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A JOURNEY THROUGH CENTRAL ASIA: *A paper read at the Evening Meeting of the Society on 30 March 1936, by*

PETER FLEMING

LAST year, like many others before me, I had the good fortune to travel overland from China to India. Since Mr. Owen Lattimore made his remarkable journey in 1926–27 certain developments in the political situation have added to the difficulties of the journey. When Mlle. Maillart and I left Peking for India we did not seriously expect to get through, and for the first four months of the journey, which took seven months altogether, we were travelling blind; that is to say, we were no more able than we had been in Peking to estimate our chances of eventual success. During those four months there was always a strong possibility that we should have, sooner or later, to turn back, and there was also, I suppose, a vague possibility of some even more unpleasant eventuality. Though whether any eventuality could have been more unpleasant I rather doubt. Personally I came to regard the prospect of retracing our steps through such desolate country as one of those contingencies which the novelists class as "a fate worse than death."

Politics were an all-important factor in our journey, and unless I say something about them the whole story loses its point. Only a very well-equipped expedition can reach India from China through the barren, almost uninhabited uplands of Northern Tibet. For travellers and merchants the only practicable route is by one of the great trade roads through the Chinese province of Sinkiang or Chinese Turkistan, either along the south of the Takla Makan desert or along the north, the way that Sir Eric Teichman travelled when he left Peking for India last September. It is also the route by which Marco Polo went to China, and the way the Chinese Buddhist pilgrims came to India. For centuries it was the only route over which commerce and culture flowed to and fro between East and West. To-day, of course, trade goes by sea, and Sinkiang is a very much less important place. It is also, curiously enough, less accessible.

I do not propose to go very deeply into the turbid recent history of the province of Sinkiang. Briefly, what has happened is this. In 1928 the governor, General Yang Tseng-hain, was assassinated at a banquet. (Sinkiang has rather curious traditions of hospitality, and most of the first-class assassinations take place at banquets.) Since his installation after the Chinese rebellion in 1911 Yang had ruled the province firmly. His successor was Chin Shu-jen, an official whose rapacity was insufficiently supported by administrative talent and who is now serving three and a half years in a Nanking gaol. Chin's place was taken by the present *tupan* or governor, General Sheng Shih-tsai. Sheng was originally a commander in the North Manchurian forces, and in 1932 he and his troops were driven out of Manchuria into Siberia by the pressure of the Japanese invasion. The Russians interned them with full military honours, and in 1933 they appeared again on Chinese soil at Urumchi, where, with Soviet Government support, Sheng Shih-tsai seized power and contracted a secret loan with the Soviet Government, a strictly unconstitutional procedure on the part of a provincial governor.

At the time of Sheng's reappearance a Tungan invasion from North-West China had precipitated a civil war which ravaged the province for two years. The Tungans are Moslem Chinese who originally had an infusion of Turki blood; they speak Chinese and think Chinese, and for practical purposes differ chiefly in that they are much better fighters than the majority of their compatriots. During the civil war everybody changed sides with bewildering rapidity and the province was as full of sudden rivalries and sudden reconciliations as the last act of a Shakespearean tragedy. Perhaps the most remarkable event during this confused period was the relief of the capital, Urumchi, by a force of Soviet Russian troops supported by aeroplanes, armoured cars, and possibly light tanks. These troops took the besieging Tungans in the rear and eventually routed them. They thus saved the cause of the Provincial Government, who from then on became even more completely the puppets of the Soviet Union.

In these days I imagine it is a fairly unusual procedure for the military forces of one Power to engage in warfare on territory belonging to another Power without either government saying anything to the other before or after the event; but the Russians got away with it pretty well, chiefly by dint of locking up all tale-bearers inside the province and doing their utmost to prevent tale-bearers getting into the province from outside. When we left Peking two Germans and a Swede, the only non-Russian, non-missionary foreigners resident in Urumchi, had been causelessly imprisoned there without trial for over a year; and of those who had tried to go into the province from outside one, a young German, had been murdered (though not by Soviet agents) near Hami; another, an Italian who arrived from Mongolia, had been arrested and sent out of the province. Even Dr. Sven Hedin, whose "face" is great in those parts and who had just concluded a road-surveying mission for the Nanking Government, had had his lorry commandeered by the Tungans and had been treated with great suspicion by the provincial authorities. It was in fact obvious that with Soviet influence astride the two main routes into the province we should be lucky if we got into Sinkiang and luckier, perhaps, if we got out. In the circumstances our only course was to make a flank march which would bring us to the one part of the province which rumour in Peking said was not completely under Soviet influence, namely, the string of oases lying to the south of the Takla Makan desert; in this area the rebel Tungan armies, who had so nearly taken Urumchi, were said to be firmly established. The Tungans had, and still have, a bad reputation, but we reckoned that perhaps they would be glad to see two special correspondents who could air, in India and elsewhere, their grievances against the Russians and the provincial governments. At any rate, it seemed at that time as if our only chance of reaching India was to travel through Tungan territory. We found it therefore convenient to assume that the Tungans were not as black as they were painted.

In order to reach the southern oases without coming up against Russian influence the map showed that we must go to Lanchow and thence, instead of striking north-west towards Hami and Urumchi, travel on past the Koko Nor and across the Tsaidam basin, the floor of which is about 9000 feet above sea-level, and finally cross over the eastern ranges of the Altyn Tagh and drop down into Sinkiang.

We left Peking a party of four. We kept our plans secret. All we said was that we hoped to make a short shooting trip round the Koko Nor. We did not apply for passports for Sinkiang, which were obtainable only from the Central Government and which they were exceedingly reluctant to issue. Mlle. Ella Maillart, who accompanied me, was a Swiss lady who was acting as special correspondent for a Paris newspaper. An international at ski-ing, hockey, and sailing, her powers of endurance are considerable. On a previous journey she had tried to get through to Sinkiang from Russian Turkistan. Unfortunately the Soviet frontier guards on the passes of the Tien Shan did not see eye to eye with her in the matter, and she had to content herself with riding a camel across the Qizil Qum desert in December, which is not most girls' idea of a merry Christmas, but seemed to suit her well enough.

I really gate-crashed this expedition, because it was Mlle. Maillart who had already found the two guides who then appeared to be essential to our plan. They were a White Russian couple, Stepan Ivanovitch Smigunov, and his wife, Nina, who had lived and traded in the Tsaidam for several years and knew the country and the people well. They had been compelled to evacuate when the Moslem rebellion in Sinkiang overflowed into the Tsaidam in 1933, but they were very anxious to get back to their former home. We offered them their travelling expenses and they were glad to go with us. Smigunov spoke Mongol, Turki, and a certain amount of Chinese, and although they knew no European language except their own, Mlle. Maillart spoke fair Russian and I knew enough to get on with. We left Peking by the Peking–Hankow Railway at midnight on 15 February 1935. We had very little baggage with us. The chief items in the supplies we took from Peking were six bottles of brandy and Macaulay's 'History of England.' The train, which for no discoverable reason was called an express, brought us safely to Chengchow. Here we had to make a connection with the west-bound train on the Lunghai Railway. We had been warned that it was a point of honour on the Peking–Hankow line to miss this connection by a matter of minutes, and we found the tradition faithfully observed. We did not want to spend the night in Chengchow and eventually, in the small hours of the morning, after a brisk hand-to-hand engagement, we secured standing room in what was euphemistically called a third-class train, though I do not think live-stock would have rated it higher than eighth-class. It consisted of open-sided trucks of the type which during the war used to be labelled "40 men or 8 horses." I do not think there were any horses in our truck, although it was difficult to see, but I know that our arrival brought the passenger list up to seventy-two. The doors of the truck, like the detachable parts of so much public property in China, had been removed and we accordingly spent a rather cold and uncomfortable night.

All the next day we jolted slowly through the hills of Honan towards Shensi. It is loess country, yellow and dusty, and curiously terraced. It is supposed to be the original home of the Chinese race; the people live in caves rather than in houses. That evening, the second day of the journey, we reached the walled city of Tungkwan, where the train threw in its hand. We spent the night in an inn there, and reached Sian the next day.

Sian was at one time the capital of China. Inside the great walls we found

The walls of Lanchow

The compound of the Mission at Tangar: Mongols loading our camels for the Koko Nor

Kumbum: Lamas coming down from their living quarters to the temples on the other side of the ravine

Mlle. Maillart and the escort in the Pamirs

a great deal of activity, for the anti-Communist campaigns have conferred upon the city the doubtful blessing of strategic importance. General Chiang Kai-shek, the commander-in-chief of the Nanking armies, had recently visited Sian, and he and his wife had launched a campaign which is called the New Life Movement and aims at the social regeneration of China. Its laws with regard to public conduct are very strict, and I was twice "regenerated" by the police for smoking a pipe in the street.

In Sian we had the honour of an interview with the governor of the province of Shensi, General Shao Li-tze. He received us in his *yamen*, which is part of the palace to which the Empress Dowager fled after the Boxer rebellion and the siege of the legations in Peking.

The rest of the day was spent in making arrangements for a lorry in which to do the journey to Lanchow. Everything was fixed up remarkably quickly and that night I wrote in my diary: "We start to-morrow at 8," but I had been in China before and I added: "I don't think." The words proved particularly apt. The lorry arrived at the right time and although it appeared to be fully loaded we climbed on top with our luggage. This was at 8 o'clock in the morning; we finally left the city just before dusk. Our lorry happened to be one of a convoy of three, one of which carried freight belonging to a man who was heavily in debt; his creditors would not let him go until he had given them something on account. It was only by bringing official pressure to bear that we got started at all.

Progress during the next eight days was uncertain and irritating. Short of actually blowing up, the lorries suffered every possible form of mishap. They fell through bridges; ice on rivers which they were crossing collapsed beneath them; they got stuck in the mud; they had punctures. Finally, at the market town of Pingliang, the owner of the convoy informed us that we were held up indefinitely for repairs. Luckily another lorry appeared and we transferred to that and started again with the loss of only one day. I thought at the time that it was rather curious that so many people had come to see us off, but I soon discovered that they were not seeing us off at all: they were all coming too. We started with twenty-seven on board. At first all went well. The lorry was a good one and climbed the 9000-foot Liu Pan Shan passes easily. From the top we could see the naked, curiously terraced hills rolling for miles and miles; it was very desolate country. But the descent was not much fun. The road ran in a series of precipitous zigzags, and we had a dashing driver; it was a terrifying experience. The foreign engineers responsible for the construction of the road had impressed upon their Chinese subordinates the desirability of marking difficult or dangerous passages with the traffic signs such as we use in this country: "S" for a double bend, and so on. The Chinese clearly thought this a good idea, but their sign-vocabulary was weak, and at the difficult and dangerous passages they merely erected a board on which they painted an enormous exclamation mark.

At night we slept in very miserable inns. The four members of the expedition shared a room not much bigger than a large-sized wardrobe, sleeping accommodation being an unheated *k'ang*—a raised earthen dais underneath which a fire can be lit. The heating problem was a simple one: it resolved itself into a choice between being frozen and being asphyxiated. The days

were very long, and there were not many incidents. Once somebody started a fight, which was a very anti-social thing to do on top of a crowded lorry. In this unfortunate conflict Smigunov, the Russian, had to take the part of mediator, who is even more essential and usually more successful in China than in Europe. Once there was a bandit scare, but the bandits never appeared. The weather was mixed: sometimes it snowed, which was a nuisance; and sometimes it was fine, which was an even greater nuisance, because then we swallowed prodigious quantities of dust.

At last, on February 27, we reached Lanchow, the capital of Kansu, on the Yellow River. For days we had been looking forward to Lanchow as a haven of comfort and security, but we had a nasty shock when we got there. The city, as far as foreigners were concerned, was under martial law. There was a Bolshevist scare; Communist troops were attacking the province from the south, and Soviet influence was known to be established at Urumchi, to the north-west. All foreign travellers, and especially Russians, were suspect. The Smigunovs, who like many White Russians in China had adopted Chinese nationality, carried passports issued in Urumchi. This was a suspicious circumstance. For six days I spent my time going round the officials, protesting our innocence and flaunting my connection with the famous T'ai Wu Shih Pao, which is the Chinese name for the *Times* and means the Newspaper-for-the-Exalted-Apprehension-of Scholars. But I did no good, and on the sixth day I was informed by the chief of police that *Ma* and *Fu*, which meant Maillart and Fleming, could proceed, but that the Russians (although no charge was made against them) were to be sent back to the coast under open arrest. This was very bad luck indeed for the Smigunovs, whose chief hope of earning a decent livelihood lay in returning to the Tsaidam. It was also fairly bad luck for us. We had lost, at a single blow, our guides, our interpreters, and our chaperones. It did not then look as if we should get very much nearer India. Of the three languages which were essential if we were to get to the Sinkiang frontier, I spoke only a few words of Chinese. However we decided that we would have a shot at it. We hired three mules, put our luggage on them, and started off on the morning of March 6. As we followed the animals through the crowded sunlit streets towards the Yellow River a troop of cavalry, wearing black fur hats, came clattering round a corner. In their midst rode a prisoner, a burly European with a long fair beard. As he passed he looked up, saw us and said, in a tone of some disgust, "Caput!" On the whole it did not look as if it was going to be a very good tourist season in North-West China.

At the West Gate of Lanchow we said good-bye to the two Russians and the missionaries with whom we had been staying, and moved off up-river. At midday we stopped for lunch at a more than usually fairy-like temple where we ate the regulation meal of *kua mien*. Our meals for the next five days consisted of this substance, which is very good indeed: it is a kind of spaghetti, bought at the wayside for a few coppers, which you eat with a great deal of red pepper. At night we slept in squalid inns; but we were doing long stages of nearly 20 miles a day—sometimes more—mostly on foot, so that we were not particular about accommodation. On the second day out we crossed the Yellow River by ferry and struck up the valley of the Sining Ho. On the

swift-flowing waters of this river huge rafts made of goat-skins or ox-skins were being poled skilfully through the rapids, carrying hides and wool on the first stage of their tremendous journey from the Koko Nor to Tientsin. There was a certain amount of traffic on the road: caravans of donkeys carrying disproportionate loads, travellers of consequence in mule litters; provincial troops coming down from Sining, their officers riding on Tibetan ponies; occasionally a camel caravan. The peasants in these regions are incredibly poor. They appear to live largely on opium and suffer terribly from disease. But Maillart and I had both been inoculated against typhus in Peking with the essence of a great many lice, and we only suffered from bed-bugs. On the third day we crossed the Kansu–Chinghai frontier. The most sinister of the rumours we had heard in Lanchow had been that telegraphic instructions had been sent to the Kansu–Chinghai frontier to have us arrested there. It was therefore with some trepidation that we approached this formidable spot, but, as it turned out, there was nobody there to arrest us, so we went on. We were between 6000 and 7000 feet above sea-level, and though it was cold when we started before dawn it was pretty hot during the day-time. The journey from Lanchow to Sining is usually done in six stages, but we did it in five, doing thirteen hours on the road during the last two days of the journey; so we were very glad indeed to see the walls of Sining, the capital of Chinghai.

Personally I have not much liking for cities, and they certainly brought us little luck on this journey. The first thing the authorities at Sining did was to say that our passports were out of order—as indeed they were—and that we must not leave the town until further notice. The result was that we spent ten anxious days at Sining, playing patience and wandering round the streets. In Sining the Moslems are the most important element in the population.

Meanwhile there had been much telegraphing to Nanking and in the end it looked as if passports were going to be issued; at any rate we were told we could go to Kumbum, the great Tibetan monastery a short day's journey to the south-west, under escort. The escort provided by the authorities proved to be a defenceless old man in his early nineties. At Kumbum we were most kindly received by the lamas. We slept in warm, clean rooms in the lamasery, and Mlle. Maillart was a big success with the monks, of whom there are several thousands in the monastery. I have neither the time nor the learning to say much about Kumbum, except that it is a very curious and impressive place. The monastery, one of the richest and most powerful in Tibet, is sacred to the memory of Tsong Kapa who in the fourteenth century founded the Yellow Sect of lamas. He was from birth destined for the priesthood. When he reached the age of seven his mother cut off his hair with a view to his entering the priesthood. On the spot where the hair fell to the ground a sacred tree sprang up and every leaf of that tree is said to bear a sort of thumb-nail sketch of the Buddha. Whether this is true or not I cannot say, because there were no leaves on the tree when we visited the monastery

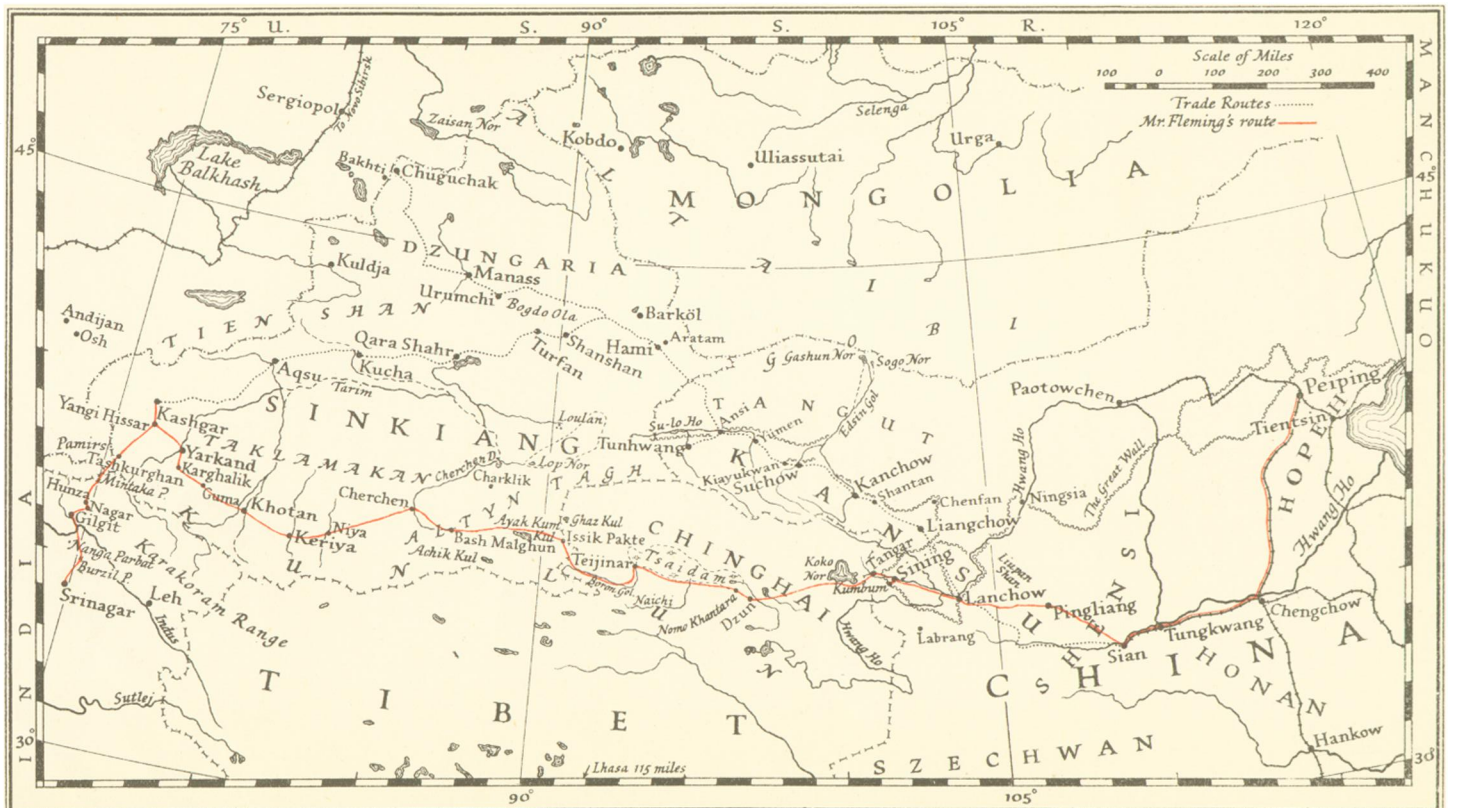
From Kumbum we walked over to Lusar, a small Chinese trading settlement next door to the monastery. Here we interviewed Ma Shin-teh, a rich Moslem merchant to whom we had been recommended by the Smigunovs. He kindly received us in a small but richly furnished room containing no less

than eight far from unanimous clocks, and promised to provide us with a guide for our journey into the Tsaidam. To this day I do not know how he understood what we were talking about, because at that time I knew only about six words of Chinese. When we returned to Sining, we were given a passport authorizing a short trip in the neighbourhood of the Koko Nor. We later discovered that it was the wrong sort of passport; but that, for once, did not matter. We wasted no time in leaving Sining for Tangar, the last Chinese village on the edge of the Tibetan plateau, which we reached, after a long day's journey, on the evening of March 21. There we had a big slice of luck, for we were greatly befriended by Mr. and Mrs. G. M. Urech, the local representatives of the China Inland Mission, who were the only foreigners in the place and who did everything in their power to help us.

