the ice between the bases of the latter. This variety, while resembling sérac-penitente in some particulars, differs from it in that its pinnacles are not separated by crevasses, but are surrounded by smooth moraine-covered surfaces. They are also more regular in shape and rise less abruptly.

Such pinnacles were met with on the lower portion of the Sachen near the central line, and at several places on the Kabery glacier at the points of disappearance of expiring white streams. Also in great size and perfection on the low-lying Gasherbrum glacier at about 4570 metres (15,000 feet). Here they ran in two parallel lines one on each edge of a central moraine-stream. The ice-pinnacles mentioned by the various explorers of the Baltoro (the origin of which none of them has adequately accounted for, though Dr. de Filippi's suggestions accord with what I regard as the correct explanation above given), and seen in Sella's photograph opposite p. 21 of *Geographical Journal*, January 1911, and also in panorama N, on pp. 208–9–10, and opposite p. 288 of 'Karakoram and Western Himalaya,' correspond to this variety, which appears to be strikingly represented on the Baltoro.

Large areas of the glacier-surfaces were covered with the smaller varieties of nieve-penitente above the *névé*-line and with ice-penitente below it, the pinnacles succeeding one another as closely as wavelets upon water ruffled by wind and making even level surfaces difficult to move over. The most numerous and, in many respects, interesting were those of the thin *débris* or pocket variety, Var. iv. of my classification. These pinnacles of all kinds, by breaking up the surface and greatly increasing the amount

of it exposed to heat, contribute materially to ablation of the glacier. Many new features were observed regarding penitente formations, or surface projections due to melting, which will be considered in detail elsewhere.

The entrance of the Tarim Shehr affluent divides the Siachen trunk into two parts, an upper and a lower, which differ from each other in their features as essentially as might be the case with two separate glaciers. The surface of the upper portion aside from its hillock-moraines is smooth, and, except for pocket-penitente, watercourses at the lines of junction of its streams, and crevasses in the higher parts, is easy of ascent.

With the lower portion the case is different. The compression of two great ice-bodies of a combined width of 7·6 kilom. (4·7 miles) into a channel 4·4 kilom. (2·7 miles) wide must effect changes in the arrangement of their constituent parts. The evidences of pressure now become more pronounced. All ice-streams, but especially the white, are narrowed and crowded higher. The regular symmetrical crowning of the upper white streams disappears, and the ice is forced up into great ridges with high, abrupt, and, in many cases, vertical sides enclosing deep ravines through which torrents rush seething downward with hollow roar. The great white body of the Tarim Shehr is elevated considerably above the level of the rest of the trunk, and its surface converted into a labyrinth of huge séracs towering to a height of 30 to 40 metres (98 to 131 feet) separated by intricate, winding gorges.

The hillocks of the hillock-moraines, previously of modest dimensions, assume gigantic proportions and lift their heads more than 100 metres (328 feet) above their bases. The depressions between them become more profound, thus adding to their height. The lakes occupying the depressions increase also in size. Notwithstanding these changes, the individuality of the larger ice-streams is not greatly disturbed until the general breaking up into chaos occurs about 2·5 kilom. (1·5 miles) from the end of the tongue.

In view of the great moraine-hillocks with dangerous precipices, enormous séracs spiked with ice-pinnacles, ravines, glacier-torrents, high ice-ridges honeycombed with water-pockets and bristling with pocket-penitente, locomotion on this part of the trunk is neither easy nor safe, especially in crossing the glacier. Its exploration demands an outfit adapted to its conditions, an intimate knowledge of ice-craft, and fertility of resource.

Coree (4657 feet), Tidbinbilla (5151 feet), Orroral (5266 feet), and Bimberi (6264 feet), are among the highest in Australia. Indeed, the territory reaches within 60 miles of Kosciusko, and includes a cluster of peaks over 5000 feet high, in addition to those mentioned.

(*h*) *Summary.*—Summarizing the topography of the territory and adjoining areas, we may classify it under six heads, which are shown in Fig. 8A :—

(1) Lake George plains, at about 2200 feet elevation. (2) The Gourock highlands, rising to 3000 feet within the territory, but reaching 3500 feet further to the south. (3) The Canberra " ridge and plain " area consisting of ridges, of 2600 feet elevation, alternating with plains of some 1800 feet. (4) The Murrumbidgee scarp (Bullen-Yarara), an isolated ridge rising to 3084 feet at Castle hill, and 4068 feet at Yarara, to the south. It extends from McDonald, in the north, along the west bank of the Murrumbidgee, to the southern limit of the territory. (5) A broad belt of country, separated by the Old Divide, at Tharwa, into the (northern) Paddy's river area, and a (southern) Gudgenby river area. It is characterized by continuous rounded ridges and moderately broad valleys ; save where the two tributaries empty into the Murrumbidgee where gorges replace the broader valleys. (6) The rugged mountainous area in the west of the territory. It is traversed by the deep gorge of the Cotter. The highest point is Bimberi (6264 feet), which is part of the Kiandra plateau. Translated into physiographic language, we may classify the features as follows :—

1. Lake George Plains	Infantile, undissected country below base level.
2. Murrumbidgee scarp and Cullarin scarp	Showing youthful features with moderately deep gorges.
3. Gourock highlands, Paddy's river area, Gudgenby area	Mature valleys, well-defined rounded ridges
4. Canberra plains	More mature stage of erosion, with big flood-plains and relics of older land surface preserved as knobs.

These are shown on Fig. 8A.

(*To be continued.*)

RELIEF IN CARTOGRAPHY.*

By Captain H. G. LYONS, D.Sc., F.R.S.

Relief indicated by Colour.—In its simplest form coloured shading is used to indicate the shadows which inclined illumination from a determined direction would cause in the region represented. Minor features, such as spurs, are accentuated by selective colouring, one side being more darkly

* Continued from page 248.

tinted than the other. Steep slopes are strongly coloured, and undulating ground is lightly tinted to indicate its form and character. In this way, the relief of the country is well shown, while at the same time the contours are not obscured, but remain clearly visible, and give a distinctive character to the map.

The new French maps, 1 : 50,000, and the Swiss Siegfriedkarte, 1 : 50,000, coloured edition, show this method at its best. Very similar results, but produced with more skill and care by the methods of "half-tone" reproduction, are used to emphasize the relief in the maps of some countries. In France, the maps on the scale of 1 : 50,000 are thus shaded in grey on sloping ground; in England, the maps on the scale of 1 : 126,720 of an earlier edition, besides having the altitudes shown by layers of colour graduated in tint, exhibit this form of shading to emphasize relief, but this has been omitted in the latest edition.

The Swiss cartographers have produced some very beautiful maps by the use of colour to indicate the form of the ground, in which modelling of form is represented with the aid of inclined illumination as opposed to the modelling of slope which vertical lighting gives more accurately.

Kummerly & Frey, of Berne, have published a number of such maps, in which special pains have been taken to obtain an effective relief effect. Not only have strongly contrasted spectral colours, reddish-yellow and green, been used for the illuminated and shaded slopes respectively, but a mauve tint has been deftly employed to reproduce as far as possible the haze effect due to looking through a slightly turbid medium, which is so characteristic of valley landscapes and low-lying ground. Under such conditions distant bright objects appear darker and dark objects seem to be somewhat lighter, so that the general result is to reduce the contrasts. The contours are shown in red, and the illuminated slopes are of a reddish-yellow tint; the reverse or shaded slopes are coloured partly in green and partly mauve, the latter being employed for the parts that are most in shadow. Valley floors are also green. The result is to produce a very strongly marked relief effect, though in consequence of this the relative altitudes of points and the degree of slope of different portions are less precisely rendered. For wall-maps and tourists' maps, however, this method is very effective, and it is for these that it is mostly employed. The result of employing the reddish-yellow on one side and the green and mauve on the other is to produce the optical effect that the illuminated slopes seem to be somewhat convex, while the shaded ones have a more concave appearance. With so much colour, a large amount of detail cannot be easily combined, but the mountainous character of the Alpine regions is very well brought out.

In 1895, Pauliny proposed a new method of representing relief by employing colours, and a map of the Raxalp and Semmering, near Vienna, has been reproduced on the scale of 1 : 37,000, according to his scheme, by the Geographical Institute of the Austrian army. The map

is printed on a grey ground on which certain details are left white, such as the main roads and rivers, and part of the contour-lines. On this the different information is printed in black, yellow-green, dark green, yellow, red-brown, and blue. The guiding principle is that objects are differently coloured according as they are on the illuminated or shaded slope, and in pursuance of this, contours are shown in white on the former, and red-brown on the latter; similarly, woods and pastures appear in yellow-green and dark green; cultivation, yellow and red-brown; while main rivers are white, streams blue, railways black and white, footpaths are shown by black dotted lines on white dots. The relief effect is well shown, but small detail is not readily recognized. The system is not now in use.

Omitting such maps as cadastral maps on very large scales on which the relief is not usually represented, we may summarize the most suitable methods for topographical and geographical maps, and for those on still smaller scales such as are included in atlases.

On the larger scales of topographical maps 1 : 10,000 and 1 : 25,000, contours are most frequently employed and are always the most satisfactory. In the 1 : 25,000 maps of Austria they are used together with hachures and vertical lighting, but in moderate ground the effect is not so good as might be desired. In the next smaller scales represented by maps 1 : 50,000 and 1 : 100,000, contours and hachures are both conveniently used, Great Britain, Switzerland (Siegfried Atlas), and the United States furnishing examples of the former and the Dufour-Karte of Switzerland of the latter. Inclined lighting is used with advantage on these scales both with hachures and in shading of contoured plans, this being particularly effective on these maps. Bands of colour to supplement contours are not really effective on these larger scales, for no relief effect is usually attainable until the smallest scales of topographical maps, *i.e.* 1 : 150,000 and the geographical maps from 1 : 200,000 to 1 : 1,000,000. Here contours alone have become rather generalized, and hachuring shows little more than ridges and valleys without bringing out the general relief of the region. In geographical maps of from 1 : 500,000 to about 1 : 2,500,000 contours, except as boundaries to colour bands, give but little idea of form, and in these maps the altitude of different surface features is a more important feature than the slopes and minor details of the relief. Colour with or without hachuring of a conventionalized type is a satisfactory means of expressing this. In atlas maps the finer forms of mountain shading can alone be used, and this is but a conventionalized form of hachuring, since the details can no longer be shown.

Passing to the different purposes for which maps are prepared, these too have to be considered in selecting the most suitable means of expressing relief. Wall maps are best served by the use of a graduated colour scheme in which shading or hachuring is used to emphasize all features of specially contrasted reliefs. Map series which include a large region in many sheets are usually on a fairly large scale, so that here contours supplemented by

shading and inclined illumination are the most suitable. Maps for military purposes are now mostly contoured, with the relief emphasized by colour or shading or both, since they are restricted to maps of large or moderately large scale.

Countries and regions which are still but imperfectly surveyed are best expressed by form lines on topographical scales and by shading under inclined illumination on geographical maps.

No general statement can be wholly satisfactory since maps are required to fulfil such varied purposes, and while absolute or relative height may be of primary importance in some cases, the form of the surface, sharp contrasts of hill and valley, passes in mountain ranges, isolated features, may all in turn demand special emphasis. It is certain, however, that when surface relief has to be expressed in the fullest manner, this will generally entail a reduction of the detail which denotes human settlement and communication. Thus, a thoroughly satisfactory representation of an area or region in all its geographical aspects cannot be obtained in a single map, but several may be needed. These will not be sharply differentiated as "physical" and "political," but some of man's relations to the land surface will be best shown on an orographical map, while others can be satisfactorily represented on a two-dimensional plan.

Sir THOMAS HOLDICH: I think you will agree, those of you at any rate who have read Captain Lyons' paper, as well as heard his remarks, that it is a most masterly summary of a very difficult technical subject. As he has said at the beginning of his remarks, it is not a new one. All these matters have been discussed for some time past, and it is certainly very desirable now that there should be some consensus of opinion as to how relief in cartography should be expressed. But there must be many gentlemen here who are prepared to offer remarks on the subject, and we shall be glad, first of all, to hear what they have to say. Amongst others we have here Colonel Burrard, who, as Surveyor-General of India, is responsible for the production of a large number of important maps. Perhaps he will kindly say a few words.

Colonel S. G. BURRARD: Captain Lyons' paper deals with the most difficult subject in cartography. All nations and geographical societies are now dissatisfied with maps. All are experimenting to try and improve relief. Captain Lyons has shown clearly the present position: he has shown that we are in doubts and dilemmas, and that our systems of relief vary with scale and purpose. I know well the work entailed in preparing an historical account of a long line of research, and I feel much indebted to Captain Lyons for his paper. I hope that it may be published, so that it may be studied by many cartographers.

Will you allow me to discuss the immediate future from the point of view of progress. I shall not take into account special maps for special purposes; I shall only refer to first-class maps prepared for general purposes of geography, such as, for example, the International 1 : 1,000,000 Map. Captain Lyons has shown that in the past there have arisen two great rival systems of relief: the scientific and the artistic. The scientific is that of contours, and its aim is truth; the artistic is that of shading, and its aim is not truth, but the conveyance of impressions. The impressions concerning the heights of mountains, and the steepness of slopes that are formed by

pedestrians, are not in accordance with truth. The two systems have given rise to different schools of thought.

Now, the system of colouring a map by layers is only an extension of the scientific system of contours. Layer colours are merely a means of emphasizing the main contours. Captain Lyons says that layers give a true foundation to the map. I agree with this view. Contours alone, though they may be true, do not bring out the main broad masses of relief. The addition of layer colours to contours is a great step forward, and we owe a debt to the Committee of the International Map for their influential support of the layer system. Their support has given to the layer system a hall-mark, and has put cartographical relief upon a scientific basis.

Unfortunately, the layer system cannot show all minor details of relief. It shows the broad masses; but if a layer colour covers all the ground between 1000 and 2000 feet high, then the peaks of 1500 are not emphasized by it. Take the plateau of Tibet: we have flat plains 15,000 feet high, but our layers omit to emphasize a range of 16,000 feet high that is protruding 1000 feet above the flat plains. The strategist will say, "This protruding range of 1000 feet is a more important obstacle to me than the 15,000 feet altitude of the plateau." So it is evident that we must supplement the layer system, that we must add to it the minor details of relief. Instead, however, of building up upon the layer system and trying to perfect that system, we have added a loose hill-shading to layer maps, and in doing so we have lost much of the progress that had been made.

Suppose you have two maps of the same area: firstly, a layer map without shading, and, secondly, a map with hills shaded, but without layers. In order to supplement the layer map, the hill-shading of the second map is now printed over the layers. To my mind this course is indefensible. In the second map the hill-shading has been drawn on the assumption that the hills are standing up above sea-level. In the combination map this hill-shading, that represents perhaps 10,000 feet above sea-level, has been printed upon layers which already represent 10,000 feet. I put forward the following proposition for your consideration: the hill-shading that is to be added to a layered map must be everywhere made supplementary and subordinate to the layers. I was having an argument on this subject with a draftsman who was showing me a map of India printed in layer colours with heavy hill-shading printed over the layers. I said to my companion, "The artist who did this hill-shading was unaware of the fact that it was to be printed over layers." My companion replied to me, "The hill-shading has to show different ranges varying in height from 1000 to 29,000 feet, and if Mount Everest is to be shown as a great peak, the hill-shader must be allowed to utilize all the artistic means in his power." Now, in my opinion, the hill shading is not intended to show Mount Everest as a great peak; it is not intended to show 29,000 feet. The layers show that Mount Everest is standing upon a base 25,000 feet high, and all the hill-shading has to do is to show that there is a peak standing 4000 feet above the 25,000-feet layer base.

These differences of opinion have arisen because hill-shading is utilized for two very different purposes. Its first purpose is to indicate those minor hill details and rock outcrops which, though important, are too small to be shown by contours. The second purpose is to give a pictorial idea of relief to the map as a whole. Public opinion favours the pictorial, not for any geographical reason, but because people like a pretty picture. I have analyzed a great number of maps, and my opinion is that the price paid for the pictorial idea is too high. The price we pay is this: firstly, we add to a scientific map a system of relief that is unscientific; secondly, the hill-shading in nine cases out of ten detracts from the value of the layers by obscuring them. We are thus subordinating the scientific to the pictorial; we subordinate the broad masses to the minor details.

The progress of cartography requires us to perfect the layer system and the layer colours, and to keep hill-shading secondary and subordinate. When a poet writes bad grammar, he pleads poetic licence; when a painter exaggerates effects, he pleads artistic licence. But astronomers and geologists do not recognize scientific licence. If cartography is to progress, its aim must be truth; it must cease to depend upon licence.

