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THE HIMALAYA AS A BARRIER TO MODERN COMMUNICATIONS : *A paper read at the Evening Meeting of the Society on 4 November 1935, by*

PROFESSOR KENNETH MASON

(Sixth Asia Lecture)

THE title of my Asia Lecture was suggested by the growth of modern communications across Asia during the last ten or fifteen years, and by a feeling that it would be well to get our ideas clear on the question whether the Himalaya can be considered a barrier to communication in the immediate future, as it has been throughout historical times.

The position before the Great War was this: India, the "keystone of the Indian Ocean," as it has been called, communicated with the West and East by means of the two sea corridors, the Suez Canal and the Straits of Malacca, and to a less extent by South Africa and southern Australia. For her prosperity she looked seawards through her four ports, Calcutta, Bombay, Madras, and Karachi. A little trade trickled across her land frontiers—by Seistan and across the Khyber Pass on the backs of camels to Kabul and beyond, and an almost insignificant amount crossed the Himalayan passes to Chinese Turkistan and Tibet, on ponies, sheep, or yak.

North of the mountains of Central Asia, north of the Altai and Sayan mountains, north of the deserts of Mongolia, there was the great Trans-Siberian Railway, a single track, connecting Moscow, through Omsk, by Lake Baikal and Manchuria, with Vladivostok. At Samara a second line branched south-eastwards across the Kirghiz Steppe and by the valley of the Syr Darya to Tashkent, while the Trans-Caspian railway linked up Krasnovodsk, Merv, Bukhara, Samarqand, and terminated at Andijan. These last two were joined together south of Tashkent, and two important branch lines led southwards to Kushk and Termez on the Afghan frontier. They were mainly strategic, and it cannot be said that they carried a great deal of trade, either with Afghanistan or with Sinkiang. But from Russian Turkistan there was some rather primitive trade with Kashgar and Yarkand.

The disasters of the Russo-Japanese War of 1904–05, and the increasing


10°
40°
70°
100°
130°
160°
Miles
500
0
500
1000
Railways
Scheduled Air Routes
unscheduled
Land over 13,500 feet
C. Chelyuskin
London
Paris
Berlin
Warsaw
Vienna
Rome
Murmansk
Archangel
Leningrad
Moscow
Obdorsk
Aldan
Yakutsk
60°
Sverdlovsk
Tobolsk
Samara
Omsk
Novo Sibirsk
Krasnoyarsk
L. Baikal
Chita
Khabarovsk
Manchuli
Istanbul
BLACK SEA
Orenburg
Astrakhan
Great circle
KIRGHIZ STEPPE
Sayan Mts.
Irkutsk
Harbin
MANCHUKUO
Vladivostok
Semipalatinsk
Sergiopol
L. Balkhash
MONGOLIA
Tokyo
Aleppo
30°
Baku
CASPIAN SEA
Krasnovodsk
Tashkent
AlmaAta
Tien Shan
Urumchi
Hami
Jehol
Kalgan
Peiping
Dairen
Seoul
30°
Bukhara
Andijan
Samarqand
Kashgar
Yarkand
Soochow
Baghdad
Merv
Kushk
PERSIA
Basra
Great circle
AFGHANISTAN
Kabul
SINKIANG
Lanchow
Chengchow
Sianfu
Nanking
Shanghai
Medina
Srinagar
Great circle
Hanchow
Duzdab
Lahore
TIBET
Chengtu
Great circle
Changsha
Lhasa
Delhi
NEPAL
Jodhpur
Canton
Yunnan
Karachi
Allahabad
Hongkong
Calcutta
40°
70°
100°
130°

unsettlement at home, had called a halt to Russia's expansion in Asia, and a convention between Britain and Russia in 1907 had settled the outstanding questions of interest regarding the status of Tibet, Afghanistan, and Persia. Almost for the first time in history the two countries were working in harmony and cooperation in Asia, and in 1913, after three years of scientific collaboration, the trigonometrical surveys of India and Russia were linked on the Pamirs.

The reorganization of the Russian Empire after the revolution brought about great changes in Asia. The Imperial province of Russian Turkistan was split up into various Soviet republics, organized, it was claimed, on racial and ethnological lines. Plans for the self support of the U.S.S.R. meant, in theory at least, that each state of the Union should be developed according to its individual capacity, in order to contribute to the Union as a whole. The tendency has been to create industrial centres at the sites of raw material, rather than to bring the raw material back to old industrial centres in Europe. The growing industrial centres in Asia have brought in their train increased agricultural development. There is, in fact, a shifting of Russian effort from Europe to Asia, with a consequent need for the development of communications in Asia. This development has been considerably speeded up during the period of the "Second Five-Year Plan."

But, while Russia's grip over her own territory has been tightened, China's has been loosened over hers. Mongolia and Manchuria have broken away, one with the connivance of Russia, the other with the encouragement of Japan; and since the war until very recently, there has been little security or stability in Chinese Central Asia. In consequence, there has been little railway development except in the Russian and Japanese spheres.

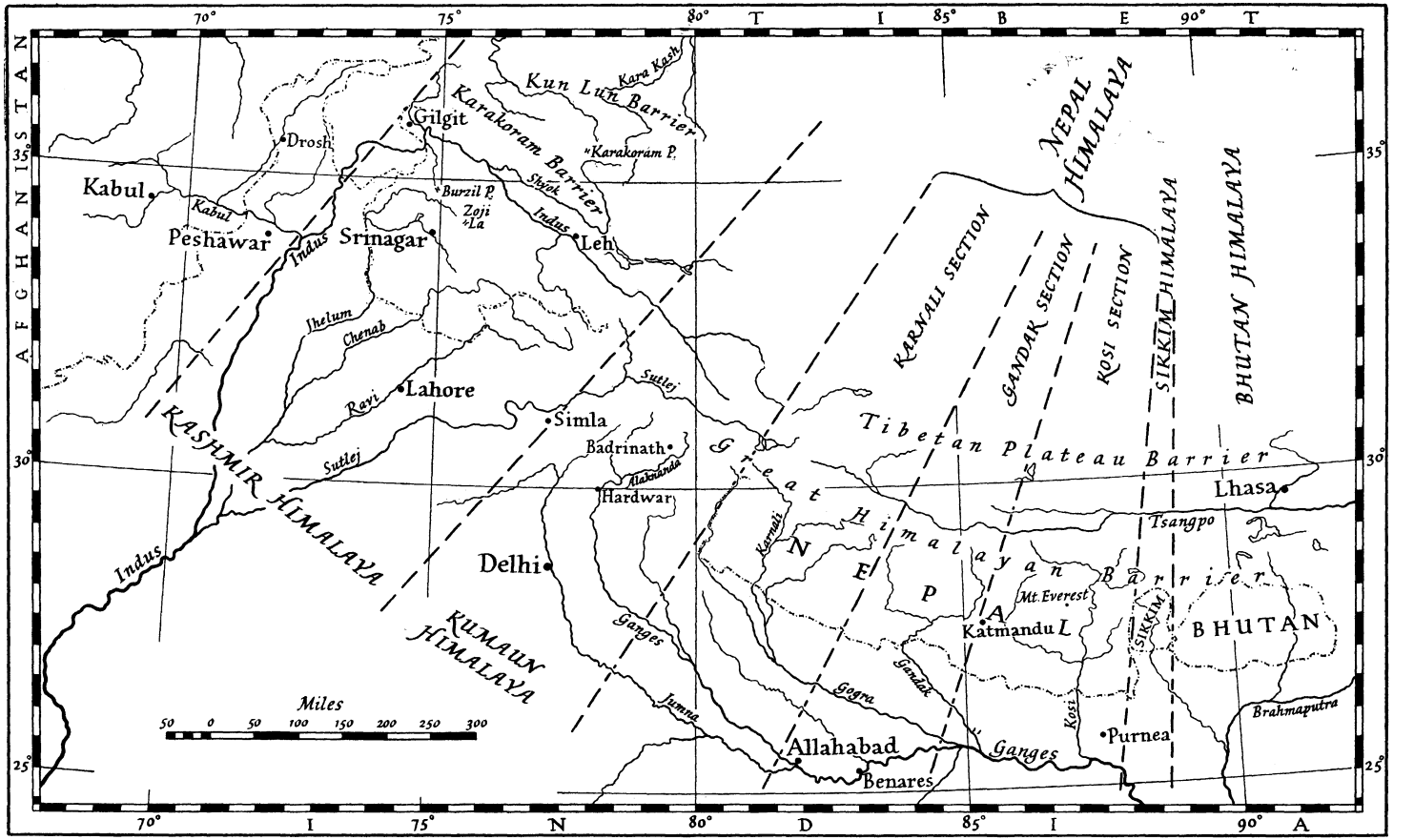
The most important railway connection that has been completed, the Turk–Sib line, links the Tashkent–Orenburg railway some miles north of Tashkent with the Trans-Siberian. It leaves the former at Aris, passes north of the Tien Shan and Issiq Köl to Alma Ata, not far from the Sinkiang frontier, and then northwards to the east of Lake Balkhash through Semipalatinsk to Novo Sibirsk. Certain small branches feel their way towards the Sinkiang frontier. The Trans-Siberian line has been double-tracked almost throughout its length, and other connections between the Trans-Siberian and Turk–Sib lines are under construction. To what extent these developments have been dictated by strategic motives, and how much has been due to economic requirements, it is not for me to say.

Now if we examine a map showing the important railways of Europe and Asia as they exist to-day, we notice the following points:

(1) India is supplied with a dense network of economic railways.

(2) Russia has three main lines stretching outwards to Central Asia, while behind her frontier with Persia, Afghanistan, Sinkiang, and Mongolia, she has a long line connecting the three main lines.

(3) For the rest, as far as Asia is concerned, railway development takes the form of rather insignificant pushings in from the coast. There is the Baghdad railway, still with a break between Nisibin and a point south of Mosul, with a difference of gauge in the two completed sections. The Persian line, under construction from both ends between the Caspian and the Persian Gulf, is


70°
75°
80°
85°
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35°
30°
25°
AFGHANISTAN
INDIA
TIBET
Kun Lun Barrier
Kara Kash
Karakoram Barrier
Karakoram P.
Gilgit
Drosh
Kabul
Kabul
Peshawar
Burzil P.
Zoji La
Srinagar
Indus
Leh
Shyok
Indus
Jhelum
Chenab
Ravi
Lahore
Sutlej
Simla
Sutlej
Badrinath
Alaknanda
Hardwar
KASHMIR HIMALAYA
KUMAUN HIMALAYA
Indus
Delhi
Ganges
Jumna
Miles
50 0 50 100 150 200 250 300
NEPAL HIMALAYA
KARNALI SECTION
GANDAK SECTION
KOSI SECTION
SIKKIM HIMALAYA
BHUTAN HIMALAYA
Tibetan Plateau Barrier
Great Himalayan Barrier
Lhasa
Tsangpo
Karnali
NEPAL
Mt. Everest
Katmandu
SIKKIM
BHUTAN
Gandak
Gogra
Kosi
Purnea
Brahmaputra
Allahabad
Ganges
Benares
TIBET

still a long way from completion. The Indian system, extended to the extreme west of Baluchistan during the war, to Duzdab, has not only moved no farther on, but the last section of 200 miles between Duzdab and Nokkundi was abandoned in 1932 as uneconomic. Meanwhile the road made fit for motors to serve the communications of General Malleson's force at Meshed has fallen out of repair. In eastern India the railway link between Assam and northern Burma has got no farther than the survey stage.

Nor has the unsettled state of China permitted the Nanking government to undertake much development, and except for activity in Manchukuo, there is nothing else to record. No important lines have been constructed south of the Great Wall. India has indeed constructed a railway through the Khyber, but otherwise she is as isolated as ever she was from the Russian and Chinese frontiers, for Afghanistan, Sinkiang, Tibet, and Mongolia, are still untouched by railways.

Since the war however many of our old ideas regarding isolation have undergone modification owing to the development of motor and air transport. Seas and deserts, in particular, have almost ceased to exist as barriers to movement, while several of the larger mountain ranges of the earth are crossed regularly by scheduled air-liners. The Rockies, the Andes, the Atlas, and the Alps, are all crossed by mail planes, while the Syrian desert and the Sahara are regularly traversed by motors and by aircraft. In many parts of Africa motor-road development is largely superseding railway construction, for with suitable restrictions during the rainy season such roads are much less costly to maintain.

In Asia also there has been development. A regular air service exists from Moscow to Irkutsk near the south-west end of Lake Baikal, taking the course of the Trans-Siberian railway, and but for political considerations, would be doubtless extended to China. Indeed, it is possible, with permission, to charter a plane and travel from Irkutsk to Manchuria and Peiping, and even from Sergiopol across Sinkiang, by Urumchi and Hami, to Lanchow, the terminus of a fairly regular service in China. From various points of this trans-continental air-line, it is also possible now to fly to distant points in the north; but at present there is insufficient traffic for regular services.

India, too, is becoming air-minded. I look back with mixed feelings to twenty-five years ago, when in December 1910 the first plane seen east of Suez arrived at Allahabad and began what were optimistically called "joy-flights." The machine was a Sommer biplane, of the pusher type, with rotary gnome engine. The receipt for payment of my flight was numbered "4," which means, I think, that I was the fifth person to fly in India. The machine had no fuselage, and before climbing on to what was called the pilot's seat on the bottom plane, my friends shook me warmly by the hand and said "good-bye." Pequet, the pilot, tucked himself between my knees, and we managed to get up to about 500 feet. This plane carried the first authorized air-mails in India, and I believe, in the world, in January 1911. Letters posted on the aerodrome were handed to the pilot, who flew them to a small special post-office, where they were taken over by the normal service.

Since the war India has of course become linked by air with Great Britain and Western Europe, and there are now three lines which control the regular

services across India: Indian Trans-Continental Airways, a subsidiary of Imperial Airways, and the French and Dutch lines, Air France and K.L.M.

I.T.C.A. runs two services a week in each direction between Karachi and Singapore: Karachi, Jodhpur, Delhi, Cawnpore, Allahabad, Calcutta, Akyab, Rangoon, Bangkok, Alorstar, Singapore. An Australian line connects Port Darwin with one of these bi-weekly services at Singapore, and Port Darwin is connected with various parts of the Australian Commonwealth. In his very interesting report last week on the development of Imperial Airways, Sir Eric Geddes stated that the Singapore–Port Darwin service would shortly be doubled, and that with the aircraft now under construction India would be reached in three days, and Australia in seven.

Air France runs one service a week in each direction between Paris and Saigon, and K.L.M. two services a week in each direction between Amsterdam and Batavia. Both these lines fly direct from Jodhpur to Allahabad, but otherwise take the same route as I.T.C.A. across India.

There are two regular feeder services running in connection with I.T.C.A.: (1) Karachi, Sukkur, Multan, Lahore, twice a week in each direction, operated by Indian National Airways; and (2) Karachi, Ahmedabad, Bombay, Hyderabad, Madras, twice weekly by Tata, Ltd. This is shortly being extended from Madras to Colombo. Both feeder services are operated with small single-engined aircraft and are run principally for mails; they only occasionally carry passengers.

That, I understand, is the position as it is to-day, or as it was at any rate a month ago. A firm called the Himalayan Air Transport and Survey, Ltd., has been carrying pilgrims from Hardwar to Badrinath, well in the hills on the Alaknanda tributary of the Ganges, and there is some talk of making this a scheduled service at certain periods of the year. Indian National Airways have also submitted proposals for a service between Lahore and Srinagar in Kashmir. Experimental flights have been carried out, and I learn from India that Srinagar's new aerodrome was opened on September 2. According to my information, the plane that flew the journey on that occasion left Delhi at 6 a.m., stopped for half an hour at Lahore, and reached Srinagar at 11.20 a.m.

These two embryo services are not of course the first occasions when planes have flown over or into the Himalaya. As long ago as 1925 I can remember R.A.F. planes flying over the Ridge at Simla during the King's Birthday parade, and they may have done so earlier. On 28 March 1929 a flight of four R.A.F. Wapiti aeroplanes flew from Risalpur, by Chakdara and the gorge of the Indus to Gilgit, and since that date the R.A.F. have, I believe, carried out the Gilgit flight with service planes regularly once a year. Along the Indus gorge the planes travel at about 12,000 feet, that is about 10,000 feet above the valley bottom, while the mountains rise in places on either hand in stupendous precipices of 15,000 feet. In 1932 a flight of five Hart machines completed the journey of 286 miles in two hours twenty minutes, passing close to Nanga Parbat.

In India also there are private flying clubs and a very enterprising Air Survey Company. Flights for police and other purposes have become a regular routine on the N.W. Frontier, while most of you will recollect the very fine performance of the Royal Air Force in evacuating the staffs of the various

R.A.F. planes passing Nanga Parbat, 17 Oct. 1932

Over the Indus valley by Shatial

legations at Kabul during the insurrection against King Amanullah in 1929. It is extraordinary how quickly the inhabitants get used to aeroplanes. In 1929 the Mirs and chiefs of the Gilgit Agency were uncertain whether it was great daring or gross sacrilege to approach an aeroplane upon the ground. In 1933 the enterprising Mehtar of Chitral flew over the North-West Frontier hills to his new aerodrome at Drosh. The only other flight that need be mentioned at this stage is the spectacular Mount Everest Flight in the same year.

On the far side of the Iranian plateau, beyond the Hindu Kush, there is, I understand, no regular scheduled air service between Moscow and the Soviet Republics of Turkistan; but there are no physical obstructions to flying, there are landing facilities at most of the large towns, and Soviet officials use the air a good deal in the course of their duties. Nevertheless, no one has yet flown overland to India from Soviet Asia over the mountain barrier. Kabul has been reached by air from beyond the Soviet and the Indian frontiers; but no one has completed the through journey, and no one has yet thought it worth while to attempt any other route.

If we examine the state of motor-road development, we find much the same state of affairs. On both sides of the mountain barrier good roads have been constructed. In a few instances surveys have been made for extensions of such roads farther into the hills; but no one has yet succeeded in getting wheeled traffic across the whole barrier. In this connection you may remember the effort made by the Haardt Expedition in 1931–32. Of the seven light six-wheeled caterpillar-tractors which left Beirut, and which reached India by way of Herat, Kandahar, Kabul, and the Khyber, two only succeeded in reaching Gilgit, and one of these managed to get a few miles farther. I use the words "succeeded" and "managed" advisedly, for the journey took considerably longer than it would have taken to crawl the whole distance on all fours, the cars had to be winched and jacked round many of the bends, and at one point they had to be entirely dismantled and carried across a bad stretch of the track on the backs of coolies. An officer who met the expedition on the Gilgit road told me that one of the party walked backwards in front of the cars to insure that they did not go over the precipice into the Astor river below.

This examination of the present position leads me to observe that a map of Asia showing air routes for scheduled and unscheduled flights, roads fit for motors, and existing railways, is no certain guide to what may be possible in the future. The extension of air-routes throughout the world has been mainly due to private enterprise and individual daring. But such enterprise can only be fully effective if all countries are sympathetic to intercourse by air. When therefore we see on such a map the lack of modern communications across the northern frontiers of India, we have to take into consideration the political factor as well as the physical barrier.

Let us consider the political factor. Flying over the states bordering India is prohibited by the governments of those states, and we respect their wishes. Afghanistan has a small air force of her own which flies within her frontiers, but on this sector of the Indian borderland no one is permitted to fly from one side of the boundary to the other. Tibet, Nepal, and Bhutan have no aircraft and want none; their rulers are definitely averse to Europeans entering their countries at all. Permission to fly over them in existing circumstances is

almost impossible to obtain, and has only been given once by Nepal and never by the other two.