At last, on March 28, four camels stalked into the mission compound. They were loaded up and we rode out of the little city in the general direction of India, which at that time seemed a very long way off. We were to join up with the Mongol caravan belonging to the Prince of Dzun, the head of one of the four Mongol tribes in the Tsaidam area. The prince was returning to his home in the Tsaidam, and most of his camels had been hired to Chinese Moslem merchants who were on their way to trade with the Mongols. On the second day out of Tangar we reached a lamasery called Tungkussu. The lamas, flitting like bats in their dark red robes, received us kindly. We had with us a Chinese called Li, who had been provided by the merchant Ma Shin-teh and who had travelled this road for years. He was not exactly a servant: we lived together and ate together on equal terms, but he did very well by us. He spoke excellent Mongol and it was through him that I bargained with the head lama and exchanged my red pony—red, for Tibetans, is a lucky colour in a horse—for a still smaller black one, a spirited animal with an anti-foreign disposition, who never failed to try to buck me off whenever I mounted him.

A year ago this morning [30 March 1935] we left the lamasery and marched south-west through the hills. At the end of the day we came down to a country of dunes where we found encamped some Mongols who were bound for the same caravan as we were. Here, for the first time, we pitched our small tent, a remarkable device designed by Mlle. Maillart. We always had to pitch the tent ourselves—usually in half a gale—so that anything larger would have been unmanageable. It served its purpose very well: it was not rain-proof, but as it never rained that did not matter. Next day we joined up with the main body of the caravan and introduced ourselves to the Prince of Dzun, an effective, cat-like young man in a scarlet robe, who ran his caravan very well. He received us kindly but did not know quite what to make of us. We gave him a secondhand telescope, and although he did not know what to make of that either, we felt we had been accepted at court.

On April 1, a most suitable date, the whole caravan moved off and our journey began in earnest. The Tsaidam is a curious place. On paper it is politically part of China, and geographically it is part of North Tibet. It is, in point of fact, inhabited neither by Chinese nor Tibetans but by Mongols, who wear Tibetan dress, because they are less warlike people than the Tibetans, and are really playing the wolf in sheep's clothing game the other way round.


Scale of Miles
100 0 100 200 300 400
Trade Routes
Mr. Fleming's route
75° U.
90° S.
105° R.
120°
45°
30°
Sergiopol
To New Siberia
Zaisan Nor
Kobdo
Uliassutai
Urga
Selenga
Lake Balkhash
Bakhti
Chuguchak
MONGOLIA
DZUNGARIA
Kuldja
Manass
Urumchi
Bogdo Ola
Barköl
Andijan
Osh
TIEN SHAN
Qara Shahr
Turfan
Shanshan
Hami
Aratam
Gashun Nor
Sogo Nor
Aqsu
Kucha
Tarim
Yangi Hissar
Kashgar
Yarkand
Karghalik
Pamirs
Tashkurghan
Mintaka ?
Hunza
Nagar
Gilgit
Nanga Parbat
Burzil P.
Srinagar
Leh
Indus
Karakoram Range
Sutlej
INDIA
SINKIANG
TAKLAMAKAN
Cherchen R.
Charklik
Loulan
Lop Nor
Tunhwang
Su-lo Ho
Ansi
Tumen
Edsin Gol
TSAIDAM
Kiayukwan
Suchow
Kanchow
Shantan
Chenfan
Ningsia
Hwang Ho
The Great Wall
Paotowchen
Peiping
Tientsin
HOPEH
Hwang Ho
Liangchow
Cherchen
Guma
Khotan
Keriya
Niya
Ayak Kum
Ghaz Kul
Issik Pakte
Bash Malghun
Achik Kul
Kul
ALTYN TAGH
CHINGHAI
Teijinar
Tsaidam
Koko Nor
Tangar
Kumbum
Sining
Liupan Shan
SHENSI
Lanchow
Pingliang
Tungkwang
Chengchow
Sian
Naichi
Nomo Khantara
Dzun
Labrang
Hwang Ho
TIBET
SZECHWAN
CSHIHONAN
Hankow
Lhasa 115 miles
MANCHUKUO

We marched along the southern shore of the Koko Nor for three days, camping wherever there was fresh water. The lake is 10,000 feet above sea-level and 1630 square miles in area. It was frozen over when we passed it. The routine of life with the caravan was simple. Li used to wake us up before dawn with what he appropriately called "eyewash water." For some reason we had forgotten to take a basin with us and such washing as we felt compelled to do had to be done in the frying-pan. The only unpleasantness about life at that time was a violent and relentless head wind which came down from the west, sometimes accompanied by snow. The wind was with us all the time and made talking, smoking, and even consecutive thought practically impossible. It got on one's nerves, and its violence made it difficult to control the cooking fires. Twice the camp was nearly burnt out and we had to beat out the flames with sheep-skins.

The caravan was a fine sight on the march; 250 camels and 50 or 60 horsemen—a file of men and animals over a mile long—wound slowly between the frozen lake and the low but jagged mountains enclosing it on the south. But the stages were very monotonous and everybody was glad when the prince wheeled off the track and dismounted, for then we knew we could put up the tents, make tea, and get out of the wind.

For the first few days our life was complicated by sight-seers and we began to realize what it must feel like to be a bearded woman. Both the Mongols and the Chinese were vastly intrigued by us and our possessions; the one thing they could not understand at all was my pipe. They all smoke Chinese pipes with small metal bowls; owing to the treeless nature of the country the people have little experience of wood, and they could not understand why the bowl of my pipe did not catch fire when I lit the tobacco. The most important item in our food supply was *tsamba*, which we ate for breakfast and lunch for three months and which did not need cooking. It is roast barley meal which is eaten by soaking it in tea with rancid butter. After lunch I used to go out with a ·22 rook rifle. I was very lucky all the time, for I usually got a goose, or a hare, or a pheasant, or mandarin duck. The last is not generally considered fit for human consumption, but it is actually very good. On the third day out I got an antelope by a fluke shot at a range of 403 paces. I mention this because it sent up our stock in the caravan. Most of the men had never seen white men before, and they used to call me by a Chinese term of respect, meaning "Pastor." Mlle. Maillart they referred to as "that French person"; they had never heard of Switzerland.

On April 4 we left the lake and struck south-west into the mountains. The country became very barren and for four or five days we saw no sort of habitation, not even the crouching black Tibetan tents which we found occasionally along the lake shore. There was not always water where we camped and sometimes we had to load lumps of ice into sacks or melt snow from the snow-drifts. It was fairly cold. On April 5 we climbed a steep little pass, about 12,000 feet high, and the animals had to be taken slowly on account of the altitude. From the pass we dropped down on to bare tablelands, and here for the first time we saw wild asses. They are very pretty creatures to watch as they wheel and gallop in herds of ten or fifteen, manoeuvring with the precision of cavalry. They are very attractive animals, and we were not

altogether pleased when an old Chinese broke the leg of one with a long shot and it was some time before the animal was killed. On the march everybody went armed on account of the Tanguts, a Tibetan tribe with a bad reputation which I have no doubt they do not deserve. We crossed another pass where we saw our first and last trees on this part of the journey; and after that we dropped down to a place where there were some tents and Chinese-style mud houses. On April 10 we crossed a little pass at the end of a valley which was, for superstitious reasons, festooned with bones of sheep and hares. Here we met a string of small Tibetan yak and camel caravans, coming from the south by a road which led ultimately to Lhasa. From now on we had done with the mountains. We were marching through a country of dunes and rank grass, typical of the country round the edge of the Tsaidam marsh. The prince began to show signs of being in a hurry, because he was getting near home, and we did a march by moonlight, a ghostly and unreal affair. At last, on April 12, slithering over the greasy plain on the edge of the marsh, we sighted Dzunchia, the headquarters of the Prince of Dzun. It was typical of us that, although Dzunchia was a most important place in our plans, we had not the slightest idea what it was going to be like. It proved to be a dilapidated monastery round which had sprung up a warren of little mud huts used as a trading post by Chinese merchants in the summer months. We spent three days at Dzunchia while Li was hiring fresh camels from the Mongols. The prince's caravan went no farther west, and from Dzunchia on we had to travel on our own. Life was dull while we were waiting to start again. Our chief occupation was avoiding the head lama, a very boring old man, and writing farewell letters. After so many false starts we were pretty good at this. They eventually filtered through to Europe and were the last news anybody had of us until we reached Kashgar at the end of July.

The only other party going farther west was a party of Chinese Moslems who were prospecting for gold in the mountains round the Tsaidam. They were not very satisfactory travelling companions, and we did not want their company on the road because we knew it was difficult to get animals that season; but we could not refuse it. At Dzunchia they could not get enough camels and had to make do with half-bred yaks. At last our camels came and on April 16 we were marching west again in warm sunlight which brought the mosquitoes out of the marsh. Our next objective was Teijinar, but we soon learned that our new camels would only take us as far as Nomo Khantara, a kind of tribal boundary between the Mongols of Dzun and those of Teijinar.

Nomo Khantara, which was only two marches distant from Dzunchia, was an encampment in an endless grove of tamarisks. Here we found two Tibetan lamas who had been held up for a fortnight because the Mongols refused to hire them camels. They refused to hire us camels too, so we spent six days persuading them to change their minds. Those six days, as I afterwards discovered, were the Easter holiday. Nomo Khantara is not a very good place at which to spend Easter. The visitor will find it secluded and salubrious, but it is lacking in gaiety. There are no tracks and no landmarks, so that it is not safe to wander out of ear-shot of camp. On the first day we spent there one of the boys with the gold-seekers went off and never returned. We sent out search parties by day and lit bonfires by night and the lamas did a good

deal of intensive clairvoyance, but all to no purpose; the boy was never found. He must have died of hunger and thirst, possibly quite near camp. Apart from hare-shooting and patience, both of which are good at Nomo Khantara, the chief feature of interest was the "Lost City" about a mile to the north of our camp. I know it was not a city, and I am not at all sure that it is lost, though I find no reference to it by other travellers; but that was what we called it. It consisted of two ancient mud forts, the largest some 300 yards square, with crenellated walls about 30 feet high and 10 feet thick. Neither the Mongols nor the Chinese could tell us anything of their history. It is difficult to see why anybody should erect forts at a point of no strategic value on the edge of a marsh. A few miles farther west we found a large mausoleum of Turki pattern, which makes the whole problem even more complicated. All one can deduce is that the Mongols at Nomo Khantara, who alone in the Tsaidam cultivate barley, learned the arts of husbandry from whoever garrisoned those forts.

On April 23 we moved off again. The next stages were now monotonous in the extreme. Our chief interest lay in seeing whether we could keep ourselves in meat, which we always just managed to do. Although we were 9000 feet up, it was hot by day and we were troubled by mosquitoes; but at night water still froze inside the tent. After six more stages we reached Gorumu, on the Naichi river, which, like all the rivers in the Tarim and Tsaidam basins, is a standing refutation of the poet's theory that even the weariest river winds somewhere home to sea. These rivers, of course, do nothing of the sort. At Gorumu we were delayed for three days by the necessity of changing camels, for which Li paid in cloth and bricks of tea; many of the remoter Mongol communities have no use for silver dollars. There was a certain amount of gold in the Naichi, and the Moslem gold-seekers decided they had come far enough. From now on we travelled alone, and it was a relief to be no longer treated as a cross between Harley Street and Whipsnade.

The future was extremely uncertain. We badly needed information with regard to the situation in Southern Sinkiang. Were the Tungans still in control of the oases? Were they still fighting, and, if so, what sort of temper were they likely to be in? We hoped to find at Teijinar two sources for this information. One was a Cossack, a friend of the Smigunovs named Borodishin, who was known to have been at Teijinar two years ago and might be there still. On the road we asked everybody we met whether there was a foreigner at Teijinar. Some said there was; some said there was not: most said they did not know. It was not until we reached Teijinar on May 7 and saw Borodishin that we realized that our luck was in. We found him a charming man, living in the most desolate exile you can imagine. He was delighted to see us, and we him. Unfortunately he could give us no news of Sinkiang. Our other source of information was equally disappointing. The Turki merchants who used to come from the southern oases to Teijinar had for two years not been there at all; since the civil war broke out in 1933 no news from the province had filtered through. We knew no more than we had known in Peking. Borodishin however said he would help us as far as he could. He advised us not to take the main route, which runs slightly north of west to Gass Kul and on to the oasis of Charklik, but to follow a little-used road through the mountains.

We were not likely to find a frontier post on it, and as we had no passports that was an important consideration.

Nobody would take the risk of hiring us camels for the journey since they were unlikely to return from it; we had to buy them. The local prince of the Teijinar Mongols was away, so we had to deal with his young son, a boy who combined pride with prejudice and did not take to us. He forbade his subjects to sell us camels. Luckily his prime minister, or the man we used to call his prime minister, went behind the young man's back and finally we got four good camels at a stiff price. At Teijinar we paid off the faithful Li. No Mongols would come with us. On May 15, exactly three months after leaving Peking, we moved off across the desert towards the mountains with Borodishin in the lead. We had four camels and two horses. It was a grilling hot day, but in the foothills we were hit by a bitter wind and a sandstorm. We had to dismount from our horses and walk, numb with cold, in the lee of the camels. We camped that night in the gorge of the Chulak Akkan river, or the Boron Gol, as the Mongols call it. Next day we started off again in a minor blizzard which luckily did not last long. The country was extremely barren, and for three days we saw no living creature except two extremely small lizards. We were doing long nine-hour stages, and my black Tangut pony was showing signs of collapse. Both our horses were apparently in good condition; but they had both eaten the first fresh grass of the year at Teijinar, and the Mongols in those parts say it always has a weakening effect on horses.

On the fourth day we came to a place where there were three Mongol *yurts*, and here we halted for a day to rest the animals. We persuaded one of the Mongols to come with us to help with the camels and the loading, because Borodishin had a weak heart and it was pretty heavy work. We were still nominally in China, but the only sign of Chinese influence was a large stone which the Mongol brought with him to ring our silver dollars on in order to be sure whether they were good or not. Luckily they were. On May 20 we started off again. The valley widened out and there were large herds of orongo antelope and some wild asses about. What they found to live on in that stony waste I do not know. We had no grazing for our horses, and very little for the camels. The river was frozen and from time to time the ice cracked with a noise which would have justified more romantically minded travellers in saying they had been sniped by bandits. On May 23 we left the Boron Gol where its course takes a southward bend and struck north-west across rolling desert country 14,000 or 15,000 feet above sea-level. My horse was more or less out of action; we had to drag him along. There was no trail and Borodishin and the Mongol lost their bearings. We finally stopped, after a march of nearly twelve hours, without having found water. Actually this was no great hardship at that altitude. In the morning we found the spring for which we had been looking, and after two more long stages we reached Issik Pakte, our immediate destination. There we found a Turki encampment, and when we saw the non-Mongoloid faces we felt that we were almost back in Europe; or, at any rate, in the Caucasus.

This was very comforting; but it was less comforting to find that at Issik Pakte, as at Teijinar, there was no news at all of conditions in the southern oases. For two years this little community of half a dozen Turki families had

The Boron Gol Gorges: Borodishin leading the camels

Prince of Dzun's caravan camped S. of the Koko Nor

The southern route along the Takla Makan, between Niya and Keriya

Leaving Cherchen: the Desert Poplar (P. varifolia)

lived entirely cut off from their fellows. They had subsisted on the meat of wild asses and antelope, washed down with red pepper boiled in water. For all we knew about the situation in Sinkiang we might as well have stayed in Peking.

Borodishin could go no farther, for White Russians have a very low survival value in Sinkiang. However he persuaded the Turkis to provide us with two guides to take us to the next inhabited spot, Bash Malghun, twelve stages further west through the mountains. During the two days we camped at Issik Pakte I shot two young antelope which provided us with meat; we compiled a Turki glossary; and I exchanged my horse for a very curious little mare which the Turkis produced out of the salt marsh, a creature amphibious rather than equine in appearance, suggesting nothing so much as a water-rat suffering from mange; but she was a very brave little animal. At dawn on May 29 we said good-bye to Borodishin with great regret and he rode off eastwards; an hour or two later we started west. For two days we marched along the northern shore of the Ayak Kum Kul. Water was only procurable by scrabbling in the shingle close to the lakeside. None of the water was good and some of it must have been very bad indeed. At any rate on June 1, when we left the lake and struck up towards a low pass in the mountains overlooking it, a kind of creeping paralysis began to overtake our caravan. Two of the camels showed signs of distress, and presently one collapsed. We removed his load and left him. For the rest of the day we travelled on very slowly and made a dreary camp that night in a waterless gully nearly 15,000 feet up. The barley was finished and there was no food for the horses. The next day we managed to drag the other sick camel for about three hours, but then he too knelt down and would not rise, so we had to leave him. I did not shoot either of those camels because I knew their sickness was due to bad water rather than to inanition, and I thought that they had a chance of recovery.

The most unsatisfactory feature of this outing was the behaviour of our Turki guides. They were throwing away camels as casually as if they had been cigarette ends. They also had inconveniently large appetites, and our supplies were low. After we lost the second camel the guides set off with the survivors at a very brisk pace and were soon out of sight. There was no trail of any sort, and Maillart's horse was getting very weak. It could only be kept going by pulling and pushing, and we had great difficulty in following the camel tracks across the hard surface of the plateau. By midday we were almost carrying Maillart's pony. We knew he was no more good to us, but we could not leave him where there was no grass and no water. Ultimately we somehow dragged him into camp, after dark, by a little river called the Toruksai. Here there was a certain amount of grass and we lay up for a day. Maillart discovered a sore on the back of one of our surviving camels and doctored it very effectively with little help from the Turkis or, for that matter, from me. On June 4 we marched on again. Before moving away we gave Maillart's pony a feast—or the best we could produce in the way of a feast—of *tsamba*, some filthy dried apples we had with us, and antelope meat. He ate these very readily and started off with us. We forded the river, but on the other side he stopped and hung his head, and we knew that he could not do another stage. It was much better to leave him where there was water and a certain amount

of grass; so we went on, after taking his saddle off. He was an ugly pony, but we had grown very fond of him.

We were now working our way round the northern slopes of the Achik Kul Tagh range. Here we saw a good many marmots, one of which I shot, an animal unique in the expedition as being the only one we shot and did not eat. We were doing long stages, the longest being on June 6, when we marched for fourteen hours without a break and camped, after dusk, without finding water. Maillart did more than half this stage on foot, because at the start we could not catch the little mare. At last on June 8 we reached Bash Malghun, a small Turki encampment in a patch of grass and scrub. We were received with a certain amount of incredulity, but the news, as far as we could understand it, was good. The Tungans were in control of the southern oases, but nobody seemed to think that the Tungans would not be glad to see us, so we got two guides and two donkeys to supplement the surviving camels and went on. On June 13 we crossed the last mountain range between us and the Takla Makan basin, and dropped down into the desert, which struck us at the time as being abominably hot. There was only very little water there and that was salt, so we only halted for a rest and at dusk marched on for seven hours into the night. The camels were tired and the dunes were cruel going. Both camels and donkeys were on the point of collapse, but we managed to keep them going. At last, on the evening of June 14, we saw a line of pimples on the horizon which we knew could only be the tree tops of the oasis of Cherchen. We camped for the night, well pleased.

The next day, June 15, exactly four months after leaving Peking, we marched into Cherchen. I do not suppose there is any greater contrast on earth—except between sea and land—than the contrast between desert and oasis, and it was a delightful experience to come into this oasis. Here were all the sounds we had almost forgotten: the wind making a pleasant noise in the leaves; water running musically; doves cooing and cuckoos calling. Then we heard a cock crow and remembered that we had not eaten eggs for about three months. The little mare was terribly disconcerted, because she had never seen a tree before and did not know what to make of it.

This was all very nice, but unfortunately we were almost immediately arrested by a Tungan officer and an orderly who rode up and interrogated us. They then took us to the bazaar, deposited us in a building which looked suspiciously like a prison, and went off with our passports to military headquarters. Our passports did not entitle us to enter Sinkiang, and Chinese officials are very particular about this sort of thing. I thought we were in for a long stay, but, for some unknown reason, they viséd our passports without even pointing out that they were out of order, and a few hours later we were comfortably installed in a large house over the gateway of which flew no less an emblem than the Union Jack. This was the house of the British *aksakal* ("white-beard"), the local representative of the consul-general in Kashgar.