Prof. HERBERTSON: Captain Lyons began his account of the progress of cartography when it had ceased to become mechanical drawing, when it attained a scientific aim, and attempted to depict not merely lines, but surfaces, and so faced the problem of the third dimension, the expression of quality and not simply of quantity. This quality can be expressed in two ways—scientific and artistic. For the scientific representation of relief there is no doubt that close contours for equal intervals are the simplest and most important in the large-scale maps, but I do not see why we should rule out of account true hachuring which is equally scientific, as it shows the true slope. For scientific purposes we may easily combine a hachured map and a contour map. This is good so far as it goes, but a form can be expressed artistically as well as scientifically. It cannot be merely mechanically drawn; for the smaller-scale maps at any rate it must be generalized, and for such maps there must be generalization even in contour-lines. The artist has a power of depicting salient features vividly, and he ought to be allowed to do so, both in line and colour.

It is very difficult to discuss in a few minutes this vast problem, because there are many requirements for which we wish maps. Unfortunately, in many maps we try to meet far too many requirements. What we need is more editions of maps. There is no reason why a small edition of the International Map should not be printed without any names at all. It would be invaluable as well as extremely effective. I have used such prints of the half-inch Ordnance map and Bartholomew's half-inch map, and find it possible to examine forms with a detail and certainty almost impossible on the map with names. There is no reason why two editions should not be printed of such maps, and the same price charged for sheets of both.

The question of shading cannot be discussed without psychological as well as artistic considerations. The beautiful 1 : 200,000 wall-map of Switzerland, I understand, owes its success not merely to the scientific geographer, but also to the artist. It is in many ways much more graphic than any model of Switzerland, and for teaching purposes it brings out the features more clearly than any other map I know. But we have not yet devised an effective system of mapping the different types of land forms, and also of showing their relative height above sea-level on the same small-scale map. The whole question of the symbols to be used for the different types of land forms on such maps seems to me to require discussion. I will not detain the meeting by attempting it, but must before sitting down thank Captain Lyons for his admirable paper.

Colonel W. C. HEDLEY: We are much indebted to Captain Lyons for bringing up this subject. He has shown us maps in every variety of style. I think there is a tendency to make maps too complicated, and, in my opinion, contours are sufficient for most purposes if the interval between them is sufficiently small. There is no clearer map, for instance, than the series published by the Geographical Section of the General Staff, on which the contours are at 100-foot V.I. on the 1 : 250,000 scale. The maps we have been shown to-day require a very high degree of skill if the results are to be satisfactory. They are the work of the best cartographers in the world, and my advice to countries who have most of their topography before them is to confine themselves to contours, unless their draftsmen, engravers, and printers are very highly skilled. As regards the International Map on the scale of 1 : 1,000,000, I agree with Colonel Burrard that a layer map of the world on that

scale would be very valuable for many purposes. I think, however, that the addition of hill-shading would be an improvement for soldiers, travellers, and for the ordinary individual using a map. I should like to see two editions, one with layers only, and one with hill-shading added. The second edition would not involve great expense. It would merely mean the addition of one extra plate to those used for the first edition.

Prof. W. M. Davis: Allow me to emphasize a matter which is probably presented in Capt. Lyons' printed text, but is not mentioned in his communication, namely, the work between the land outdoors and the printed map which we ultimately receive. The surveyor is on the land, and he brings in, as a result of his work, certain marks on a sheet of paper. We do not see those marks; we see something more or less modified from them. His lines are usually drawn in pencil; they have to be gone over in ink, and in that process there is nearly always more or less obliteration of certain delicate details, which the cartographer may have had the skill to see and to represent. The least departure from the original record will be made in the case of a contour-line map, drawn on the ground and very carefully copied in publication. On the other hand, when it comes to representing relief by shading, that, I believe, is very rarely done on the ground by the topographer; it is nearly always done at an intermediate stage between the ground and the finished map by the draftsman or the lithographer, who has very seldom seen the ground himself. He must interpret the topographer's record and transform it into such style of shading as he adopts. He nearly always fails to bring out certain sharp details, and gives an impression of soft forms that is incorrect in forms of sharp angles and cliffs. The new sheet of the Killarney district illustrates this difficulty. I believe the man who shaded that beautiful map—beautiful in the sense of a delightful picture—was not on the ground with the topographer, and therefore did not have direct sight of the forms he was to represent. I happen to have walked, two years ago, through the Gap of Dunlo, and on looking at that part of the map, I find that the cliffs are very much less perfectly represented than the gently rounded slopes of the neighbouring mountains. Therefore, between a careful survey on the ground and a beautiful publication in our hands there is a considerable danger of inaccuracy in the interpretations of a lithographer who has not seen the ground, but whose work, when it is printed, is quite as impressive as any lines drawn by the original surveyor. One of the greatest difficulties, therefore, is to have the matter of interpretation by the lithographer who has not seen the ground correctly done. The maps of our United States Geological Survey are now produced in contours in the field by the topographer; then the contours are carefully reproduced on the printed map, so that there is as little as possible interpretation by the lithographer who has not been on the ground. A contour-line map thus produced is therefore an accurate map. It may not be so beautifully legible as a tinted map of Lake Lucerne, or a shaded map of the Killarney district, but it avoids the element of interpretation by the lithographer who has not seen the ground. In the coloured maps of the Ordnance Survey, of which Snowdon is an excellent example, the hachures were, I presume, not drawn on the ground, and some of the sharp cliff-edges seem to me too much softened in the printed map. That is an effect of interpretation which I think is unfortunate. I also regret very much that, on the Ordnance maps of a scale of 1 inch to the mile, only 100-foot contours are printed. Truly only these lines are surveyed, but the surveyor on the ground is a skilled observer, and he might, with great advantage to the reader of the map, sketch in 25 or 50 foot lines. The public can be informed that the full red lines are surveyed, the dotted red lines are sketched; no one is deceived. Permit me, in conclusion, to express my gratification that a certain phrase used by the first

speaker was introduced without explanation, as if it were perfectly orthodox—namely, a maturely developed surface. It is encouraging to see that the use of such explanatory phrases is gaining ground, even in this room.

Admiral PUREY-CUST: I have not had an opportunity of hearing Captain Lyons' lecture, or of examining the maps, so I cannot criticize what has been said. I can only make a few remarks on how the subject appertains to the Admiralty Charts. These are, of course, looked at from quite a different point of view—whereas maps are mostly used to find the way about on land, charts are almost entirely used to find the way about on water, so we do not want all the detail that is required on maps of the land; we are well content to clearly delineate the features of the hills so that they can be readily recognized by the sailor when he sees them from the sea, paying particular attention to all prominent summits and the heights of them. The use of colour on the Admiralty Charts is not at present practically possible, and we should propose, if we used it at all, to use it for the under-water depressions rather than the above-water elevations. We have always contented ourselves with black and white; all hillwork was originally shaded by vertical hachures, but horizontal shading lines were adopted later principally on the score of expense; at other times we have used contours only, and lately contours with the addition of shading on the dark side of the hills (light from the north-west corner of the sheet), which has been done by stippling on the copper plates, and is very effective. I have brought a few specimen charts here of the different shadings we have adopted from time to time.

Mr. WILLIAM STANFORD: There is one point which I notice, and that is, that you all have spoken almost entirely of large-scale maps. Some of us who have to make maps, chiefly school maps, which go very largely into the elementary schools not only of this country, but of the United States, are to-day looking to this committee for a lead as to what in their opinion is an ideal school map, how it should be coloured, and how it should show the various physical features. It can either be the conventional map coloured politically, *i.e.* to say, if the map be a continent, showing the international boundaries, or, if the map be a country, the boundaries of the respective Local Government areas, whatever they may be. Or it can be, and there seems to be little doubt that it should be, a contoured map; but it is more difficult to decide what is the best contoured map, and what is the best scheme of colouring. There seems to be some doubt amongst many that I have spoken to as to whether the scheme propounded by the International Map Committee, a combination of browns, greens, pinks, is the best. I know that some claim that all the land features should be shown in browns. There is also the question whether on a contoured map the actual ranges should be indicated by hachures as they are in most of the German school maps. This question of school maps deserves special consideration from some of the speakers who are or have been Engineer officers, as there can be no doubt, in the future even more than in the past, the world surveys will be completed very largely by men who have been trained in this branch of the military service, and it would therefore be to the advantage of those men in the earlier part of their career if they had been brought up in the elementary school on maps and atlases which were based on the lines which they would follow out (though, of course, in much greater detail) in their subsequent careers. I shall be especially interested to hear what Prof. Davis thinks of this subject of school maps, as at present a very large number of school maps in use in the United States are made in England or Scotland. I feel sure that all we map makers are only too willing to follow any good lead that may be given us by such an authoritative body as this committee, but to-day we are confused by a multitude of counsellors—one says no greens, another all browns, and another green, brown, and hachures.

Mr. H. O. Beckit: I wish to join in the thanks to Captain Lyons for the very full and useful statement he has printed of the most urgent and difficult of all cartographic problems. There seem to be three requirements in its solution, which may perhaps be set in this order: (1) accuracy, (2) legibility, (3) beauty. I should like to make a few remarks about the second. Captain Lyons has pointed out how the amount of other detail to be shown seriously affects the legibility of the representation of relief on a map; but is it not true that in the relief methods by themselves an attempt is being made to satisfy two distinct sets of people—the general public and the practised map-user—and also two quite different uses of the map, that made in a general and perhaps distant inspection on the one hand, and close detailed examination on the other? For the former, some degree of plastic effect and discrimination of principal from minor features seems necessary; for the latter, the smaller forms must not be obscured. I suspect that neither these two publics nor these two uses can be really satisfied by one and the same article, and that we need an otherwise unfortunate multiplication of maps, not merely on different scales, as Captain Lyons points out, but even on the same scale in different styles.

Turning for a moment to a matter of detail, related chiefly to the production of large-scale topographic sheets, I should like to ask whether the employment of colour printing, in itself very welcome, is not being carried a little too far. We find cases where colour has been applied in three and four, if not five, distinct ways to show relief alone; and one is tempted to doubt whether in practice the results are likely to compare very favourably, for precision of execution, with the old black-and-white methods.

Sir Thomas Holdich: This is no doubt a large subject, and one on which there may be a great variety of opinion. I have no remarks of my own to add except just this, that after having seen the great variety of maps, and the different schemes of colour presented on that screen in illustration of Captain Lyons' lecture, I think it is quite time that there was some consensus of opinion as to what particular shades of colour should be adopted in order to represent relief. I cannot see that this presents any very great difficulty. We all know the ordinary little maps which are used when we are wandering about the country, motoring or otherwise, which are turned out by Bartholomew, and which are printed in certain colour-shades. The public are gradually getting educated to use these maps intelligently. I agree with Colonel Hedley that we should consider the utility of maps for the people who are going to use them, and make them easily intelligible. As the public are getting used to those maps, and are making, I hope, a considerable advance in the knowledge of geography through them, I should suggest as the basis for adopting a general scheme of colour that the colours utilized by Bartholomew should be adopted. I have seen some colour schemes on maps which seem to be hardly short of outrageous. I have seen a wall-map in which the mountains grew darker and darker as elevation increased, and finished, not with a white snow-capped line of peaks, but with a furious red colour on the top, indicating, apparently, that they were in a state of eruption. This seemed to me entirely wrong, particularly in regard to wall-maps used for educational purposes. Some decision should be come to as to what the system is to be, because children will grow up with their minds confused if relief in maps is presented to them at one time shaded from light to dark, and the next time from dark to light. We are all of us much indebted to Captain Lyons for the way in which he has put the case before us. We know a great deal more about it now than we did before his lecture, and certainly, in his paper and in his remarks, he has left us a great deal to think about. Before asking Captain Lyons to reply to any criticisms that have been made, I would ask you to join in a vote of thanks to him. I would also include thanks to Messrs. Zeiss for their demonstration by the epidioscope, and would ask you after

the lecture is over to inspect that excellent apparatus for illustrating maps on the screen.

Captain LYONS: The discussion has shown what is really the essential point, that in all the larger scales we want contours as liberally as possible, and as accurately as they can be drawn from the observations on the ground. I do not know whether I understood Dr. Haverfield rightly as urging as a disadvantage that the line of a contour may miss by a few feet above or below a feature of importance. That only comes to what Prof. W. M. Davis has said, viz. that there should be as many contours as possible, and that those should be drawn on the ground. I was much interested in what Colonel Burrard said, that for the basis of the smaller-scale maps at the present time the most suitable thing seems to be to trust to the layer colouring for the absolute altitude, and some form of hachure or colouring for the relative altitude. Regarding Sir Thomas Holdich's remarks, need we always be bound by what the public is used to, because these layer maps were started as an experiment in scientific cartography, and after some twenty years they are found to be exactly what the public want? Dr. Haverfield's difficulty about some features disappearing on the small scale is inevitable. You cannot work out a single area on a single scale, and maps on different scales must be used. Maps are not valuable things to be put away in presses, but are pieces of paper to be used up in the course of work and then replaced. With regard to Mr. Stanford's point, I should like very much to see a demonstration and a discussion on the subject of wall-maps, which raise the same questions from a somewhat different point of view, because these are much more of the nature of a diagram than of a map, and the questions of colour, of what colour, and of the position of the colour, come in. That is another large subject and one which it is impossible to touch on at this time of the evening, but I think the Society could do a great deal by arranging for a serious discussion on this very important subject.

The following letter was read from Dr. HAVERFIELD:—

Oxford meetings—a too common ailment—forbid my attendance at the Geographical Society on November 20. But I am greatly interested in the subject to be treated by Captain Lyons, and the proofs of his paper, which I have read, increase my regret that I cannot be present. I send instead a few remarks on one part of his problem.

There is, of course, no absolutely best way of showing relief in cartography; a "mathematically correct reproduction of the Earth's surface" is, strictly speaking, impossible. Each worker has to follow the methods which yield the greatest accuracy and greatest clearness for his own purpose; he must consent, at least tacitly, to ignore certain features and to repair the omission by conventional devices which best suit his own end. I have been mainly concerned, in such geographical teaching as I have attempted, in setting before students of Ancient History the geographical factors which have conditioned the culture, trade, or frontier strategy of the Roman world—and I include in these the factors which might have been expected to affect Roman History, but which for some reason did not. These features I have had to explain to largish classes of eighty or one hundred, most of whom know very little geography—not even that old-fashioned topography of where certain places are, which used to be thought geography. My excuse for these notes is that (as I imagine) a great many other teachers are giving similar lessons in applied geography to non-geographers, and though their work may not satisfy the purists of our Society, it nevertheless does a great deal of good to the learners and arouses an interest in and a knowledge of more advanced geographical studies.

My material falls naturally into largish blocks—for example, the Roman frontier on the Rhine in its strategic aspects; the relation between the physical conditions of the Spanish peninsula and its political divisions, civilization, and trade in the Roman period; or, the military and commercial relations between the Mediterranean and the Danube frontier. To explain such things I have sometimes used large wall-maps, as supplied by our School of Geography, which does a great deal to help geographical teaching in Oxford outside the limits of its own special lectures. Unfortunately, wall-maps grow dim in the distances of large rooms, and they are easily forgotten afterwards. Sometimes I have used slides, but the true value of slides, I think, would be, not to show maps, but to show typical landscapes, —and these are hard to get. Most often I have used small hand-maps, prepared for me by some cartographer (I have tried several in the last dozen years), distributed to the audience, and commented on in the lecture. These maps are on small scales—1 : 5,000,000, or even less; they show only a few features, with space for the audience to write others in; they indicate relief by contour colours mixed with caterpillars, and (obviously enough) they have to be done very cheaply, that is, very roughly. They have, however, given me a certain experience in methods of indicating cartographic relief for classes such as mine. I would urge the following points:

First, the only good results are given by maps which combine coloured contours with hachures. Colours are not enough by themselves; the Earth is not laid out in steps or terraces. No doubt, if you can use many colours, some good can be done by them alone. I have before me an admirable map of Asia Minor and North Syria, on the scale of 1 : 2,500,000, prepared by my colleague, Mr. J. G. C. Anderson, who knows much of the country himself, drawn by Dr. Bosse, and issued by Mr. Murray. In this, only colours are used, yet the physical features stand out clearly. But then this map contains, including the blue sea, fourteen distinct shades to get up to 12,000 feet, and though this does not mean quite so many distinct printings, the cost is very great, and the method can never be used widely. The alternative is a use of hachuring which may here and there serve instead of several shades or colours.

Secondly, with coloured contours it is necessary—perhaps more necessary than Captain Lyons has actually pointed out—to choose your contours with great care. I have in mind another map of Asia Minor, prepared with a very few colours, in which the contours selected were so unsuitable that the peninsula looked like a flat plain. Everybody has seen similar misrepresentations of other countries. It is not really so very easy to avoid these misrepresentations, if you wish to be mathematically accurate. Here, as in many other matters, *summum jus, summa injuria*. The "mathematically correct reproduction of the Earth's surface" is inaccurate. I incline to think that coloured contour layers ought not rigidly to follow definite contour-lines. They are really quite as undefined as the horse-power of motors. Instead of drawing on your map a hard line—as one does for example in England, of 600 feet altitude—the line should be rather "plus or minus 600 feet," say 560-640 feet. Where the ground a little below 600 feet belongs practically to the ground that is above it, it should be included in the latter, and *vice versâ*. There are many places in England where a strict adherence to the 600-feet line gives an absurd impression of the real character of the country in a map of coloured contours.