China is, as we should say in the West, more "progressive." Assuming, then, that China and her loosely controlled province of Sinkiang might possibly be willing to permit flying over the latter country, the only routes across the Himalayan frontiers of India must lie between the North-West Frontier hills and the western boundary of Nepal. The whole of the rest of the Himalayan frontier is enclosed by Tibet on the north. This sector west of Nepal contains the state of Kashmir, whose Maharaja is sufficiently air-minded to fly out to India by Imperial Airways, and thence by private plane to Srinagar.

So much for the political considerations. Before considering in detail the best lines for air travel across the Himalaya, irrespective of those considerations, I will draw attention to certain governing factors of air travel. And here, being no expert, I must be subject to correction. I am told that, though it is possible to land with a light load at 15,000 feet, it is much more dangerous, if not impossible, to take off above that altitude. Aeroplanes presumably could be designed for the special purpose of high altitude landing and taking off, but such planes, I understand, would not be so handy at lower levels. Flying over mountainous country for long stretches is very much more difficult than over lower and more populous levels. An air-route over mountains covered in snow or clothed in forest is difficult to identify from the air, and the lack of obvious landmarks makes it difficult to keep to a definite course; engines develop trouble more easily at high altitudes; storms and cloud, with consequent bad visibility, are more frequent; and forced landings may be most common where the ground is least suitable. In mountainous country wind currents are more variable, while, if one attempts to avoid them by flying at great altitudes, additional oxygen and special warming apparatus for man, machine, engine, fuel, and instruments are necessary, and add considerably to the cost.

Neglecting political considerations, let us now consider the shortest routes by air between London and India. Bombay is roughly half-way on a great circle course between London and Perth in Australia. There may come a day when it will be possible to fly that course in twenty-four hours, stopping for lunch at the Gateway of India. But the day is not yet. The great circle course between London and Bombay would approximately take the line London, Cologne, Sebastopol, Batum, Tehran, Seistan, Karachi. That course itself would shorten the journey to Karachi by more than a day even at present cruising speeds. The great circle course between London and Calcutta would be farther north: London, Berlin, Warsaw, Kiev, Astrakhan, and a little north of Bukhara, the Khyber, Delhi, Allahabad. Its continuation would be to Rangoon and Bangkok. It will be observed that neither of these two great circle courses passes over the high Himalaya. Nor would a great circle course from Tokyo to Calcutta pass over them. Nanking and Hankow would be on such a route and it would enter India a little south of the Lohit branch of the Brahmaputra. It seems to me that for long distance air-routes such as these, multiple-engined air-liners of special construction could be designed to make the journey without excessive risk, always provided the

political considerations were favourable. Judging by what has already been accomplished, the routes Batum, Tehran, Duzdab, Karachi, and Astrakhan, Bukhara, Termez, Kabul, Peshawar, are quite practicable.

With the Himalaya however the problem is different. The distances over the mountains are considerably greater, the altitudes much higher, the country much more rugged, and beyond the Himalaya there is either the additional broken country of the Karakoram, or the wide 16,000-foot plateau of Tibet. Even these are not the end of difficulties. The Kun-Lun forms a further obstacle, while either the Pamirs or the uninhabited Taklamakan desert, as well as the Tien Shan have still to be crossed before the main artery of Asiatic communication is reached. The shortest distance between the existing trans-Indian and trans-Siberian air-routes is about 1800 miles of this difficult country, though the Turk-Sib line at Alma Ata, the railway centre near Lake Issiq Köl and the Sinkiang frontier, is only about 1000 miles from Lahore. It may be that, with the gradual shifting of the economic centre of the U.S.S.R. to the region of Omsk in Asia, some such long distance connection will become advisable. When I look back to the developments of the last twenty-five years I cannot help feeling that it will certainly become possible.

But perhaps I should confine myself to what would be practicable at present, if it were not for political considerations, and I propose now to examine the barrier by itself in some detail. I need hardly remind you that the existing method of transport is by pony, yak, sheep, or man, and that very few of the land routes are open for more than six months of the year. There are high snowbound passes and profound gorges to be traversed. Some of the less important routes are full of difficulties, the rivers being unbridged or only crossed by rope suspension bridges. In the densely forested east the track may be taken along the hillside on bamboo platforms. In the drier regions of the west the track may climb over the barren precipices 1000 feet above the rivers. Travelling off the main trade-routes is still primitive, and I for one hope that it will long remain so.

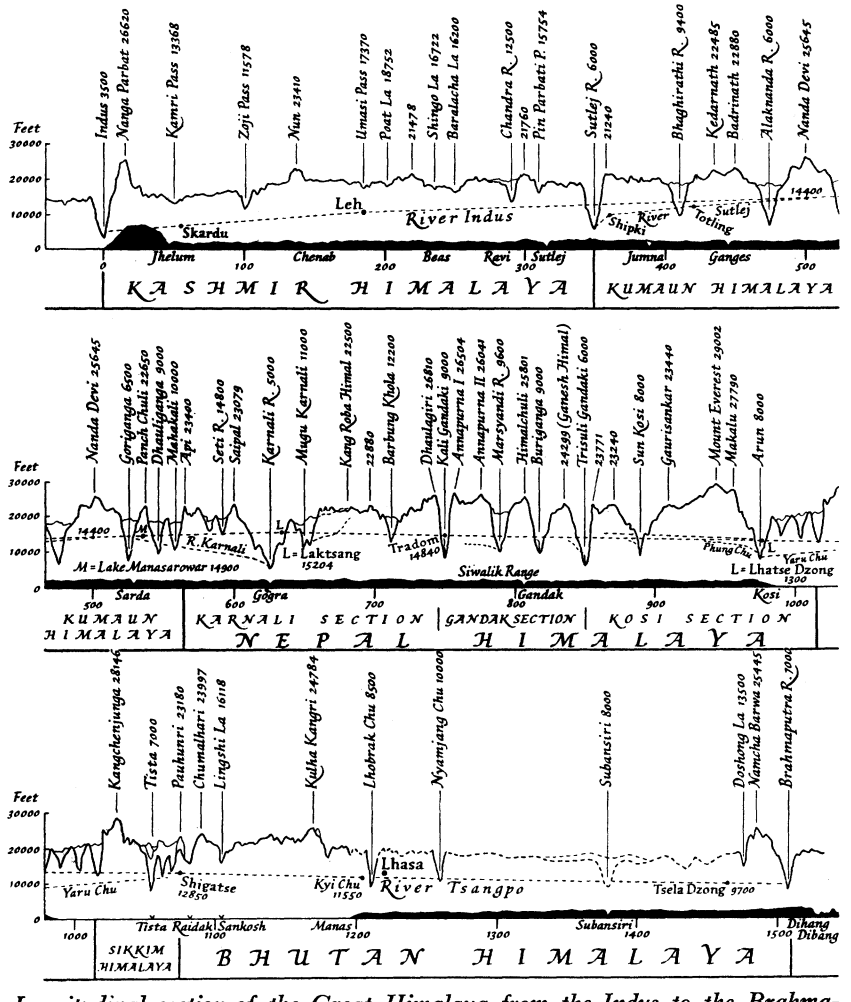
It is usual for geographers to divide the Himalaya into three zones: the outer Himalaya, comprising the low Siwaliks and the *Duns* behind them; the Lesser Himalaya, made up of the eroded ranges and ridges north of the Siwaliks; and the Great Himalayan zone which contains the great peaks. The distance in a direct line from Lahore to Kashgar is about 600 miles, and from Calcutta to Lhasa not much less.

At a few points the Siwalik zone is entered and crossed by railways, as, for instance, at Hardwar, where the Ganges breaks through the range; and at two points, Simla and Darjeeling, the railway climbs laboriously up to the outer edge of the Lesser Himalaya. The outer zone is crossed at many places by modern motor roads, and it cannot be said to present obstacles to aircraft.

The general altitude of the hills of the Lesser Himalaya varies from 7000 feet to 15,000 and even 16,000 feet. Within it there are certain open valleys, which are considerably lower. The Vale of Kashmir, north of the 15,000-foot Pir Panjal, is at 5000 feet; Katmandu, in the valley of Nepal, is at 4200 feet. As I have already stated, aircraft have already landed at Srinagar and at Badrinath in the Alaknanda valley, in the Lesser Himalayan zone. This zone is undoubtedly practicable for aircraft by certain routes, and at certain seasons

of the year; though landing-grounds would have to be prepared with more than ordinary care, and emergency landings, except in a few open valleys, would always be dangerous.

As regards motor roads, there are two good routes to the Vale of Kashmir, and motors can reach most of the Himalayan hill-stations. Some of these



Longitudinal section of the Great Himalaya from the Indus to the Brahmaputra. Horizontal scale in miles measured approximately from the Indus

roads have been extended farther into the hills, as for instance to Kulu, where there is some economic justification. They are however constantly liable to interruption by landslips and are costly to maintain. Undoubtedly roads, such as the Treaty High Road, between Srinagar and Leh by the Zoji La, or the Hindustan–Tibet Road through Bashahr, could be made fit for motors and kept open for some months of the year; but it is difficult to see how they

could be economically justified in view of the small amount of trade, and the heavy snowfall during the winter months.

Nevertheless it is the Great Himalayan zone that presents the most formidable obstacle. This forms a great barrier averaging 40 or 50 miles wide, with a double and sometimes a treble crest zone of peaks. Except in Kashmir, where the average elevation of the range is about 17,000 feet, the average altitude is roughly at 20,000 feet, with many great massifs rising to 23,000 and even 25,000 feet. A longitudinal section of the range shows that where it has a high average crest altitude and many higher mountain groups, it has been cut into blocks by deep gorges, while towards the extremities, in Kashmir, and probably in Bhutan, where the general altitude is lower, the carving of the great range is less marked. It is in fact a very noticeable fact that the highest mountains are closely associated with the deepest gorges, especially in Nepal. In Eastern Nepal, Sikkim, and Western Bhutan, the outer Himalaya have been entirely eroded away, the Lesser Himalaya have been very largely destroyed as ranges, and the watershed of the Great Himalaya has been driven back into the Tibetan plateau.

These points are, I think, obvious from the section that I have drawn from large-scale maps. I have shown the mountain blocks and the river gorges to scale. In general, it is by these breaks in the main range that the limited communication between India and Tibet, or Nepal and Tibet, takes place. In Kashmir, where there are no such gorges between the Indus and the Sutlej, caravans make use of passes over low depressions in the range.

The most important routes from west to east cross the Great Himalaya at the following gaps:

From	*To*	*At*	*Height*
Srinagar	Gilgit	Kamri pass	13,368
		or Burzil pass	13,775
Srinagar	Leh	Zoji La	11,578
Simla or Kulu	Leh	Baralacha La	16,200
Simla	Shipki	Sutlej valley (H.T. road)	*c.* 6,000
Tehri	Totling	Bhagirathi valley	*c.* 9,400
Garhwal	Totling	Alaknanda valley	*c.* 6,000
Almora	Gyanima	Goriganga valley	*c.* 6,500
W. Nepal	Laktsang	Karnali valley	*c.* 5,000
Central Nepal	Tradom	Kali Gandaki valley	*c.* 9,000
E. Nepal	Lhatse and Lhasa	Sun Kosi valley	*c.* 8,000
E. Nepal	Lhatse and Lhasa	Arun valley	*c.* 8,000
Sikkim	Shigatse and Lhasa	Tista valley	*c.* 7,000

I do not mean to infer that these are the highest points reached by these routes, but merely the altitudes at which the Great Himalayan axis is crossed.

Considering the very high altitudes that aircraft would have to fly to clear the range itself, it is interesting to examine the possibility of using these valley routes. Valley routes have certain advantages as well as disadvantages for air travel. Among their advantages I would put the comparative ease of identifying the route; the lower altitude of the flight; the finer weather, owing to local rain-shadowing; the greater likelihood of suitable ground for forced

landings. The disadvantages seem to be the danger from air pockets and shifting winds, and the consequent danger of hitting the mountain side if visibility is bad. Applying the advantages and disadvantages to the different valley routes enumerated, I would put the Sutlej and the Karnali as the most suitable routes for air travel, then the Alaknanda, the Arun, the Tista, and possibly the Sun Kosi, while I would rule out the Bhagirathi, the Goriganga, and particularly the Kali Gandaki, as dangerous. In Kashmir there seem to be no great objections to the Kamri, the Burzil, or the Zoji La. Unfortunately, in the Kashmir section, where the Himalaya is lower, the real obstacle comes from the ruggedness and altitude of the Karakoram range north of it. From Gilgit the Karakoram can be turned by the course of the Hunza valley; from Leh, less easily by the upper Shyok and the Depsang plains. It is just possible that a forced landing here might not be fatal, though it would have to be made at a high speed; but it would be much too high with existing designs of aircraft for a successful take-off again. The main mass of the Karakoram should most certainly be avoided.

In view of what I have already said regarding rail and motor possibilities in the Lesser Himalayan zone, it would be superfluous to discuss such development across the Great Himalayan zone in detail. But there is one point which is important. Roads fit for motors could be constructed across the plateaux of Tibet and the Pamirs to the northern foot of the Himalaya or Karakoram without any great difficulty. It is the actual gorges through the range and the weather-worn southern flanks which form the most formidable barrier to motor traffic. Such roads across the high plateaux would however never be economically justified.

I have left the question of weather to the end. The Himalaya forms an almost impassable barrier to the south-west monsoon. Beyond it we get the clear atmosphere of Tibet. I believe that no one in their senses would attempt to cross the Lesser Himalaya by air during the monsoon period from say June 20 until mid-September, except perhaps in a multiple-engined air-liner with a ceiling of 40,000 feet, with everything and every one artificially warmed. The monsoon is a low-altitude current and the clouds break against the mountain sides. In the eastern Himalaya the monsoon is particularly heavy and prolonged. At Darjeeling, for instance, the average rainfall for the four months from June to September, taken over a period of thirty-eight years, is 102 inches. Eighty-eight days in these four months are wet, and visibility is generally bad on the remaining days. The highest summits might be clear, but they would be like islands in an ocean of cloud. I need not stress the dangers of attempting to cross such a country at such a time.

The other period of unsettled weather is due to "western disturbances," beginning towards the end of December and lasting in the high Himalaya of Kashmir as late as the beginning of May. It is these disturbances that recover the Himalaya with snow. In March and April it is usual to have spells of five fine days between spells of bad weather. The intervening periods, from early May to June 20, and from the end of September to mid-December, are generally fine and present good flying weather. November is the finest month throughout the Himalaya. Visibility is then about as perfect as any pilot could wish for. There are more wet and cloudy days in the period May–

June, before the monsoon breaks than after it is over, but when fine, visibility is good and the temperature is less exacting than in November. The outer ranges, such as the Pir Panjal, of course, do rain-shadow the valleys to the north to some extent, and the published figures for stations in the Vale of Kashmir seem to indicate that the monsoon is largely ineffective here. This is however not so; for while the amount of rainfall is effectively diminished by the outer ranges, the actual number of wet and cloudy days is still considerable even in the valleys, while the surrounding hills are much worse off than the lower stations. I remember years ago, on the false assumption that the greater part of the monsoon rainfall was precipitated on the outer hills, and that the inner hills could be relied upon for generally fine weather, we attempted to carry on our survey throughout the monsoon period. It turned out that not one day in six was fit for work. Beyond the Great Himalaya it is a different matter altogether, but the airman has to get there first.

I could enlarge further on the physical obstacles to communications across the Himalaya and describe the difficulties due to forest growth, landslides, avalanches, and the rest of Nature's mountain armaments. But I have said enough. Whatever the future brings in the way of surprise, it seems to me that the Himalaya will always remain the pedestrian's paradise. Motor roads and railways have been developed as far as they are economically justified; we want no more of them. Political and physical obstacles combine with technical difficulties to prevent air development across this barrier; I thank God for that! And until we can cross it in artificially warmed, multiple-engined air-liners, with a ceiling of 40,000 feet, in one "hop" of 1000 miles or so, I see no prospect of air development. And I am glad that it should be so.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: The lecture to-night is the Sixth Asia Lecture. The last was delivered in March 1934 by a missionary lady, Miss Mildred Cable, on her experiences in Dzungaria. To-night Professor Mason is to lecture to us on "The Himalaya as a Barrier to Modern Communications."

The Asia Lecture, I would remind you, was endowed by the Rev. Livingstone Dickson to provide a lecture every second year on some subject of general interest appertaining to Asia: and we are very glad to have Mr. Dickson with us to-night.

Professor Mason needs little introduction to any one in this audience. He was for many years in the Survey of India. He has a thorough knowledge of the Himalaya from all points of view: as a climber, explorer, and surveyor. You could hardly have a better combination for speaking with authority on any subject connected with the Himalaya.

As to the question of a barrier to communication, I first went to India half a century ago, and I remember that in those days we regarded the Himalaya as an absolute barrier to the possibility of a Russian advance towards India. We shall hear from Professor Mason how he regards that aspect of the Himalaya under modern conditions. They have changed greatly.

Professor Mason then delivered the lecture printed above, and a discussion followed.

The PRESIDENT: Sir Francis Younghusband is here, and to us he is the father of the Himalaya. I remember fifty years ago, nearly, when he came across from

China, what a stir it created among his young comrades in India. I will ask him to speak.

Sir FRANCIS YOUNGHUSBAND: As I listened to the lecturer it struck me that he was talking against the grain the whole way through. He was talking about flying across the Himalaya when all the time he was longing to be walking across it. It was only in the very last sentence, when he said that the Himalaya was the pedestrian's paradise that his true heart came out. Very fortunately for me I was a pedestrian, and am now, and crossed the Himalaya eleven times from the plains of India to the plains of Turkistan, or the Pamirs, or to Tibet, and back, and I should agree with the main conclusion of Professor Mason, that while that barrier is fairly easy of access from the north it is always on the south that you get the real difficulties, either having to cross high passes or go through the most tremendous gorges. I should imagine the best way in the future would probably lie through the Hunza valley. Terrific gorges would be met with, but they can be negotiated, and it is the nearest way to Central Asia. By the Karakoram is a long way round, and you have to cross some very high passes.

I know nothing at all about flying, but I was wondering, as I listened to the lecture, whether those new machines, the autogyros, would be in future, perhaps, of more use than ordinary planes when flying up those valleys.

Then there is a little detail—I do not know whether it is worth mentioning. The lecturer spoke about the rivers cutting through the Himalaya. It is very noticeable that some of the greatest rivers rise on the northern side of the Himalaya—the Brahmaputra and the Indus, the Sutlej and the Arun—and find their way through the barrier, and it may be that the river is older than the mountains. It may not be that the river started first and cut its way through the mountains, but that the mountains have gradually risen on each side of the river.

As regards the economic worth of any route through these mountains to Turkistan or Tibet I would imagine there was very little to be gained. As the lecturer has said, there could never be very much trade between the plains of Turkistan and the plains of India. So I would agree with him in what he said as regards the economic worth of any routes that way.

I conclude by congratulating Professor Mason upon having recovered his real heart at the end of his lecture. I hope he will always keep it.

The PRESIDENT: We have Mr. Ruttledge with us, whom we hope is going to the Himalaya. Perhaps he will come and say a word or two.