We stayed at Cherchen for five days, and spent most of the time eating and doctoring; we could not persuade the people that we were not highly qualified physicians with an unlimited supply of medicine. On June 20 our luggage was loaded on four donkeys and we took the road again; as we had been unable

to sell our two camels and the little mare, we took them with us unloaded. June and July are not the best months in which to travel in the Takla Makan. Maillart at this stage developed acute lumbago, and I imagine the last thing one wants to do when one has lumbago is to ride for ten hours without a stop through desert. Nevertheless at the end of every stage she still had sufficient strength to doctor the camels who had sores on their backs in which flies had laid eggs and which were now full of worms. She completely cured the sores. For nine days we marched on through mixed country: sometimes dune country, sometimes terraces of white hard mud, sometimes just flat desert. Five Turkis joined up with us, including a woman. They were rather tiresome people. One young man insisted on singing all the time; he only knew two songs. In this empty country we felt very homesick for the mountains and cursed the mosquitoes. Curiously enough, the things we missed most were uncertainty and hunger. It was too hot to eat or want to cook, and we lived almost exclusively on tea and bread. Although a journey through country held by rebel Tungan armies sounds, on paper, very exciting, in practice it is nothing of the sort; therefore we missed the uncertainty. The only thing we had to look forward to was the water-holes, which were saltish and full of obscure forms of insect life. It was only when we reached India that we were made to realize what a serious breach we had made with expeditionary etiquette by drinking unboiled water and going without hats. They practically told us that we had got to go back and do the thing properly. We crawled on very slowly day after day. We had only been able to purchase one horse in Cherchen, and chivalry and Maillart's lumbago compelled me to ride a donkey. Thrice we were hit by sandstorms, which is an unpleasant experience. On June 28 we reached the oasis of Niya, cooled off there for one night, and went on for another three days through the desert to Keriya. Here the road or track began to be more definitely marked, the chief features of the landscape being what the Chinese call *potai*, a kind of enormous milestone put up at, roughly, $2\frac{1}{2}$-mile intervals. Some say they were erected by Chingghis Khan, but I think they were put up by the Chinese. At Keriya there was a large Tungan garrison, the commander of which sent us four sheep and six bottles of Russian eau de Cologne. All the bazaars were flooded with cheap Russian goods, for Russia dominates the province, politically as well as commercially.

On July 6 we reached Khotan, the headquarters of the Tungan army, and here we paid a number of official calls, including one on the commander-in-chief of the Tungans, a young general called Ma Ho-san. We also inspected the "mint," and were interested to hear that no less than 30,000 banknotes a day are produced without a penny of capital behind them. At Khotan we also found an eighty-five-year-old Armenian, a British subject who took in the *Times*. From his papers we learnt that England had been celebrating the Jubilee. We stayed for three days in Khotan, and then did six more very hot stages which took us out of Tungan territory. After passing the last Tungan military post we travelled through an informal demilitarized zone into territory controlled by the Provincial Government, which is of course controlled by the Russians. The Turki troops on the march sing the same kind of Communist songs as you hear in the streets of Samarkand and

Tashkent, and every unit is run by a Soviet agent holding an "advisory" position on the staff.

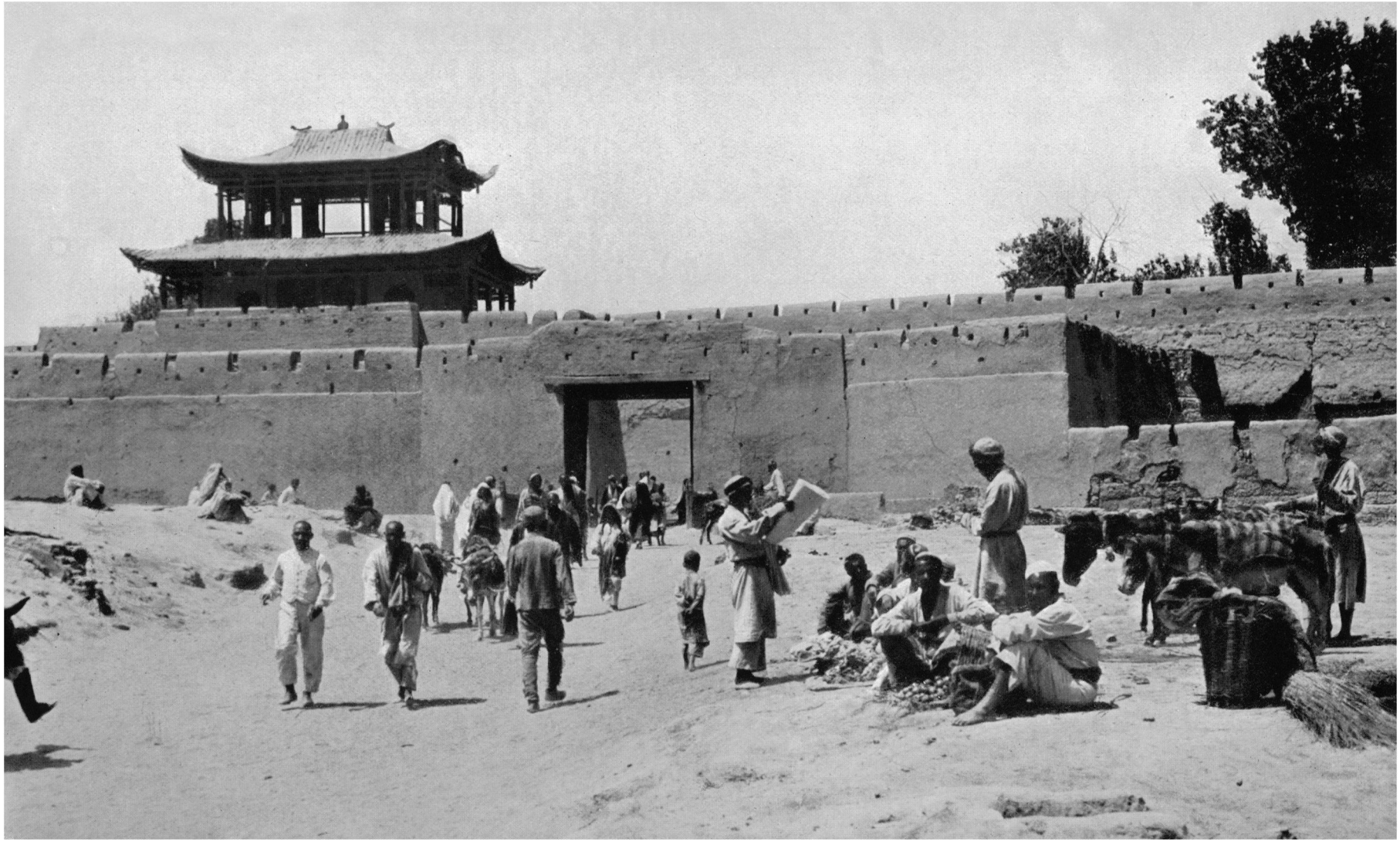
On July 17 we reached Yarkand. During the Chinese civil war the New City withstood a siege at the end of which the Chinese garrison were granted safe conduct to Kashgar. They marched out of the city and, in accordance with the best traditions of the province, the whole two thousand of them were massacred in the desert. We were now pretty tired, for we had been travelling fast. We were only four or five marches from Kashgar and very excited at the prospect of reaching it. We entered Kashgar looking like something which had escaped from Devil's Island. But Colonel and Mrs. Thomson-Glover and Mr. Barlow, the vice-consul, gave us the kindest of welcomes. Although the nearest railhead in India was six weeks away, we felt that we had got to the heart of civilization. We spent a fortnight at the consulate as the guests of Colonel and Mrs. Thomson-Glover. We paid many official calls, and on our last night in Kashgar the officials gave a banquet in our honour. There were a great many speeches in several languages but no assassinations.

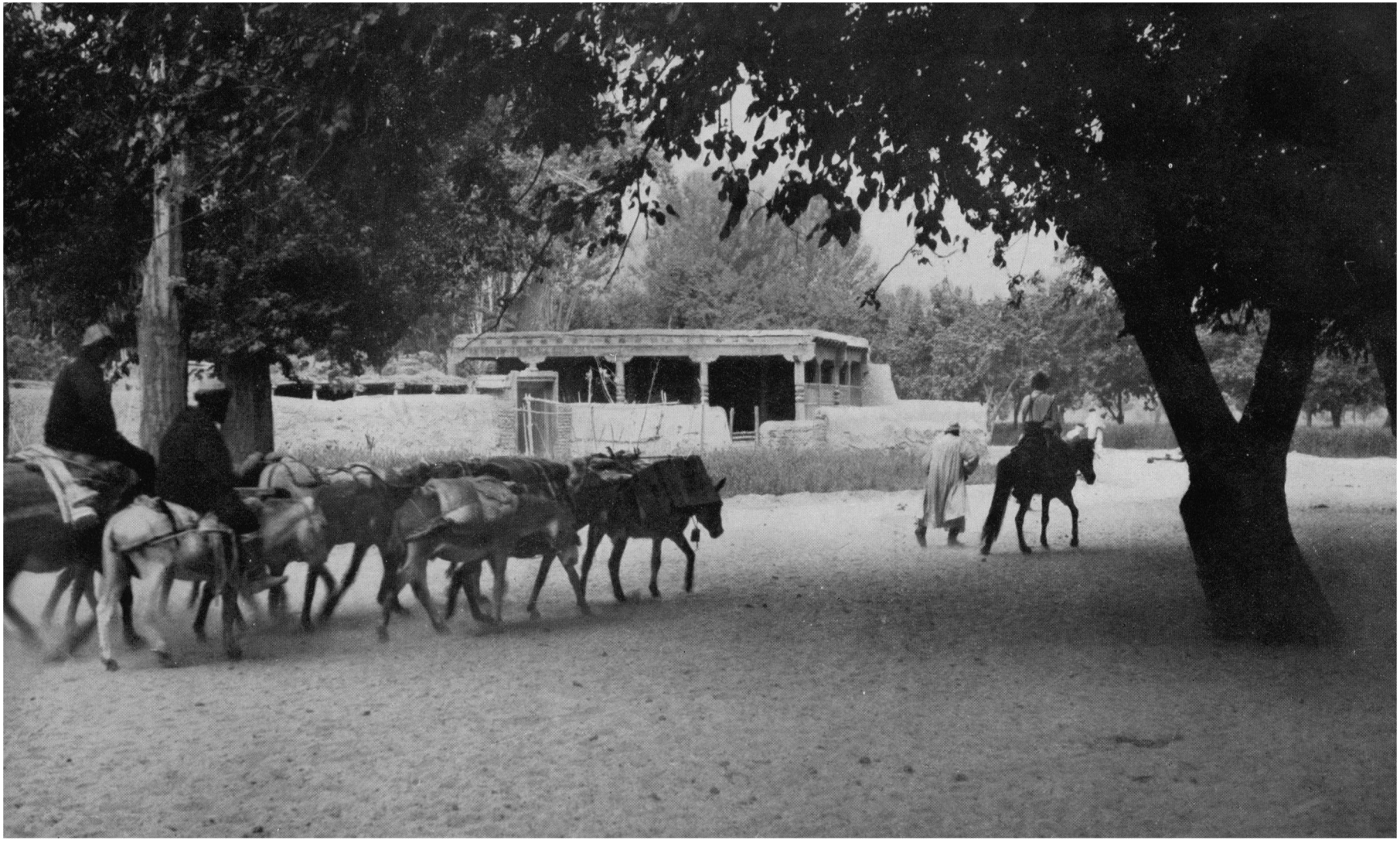
At last, on August 8, we turned our backs on Kashgar and took the road for India. At Yangi Hissar, two days out of Kashgar, we left the desert and struck up into the mountains. The authorities had provided us with a body-guard of two Manchurian soldiers. We were glad to be back in the mountains. It was lovely country where the water was clear and it was cool at night and everything was no longer hidden in dust-haze. The senior member of the bodyguard, Lui, was an agreeable man whose great ambition in life was to shoot a marmot. I shudder to think how much of the Provincial Government's ammunition he expended on this task, but I doubt whether he has yet succeeded. He was a bad shot. There was no road worthy of the name. We merely followed, as before, the only practicable route for animals, and agile animals at that. One day we had to ford a river six times, which was anxious work for us because, like all travellers, we had been accumulating such things as films and papers as we went along and we were terrified of getting them wet.

The three Turkis with our caravan seized the opportunity to bring with them three pony loads of their own merchandize to sell in Gilgit, and we had to add to our caravan some yaks hired locally. It was lovely weather and magnificent country; except for the sores on the backs of the pack-ponies we had no worries of any sort. On August 17 we reached Tashkurghan, where a big fort dominates the valley of Sarikol. Four days later we reached the Chinese frontier post of Mintaka Karaul, where the Russian, Afghan, and Indian frontiers are all within a day's march. The official in charge of the post was a crafty Tadjik who spoke excellent Russian. He expressed his abhorrence of the Bolshevik régime; but he smoked a brand of tobacco only issued to the Soviet fighting forces and police. In point of fact he took his orders from the commander of the nearest Soviet frontier post. He tried to confiscate my rook rifle, but we managed to escape with the formidable weapon still in our possession.

We rode on to climb slowly up the Mintaka Pass, the Pass of a Thousand Ibex, 15,600 feet high, which separates India from China. The animals were in a bad way, but we eventually got up to the top of the col and found ourselves

Yarkand: the walls of the New City





looking into India. We picked our way with difficulty down the other side of the pass and spent the night at the foot of the Gulkoja glacier in a stone hut, maintained by the Mir of Hunza for the benefit of mail-runners.

From now on everything was plain sailing. The Gilgit road may not be a very good road, but it is a road, and every night there was a dak bungalow of some kind to sleep in. We were in the country of the Hunzas, a very fine race of mountaineers who reminded me of stalkers in the highlands of Scotland. The people live in the valley of the Hunza river in small oases which they make on the sparsely covered shelves of rock by means of an ingenious irrigation system. On August 24 we reached Misgar, the terminus of the telegraph line from India, and here we got the Kashmiri clerk in charge to get in touch with Gilgit and ask that telegrams we knew were awaiting us there might be repeated. A less pleasant occurrence was when one of our careless Turkis dropped the pony carrying our suitcases into a violent torrent which runs through the centre of Misgar. South of Misgar the road improved and at difficult passages a small balustrade had been thoughtfully erected to prevent one falling off the track. I was riding a stallion which the consul-general in Kashgar wanted me to present, on his behalf, to the Mir of Nagar. He was an anti-social animal and whenever we got jammed together on a difficult place he began kicking.

On August 26 we skidded across the Batura glacier and two days later rode into Baltit, the capital of Hunza, perhaps the most beautiful capital city in the world. Here we had a slice of luck. Colonel L. E. Lang, the Resident in Kashmir, and Major George Kirkbride, the political agent in Gilgit, were both visiting Hunza and, in spite of the fact that we were disreputably dressed and villainous in appearance, they took us under their wing, and we saw the festivities arranged in their honour by the Mir of Hunza, a shrewd and remarkable gentleman of seventy. We rode ceremonially on yaks up to the Mir's palace, from which there is a fine view over the valley, blocked at the far end by the towering ice-walls of the 25,500-foot peak of Rakaposhi. From Baltit we crossed to Nagar by a rope bridge over the river. Nagar is to Hunza what Harrow is to Eton, though nowadays they get on well enough. At Nagar we were also kindly received, and there were more festivities in honour of the Resident and the political agent, including a sword dance characteristic of that part of the Himalayas. On September 1 we left Nagar and three days later rode into Gilgit. From Gilgit to Srinagar the journey normally takes twelve days, but as we were travelling very light we did it in eight. I believe the record is held by Lord Curzon who, with special relays of ponies, did it in six days. On the evening of September 12 we got off our ponies for the last time, gave away our kettle and cooking-pot, not without a sentimental pang, and drove into Srinagar by car. In the hotel people in evening dress looked at us with horror and disgust, and we knew that we were back in civilization.

So ended a journey which covered about 3500 miles and lasted for seven months all but three days. It cost us about £150 each. I have done my best to make it sound a difficult journey, but in point of fact we were never in danger for a moment: we were never ill, and we were never seriously short of food. It was merely a question of being moderately lucky all the way. The

The oasis of Niya

journey achieved absolutely no results of scientific or any other value, and the only possible justification for it was that it was great fun to do.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: To-night Mr. Peter Fleming is going to tell us of his journey across Asia. Most of those present probably have a general knowledge of his journey, from the series of articles which he wrote for the *Times*. Earlier he had written a very taking book entitled 'A Brazilian Adventure,' the result of an expedition which he joined in South America, one feature of which was an endeavour to obtain the latest reliable news of Colonel Fawcett who, as you know, disappeared ten years ago and has not been heard of since. Mr. Fleming next went out to Central Asia for the *Times* and is to tell us to-night of his journey straight across from Peking to India. We are extremely fortunate to have him with us to-night.

I should like to mention here that Mr. Fleming was accommodating enough to arrange with us a date for his lecture here which would coincide with Mlle. Maillart's presence in London, and it is with very great pleasure that we welcome her to-night. She has been good enough to agree to come on to the platform for a few minutes after the lecture to give us some sidelights on the journey.

We are also fortunate in having with us Sir Eric Teichman, who has just come across by more or less the same route and has made an extraordinarily fine crossing from China into India, crossing some very high passes under winter conditions during the course of the journey; a really wonderful accomplishment. We hope that he too will have a word or two to say after the lecture.

With this short introduction I will ask Mr. Peter Fleming to deliver his lecture.

Mr. Fleming then delivered the lecture printed above, and a discussion followed.

The PRESIDENT: As I told you, Mlle. Maillart agreed to come and tell us something of the part she took. I only need say a few words by way of introduction. As you have already heard, Mlle. Maillart is an athlete of international repute, on the one hand, and has been a great traveller, in the last ten years, on the other. She tells me that she counts on being enabled to finance her travels by her writings after her expeditions. I very much hope that we shall see a book from her on the subject of this very fine journey of which I now ask Mlle. Maillart to tell us a few of her own experiences.

Mlle. ELLA MAILLART: I feel greatly honoured by being invited on to this platform to-night, but really my friend Peter Fleming has left nothing for me to tell you. I can only say he has paid me a great many nice compliments and has tried, maybe, to make me forget that most of the time I was grumbling very much against him because, being the male of the expedition, he was forcibly the leader and I kept on saying, "It is very annoying for me to feel that I am being dragged about like a parcel of some sort." His reply always was, "Anyhow, you are very useful." Most annoyingly, he kept on saying the same thing.

As we travelled very slowly across Asia during those many weeks and months, we sometimes spoke about matters in Europe; we said that if we would succeed, we might one evening be standing here in order to tell you about our journey; but from so far away that seemed a most improbable happening, not only because there were so many miles between London and Central Asia, but because we had been travelling so many centuries backwards. Standing here now, I cannot help wondering whether I am dreaming, and feel I shall suddenly wake up in the middle of Central Asia.

The journey had a particular interest for me because three years ago I had been in Russian Turkistan, as far as the Chinese border, in the Tien Shan or the Celestial Mountains. I travelled on horseback and spent two months studying how the Khirgiz live. I had hoped to be able to continue my journey through into Chinese Turkistan so as to draw a parallel between the ways and customs of the natives on the other side of the border. That was, unfortunately, not possible owing to the civil war. I had to turn back. When on my journey with Peter Fleming I again found myself among camels and nomads living under tents I naturally felt at home; but of course it was not as exciting for me as for Peter Fleming, who was seeing it all for the first time. After a few years I suppose conditions will be the same on both sides of the border as a result of the propaganda slowly being carried on by means of the cinema and newspapers and, of course, the radio.

I thought that the Mongols in the Tsaidam would be happier than us Europeans and have less worries, being so far from the rest of the world; but that is not the case. They are very sad indeed because, as a result of the Chinese traders coming every year and selling them so many things they cannot pay for, they are always in debt to those traders who, the next year, return, go to the homes of the people, and take the best sheep as payment.

Much has been said about the cooking and our food, and I fear I cannot say much about anything else I did, except doctoring the Mongols; I certainly tried to use the well-known rook rifle once, but just missed an antelope. The cooking was easy: our man Li used to fetch the water and keep the pots clean. I just had to say "Now it is 6 o'clock. Put the duck in the pot." And then at 7 o'clock I used to say: "Now take the duck out of the pot." Perhaps the only brain wave I had concerning the cooking was before leaving Tangar, where I bought plenty of onions; I thought they would give flavour to the food, but the effort was wasted because Fleming used to sprinkle an enormous amount of red pepper on everything he ate. As for what he described as "filthy dried apples," they were very good indeed, but he was much against a vegetable and fruit diet, so I had them for myself and my horse.

Tsamba was very useful because we could eat it for breakfast and lunch and thus only had to cook once a day, which was quite tiring enough for me, as you can realize now! As the result of much effort I succeeded in forcing Peter Fleming to drink our Ceylon tea, so as to save half a brick of our last Mongol tea, which I am able to show you now. He explained how the Mongols are paid sometimes with a brick of tea or with cloth, rather than by dollars. At Sining and Tangar when we left the last Chinese village, a brick of tea was worth four dollars (Mex.) which is about four sheep in the Tsaidam; but a month farther on the price had doubled, and when we reached Cherchen such a brick was worth fourteen dollars (Mex.).

The natives use very little of that tea. They boil it in a copper pot with salt. Only the princes use a little piece of sugar and the rich Mongols use butter. Their butter is made once or twice a year only, so that after a few months it is very rancid, with green streaks in it and looks and tastes more like Roquefort or Gorgonzola.

Tsamba is eaten by soaking it in tea put with the butter into the sort of bowl which every Mongol carries inside his sheep-skin coat. If the Mongol is rich, the bowl is lined with silver, but we could not buy such a bowl, probably because the Mongols we met were poor or because those who had the bowls did not want to part with them. The barley used for *tsamba* is roasted first and then ground. This piece of leather in my hand contained a week's ration of flour. It used to belong to our friends the Smigunovs and had been used for carrying

koumiss, which is the fermented mares' milk the Khirgiz make. The leather still smells of *koumiss*.