Thirdly (and here contours and hachuring are equally likely to mislead unless they are corrected intelligently), some correction must be used to show the character of mountain valleys or even of plains. Two examples will explain what I mean better than any generalizations. (1) The Brenner is perhaps the most important pass in Europe. But it is simply undiscoverable on the best wall-

maps. They wholly fail to indicate that, for physical reasons, this particular pass was for centuries the front door of Italy. I find it almost impossible to persuade my pupils, when I confront them with a wall-map, of the real character either of this pass or of the Alps generally. In one of my own maps I have shown the Brenner by a streak of light brown which (measured mathematically) is 10–12 miles wide. That is "grossly unscientific." But it is quite as accurate a representation of cartographical relief as anything in the much larger-scale wall-maps, or indeed in the ordinary small atlases on scales similar to those which I use.

This illustration will show the difficulty which arises with respect to passes. Now (2) for plains. I remember a quite good map of Greece in which the alluvial plains, on which the existence of many towns depended, were shown green, whether they were 100 or 1000 feet above the sea. I do not recommend this method of colouring, because green is conventionally associated with lowlands. But it seems that we need some notation for plains, just as much as we actually have a notation for mountains. Mountains can be shown by hachuring, and on large-scale maps which are covered by a good deal of mountain hachuring, it is possible to indicate the plains among the mountains by dead white. On smaller maps that is not possible. Many hachures on a small map make it unreadable. But by a combination of hachuring and colouring, and perhaps of other symbols, the plain might be allowed its place in the sun. Even in England such expanses as have resulted from the prehistoric lakes of Didcot or Pickering deserve to be distinguished. On a large-scale map, say ½ inch to the mile, with coloured contours and perhaps some hachuring, this can be done easily. On a smaller map, such as I have before me, with a scale of about 1 : 600,000, comparatively few colours and no hachures, these expanses can hardly be credited when pointed out; no one would guess them of themselves. I should be glad if some one would devise a method, perhaps of stippling colours, perhaps of hachuring the limits of these plains, which would make them more visible. Human history depends very largely on plains and passes, and any system of indicating relief in cartography which ignores them, even if it emphasizes perhaps peaks and glaciers, is very unscientific.

Mr. JOHN BOLTON sends the following statement:—

I listened with much pleasure to the excellent paper by Captain Lyons on "Relief in Cartography," and was very glad to learn from the discussion that it is now generally agreed by experts, that the application of colour to this purpose has gone a little too far. I might venture to say that a warning against much colour is afforded by a sheet of the 1 : 1,000,000 map of 'India and Adjacent Countries' that has quite recently been issued. Prof. Davis's suggestion appeared to me to be a most excellent one; if additional contours could be sketched in between the surveyed levels while the surveyor was still on the ground, the addition of hachures on a systematic basis, added afterwards, would give a very accurate picture of the inequalities of surface and gradient, and this without the necessity of guessing at light and shade or imagining rays of light coming from any corner of the map to cast supposed shadows. Let the horizontal interval between the contours be divided into squares, as nearly as may be, the measure of the sides of the square to be equal to the horizontal interval between the contours; draw a number of hachures within each square, always the same number and always of the same strength of line. The lines will, of course, mechanically expand, or contract with the increase or decrease of the angle of slope, and the result must be that undulations of the ground will be represented on the map accurately; almost mathematically accurate.

The only published example of this method known to me is the Plan of Jerusalem in Smith's 'Atlas of Ancient Geography.' This was the first map done by

this method, by draughtsman and engraver, and it may therefore be looked at in the light of an experiment; it will, I think, be admitted that the varied surfaces are represented wonderfully well. This sample was drawn on the surveyed contour-lines as engraved on the Ordnance Survey plan of Jerusalem; but the intercalation of lines, as suggested by Prof. Davis, would add very much to the beauty and accuracy of the picture. This system is scarcely applicable to maps on a smaller scale than 1: 250,000; for smaller scales and for wall maps and school maps we are reduced, as Prof. Herbertson says, to the representation of masses, the broad or diagrammatic features, and these are best represented by contours and flat tints, the so-called layer system.

A DESCRIPTION OF THE GIRARA DISTRICT, WESTERN PAPUA.*

By W. N. BEAVER, F.R.G.S., F.R.A.I.

THE western part of Papua (British New Guinea) has commonly been supposed still to conceal many remarkable features; it certainly contains the last remaining unknown and unexplored areas, though these are rapidly being dealt with. One of these little-known areas is that now to be described as the Girara district, because it is inhabited by people of common kinship, and speaking a common language known as Girara. The district lies between the eastern bank of the Fly river and the head-waters of the Bamu river. I was not the first person to come in contact with the people, but I am not aware that they or the district have been described elsewhere than in official reports. My own knowledge of the district covers a period of some four years.

The banks of the Fly river for over 200 miles are low-lying and swampy; but on the eastern bank about 60 miles from the mouth of the river there is a tract with a more or less elevated shore. At one point called Gaima, where there is a village which is practically the first outlet of the Girara people to the Fly river, the bank is several feet above high-water mark, and is formed of a hard red clay, in striking contrast to the nipa-palm swamp which elsewhere borders the river. Just below Gaima—where the Fly is over 2 miles across from the shore to the nearest islands (Dugope)—a reef, of hard sand and small shells and of mud much impregnated with iron, juts right across the river. This is the only reef, as far as I know, in the lower reaches of the Fly river, with the exception of a small one about 14 miles lower down on the western shore opposite a village called Nabodai. The red clay banks extend—with breaks—from a point about 8 miles below Gaima to nearly double that distance above. The whole formation is curious and interesting. Gaima is situated on a high, rather fertile point, and the whole position is distinctly attractive.

The district was discovered in 1900, I think, by C. G. Murray, then Resident Magistrate of the Division. The natives of western Papua

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* Map, p. 480.

the doll's house they keep themselves." "No more industrious and thrifty soul exists on this planet than the Japanese peasant. 'All work and no play' is his lot from one year's end to another. Soon after sundown a hush falls over street and house. A 'tub,' a frugal meal, a pipe, and the people are asleep. Which is not surprising, seeing that they rose with the dawn and have toiled in the fields ever since. There is no social life in a Japanese village, because there is no leisure." "Education and religion are, therefore, more closely connected in Japan than, probably, in any other country. More definitely, too, than in any other country are they used as a means to an end. That end is patriotism." "The Japanese believe that they have a mission in the world." No one who wishes to know Japan as a whole can afford to omit this book from his sources of information. B. C. W.

Exploration in Kashmir.

'Thirty Years in Kashmir.' By Arthur Neve, F.R.C.S.E. With illustrations and a map. London: Edward Arnold. 1913. 12*s.* 6*d. net.*

Dr. Arthur Neve, in this book, gives us an account of all his explorations and mountaineering expeditions in Kashmir during the last thirty years.

He has travelled far and wide in that part of the British Empire "where three Empires meet," and all who are interested in Kashmir and the great mountain ranges that lie to the north of it will find in Dr. Neve's book plenty and to spare of information, adventure, and interesting reading. No one knows this part of the world better than Dr. Neve. Since 1886 he has been in charge of the Medical Mission in Srinagar, together with his brother Dr. E. Neve; and it was during such time as could be spared for holidays that most of the journeys described in the book were undertaken.

Some of the country he describes is the most magnificent in the world. The great range of the Karakoram mountains, the unique Indus valley, the lofty Himalayan peak Nanga Parbat, and the twin peaks of Nun Kun, are amongst the most important subjects he deals with. He has explored new country, crossed passes not visited before by Europeans, climbed several times to over 20,000 feet, and at the same time has always been ready to help all the natives he came in contact with by medical advice, and by performing such small operations as were possible under the circumstances. It is not to be wondered at that he and his brother are more widely known and respected by the inhabitants of Kashmir, and of the intricate and out-of-the-way districts that lie to the north of Kashmir, than any one else; they have spent thirty years in helping and giving medical aid to the natives, who without their aid would get none.

The first journey Dr. Neve describes is one to the Nushik pass, a pass over the Karakoram from Shigar to Hunza. This was in 1895. Some years before it had been crossed in the opposite direction by Colonel Bruce and Zurbriggen, who were with Sir Martin Conway. Dr. Neve, however, visited it much too late in the year (September), and as a result found the crevasses on the north side of the pass impracticable. He next visited that outpost of civilization, Chilas on the Indus, that only a few years before had been held by one of those robber tribes that allowed no Europeans into their country. To get there the Himalaya had to be crossed; Dr. Neve chose the Barei pass, and made the first recorded crossing by a European. He visited that astounding valley of the Indus just north of Nanga Parbat. No grander, more desolate, or more colossal rift can exist anywhere on the Earth's surface. On the north side the cliffs rise over 12,000 feet above the Indus river at their base, whilst on the south side the summit of Nanga Parbat is nearly 24,000 feet above the bottom of the

valley. He gives a particularly interesting account of the Hunza campaign (1891), one of those dramatic border wars where three V.C.'s were earned. Next he visited those two great peaks of Nun Kun (23,447 feet) that lie just east of Kashmir. These he re-visited in 1910, and proved conclusively that the great west glacier of the range flowed down to the Bhot Kol. This had been contradicted. Dr. Neve's most important expeditions, from a geographical point of view, were in 1908 and 1909 to the Murgisthang glacier, and in the following year with Dr. Longstaff and Lieut. A. M. Slingsby to the Saltoro and the Bilaphond pass. It was after crossing this pass that they discovered the Siachen glacier, which is by far the largest in Asia or elsewhere outside the Arctic regions. They also discovered a whole range of mountains unknown to the Indian Survey, the highest, Teram Kangri, being about 25,000 feet. In the book Dr. Neve also gives much information about the people, their customs, and their habits. There are chapters on Srinagar in the Eighties, the Medical Missions, the Conquest of Ladak, the Gilgit frontier, etc.; there is also a good deal of information about most of the important political events connected with Kashmir and the borderland north of Kashmir. Dr. Neve has made good use of his unique opportunity for amassing information during thirty years, he has produced an eminently readable book, he has added to our geographical knowledge, and has contributed one more important work to the literature of our Indian Empire.

J. N. C.

AFRICA.

South Africa.

'The South African Scene.' By Violet R. Markham. London: Smith, Elder & Co. 1913. *7s. 6d. net.*

The first part of 'The South African Scene' ranks with the best of the impressionist sketches of the southern portion of Africa. Miss Violet Markham knows the country from Cape Town to the Victoria falls, and she has admirably caught the atmosphere of its vast spaces and great solitudes. Equally well does she enter into the spirit of the older, more settled districts, as her chapter on "The country of the Van der Stels" proves. The result is that her travel sketches leave clear-cut impressions, and if they do not teach geography formally they give the reader a distinct and accurate picture of the general characteristics of the land and of the people who dwell therein. The second part of the volume is called "Some Policies and Problems." In it Miss Markham deals in an able, lucid, and attractive manner with the great political, social, and racial problems which await solution in South Africa. This is not the place in which to enter upon a discussion of those problems, but the author may be thanked for her plain speaking on subjects often slurred over and misunderstood. No one who loves South Africa, no one concerned in the welfare of the Empire, should neglect to read this book. Like Sir Percy Fitzpatrick's 'Jock of the Bushveld,' it goes straight to the heart of things.

F. R. C.

South-West Abyssinia.

'Au Pays Ghimirra: Récit de mon voyage à travers le Massif éthiopien (1909–1911).' Par Dr. George Montandon. Neuchâtel: Attinger Frères. 1913. *Illustrations, Maps, and Diagrams.*

This book (which forms vol. 22 of the *Bulletin de la Société Neuchâteloise de Geographie*) is the definitive record of a journey chiefly noteworthy for the elaborate anthropometrical details given concerning the Gemira—a people not

A JOURNEY FROM MYITKYINA TO SADIYA VIÂ THE N'MAI HKA AND HKAMTI LONG.*

By the late Captain B. E. A. PRITCHARD, Indian Army.

CAPTAIN PRITCHARD'S little party consisted of some orderlies from the Myitkyina battalion of the Burma Military Police, three of whom (*i.e.* two Gurkhas and one Kachin, the latter perhaps the best of the three) were with him from beginning to end of the journey. A Yawyin recruit accompanied him most of the way. One Ram Pershad accompanied him for survey work. In acknowledging the services of these men, Captain Pritchard acknowledges also, with gratitude, the assistance and advice of Messrs. Clerk and Hertz, C.S.I.

Leaving Myitkyina on December 19, 1911, Captain Pritchard caught his first glimpse of the N'mai at Seniku on the 22nd. Of the valley of the N'mai and the country generally, he says: "It may seem fanciful perhaps to liken the natural configuration of the country to the ribs of an enormous skeleton, yet that is just the impression one receives, not only here, but at many other points further up, from which a stretch of the river-valley can be seen. It is by an everlasting rise and fall over these parallel spurs or 'ribs' that the traveller makes his way beside the valley of the N'mai.

"The N'mai river is typical of the Burmese drainage system, which consists of streams flowing in a north-south direction in structural troughs, owing their origin to the series of meridional folds which constitutes the Burmese mountain arc. To judge from the character of the slopes on either side of the valley, the latest phase of the river has been one of rapid erosion, resulting in the steep fall of the lateral spurs from 8000 feet and more to between 4000 and 5000 feet, in the course of a mile or so. This appears to have succeeded an earlier phase—represented by the long east-

* The following account is compiled from the notes of the late Capt. B. E. A. Pritchard, Indian Army, who was drowned last year in the Taron river. A man of superabundant energy and inexhaustible vitality, he coupled a keen sense of the humorous with a keen power of observation. His loss is deeply to be regretted. Into the circumstances which led to his undertaking a journey up the N'mai or eastern branch of the Irrawaddy it is unnecessary to enter here. But for eleven years he had been steadily preparing himself for this, and other exploration work, in Upper Burma. During that time he had acquired by long study, a mastery of Burmese, Yunnanese, Shan, and Kachin.

Very little still is known of the Kachin and Maru country lying north of Myitkyina. In 1890, Captain Elliot visited the country between the Mali and N'mai rivers, west of the Nsendaru ferry; and in 1895, Mr. Litton, Mr. Leveson, and Captain Lakin made a journey to the Chinese frontier near Hpimaw. In 1897, Lieuts. Pottinger and Lawrence proceeded some distance up the N'mai Hka, but, short of the A'mekh, were forced to turn east, up the Laking river, through the attitude of the tribes. With the exception of the exploration missions under Mr. Barnard in Hkamti Long, few other expeditions of note have been made in this part of the world.

west spurs sloping gradually from 8000 feet up to 10,000 feet—during which the gradient of the river-bed was less steep and the stream carved out for itself a comparatively broad valley. Owing, perhaps, to elevation in the Himalayan region to the north, the gradient was increased, with the result that the phase of comparatively slow erosion gave place to one of rapid deepening of the river-bed. This has led to the development of an extensive series of lateral streams on either side of the valley, some of which, especially among the east bank tributaries, appear to be of considerable size, a feature which may be due to the capture by a transverse stream of a river occupying a longitudinal valley parallel to that of the main river.

"As far as Pashé the actual valley of the river might be utilized as a line for a road. But beyond this point the spurs drop down too precipitously, *e.g.* at Kabap there is a fall of nearly 3000 feet in three-quarters of a mile down to the ferry. Here and there, on either bank of the river, and on almost every spur, a village is located, generally at an altitude of 3000 to 4000 feet. The whole valley is densely clothed with tree-forest and undergrowth, except where the land is under cultivation, or has, in recent years, been cleared. Near the larger villages the area thus cleared gives the country quite an open appearance. This cultivation is both above and below the villages. In the former case it is seldom at a higher altitude than 5000 feet, while in the latter case it not infrequently extends to within a few hundred feet of the river itself. A regular belt of forest marks the dividing line above which land is not cultivated, while below extend steep hillsides, more or less open according to the number of years that may have elapsed since clearing was last done on them. A grove of sago palms denotes the presence of a tributary stream, while on both banks the spurs appear to end abruptly, the more or less steep drop down to the N'mai being barely suggested to the traveller when at an altitude of 4000 feet. Villages are, on an average, about 3½ miles apart, though the distance in an air-line would be very much less. North of Hkrangkao, from villages and their vicinity, as well as from the river, snow-peaks are to be seen on the main ranges. Thus, from the spur beyond Kabap, as many as five snow-peaks may be seen in different directions, and most of these are visible from the Kulai ferry at the foot of the spur.