Mr. HUGH RUTTLEDGE: It is a great privilege for an ordinary pedestrian to be allowed to follow that most distinguished pedestrian, Sir Francis Younghusband, in congratulating his old school-fellow and fellow-pedestrian, Professor Mason.

I think it is pretty clear from Professor Mason's lecture that the crossing of that great barrier is very difficult in nearly all places except the old, traditional route up by the North-West Frontier. The parts that I know slightly are the Central Kumaun Himalaya and the eastern end. Personally, I should be very sorry indeed to try to fly up through those gorges of the Kumaun Himalaya. I daresay Professor Mason would not mind because I saw him go up on those early flights at Allahabad and I know he risked his life during the few moments he was up. The wind, what is called locally "Ráni ka punkha," in the Kumaun gorges is simply terrific. I do not think you would have the slightest chance if anything went wrong with your plane. I daresay you could get up at the eastern end, by the Chumbi Valley, but it does not seem to be worth it. The only places that will be worth coming down through, I think, will be on the west, but I naturally hope the day will be far distant when the combustion engine replaces

the homely yak and those gallant, simple people of the hills with whom it is such a privilege to associate.

The PRESIDENT: Sir Percy Sykes, would you be so good as to speak to us for a few minutes?

Sir PERCY SYKES: Professor Mason has looked at the Himalayas more or less from India. I have looked at them on the other side, on the north, from Kashgar and Yarkand. When I was there some twenty years ago I do not think we had ever heard of aeroplanes in the country, but goods were sent by pony caravans over the Himalayas to Ludakh and India. The big range across which lay the route was called the Karakoram. It was known among us as the "Ridgepole of the World." The range was only open for about five or six months in the year, and a variety of goods were carried across it: a certain amount of jade, a certain amount of hemp, and a certain amount of silk. In return the traders brought back Manchester goods, and sugar, tea, and so forth. On the whole, the natives bravely faced the difficulties of the route and were certainly practical. For instance, it is very cold in that part of the world, and they always very kindly gave the sheep overcoats when they marched them, and in order to make the coats quite warm they filled them up with borax, which is one of the exports; so they really are very practical people.

As to flying, of which we have heard a great deal, there is one thing which Professor Mason has not told us, namely, that in Chinese Turkistan, where I do not think he has been, the loess in the atmosphere makes it absolutely impossible to see more than 200 or 300 yards, which rather knocks a multiple-engined aeroplane, or any other type. I once travelled through Kashgar, Yarkand, and then to Khotan, where there is a huge range, the Kun-Lun. I noticed in reading Marco Polo that he never mentioned the existence of that range. I went along it to Khotan and I never saw it either, the reason being that the loess rendered the whole range invisible, and that is the case practically all the year through. This fact, I think, is rather against flying in that part of the world.

I may add that when my sister and I mounted the Pamirs, the "Roof of the World," I had the pleasure of meeting the Russian Survey Officers, who had completed the triangulation with the British, and I must say they had the greatest admiration for our lecturer and the very fine achievement by British officers of that very difficult piece of work.

Finally, may I say a word about Persia, namely about the railway there? The railway is not quite as Professor Mason said. It has been started from Khor Musa, an inlet situated at the top of the Persian Gulf into the interior from that end, and it is also making very good progress from the north through the main Elburz range. It is expected that it will be finished in about four or five years' time.

We have heard an extraordinarily valuable lecture and, as it deals with a part of the world in which I have spent most of my life, it has been of special interest to me.

The PRESIDENT: I do not know whether there is any Air Force officer here who would care to comment on the air aspects of the problem? Apparently not.

It only remains for me to sum up. I am sure that you will agree with me that we have had a most instructive and a most efficient lecture. I do not think the problem could have been more lucidly stated nor any illustrations more apt than those shown by Professor Mason.

Not being an airman, I know little about air possibilities, but it seems to me that pending the invention of an autogyro or helicopter it would be quite impossible to negotiate the Himalaya for any commercial purpose by aeroplane.

I will not detain you further. I only ask you to join me in thanking Professor

Mason for his very fine lecture. He must have spent an infinity of time and trouble to prepare such an efficient and satisfactory discourse. I ask you to join me in thanking him most warmly.

Editor's Note.—During the course of the discussion the point of the correct pronunciation of the word "Himalaya" was raised. This has already been discussed in the *Journal* (vol. 84, p. 395), and it has therefore been considered unnecessary to include the discussion here. No new facts were produced and no conclusion reached.

THE MOUNT EVEREST RECONNAISSANCE: *A paper read at the Evening Meeting of the Society on 2 December 1935, by*

ERIC SHIPTON

WHEN last spring the Mount Everest Committee received the permission of the Tibetan Government to launch another attempt on the mountain they were faced with an unusual situation. The permission to operate in Tibet covered a period of a year from June 1935 until June 1936. It was too late in the year for a pre-monsoon attempt on Mount Everest, and yet it was obviously a pity not to utilize all the available time.

There has been a very considerable body of opinion which held that the correct time for an attempt on Mount Everest was during or immediately after the monsoon, and there was much to be said in favour of this view. Probably the most serious and dangerous obstacle climbers have met with on the mountain has been the terrible north-west wind which is such a constant menace before the breaking of the monsoon. When the monsoon winds are established this obstacle is removed and there follow some months of comparatively calm and warm weather. Weather conditions indeed are then ideally suited to prolonged siege tactics such as those employed with such remarkable success by the Bavarian expedition on Kangchenjunga, tactics which would be quite impossible to employ on Mount Everest before the monsoon. But unfortunately the heavy snow which falls on the mountain during the monsoon makes a fresh obstacle about which we had very little data. It was known that the snows which fall in the earlier part of the monsoon would consolidate readily on flat glacier and on the great fluted ice ridges of the Himalaya, but we were by no means certain about the behaviour of the snow lying on extensive faces at altitudes above 23,000 feet. The disastrous avalanche on the North Col in 1922 and the impasse with which the Bavarians on Kangchenjunga were faced as soon as they left their ridge in 1931, were indications that monsoon snow at great altitudes formed at least a temporarily impassable barrier. Whether or not there occurred any time during the warm monsoon period when this snow was in a manageable condition was a question badly in need of an answer.

Therefore the Committee decided to send out a reconnaissance expedition with the following objects in view:

1. To collect data about monsoon snow conditions at high altitudes and investigate the possibility of a monsoon or post-monsoon attempt. This necessitated our remaining in the vicinity of the mountain during the whole period of the monsoon.

2. To examine the possibility of alternative routes from the west. Two had been suggested: the north-west ridge which rises from the head of the Central Rongbuk glacier; and the practically unknown Western Cwm which is really a tributary of the valley which contains the Khumbu Glacier.

3. To report on the present ice formations on the North Col. This would be of use in deciding what apparatus will be necessary for the main expedition next year.

4. To try out new men as possible candidates for the main expedition and to secure for them preliminary acclimatization.

Telephoto from Nyonno Ri range. Lhotse, Mt. Everest, N. Col, Changtse (N. Peak); Khinge in foreground

The Western Cwm and Nuptse

5. To try out new designs of tents and other equipment; and also new ideas for provisioning high-altitude expeditions. In this latter connection I secured great assistance from Dr. Zilva of the Lister Institute.

6. To carry out a stereo-photogrammetric examination of the northern aspect and valleys of Mount Everest, and to continue the work of the Reconnaissance Expedition of 1921. It is unfortunate that the all-absorbing problem of reaching the summit had relegated science to the background, and that we had still little precise knowledge of the heights and contours of the Northern Face.

This then was a golden opportunity; and the Committee invited Michael Spender to join the expedition. He had only just arrived in England for a short holiday from Copenhagen, where he was engaged in working out the results of his last Greenland expedition. The Danish authorities kindly released him from his contract and he had just three weeks in which to make his plans and to collect his instruments. Now, as on the expedition itself, he displayed an energy and enthusiasm for which I soon came to have a considerable respect. We took with us the Wild photo-theodolite which had been used by Professor Mason in the Karakoram in 1926, and a lighter Zeiss photo-theodolite lent by the Danish Geodetic Institute and adapted to take films.

I budgeted to run the expedition for an inclusive cost of £200 per head. The Committee invited five other mountaineers to join the expedition: H. W. Tilman, who had been my companion in the exploration of the Nanda Devi basin last year; L. V. Bryant of New Zealand, who brought with him a very considerable reputation for toughness and mountaineering skill; Edwin Kempson, a house master of Marlborough College, who had some twelve years of winter and summer mountaineering in the Alps to his credit; Dr. Charles Warren, who had had previous Himalayan experience as a member of Marco Pallis' expedition in 1933; and E. H. L. Wigram, a medical student at St. Thomas', the youngest member of the party. The last three named had all been members of the Cambridge University Mountaineering Club which has already produced such a remarkable number of Everest climbers of note.

The party assembled in Darjeeling about May 21 and were ready to move off three days later. We took with us as interpreter Karma Paul, who has served on all the Everest Expeditions except the first, and fifteen Sherpa and Bhotia porters amongst whom were our old friends Angtharkay, Passang Bhotia, Tsering Tharkay, and Rinzing. Our passport had not yet arrived from Lhasa, and this caused us some anxiety; but on the way up to Lachen we met Rai Bahadur, the personal assistant of Mr. Williamson, who kindly gave us a temporary pass to cross the frontier. We entered Tibet by way of the Kongra La at the head of the Lachen Valley. This, by the way, would be an infinitely preferable route for the main expedition if the pass were fairly clear of snow by the beginning of April, which I have reason to believe is the case in a normal season. The heavy transport need not accompany the climbers on this portion of the march. For our purpose there was no need to go straight to Mount Everest, and we hoped to be able to see something of the beautiful Nyonno Ri range which had attracted Wager and me so much in 1933. From Gompa Lawu across the Kongra La we struck due west, thus avoiding Kampa and Tengkye Dzongs. We lived mainly off the country and our diet consisted largely

of tough mutton and eggs. We were able to obtain large quantities of the latter at each village and frequently consumed as many as a hundred amongst the seven of us in a single day. Once, when the party was split up, four of us ate a hundred and forty in one day. They were by no means always fresh and had to be scrambled in order to disguise the bad ones.

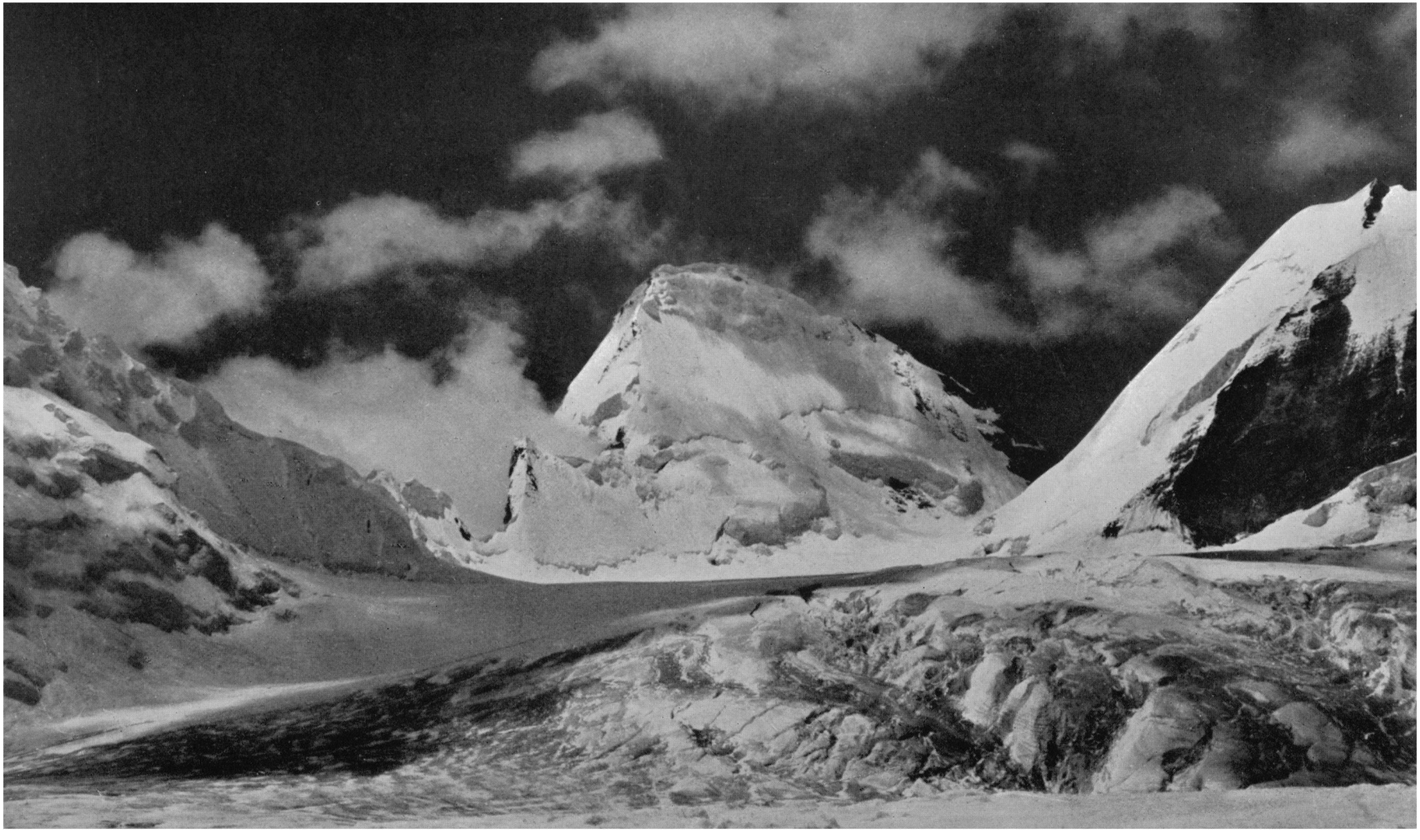
We reached Sar on June 8, and the party was divided into three: Spender with a group of Sherpas selected for their intelligence was to photograph the eastern aspect of the range from the rounded hills above Sar. This he succeeded in doing with characteristic thoroughness. He occupied five stations in ten days. Tilman, Kempson, and Warren, were to attempt to climb Nyonno Ri itself and also to explore the southern part of the range, taking with them the light photo-theodolite; while Bryant, Wigram and I would attempt to cross a high pass to the north, examine the interesting basin lying immediately to the west of the main watershed and return by some southern pass, thus completing the circuit of the main massif. We agreed to return to Sar after ten days.

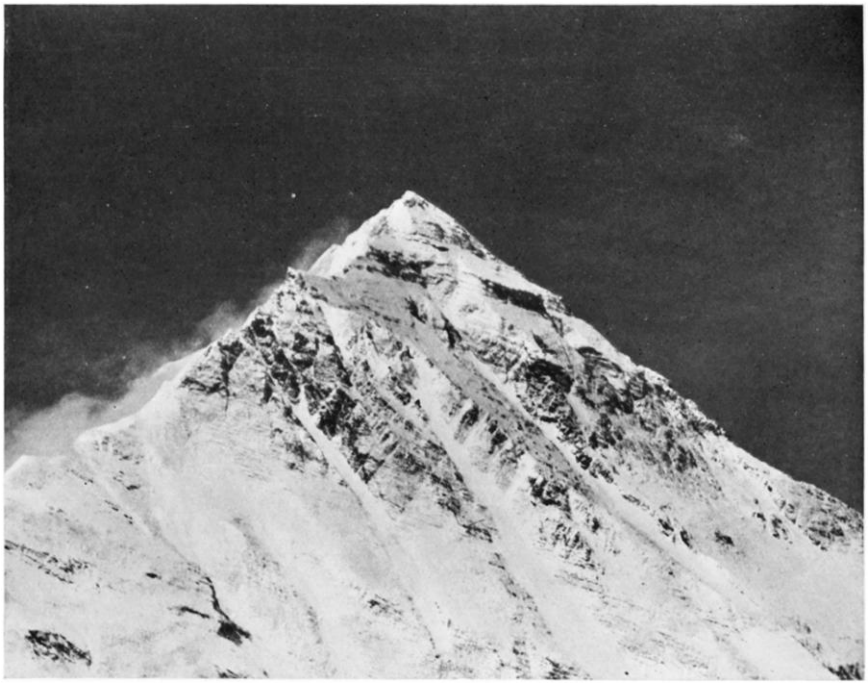
Tilman and his companions encountered considerable difficulties on Nyonno Ri and failed to reach the summit. They had an interesting time however and did some useful work in the southern part of the range. We got over our pass and found ourselves in a strange basin completely surrounded by snow peaks. There were extensive areas of rich pasturage and we found that it was used as a grazing ground by the inhabitants of the Kharta Valley. We had a delightful time exploring this beautiful country. From various hills which we climbed we obtained views of Mount Everest and Makalu, and it was interesting to note that although it was already the middle of June these peaks were still clear of monsoon cloud, and there seemed to be little wind on them. Evidently this would have been a good season for an attempt on Everest. May we hope for a similar one next year. As I had hoped we managed to cross a pass to the south of Nyonno Ri and so returned to Sar.

Thus the parties were occupied until June 20, and I now hoped to be able to examine the southern extremity of the range. But unfortunately on our return we learned that this diversion from the usual route was not approved by the Tibetan authorities and in obedience to their wishes we proceeded as directly as possible to the Rongbuk valley. Now as in 1933 we were received with the greatest possible courtesy and hospitality by the Tibetans. The head man of Sar gave us free use of his house. He held several banquets at which we were fed lavishly and entertained by music and dancing. Our host was a great connoisseur of "Chang" and it was no penance to drink with him. The evenings occasionally became somewhat boisterous. Several times this year I took the opportunity of tactfully asking these head men the reason for their objecting to Europeans entering their country. In each case they replied that they believed that money and Western civilization could do nothing for them but promote unhappiness. I feel sure that the British Government would wish that this point of view should be respected.

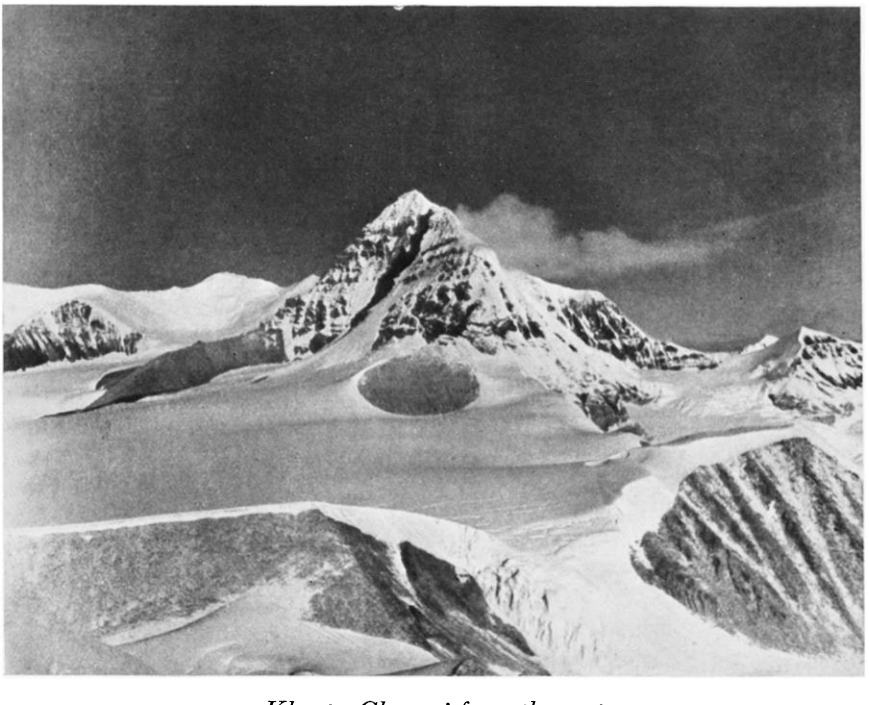
We left Sar on June 26 on which day the first rains fell over the country, indicating that the monsoon had arrived, and we reached Rongbuk in nine marches, arriving there on July 4. We were delighted to find that our old friend the abbot of the monastery was alive and well. He received us with his usual good humour and gave us a good deal of sound mountaineering advice.