If you are visiting a rich Mongol he puts a very large slice of butter in your cup and then gives you some flour. Also if the Mongol is rich he gives the flour to you out of a large wooden spoon, but as wood is so scarce in that part of the world the Mongols usually use their hands both to serve and when they mix the flour with the butter. As a matter of fact we started from Tangar with four spoons we bought, but as they broke very quickly we were left with nothing but two teaspoons. They were of no use for taking up soup or taking *tsamba* out of the bag. When we tried to buy another spoon from the natives they wanted to charge as much as one sheep, which was then one dollar (Mex.), which we thought too high a price.

Boiling tea, with salt added, is poured on to the butter to melt it, and you keep working the flour and the butter together while you carry on a conversation with your host about the affairs of the country. Mr. Peter Fleming, whenever we ate *tsamba*, used to mix it with Worcester sauce and red pepper. I preferred mine mixed with sugar and raisins. The flour, when you visit the tent of a rich Mongol, is sometimes mixed with a curious sort of biscuit made out of dried milk. In the summer season when the Mongols have quite a lot of milk they boil it for a long time and then dry it in the sun, and make themselves a supply of the biscuit to carry them the year round. It is not a very nice biscuit, but we found it only with rich Mongols.

When the flour and the butter are worked together you have a smooth cake which looks like a piece of bread. You kneel round the fire, eat the *tsamba* and drink the tea to wash it down.

The PRESIDENT: And now we should like to hear a word or two from Sir Eric Teichman, Chinese Counsellor at the British Embassy in Peking.

Sir ERIC TEICHMAN: I have been greatly interested to see the pictures which Mr. Fleming has shown us this evening as I have just come over, during the latter part of my journey, much the same route. But it is too late to commence discussing the details of the journey, because, once started, there would be so much to say.

I had the pleasure of meeting Mlle. Maillart and Mr. Fleming in Peking rather more than a year ago, when they were starting on their expedition. They told me they were going off to the Koko Nor, and I for one had not the least idea that they meant to try to get through to India. I am quite sure, as a matter of fact, that, if they had let us know and had tried to obtain passports for the journey in the usual way, that journey would never have been begun. The only way they could have made the journey was the way in which they did make it. Having left Peking to go to Kansu, they disappeared into the blue. I do not suppose there are many parts of the world from which one can disappear into the blue quite so completely as in that part of Central Asia. For many months we heard no more about them. And then, if I remember rightly, the *Times* got rather anxious as to what had happened to Mr. Fleming; a very valuable member of their staff had apparently disappeared. They started making inquiries, but no sooner had those inquiries been set on foot than a telegram arrived from Colonel Thomson-Glover, the Consul-General in Kashgar, to say that these two intrepid travellers had arrived there. That was the first we heard of them for many months.

The map showed you the route they followed. To those unacquainted with that part of Asia it may not have meant so much as it did to me. To me it meant a great deal. The other two routes to Chinese Turkistan are very well known, but, so far as my fairly comprehensive knowledge of the literature of Central

Asian exploration goes, I do not think anybody has ever entered the Sinkiang by the route across the Tsaidam. Mr. Peter Fleming and Mlle. Maillart have opened up a big stretch of practically new country.

I am afraid it is no use whatever Mr. Fleming and Mlle. Maillart telling us that there was nothing in the journey. Those of us—and there are quite a few in this room to-night—who know those parts of the world realize that theirs was a very remarkable journey, and I think there are only one or two parallels in the history of Central Asian travel for such a journey having been undertaken by a lady.

The PRESIDENT: Mr. Fleming and Mlle. Maillart have given us a delightful evening. As you have heard from Sir Eric Teichman, the expedition that they accomplished is of no little value geographically; they have opened up quite a piece of country that was practically unknown. The charming way in which Mr. Fleming delivered his lecture and the attractive touches with which Mlle. Maillart has delighted us since, can but call forth our very warm praise. I ask you to join me in enthusiastic thanks to them for a very interesting evening.

The vote of thanks was enthusiastically accorded, and the proceedings terminated.

THE ARUN RIVER DRAINAGE PATTERN AND THE RISE OF THE HIMALAYA

L. R. WAGER

THE Arun river collects its waters from the north side of the Himalaya and from the south side of the lower indefinite range known as the Nepal–Tibet watershed. After flowing approximately eastward along the grain of the country it turns abruptly south and in a series of magnificent gorges cuts through the Himalaya between Mount Everest and Kangchenjunga. The remarkable behaviour of the Arun and several other rivers in cutting across from the plateau of Tibet through the much higher Himalayan range has frequently been commented upon, and two alternative theories, with very different implications for the student of the geology and geography of the Himalaya, have been put forward to explain it. One of the theories postulates that at an early stage the Himalaya had ordinary consequent drainage, the rivers flowing north and south from the crest. This simple drainage pattern is considered to have been modified to its present form by some of the south-flowing rivers cutting back through the range and capturing rivers on the Tibetan side. The much greater precipitation on the south side of the range and the much steeper fall and therefore greater erosive power are put forward as possible reasons for the unusual behaviour of the south-flowing rivers. The alternative theory postulates that the Arun and similar rivers always had their present courses which, when they were inaugurated, were the easiest routes down an irregular surface sloping towards the Gangetic plain. Subsequently the Himalayan range is considered to have risen up across the rivers, but so slowly that by vigorous erosion they were able to keep open their original channels. If this latter theory of antecedent drainage, as it is called, could be substantiated, it would provide definite evidence of an important early stage in the surface form of the Himalaya, and it would also give a definite indication of the mechanism by which the Himalaya has grown to its present height.

The theory that the Arun has cut back through the Himalaya and captured Tibetan rivers has been supported by Hayden [1] and Heron.[2] Fox,[3] in a discussion of Heron's paper, and Odell [4] have tentatively suggested the alternative view. Many others, especially Medlicott, Oldham, and Burrard,[5] have discussed similar cases or the general case of which the Arun is an

[1] Hayden, H. H., "The geology of the provinces of Tsang and U in Central Tibet," *Mem. Geol. Surv. India*, vol. XXXVI, Part 2, 1907, p. 5.

[2] Heron, A. M., "Geological results of the Mount Everest Reconnaissance Expedition." *Mem. Geol. Surv. India*, vol. LIV, Part 2, 1922, pp. 215–34, ε → *Geogr. J.* 59 (1922) 418–31.

→ Fox, in the discussion of Heron's paper, *Geogr. J.* 59 (1922) 431–6.

[4] Odell, N. E., "Observations of the rocks and glaciers of Mount Everest," *Geogr. J.* 66 (1925) 300. And Appendix in 'The fight for Everest,' pp. 305–6, 1925.

[5] Summaries with references are given in Burrard, S. G., and Hayden, H. H., 'A sketch of the geography and geology of the Himalaya Mountains and Tibet,' revised by by S. G. Burrard and A. M. Heron, Delhi, 1934, pp. 261–6 and 347–9.

example, but the evidence has not been sufficient to come to a final conclusion. During the 1933 Mount Everest expedition there was an opportunity of seeing much of the Upper Arun, and I propose to give here some general observations on the physiography of the region and then to describe certain features which I believe afford definite evidence that the Himalayan range has risen across the course of the Arun without modifying to any significant extent the original direction of the river.

The Upper Arun and its tributaries

The relief of the mountain country through which the Arun flows can be most satisfactorily shown on a small-scale map by giving spot heights along the course of the river and indicating the position of the high land by marking all peaks of certain height intervals. Thus on the folding map all peaks between 19,000 and 22,000 feet are shown by small triangles, and all peaks above 22,000 feet by larger triangles. By choosing these particular heights the position of the indefinite range, the so-called Nepal–Tibet watershed [1] which forms the northern limit of the Arun drainage system is well brought out, while the main Himalaya is shown as a range with many peaks higher than this. From the Survey of India maps on the scale of 4 inches to 1 mile [2] the profile of the river can be drawn (see folding map). The actual profile is very different from that of a graded river, the form given in a misleading diagrammatic section by Burrard.[3] An abrupt increase in gradient occurs where the river leaves the plateau and begins to cut through the Himalaya, and it is here, soon after the point where the valley floor becomes convex, that the Yo Ri gorge, the first of the striking gorges through which the Arun flows, is found. The main gorge begins at Kharta Shika and with occasional broadenings continues for the next 50 miles. Twenty miles beyond this point the Arun joins the Kosi, then shortly reaches the southern boundary of the Himalaya; here the river is at a height of only 200 feet although still 400 miles from the sea.

In Tibet the Arun has at least two names, the Men Chu for the first 60 miles and then the Phung Chu as far as the Nepal–Tibet boundary. In this paper I propose to simplify the nomenclature and use the name Arun for the whole of the river. The Arun rises on the north slopes of Gosainthan, a peak of the Himalaya 26,291 feet high, and for the first 150 miles its course is mainly east along the strike of the rocks. Heron, who visited the uppermost part of the river as a member of the first Mount Everest expedition, describes how the few abrupt bends that the river makes are such that it avoids areas where granite veins have hardened the rocks. From his geological mapping Heron also showed that in Tibet the Arun tends to flow along synclinal zones. In a region of mature topography rivers usually follow the course of anticlines, since the rocks are there more easily eroded. The fact that the Arun

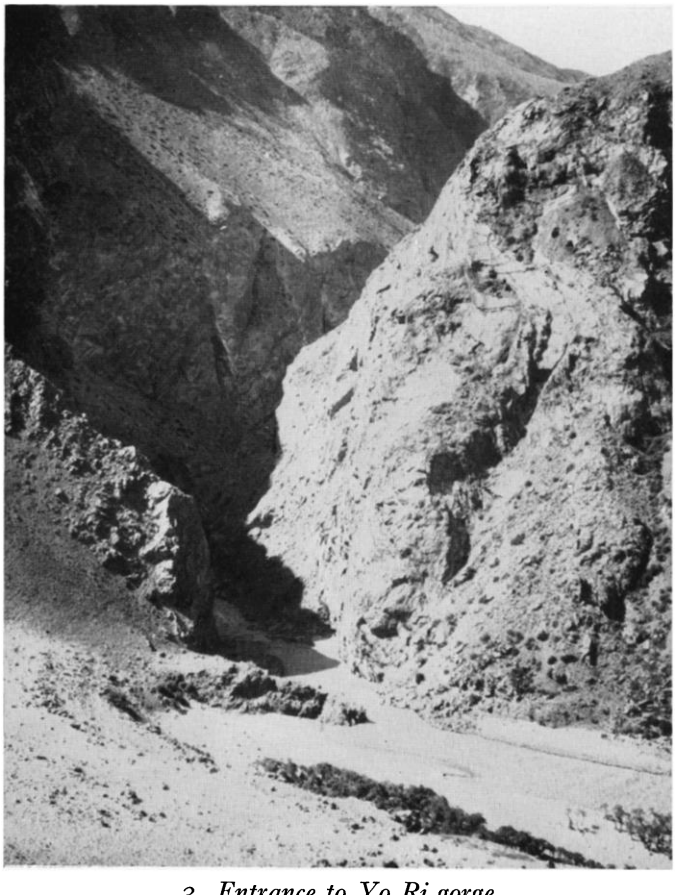
[1] Formerly regarded as an easterly extension of the Ladak range but now given this name by Burrard.

[2] According to a personal communication from Professor Kenneth Mason the probable error of these maps is not large enough to affect significantly the profiles given in this paper.

[3] *Op. cit.*, Chart XXXVII.

1. The Upper Arun near Pangla, south of Shekar

2. Yo Ri gorge and Kuyok La. Moraine mounds in the middle distance half buried by post-glacial gravels



3. Entrance to Yo Ri gorge

still flows along what were tectonic valleys in the original surface shows how relatively recent is the development of the drainage system.[1]

At present, in its upper part, the Arun is a braded river flowing over an extensive spread of gravels. Harder masses of rock stand up as subsidiary hills within the valley (Plate 1), and where hard bands cross the river minor gorges occur.[2] The valley is still youthful in character, but there has been a recent prolonged period of aggradation which has filled the bottom of the valley with a level spread of gravel. Still more recently the river has begun to cut into the gravels, forming a system of river terraces—features which have struck the eye of all travellers to the region. Although there are many indications of a complex system of terraces which will require more detailed maps and careful levelling for their interpretation, yet the last great spread of gravels and the terraces developed from them can be widely identified even during a hurried journey through the country. Moreover, the age of this conspicuous period of aggradation can be fixed relatively to the period of maximum Quaternary glaciation. Thus a quarter of a mile above the confluence of the Dzakar Chu and the Arun the terminal moraine mounds of a glacier coming down from the Nyonno Ri range are surrounded and almost buried by the gravels of the recent period of aggradation (Plate 2). This moraine is the lowest observed in the district and was formed during the maximum extension of the Quaternary glaciers. Further evidence of age is also found at Rongbuk, where the same spread of gravels merges into the outwash fan of the lowest moraine of the Rongbuk glacier. No fourfold division of the Quaternary glaciation such as is suggested for other parts of the Himalaya by the work of Dainelli, H. de Terra, and T. T. Paterson has yet been recognized in the Arun region. All that can be stated at present is that the spread of gravels was formed at the time of, and after, the maximum Quaternary glaciation of the region. For convenience of reference these gravels will be called the post-glacial gravels and the terraces developed from them the main terraces.

About the middle of its course in Tibet, near Shekar Dzong, the Arun has cut only shallowly (50 feet or less) into the post-glacial gravels. Traced down stream the river is found to have cut increasingly deeper. The Dzakar Chu, a tributary to the south, shows the same features. The heights of the terraces have only been estimated by eye and no reliance must be placed on the absolute values given, but the general increase down stream is obvious. Traced from Tashi Dzom up stream, the terraces of the Dzakar Chu decrease in height above the river, but shortly after Chodzong they begin to increase again, and near Rongbuk they are well over 100 feet. This rather remarkable behaviour of the terraces should be searched for in other streams which turn south towards the crest of the Himalaya. If it is found to be widespread it may be that it is an effect of the recent gradual upwarping of the main Himalayan zone for which evidence is given below.

The largest tributary of the Arun is the Yaru Chu, which rises in the hills

[1] Pascoe, E. H., in the discussion of Heron's paper, *op. cit.*, p. 436, has suggested an alternative reason for this relation between the river courses and the synclines, but it seems probable that Heron's original suggestion is the right one.

[2] Heron, *op. cit.*, p. 420.

north of Kampa Dzong and enters the Arun from the east after passing through the northern continuation of the Nyonno Ri range in the Rongme gorge. Much of the middle part of the Yaru valley has been recently occupied by a shallow lake of which the small lake near Tengkye and the marshes to the south and south-west are the remnants. Spender [1] has stated that he found evidence of this lake east of the village of Sar. Half a mile north of Linga, which lies some 6 miles east of Tengkye Dzong, there is a curious long spur of gravel pushing out southward from the hills on to the flat plain. In 1933 I examined this feature and found that it was a delta of coarse materials put down by a stream when the plain about Linga was covered by a lake some 300 feet deep. The extent of the lake is not known, but should be easily determined when the region is carefully mapped.

The Chiblung Chu, a tributary of the Yaru Chu, cuts through the northern continuation of the Nyonno Ri range at Jikyop in a gorge like that on the Yaru Chu at Rongme. The height of the main terrace in the gorge is some 400 or 500 feet above the river, but traced up stream the height rapidly becomes less, and 7 miles above the gorge is only about 30 feet. Exactly similar changes in the relative height of the main terrace and present river-level are to be seen in the Rongme gorge and have been commented upon by Spender.[2] It would be of great interest to determine with reasonable accuracy the absolute height of the post-glacial gravels as the continuation of the Nyonno Ri range is approached. Without this information the reason for the behaviour of the terraces is in doubt; it may be that the gravels have not been upheaved since deposition, the change in height of the terraces above the river being the effect of rejuvenation which has only worked a small distance to the east of the range. An alternative however, which I believe from the general tectonics of the region to be more probable, is that uplift of the range has caused local upwarping of the recent gravels. Near Sar, also to the east of the Nyonno Ri range, I found fine-grained river or lake deposits tilted away from the range at 20°. A brief examination showed no evidence which would suggest that the high dip was due to land slips, solution effects, or thrusting by glaciers, and the silts seemed too fine-grained to be the fore-set beds of a delta originally deposited at this angle. I had to conclude that the dip was the direct effect of localized earth movement perhaps near a fault. It seems likely that the former lake occupying part of the Yaru Chu valley and the apparently upwarped terraces in the Rongme and Jikyop gorges are the result of recent uplift of the Nyonno Ri range.

The extent of the maximum glaciation in the Upper Arun valley

Before describing the remarkable gorges which occur on the Arun river I wish to review briefly the evidence which seems to me to eliminate the possibility that ice, either as a sheet or as glaciers, has played any important part in their development. All travellers agree that in Tibet evidence of an ice-sheet or of extensive valley glaciers is nowhere conspicuous. A prejudice in favour of the view that Tibet was once covered by ice seems to result from the undoubtedly far greater extent of the Himalayan glaciers in past time.

[1] Spender, M. A., *Geogr. J.* 88 (1936) 293.
[2] Spender, M. A., *op. cit.*

For instance, the Zemu glacier coming from Kangchenjunga formerly extended down to a height of 9000 feet.[1] Had the glaciers running northwards from the Himalayan peaks had a tendency to persist to similar low levels, it is clear that the whole of southern Tibet would have been covered by an ice-sheet; this is the view originally taken by Blandford and later by Trinkler.[2] Odell [3] has tentatively suggested that the Upper Arun drainage area shows some general evidence of a former ice-sheet, but with this I am not able to agree. Hayden stated that moraine from the mountains to the south occurs on the hills near Kampa Dzong. This however might be explained by a single glacier tongue from the Pauhunri group, though I observed neither near Kampa Dzong nor in the Kanchenjhau and Pauhunri region anything which would suggest this. An extension of the glaciers to far lower levels in the Himalaya than in Tibet is to be expected because of the steeper gradients, and because of the far higher precipitation. Even during a secular lowering of temperature such as would have no doubt occurred during the Glacial Period it is probable that Tibet would require a considerable increase in precipitation to nourish an ice-cap. In Pleistocene times the monsoon may have been a little stronger and the Himalaya a little lower, yet I believe that the precipitation reaching Tibet was still too small to allow an ice-cap to form.

Within the Arun drainage area I observed no definite traces of the effects of ice away from the higher summit of the Nepal–Tibet watershed and away from the Himalaya; there were on moraines, no "roche moutonnée" or striated surfaces, no "crag and tail" effects, no U-shaped valleys or glacially truncated spurs. It has been suggested that Tibet would support an ice-sheet which would be so nearly stagnant that the usual effects of moving ice would not be produced. Such a view is difficult to disprove. However gradients in much of England where the effects of the Quaternary glaciation are conspicuous are much less than in this part of Tibet, and small hills, as for instance those which rise up in the valley of the Phung Chu near Pang La (Plate 1), should not have remained unmodified by the ice had it ever covered the region. The waning stages of an ice-sheet as it broke into lobes occupying the lower valleys should in particular be indicated now by terminals and lateral moraines, but none have yet been found. The present glaciers flowing north from the Himalaya all show evidence of being more extensive in the past, but the amount of extension was small. The lowest moraine of the Rongbuk glacier is at Rongbuk, only 5 miles from its present snout. The extension of other glaciers in the Nyonno Ri range, the Lashar Plain valley, the Lhonak valley and about Pauhunri is comparable with the extension of the Rongbuk glacier. Thus in this part of Tibet there only seems to be definite evidence of a slightly greater Quaternary extension of the present glaciers and no evidence for the former existence of an ice-sheet.[4]

[1] Garwood, E. J., Appendix, pp. 298–9, to 'Round Kangchenjunga,' D. W. Freshfield, London, 1903.

[2] *Geogr. J.* 75 (1930) 225–32.

[3] *Geogr. J.* 66 (1925) 311–13.

[4] De Terra, from his travels in Little Tibet, has come to a similar conclusion. *Geographical Review*, vol. XXIV, 1934, p. 32.

The Yo Ri gorge

Yo Ri, a mountain 17,987 feet high, dominates on one side the remarkable uppermost gorge of the Arun, while on the other it overlooks a low pass, the Kuyok La, crossed by the mule track up the Arun valley as no way is possible through the gorge. The present configuration of the region is remarkable because the river has cut a deep, artificial-looking gorge like a railway cutting between high mountains, whereas the way by what is now the Kuyok La would seem to have offered a much easier route. Twelve miles above the gorge, where the Arun is joined by the Yaru Chu, the river is flowing in a broad valley over the post-glacial spread of gravels. Traced down stream the valley remains open, but the river cuts gradually deeper into the gravels lying in the bottom of the valley until at Kharkung, immediately before the gorge, the river is flowing 700 or 1000 feet below the upper surface of the gravels. Here the river plunges into the mountain side (Plate 3). The pass which the river avoids is only about 1800 feet above the river, and is broad, with slopes of easy gradient. The steep walls of the gorge tower 6000 feet above the river on the west side and still more on the east. The gorge runs south for 4 miles then turns through a right angle and continues in that direction for another 4 miles before ending as suddenly as it began in a broad valley. This valley is also floored by post-glacial gravels belonging to a set extending up the Dzakar Chu, a tributary of the Arun. Into these gravels the rivers have cut 100 feet or so (Plate 2).