"To the traveller looking westward from the left bank of the N'mai north of Hkrangkao, the country across the river presents a very similar appearance to that in one's vicinity, except that the tributary streams are smaller, the drainage area being more confined. The villages are about as numerous, of the same size, situation, and at about the same altitude as those on the left bank, and the area of land under cultivation is about the same. The range dividing the Mali and the N'mai is irregular, but attains a greater altitude towards the north, being about 10,000 feet at Ngawchang, 12,000 feet at Pashé, and 15,000 feet at the A'mekh confluence."

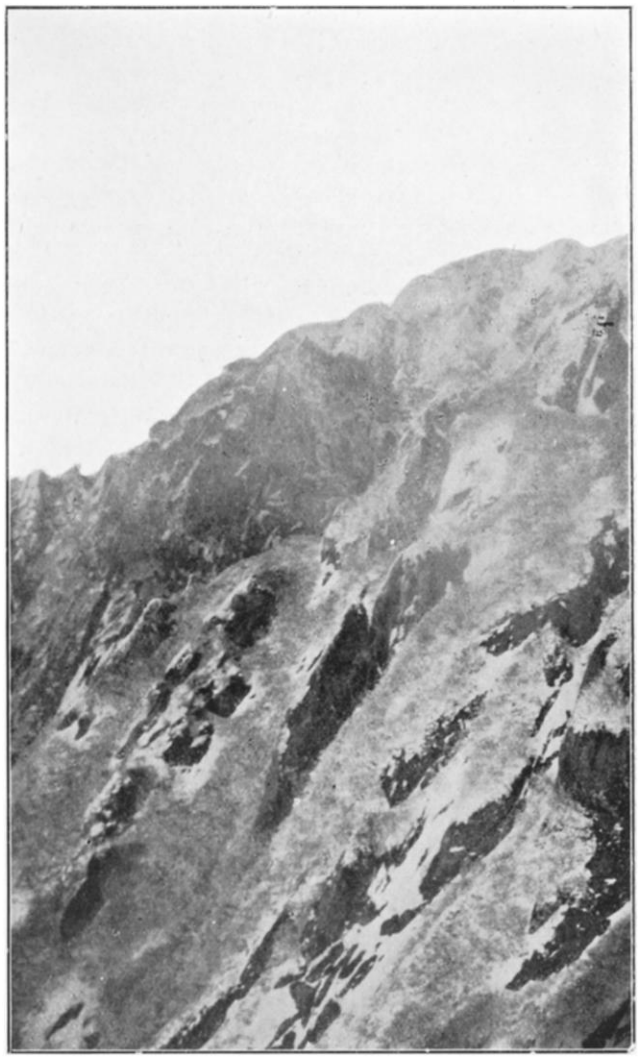


FIG. 1.—TOP OF THE CHENGAW RANGE.

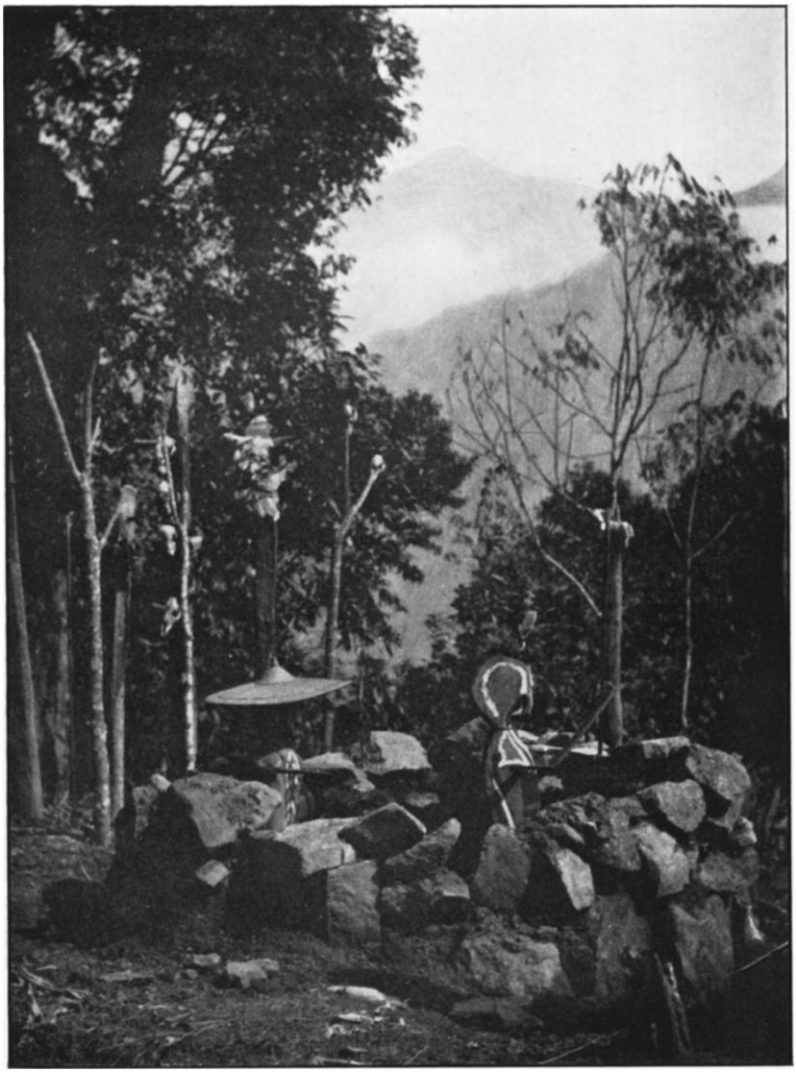


FIG. 2.—A TYPE OF NAINGVAW GRAVE.

In other places along his journey Captain Pritchard often refers to the country as being true to the type he has described here. On December 29, Captain Pritchard left Lauhkaung for Hkrangkao, which he reached on January 7, 1912. Here, with Ram Pershad and an orderly, he decided to strike east on to the Chengaw range to map in a stretch of the Salween-Irrawaddy divide, with the intention of striking north to Maghre and thence down the Laking river to the N'mai Hka. The party encountered severe weather. At an altitude of 12,000 feet and in 2 feet of snow the carriers deserted them. For ten days Pritchard tried to struggle on, but at length had to return to Hkrangkao, leaving behind him, in the snow, most of the kit he had taken. As a souvenir of this episode, his chilblains ulcerated, with the result that, for the next month, Pritchard had to walk barefooted. Of the country about Hkrangkao the traveller writes :—

" Sometimes as many as six crops were to be seen in one field, *e.g.* rice, ' lak maw,' millets, beans, etc. Glanced at casually, the crops looked good enough, but closer investigation revealed the fact that there was no grain in the ears. The country, in fact, was suffering from a total failure of the crops. In these circumstances the money earned by road-work is a God-send to the people. They have a curiously primitive system of insurance against famine, which is also in vogue among the Naingvaws. They plant sago-palms (*Caryota urens*, Linn.), which are never cut down until starvation is at their doors. These beautiful palms grow to a height of 70 feet, and are sometimes as much as 7 feet in girth. The pith, or farinaceous part of the trunk of old trees, yields a sort of sago, and so nutritious is it that so long as the trees last, famine is averted. I was unable to discover whether the natives are aware of the properties of the leaves, from which in India, ropes, brushes, baskets, etc., are manufactured. Nearer home the cord-like fibres from the interior of the stems have been used instead of whalebones, in corset-making, a fact I did not think it worth while to communicate to the Naingvaw ladies ! The men folk would have been more interested, perhaps, to learn that ' arrack,' or the gin of India, is made from the palm. Regular clumps of alder (*Alnus nepaliensis*) are to be seen hereabouts. These trees are planted by Kachins and Marus on taungya (hill cultivation), and when of sufficient growth are burnt with the rest of the taungya, yielding highly fertilizing ashes. This process is practised particularly in the more congested parts and reduces the cycle of years during which the fields have to lie fallow ; the normal term is seven to ten years. Horse-chestnuts are fairly common near here. Between Shichang and Myawjawng we left the track to climb a hill from which a splendid view of the N'mai valley was to be had, and from here too we had our first glimpse of the snows. Next day we saw the first of the cane suspension bridges, one spanning the Ngawchang, which the local Maru is an adept at constructing ; its length was 200 feet. At Kabap several Lashis, bringing dogs for sale, came into our camp. The Lashis are much more Tibetan in type than any of the other peoples met with so far. The

local Maru eats dogs. Near some of the villages here, a little tea was growing, and the country from here to the east could probably produce large quantities. Tea-growing and the extraction of minerals would seem to be the two industries by which the country might be developed. . . .

"A small girl died when we were at Hkrangkao, so a death dance was held. As usual with such people, the performance was monotonous. But the regularity of their movements, which consisted chiefly in bowing the head and bending the knees forward, at intervals describing a small semicircle with the left foot, would not have discredited a troupe of ballet girls. Three gongs beaten, 1–2–3, 4, 1–2–3, 4, provided the music. The Marus apparently burn their dead, except during the harvesting season, when they bury them."

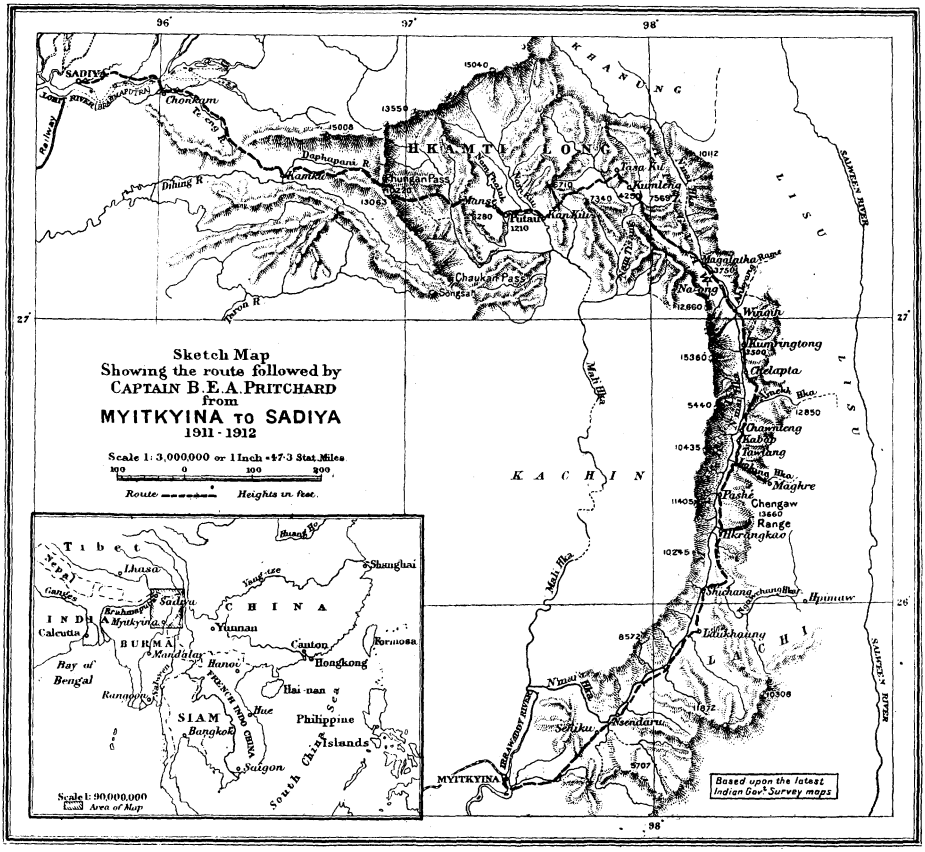
Getting fresh rations at Hkrangkao from the temporary post he had left there, Captain Pritchard, on January 19, left for Tawlang and the A'mekh confluence. Concerning the march north he writes—

"Never before have I experienced quite such severe ascents and descents without the shortest stretch of anything approximate to level. There is no relief on reaching the top of a spur, for the almost precipitous descent is just as difficult as the struggle up. The Naingvaws further north illustrate a difficult march by holding up one hand with the fingers vertically outstretched, and then running a finger of the other hand up and down over them, and this sign manual also aptly describes the country hereabouts. A day's march averaged less than 4 miles, and was yet quite good going.

"The people were quite willing to carry our loads for six annas a day or for a few brass buttons, blue beads, and other baubles, of which our supply was large. Their only objection was that accompanying us took them from their normal occupation of hunting for edible roots, etc., in the jungle; so, whenever a little rice was obtainable, I promptly purchased it and divided it among the carriers. The dearth of grain throughout the country was very noticeable. . . . The next day's march was again $3\frac{1}{4}$ miles, and at the end of it we camped among cultivated fields above the Mu (Lamu). The first hundred yards from this river took us up 200 feet of as steep an ascent as one is likely to meet anywhere, and was only compassed by hoisting one's self up from tree to tree by roots left carefully exposed for hand and foothold. . . . During the day's march I noticed several coolies cutting shavings off a soapy-looking tree, to be used, so they said, as a hair-wash, though I had some difficulty in believing that they were not in reality destined for the cooking-pot. To use a hair-wash regularly would be to deprive Marus and Naingvaws alike of their favourite amusement. . . . Again next day $3\frac{1}{4}$ miles to Pashé, including a descent of 3000 feet in $1\frac{1}{4}$ miles, the wet mud was as slippery as ice, and the only way to get along was to plant pointed bamboos in the ground ahead of one, and then slide down on top of them."

On January 31, Captain Pritchard reached Tawlang, which is a few miles north of the Laking river.

"The Laking river may be taken as the southern boundary of the Naingvaws, the border-line between them and other Marus. In this immediate neighbourhood there is naturally a certain intermingling of the tribes, but, generally speaking, the Marus up to this river are a homogeneous people, very similar in appearance, manners, and customs to the Marus of the Northern Shan States, with whom also I am familiar. Up



to the Laking only a small percentage of the Marus are addicted to opium, and I saw no drunkenness. . . . The Naingvaw young women enjoy the same privileges as their Kachin sisters, in that one room is set apart, and is known as the 'maidens' sleeping-apartment.' The parents never enter this room at night. High revel is held here with the young 'bucks' of the village, each lady having for her companion the youth of her choice. Conversation is kept up until the early hours of the morning, when most of them turn in in couples. This surprising freedom of intercourse is said, among the Kachins at least, to have one point in its favour, and that is that after marriage infidelity is rare. They are laughter-loving people."

Dealing with their ethnology, etc., Captain Pritchard writes—

"From Lauhkaung outpost up both banks of the N'mai the people are practically all Marus as far north as the Ahkyang junction. The Naingvaws are merely an isolated clan (of which there are about ten) of the Marus. The Laking valley may be taken as the southern limit of their territory, which extends up both banks of the N'mai to where they merge into the Khanungs or Nungs. In reply to questions as to where they originally came from, the almost invariable answer is, 'We have always been here.' Like the Kachins, the Marus are classified as Tibeto-Burmans. Most authorities, including the Marus themselves, say they are not Kachins. The Maru language is akin to Burmese, and quite different from Chingpaw or Kachin. But the Marus, however, mingle freely and intermarry with the Chingpaws. There are probably few places where the student of ethnology would be confronted with greater difficulties than among the Tibeto-Burman hill-tribes; this being the case, the traveller should avoid dogmatizing; nevertheless, some facts may be asserted without fear of contradiction. The Naingvaws are but one of the ten Maru clans. They are identical with the Khanungs or Nungs inhabiting the valley of the N'mai further north, and, except for slight dialectic differences, their language is the same. A study of their customs reveals the fact that these are almost exactly similar to those in vogue among the Kachins, and there is little doubt in my mind," says Captain Pritchard, "that they were originally the same people. Little reliance can, of course, be placed upon these people's accounts of their origin, etc., yet it is significant that the Naingvaws told me that if they went further down the river they became Marus, and if further still they became Kachins. The Maru genealogical table begins, 'Ah-maw-i married a monkey,' which somewhat discounts the value of their statement that they are not Kachins. Nor should one regard the difference in the Chingpaw and Maru languages, as some frontier officers do regard it, as conclusive proof that these are different peoples, for not only is the language test admittedly frequently misleading, but there is as much difference between Naingvaw and Maru as between the latter and Chingpaw."