The highest peak of Lingtren from the east





North-eastern aspect of Mount Everest from the summit of Khartaphu
[*Telephoto*]

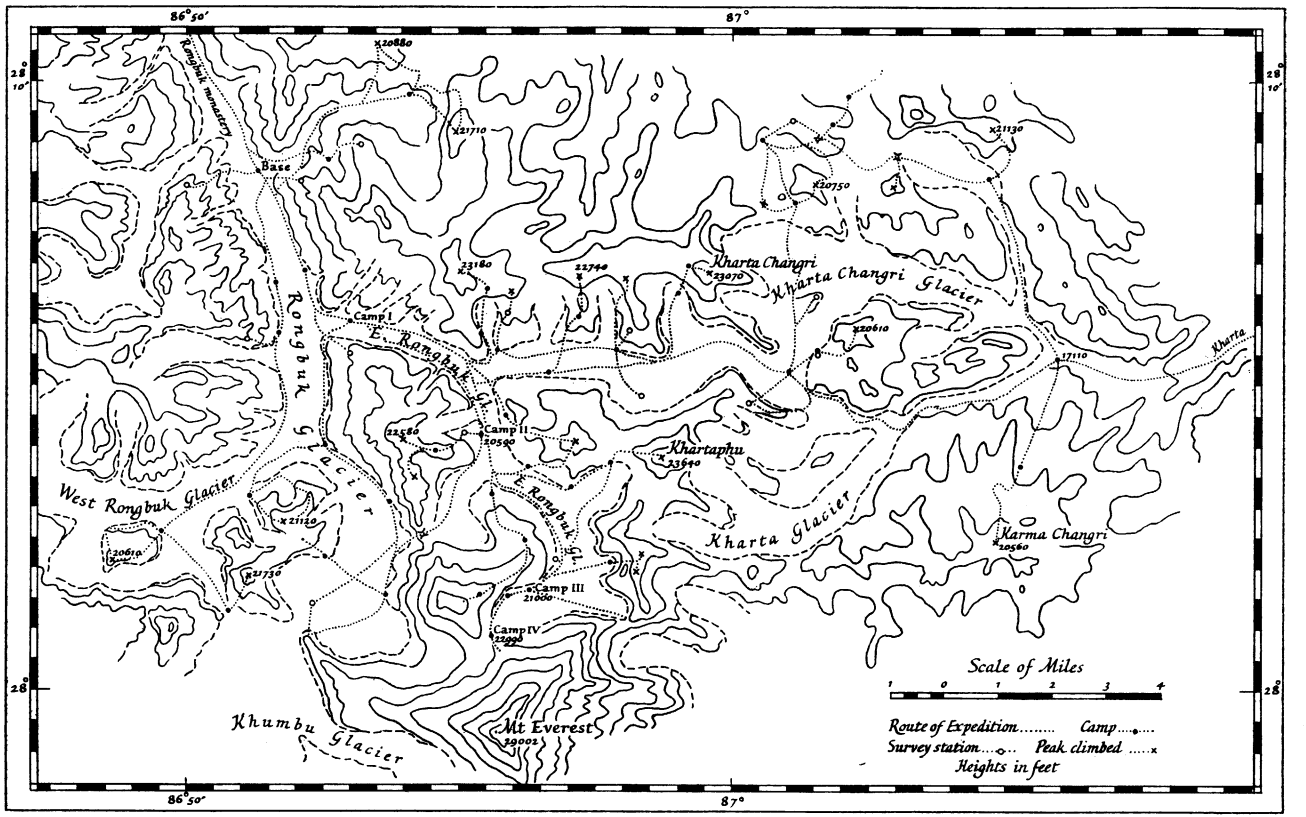


Kharta Changri from the east

The whole party, with the exception of Karma Paul, left the Rongbuk Monastery on July 6 in gloriously fine weather, taking with us sufficient food for five weeks, and forty Tibetans to carry our gear as far as Camp II. We left Spender and his cameras, together with a few of the older and more experienced Sherpas, at the old base camp and went on ourselves to Camp I the same day. While we made our way up the glacier to Camp III the weather continued fine and the north face of Everest became quite black and soon began to resemble the mountain in its pre-monsoon aspect. The days were hot and windless, the nights clear and cold, and it was difficult to imagine how the slopes of the North Col could be in anything but perfect condition by the time we reached them. Bryant unfortunately now became ill and had to be left behind at Camp I to follow up when he had recovered.

We reached Camp III on July 8 without much incident or effort and had enough food there to last us for three weeks, having dumped the rest at Camp II. The next day the weather became unpleasant, though very little snow fell. We spent the day moving camp farther up towards the North Col. A few hundred yards above Camp III, in fact within sight and hail of it, we came upon the body of Maurice Wilson. It was evident that he had died in his sleep from exhaustion and not from starvation, as he had found a dump of food which had been left in 1933 and which was still well stocked.

A great deal has been said about the danger of snow avalanches on the North Col. Exactly why these slopes should differ from any others at a similar altitude it is difficult to say, but the memory of the disastrous avalanche of 1922 is partly responsible for the extreme caution with which subsequent parties have tackled them. *We* regarded the North Col with the same respect and were determined not to run any risk with snow which we considered to be in the least bit doubtful. Kempson had had very considerable experience of winter snow conditions in the Alps, while I imagined I was familiar with a fairly wide range of Himalayan snows. The weather conditions for the past week had been ideal for packing the snow, and although we examined carefully each section of our route we could not detect anywhere the slightest tendency to avalanche. In detail the aspect of the North Col had changed considerably since 1933. The middle section of our old route, known to us as the Punch Bowl, and the 30-foot wall above it were contorted beyond recognition into a mass of tottering séracs, which would have rendered the 1933 route exceedingly difficult, if not impracticable. A tongue of ice a few hundred feet to the right had protruded somewhat and now provided us with comparatively easy access to the old site of Camp IV. The ledge on which this camp had been had now completely disappeared, and the ice was far too steep for us to think of pitching a tent. In the upper section great bulges of ice forced us to traverse right across the face before we could climb to the crest of the col which we reached at a point very close to the site of our old Camp IVa. The big Arctic tent and the food dump which we had left in 1933 were buried under some 8 feet of (presumably) monsoon snow. For three days we worked on the ice slopes of the North Col and by July 12 we had established a camp at the foot of the north-east ridge and stocked it with sufficient food and fuel to last us for fifteen days. It was occupied by Kempson, Warren, and myself, and nine Sherpas. Our plan was to take a light camp up to 26,000 feet and from there


86°50'
87°
28° 10'
28°
Rongbuk monastery
Base
Camp I
Camp II
20540
Camp III
21000
Camp IV
22990
East Rongbuk Gl.
Rongbuk Glacier
West Rongbuk Glacier
Rongbuk Gl.
Khartaphu
23640
Kharta Changri
23070
Kharta Changri Glacier
Kharta Glacier
Karma Changri
20560
Kharta
Mt Everest
29002
Khumbu Glacier
Scale of Miles
1 0 1 2 3 4
Route of Expedition..... Camp.....
Survey station.....o... Peak climbed x
Heights in feet

to investigate the snow conditions on the slabs of the upper part of the mountain and to reconnoitre some of the ground about which there has been so much debate.

We had established ourselves on the North Col in less than a week after leaving Rongbuk, and it seemed advisable to spend the next two or three days in rest and acclimatization. The weather was bad and we were worried by a nasty wind which was particularly fierce at night. We spent four uncomfortable days waiting for better weather, during which time we went some way up the ridge. As time was of no particular object and our job was to keep a watch on the mountain during the whole of the monsoon, we had made up our minds that we should not force our way up in bad weather. It seemed a waste of time to hang about doing nothing, so we decided to leave on the North Col all the food and fuel we had with us and what tents and equipment we could spare and descend to Camp III to spend our time climbing other peaks in the vicinity until the weather improved. We could then return to the North Col without being obliged to carry anything further up there. With this plan in view we started to descend on the morning of July 16. Although the weather had been bad, only a few inches of new snow had been deposited on the mountain during our stay on the North Col and although we tackled the slopes below with extreme caution they did not seem to have altered materially since we had last seen them. We descended in two parties: Kempson and I were in front with five Sherpas, while Warren was some way behind with the other four. We had not gone far before we were brought up short at the brink of a sudden cut-off which stretched for several hundred yards in either direction. This indicated that an enormous avalanche had recently broken away largely along the line of our ascending tracks. In fact the whole face of the slope had peeled off to a depth of 6 feet. This was an alarming discovery and there followed a somewhat heated debate as to whether we should retreat to the North Col or carry on down. The others advocated the former course; but it seemed to me that if, as we had reason to suppose, the avalanche had occurred on the previous night its track must indicate a temporary line of strength, and it was not likely that another avalanche would fall immediately, while if we returned to the North Col we would later have to face a risk which we had no means of gauging. Anyway my argument was the simpler to put into effect and so we crept down with our hearts in our mouths and reached the glacier unharmed.

To my mind the incident had considerable significance. As I have said, very little new snow indeed had been deposited on the slopes and this cannot have had any appreciable effect on the stability of the old snow which we had unanimously agreed seemed perfectly sound. And yet the avalanche had occurred along our ascending route. That merely indicated that we were not competent to judge the stability of monsoon snow at these altitudes. Anyway I decided there and then to abandon our stores and have nothing further to do with the North Col during the monsoon. Later we were to have substantial evidence that the monsoon snow does not either disappear or consolidate at an altitude higher than 23,000 feet in the region of Mount Everest. We were thus able to provide a definite answer to one of the chief problems which we had come out to solve. In my opinion the only time of

year that one can reasonably hope to reach the summit of Mount Everest is during the exceedingly short interval between the end of the winter gales and the arrival of the monsoon. In 1933 there was no such interval.

When we reached Camp III we found a note from Tilman saying that he and Wigram had gone down to Camp II to bring up more food. They had climbed two peaks of over 22,000 feet in the neighbourhood. On the next day, the 17th, we moved a camp up to the head of a big unnamed glacier which flows into the East Rongbuk from the east. From here we climbed the peak known as Khartaphu—23,600 feet high. We carried the light theodolite with us, but before we could reach the summit clouds had rendered it impossible to do any useful work. However we managed to get some fine views into the country to the east which later proved to be very useful to us. We also took some telephotos of the summits of Everest and Makalu. We descended to Camp II the next day where we met Spender. He had completed several stations on both sides of the Main Rongbuk Glacier and had obtained sufficient data to enable him to draw a large-scale plan of the north face of Everest and to calculate with sufficient precision the altitude of any point on that face, both of which achievements will be extremely useful in planning a fresh assault on the mountain.

The party was now divided into two. Spender, Kempson, and Warren were to attempt to explore the country lying between the East Rongbuk Glacier and the Doya La while the rest of us remained in the vicinity of Camp II. We moved across to the east and climbed the much-photographed Kellas Rock Peak, 23,000 odd feet. This mountain has so often appeared in newspapers under the name of "Mount Everest" that we experienced quite a thrill in reaching its summit. There, as on Khartaphu, we found that there was a very marked and sudden change in the quality of the snow as we reached 23,000 feet. The snow on the ridges below was good and safe, but that lying above 23,000 feet had always to be treated with the utmost caution. After returning to Camp II we climbed the beautiful ice peak which rises above it—it is 22,580 feet high. After this we explored the little valley which joins the main Rongbuk Valley on the east, and climbed two more peaks of 21,000 feet in the neighbourhood. This was done in order to be able to supplement with photographs the work which Spender had done in this valley a fortnight before. We returned to Rongbuk on the 31st and were surprised to find that Kempson was already there. A series of misfortunes had prevented them from completing the task they had set out to do. Their food supply had run short; they had encountered vile weather which seems to pour up through the Arun Gorge during the whole of the monsoon; two of their Sherpas had developed dysentery, and Spender himself had developed a complaint with disturbingly similar symptoms. However they had done some very good work. Spender had completed several good stations in the vicinity of what had come to be known as the Kharta Changri Pass, while Kempson and Warren had climbed two peaks of over 22,000 feet, up one of which they had taken the light photo-theodolite. They also climbed the beautiful peak of Kharta Changri which is just over 23,000 feet high. The rest of the party arrived in heavy rain that evening and the next two days were spent in devouring the luxuries which Karma Paul had collected in our absence and which consisted of two sheep,

twenty-one dozen eggs, and a little rancid butter. Tewang and Namgir, the two sick Sherpas, were discharged. The party was greatly weakened by the departure of Kempson, who had to return to England.

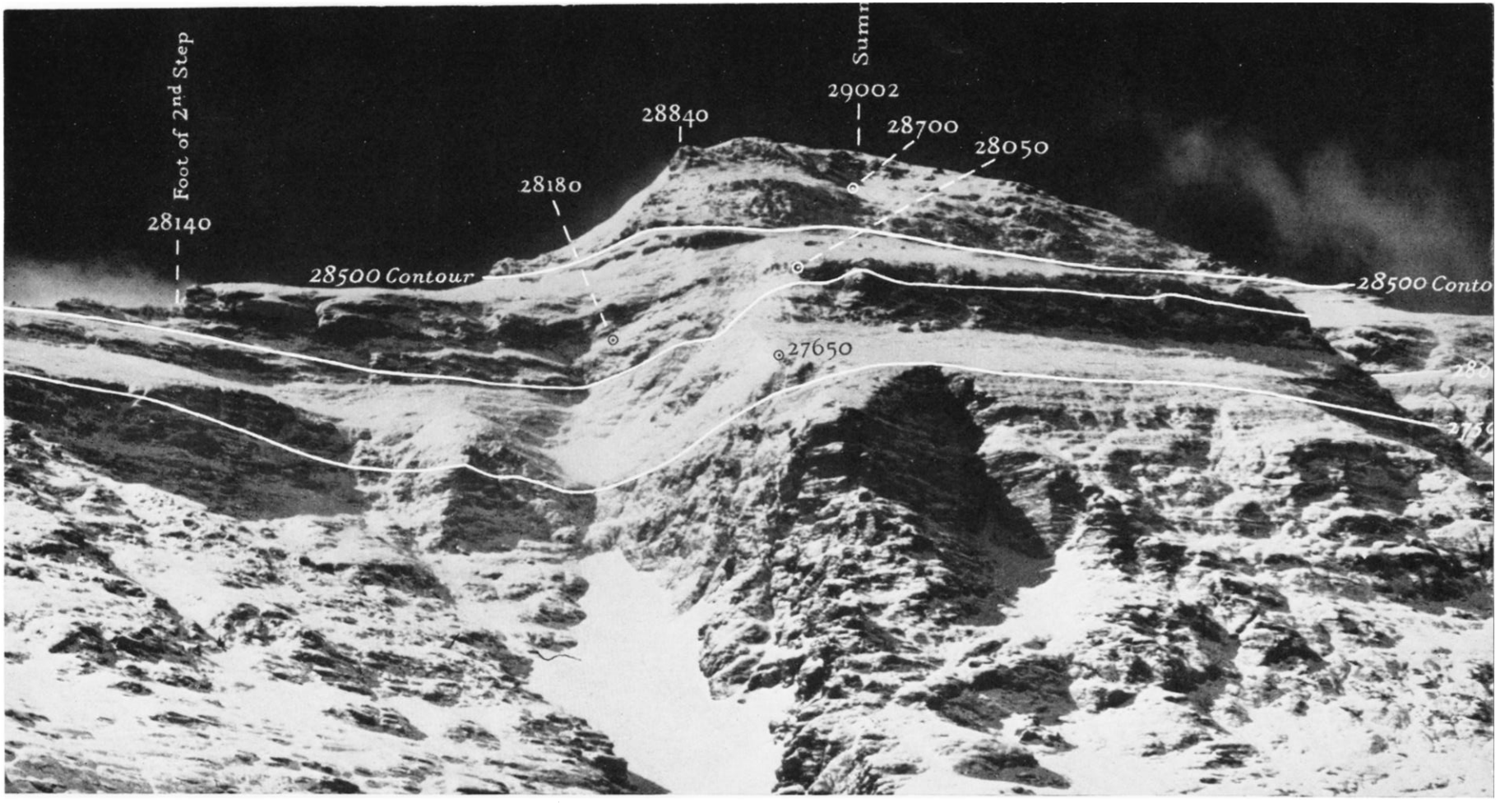
Our next intention was to examine the western side of the mountain. Although Mallory in 1921 had visited the watershed in two places he had experienced bad weather while doing so and had not seriously commented on the mountaineering aspect of the southern side. Another task we had was to report on the feasibility of the suggested route up the north-west ridge of the mountain. Tilman, Wigram, Bryant and I left Rongbuk on August 3 making towards the head of the main Rongbuk Glacier. Warren stayed behind with Spender who was still sick. Some days later these two followed us up and completed Spender's work on the north-western aspect of the mountain. After two days' march up the west side of the main valley we divided our forces into two. Tilman and Wigram were to attempt to cross the Lho La to the foot of the Western Cwm while Bryant and I went up the West Rongbuk Glacier. We climbed two peaks, one a fine fluted-ice peak which commanded one of the most magnificent mountain views I have seen, the other Lingtren Nup up which we managed to take the theodolite for a round of angles and photographs. After this we took a camp on to the crest of the watershed and stayed there for two stormy nights. On August 10 from this camp we climbed the triangulated peak, 21,730 feet. The day was an adventurous one. Conditions rendered the climb a very delicate job; on the descent while we were making our way along a narrow ice ridge I heard a roar like a heavy gun going off, felt a jerk of the rope round my waist which nearly cut me in two, and found myself standing alone on the ridge. Bryant had broken away a bit of cornice, had gone down with it, and was now almost hanging on the other end of the rope some way below the crest of the ridge; but he had retained possession of his axe and was thus able to cut his way back to me. Later in the descent we got involved in a small snow avalanche which, fortunately, we were expecting. Early on the following morning, having spent an entertaining night trying to drown the noise of the wind with some of Bryant's extraordinary repertoire of comic songs, we erected the theodolite with considerable difficulty on the crest of the pass and took a round of angles and photographs. Unfortunately the photographs were spoilt by the film jamming in the camera. However we secured several somewhat cloudy views over that interesting section of Nepal which the Sherpas refer to rather vaguely as Sola Khombu. We also saw up into the mysterious Western Cwm. No descent is possible on the southern side of this col, and we were sorely tempted to try to find an exit from the basin of the West Rongbuk Glacier to the west but we had agreed to reassemble at Rongbuk on August 14. On our return there we learnt that Tilman and Wigram had found that there is no route southward from the Lho La, and having climbed a peak in its vicinity, had crossed a difficult pass lying immediately north of the North Peak and descended direct to Camp II. They had then climbed two more 22,000-foot peaks before returning to Rongbuk. While at the head of the main glacier they had found time to examine thoroughly the lower section of the north-west ridge which had been strongly recommended as an alternative route up Mount Everest. They were both convinced that an attack from this quarter would not offer the slightest

chance of success. From the mountaineering standpoint these two had put up a fine performance.