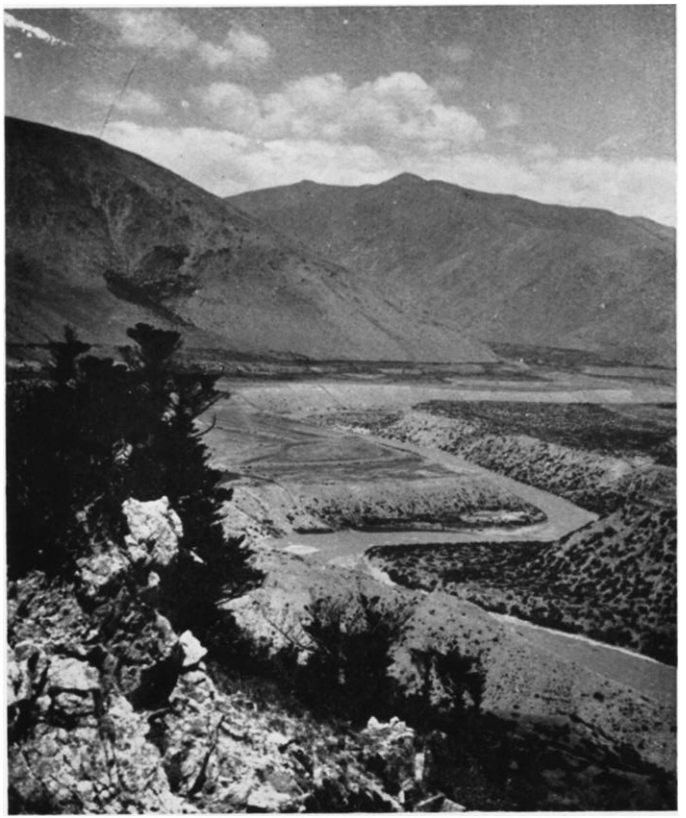
The Yo Ri gorge was briefly described by Heron in a paper to the Society,[1] and it was singled out for discussion after the paper by Mr. C. S. Fox and Mr. A. R. Hinks, who both realized its extraordinary interest. No satisfactory explanation of it however was reached. When actually confronted with the gorge it is impossible not to feel that, if this apparently unreasonable behaviour of the river could be understood, it would throw light on the cause of the anomalies of the whole Arun drainage.

Heron observed that the Yo Ri gorge is cut in hard gneiss while the pass to the east is cut out of comparatively soft schists. I believe that the germ of the explanation of the gorge lies in this observation which was confirmed in 1933. The change from the relatively soft schists of the Kuyok La to the hard resistant gneisses is abrupt. Some shattering of the harder gneiss, probably produced by faulting, was noticed at the entrance to the gorge. This has not the appearance of the usual Tertiary gneisses, but seems rather to belong to what I have tentatively called Peninsular India type.[2] Whether faulting or an unconformity has produced the abrupt change in the rocks was not decided.

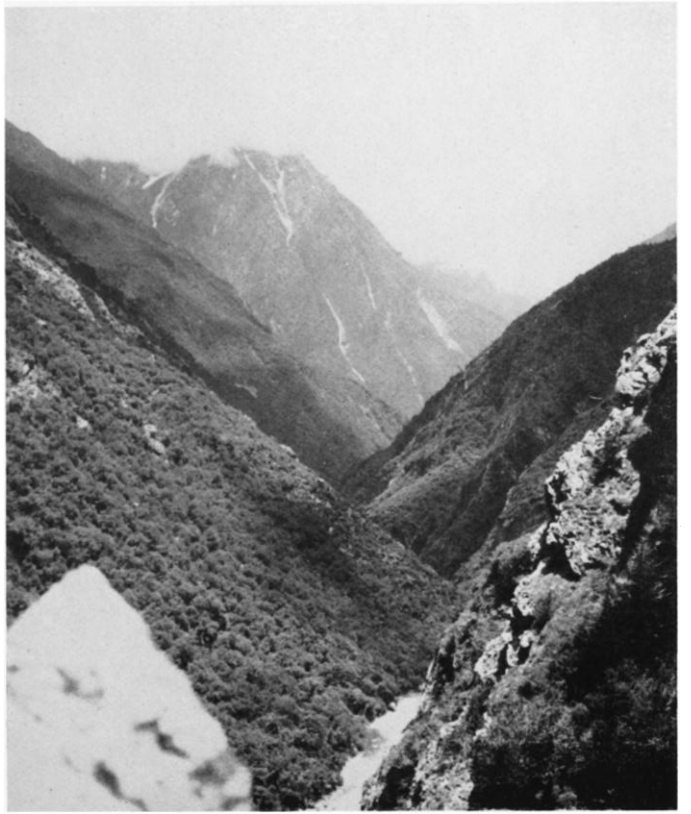
Had the Arun ever flowed over the Kuyok La in relatively soft rock it would never have changed by any ordinary process of river capture to its present course through the corner of a mountain mass of much greater height and composed of harder rock. On a small scale ice-sheets have produced channels across spurs, but not only is the Yo Ri gorge on a very different scale but there is no evidence in the region of a former ice-sheet. The enormous thickness of sediments eroded from the region must be taken into considera-

[1] *Geogr. J.* 59 (1922) 421, and plates opposite pp. 420 and 421.

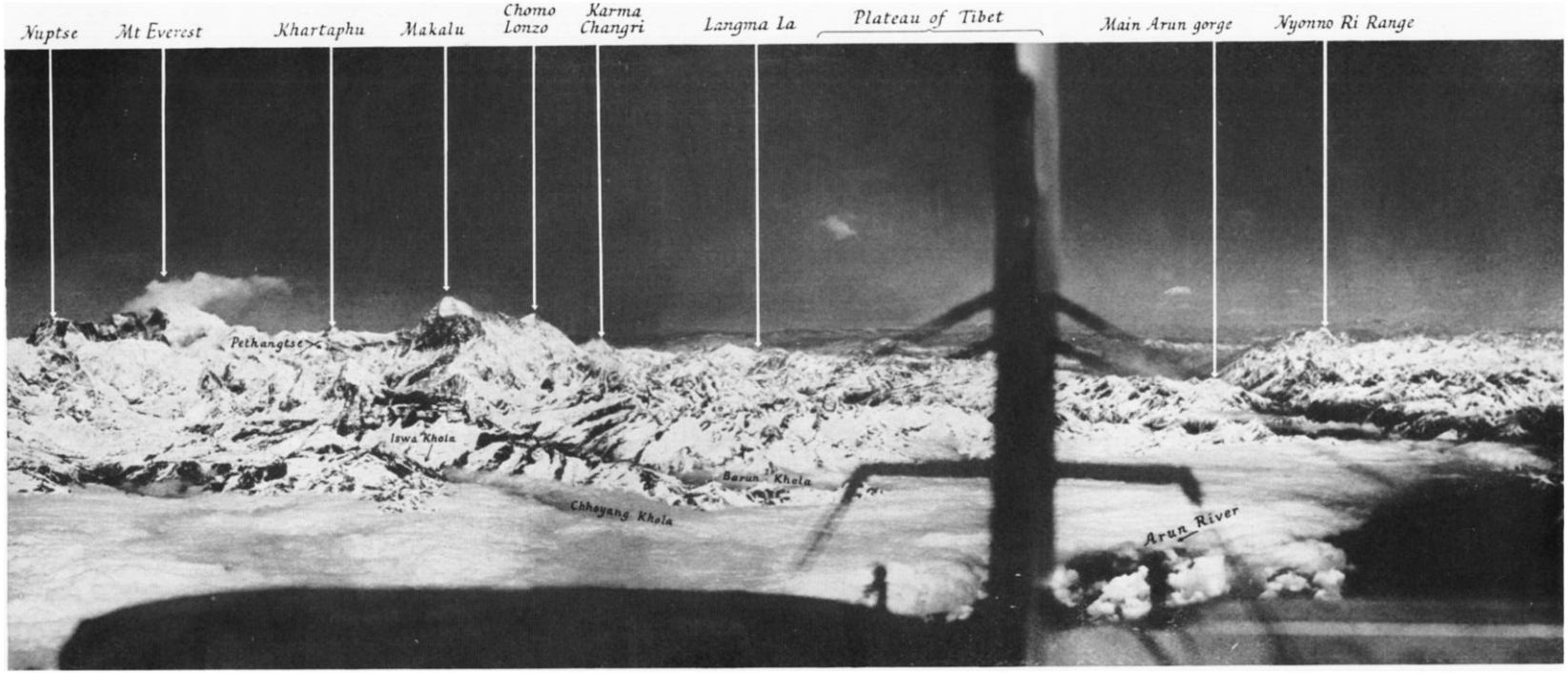
[2] 'Everest 1933,' p. 320.



4. River Arun immediately above the main gorge



5. Looking down the main gorge of the Arun



6. Looking north at part of the Great Himalaya Range

Houston–Mount Everest Flight.
By permission of "The Times"

tion in any explanation of the present gorge. Above the present surface there formerly existed the Mount Everest Limestone Series, the Lachi Series, and the Jurassic and Cretaceous beds, in all many thousands of feet. The Arun once flowed on a surface high above the present one, and the course it now follows may be taken as giving an indication of the form of this surface since the river must have followed the easiest downhill route. In this surface the river incised itself and formed a valley; at the same time general erosion by rain and streams lowered the whole area. The Arun, in its upper part, is still cutting into soft sedimentary beds, and as a result the valley is wide with gently sloping sides. Where the Yo Ri gorge occurs, the river, in cutting down, has come across hard gneisses. The gorge which has been produced, as in many other cases, is simply the result of the change to harder rocks. Rain, streams, and the other erosive agents which tend to widen valleys have had far less effect on the hard gneisses of Yo Ri than on the softer sediments farther up stream, and thus the valley sides remain steep. The change from the two types of rock occurs abruptly. The Kuyok La marks the beginning of the softer rocks and has been produced by the general erosion of rain and small streams and not by the river.

It is possible to decide what causes the change in the hardness of the rocks to which the formation of the gorge is due. The rocks forming the central core of the Nyonno Ri range were reached at Yo Ri and on the east side of the range above Phuru. They proved to be gneisses of Peninsular India type which underlie the schists and gneisses of the Mount Everest Pelitic Series and Limestone Series. The Nyonno Ri range is therefore structurally an anticline which brings up deep-seated and harder rocks. The deflections in the courses of the Arun and the Yaru Chu round the Nyonno Ri range suggest that an early stage of this anticline existed as an upward bulge of the surface on which the drainage was established. The increase in height of the main terraces above the river as the Yo Ri gorge is approached suggests [1] that uplift is still going on (*cf.* below). As uplift and denudation continue it is likely that the Yaru Chu where it makes an abrupt elbow bend at Sar will one day find itself cutting into the harder gneisses below the sediments on which it is now flowing and then another gorge very like that at Yo Ri will be formed.

The most interesting feature of the Yo Ri gorge is its close association with the low pass of the Kuyok La. If the original surface on which the Arun flowed had been anything like the present one then the river would have taken a course over the lower ground to the west of Yo Ri which is now the Kuyok La. Since this is not the case the Arun must have firmly established its course before the development of the present form of the land. Some of the present greater relative height of the Nyonno Ri range above that of the land to the north-west and east is to be ascribed to the direct effect of the anticlinal uplift, but much is probably the result of a secondary effect, namely, the resistance to erosion of the hard gneisses of Peninsular India type which form the range. Subjected to roughly the same intensity of erosion the hard

[1] This can only be suggested. The possibility that it is due to rejuvenation cannot be ruled out until accurate measurements of the absolute height of the terraces have been made.

rocks of the Nyonno Ri range are lowered much less than the softer rocks to the north-west, and thus is produced gradually a greater difference in height than is produced by the direct effect of uplift. The history of the development of the Yo Ri gorge, as I read it, implies that the Arun has had exactly its present course for a very long time, long enough in fact for the great inequalities in height between the Nyonno Ri range and the ground to the west to be developed.

Minor gorges on the Yaru Chu and Chiblung Chu

The Yaru Chu crosses the continuation of the Nyonno Ri range by the Rongme gorge already mentioned, and its tributary, the Chiblung Chu, crosses the same range a few miles to the north by the similar Jikyop gorge. To the east of the range there is a low col between the two river valleys which is 2000 feet lower than the range itself. Heron [1] commented upon this and suggested that the Yaru Chu once flowed over the low col and joined the Chiblung Chu. He supposes that a stream has since cut back along the present river gorge at Rongme and captured the Yaru Chu. An explanation essentially the same as given for the Yo Ri gorge seems however more satisfactory. The rocks at the col are almost unmetamorphosed and easily eroded sediments, while those of the range have been hardened by metamorphism which was sufficiently intense for biotite to have developed in the slates. General denudation must have been more effective over the region to the east of the range and lower ground is therefore to be expected there. Further, the height of the river terraces and the existence of the former Yaru lake suggest that there has been localized uplift of the Nyonno Ri range. This would also have the effect of producing relatively low ground on the east side. Besides the direct effect, the greater uplift has exposed more deep-seated rocks which, being harder, are less easily eroded. The difference in the hardness of the rocks is the factor essentially responsible for the gorge form, but it is itself the result of a localized region of special uplift.

The main Arun gorge and its origin

For 11 miles below the Yo Ri gorge the Arun river flows in a moderately wide valley floored by the post-glacial gravels. The river is at present cutting into the gravels and the terraces lie 100–200 feet above the river. The main Arun gorge begins abruptly just below the confluence of the Kharta Chu. From a spur 1000 feet above the river at the entrance to the gorge a traveller may look north over a treeless Tibetan landscape with the river flowing between high gravel terraces (Plate 4). Looking south from the same point the view is typically Himalayan (Plate 5); the valley is a narrow wooded defile with such steep sides that it cannot be followed by a mule track. The first description of this gorge was given by members of the Mount Everest reconnaissance expedition [2] and it was explored by Morris and Noel, members of the second Mount Everest expedition.[3]

From the junction with the Kharta Chu to Kimathangka the river descends

[1] *Op. cit.*, p. 421.
[2] 'Mount Everest; the Reconnaissance 1921,' pp. 110–11 and pp. 125–6.
[3] 'Assault on Mount Everest 1922,' pp. 89–102.

3300 feet in 18 miles, and the descent is made without definite waterfalls. The village of Lungto near Kimathangka is stated to be situated on a terrace or bench 1200 feet above the river,[1] and indeed traces of similar high terraces are to be seen at the top end of the gorge. Below this point the river enters Nepalese territory and Europeans have not been allowed to visit it, but from the maps it is clear that the river continues to flow in a gorge for another 40 miles, by which time it has descended to a height of only 2000 feet. This part of the valley can be roughly followed by a track while villages and cultivated areas occur at intervals.

The main gorge of the Arun is a magnificent example of a feature which occurs on many of the Himalayan rivers. The neighbouring Tista valley, being in Sikkim, is better known. The part of this river which is Tibetan in character is short, then the valley narrows and becomes a gorge of the same type as that of the Arun but not so impassable. This is no doubt because the river is smaller and is not able to cut downwards so fast as the Arun. The profile of the Tista (see folding map) is closely comparable with that of the Arun, and again the gorge corresponds to the lower half of the convex portion of the profile. Between Singhik and Dikchu the valley widens and some lateral erosion by the river begins. In this region the profile changes from being convex to concave again.

The profile of Himalayan streams and rivers will provide an interesting study when accurate data can be obtained. Even from the existing maps of Sikkim profiles can be drawn which show certain significant features. Thus streams of the foothills give an approximation to the even curve of a graded river. Streams which rise among the once glaciated hills from 12,000–15,000 feet high have this even curve interrupted. In the case of two valleys near the Natu La, which were visited during the 1933 Mount Everest expedition, the change from the normal curve of water erosion takes place at the lowest point of the former glaciers of the district. Here, where the ice had practically no forward motion and where masses of moraine were being put down, the valley lies above the level which would be expected if the curve of water erosion was continued to the watershed. At this point there is also a change from the narrow V-shaped valley, due to river erosion, to a broad upland valley with U-shaped cross-section. The nature and extent of glacial erosion are variously assessed by different observers and this is not the place to consider the problem, but I am convinced that useful conclusions would come from a careful study of the region about the Natu La.

The unusual profiles of the Arun and Tista, their gorges, and their peculiarity in cutting through a high range, seem to be related facts having the same cause. The views of different observers on the origin of the gorges are summarized by Hayden and Burrard in 'A sketch of the geography and geology of the Himalaya Mountains and Tibet,' which was revised in 1934 by Burrard and Heron. Despite difference in detail the various theories are essentially of only two kinds, those based on the idea of antecedent drainage and those based on the idea of river capture. In the revised monograph the Arun and Tista are still, without question, given as examples of rivers which have cut back their headwaters and captured Tibetan streams. The number

[1] 'Mount Everest; the Reconnaissance,' p. 125.

of factors controlling the behaviour of rivers in such a region as the Himalaya makes it impossible to reach a decision between the alternative theories by any deductive reasoning. It happens however that in the case of the Arun the existence of the remarkable Yo Ri gorge provides definite evidence in favour of antecedent drainage. The peculiarities of the topography about Yo Ri can only be explained on the view that the present course of the Arun was established a long time ago on a surface high above the present one, and that since that time some localized uplift and much general erosion has greatly modified the original form of the surface. The possibility of any recent capture of the upper part of the present Arun drainage by a Himalayan river seems therefore to be eliminated. The hypothesis of antecedent drainage also provides a reasonable explanation of the wide departure in the profile of the Arun from that of a graded river. The present profile of the Arun must be regarded as a temporary stage due to uplift of the Himalayan part of the valley along with the general uplift of the whole Himalayan region. The thick gravels flooring the valley were the result of a period of aggradation which extended into post-glacial time. It seems likely that this aggradation is to be ascribed to more vigorous uplift which partly dammed back the river or at any rate reduced its gradient. The original Arun must have found a downhill course among the minor undulations of the original mountain slope which formed the descent from the Tibetan plateau to the Gangetic plain, in those days perhaps an arm of the sea. No such general surface exists nowadays because since that time the range of the Himalaya has risen across the middle part of the river's course.

Isostasy and the upwarping of the Himalayan region

The effect of loading and unloading the crust of the Earth can be studied in the records of the formation and dissipation of the Quaternary ice-sheets of the world. Despite complicating factors, due for instance to changes in the volume of water in the oceans or to mountain building movements in the crust, observations in Scandinavia and North America demonstrate conclusively that when thick masses of ice have developed the crust has been depressed, and that later when the ice has disappeared the crust has slowly and somewhat irregularly risen. The difficulty of understanding the mechanism of these effects, the obscurity of their relations to the complex results obtained by gravity surveys, and the confusion that exists about the exact meaning of the word isostasy, should not be allowed to mask the fact that the loading and unloading of the Earth's crust has the effect of raising and lowering the average altitude of the surface by an amount which is roughly proportional to the load added or subtracted.

Where the Arun crosses the Himalaya the major topographic units are less complex than elsewhere in the range (Plate 6); the Tibetan plateau is a fairly even surface at an average height of about 16,000 feet, and the Himalaya closely approaches a linear feature. As a result of this simplicity certain probable effects of erosion can be better discussed for this region than for other parts of the Himalaya. The removal by the rivers of vast quantities of rock to form the deep valleys which here cross the range should have produced local uplift due to reduction of the load on the crust just as uplift has taken place

with the disappearance of an ice-sheet. Nansen[1] and Jeffreys[2] have both discussed from a theoretical point of view the nature and extent of the vertical uplift to be expected where valleys are formed and deepened in a mountain range. The Arun river provides evidence that the effects which Nansen and Jeffreys considered theoretically likely have in this part of the Himalaya actually taken place.[3]

Many observers have given evidence of recent and even present uplift of the Himalaya. Pliocene overthrusting in the foothills was proved by C. S. Middlemiss,[4] who also showed that the recent Karewa deposits sweep over the Pir Panjal range with dips which in places reach 50°.[5] The latter observations have been confirmed by Dainelli.[6] De Terra[7] has recently given geological evidence that the uppermost topographic relief in the area between Kashmir and the Indus valley "has suffered from gentle warping, long after the Tertiary orogeny, and subsequent even to the intra-Pleistocene folding." Some of the recent earth movement in certain parts of the Himalaya seems to be the result of a continuation of horizontal pressure which produced the original region of high elevation, but some seems to be vertical uplift of a different sort. In Sikkim and the neighbouring parts of the Himalaya there is evidence that uplift to maintain approximate isostatic equilibrium during the development of the valleys is the cause of the upwarping and is responsible for the extra height of the Himalayan range above the plateau of Tibet. I have briefly stated elsewhere[8] that if the Sikkim part of the Himalaya were levelled by piling the tops of the mountains into the adjacent valleys, a plateau sloping gently towards the plain of the Ganges would result, and that the height of this plateau where the main range of the Himalaya now stands would be approximately 15,500 feet. It is significant that 15,500 feet is a little lower than the average height of that part of the plateau of Tibet which lies immediately to the north of Sikkim. In relation therefore to the isostatic balance of the crust the Himalayan range is here equivalent to the southward extension at a steadily declining height of the edge of the Tibetan plateau. It has been shown above that the Arun and Tista rivers must have originated on just such a surface. Here then is some evidence that maintenance of approximate isostatic balance during a period of erosion is the cause of the upwarping. The Eastern Himalaya as I visualize it have been produced in two distinct stages[9] and by two different processes. The first stage was the production by horizontal compression of an elevated plateau in approximate

[1] Nansen, F., "The Earth's crust, its surface-forms and isostatic adjustment." Norske Videnskaps-Akademi, i Oslo i Mat. *Natur.*, Klasse 1927, No. 12, 1928, pp. 1–21.