Up to the time of this journey but little was known of the Naingvaws. Captain Pritchard therefore deals with them in some detail. He says—

"Their chief characteristic is low cunning. The men are avaricious, deceitful, untrustworthy, and excitable, but they are kind to their womenfolk; they are not nomadic. Hospitality to the extent of allowing the stranger to occupy their houses is a redeeming feature. The men are arrant cowards; they have no warlike instincts, and appear to be quite content to wear any yoke their more warlike neighbours see fit to put upon them. They are less addicted to strong liquor than most of the hill tribes. The women and children are neither suspicious nor afraid of the white man. They appreciate a joke and indulge in the hilarious

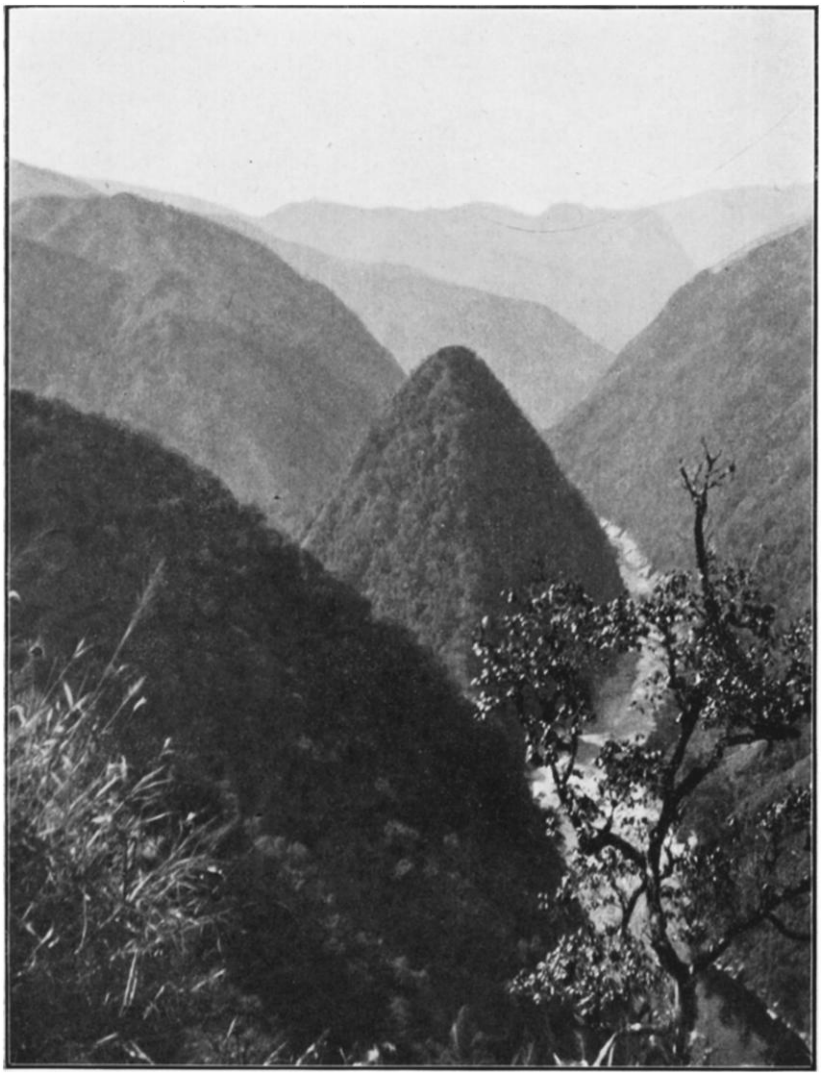


FIG. 3.—THE TWO CONICAL PEAKS AT THE CONFLUENCE OF THE N'MAI AND A'MEKH.

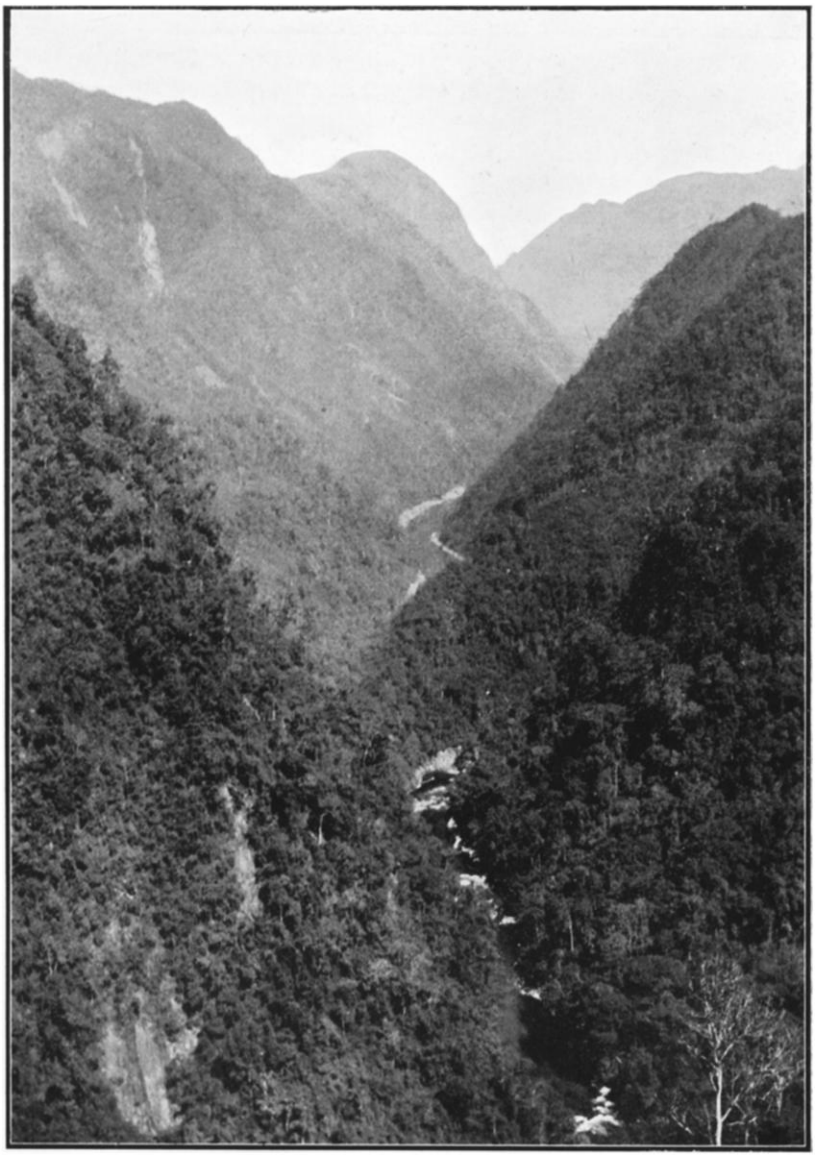


FIG. 4.—VIEW UP THE PASS BETWEEN THE TWO CONICAL PEAKS AT THE CONFLUENCE OF THE N'MAI IN THE MIDDLE DISTANCE AND A'MEKH (FOREGROUND).

laughter their Maru sisters do. Like most semi-savages, they are inordinately curious. The average height of the men is 5 feet 2 inches, and 2 inches more constitutes a tall man. The women are not very much shorter. The tallest man met with was 5 feet 7 inches. Though small, they are decidedly well-built. They are well-nurtured, but not physically strong, though able from constant practice to carry considerable loads in very hilly country."

In marked contrast to the more prevalent Mongolian type were a few individuals among the Naingvaws met with about the centre of their country. These possessed features of a decidedly Caucasian type, and the following description of them (based on Captain Pritchard's photographs) is furnished by Colonel Manifold, the well-known traveller in Western China :—

"The most marked feature separating them from the tribes around them is the straight prominent nose, which, except for a tendency to width at the nostrils, might almost be called Grecian. The lips, though somewhat unduly full, are well cut; the cheek-bones are not very prominent, and the face at this point shows breadth, and from the cheek, the curve to the chin, which approximates to oval, is rounded and well-shaped. The supercilious arches are prominent, giving rise often to rather deeply cut lines at the base of the nose. The eyebrows are heavy and thick, the forehead is somewhat rugged, and is surmounted by a mass of wavy hair, rather fine in texture, which falls in natural curls over the shoulders. The face is usually quite smooth, a somewhat large upper eyelid giving a perfectly well-curved aperture without the least tendency to obliquity of canthus."

Colonel Manifold says he has met this same type in the villages along the eastern tributaries of the Mekong. They speak a Tibetan dialect and belong to congeries of tribes known to the Chinese as Sifans. The limits within which they were found by Colonel Manifold extend from west of Ta Chien-Lu to the east of Batang. Colonel Manifold suggests the possibility of their being descended from the Græco-Bactrian race, who are said to have made an incursion into the north-west corner of Ssu-Chuan during the epoch immediately preceding the Christian era. In Captain Pritchard's opinion, it was, perhaps, equally possible that these people were the remains of some group of early Aryan invaders who made their way in advance of the general wave of Aryan invasion into this wild tract, and were left stranded among the surrounding Mongolian races, still preserving their characteristic physiognomy. In either case, it would seem that the occurrence of a group of such markedly European type in this part of the world deserves further study. Proceeding with his description of the Naingvaws, Captain Pritchard says—

"As with the Marus, further down the N'mai, there is a marked absence of naturals, cretinism, and deformities generally, as also of goitre. The appearance of the people testifies to the healthiness of the N'mai valley

between 3000 feet and 4500 feet, as well as to greater morality in private life, than is to be found amongst most of the neighbouring hill tribes. The dress of both men and women is exactly as worn by the Marus, except that practically all the women and a few of the men wear bamboo-tube earrings (like Kachins). Naingvaws intermarry with other Maru clans; men of one clan take wives from another, practising polygamy. Polyandry is not practised."

Naingvaw children are named, as with the Kachins, in accordance with their sex and the order of their birth. Their houses differ but little from those of Marus or Kachins, the piles on which the houses are built being, however, shorter, *i.e.* from 2 to 4 feet. Each house has four or five rooms or cubicles. In the front porch are partitions for pigs and fowls. Floors are of split bamboo, and each room has a fireplace. A granary is attached to each house. The Naingvaws do not object to strangers entering or leaving their houses by the back entrance, as do Kachins. The number of inmates of a house varies from two or three to as many as twenty, ten perhaps being a fair average.

It is possible that slavery is practised on a small scale among the Naingvaws, though they deny that it is so. Captain Pritchard could find no trace of it, but he adds that "the practice of selling people as slaves to the Kachins is rampant among the Marus in some parts of the N'mai valley."

The Naingvaw religion is apparently, if it can be so termed, the purest animism. They believe in *nats* and the necessity for duly propitiating them. Their various officers of religion are the same as with the Kachins. They have a priest (medicine man), a sacrifice slayer, a seer (who is supposed to have second sight), and a man who seeks out the *nat* which wants propitiating. They have no appreciation of who or what Karai Kasang (the Kachin term for the Lord of the universe) is, the few Naingvaws who have come in contact with Kachins only recognizing him, but rating him lower than the *nats*.

The Naingvaws are not addicted to opium, but all adult males and a small percentage of the women (though not children) smoke tobacco, generally in pipes. The tobacco is of good quality.

Hman is chewed and applied to wounds and eaten for fevers; it is the local panacea for most, if not all, ills. Its medicinal properties are well known, in Bengal, and every tribe from Assam or Burma to Yunnan values it highly. It is also interesting to note that Hman is valued by people so widely separated as the above tribes and the Red Indians of North America.

The Naingvaws are expert hunters. Some of their traps are very ingenious. Monkeys are caught by a device of bamboo poles held in position by slips of bamboo with maize as bait. On pulling the maize one pole is released, which lets free the lower one on which the monkey has been standing, and the animal falls to be transfixed on sharp "panjies" placed below. Fish are caught by ordinary nets, but in the more isolated

parts the mode of capture is to dam the stream with a framework of wood covered with brushwood. A hollow palm-tree about 25 feet in length is then laid with one end in the water and the other end on the dam, the slope being upwards. The fish, being unable to get through the dam, go up the palm and fall into a basket ready to receive them. The method is, says Captain Pritchard, very effectual.

The Naingvaws improvise most of their songs. One man, ranking higher than his fellows as a singer, renders a solo, the others joining in a long drawn-out note which serves as a chorus. None of their stories or songs are printable. Their version of the "fall" is that the original two were brother and sister and that the sister was to blame—and beyond that it is unsafe to go! They also have a version of the Tower of Babel, which finishes "and so one man reached out and seized the moon, when the N'mai gushed out and all was dark."

Leaving Tawlang, Captain Pritchard proceeded to Chawnteng, which he reached on February 5, and to Shija, where he arrived on the 10th. Within a quarter of an hour of his arrival at the latter place, all his coolies decamped without pay. But, to make up for it, they stole several things. Here he had the greatest difficulty in obtaining other coolies, and was delayed several days. He utilized the time in compiling a glossary of the Naingvaw dialect and in visiting the place on the A'mekh where the Lisus dig for gold, but he only saw it from the far side of the A'mekh. The gold is apparently alluvial, though nuggets varying in size from a pea to a bean are said to be occasionally found. One fact he elicited, *i.e.* that the Chinese never use the A'mekh route.

By taking *rough* cross-sections of the rivers N'mai and A'mekh at their confluence, Captain Pritchard worked out the comparative volumes of discharge of the rivers to be—

N'mai	10,755 cub. secs.
A'mekh	1,655 cub. secs.

From this it will be seen that the N'mai is rather more than six times as large as the A'mekh, and the latter river is therefore only an affluent of the former. Until recently it was commonly supposed that both were rivers of about the same size, combining to form the eastern branch of the Irrawaddy. This theory Captain Pritchard therefore effectually disproves.

The utmost tact, and the promise of his mackintosh to the local headman if ten of his people would carry for him, only made Pritchard so popular that they begged him to stay for a month. It was not until a show of force was made, coupled with a promise not to visit the gold reef, that Pritchard finally obtained sufficient carriers to take him northwards. On February 18 he started up the A'mekh. He remarks that the valley of that river closely resembles that of the N'mai, the spurs being as frequent, as steep, and equally as impossible. The spurs run up to snow-clad heights of 15,490 feet on the Laking-A'mekh divide, and to 14,720 feet on the

A'mekh-N'mai divide. Jungle extends, he says, from the top of the divides to within a few feet of the river, the greater part of the existing cultivation lying between 5000 and 2500 feet.

On the 27th the party reached Chelapta on the N'mai, marching part of the way in thunderstorms, which only allowed them "glimpses of great mountain ranges."

From Chelapta onwards the path was most difficult. It took six hours to traverse 4 miles, the first 2 miles of which was mostly along a steep rock face. Where the path was horizontal, more or less, it consisted of one or two bamboos, either fastened to trees or hung along the face of the rock. Where the path ascended or descended, notched logs were set up against the rock, or sometimes a bamboo pole was fastened to a stake driven into the rock, with the aid of which the party had to swarm up or down the cliff. In the second 2 miles the path traversed dense jungle of tall *Kaing* grass, through which they had to burrow. At the end of this march they camped in the jungle, a procedure which did not recommend itself to the Chelapta coolies, who demanded heavy wages before they would agree to go on. Next morning the mists began to lift at 6 a.m., and until 9 a.m. large drops of water fell like rain, making the jungle damper and the path more slippery than ever. Later on, rain fell, and it took nine hours' hard going to cover the next 5 miles into Kumringtong.

Captain Pritchard was still walking barefooted as the result of his ulcerated chilblains, which prevented him getting on his boots, but he fell fifteen times in half a mile and twice "plunged literally headlong down the hillside." The sun's only appearance was for one minute at about 4 p.m. The party could not even see across the N'mai, so that survey work for that day was impossible. The track in one place rose 1750 feet in three-quarters of a mile, and the only means of progression was to send two men in front to plant bamboos in the ground, by which the rest of the party could pull themselves up.

It is no wonder that with the main tracks of this description the people are not "nomadic." In talking of these tracks, Captain Pritchard says—

"A double line of bamboo sticks high up on the hillside may be taken as an indication that a descent is imminent. These sticks have assisted Naingvaws to climb up from the other side, and are stuck in the ground when the climb is over, as no longer wanted. Probably much the same feeling leads the Naingvaws to make this bamboo alley, as prompts the European to make a stone cairn on the summits of high hills."

On this march a lad accompanied Captain Pritchard who described himself as a Pashé Lagu and not a Naingvaw. He was sixteen years old, and had been a slave in Kachin country for two years. His people had sold him originally for a coat and cooking-pots. He had nothing but good to say of his Kachin owners, and was found to be most useful, probably because the two years away from his own people had enlarged his mental

FIG. 5.—ON THE BANKS OF THE NAM HKAMTI RIVER.