After two days' rest we set off once more up the East Rongbuk Glacier, having instructed Karma Paul to meet us in three weeks at Kharta with such surplus gear as remained. Our first objective was the North Peak, though Tilman's report of increasingly bad snow conditions above 22,000 gave us some misgivings as to the advisability of attempting a peak of nearly 25,000 feet at this time of year, and we bitterly regretted having left this until so late. We had two main objects in climbing the peak: one was to be able to secure some telephotographs of the upper part of Everest from its summit, the other was to collect further evidence of the behaviour of monsoon snow at these extreme altitudes. From Camp II we made our way up to and along the great horseshoe ridge of the mountain. We found that the snow was in a frightful condition and the higher we got the worse it became. We had three camps on the mountain, the highest of which we placed at about 23,200 feet, almost directly above the North Col. In order to reach it we had to flog our way through snow up to our waists. The weather was bad and at this camp we spent one exceedingly unpleasant night. Our primus stove ceased to function as the jets were too large for that altitude and we could not melt enough snow for drinking. The next morning we started at dawn but found that the snow was worse than it had been below and soon we were floundering in a seemingly bottomless morass. From where we were we could look down on to the North Col and could see that the large Whymper tents which we had left there in July were now buried under fresh snow. The final ridge of the North Peak we found to be very sharp and under the existing snow conditions it was impossible to reach the summit, and we were regretfully compelled to abandon the struggle. When we regained the East Rongbuk glacier the next day we found Spender waiting for us in the central trough, having completed with much difficulty two stations in the Eastern Cwm.

The next fortnight was spent in making a high level route between the East Rongbuk Glacier and the Doya La above Kharta. It was certainly the most delightful two weeks of the expedition and yielded the most interesting geographical results. We crossed the Kharta Changri pass to what Spender with his arctic terminology had called the Ice Cap Station. Indeed the upper glaciers of this district appear to resemble closely those of the Greenland ice cap. But in their lower reaches they are very Himalayan in character and take a great deal of negotiating. From here we had a delicious time crossing new passes, climbing peaks and unravelling the most interesting mountain topography. The mornings were generally fine, which allowed us to work in camera stations at suitable points all along our route. When we reached the Doya La we experienced again that indescribable pleasure of coming down to living things after a long sojourn in high glacier regions. The smell of grass and flowers was almost intoxicating. On September 6 we reached Kharta, where we hired ponies and hurried as fast as these would carry us to the Choten Nyima La. We spent the remainder of our time climbing in the little-visited Dodang Nyima Range of North Sikkim. As is generally the case, the results of the expedition fell short of our hopes, but our inability to wander far afield enabled us to do more mountaineering than we had intended. Twenty-

A basin west of Nyonno Ri



Summit of Mount Everest from the North Col

[*Telephoto: heights and contours prepared at the Geodetic Institute, Copenhagen*]

six peaks, all over 20,000 feet high, had been climbed, the summits of only two of these had previously been reached.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: It is very cheering, judging by the size of the audience, to see that Mount Everest is still a good draw. The paper we are to hear is on the Reconnaissance Expedition of 1935 by Mr. Eric Shipton. He will tell us the origin of the expedition and the conditions under which he led his party last summer. I will merely say a word or two to give you the background and refresh your memories.

When the 1933 Expedition came home, the earthquake in Nepal and the death of the Dalai Lama seemed to make it very unlikely that we should get permission for another expedition for some time to come; but the whole question was discussed and it was decided that one never knew when permission might be forthcoming. Some fortuitous event might suddenly make it possible for an expedition to make another attempt. Therefore it was decided to keep a watchful eye on opportunities for asking permission for another expedition. Unexpectedly in January 1934 we received that permission. It was not received in time to enable us to fit out a strong main expedition to attempt the summit during 1935, but we were loath to risk letting the permission lapse by not starting operations at once, so we decided to send out this reconnaissance under Mr. Shipton.

Mr. Shipton has a very fine record as a climber. Before he made any attempt at climbing in the Himalayas he climbed in Kenya with Mr. Wyn Harris, and he was one of those of the 1933 Expedition who very nearly got to the top of Everest. It will be remembered that he was with Mr. Smythe on the second assault. Afterwards, when the expedition returned to England, he was not to be denied, and made fresh plans for the following summer and did a fine piece of mountaineering by penetrating into the basin surrounding Nanda Devi. On his return he read us a paper on that subject. He is now to tell us of his experiences on the Everest reconnaissance in 1935.

Mr. Shipton then read the paper printed above, and a discussion followed.

The PRESIDENT: I call first upon Mr. Hugh Ruttledge, who led the 1933 Expedition and is going to lead the 1936 Expedition.

Mr. HUGH RUTTLEDGE: I wonder if all of us have realized, when listening to Mr. Shipton quietly describing his adventures, exactly what has been done during 1935, because the achievement which he has been describing so quietly is one of the most remarkable in Himalayan annals. Quite casually at the end of his paper he said that twenty-six peaks of over 20,000 feet had been climbed. If he had told you that he had entered twenty-two public houses this afternoon it would have sounded much more exciting.

But actually what has been done during 1935? Firstly, I think this performance has proved beyond reasonable cavil the right season for attempting to climb Mount Everest. Many people have sincerely believed that we were making a mistake in not attempting the mountain during the monsoon or, at any rate, just after it. I think the party's experiences this year have put that out of court. Secondly, the mountaineering judgment of Mallory in 1921 has been fully vindicated. It has been put beyond reasonable doubt that it is not the slightest use attempting the great north-west *arête*, which to one or two mountaineers has seemed rather attractive. That was seen at close quarters, and certainly that route will not do. Thirdly, we are pretty certain now, as I think

we were practically certain in 1933 also, that the proper route of ascent is that traverse which Brigadier Norton discovered with Somervell in 1924.

Fourthly, and most important, the monsoon snow conditions above 23,000 feet have been found to be difficult and dangerous; but more than that, the conditions on the North Col itself have been very thoroughly explored. Nothing but the most superb mountaineering judgment and skill would have got that party down off the North Col in the way it was done, and we must all endorse Mr. Shipton's judgment in coming straight down after that huge avalanche had fallen. None but mountaineers can understand. You saw that long line across the snow face of the North Col; that probably represented an avalanche of many hundred thousand tons of ice and snow, and it swept right across the route of ascent. Mr. Skipton was absolutely right to have nothing to do with the North Col after such a happening as that. So we must try to get up the mountain next year between, shall we say May 15 and, in more or less normal conditions, June 7. This year of course was an exceptionally favourable year in some ways, possibly the period during which the mountain might have been climbed may have been a little longer, say to June 14. You will remember that Mr. Shipton told us the monsoon did not break until about June 26, but probably the snow conditions were getting steadily worse by that time and a little before.

Fifthly, there is the fact that this party has subjected itself to that intensely exacting ordeal of acclimatization. I believe it is a fact that no test is known to medicine by which it can be proved how a man will react to very high altitude conditions. The party that was sent out this year had to undergo that test and, most unhappily, all did not pass it. They were all first-rate men, but it was the only thing to be done, and we can at least say that as a result of this test the nucleus of next year's party consists of men who have been thoroughly tried out and are known to be able to climb at those altitudes. That gives us a very much better chance of success in 1936.

In conclusion, may I congratulate not only Mr. Shipton on his extraordinarily fine leadership and judgment but also all the members of his party. I think I am right in saying that only two of the others have been in the Himalayas previously, but all climbed like veterans. I must not forget the fine performance put up by Mr. Spender who, I believe I am right in saying, had not done much climbing before he went with the party. How he got to some of his stations and did that valuable work for us in examining the north face of the mountain I do not know. Certainly he will train to be a good mountaineer if he is interested.

Finally may I say for myself that it is with a very deep sense of privilege and of responsibility that I am going to do my very utmost in 1936 to place these splendid climbers in an attacking position.

The PRESIDENT: We have Mr. Spender and Mr. Kempson with us. I am going to ask them to come up in turn. Mr. Spender, as you have heard, was the scientific element in the expedition and did very valuable work on the topography of the untrodden mountain region which the party were exploring.

Mr. MICHAEL SPENDER: I think the best contribution I can make to this evening's discussion is to say something as shortly as I possibly can about weather in general and Mount Everest weather in particular: it helps one to understand what happened to us and it may help others to understand what happens to next year's party.

As you all know, the typical feature of the weather which is met by the party which goes out before the monsoon is a frightful north-west wind, a wind of very great persistence and very cold. This year's party went out later in the year, at a time when the north-west wind would be weaker. It went out at the same time as Colonel Howard-Bury's party went out in 1921, and we could look

to them for an account of the kind of weather we might meet. So we borrowed the Secretary's copy of the account and read about their kind of weather and, Mr. President, we were depressed because they had a dreadful time in 1921; a time of perpetual cloudiness and frequent snowfall. We thought it might be difficult to take photographs under such conditions and that even the mountain climbers might lose their enthusiasm. So when we finally got to Rongbuk and the sun shone and the snow peaks gleamed we were very gratified.

As the season went on there was a worsening and unfortunately the day Shipton was on the North Col, July 15, was a very bad day indeed. By August 15 the worst of it was over. But even when it was at its worst the weather did not give us bad days in succession. There would be one bad day and then we were able to get on with the job the next day. It was not as in the Alps, where bad days come in such long periods as to make one restless. Those single bad days were welcome to us as periods of rest.

The principal point is that the north-west wind is the dominant factor. You must think of the monsoon as a great mass of warm air trying to trespass on the rightful stream of air for those parts. This has actually a very curious effect; for when you get the bad weather in the monsoon period it appears to come from the north and our joke was to call it the Gobi Desert monsoon. The real monsoon splits round the land mass of India into two branches, one of which comes from the Arabian Sea direction and the other makes a sort of flanking attack along the east coast. The first, the Arabian Sea monsoon, hardly ever gets to Mount Everest: it is the second wind that really brings the bad weather.

When the monsoon first comes up towards India the layer of warm air is only a few thousand feet thick, and it has no chance of reaching the summit of the Himalayas. But when you have a front of warm air advancing against this north-west stream of cold air, all sorts of disturbances are set up which develop into the storms which wander up and down and to and fro till they strike the Himalayas. When the first of these disturbances gets to Mount Everest there is some cloud and snowfall, and the expedition telegraphs back "The monsoon has broken." Well, that is just as you like to take it because the real mass of warm air has not yet reached Everest. That will come later on. Until the warm air gets to Everest there may be longish periods of fine weather, although there is always the risk of other circumstances coming in.

We got to Rongbuk just at such a fine period. We left it on July 6 in the most beautiful weather, when Mount Everest and all the other high peaks were glittering with new snow and there seemed to be no wind or cloud. But as we went on, and even until the beginning of August, we only got the warm air in fits and starts. From August 9 for a few days we had stormy weather, and it was very difficult to go on with my sort of work. That was the period when Mr. Shipton and Mr. Bryant were climbing together, and they had an uncomfortable night and very bad snow conditions. A few days later, when Shipton was at 23,000 feet on the North Peak, there were only 3° or 4° of frost at night.

The reason things were like this in the summer was because the north-west wind held its own more effectively than it generally does. The Bengal Bay monsoon actually was blown sideways by the north-west wind. Those of you who have had reports from India are already aware that Calcutta had only half its former rainfall and that Lower Bengal in general was very short of rain. On the other hand, Assam, Upper Burma, and Sikkim had too much, as we saw when we came back to Sikkim: roads had been washed away, bridges were down, and so on. Very probably Tibet had a good supply of rain, and we came in for the benefit of that because as we walked home we walked through good crops which the headmen were kind enough to credit in part to us.

On the whole, we really had finer weather than we should have had, and the little bit of bad weather we had in August was due to a disturbance skirting the foothills of the Himalayas and drawing up the warm air into the mountains; but as soon as that was past the north-west wind came in again and you could see it blowing over the top of the warm monsoon air. As August came to an end we watched the north-west wind gradually deepening and gradually pushing before it the warm summer air and taking the clouds away from the regions visited by the monsoon

Mr. E. G. H. KEMPSON: Acclimatization, I am afraid, is as necessary in speaking in public as it is in mountaineering, so I shall not detain you for more than a minute or two. There is one thing Mr. Shipton told you that I should like to underline, and that is the remarkable change in conditions that appears as you rise from the 21,000-foot level to the 23,000-foot level and above. On the occasion when Dr. Warren and I were climbing Kharta Changri we had a delightful camp on the glacier at 21,000 feet; it was a beautiful crisp night, with 30° of frost and actually the coldest night we had during the usually temperate monsoon weather. When we started up our peak it was perfect alpine weather. We got on to our col just making nicks with our feet in the ice, but as we rose to about 22,000 feet conditions got progressively worse. First we found crust such as you sometimes, unfortunately, get in spring ski-ing; then this degenerated into the powder snow of which you have been hearing. The worst characteristic of that powder snow was the fact that the steeper it got the deeper it got: progress was very slow. We actually took four hours getting to the top of our peak whereas it took us only thirty-five minutes to come down. This gives a measure of the work in the ascent.

I cannot close without saying two things: first, and you all know it, the porters that we had were simply superb. Some of us started by being just a little ashamed of not carrying enormous loads when every one round seemed to be carrying 60 and 80 lb., but you get over that after a bit. The porters were really quite first rate, and my porter who came back to Darjeeling through Tibet with me was one of the best. Secondly, and this I also need scarcely say, I cannot tell you what an excellent leader we had in Shipton. He left out one point about himself. He suggested that he always ate a great deal. Well, perhaps he did when he was in the valleys but he was an astonishing person up high. He seemed to subsist on nothing, though he himself would dispute that fact and blame all of us for eating nothing. But that is the only fault I can find in him. It is sufficient to say that our party under his leadership had not a single quarrel.

The PRESIDENT: Colonel Howard-Bury who led the original reconnaissance expedition is here. We shall be very disappointed if he will not give us a few words. It must have been of great interest to him to compare his own experience with what he has heard to-night.

Colonel HOWARD-BURY: I came here this evening to try to recall some of the old places that I had seen about fifteen years ago, but I should really like to congratulate Mr. Shipton on those wonderful photographs he has shown. He mentioned the enormous consumption of eggs on the way up. I should like to ask whether they were chickens' eggs, for on our way up we were presented with wild geese eggs, and we could not possibly have competed with the 1935 party's consumption. Further, I would like to ask him whether he was also given eggs on the way down. The children found out that we liked eggs very much and kept the eggs all the summer, offering us them in the autumn, and being surprised that we would not have anything to do with them as food!

What has interested me enormously is that Mr. Shipton has taken a totally different route from other expeditions. We only saw the map for a short time,

but the way he went to Mount Everest was completely new. All along, he has been through a new line of country, and though he has told us very little about the geographical work that has been done, I am sure that a great deal of most useful geographical work has been achieved in the reconnaissance that he has done this year. For whereas in 1921 we went along, I might say, the valleys, he seems to have been going along the tops of the peaks the whole time. But he has borne out very much what we found out round Mount Everest about climate. We were there throughout the whole summer and until comparatively late in the autumn. We too found that there was that heavy snowfall and that the mountain looks completely different in the autumn from what it does in the spring, when it looks quite black. Then there is that perpetual terrible wind that begins after the monsoon and blows with increasing force the whole time. Clouds of snow blown off from the summit of the mountain render a climb after the monsoon quite impossible. I am glad it has been again established that at that time it is no use attempting to climb the mountain.

I congratulate Mr. Shipton most heartily on his expedition, on the geographical work that he has done, and on the most excellent photographs that he has taken.

Dr. T. LONGSTAFF: I am glad to have the opportunity of paying my compliments to Mr. Shipton. I do not think he has made it evident that during the expedition last summer about as many peaks of over 20,000 feet were climbed in the Himalaya as have been climbed since the days of Adam, so far as I remember the list.

I would also like to say that I am as firmly convinced as ever that his system of sending people up to 20,000 feet and over as often as possible and bringing them down again is the best form of acclimatization that there is; that it is a very much better method of acclimatization than keeping people permanently at a high altitude, and I have no doubt the climbers who were with Shipton will show that that form of acclimatization remains with them permanently. The oftener you go to 20,000 feet the better able are you to go again, but if you stay for a great length of time at a high altitude your general condition degenerates.

I must also congratulate Mr. Shipton on the extremely economical way in which he conducted the expedition. He has always been a shining example in that respect, yet although the expedition's work was executed with great financial economy you will notice that he did not grudge his party 140 eggs a day! If we can manage to collect a team of mountaineers of the technical capacity of Mr. Shipton there is no doubt that Mount Everest will be climbed, given the luck of the weather.

The PRESIDENT: It may interest you before we close this meeting if I let you know the names of those who have been invited and have accepted the invitation to be members of the 1936 Expedition. Mr. Hugh Ruttledge will lead, as you know, and I am very glad to say Mr. Smith Windham will take charge of the wireless; Mr. F. S. Smith, whose climbing reputation you know; Mr. Shipton; Mr. Wyn Harris, who did so well in 1933, coming from Kenya again; Mr. Kempson, whom you have just heard and who well won his spurs on the recent reconnaissance; Dr. Warren, who was with Mr. Shipton; Mr. Wigram and Lieutenant J. M. Gavin, R.E.; Major Morris, a retired officer of the 3rd Gurkhas, who has been in Nepal and is on his way to Darjeeling, and whose business it is to collect the Sherpa porters and run the transport. Finally Dr. Noel Humphreys, whom all of you know by name and who has recently returned from an expedition which he led to Greenland with Edward Shackleton. That makes eleven; there is one more place to be filled.

Now to say a word of thanks to Mr. Shipton. It is an astonishing accomplishment that they should have been able to climb successively twenty-six fine

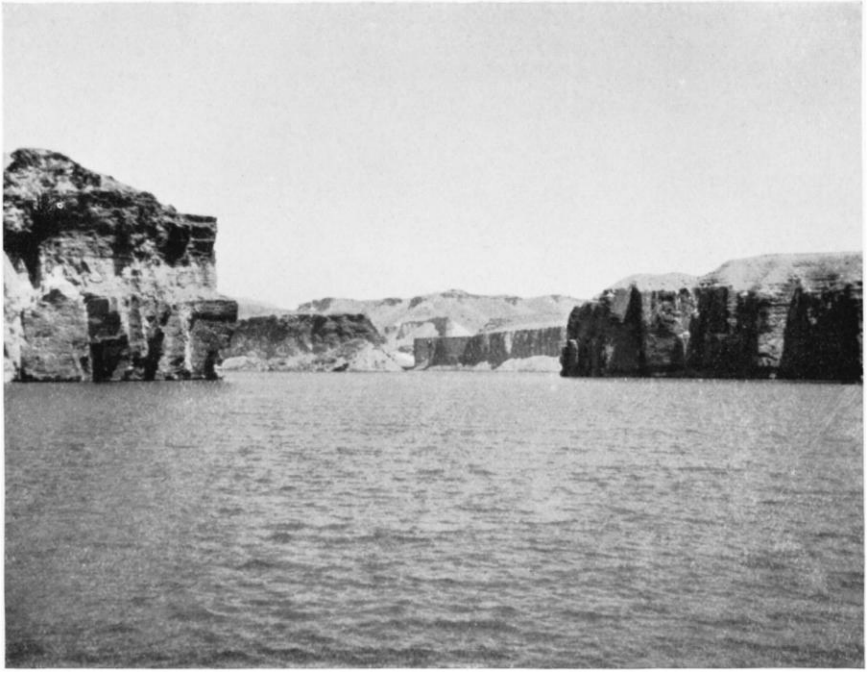
peaks all over 20,000 feet. This, as Dr. Longstaff put it, is more than the separate climbs that we know of in the Himalayas since the days of Adam. You will agree, I am sure, from what you have heard that it was entirely worth while sending out this reconnaissance. We have learned a great deal from it. Unfortunately two men who were believed to be candidates for the 1936 Expedition were found to acclimatize badly and had to be dropped out. If they had not been tried on this occasion they would have gone on the main expedition and failed at the last trial. Mr. Shipton himself has come back extraordinarily fit and well: all the better for his summer experience, and fit to go again and to attack the summit we hope. I ask you to join me in thanking Mr. Shipton and his companions very heartily for addressing us and in congratulating them on their splendid performance.