[2] Jeffreys, H., Gerlands Beitrage zur Geophysik Bd. XVIII Heft, 1/2, 1927, pp. 17–18.

[3] Garwood, in D. W. Freshfield's 'Round Kangchenjunga,' has given other evidence for vertical uplift and tentatively suggested that isostatic uplift consequent on shrinkage of the glaciers of the region was the cause.

[4] *Mem. Geol. Surv. India*, vol. XXIV, Pt. 2, pp. 59–142, 1891.

[5] *Mem. Geol. Surv. India*, vol. XLIV, p. 241, 1923.

[6] → E. G. Garwood's review. *Geogr. J.* 63 (1924) 243–6.

[7] H. de Terra, *Mem. Connecticut Acad. Surveys*, vol. VIII, p. 67.

[8] *Nature*, vol. 132, p. 28, 1933; and 'Everest 1933,' pp. 328–31.

[9] This conclusion I have stated before ('Everest 1933,' pp. 330–31). De Terra has recently given other evidence for the same view (*op. cit.*, p. 71.)

isostatic equilibrium. This plateau is essentially the present plateau of Tibet, but when formed it extended farther south over the region which is now the Himalaya. The second stage, which is presumably still going on, is one of vertical upwarping of the edge of the plateau to maintain approximate isostatic balance as the rivers cut deeper and deeper valleys into its edge. The second stage is the one which has produced the extra height of the Himalayan mountains above the plateau of Tibet. In the Eastern Himalaya, without the deep valleys and gorges, it is probable that there would have been no peaks towering 10,000 feet above the plateau of Tibet.

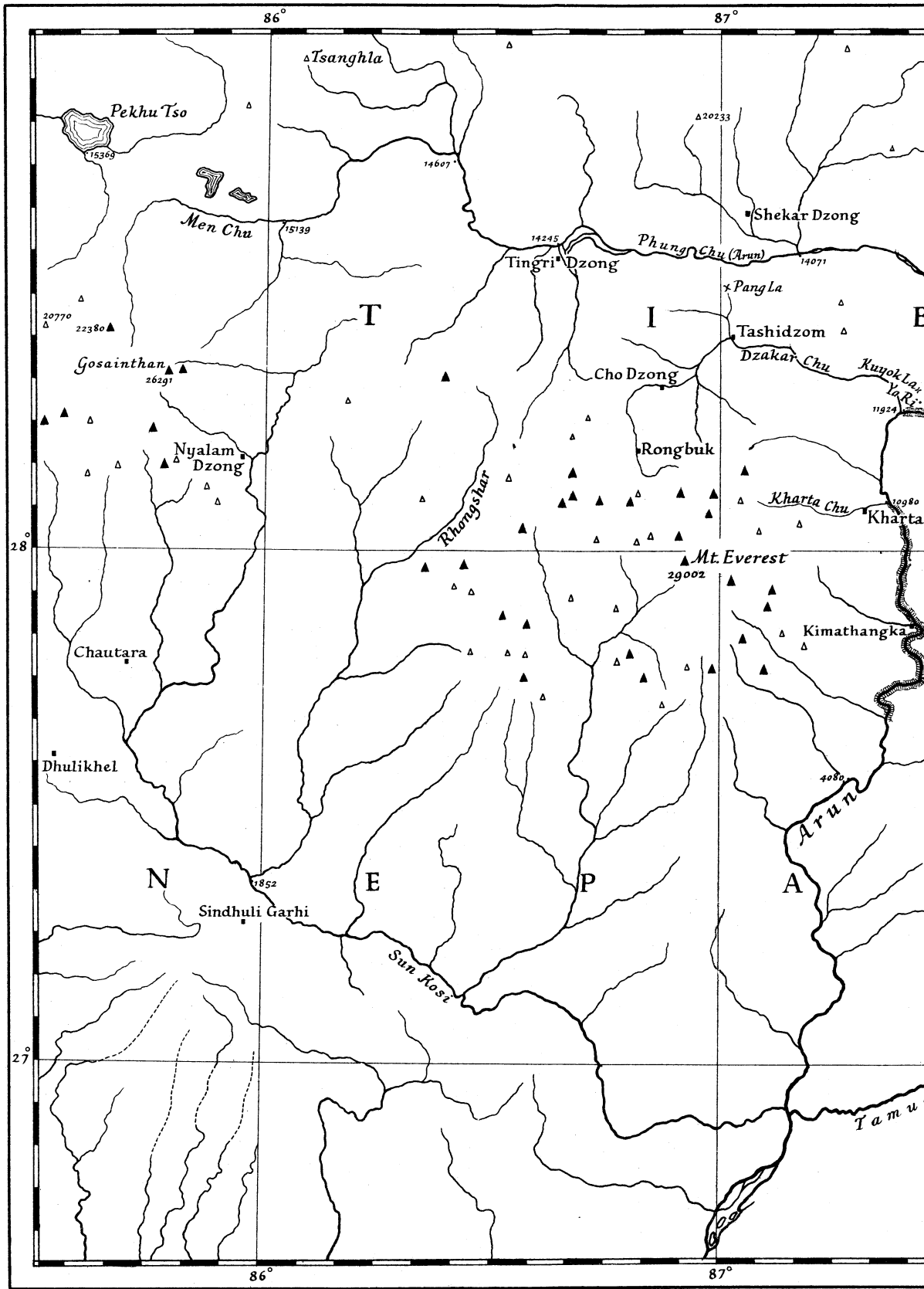
THE BRITISH GRAHAM LAND EXPEDITION, 1934–37

SINCE the work of the British Graham Land Expedition was last summarized in the August number of the *Journal*, a whole season's sledging has shown that the lower third of the map published with that summary must be radically altered. Before the flight of Sir Hubert Wilkins in December 1928, Graham Land was thought to be a long peninsula of the main continent. The indications of the photographs and observations from that flight were that the peninsula was an archipelago with at least three channels cutting through it, which were named Crane Channel, Casey Channel, and Stefansson Strait, from north to south respectively. The existence of the two southern channels is now disproved, and much doubt is cast on that of Crane Channel. The work of one Australian, Rymill, has undone the work of another, and it must be admitted that photographs from the air under the conditions of a long and hazardous flight may lead to entirely erroneous conclusions. Until the expedition returns with its detailed surveys it is impossible to estimate how great the changes in the map will be, but it seems likely that Stefansson Strait will have to be replaced by a fjord opening eastwards from a more or less ice-covered plateau up to 7000 feet in height, and that Alexander I Land must be magnified to at least five times its supposed size.

It will be remembered that the *Penola* left the shore party on Barry Island, at the north-eastern corner of Marguerite Bay, in March 1936. Rymill had with him at the base Bertram, Bingham, Fleming, Hampton, Meiklejohn, Moore, Riley, and Stephenson. The early winter (southern) of 1936 was spent in training the dog-teams for the projected sledge journeys, overhauling the equipment and fitting skis, instead of floats, to the plane. Blizzards at the beginning of May, the worst yet experienced by the expedition, delayed the formation of the sea-ice; the wind at its strongest reached a force of 110 m.p.h., and a hurricane force of 90 m.p.h. was recorded for several days, accompanied by low temperatures. By May 15 however the ice was bearing in most places, after a period of calm, cold weather, and nearly a month later it had reached a thickness of over 1½ feet. Conditions seemed to promise well for the spring sledging programme.

On June 9, in the uncertain winter twilight, Hampton, Rymill, and Fleming made a flight southwards after two trial trips, and saw, from a height of

The Drainage Areas



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Feet
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Peaks of Nepal-Tibet Watershed

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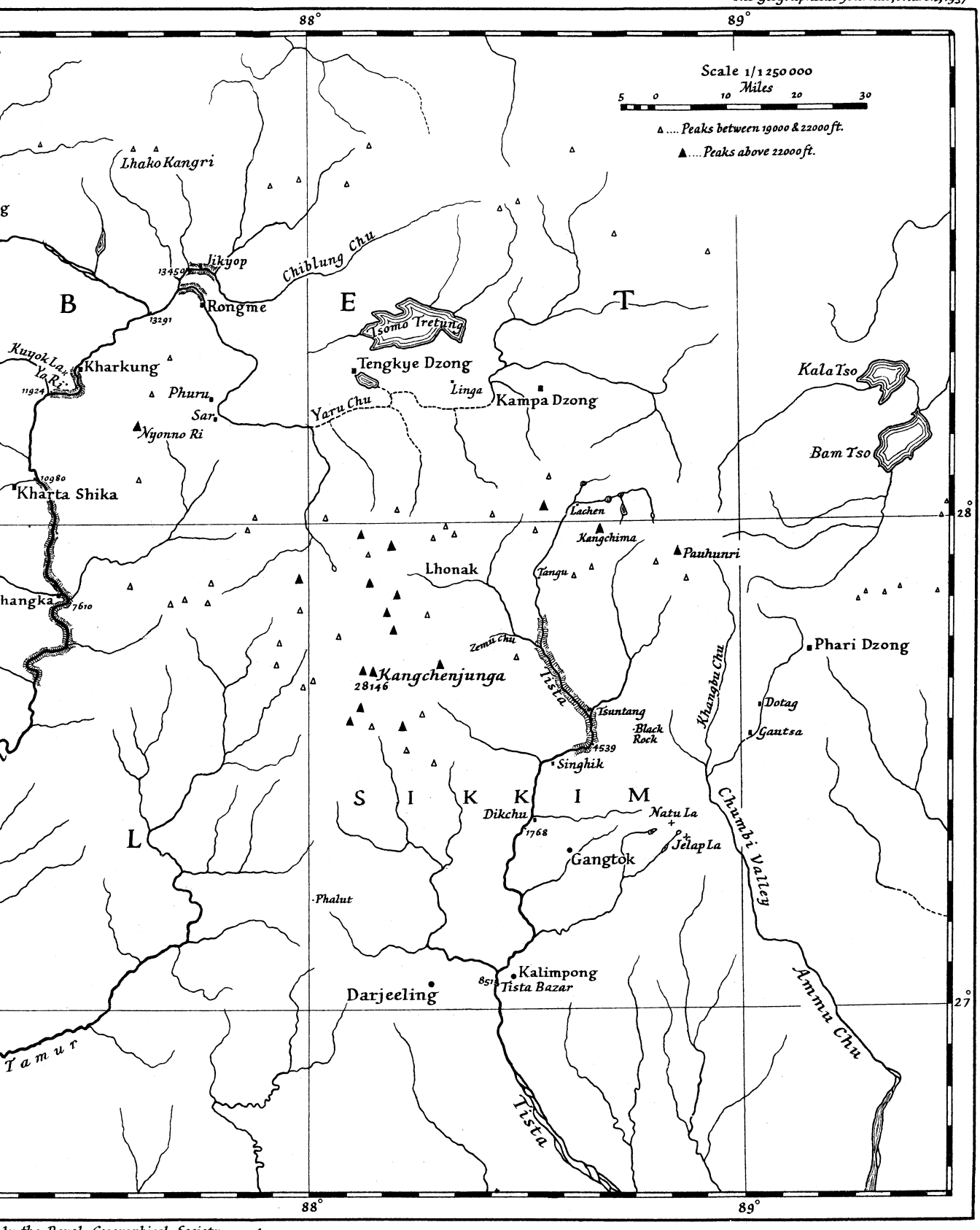
Areas of the Arun and Tista



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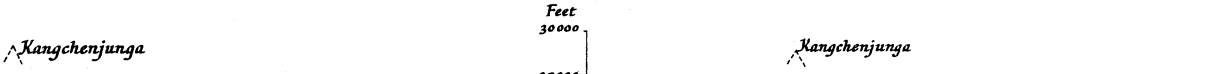

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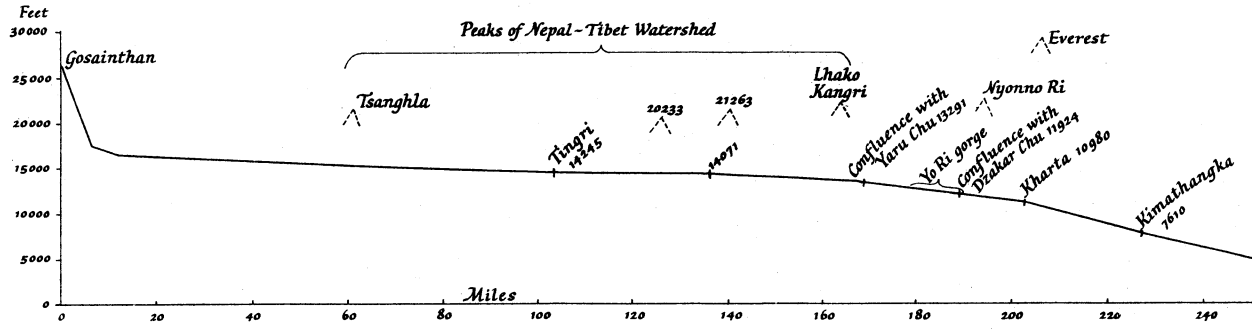
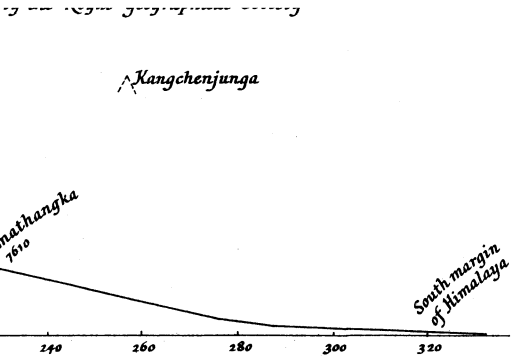
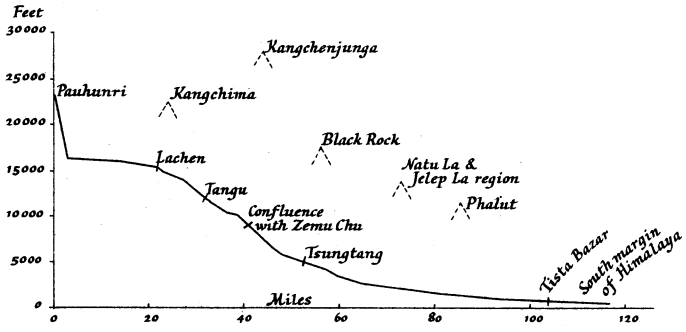


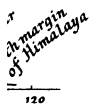
Profile of the Arun in Tibet and Nepal





Profile of the Tista

The heights of certain peaks are indicated above the profiles where they are nearest to the valley



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PHOTOGRAPHIC SURVEYS IN THE MOUNT EVEREST REGION: *A paper read at the Afternoon Meeting of the Society on 11 May 1936, by*

MICHAEL SPENDER

THE main purpose of Mr. Shipton's Expedition of 1935 (*Geogr. J.*, February 1936) was to see whether the conclusion of 1921, that the monsoon season was unsuitable for an attempt on Mount Everest, was applicable every year. When I was asked to undertake survey work as a member of the 1935 expedition I realized that conditions were likely to be adverse, since the Reconnaissance Expedition of 1921, while carrying out the important preliminary mapping of the region, experienced much bad weather and cloud. But it seemed that photographic methods of survey might be suitable, and it gave an opportunity to put the technique acquired in Greenland to a test of some severity.

From a surveyor's point of view things turned out by no means badly. Not only was Shipton an encouraging and gifted leader to the party, but he and his colleagues surprised me by throwing themselves actively into the business of assisting the survey. In particular he, Warren, and Kempson showed throughout the summer an unflagging interest in map-making which expressed itself in taking one of the instruments to stations on pinnacles and places that an untrained mountaineer would never have reached. Nothing can be more gratifying to a surveyor than such practical enthusiasm.

The dominant recollection of the summer is cloud. Nevertheless the weather was, I think, better than that of 1921. Wheeler must have had a very difficult time during his survey. He covered a large area and occupied high stations, resolutely climbing several times to the same point if necessary. One advantage he had over me: he was an experienced climber. But on the other hand I think I can reassure any prospective surveyor without this training by saying that even in the Himalaya effective stations can be reached by just walking; and that as far as 22,000 feet the normal person is not put to any severe endurance test.

The Mount Everest Committee were anxious to obtain a more detailed map of the north face of Mount Everest than that available: a more precise

knowledge of the heights on the route followed up the mountain would also be of value to the mountaineers of the 1936 expedition. This then was the principal task. Naturally we hoped to be able to add something *en route* to our rather slight knowledge of the country through which we were to pass.

The Wild photo-theodolite belonging to the Society and used by Major Mason in the Shaksgam in 1927 seemed in every way suitable for the Mount Everest part of the survey. But I felt that for rapid work in high territory something at once lighter and to me more familiar would be desirable. So I suggested that the Committee approach Professor Nørlund, Director of Denmark's Geodetic Institute, to see whether he might be willing to lend us the Zeiss photo-theodolite adapted for roll-film that I had used in Greenland in 1933. With great and, if one may be so bold as to say so, characteristic, generosity Professor Nørlund put the instrument and two tripods at our disposal, and in this way assisted the expedition very materially. All the work of assembling the equipment had to be done in three weeks, and I have reason to be grateful for the promptitude shown by certain firms such as Messrs. Agfa and Perutz, supplying film, and Messrs. Watts and Leitz (Leica), supplying instruments.

Mr. Hinks and I were agreed in considering the opportunity as one in which the broadest possible experience should be gained. So to the two sets of equipment already decided upon for photographic survey we added a third. The Watts-Leica photo-theodolite was to be the very extreme of portability and simplicity. The instrument as we took it into the field was a hastily constructed assembly of a Leica camera on a Watts Mountain Theodolite. It was intended for the Canadian or single-picture method of photogrammetry; but it was also an end in itself to find out to what extent this or any other technique of photogrammetry could suitably be recommended for people more skilled in climbing or travelling than in survey work. The value of a semi-calibrated camera to the explorer has not yet been fully worked out; here was a chance to make a start towards finding the usefulness of photographic methods to exploratory surveying. (Folding map at the end of the *Journal*.)

To glance over a few sheets of the Trans-Frontier $\frac{1}{4}$-inch survey is to realize how many opportunities there are for a surveyor in Tibet. At one time we had hoped to photograph the country to the west of and, for us, beyond the approaches to Mount Everest. The Lapche Kang range is only very approximately known and might have given some climbing experience to the party. But after talking it over we thought that it would be better, if we were to attempt any work away from Mount Everest, to use the fine weather before the monsoon broke. Since we expected to reach Rongbuk at about the time of the break of the monsoon, this meant that it would be best to photograph some district on the road between Sikkim and Everest. The Nyönno Ri range was the obvious point of interest.

After leaving Darjeeling on May 27 we crossed into Tibet on June 4, making for the junction village of Sar, which lies at the foot of the range we called the Nyönno Ri, after the Survey of India's designation of the highest peak, a 22,000-foot mountain. (This name, by the way, was unknown in the district. Nor was the name Sangkar Ri, for a conspicuous point on the same range a

Looking across the head of the Khartachangri Glacier. Points 20750 (left) and "Dent Blanche"(right)

Deglaciated country at the head of the Lang Chu

little farther towards the north, familiar to the local inhabitants.[1]) Some of us who had been finding the continued climbing slightly distressing towards the end of the route out of Sikkim enjoyed walking over the level tracts of Tibet. The ritual of Asiatic travel was new and the weather fine. At nights it would freeze, but the mornings were clear, so that until about 10 o'clock the snow-range we were marching for stood challengingly before us. We were walking along the headwaters of the Arun river. A day's march from Sar a big stream from one of the glaciers in the Himalaya to the south crosses the route, turning the uncertain trickle that comes from farther eastwards into a decisive river. At Sar it swerves north to enflank the range before altering its course southwards into the valley above Kharta, after which it enters the well-known gorge cut through the Himalaya into Nepal.

There had been some delay in the issue of our passport from Lhasa, and we arrived at Sar without it. So in any case a halt was obligatory. We asked at once whether the authorities had any objection to our making a reconnaissance in the region. Finding no obstacles in our way we quickly got to work, urged by the patent inaccuracy of the existing map.