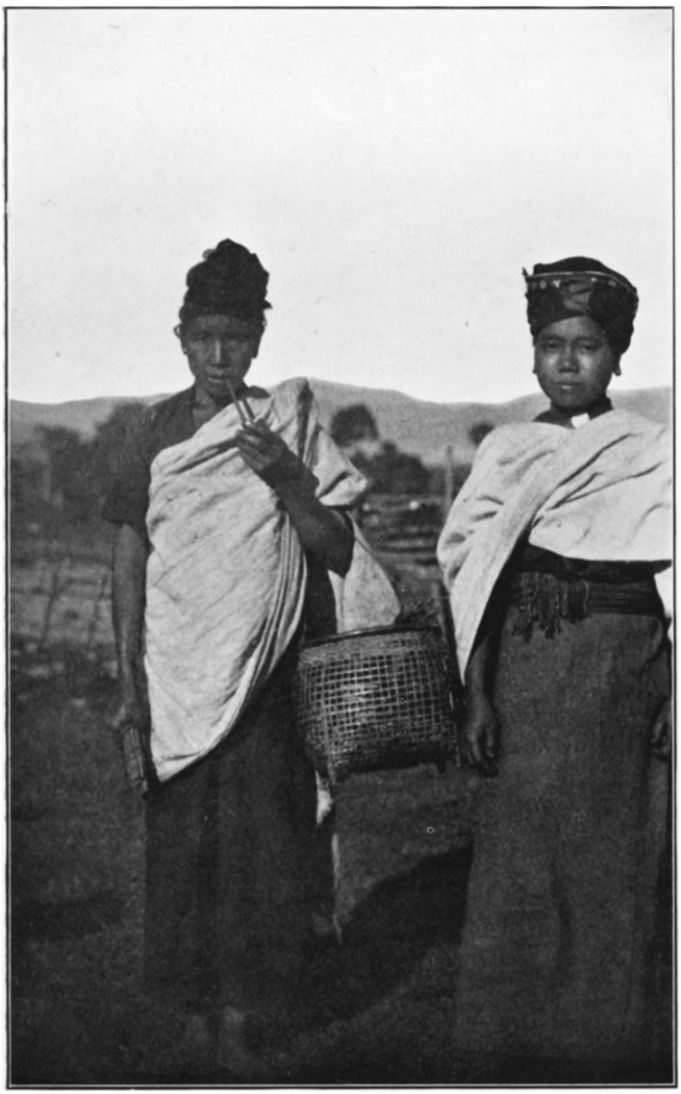


FIG. 6.—SHAN WOMEN OF HKAMTI.

horizon. Pritchard asked him why he did not run away from his Kachin masters, and he replied that, in the first place, he had no wish to do so, as he was very well treated; and, in the second, his own people who had sold him had told him that they would sooner or later buy him back.

Leaving Kumringtong, the party reached Wingin on March 4, where Captain Pritchard mentions several fine waterfalls. On March 5 he visited the Ahkyang *tuk* or confluence in order to take a cross-section of the rivers. He found the N'mai above the confluence to have a maximum depth of 71 feet, with a depth of 51 feet within 1 yard of the right bank, the river being about 70 yards broad. The Ahkyang he found to be about 30 yards broad at the junction, but owing to the rapids he was unable to obtain a cross-section. His attempts to do so were much hindered by the Naingvaws, who were afraid of rousing the ire of the river junction *nats*.

From the confluence the Naingvaws reported the Salween as being six days distant, the divide being crossed on the third day by the Wahkyet pass. But, as Captain Pritchard points out, this probably means six days for a native doing two or three stages daily. Another pass across the divide was also mentioned—the Tsaptse.

On March 6, owing to the threatening attitude of the Lisus on the left bank of the N'mai, Captain Pritchard crossed to the other side. The party was followed, but not molested, by some few Lisus, and reached Na-cng on March 10.

Concerning these Lisus, the traveller says—

"After passing through a succession of Naingvaw villages, to come suddenly upon a Lisu one, is like being translated to China, for the men have adopted the ordinary Chinese black skull-caps or blue turban, and blue coat and trousers. Both sexes of all ages wear short, untidy queues, and, though not a man of them knows Chinese, there is an obvious admixture of Chinese blood in them. Long hempen overcoats are worn, and bags of lungoor, cat, cow, and other skins are the fashion. Curiously enough, they have the same names as the Naingvaws, *e.g.* Adu, Achung, etc. Both sexes are handsome, but there is a low and evil-looking type—less like Chinese—as well. The average height of the men is about 5 feet 9 inches. Some of the women had navel-cords of their children tied round their necks by a hempen cord, like a pendant brooch—probably as amulets. The women wear a double row of white buttons round the head, from which one-inch strings of beads and seeds hang in a fringe, terminating in a tiny metal bell. They also wear bone ornaments round the head and on the straps of their skin satchels. Their earrings are of silver, with a piece of coral (?) attached. These rings are sometimes 4 inches in diameter. The headdress is picturesque. The men all carry the formidable Lisu cross-bow, and the boys have miniature ones. Their swords are 4 feet long, of which the blades are 3 feet, and are ill-balanced and not as formidable as an ordinary Kachin *dah*. While both sexes are particular as to their dress and comparatively cleanly in their persons, it is curious

to find their houses rickety, draughty, small, and dirty. They are built on piles of varying height, and have only one partition in them.

"During the last twenty years, the Lisus have driven many Naingvaws from the N'mai (about lat. 27° 25′ N.), and do not allow them to reside there or on the road to Kumleng. Some of the evicted went to the west of the Mali-N'mai divide, others into China. A wooden banjo of the ordinary Chinese type is the only musical instrument."

He goes on to say that the hundreds of Lisus who come to dig for gold annually near the A'mekh river junction, bring metal cooking-pots and blue Chinese coats, which they exchange for such provisions as the local villages can muster, consisting generally of rice, eggs, and a small quantity of salt. The Naingvaws deny that the above commodities are given as tribute, and state that the interchange is by ordinary barter.

Moving again on March 11, Captain Pritchard found his road along the bank of the N'mai, here 120 yards broad. The weather being excellent, the party reached Magalatha on the 12th. He notes the quantity of temporary shelters along the route, and deduces therefrom that the road is fairly frequented. The party halted a day at Magalatha to recruit coolies for the six days' march along the jungle track to Kumleng, which was the next village. Leaving again on March 14, Captain Pritchard writes of the march on the 17th and following days—

"The brain-fever bird and the cicada were here to deafen us with their noises and to remind us that we were nearing the plains. Our next march was through dense jungle, the dampness of which seemed to suit insect life of an unpleasant nature. Enormous ticks, blood-blister flies, and leeches combined to give us an unrestful time. The march to our last jungle camp had all the entomological disadvantages of the preceding one, but we got about twenty pounds of fresh fish, caught in traps by villagers from Kumleng. The Ratnamhti (Nam Tisang) would afford good sport to the angler. We saw some duck going down the Ratnamhti river and heard several barking deer. This was a great change after the scarcity of animal and bird life experienced so far."

At Kumleng the party entered the territory of Hkamti Long, or "great gold land."

From Kumleng Captain Pritchard made a *détour* to Tasah Ku to pick up 600 pounds of rice which, with great forethought, Mr. Barnard had sent for him from Hkamti, and here he parted with the Magalatha coolies. Obtaining fresh ones, Captain Pritchard reached the Shan village of Kan Kiu on March 27. Leaving his kit and party to go by boat up the Mali Hka and Namphalak, Pritchard walked in from Kankiu to Putau to meet Mr. Barnard, and to get the latest news from home.

On the stage from Tasah Ku he noted that the Nam Tisang, where he crossed it in lat. 27° 30′ N., was 200 feet wide and fordable, whereas the Nam Kiu, in lat. 27° 23′ N., was 166 yards broad and 20 feet deep. The traveller mentions this particularly, as Errol Gray made the curious

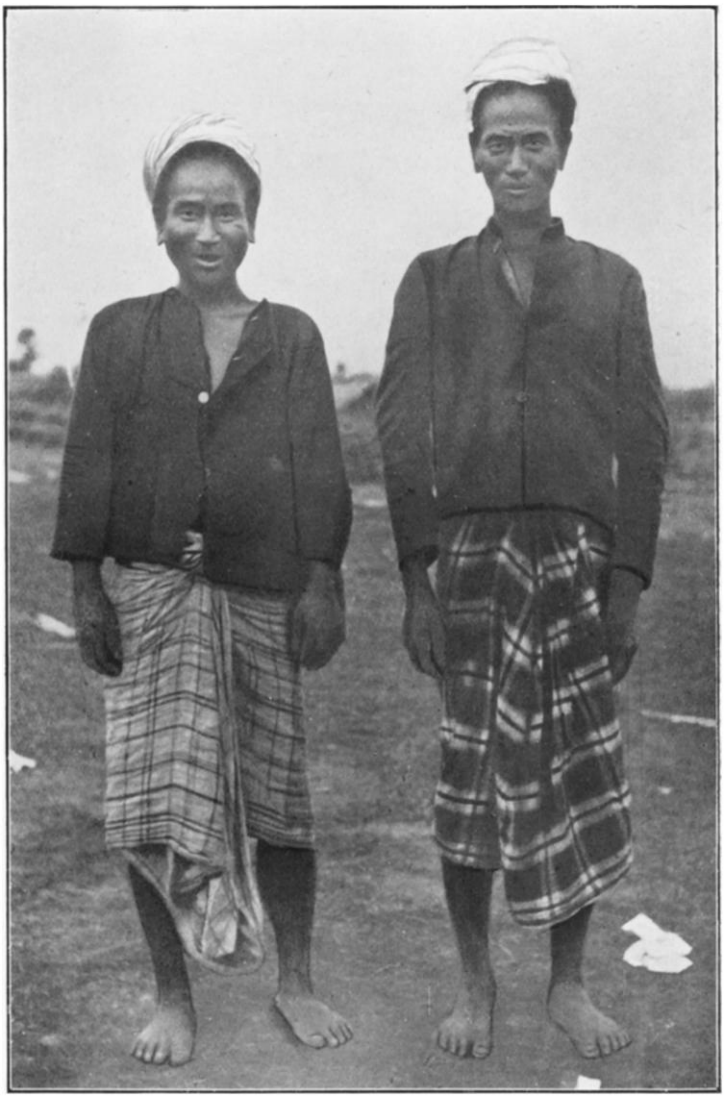


FIG. 7.—KACHINS AT KUMKU.

mistake in his diary (as printed in *Geographical Journal*) of saying that the Nam Tisang was somewhat larger than the Nam Kiu.

Owing to the ever-present difficulty of obtaining coolies in Putau, Captain Pritchard changed his quarters to Manse, where coolies were reported as being quite ready to take him anywhere he wished to go. His idea was to take the N'Lulong road into the Hukawng valley and return to Burma by the Chindwin, and the coolies were agreeable. But they made the proviso that they were not to be blamed if they were unable to find their way, as it had not been traversed for fourteen years.

Further accounts of the N'Lulonglam decided Pritchard. He changed his mind, and determined to go to Assam by the Phungan route. It was with great regrets that he did so. His desire was to visit the Tamai and Taron streams, and he adds, "I trust I shall be allowed to make the attempt later." This he did in 1913, and it was in the Taron that he met his death.

Of Hkamti Long Captain Pritchard writes: "The Hkamti Shans and their country have been eulogized by most travellers, who have naturally been delighted with a people so civilized, after journeys where Kachins, Kahnungs, and Lisus have been met with, while the country is a land 'flowing with milk and honey' compared to the more or less barren land one traverses to reach it. But, regarded as a remnant of the once great and powerful Tai kingdom, the people do not impress one so favourably. They are a decaying race, and the country might produce much more and a much greater variety of crops than it does. The 'great gold land' is indeed a fertile one, with great possibilities. What it most requires is a population, and this requirement will probably be met only when a railway pierces the Hukawng valley, bringing with it natives of India. An examination of the history of the Shan race will reveal the fact that their present marked characteristic, a social disruptive tendency, has always been their weak point. Such political characteristics have made a permanent mark on the history of most nations. Thus the Slavonic inability to recognize that a minority must give way to the wishes of a majority leaves its traces alike in the *liberum veto*, which was the ruin of Poland, and in the methods in which a Russian *mir* transacts its business to-day. The Nanchao rulers of Tali Fu were the head of a great nation, and at one time extended their domination over Yunnan, part of Ssu-chuan and Kwanghsi, northern Burma, and a portion of Assam, as far as Oudh. But, owing to their tendency to follow tribal rather than national interests, they could not hold what they had grasped, and finally succumbed to the onslaught of Kublai Khan and the Mongols. The centre of Shan political influence then shifted from Tali Fu to Meng-Mao, when the Mao Shan branch for a long time exercised a great influence over the political destinies of Siam and Burma, till, in 1562 A.D., their power was taken by the King of Pegu and their kingdom reduced to vassalage. Enough has been said of the political history of the Shan race

to throw light on the present situation at Hkamti Long. Its seven *sauhpas* are in constant disagreement with one another; and the feuds which arise from this cause are bound, sooner or later, to effect the disruption of the state of Hkamti Long."

As an instance of this jealousy which exists between *sauhpas* and their followers, apparently all villagers from Putau use the Chaukan route, and all from Manse the Phungan route, in their journeys to Assam. The route to the Hukawng valley, for which no guide was to be obtained, is *viâ* the Songshan, and therefore, says Pritchard, Young is "in error in stating that the Chaukan route is in disuse and the Songshan one frequented."

On April 6 the party left Manse, proceeding westwards. The next day they met a party of six Putau men, who said they had taken twenty-two days to come from Kamku. Says Pritchard: "One has to be a philosopher or have the *wanderlust* strongly developed to appreciate travelling in the Burma-Assam jungles. An ill-defined track, much overgrown and obstructed by fallen trees and bamboos, even the standing trees coated with moss; a carpet of wet dead leaves under foot; the continual swish of bamboo and undergrowth in one's face, despite the crouching attitude adopted—all this, combined with the gloomy, dark jungle, tends to cause a sense of depression, which is scarcely alleviated by a very occasional glimpse of the sun. The mist everywhere hides all but one's immediate neighbourhood. The slow pace of half a mile an hour, which is all that the coolies can, or will, make, heightens the resemblance which their carrying baskets give them, to gigantic snails crawling through dense forest. Some variety is lent by an occasional mile or so of a snow-fed stream, where at first one jumps from boulder to boulder, where possible, but after getting soaked to the waist these aids are abandoned in favour of wading. Over all is rain—rain in the morning, rain during the day, and rain at night. To light and keep a fire going is a work of art. It would occur to most people to shave wet wood to get dry timber, but the fact that dead hanging creeper is preferable to the dead wood may not be so widely known. . . . Though the standing trees are not blazed to show the path, one cannot go half a mile without coming across a fallen one over which the track lies. These are invariably slashed with *dahs* to give a better foothold, and were one to come across two or three in succession ungrooved, one might safely conclude one had left the track."

On April 11 one coolie refused to go further. Rain poured all day, so that the crossing and recrossing of the Nam Pangan (which occurred three times) was no easy matter. There was only one cane rope bridge. It consisted of a single cane rope, with two or three loops of cane about 2 feet in diameter, hung round it. The traveller sits in the loops and works his way along below the cane rope—no easy matter apparently, and Captain Pritchard did not attempt it.

The Pangan (Phungan) pass was crossed on April 17, the actual crossing being easy. Three hundred paces down the pass the party came across

melting snow forming a trickle, which was the headwaters of one of the four main branches of the Daphapani. Half a mile below the pass they left the actual path, and, following the track of a musk-deer, struck the main range near where the Dihing-Dapha divide joins the Chaukan-Pangan range. The divide was rich in both tree and ground orchids, while the rhododendron trees were covered with white flowers. The average width of the watershed was about 5 yards. Very little could be seen of the actual waters of the Dihing and Dapha, but their course was very plainly marked out by the dense mists overhanging them. The jungle was full of game, and the animals' "roads," says Captain Pritchard, "compare favourably with those used by humans."

On April 22, about Kamku, he again mentions the quantity of game, and that the elephant tracks were a good deal better than the track he was following. Despite the quantity of game, however, he was unable to get a shot, owing to the thickness of the jungle. He also mentions some sulphur springs, to which, he said, "animals seem to resort as salt-licks." The Dapha he found to be then running in three channels, but even so it took him 650 short paces to cross to Kamku.

In his last march to the Dapha, he found a nest of fifteen leeches in one boot, which was, of course, full of blood, but he says his plight was better than that of his carriers, many of whose leech-bites had developed into wounds, "having been regularly scratched and never washed."

The party left Kamku on April 25, passing through several Mishmi villages, the people in which seemed much interested in, and not a little afraid of, the travellers.

On the 28th Captain Pritchard took to a dug-out on the Te-eng, floating down with the headman of Chonkam's son Chowna. Both Chowna and his father Chowsam had travelled with Cooper, Needham, and Williamson, and had much to say of their travels.

On the 29th, as the sun was setting on the Abor hills, the party reached the Dihing Mukh and shortly afterwards found themselves on the wide stream of the Lohit Brahmaputra. Next morning they reached civilization at Sadiya.

"It was not," says Pritchard, "without a feeling of regret that I found myself buying a railway ticket instead of persuading or bullying reluctant savages to act as my porters. The charm of these wild surroundings remains with one always, and will not cease to call one back to the rushing torrents and the lofty mountain ranges which are encountered ere the goal is reached where the Great River of Burma has its birth."

of internal rainfall coincident with the uplift of the country for about 1000 feet.

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THE INDO-RUSSIAN TRIANGULATION CONNECTION.

By Lieut. KENNETH MASON, R.E.

DURING the International Geodetic Conference of 1909, which met in London, the question of a triangulation connection between India and Russia was discussed, and it was suggested that a link might be effected across the northern boundary ranges of India to the Chinese or Russian Pamirs, and in the early part of the year 1911, the Surveyor-General of India received a request for the Indian triangulation to be carried on to the northern frontier.