BAND-I-AMIR

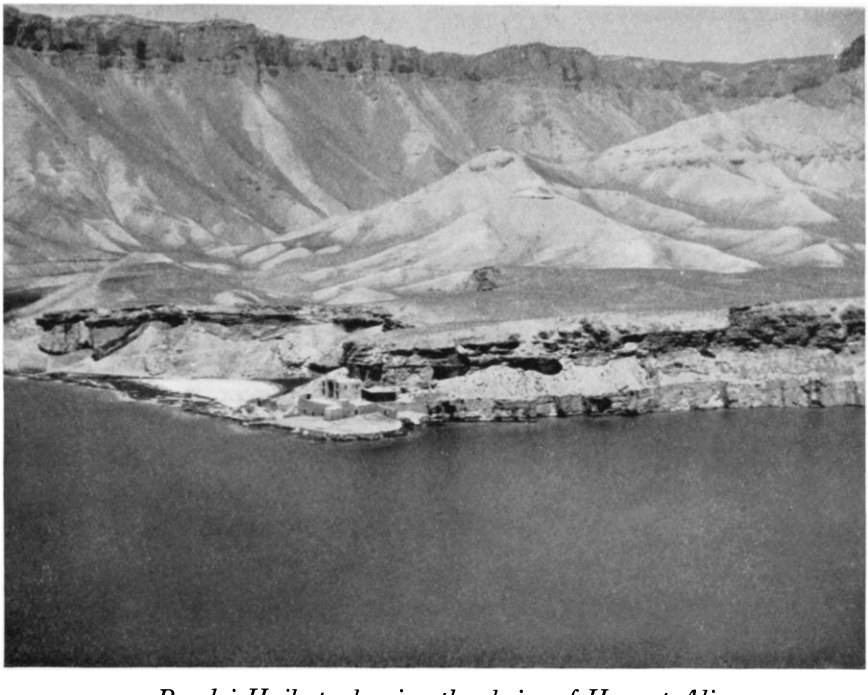
MAJOR W. R. HAY

BAND-I-AMIR is the name given to a chain of five small lakes, or more correctly to the dams which form them, situated about lat. 34° 50′ N., long. 67° 12′ E. in the Yakh Walang district of Afghanistan. They lie at an altitude of about 9500 feet stretched out along the valley of a stream which takes its name from them and which after many wanderings in the mountains eventually debouches into the plains of Northern Afghanistan to feed the eighteen canals of the Hijdehnahr district with the water they conserve. The shores of the most important of the lakes, which bears the name of Band-i-Haibat, can be reached by car from Bamian without very much difficulty in fair weather during the summer and autumn. The distance is about 45 miles and the journey takes four hours to perform. Three passes have to be crossed—the Shahidan (9945 feet), the Shibartu (10,235 feet), and the Kham Kotal (11,660 feet). The last of these is difficult to distinguish and is merely the highest of a series of undulations on an elevated plateau, which when we crossed it in August was dotted with the black encampments of nomad Ghilzais. The gradients are nowhere very severe but some very sharp bends have to be negotiated during the ascent of the Shahidan Pass from the eastern side. During wet weather the soft soil in some of the depressions in the hills turns into deep mud and the road becomes impassable, while in winter the whole country is deep in snow. From the plateau described above the road descends sharply down a narrow spur and before long the traveller sees about 1000 feet below him a strip of vivid blue surrounded by tremendous slopes. This is a portion of the Band-i-Zulfiqar, the uppermost and largest of the lakes. It is about 4 miles long. Another portion of it lying broad and open comes into view farther down the road, with trees along its nearer edge, the only ones visible as far as the eye can range. The second of the lakes—the Band-i-Panir—lies immediately below the Band-i-Zulfiqar and is little more than a pond, being only about 150 yards across. The road gradually descends towards the third lake, the Band-i-Haibat, which is about 2 miles long and 500 yards broad. Its sapphire waters blaze like a jewel in the huge expanse of bare hills. Sheer pink cliffs with numerous inlets enclose the upper portion of the lake. Its southern end is open and the water laps over the great dam of natural rock and falls in thin cascades on to a sort of platform 40 feet beneath. This platform, which is partly rock and partly soil, is all covered with a white or pale yellow deposit, presumably of sulphur, and the water trickles over it to form another small lake a mile or so below. This lake which is known as the Band-i-Kambar is merely a shallow pool. The fifth and last lake—the Band-i-Ghulaman—can be seen in the distance below it. It is circular, roughly three-quarters of a mile in diameter, and said to be quite shallow. The lakes are surrounded for a short distance by low undulating country which is bounded on the west by a huge yellow bluff, rising to about 2000 feet above the level of the lakes, composed of some soft substance and scarred along its face by outcrops of solid rock.

It appears to be the same rock which cropping out across the valley has

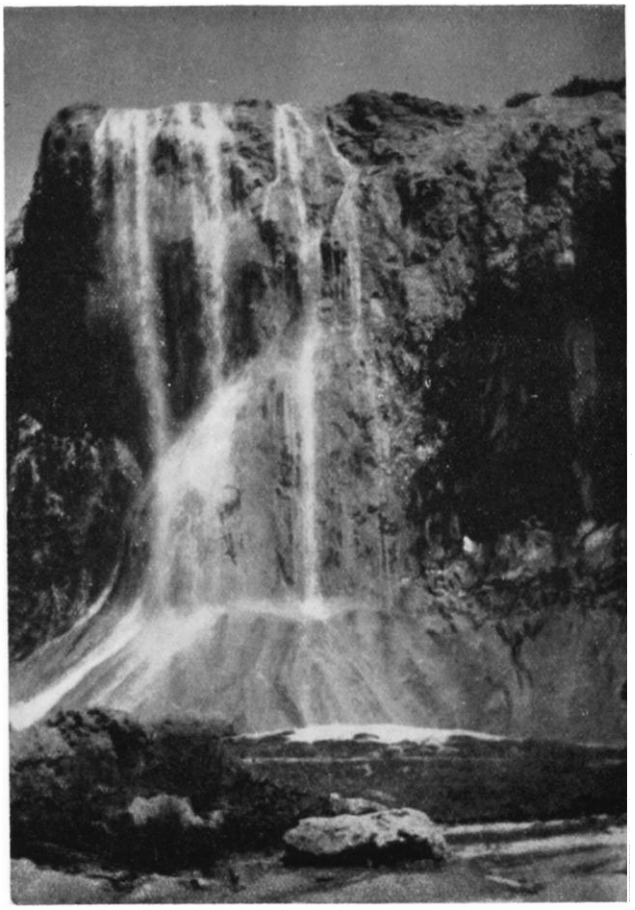


Band-i-Haibat, looking north



Band-i-Haibat, showing the shrine of Hazrat Ali

Band-i-Haibat



Band-i-Haibat: below the dam

created a series of natural dams and formed these unexpected lakes. The barrier at the end of the Band-i-Haibat itself is a wall of solid rock about 40 feet high at the centre, of no very great thickness at any rate at the top and forming an almost perfect curve. The barrier which encloses the Band-i-Zulfiqar is said to be similar in character. The other three barriers are not so perfect and have only allowed comparatively small quantities of water to collect. The traveller crosses the white platform below the Band-i-Haibat and comes up on the western side of the lake where stands a white shrine sacred to Hazrat Ali, the son-in-law of the Prophet. All round the edge of the lake just below its surface runs a ledge of pure white rock which makes even deeper the intense blue of its waters. Swarms of great yellow fishes swim lazily about, and the whole with the quaint white shrine and the straight pink cliffs produces an impression of something nearer fairyland than anything else in this world that it has been my fortune to see.

Soon after our arrival the local Hazaras began to collect and sat quietly round the shrine watching us. One produced a rope—rather than a line—and caught one or two of the yellow fish—which are known locally as *chush*. I went for a swim but the water was so cold that I did not stay in more than a minute. The lake is locally reputed to be unfathomable. It is said that the Amir Habibullah endeavoured to measure it and failed to find the bottom with 75 yards of rope. Numerous flowers grow round the open southern end of the lake and on the face of the rock barrier where it is not too steep. The Shiah Hazaras of the neighbourhood ascribe a miraculous origin to these dams which are so much stronger than anything human art could build. It is stated that in the days of old the land was ruled by an infidel king called Barbar (from whom the lakes are also sometimes referred to as the Band-i-Barbar), who oppressed his subjects mercilessly. One of them, who had been unable to pay some money demanded by the king and whose wife and children had been imprisoned in consequence, went in search of Hazrat Ali to obtain his assistance. He found him on the road near Haibak. Hazrat Ali told him to tie him up with a rope and take him for sale as a slave to Barbar. He was to demand an extravagant price and when Barbar asked the reason to say that the slave could do anything he was told to. This was done and Barbar demanded that the slave should perform three tasks in one day. The first was to kill the dragon of Bamian, the second to dam the valley where the lakes now lie, and the third to bring him the head of Ali. Ali forthwith slew the dragon of Bamian, and then in a mighty rage hurled the rocks together to form the Band-i-Haibat or the Dam of Wrath. He next as with a sword clove the mountains and created the Band-i-Zulfiqar or the Dam of the Swordsman. He then presented himself before Barbar and told him to load him with every chain he possessed. When he had been thus bound he recited the Muhammadan profession of faith on which Barbar and all his minions fell senseless. He thereupon burst his chains, slew a great part of Barbar's army and compelled Barbar himself to become a Muhammadan.

The Band-i-Panir or the Dam of Cheese was created when a nomad woman presented Hazrat Ali with a cheese. He gave her gold in return and she became the ancestress of the Saiyads who now have the care of his shrine. Strictly speaking the term Band-i-Amir is only applied to the three upper dams

as having been created by the Amir, *i.e.* Hazrat himself. The Band-i-Kambar was built by Kambar, the groom of Hazrat Ali, and the Band-i-Ghulaman or the Dam of the Slaves by the fifty thousand servants of Kambar. Immediately below the rock barrier of the Band-i-Haibat there is a spot where the water wells forth icy cold to form a small pool. The water is crystal clear and the bottom of the pool is of a uniform pale yellow. The spring is called the Ab-i-Safa or the Pure Water and is reputed to have miraculous medicinal properties. The story goes that after Hazrat Ali created the dam it proved so efficient that it let no water pass. The people lower down the valley complained, on which Ali with a blow of his fist made the hole through which the water now springs.

It is perhaps hardly necessary to state that Hazrat Ali never visited Afghanistan and that the legends connecting him with the creation of these purely natural dams have no foundation in history whatever.

THE GLACIATION AND SOLIFLUCTION OF MINYA GONGKAR: *A paper read at the Afternoon Meeting of the Society on 10 February 1936*

PROFESSOR ARNOLD HEIM

UNTIL the year 1930 practically nothing was known of the eastern Tibetan frontal ranges and of the highest mountain of China, here called Minya Gongkar. This holy mountain was first designed and measured on long distance by Kreitner of the Szechenyi Expedition [1] in 1877–80 under the name of Bokunka. The height was determined as 7600 metres. Forty-five years later the missionary J. H. Edgar,[2] apparently not knowing of this observation, published a rough sketch from the same point at Yinkwantshai, and called the mountain Gang ka.

The excellent map of Yünnan by Davies 1906 [3] does not show the glaciated frontier wall, and the Map of India only gives the name Mount Koungka.[4]

In 1929 J. F. Rock,[5] on behalf of the National Geographic Society of Washington, made the first photographs from the western side of Minya Konka. The result of his measurements is 25,600 feet or 7800 metres. The following year H. Stevens, of the Roosevelt hunting expedition, published his 'Sketches of the Tatsienlu Peaks.' [6]

After Rock followed the writer's expedition [7] of 1930–31, and the admirable ascent of the summit by Burdsall and Moore of 28 October 1932.[8] Their book contains numerous careful measurements and photographs of geographical importance.

Professor Ed. Imhof, of the writer's expedition, by photogrammetric surveying came to an elevation of 7700 metres for Minya Gongkar, while Burdsall and Emmons, by direct triangulation, found 24,900 feet (7590 metres). If we consider that all measurements are based on barometric pressure, the differences for such a remote region are not surprising. The figures given by Rock seem to be all too high. If we accept 7600 metres, we will not be far off.

Besides the writer's book 'Minya Gongkar,' which in his opinion gives the correct spelling, several papers and reviews have been published, amongst which a few are cited below.[9] The aim of this paper is to give a general view

[1] 'Die wissenschaftlichen Ergebnisse der Reise des Grafen Szechenyi in Ostasien.' Wien, 1893, Bd. I.

[2] Journal of the West China Border Research Soc. Chengtu, 1922/23, p. 58.

[3] Major H. R. Davies, Map of Yünnan 1 inch to 20 miles (1 : 1,267,200).

[4] Map of India 1 : 1,000,000 Sheet No. 100.

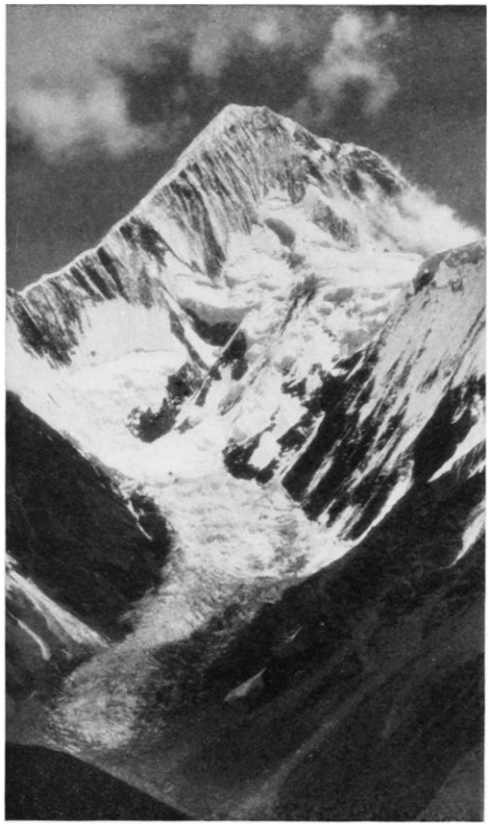
[5] J. F. Rock, "The Glories of Minya Konka." *Nat. Geogr. Mag.* October 1930.

[6] *Geogr. Jour.*, vol. 75, p. 345.

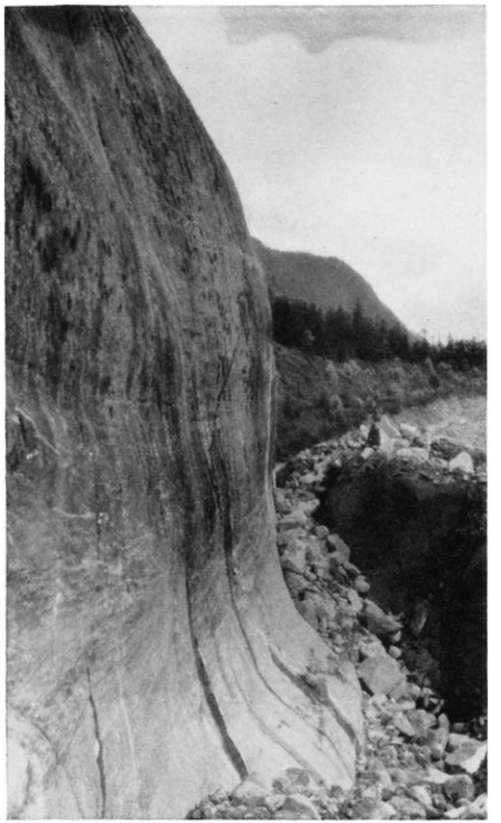
[7] Arn. Heim, 'Minya Gongkar, Forschungsreise ins Hochgebirge von Chinesisch Tibet.' With 26 designs, maps, panoramic view and 146 photos, amongst which 6 plates in colours. Hans Huber, Bern.

[8] R. L. Burdsall and A. B. Emmons, 'Men against the Clouds. The conquest of Minya Konka.' Harper and Brothers, New York and London, 1935.

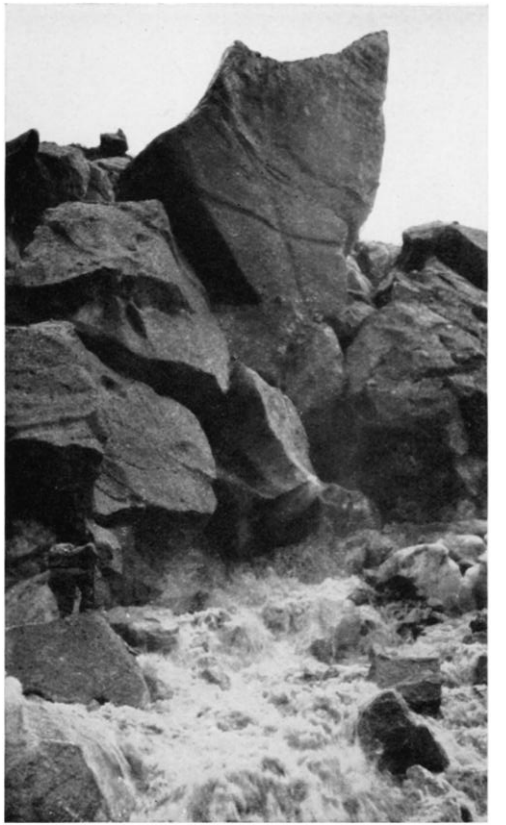
[9] Arn. Heim, "Szechuan–Tibet Expedition der Sunyatsen Univ. Canton." *Zeitschr. d. Ges. f. Erdkunde*, Berlin 1931. "The structure of Minya Gongka. Preliminary sketch." *Bull. geol. Soc. of China.* Peking 1931. Tectonical sketch of the Yangtse



1. Minya Gongkar (7600 m.) and Small Gomba Glacier, from W.



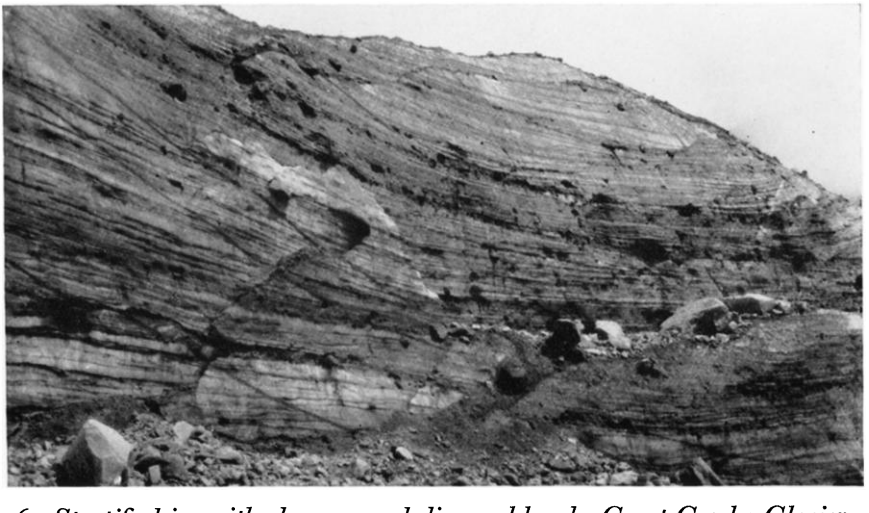
2. Polished granite at knee of Hailoko Glacier, looking E.