Impressions from the Sar work have been somewhat overwhelmed by the more vivid experiences in the Mount Everest region. Sar is at about 14,000 feet and the stations were at about 18,000 feet. The heights being moderate and the going easy, one could start some hours before dawn, picking a way across the marshes with a lantern and hoping for the sunrise as one kicked a way up the frozen scree-slopes. Between June 10 and June 20 I was able to occupy six stations. These I naïvely thought of as the beginning of a far-reaching survey to include the Nyönno Ri range and the territory to the east as far as Muk and to the south as far as the watershed. The work started by Shipton taking the plane-table, Kempson the Watts-Leica photo-theodolite, and I the Danish light equipment. Shipton found a pass through the range and made a beginning with fixing detail to the westward. Kempson's stations were on the range and commanded the country to the east. My stations were to map the range itself and then the main river valley as far as Lungme. Not until June 20 did it appear that we had unwittingly gone further than was pleasing to the higher authorities. By the next day it was clear to us, all parties being reassembled in camp at Sar, that the remaining photography we had hoped to do in the unknown western parts of the range could not be done. June 21 to 25, days of idle confinement in camp, were remarkably fine. The account of our work here would be incomplete without recording the generosity and hospitality of the Dzongpen of Sar.

The march from Sar to Rongbuk showed that the existing maps are very inadequate between Lungme and Tashidzom. When we arrived at Rongbuk on July 4 the wind was westerly and the whole country under cloud. This was responsible for giving us a very imposing first sight of Mount Everest. As we walked up through what Norton called the "gates of altitude" a slight clearing in the cloud revealed the mountain—but not where we had looked for it. The peak was just about twice as high above the horizon as expected, and the bulk of the mountain appeared enormous. The ridge to the summit seemed utterly remote and inaccessible.

[1] It is Mr. Odell's opinion that this range should be called the Gyangkar Ri.

The Rongbuk valley itself produced something equally fantastic. The numerous chortens, cairns and *mani* walls made one conscious of treading on sacred territory. But when suddenly the barren valley contained a crowd of some two hundred persons, inhabitants of the monastery, one wondered where one had strayed.

That night there was a great thunder and hail storm and in the morning the wind was in the east. July 5, 6, and 7 were days of dazzlingly fine weather, when Mount Everest and all the high peaks, white with new snow, were clear and glittering the whole day through. Unavoidably a certain amount of time had to be spent in unpacking and rearranging stores, as well as in observing the customary formalities at the monastery. We had arrived just at the end of one of the occasions of pilgrimage. Among those who had come to Rongbuk was a friend of former expeditions, known as Old Father William, a wealthy Tibetan from the Kharta valley. There was a very great crowd of people at the monastery and on the last evening they played some fine concerted music.

My own plans had meanwhile developed to become an attempt to make a survey bounded to the west by the western heights of the Rongbuk valley, to the north by Base Camp, and to the south by Mount Everest: the eastward limit was left indefined.

The decision to re-survey in part a region already surveyed did not imply that the existing map was in any way inadequate. On the contrary, Wheeler's 1-inch map covers a very large area and without it as basis I doubt whether the present photogrammetric survey would have been possible.

I began by taking stations on each hand of the Rongbuk valley at the Base Camp. Fording the glacier stream before dawn to reach the western station was possible but exceedingly unpleasant. I then went up the side valley to the east of Base Camp and managed to get two stations in the basin north of the triangulated peak 23180 (Kellas Rock Peak). After summoning more provisions from Rongbuk I started up the western side of the Rongbuk glacier, with the idea of pushing up towards the Lho La, but decided that it was the wrong side from which to descend on to the glacier, which in any case was a very unfamiliar kind of glacier to me. So, after getting a station on a height opposite Camp I, I started off to join Shipton and the rest of the party at Camp III. My party met some of the Sherpas of the climbing parties at Camp II. We were told dreadful stories of the necessity of going through raging glacier torrents waist deep in which somebody had nearly been drowned the day before. But next day we got to the "trough" up the centre of the East Rongbuk Glacier without any trouble and there met Shipton, Kempson, and Wigram descending.

There followed some change of plans. For the rest of the season I was privileged to be with one or other climbing party, on the two journeys up the Khartachangri Glacier and the final tour to Kharta. The sequence of events is described in Shipton's paper (*Geogr. J.*, February 1936).

Generally speaking I worked as described in the paper by Professor Nørlund and myself ("Some Methods and Procedure developed during recent Expeditionary Surveys in South-East Greenland," *Geogr. J.*, October 1935). But bases are much more difficult to obtain in the Himalaya than in Greenland. In particular it is difficult to find a base commanding Mount Everest.

One's problems are much confounded by the bad weather and the natural reluctance to climb induced by the altitude. Even if one knows of a possible base it is difficult to decide how many days one is prepared to invest in its doubtful success. The climber, forced to make his peak in a snowstorm and fog, considers his achievement a partial success and moves on to the next task. But a surveyor requires much more of the weather: the longer he spends getting to his station, the less likely he is to get the weather he requires.

As July passed and led into August, extreme speed of working became necessary: often I had to have all the observations from a station finished by 7 a.m. I used to attempt to get into position at the station by 5 a.m. and from then would wait until the dawn brought enough light to illuminate the theodolite circles. This meant abandoning most of the desirable features of triangulation routine. A second round of angles was quite out of court. The collimation constant of the level, which has to be known for the Wild instrument, could only be determined about once every four stations. Very careful choice had to be made of the points to which observations were made, if the station was to be finished. These rushed stations were very tiring, as much or more than a whole day's travelling.

My Sherpa assistants were excellent. In particular Tewang and Ang Tsering deserve mention. The latter was new to responsibility, but showed himself in the course of the summer to be reliable and sensible and to have a natural gift of leadership. Tewang is better known as a trustworthy and intelligent person—he can in fact write; but he is beginning to be rather too old for load-carrying at high altitudes. This summer he struggled on handicapped by amoebic dysentery: he must have had a good deal of distress, but only went back to Kalimpong for treatment after I had been frightened by the appearance of similar symptoms in myself.

On September 6 we finished as much as we were able to do for the photogrammetry of the Mount Everest region, and returned via Kharta, regretfully abandoning the completion of our photography in the Nyönno Ri Mountains in obedience to the wishes of the local authorities, who had received definite instructions on the subject from Tenkye Dzong. We had some ten days to spare, and it then occurred to me to make use of the remaining survey material in a short campaign in the extreme north of Sikkim. We had noticed on the way out that those fine peaks and ranges near and on the Tibetan border were very inadequately mapped. So I thought of spending a week in the valley which runs parallel to the frontier north of Kangchenjhau (Kangchima) and Pauhunri. The base would have been at the station Gayokang. But when we arrived there a variety of circumstances such as the parlous state of our equipment and the obvious persistence of the monsoon, together with the consideration that I had work at home more urgent than a survey having nothing to do with Mount Everest, persuaded me to give up the project and push on to Bombay with all speed.

It was possible to make a few physiographical observations on the journeys in Tibet. For instance it is obvious before one comes to Sar that the wide flat-bottomed valley of the Yaru Chu is a lake bed. My untrained eye was not able to trace evidence for more than one lake terrace above the gorge at Rongkong. In the neighbourhood of Tshetok there is still extensive flooding

of the valley floor. The lakes contain much pond-life, weeds and crustacea, which one would have liked to investigate. There are trout in the rivers and channels all up this valley. But most surprising of all is the number of common terns—animals one had previously thought of as sea-birds. There were many birds here which Kempson attempted to observe and will perhaps at some time give an account of. The Tibetan goose is one of the most striking of them.

Beyond Rongkong the river has cut itself a gorge, which is now working back through the lake deposits. The river is there called the Yaru Tsangpo and again runs over a lake bed, though here the terracing is more complex and much higher above the valley floor. The structure of the river already observed is typical. A lake basin is followed by a gorge which now cuts back into the basin preceding it. The Kharkung gorge extends really from the head of the Kharta basin to the villages round about Ne. The present stream has cut deeply into the water-laid strata, apparently revealing alternating periods of drought and raininess. Terracing is again obvious in the valley of the Phung-Chu above the Kharta district.

The filled-up lake floors, the rubble-filled narrow valleys seen between Lungme and Tashidzom, and the type of erosion in the Sar district all point to a period or periods of great rainfall rather than an extension of the existing glaciation. Auden, of the Geological Survey of India, has told me of similar pluvial evidence on the southern slopes of the Himalaya.

The Arun river itself is distinguished by its gorge through the Himalaya. It is generally assumed that as the folding of the Himalayan range took place the gap maintained itself. But there is a striking point in connection with the glaciation of the region. To cross from the Rongbuk region to a side valley of the Arun is equivalent to passing from East to West Greenland. The two districts are in completely different stages of glaciation. But the maximal glaciation would appear to have been the same on both sides. The present retreat of the glaciation in the Kharta valley is due to the masses of warm air coming up the Arun valley. As explained in Appendix IV, the cold north-west wind holds at even moderate heights during most of the monsoon period. Often, when the weather in Rongbuk was fine and cold, the Kharta district could be covered in a dense ceiling of cloud, under which, presumably, rain would be falling. These facts might be taken to indicate a more recent origin of the gorge.

From the photographs taken with the two photo-theodolites and earlier material the network of the Everest and adjoining survey is now plotted and heights have been calculated in the Everest region. Plotting has been by graphical methods; none other would have been possible. The rays were laid out on Kodatrace and the sheets from several stations superimposed where doubts or discrepancies arose. The state of affairs seems to be somewhat as follows. Wheeler started with a number of points supplied by the Survey of India. Morshead attempted to check the accuracy of these points by observations from a station north of the range, but he was impeded by cloud from getting any results. Wheeler found that some of the points given were non-existent, or grossly in error. Others were somewhat in error—for these Wheeler was able to determine better positions by use of the remainder. But even the remainder were probably slightly in error and any attempt to survey into the

View from above Sar eastwards up the valley of the Yaru Chu

compromised network reveals the shakiness of the whole system. The principal effect is to make it seem that certain individual points are erroneous, partly due to an accumulation of slight error from other points. Actually the adjustment in plan can be made so that the distortion is very slight indeed. But where the observations to peaks are at such considerable angles of elevation it is difficult to make a height network of great accuracy, or even sufficient accuracy for photogrammetric purposes.

As previously stated, the long-base range-finding method was used. Its value for reconnaissance was very strongly shown during the journey to Kharta. Here, as on so many other reconnaissance surveys, it was necessary to travel as fast as possible. As travel meant crossing at least one pass every day, one tended to lose sight of one's fixed points. After crossing the last pass into the Lang Chu we were in very foreign territory. Three stations were planned and occupied in two mornings, Dr. Warren taking one of them with the Watts-Leica instrument. It was by no means easy to fit these stations together or into the network. There were in fact several possible solutions. But by using the approximate length of the rays along which distances had been measured in Station XXV a criterion for the final solution was obtained. Thus the actual lengths were not used; but the fact that they must be approximately correct was decisive.

For a surveyor interested in the development of the technique of exploratory and reconnaissance survey it was a productive summer. I found that travellers of Shipton's calibre became with greater experience more and more anxious to make maps; I feel that it is a proper occupation for experts to turn this enthusiasm to good purpose and devise methods of survey whose field operations can be carried out by climbers and people with non-technical minds. Photographic methods are not only adaptable to this end, but were taken up with understanding by the members of the 1935 party. In fact they asked to be initiated into the methods of stereo-photogrammetry, seeing its value in the survey of a region often obscured by fog, when the grasp of the topography and recognition of points necessary for plane-tabling become very difficult. The impression, strengthened by such abortive attempts to use the R.G.S. equipment as that of the Oxford University Club's expedition to Spitsbergen, that the photogrammetric method is not suited to exploratory surveys is erroneous: the criticism contained in the appendix to Mr. Glen's account ('Young Men in the Arctic,' Faber & Faber, 1935) is that of an uninstructed person.

As I see it, the crux of the problem of photographic survey is provision for the working out of results afterwards. Certainly intrinsically better and greater results can be obtained by the use of photogrammetric methods in the field; but something like a permanent establishment is required to plot the work afterwards, equally whether mechanical or simple methods are used. I suspect that in such an institution as Professor Finsterwalder's in Hanover those learning survey can help in the plotting of expedition results. No doubt the Royal Geographical Society will see to it that a Mount Everest survey is plotted. But one hesitates to advise other expeditions to use photographic survey as long as there is a risk that there may be no opportunity of getting the results worked out.

Journey to the Lang Chu: looking northwards on to the Tibetan plain

APPENDIX I: THE SOCIETY'S WILD PHOTO-THEODOLITE IN THE FIELD

In its original form the Wild outfit is portentously bulky and heavy for exploratory work. A beginning was made towards lightening the assembly by replacing the old tubular subtense-bar by the new invar bar from the same firm. Lighter tripods have also appeared since 1927; they weigh 10 lb. complete. In the field weight was cut down by leaving at the Base the long-focus camera, used only on special occasions. (That the camera was afterwards stolen from the dump was an unfortunate, but not a necessary, consequence.) Nor was this the final weight-saving. The equipment includes a heavy box containing three pairs of base-rings and sighting targets. It became my custom to take two rings and one target in my rucksack, leaving the rest below. When the station to be occupied has been especially difficult I have taken the plate slides wrapped in clothing in my rucksack and left their case (of metal) behind.

But even without this last expedient the total load was cut down from nearly 250 lb. to something nearer 130 lb., if only a dozen plates and two tripods are taken into the field. This can be distributed as three very moderate loads for mountain work or two full loads for valley transport. The remaining accessories, note-books, binoculars, etc., must be carried by the surveyor himself.

There is still a possibility of saving weight on the subtense bar, weighing at present 14 lb., by using a type that I have seen in experimental application in Denmark, where a couple of targets slip on to the ends of an aluminium rod, divisible like a tent-pole and held in a light aluminium casting. All weights in exploratory survey must be measured against the 2 lb. which is the weight of a man's daily food ration.

APPENDIX II: LUBRICATION

A minor point arising out of the use of both the Wild instruments, the Society's photo-theodolite as well as the Survey of India's Universal theodolite, was the defective lubrication. Both instruments became unreasonably difficult to handle at very moderately low temperatures, *e.g.* at no more than 10 degrees of frost. If however the instruments had been all night in the field—frequently during a high traverse I would visit the station on the previous evening and leave the gear up there—exposed to such temperatures as 20 degrees of frost, then foot-screws, slow-motions, focussing-ring, etc., were all locked fast and only to be shifted by the use of considerable force. It was the grease or vaseline with which the various bearings are packed which was at fault. In one or two instances the oil supplied accessory to the instruments was used to replace the grease; it seemed to be perfectly satisfactory at low temperatures. The grease has not only the disadvantage of arresting the motion of the bearings at low temperatures, but it also begins to run at moderate degrees of warmth, so that the handling of the instrument becomes a function of temperature.

APPENDIX III: TRANSPORT

The approach to Mount Everest is over a path passable to mules, donkeys, and yaks. Which of these animals one gets is generally settled by local conditions. The mules are fastest and in good condition can do the average 25 miles of a double stage in a day. Donkeys are not so fast; when they are in good condition a double stage is not beyond their powers, but successive double stages cannot be covered without distressing the animals.

Yaks are strong and reliable, but so slow that there can be no question of double marching.

Each of these methods of transport is very rough on the loads. The best loads would be packed in boxes and would weigh about 60 lb. When Major Mason was in the Karakoram in 1927 he packed the loads in a layer of spongy rubber; the wisdom of this arrangement was well shown during this year's expedition. My own ignorance of conditions led to some avoidable wear and tear. The "Venesta" boxes are to be recommended, especially for stationery and minutiae. Rucksacks were not good; not only the contents, but usually also the rucksack itself became broken. This style of packing also offers too much temptation to mule-drivers to search and to rob.

It might have been thought that boxes were an awkward form of packing in very mountainous country. But this is not the case. A Mount Everest porter makes up such a load with his own property into a cumbrous parcel which he carries by means of a head band. It is convenient if loads can be broken down into smaller units than the above-mentioned 60 lb., though 60 lb. is a load which could be carried by a porter on a main transport line between camps.

APPENDIX IV: WEATHER

The main periods of the weather were defined first by the approach of the monsoon and then by its weakening. The front of the monsoon is not a definite thing; it is rather a zone in which disturbances from the main monsoon advance and retire and traverse. In Mount Everest literature the "break" of the monsoon is a term usually employed to mean the instant of arrival of the first of these skirmishing disturbances. From that time onwards, of course, similar disturbances are likely to come up from the plains, bringing snow and cloud. But it may be some time later that the great body of warm air reaches the highest Himalaya. And there may be a longish period of fine weather between the first storm and the arrival of the deep mass of monsoonal air.

We crossed the frontier into Tibet on June 4 and did not reach the Mount Everest region until the first days of July. Our observations are therefore taken at different times in different places. When we entered Tibet however we found a definite routine obtaining which we took to be typical of pre-monsoonal conditions for that territory. We had the Sar district under observation from June 4 until June 26, since the Nyönno Ri can be seen from the Kongra La. The mornings were fine and clear until about 9 a.m., when cumulus clouds would form round the mountains; at about 10 a.m. a south-west wind would begin to come in, soon hardening to a fresh breeze and itself strong enough to forbid instrumental work, even if the clouds had allowed it. Such conditions were however very nearly ideal for survey. The nights were cool—at 15,000 feet in the valleys there were a few degrees of frost on most nights. But even at 18,000 feet the cold was not severe. Work was possible from 5.30 a.m. onwards and to finish a station before 9.30 presents few difficulties. The form of the hills made the choice of bases easy; probably the whole district could have been surveyed without recourse to bases laid out on snow.

It is not suggested that every day was of precisely the type described. There were of course alterations superposed on this régime. But it was not until June 26 that this rhythm seemed definitely to be broken. What actually happened was that it began to rain at night and on into the morning. The days were continuously clouded. In that part of the world, some hundred miles eastward of Mount Everest, the upper, rain-bearing wind seemed to be easterly

or north-easterly, although often the day wind from south-west or west would blow underneath it. Both the valleys flanking the Nyönno Ri, the valleys at Sar and at Kharta are noted for the strength of their local winds. Curiously enough we found even during the pre-monsoonal period that as low as 2000 or 3000 feet above the valley floor these winds were very much weaker.

The weather about Mount Everest between the fine period at our arrival and the beginning of August was irregular but seemed to overlie a rhythm, occasionally concealed, of the same type as the weather of Sar. Interspaced between days which started fine and clouded up fairly early there were single days of bad weather. The worst day was July 16, when snow fell until well below 16,000 feet. This day found Shipton and his party on the North Col, where the great mass of snow made movement dangerous and rather falsified the impression of conditions there. But in general the bad days came singly, not as in the Alps in groups.

During the first part of August these bad days increased in frequency until the peak of the monsoon period. The worst week began on August 9 and was, as we found later, caused by a depression passing along the foothills of the Himalaya. The wind began in the north-easterly quadrant and snowfall was fairly continuous, though there was a tendency to clear in the forenoon. The temperatures were high even at considerable heights and the daily range very small. At that time, I was told later in Calcutta, the warm monsoon air extended to a height of 20,000 feet above the plains of India. The party attempting the North Peak encountered temperatures little below freezing point at night at a height of 23,000 feet. It was hardly surprising that snow conditions were so bad.