By this time, the Russian work, which had been initiated by Colonel Tcheikine from the base Ourtak-Tchoucour-Machali-Goudour, latitude 39° 33′, approximately, on the Trans-Alai mountains, had reached the neighbourhood of Pamirski post, about lat. 38° 13′, long. 75°.

An Indian Principal Series, started from near Rawal-Pindi in 1909, from the base Nerh-Khagriana, of the North-West Himalaya series, by Mr. J. de Graaff Hunter, had been taken to the neighbourhood of Shardi by the end of 1910, and forward stations were reconnoitred up to the neighbourhood of Gilgit. It had been decided to take this series as far north as this, independently of the idea of making a connection with the Russian work.

During 1911, the late Lieut. H. G. Bell, R.E., who succeeded Mr. Hunter in charge of the detachment, carried this principal series up to Gilgit. Many difficulties were encountered owing to the necessity of an early start; snow lay as low as 8000 feet, and great difficulty was experienced in placing the lamp squads on the hills for the observations from the first station. A bad spell of weather set in when Lieut. Bell was on Liowi H.S., 17,480 feet, and he was detained there from June 13 till June 21, with a minimum temperature of 20° F.

Again, on Zinghi Shish, the detachment met with very bad weather, and the portable lightning conductor, which had been erected over the observatory tent, was struck.

While on the march up the Indus valley, a severe earthquake shock was experienced which caused a cliff to be precipitated into the river. The heat here was so intense that marching could only be undertaken during the early morning and late evening, which offered a marked contrast to the high camps situated on snow.

With a view to reconnoitring a feasible line for effecting a junction with the Russian system, Lieut. Bell and Mr. Wainwright left Gilgit on August 1, the former taking the Darkot route, while the latter reconnoitred up the Hunza valley. Lieut. Bell first visited the Darkot pass, by way of the Yasin valley, examining the peaks in the vicinity, in the hope of finding some possible connection on to the Salisbury and Concord peaks on the Russo-Afghan frontier. He found the extensive glacier, rising on the pass, much intersected by crevasses, and only passable in the very early morning. The highest peak, about 19,370 feet, west of the pass, was found to be quite inaccessible for triangulation purposes, and the neighbouring peaks, though lower, were useless, owing to the high unclimbable peaks to the south and south-east. From Darkot, Lieut. Bell visited the approaches of Garmush, 20,564 feet, but found that the glaciers in the neighbourhood were extremely dangerous, and the slopes very subject to avalanches. The Darkot-Askuman pass was crossed, and a peak ascended with a view to obtaining a more extensive reconnaissance of Garmush and the other peaks of the Sakiz-Jarab range, but the term "glorified Matterhorns" which has been applied to the Karakoram peaks further east, was found to be equally applicable here. In a letter written from hereabouts to me, Lieut. Bell mentioned that he doubted whether the peaks would be accessible for an experienced party of climbers, and that it was a physical impossibility to take an instrument up any one

of them. A move was now made up the Karumbar valley, in the hope of finding a possible line of connection to the Russian stations from here. The lower reaches gave hopes of success, but from Imit northwards the valley closes in, and the mountains rise precipitously from the banks of the river-bed. Progress was slow up the western bank, and the route was further barred by a landslip, which night and day discharged rocks and earth into the river. Further advance became impossible when the Karumbar flooded, for this river, like all others of any size in the Hindu Kush and Western Karakoram, rises to such a size that the fords upon which the route depends become impassable in the summer. The possibility of utilizing this route was, however, never abandoned by Lieut. Bell, should the Hunza valley route fail to yield better prospects of success.

Mr. Wainwright meanwhile made a reconnaissance towards the Kilik pass, and reported that it would be practicable to run a series as far as Misgar, but that it would be advisable from here to branch off up the Khunjerab valley, and effect a link by means of the Kharchanai pass. Owing to the rough track, he advised the use of a smaller instrument than the 12-inch theodolite.

During the summer of 1911, the Russian triangulation had been extended to the Russian frontier, and two stations—Beyik, approximate lat. 37° 18′, approximate long. 75° 7′, and Taghramansu, approximate lat. 37° 16′, approximate long. 74° 54′—had been fixed. Owing to the results of Lieut. Bell's reconnaissance, however, since the peaks of the Sakiz Jarab were unsuitable, this method of connection had to be abandoned, and it was decided to make the attempt *viâ* the Mintaka, Kharchanai, or Kilik passes.

Lieut. Bell was again in charge of the detachment during the summer of 1912, and arrived in Gilgit by May 31. It had been decided to base the connection on a side of the Kashmir Principal Series, in lat. 35° 55′ and long. 74° 20′, from which it would trend northwards to near Chalt, and thence, following the bends of the Hunza river, it would more or less keep to this valley till the passes were reached. From there it was intended to take the series to the Russian stations, Kukhtek and Sarblock, on either side of the Beyik pass, in about lat. 37° 20′ and long. 75° 10′. Lieut. Bell decided to go straight through to the Russian end and work back, while a second squad under Mr. Collins worked up from the neighbourhood of Gilgit.

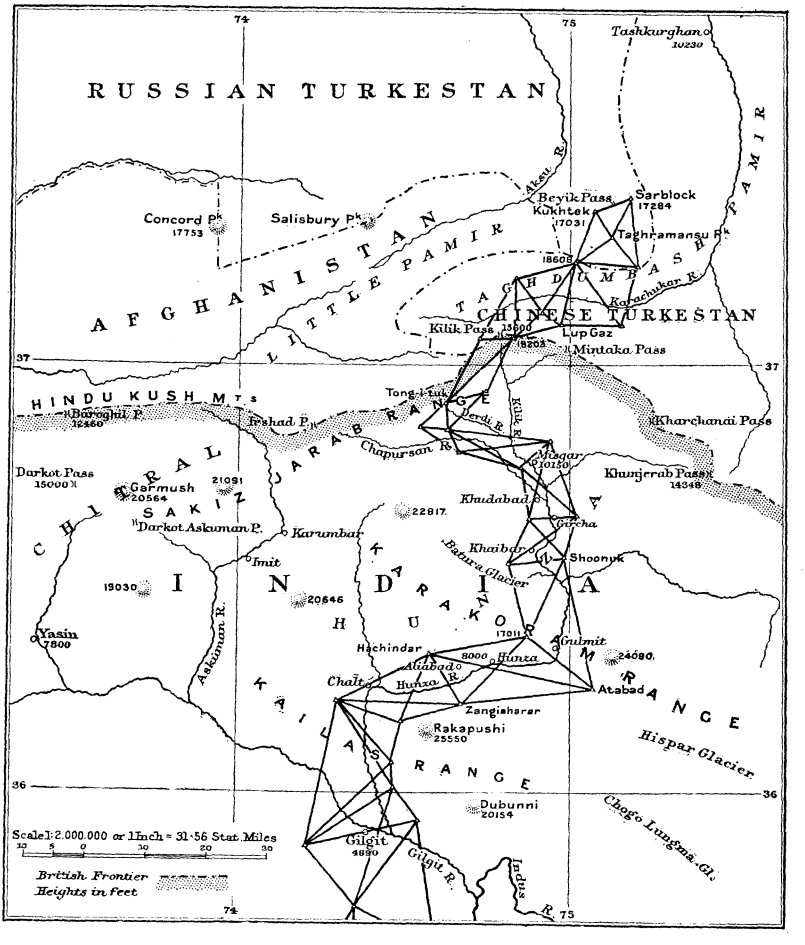
The year was a disastrous one for the Survey. Early in June the various detachments left Gilgit, but the weather was very unfavourable, and while on Yashochish hill station, on the Great Himalayan range, the camp of Mr. Abdul Hai was wrecked by lightning; his servant was killed and his recorder was severely burnt, while he himself received a bad shock which necessitated his return to Gilgit. This district is notoriously bad for electrical disturbances, and very different from the regions of the Karakoram, which, as has been observed by the Duke of the Abruzzi, are

very free from storms. Mr. Collins now carried on the triangulation from Gilgit towards Hunza, when, on July 28, he had to take over charge of the detachment owing to Lieut. Bell's death.

The latter, with Mr. McInnes, had travelled *viâ* the Hunza gorge to the Pamirs, crossing by the Mintaka pass to the Taghdumbash. After detailing Mr. McInnes for the work of reconnaissance towards the Kilik

THE INDO-RUSSIAN TRIANGULATION CONNECTION.

To illustrate the paper by Lieut. Kenneth Mason, R.E.



pass, Lieut. Bell proceeded to the Russian stations on either side of the Beyik pass on the Russo-Chinese frontier, and met the Russian triangulation party under Colonel Tcheikine on the pass. He completed three stations, and ascended a fourth, but found some difficulty in observing from it to Lup Gaz. He therefore moved his camp back to the latter station with a view to finding out whether the ray was visible. He had not

been very fit for the last few days, and had been over-exerting himself. On July 19, when at his camp on Lup Gaz hill station, he awoke in very great pain, and finding that he became no better, he had himself carried down to his base camp in the Lup Gaz Jilga. He remained here for a few days, and on the morning of the 24th, sent a note to Mr. McInnes asking him to come and take over the observations. Mr. McInnes received this when in camp near the Kilik pass on the following morning, and immediately left for Lup Gaz, traversing the Pamir from the Kilik to Lieut. Bell's camp, a distance of nearly 40 miles, the same day; he arrived in the evening to find Lieut. Bell very weak. The latter refused to allow Mr. McInnes to sit up with him, urging that he must be very tired, and should go and lie down and rest after his long ride. It was characteristic of him absolutely. He knew the gravity of his case, for he went into a few details of the work, and asked Mr. McInnes to go up the station the next day, and get through as much of the work as he could, but he tried to look on his illness as cheerily as he could, saying that he hoped soon to be fit enough to carry on again. He assured Mr. McInnes that he would call him if he wanted anything during the night, but about midnight he passed away alone. It is hardly necessary to add after what has been said, that the ultimate success of the work was due almost entirely to the energy and devotion of Lieut. Bell. During his short stay on the Pamirs, he had earned a reputation for unselfishness and self-sacrifice, and I found this year that he had been held in very high esteem. On his death I personally lost my dearest friend, and I had known him intimately for many years; he was a daring mountaineer, and absolutely fearless, and his loss to the Service and to Geography is incalculable.

This disaster delayed the work very largely, and by the end of the season, a late one as Pamir summers go, the triangulation had only been completed from the Gilgit side to a point some little way below Hunza. Mr. McInnes finished the reconnaissance of the Pamir section, but the work done in the Hunza gorge showed that a departure would have to be made below Misgar, in order to obtain suitable figures. As the crow flies, there remained about 70 to 80 miles to be traversed by the triangulation, but the actual length of the chain was nearer 120 miles. Of this, some 75 miles had been reconnoitred and the stations built, and with the exception of the two stations near the Kilik pass these were subsequently found suitable.

During the early part of 1913, I was given charge of the detachment to complete the connection. All through the season we were luckier than last year; and, owing to an earlier start and fine weather on the passes, we reached Gilgit a fortnight earlier. The detachment, which had marched up in three separate squads in order to facilitate transport, concentrated at Aliabad, Hunza, on May 20, after leaving a main depôt at Gilgit. The distribution of the work was arranged in a somewhat similar manner to last year's scheme. Mr. Collins was to work up the Hunza river, Mr.

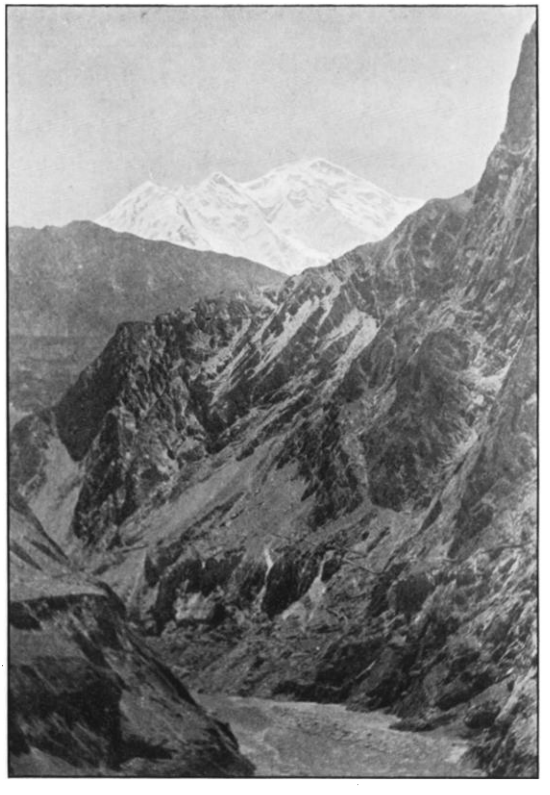


FIG. 1.—RAKAPUSHI FROM NEAR TASHOT, HUNZA OR DUMANI.

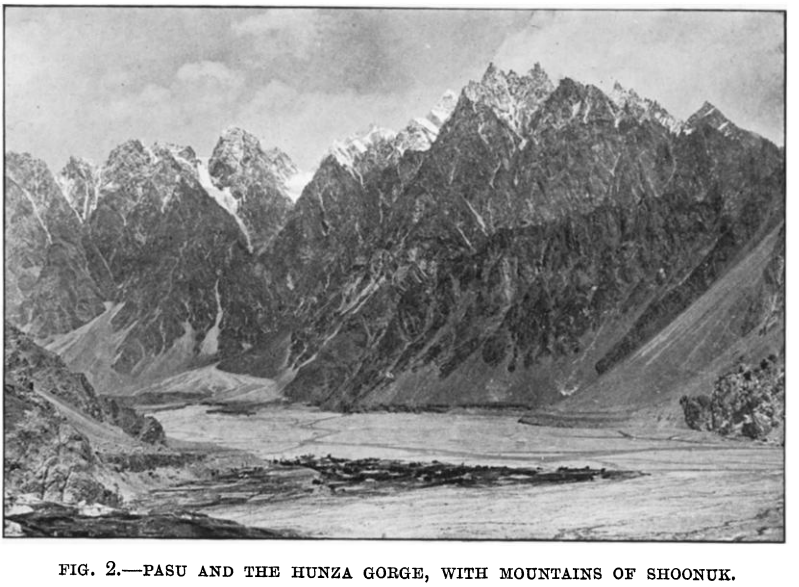


FIG. 2.—PASU AND THE HUNZA GORGE, WITH MOUNTAINS OF SHOONUK.

FIG 3.—VIEW SOUTH FROM KILIK WEST H.S., SHOWING ON THE RIGHT THE MOUNTAINS OVER WHICH THE TRIANGULATION WAS CARRIED. THE V DEPRESSION ON THE LEFT IS THE HUNZA GORGE AT MURKUSHI.

FIG. 4.—KILIP EAST H.S. (ABOUT 19,000 FEET).

McInnes to reconnoitre in the country between Khudabad and the Kilik, while my detachment proceeded straight to the Pamirs, to the point where Lieut. Bell had left off. Captain R. W. G. Hingston, I.M.S., who had been attached to the party, accompanied the latter detachment, with a view to studying the natural history of the district, and rendering any medical assistance that might be required.

Mr. Collins' detachment commenced work about the end of May, visiting his two last stations of 1912, Zangiaharar and Hachindar, the former on the northern slopes of Rakaposhi, the latter on the hills above the right bank of the Hunza river (Fig. 1). Helio squads were placed there, and Mr. Collins then proceeded up the Hunza valley. He found that his next station, Atabad, on a spur of the mountain for which Sir Martin Conway obtained the formidable name, Mount Boiohaghurdooanasur—which means in the Burishushki * language, " Where only the horse of a demon can go "—too difficult to climb at this early season. So he decided to continue up the valley, and return at a later season. Between Atabad and Gulmit, the valley narrows to a precipitous gorge, where the Hunza cuts its way through the main axis of the Karakoram, and the summer road, carried high up across the face of a cliff, a thousand feet or so above the river, is only laid on pegs driven into the rock, and is distinctly sensational. Mr. Collins' next stations were on either side of the river just south of the village of Khaibar, that on the left bank, being on the rocky peaks of Shoonuk (Fig. 2), while the other was on the northern boundary wall of the long Batura glacier. This detachment completed the triangulation up to the junction of the Chapursan and the Kilik rivers, including four more stations besides those already mentioned, namely, Kirilgoz and Sirsar on either side of the river at Gircha, and Tehri Sar and Raminj Sar at the mouth of the Chapursan valley. It then marched down the Hunza and completed the observations at Boorihararand Atabad, making a total of eight stations, of which the average height was 15,090 feet.