3. Dirty block-ice at mouth of Great Gomba Glacier, 3800 m.

4. Great Gomba Glacier: Mount Chu (6500 m.) on left and Nyambö (6200 m.)

5. Minya Gongkar and Gomba Glaciers from the west



6. Stratified ice with cleavage and diagonal bands, Great Gomba Glacier

on the glaciation, while the main geological work with a geological map will follow later.

The present glaciers

The main glacier on the west side is the Great Gomba Glacier. It was first photographed by Rock and called by mistake Nyambö Glacier. The ice is collected on the south side of Minya Gongkar. The stream has a length of about 10 kilometres. The tongue is only 2 kilometres north-east of the monastery Gongkar Gomba, at 3800 metres above sea-level (Pll. 3, 4).

The Small Gomba Glacier derives from the north-west side of Minya Gongkar and joins Great Gomba Glacier at nearly a right angle without contributing to it. It is cut off by the greater neighbour. Both Gomba Glaciers are largely covered with blocks, especially of granite from the highest peaks. Several small green lakes are found on the surface of the moraine-covered ice stream.

On both sides the ice tongue is separated from the slate rock by deeply cut V-shaped glacial streams. The one to the south partly runs on ground moraine and is cut 100 metres deep below the middle part of the glacier. It seems that the glacier is overriding its own ground moraine, unable to remove this abundant detrital material.

The glaciers on the north and east side of Minya Gongkar were discovered by the writer in 1930, the eastern one being the largest of all the glaciers of the range, and the only one which extends down into the forest region.

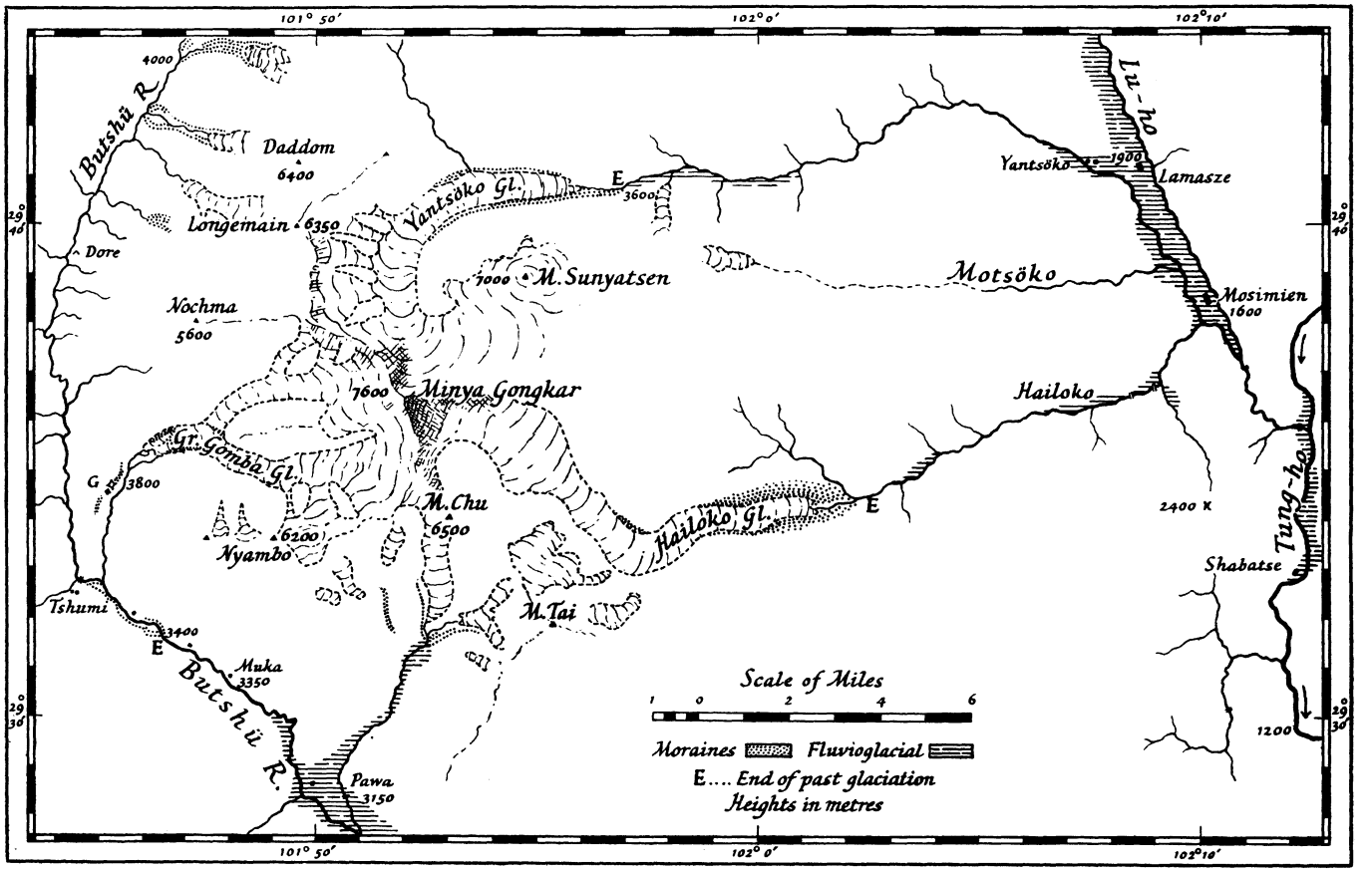
The Yantsöko Glacier derives from the great snow trough between Minya Gongkar and Mount Sunyatsen (7000) and bends around like a snail towards west, then to north and east. A tributary stream of 3–4 cubic metres per second coming from the valley in the north-west falls into a cave of ice and comes out again at the glacier foot 3–4 kilometres farther down, together with the melt-water of the Yantsöko Glacier. In contrast to the Gomba Glaciers, the side moraines are well-defined crests with sharp scarps towards the glacier, 10 to 20 metres in height (Pl. 7, left side). They are probably of pleistocene age.

The Hailoko Glacier has a length of about 16 kilometres and reaches the fir-tree jungle in the shape of a rounded tongue (Pl. 10). It has two ice falls, one just below the knee (Pl. 10), and a larger one with a strongly convex surface of some 500 metres drop in the upper part (Pl. 11). Like Yantsöko, it is accompanied by pronounced ridges of old moraine which are scratched by the actual ice flow. Some very pretty glacier tables are found in the lower part. The glacier gate is surrounded by jungle of firs, beeches, and rhododendron. On account of broken instruments, the elevation could not be measured, but is guessed as about 3000 metres or less.

The next largest known glacier of Gongkar Range is the Djaze Glacier (Pl. 14), 20 kilometres north of Minya Gongkar. Adjoining it is the Reddomain Glacier (Pl. 9). The supposed glaciers on the east side of Djaze Gongkar

from Ichang to the Red Basin. Geol. Survey of Kwangtung and Kwangsi, Spec. publ., No. XIV. Canton 1933. "The Batholiths of Minya Gongkar and Lamoshé, Chinese Tibet." *Eclogae geol. Helv.* 1934.

Albr. Penck, "Minya Gongkar." *Zeitschr. d. Ges. f. Erdkunde* 1934.


101° 50′
102° 0′
102° 10′
29° 40′
29° 30′
Butshü R.
Daddom
6400
4000
Longemain
6350
Dore
Nochma
5600
Yantsöko Gl.
E
3600
7000
M. Sunyatsen
Minya Gongkar
7600
Gr. Gomba Gl.
G
3800
M. Chu
6500
6200
Nyambo
Tshumi
3400
E
Muka
3350
Butshü R.
Pawa
3150
M. Tai
Hailoko Gl.
E
Hailoko
Motsöko
Yantsöko
1900
Lamasze
Lu-ho
Mosimien
1600
2400 x
Shabatse
Tung-ha
1200
Scale of Miles
1 0 2 4 6
Moraines
Fluvioglacial
E.... End of past glaciation
Heights in metres

are yet unexplored. Little also is known of the glaciers between the Tatsienlu Peaks (Lamoshé Glacier, Tatsienlu Glacier, see map 1 : 275,000 in 'Minya Gongkar').

Snow fall and hoar ice

In the upper region the snow falls chiefly during the later part of summer and in autumn, especially in August, September, and October. September seems to be the worst month for travelling. For months the mountains were hidden in clouds. During winter we had only one snowfall of importance, namely on November 22. It was snowing again a little on January 14. Some more snow may fall in early spring. As a whole the winter is dry and clear, and little, if any, snow is found on the Tibetan highland behind the great front ranges. As already pointed out by Edgar, the summer floods of the Yangtse cannot derive from snow melting in the interior, and they are connected only to a very small extent with ablation of ice and snow of the Tibetan front ranges.

Hoar ice seems to be of special importance in the highest regions of Asia, where it may be formed even in summer. Pl. 7 shows Minya Gongkar from the north, with its summit completely covered by a mantle of bright white ice. It sticks even on the vertical walls, where no ice could be formed of snow. Hoar ice produces rounded surfaces. By this and the cleanness it can be distinguished at long distances. In Pl. 7 the lower limit is easily traced between 5800 and 6000 metres; in Pl. 8 (M. Tai) it is at the same level however, without forming a level line.

Even when the sky in winter is clear, all around the highest peak of Minya Gongkar is capped with a white streamer. Sometimes it is made of snow drift, but frequently it must be fog which produces hoar-ice crystals.

The snow line, on account of bad weather, could not be determined accurately. On the west side of Minya Gongkar it seems to be between 5200 and 5400 metres.

Ablation and drainage

As a result of the writer's observation we can state that all the water of Minya Gongkar is drained to the east by the Tung-ho. The glacier water from the west side is collected by the Butshü river. It was estimated at Pawa at the beginning of September 1930 as yielding 40 cubic metres per second. About 80 per cent. of this amount seems to derive from ablation. A similar amount may be produced on the eastern side of Gongkar range. We thus come to a total of roughly 100 cubic metres per second. This figure is still very small as compared with the enormous amount of water carried by the Yangtse in times of flood.

The tropical form of snow melting called *nieve penitente* was observed in Pawa Valley at 5200 metres (October 30) and on Haitseshan on the north-east side of Mount Jara, 50 kilometres north-west of Tatsienlu, at 4400 metres (6 January 1931). (Pl. 15)

Extension of former glaciation and of fluvioglacial terraces

Let us first record some observations on terminal moraines and erratic blocks. The greatest difference between recent and old moraines was found

on the west side of Minya Gongkar. Indeed, the slope at Tshümi (Tsemi) is strewn with huge blocks of granite derived from the summit of Minya Gongkar. The last erratics were noted about half-way between Tshümi and Muka, at about 3400 metres. The pleistocene glacier thus had a length of about 18 kilometres as compared with the actual 10 kilometres, the glacial tongue reaching about 400 metres farther down.

In the Pawa valley the side glaciers just came together. There the old moraines pass into a vast fluvioglacial fan deposit which extends far down below Pawa in the Butshü (Tienwan) Valley (Sketch-map).

The old moraines of Yantsöko Glacier only extended 2–3 kilometres below the block-covered ice of the present time. There the fluvioglacial terrace commences about 40 metres above the glacial river, its surface dipping 8–9 degrees in the direction of the valley. Some 4 kilometres farther down, the terrace is at 50–60 metres, dipping 6–8 degrees towards east.

At the villages of Lamasze and Mosimien the same fluvioglacial terrace is widely extended and cultivated. Its general slope is 5 degrees to east. The rivers on both sides have cut out deep channels down to more than 100 metres below the table terrace. The thickness of the fluvioglacial deposit in places may exceed even 100 metres. Frequently large blocks of several cubic metres are enclosed in the coarse gravel. On the surface of the terrace some granite blocks of 10–20 cubic meters were observed, and one of even 100. It is difficult to explain their position. Possibly they fell down from the slopes before the side ravines were formed.

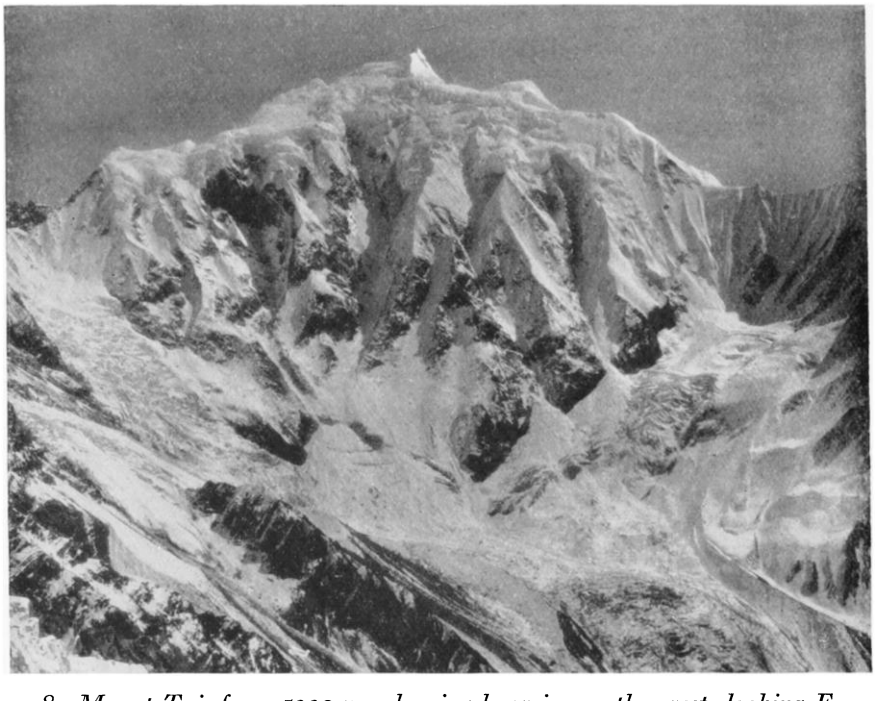
On Hailoko Glacier little, if any, signs of a larger extension of the former glaciation are left in the uppermost part (Pl. 12). Above the knee a left side moraine is preserved, which reaches 15 to 20 metres above the ice. The granite forming the knee is nicely polished up to about 20 metres (Pl. 2). In the lower part of the glacier the left side moraine is overgrown with jungle of fir trees, larches, and rhododendron.

Two crests may be distinguished here, an inner one 15–20 metres above the ice, and an outer, still older one at about 25 metres. Near the glacial gate this old moraine is 60–80 metres high, but seems to reach its end already 2–3 kilometres farther down stream. No connection was seen with the fluvioglacial terrace so well traced at Yantsöko Valley. It seems that the passage zone has been washed out by side streams. But 10 kilometres farther down, at Hailoko (Chinese mountain farms), the fluvioglacial deposits are well developed.

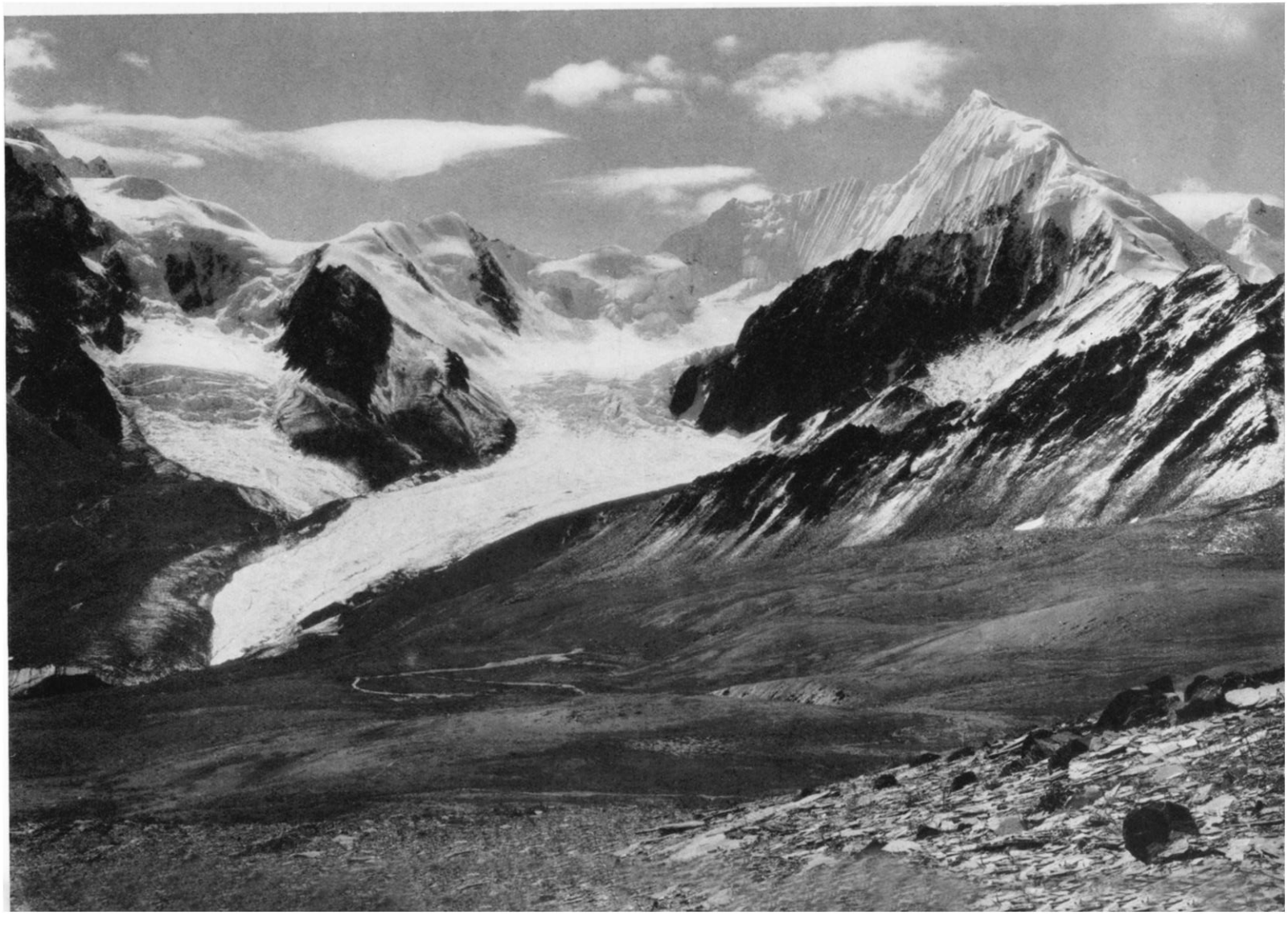
The gravel terrace corresponding to that of Mosimien is at about 70–80 metres above the river. Above it two more terraces were observed. They seem to be terraces of erosion, one at about 130 and one at about 300 metres above the river.

The continuation of the terrace of Mosimien (Mosimien stage of glaciation) is interrupted by a granite gorge, but is recognized again along the Tung-ho. There, in the region of Shabatse, low terraces of 35 and 45 metres above the river were noted, while the high terrace is at 60–70 metres. It is the latter that seems to correspond to the widest extension of pleistocene glaciation (Mosimien stage).

7. Minya Gongkar and Yantsöko Glacier from N.



8. Mount Tai, from 5000 m., showing hoar ice on the crest, looking E.



9. Ice horn and glacier of Red-domain. Foreground under solifluction

Solifluction

It is generally known that in cold regions where the temperature frequently changes around the freezing point, the slopes of talus are gradually slipping. Most beautiful examples of this kind were observed by the writer on the Nugsuak peninsula in Greenland. Even the bottoms of the side valleys there are slipping in the shape of a glacier, although there is no snow field above to collect ice. Solifluction also is known from the Alps, as for instance in the flysch region of the Segnas Pass.

Chinese Tibet in greatest part is made of slates and sandstones of the flysch type. The most characteristic solifluction in this region was observed on the north side of the Rutshe Pass, 20 kilometres north-north-west of Minya Gongkar, at elevations from 5000 metres down to 4200 metres (Pl. 9). More than 5 square kilometres are slowly moving downwards. The plates of slate, especially in the ravines, are frequently raised up (Pl. 9, black spots at right foreground). The cushion plants which cover the ground are torn by cracks which illustrate directly the amount of slipping. Frequently also the stone plates are found in a geometrical order.

Other places of widely extended solifluction are the north-west side of the Cheto Pass west of Tatsienlu at 4600–4000 metres, and Haitseshan Pass at 4500–4200 metres.

In the background of the Pawa valley at 3800 metres, and on the Yatsiaken Pass, at a similar elevation, huge fields of angular blocks were encountered. They have neither the shape of moraines nor of a mountain slide. Rain and fog at Yatsiaken made careful observation impossible. On the north-west side of this pass some small lakes dammed by ground moraine were noted down to about 3600 metres. As a rarity it contains some pebbles of striated Serpentine, a rock not yet known *in situ* in the whole region. Bad weather did not allow me to determine whether this moraine has slipped down by solifluction.

Usually the striæ of solifluction are easily distinguished from those of glaciers. They are more superficial and chiefly or exclusively found on softer and angular rock fragments like slates and sandstones, while those from glaciers, on account of the higher pressure below the ice, may be found on the hardest rocks which frequently are rounded and polished.

Von Lóczy of the Szechenyi Expedition has accepted a very large extension of former glaciation. It seems to the writer that he has confounded striation by solifluction with true glacial striation. In every case it is of greatest importance to give most careful attention to these pseudo-glacial deposits in regions of frozen ground.

Morphological features

The morphological observations are conformous with the determination of the end moraines. Rock polishing so general in the Alps, in Scandinavia, and in North America is rather exceptional on Minya Gongkar. None of the valleys shows the signs of glacial erosion. All the main features are those of water erosion. The old side moraines in the Pawa valley and in the upper Butshü valley just reached the valley bottoms at 3800 and 4000 metres without extending farther down (Sketch-map and Pll. 1, 4, 5, 11, 12). Already the

distant view of the Butshü valley with its sharp crests is characteristic of a non-glaciated valley (Pl. 12).

In vain also the writer sought striated pebbles in the Tatsienlu valley. Neither the Lamoshé nor the Tatsienlu Glacier seem to have ever reached the bottom of the main longitudinal valley.

The above observations show that the former glaciers were more widely extended than they are now, but not to compare with the pleistocene glaciation of the Alps. The former glacier tongues reached 200 to 500 metres farther down at the most. Taking the length of the present stage as 1, the former glaciers reached 1·1 to 1·6 (Gomba 1·6, Yantsöko 1·2–1·1, Reddomain 1·3). In the Alps, where the present glaciation is of the same type, the proportion is from 1 : 12 to 1 : 30, the early glaciation thus twenty times stronger.

The great feature of the pleistocene glaciation is the fluvioglacial deposit. The terrace gravels washed off from the former moraines have a more gentle slope than the actual valleys. The Yantsöko and Hailoko glacial rivers have cut themselves into the gravel terrace 30–40 metres deep in the upper part, 50–60 in the middle, and 70–110 metres in the lower part (Mosimien). The deposition of the vast fluvioglacial material that fills the valleys must have occurred at a time of lesser fall of the rivers. The cause of the accentuation of erosion in recent time must be the general uplift of the Tibetan mountain region. This result already was derived from a study of the platform of Chinese Tibet which must have been formed at lower levels. It was a semi-mature landscape lifted recently into higher levels. The vegetation also points in the same direction. The extreme abundance of semitropical plants mixed with alpine types is explained by the lack of glacial destruction and by this quaternary uplift. Thus the subtropical forms became gradually adapted to the cooler climate, while the nival forms had to migrate downwards and to join hands with their companions from below. All such reflections result in the conclusion that the general cold climate of the pleistocene ice age at the eastern Tibetan front ranges was nearly counterbalanced by its formerly lower position. This is the writer's explanation for the relatively small extent of past glaciation.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: The paper this afternoon is on the "Glaciation and Solifluction of Minya Gongkar." Professor Arnold Heim, who is reading the paper, has travelled over a great part of the world and was for some years Professor of Geology in the University of Canton. He is the distinguished son of a distinguished father, who also was a great geologist.

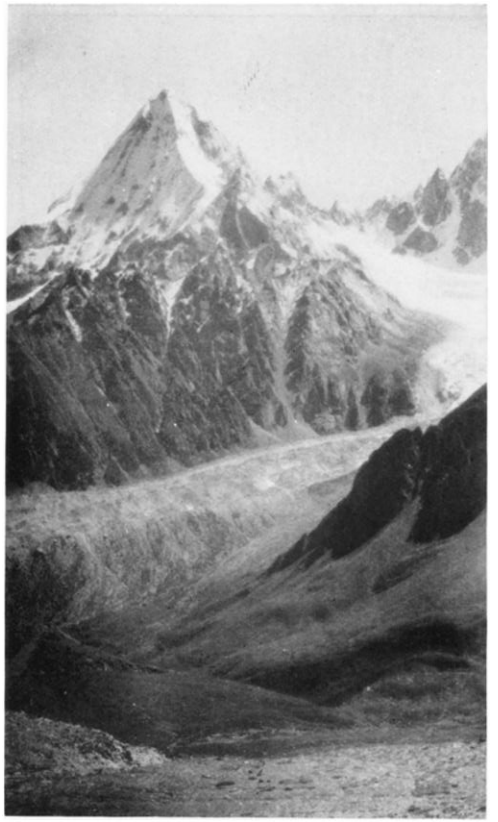
As those of you who have attended recent meetings of the Society know, a great deal of attention has been paid to the movement and behaviour of glaciers, and Professor Heim proposes to address us on this subject. The word "solifluction" was new to me when I heard it recently. I could not find it in the dictionary, and when I asked a friend the meaning of it he said that he was not sure whether the "soli" element in the word referred to melting from the heat of the sun or to movement of the soil. Professor Heim tells me that, so far as he is concerned, it is a word introduced by Gunnar Andersson: and that it relates to the fluctua-

10. Lower Hailoko Glacier, looking down stream

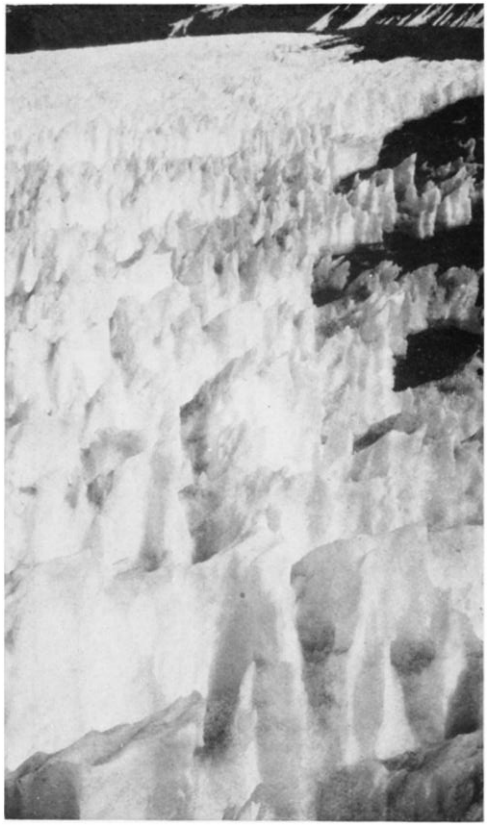
11. Upper Hailoko Glacier and Minya Gongkar from S.E.

12. Upper Butshü Valley shaped by water erosion, looking N.E.

13. Banded ice near end of Great Gomba Glacier



14. Chiburongi (6000 m.) and Djaze Glacier



15. Nieve penitente, Haitseshan (4400 m.)

tion or movement of the soil, and not to melting by the sun. With this brief digression I will ask Professor Heim to read his paper.

Professor Heim then read the paper printed above, and a discussion followed.

The PRESIDENT: Before we go further I should like to ask you to join me in congratulating Professor Heim on the extraordinary perfection and fluency of his English. And now I call upon Professor Boswell, Professor of Geology at the Imperial College, to add a word or two.

Professor P. G. H. BOSWELL: I thank you, Mr. President, for the privilege of being able to join in the tribute to my friend, Professor Heim. As the hour is getting late I will be brief and refer only to two of the geological questions which he raised.

First, his main thesis is that on the evidence of the morphology, the absence of extensive ice scratching, and the mixture of the plant life, this area has, unlike certain other mountain ranges with which we are familiar, risen in comparatively late geological times. Professor Heim is well familiar, of course, with the fact that the extent of glaciation depends not only upon elevation but on the amount of alimentation, and thus on the proximity to ocean waters and the direction of moisture-bearing winds. Although I feel that he has established his thesis on several grounds, probably he will be able to tell me that he has definitely ruled out all possibility that past glaciation here was the result of the non-arrival of moisture-bearing winds.

I feel that the remarks on solifluction—the second point I wish to make—are going to be of very great value to us when we are able to read them in detail. Studies of solifluction phenomena at the present time are far too few. We happen in this country, and of course we share that condition with certain other European countries, to be just on the position of the oscillating ice margins of the great Ice Age, with the result that here where we are standing at the moment we can imagine glaciers reaching perhaps as far as Finchley to the north, and solifluction phenomena, soil creep, and so on, going on in the area southwards to the English Channel. Those deposits have puzzled geologists for many years. They have been attributed to frost and soil movement, but with some caution, and it is not surprising that geologists were afraid of getting cold feet. If we can have present-day evidence of solifluction described from such regions as those that Professor Heim has visited, then such evidence will be of great use to us in the interpretation of solifluction phenomena during the later stages of our own Ice Age here.

There are many other interesting points that Professor Heim has touched upon, but I feel that I must finish with the expression of great pleasure and satisfaction at the success which Professor Heim has achieved in his expedition and in his lecture.

Professor HEIM: The President has asked me to reply to Professor Boswell, and, in doing so, I would point out that when the whole mountain range was lower than it is at present, the alimentation of the moisture was also less, so that is only a further point in my favour.

Professor BOSWELL: Let us not assume that the range is higher now than it was.

Professor HEIM: Yes; but then I do not know whether there was any evidence that the moisture previously was less, so we need not even in that case accept that the mountain was less high because it was so little glaciated.

Mr. PATERSON: I have listened with great interest to Professor Heim's lecture, in view of the work in which I have been engaged during the last three years. I was with Mr. Wordie on his expedition to Baffin Land in 1934, and there paid particular attention to this very phenomenon of solifluction which Professor Heim

has called to our notice. During the summer of 1935 I was busy in the North West Himalaya studying these same phenomena and the glaciations there, so that Professor Heim's observations, though they be in a region fairly far removed from those where I have been working, certainly are of importance to my particular study. I found there many parallels which one might draw.

In the first instance, I am interested to hear and to see Professor Heim's evidence for the action of ice and how much one can attribute to that factor, because I found in the Himalaya that the major part of the erosion is due to the action of water proceeding from the glacier and not to erosion by the glacier itself. Secondly, in Lower Pleistocene times the Sind glacier, now measuring less than two miles in length, was then 60 miles long, a comparison of the order encountered in the Alps. But in the Middle Pleistocene the Pir Panjal or Outer Himalaya was elevated almost 4000 feet and subsequent glaciations nearer the core of the main range were much smaller, which may be due in part to the blanketing effect of the newly risen mountain range, where also corresponding later glaciations were much more extensive. That may help to solve the question which Professor Boswell has raised.

As a third point, the matter of solifluction is deserving of attention because I find in the regions north of Kashmir large areas of *Felsenmeer* similar to those described by Arctic travellers. In Baffin Land these enormous areas of stones extend for as many as 30 square miles, reaching finally to a base angle of slope as small as 5°. Even then stones many tons in weight can move. In the Sind Valley of Kashmir I have seen deposits up to 200 feet thick composed entirely of solifluction material. Solifluction it seems, then, is a factor in geographical development which cannot be ignored and therefore excellent observations such as those of Professor Heim assuredly are of value to a study of that factor.

Professor BARBOUR: In expressing my thanks to Professor Heim I need only add that his picture of the glacial history appears to accord perfectly with recently developed ideas regarding the topographic changes connected with the evolution of the Yangtze, more particularly with its diversion from a previous southerly course during the Pleistocene Period. May I add to the appreciation already expressed by others my own gratitude for a lecture of such interest so well presented.

The PRESIDENT: We should like to have heard Professor Mason, but he has had to leave to catch a train. He has however left a few notes which I will ask Mr. Hinks to read.

The SECRETARY then read the following from Professor MASON: I should like to say how much I have enjoyed Professor Heim's extraordinarily instructive paper. The detailed exploration and survey of this region must have an important bearing on the question of the extension of the Himalaya east of the Tsangpo–Brahmaputra gorge.

In this connection I think there are certain pointers of great interest in Professor Heim's paper. He has, I understand, concluded that the mature landscape of this region of late Tertiary times has been uplifted in Pleistocene times, a conclusion derived from the vast fluvioglacial deposits of an earlier epoch, by the subsequent rejuvenation of streams, and by certain vegetational evidence.

Far away from Minya Gongkar Dr. de Terra has come to a precisely similar conclusion from a study of the terraces and deposits in the region of the Pangong lake and eastern Karakoram. In that region Dr. de Terra has suggested a post-mature landscape in late Tertiary times, with four subsequent periods of uplift, separated by three pleistocene ice advances and followed by dissection.

The same general morphological features at such widely separated intervals

of course proves nothing; but, taken in conjunction with other evidence which is gradually accumulating, it does seem more and more probable that these Tibeto–Chinese ranges, with their strongly marked north–south trends, bear the same relation to the supposed flexure of the eastern Himalaya as the Karakoram–Hindu Kush ranges do to the western Himalaya.

In the north-west we have the resistant horst of ancient India projecting northwards and influencing the trends of all the mountains north of it as far as the Pamirs. In the east there is the resistant block of the ancient Shillong plateau projecting north-eastwards, similarly influencing the trend of the mountains north-east of it. In the north-west the Himalaya have been moulded, with a sharp flexure, as Wadia has shown, round the horst. Beyond the Himalaya the flexure of the Karakoram–Hindu Kush is less acute and, as de Terra has shown, the Karakoram–Tibet region has been raised in very recent times. Wadia, Misch, and de Terra have all shown in different parts of this northern region that even the most recent deposits have been tilted, a fact that shows that these mountains are not yet at rest.

In the east our scanty evidence all points the same way. The ancient Shillong plateau is so stable that the Tertiary deposits lie horizontal and undisturbed along its southern flank. But to the north-east and east there is unrest. The younger outer ranges seem to have been moulded with an even greater flexure round this block than in the north-west; their trend changes sharply from east-north-east in the Abor hills to north–south, and then to north-east–south-west round the head of the Assam valley. Behind them and farther to the east we see an apparently gentler flexure of the Tibeto–Chinese ranges which, in the region examined by Professor Heim, show characteristics identical with those of the Karakoram.

I very much hope that Professor Heim will be able to continue his studies in this field.

The PRESIDENT: It only remains for me to thank Professor Heim most warmly for his interesting and valuable paper. I am sure the experience of many here will lead them to agree with his when he says that on these arduous journeys the tendency is to forget the difficult and unpleasant parts, and to remember only the bright patches. Indeed while he was displaying those beautiful pictures the thought was in my mind what an infinity of toil and perseverance it must have cost him to reach his objective. We must compliment him too on the very clever imitations he gave of the cries made by the Tibetans as they go over the higher passes.

I ask you now to join me once again in thanking Professor Heim for his most interesting lecture, and at the same time express the hope that fortune will enable him to continue his studies of these glacial problems.

Dr. KENNETH SANDFORD sent the following contribution to the discussion: Professor Heim's paper reintroduces from another angle the question of the relative efficacy of rivers and glaciers as valley-eroding agents in mountains. Professor Garwood sifted the evidence and revived this long-standing controversy, so far as it concerned the Alps, in his Presidential Address to the Geological Society in 1931: the tendency in the Alps and Himalaya seems to be toward crediting rivers during glacial minima with profound vertical erosion, and glaciers at their maxima with smoothing and steepening of the valley sides.

In the valleys around Minya Gongkar down-cutting seems to have preceded the deposition of the great fluvioglacial gravels, for Professor Heim quotes from the vicinity of Lamasze and Mosimien gravels possibly more than 100 metres thick and now eroded by rivers to that depth. But there are two terraces of erosion, at 300 and 130 metres above the river in the Hailoko district: there

are therefore at least three periods of river erosion, and now a fourth, and one, at least, of great fluvioglacial accumulation. These recall in some measure de Terra's results, and both authors attribute one or more periods of river erosion to general uplift.

Professor Heim proves the striking contrast between the present and former lengths of glaciers in the Alps, ratio 1 : 12 to 1 : 30, and in this part of Tibet, ratio 1 : 1·1 to 1 : 1·6; he attributes the small ratio of Tibet to lower elevation during the Ice Age than at the present day. While welcoming the further demonstrations of Pleistocene elevation and valley deepening in Tibet and the Himalaya, which may still be in progress, I would like to ask Professor Heim whether the geographical position of Minya Gongkar with relation to the distribution of monsoon rains would not fully account for the small ratio of Pleistocene to present glaciation. In this region there seems to have been no glacial overloading at any time, and it is unlikely therefore that the progress of elevation has been hindered by any extrinsic factor.

Why, then, has elevation halted at intervals? Have there in fact been pauses? If we assume, as it seems we must, that the causes of checks in elevation in this region are geophysical, we must not be too ready to assume that glacial overloading has played a part in punctuating uplift of other parts of the mountain arcs and plateaux.

To conclude therefore even if some of us may be unwilling to accept the ratio of glacier length as evidence of recent uplift, there is abundant evidence of general elevation in the trenching of the valleys. The periods of elevation, pause, or even reversal of movement, here and elsewhere, may be the cause and not the effect of variation of glacial load. Our thanks are due to Professor Heim for this further demonstration of the danger of dogmatizing about Quaternary climate and ice ages from as yet insufficient meteorological and geological data.