Mr. McInnes' detachment marched direct to the Chapursan and rapidly selected the stations up this valley. Like the majority of the longitudinal valleys of the mountain barrier, the valley is not very precipitous, particularly in its lower reaches. The difficulty arose when the question of connecting on the work from here to the Pamirs came to be settled, and Mr. McInnes climbed a large number of hills before he succeeded in even finding one that would range through to the north, and this necessitated a change of two stations near the Kilik pass. After first reconnoitring Hark mountain † from the south, he brought his detachment to Bun-i-kotal, south of the pass, and we discussed the possibility of

* Or Burishaski. See ' Tribes of the Hindu Kush,' Biddulph.

† Hark mountain, or Tong-i-tuk, is situated on the watershed between the Derdi valley and the Hark, which is the last and most northerly tributary of the Kilik river from the west, and joins this river at Bun-i-kotal.

effecting a link across these mountains.* Hark mountain, 19,135 feet, is extremely difficult to climb from the north, and Mr. McInnes, who decided to tackle it from the south, and left us at the pass on July 2, did not succeed in getting his instruments up until the 22nd; this mountain is called Tong-i-tuk from the south.

After making a station on Tong-i-tuk, Mr. McInnes again had difficulty in finding another hill from which he could join on to this station and the Kiliks, and the final connection was not completed, owing to unfavourable weather, until August 25. Mr. McInnes observed from five stations, of which the average height was 17,616 feet.

The Pamir detachment, which came with me, left Hunza on May 23, and after marching up the Hunza valley, reached the Taghdumbash Pamir *viâ* the Mintaka pass, on June 3. Reconnaissance was carried out to ascertain that Lieut. Bell's stations had not been lost during the winter, the signallers were placed on their posts, and we marched to the Russian station of Sarblock. A bad spell of weather set in which lasted a week or so, and delayed the observations, so that only three stations were completed by the end of the month. Early in July, after meeting Mr. McInnes at the Kilik pass to arrange with him the details of the link, the party was again held up for some days and nights on Kilik east hill station, 18,203 feet,† and was hardly able to leave the Whymper tents (Fig. 4 shows the observatory tent on this station). When the weather again cleared, the work was hurried on, but was delayed somewhat by a signaller and his mate going sick and being unable to show a helio. The recorder met with an accident, but Captain Hingston very kindly undertook his duties in addition to his own. In spite of these troubles, however, by the end of July, the triangulation had been carried to the Kilik pass from the Russian end, and on August 5, was completed at Mr. McInnes' southern stations, making a total of ten stations, averaging 17,716 feet.

The weather in these parts is very unfavourable to triangulation. Nearly half the days had seen snow falling, but on many of them work was possible at some time or other. Owing to the strain on the eyes of observing on hills covered with a mantle of snow, I suffered from an attack of snow-blindness, and, after this, frequent rests were essential on the hill stations, and work in camp of an evening became troublesome. One of the greatest difficulties, however, was the rationing of the detachments, which in the case of the Pamir section numbered over 100 men. The Pamirs produce nothing but milk, sheep, and goats, and the latter were ruinously expensive. We bought for this detachment alone, 200 maunds (16,000 lbs.) of ata (flour) before leaving Hunza, but some of this was to be sent up later; the Hunza authorities delayed the despatch of this convoy, and it eventually arrived within reach of two days' march, three weeks late, when the detachment had been on half rations for some days,

* Fig. 3 shows this country as seen from Kilik West H.S.

† Aneroid height, 19,300 feet; 1100 feet too high.

and had only four days' half rations left. Luckily the detachment did not realize that the depôt camp was empty. Again, towards the end of the season, owing to a promise from the Amban of Tashkurghan, on which we had been counting, and which he was unable to fulfil owing to the arrival of Chinese troops, we were again thrown on half rations for a fortnight, and eventually left with only four days' half rations.

On August 25, Mr. McInnes connected through to the two Kilik stations from the Indian series, and the connection between India and Russia was at last complete.

The chain connecting the Russian stations with those of the Indian Principal Triangulation near Gilgit, consists, as may be seen on the sketch-map (p. 667), of seven quadrilateral figures in which the diagonals were uninterrupted rays, two other four-sided figures in which a central station had to be inserted, and eleven single triangles. The number of stations, including those from which it emanates and those on which it closes, is thirty-three. The average height of the stations is 16,222 feet. The highest is Tong-i-tuk, 19,135 feet. This station was climbed by Mr. McInnes.

The average length of the sides of the triangles is 8637 miles, and the co-ordinates of the Russian stations as computed from the Indian side are—

	Height. Feet.
Russian west, lat. 37° 17′ 32″·97, long. 75° 00′ 12″·19	17,031
Russian east, lat. 37° 18′ 58″·92, long. 75° 04′ 41″·17	17,284

Besides the work of triangulation, Captain Hingston and I took a series of photographs on the extended stereoscopic base system, for the subsequent compilation of a map by stereo-photography, by the method devised by Captain Vivian Thompson, R.E. This cannot hope to be an absolutely complete map, as the topography had to be treated as of very secondary importance, and no reconnaissance was possible, but it is to be hoped that in addition to an accurate map of those parts photographed, much light will be thrown on the question of the easterly extension of the Northern Hindu Kush range. I do not believe that the Sarikol range extends south of the main Karachukar river, nor does it connect on with the Aghil range at all, and this range is possibly an extension of the northern Hindu Kush and old northern Karakoram ranges, the latter range having now been cut so much into granite blocks and isolated massifs by the headwaters of the Hunza river, that it has lost all appearance of a present-day range. Some observations were made of geological interest, and rock specimens were brought back from both Hunza and from the Pamirs by the detachment. These have since been classified by Mr. J. Coggin Brown, of the Geological Survey of India.

A Botanical collection was also made of all plants met with, but these comprised only 48 species, the Pamirs not being at all rich in flora. The collection is now being classified at the Royal Botanic Gardens, Sibpur,

Calcutta. It seems probable that two or three of the plants collected are of new species.

Captain Hingston also made a very complete zoological collection of the fauna of the Taghdumbash and of the district included by the road between here and Bandipur, which he is now working out, and in addition made a series of hæmatological observations at various altitudes ranging up to about 18,500 feet, which seem to throw some light on mountain distress. As regards the latter, the whole detachment was remarkably free from any ill effects from altitude, though loss of appetite was experienced after remaining at an average height of approximately 15,000 feet for two months with constant work on hand.

In addition to these results, Captain Hingston took a series of observations to cirrus clouds for the Meteorological Survey of India, as often as they were visible.

In conclusion, I have to record my deep indebtedness to the Hon. Mr. Stuart Fraser, Resident in Kashmir, to Major A. D. Macpherson, Political Agent at Gilgit, and to Sir George Macartney, His Britannic Majesty's Consul-General at Kashgar, without whose extreme kindness and sympathy, the work could never have been carried out; to Mr. H. H. Hayden, Director of the Geological Survey of India, and to Dr. Gilbert Walker, Director-General of Observatories, for their assistance and kindness; and lastly to my fellow-workers and faithful coolies, who never failed to lighten the work to the best of their power.

DR. F. DE FILIPPI'S ASIATIC EXPEDITION.

DR. F. DE FILIPPI sends from Leh, Ladakh, the following account of the scientific work from November 5, 1913, to March 31, 1914:—

A plan to make a gravimetrical station to the south of Skardu, on the range which girds from this side the Deosai plateau, was mentioned in the former report (*Geographical Journal*, January, 1914, p. 32). This was successfully carried out between November 6 and 17. The station was made at Wozel Hadur, a narrow terrace in the vale of Burgi La, at an altitude of 14,042 feet, beyond which it would have been impossible to pitch the tents, owing to the steepness of the ground and to the deep snow.

The pendulum observations were made in a large tent with three walls, which had been especially devised, and which answered the purpose very well. These were followed by the magnetic observations, and regular readings were taken of barometers and hypsometers, pilot-balloons were sent up, and determinations of the intensity of solar radiation were made with Ångström's and Abbot's pyrheliometers. In addition to the photographic work for topographical purposes, Lieut. Antilli took telephotographic panoramic views (on November 8 and 12) of the Karakoram ranges from a peak to the east of Burgi La, at an altitude of 16,600 feet.

Soon after their return to Skardu, Commander Alessio and Prof. Abetti established the local gravity station. Then followed a period of twelve days of wireless transmissions of time-signals from Lahore, which were received and registered simultaneously at Dehra Dun and at Skardu.* Star observations for the determination of time were taken before and after the transmission of signals.

The results of this first series of experiments, while good enough to allow a sufficiently correct determination of difference of longitude between Dehra Dun and Skardu, showed certain irregularities in the perception of signals, which appeared to be worthy of further investigation. These irregularities might be attributed to the type of receiver employed (carborundum crystals), or to special and varying conditions of the atmosphere in the regions traversed by the Hertzian wave, or to both these causes. The present expedition offers very exceptional opportunities for this research, because of the great variety of places, of distances, of topographical conditions, and of seasons in which it is bound to find itself in the course of time.

Therefore the observers have submitted to the competent departments of the Government of India a programme of extensive experiments to be made at different times and stations. It is hoped that these experiments, besides being fundamental in determining the differences of longitude between the said stations and Dehra Dun, may lead to some conclusions regarding the conditions which influence the wireless transmissions across vast mountainous regions. At the same time, in order to study the question from every point of view, a request was addressed to the Royal Hydrographical Institute of Genoa for Ducretet's electrolytical receiver. The latter has lately arrived to Leh, and the wireless station of Lahore has been instructed by the Department of posts and telegraphs to execute the whole programme of transmissions proposed, while the trigonometrical survey at Dehra Dun, with the usual favour shown on every occasion to the work of the expedition, has appointed some of its officers to cooperate in these researches.

The last weeks of 1913 were taken up with the astronomical observations for latitude and with the measure of a base line. The expedition is supplied with four invar wires for the measurement of the base lines.

During January, 1914, Alessio and Abetti were engaged in topographical work and in the determination of the daily magnetic variation. These were preceded and followed by observations on the absolute magnetic elements.

Meteorological records were regularly taken in Skardu by Marchese Ginori three times a day. Winter in Skardu has been on the whole less

* In the former report mention was made of the preliminary experiments carried on in this field during the month of October, 1913.

severe than might have been expected. Towards the end of December there was a short period of cold days when the thermometer registered + 1·9° Fahr. In January the temperature only fell to + 8·6° Fahr. The air was always absolutely still; snow fell at short intervals, but always in small quantity. The sky, especially in January, was mostly overcast, and the mountain crests were covered with mist and clouds, which considerably hampered the topographical work and the pilot balloon observations, as well as the determinations of solar radiation (pyrheliometers of Ångström, of Abbot and of Amerio).

The mild winter, the small amount of snow, and the absence of storms allowed Prof. Dainelli to make extensive geological excursions. During November he explored the basin of Skardu; in December he went up the Shigar valley and its two main branches, the Braldoh and the Basha valleys, and inspected the terminal portions of the Biafo, the Baltoro and the Chogo Lungma glaciers. Finally, in January, he went up the Shyok valley from its termination in the Indus valley to Biandong (Ladakh), and on his way back ascended the Saltoro and the Nubra valleys up to the glaciers. These explorations, and those made later on in Ladakh, will lead to a general discussion and to the modification of some of the prevailing theories about the geology of this district. Prof. Dainelli has also conducted systematic observations of the people, which will serve for an anthropogeographical study of the country, and to fix the character and the habits of the various ethnical types which it contains.

Among other things, these excursions of Dainelli proved how easy it is to travel in these valleys during winter, and encouraged the expedition to make an early start from Skardu. One more series of wireless time-signal transmissions was made between February 2 and 14, and immediately after, on the 16th, the expedition left Skardu, and, retracing its steps up the Indus valley, arrived on the 22nd at Kargil, situated in the Suru valley, 8790 feet above sea-level.

Four stages above Skardu, at Kharmang, the Indus was entirely frozen, and the ice was thick enough to allow horses and men to cross. These natural bridges occur more and more frequently higher up, and they make easy communications between villages of the opposite banks which are entirely isolated in every other season. Dainelli took advantage of this facility to explore a portion of the Indus valley between the confluence of the Suru-Dras and the confluence of the Hanu, which has been rarely, if ever, visited by travellers. This gave him a chance of collecting anthropological and social data of certain groups of Dard people which have here preserved unmixed their ethnical characters. These studies are now being extended to the Ladakhi people.

A halt of ten days was made at Kargil for the usual observations in gravity, magnetism, meteorology and aerology, and for another series of wireless transmission of time-signals. Here the lowest temperature was recorded on February 25 of 4° Fahr., and the heaviest snowfalls were

observed, due no doubt to the neighbourhood of the Himalayan range. On March 5 the expedition left Kargil during a heavy snowfall, and after crossing the Nawika La (13,000 feet) and the Fobu La (13,435 feet), arrived on the third day at Lamayuru (Ladakh). Here from the 8th to the 18th another set of geophysical observations and of wireless experiments was made.

Meanwhile, Prof. Dainelli, Lieut. Antilli and Marchese Ginori made a most interesting tour out of the beaten track through Ladakhi villages and monasteries, collecting many illustrations on the way. Lieut. Antilli has collected a considerable number of photographs, telephotographs, panoramas and cinematographs to illustrate the countries traversed by the expedition in regard to the scenery as well as to the social and religious manners and customs of the people. To these are to be added the photographs specially taken for topographical purposes, and for the geological and anthropological documentation.

The whole expedition was again collected together at Leh (11,280 feet) on March 22. Dr. De Filippi had arrived here twenty days in advance, to make the arrangements for transport. The supplies needed to feed men and animals from Leh onwards, and during the summer months in the Karakoram, had been collected in the preceding months. They amount to over fifty tons in weight, to which are to be added the provisions for the Europeans, the scientific equipment and camp baggage.

It is very fortunate for the present expedition that the old route from Leh to the Karakoram Pass, by the Khardong La, the Nubra valley and the Sasir Pass, which was hardly suited for loaded animals, and was only opened to caravans in July, has now been replaced by a new road, which crosses the Kilas range by the Chang La and then follows the upper Shyok valley to the foot of the Depsang plateau, where it joins the old track. The Chang La, although 18,366 feet high, is very easily crossed during the summer. At present, however, it is covered with deep snow, and a track had to be beaten through it by a large number of yaks and coolies, over which the transport caravans have begun to cross the pass. This is only possible thanks to the very exceptional endurance both of men and of animals.

Captain Gabriel, the Joint Commissioner for Ladakh, who resides in Kashmir during the winter, has very kindly lent the Residency Bungalow of Leh to the expedition. In the adjoining dak-bungalow the various laboratories have been installed, and near by are the meteorological, the astronomical and the wireless stations. All the usual observations are being made. The wireless signals are perceived unusually strong and distinct.

Prof. Dainelli left Leh on the 27th for a five-weeks' excursion up the Indus and the adjoining high plateaux. His object is to study the Rupshu Plains, and some of the typical closed basins, containing brackish lakes, such as the Tso Moriri and Pangkong, besides which he will have an

opportunity of making investigations on the Changpo, the nomad shepherds of the high lands.

After completing their work in Leh, Alessio, Abetti, and Ginori will also go up to the Rupshu Plains, to make pendulum observations at Moré, a station at an altitude of 15,427 feet. Here, in June, 1871, a gravimetrical determination was made by Captain J. P. Basevi, of the Indian Trigonometrical Survey. He died after two months, and the calculation of his observations led to results so peculiar that they were not generally taken into account, though giving rise to some very controversial theories. Therefore it is necessary that the determination should be repeated.

The usual work in meteorology, aerology and solar radiation will also be done at Moré. And the wireless station will also be put up with the view of investigating a possible new application of it. The results already attained in the determination of difference of longitude by the wireless transmission of time-signals, seem to justify the hope that the method, even in its present very simple form, may serve to determine the clock rate in the observations of relative gravity.

The second group of members of the expedition is expected to reach Leh by the end of April. It is composed of Major H. Wood, of the I. T. S., accompanied by two Indian Surveyors; Professors Marinelli, geologist and Alessandri, meteorologist, and Mr. J. A. Spranger, topographer. Prof. Alessandri, the Director of the meteorological observatory of Monte Rosa and of the meteorological station of the "Magistrato alle acque" of Venice, has replaced in the expedition Prof. Amerio, who was first enlisted, and has been unable to leave Italy.

It is hoped that all arrangements will be ready to allow the whole expedition to leave Leh early in March.

THE YALE UNIVERSITY AND NATIONAL GEOGRAPHIC SOCIETY PERUVIAN EXPEDITION.

By HIRAM BINGHAM, Director.

LAST month there sailed for Peru the topographical division of a new expedition. The chief engineer, E. C. Erdis, of the 1912 expedition, had sailed the week before. In a short time two more members of the expedition will sail, and as soon as the maps have been completed and are ready for use, the scientific members of the party will leave for the field. This will probably not be until early in 1915. As in 1912, the expedition is under the joint auspices of Yale University and the National Geographic Society. Unlike former expeditions, it will cover a period of two years, instead of being confined to one field season. Three members of the expedition, the chief engineer, the chief assistant, and the assistant topographer, will be in the field for a year and a half or more.