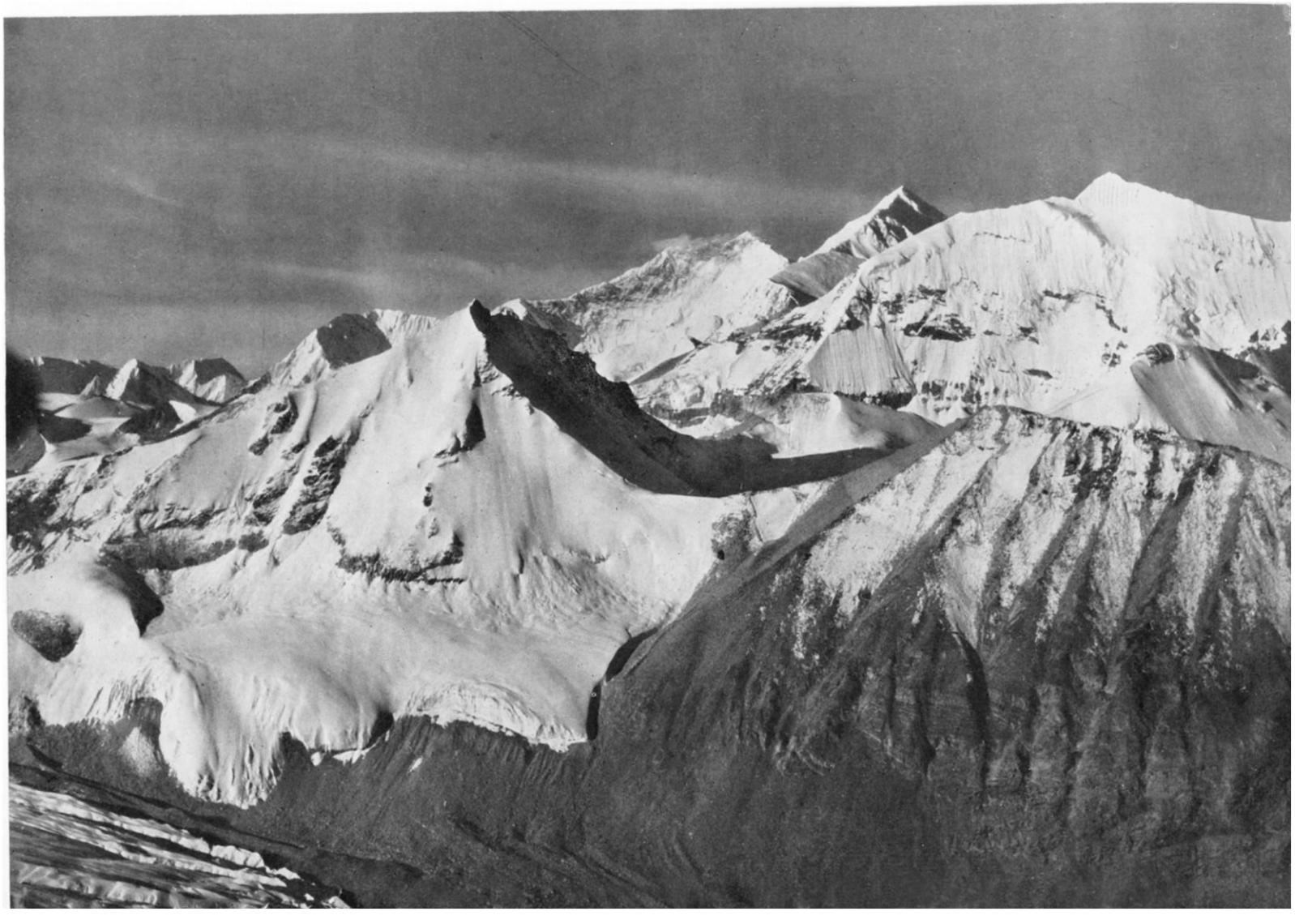
Towards the end of this period the wind veered round to the west. As early as August 18 I find entered in my diary the query: "Is the north-west wind beginning to blow over the top of the monsoon?" During the bad weather period survey work had been much impeded, and it had been only possible to snatch a few subsidiary stations.

Thenceforward the weather improved continuously and it was plain that the cold, dry north-west wind was becoming dominant. The nights became colder; temperatures down to 10° F. prevailed at night at 20,000 feet and the daily range increased again. The old routine of clear mornings became re-established in the Rongbuk region and steadily spread its influence eastwards. It became possible to work major stations again, though they were actually beginning to be difficult to carry out on account of the low morning temperatures, the later sunrise, the early and sudden formation of cloud and the fact that we were often working on snow.

When we returned to Sikkim in mid-September we were somewhat surprised to find the Bay of Bengal monsoon still vigorous. Mr. Sen, of the Calcutta Meteorological Office, was kind enough to give us an interpretation of this and the other features of the 1935 summer in India.

It had, he stated, been an exceptional summer. The monsoons both in the Arabian Sea and in the Bay of Bengal had been late in starting. Nevertheless the total rainfall in Burma, Assam, and Sikkim were above the normal. On our way back to Gangtok we ourselves witnessed spoilt crops, soil washed away, landslides, damage to roads and destruction of bridges—all the features of excessive rainfall. On the other hand, Calcutta and Lower Bengal were markedly short of rain. These varied phenomena can be linked up by showing them to be caused by the exceptional strength of the westerly Himalayan wind-current, which, persisting throughout the summer, diverted the whole body of the Bay monsoon away towards the east. For the Mount Everest district this meant a weakening of the Bay monsoon to almost negligible proportions. The greater

Ama Drime in the "Nyönno Ri" range: Sar in the right middle distance



From a pass on the route to the Lang Chu: showing points 20750, Lhotse, Everest, and Khartachangri

part of the precipitation in that district is normally caused by the Bay monsoon. Actually the two branches of the monsoon, that from the Arabian Sea and that from the Bay of Bengal, meet in the neighbourhood of Mount Everest. The persistence of the north-west wind this year prevented, at all events in July, anything but occasional carry-overs from the Arabian Sea reaching our district. The August period was more normal; the presence of the depression south of the Himalaya induced monsoon air into the region. But as soon as that depression moved eastwards and filled in the north-west wind re-established itself and brought fine weather.

APPENDIX V: PHOTOGRAPHY

In the Wild camera the so-called Topographic emulsion made by the Ilford firm was used on plate-glass plates. The material was developed in England after the plates had passed twice through the tropics. On development the plates were found to be in no way fogged; the images were bright and excellent. There were however disfiguring marks all over the plates in the form of patches of deposited silver. These deposits occurred where the surface of the emulsion had been rubbed against the surface of the plate packed opposite, during the long, jogging ride on yak or mule-back. The marks were visible before the development of the plates. Had the plates been repacked with separating strips of cardboard (as they are packed by the makers) no doubt this annoying trouble would not have occurred. I have never heard of a similar case of this source of damage. However it is not expected that the plates will be any less valuable for survey purposes from this cause.

The film material was the same as that taken to Greenland in 1933. It was the well-known Perutz "Topo" emulsion on thick air survey film. On development (again after return) we were spared the disappointment of finding disfiguring marks. In fact most of the illustrations for this paper are from this survey camera. But there was a certain loss of brightness of the images, as though there had been consistent slight under-exposure. Something of the same sort happened to the film kept for a long time after the Greenland season, especially where the film had been kept in considerable warmth. After talking to Messrs. Kodak about these phenomena I realize that exposure should be deliberately made very liberal if there is a likelihood of delay before development.

The electric exposure meter by Weston was invaluable for all classes of photography and showed itself capable of standing up well to the severe conditions of a Mount Everest expedition.

APPENDIX VI: NOTE ON THE MAP

The map published with this paper has been drawn by Mr. Milne with the help of all available photographs. No really satisfactory base was obtained commanding Mount Everest; the lie of the country and the outstanding height of the mountain make it a curiously difficult subject for terrestrial photogrammetry. From the floor of the valley at Rongbuk the mountain is seen at a better angle than from the 24,000 ft. summit of the North Peak. Yet no convenient position for a long base was found at a great distance; in contrast the survey of Makalu, for instance, would be straightforward. Closer to Mount Everest all the accidents of the terrain work against finding a base. In consequence neither of the stereogrammetric stations VIII or XI gave really good contours. However, the contours obtained have been the basis of the present map; they have been checked and improved by a multitude of spot-

heights obtained by intersections from the photographs at these two stations, occasionally amplified by rays from Col. Wheeler's photographs of 1921. Prof. Nørlund kindly allowed me to plot one pair of plates at the Geodetic Institute in Copenhagen; the second pair, taken with the Wild instrument, were kindly plotted for us by Messrs. Wild at Heerbrugg. The rock drawing is taken from the diversity of pictures accumulated during the course of the various Mount Everest expeditions, and the position of the detail was fixed in relation to the spot-heights. The map is, then, a fully responsible photogrammetric survey.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: Mr. Michael Spender has been well known to us as a surveyor since he took part in the Great Barrier Reef expedition. On his return in 1929 he devoted himself to the study of photogrammetric survey, spending more than a year under Professor Baeschlin at Zurich and in the field with the Swiss Federal Surveys. He then went to study in Germany. Following that he has spent two or three years with the Danes, first with one of Knud Rasmussen's expeditions, and later in the service of the Danish Geodetic Institute on the East Coast of Greenland. With this wide experience of the several methods in use on the continent of Europe he probably knows as much as any living man of this intricate subject of stereogrammetric survey. His latest task was, as a member of the Mount Everest Reconnaissance Expedition of 1935, under Mr. Eric Shipton, to make the first accurate survey of the northern face of the mountain, and to introduce the climbers in training to the charms of photographic survey, with the excellent results which he will now describe.

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

The PRESIDENT: I will ask Professor Mason to speak, if he will be so good. He knows the Himalaya exceedingly well and has done much good surveying there.

Professor MASON: There are one or two points I should like to stress in the extremely interesting paper submitted by Mr. Spender. Towards the end of the paper he says that the impression "that the photogrammetric method is not suited to exploratory surveys is erroneous: the criticism contained in the appendix" to a recent book "is that of an uninstructed person." I think it must be obvious to everybody that if it is possible to get an accurate map by this method at a station in twenty minutes of fine weather, an accurate map, for instance, of the north face of Everest, there are some points, anyhow, about the method. We have been waiting for the map of the north face of Everest ever since 1921. Now we have it, thanks to Mr. Spender and twenty minutes of fine weather.

As to the question of "uninstructed persons," we have no means in this country of properly instructing persons—Mr. Spender himself was instructed abroad—and I think that is a great pity. It is now nearly thirty years since this country took the lead in this method. In 1907 Vivian Thompson designed an instrument and plotted a map of the Lake District from stereoscopic pairs of photographs. He was told that the map was too much like the Ordnance Survey Map and that he must have taken a little help from that Survey.

In 1913, when we in India produced a map of the Taghdumbash Pamir, we were told that it was very nice, but that there was no map to check it by. Since then we have lost the lead. Both instruments and methods have improved vastly, and yet we are still in that extraordinarily conservative habit in this

THE NORTHERN FACE OF MOUNT EVEREST

based on Photogrammetric Surveys by Michael Spender

Scale 1/20 000

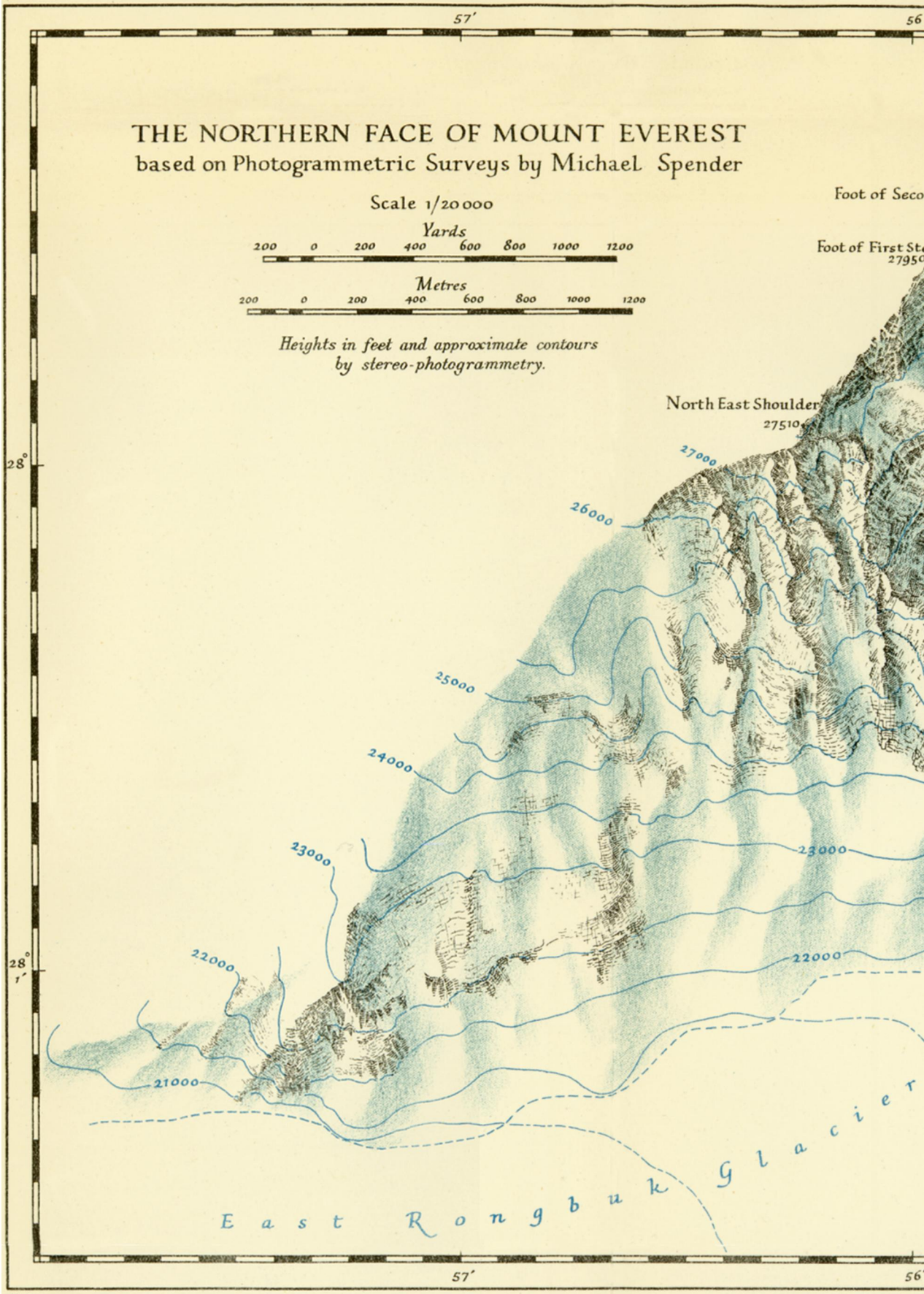
Yards

200 0 200 400 600 800 1000 1200

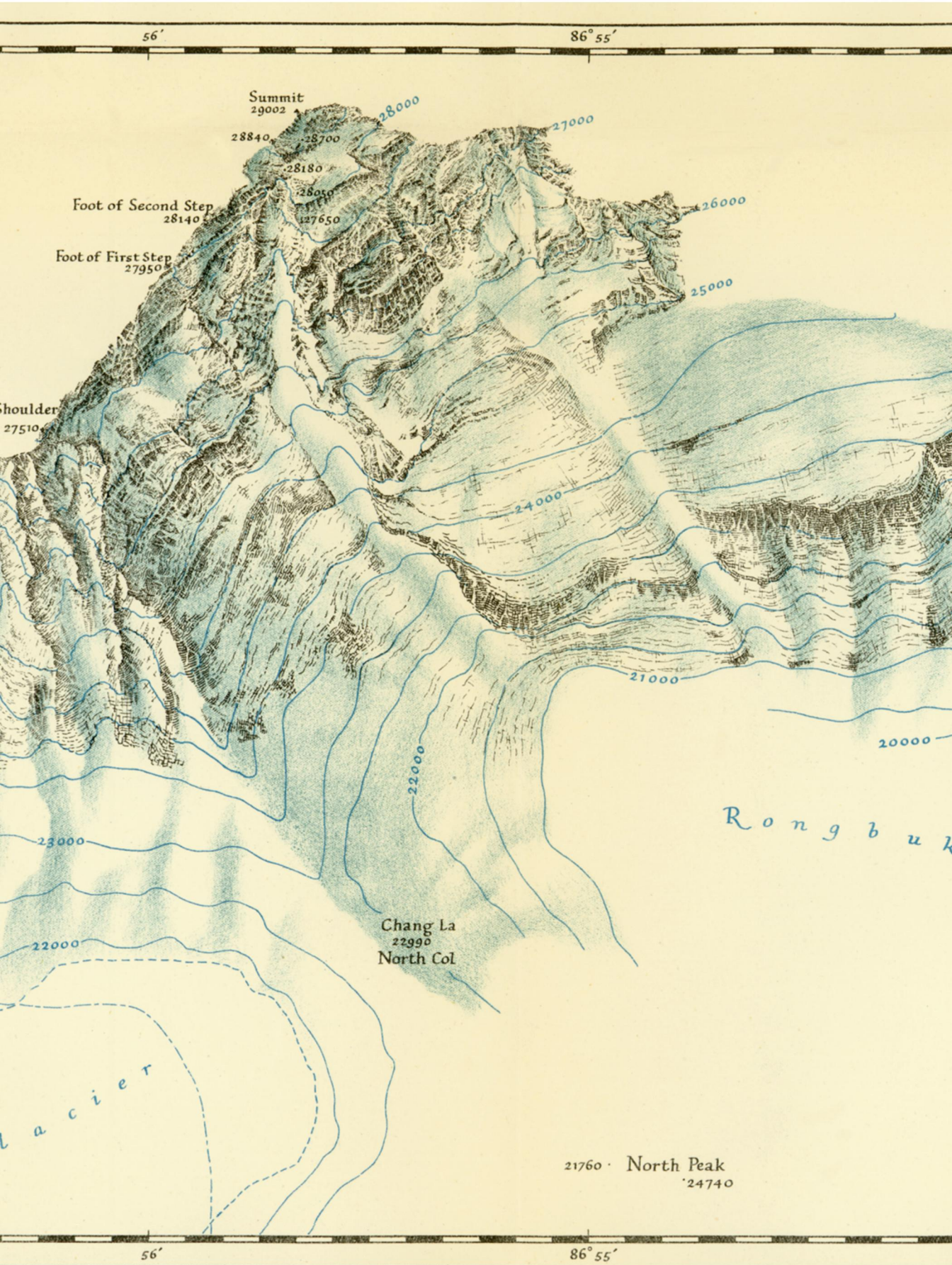
Metres

200 0 200 400 600 800 1000 1200

Heights in feet and approximate contours by stereo-photogrammetry.



H.F. Milne, del.



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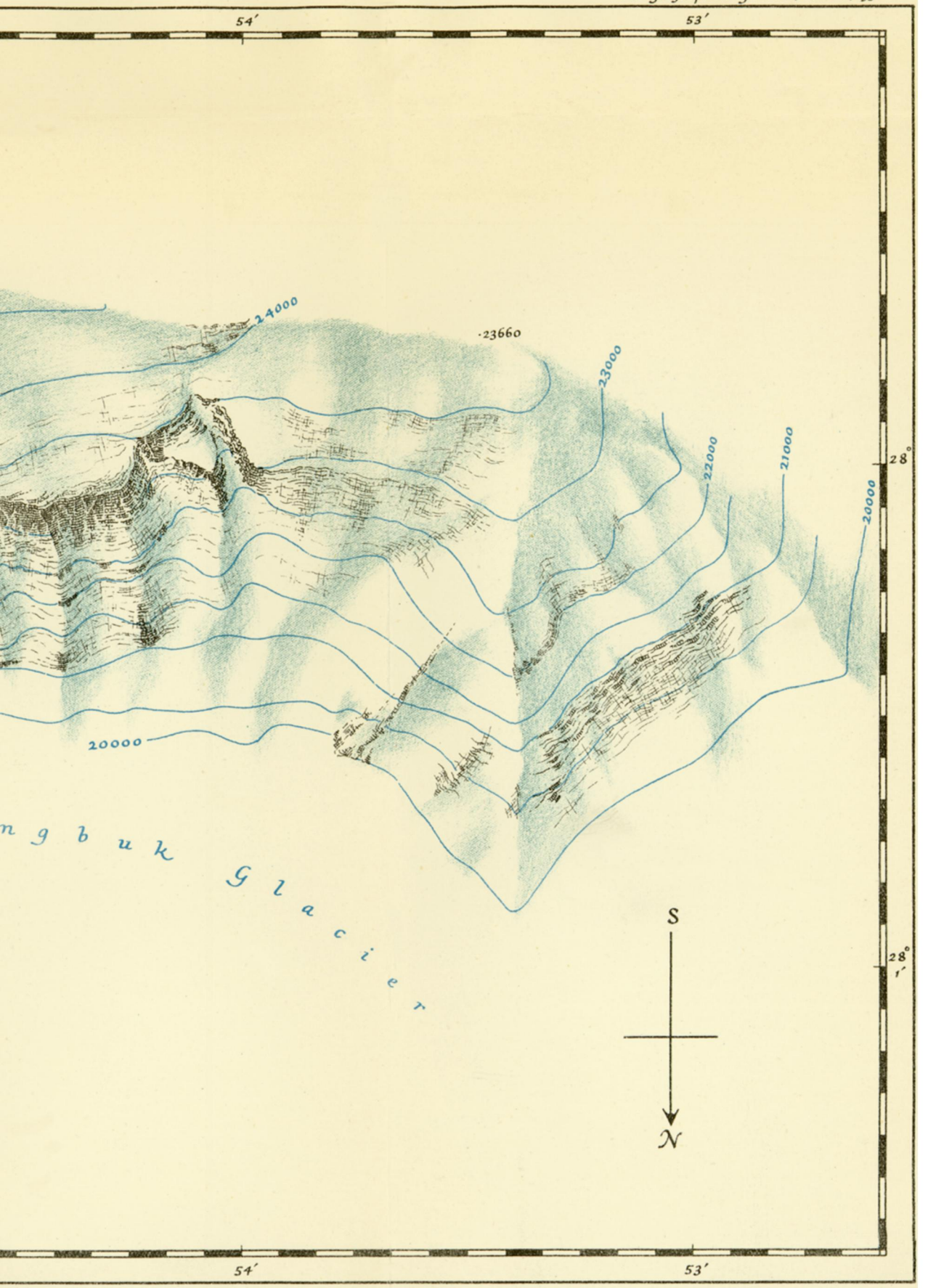

MOUNT EVEREST
Spender

THE NORTHERN FACE OF MOUNT EVEREST

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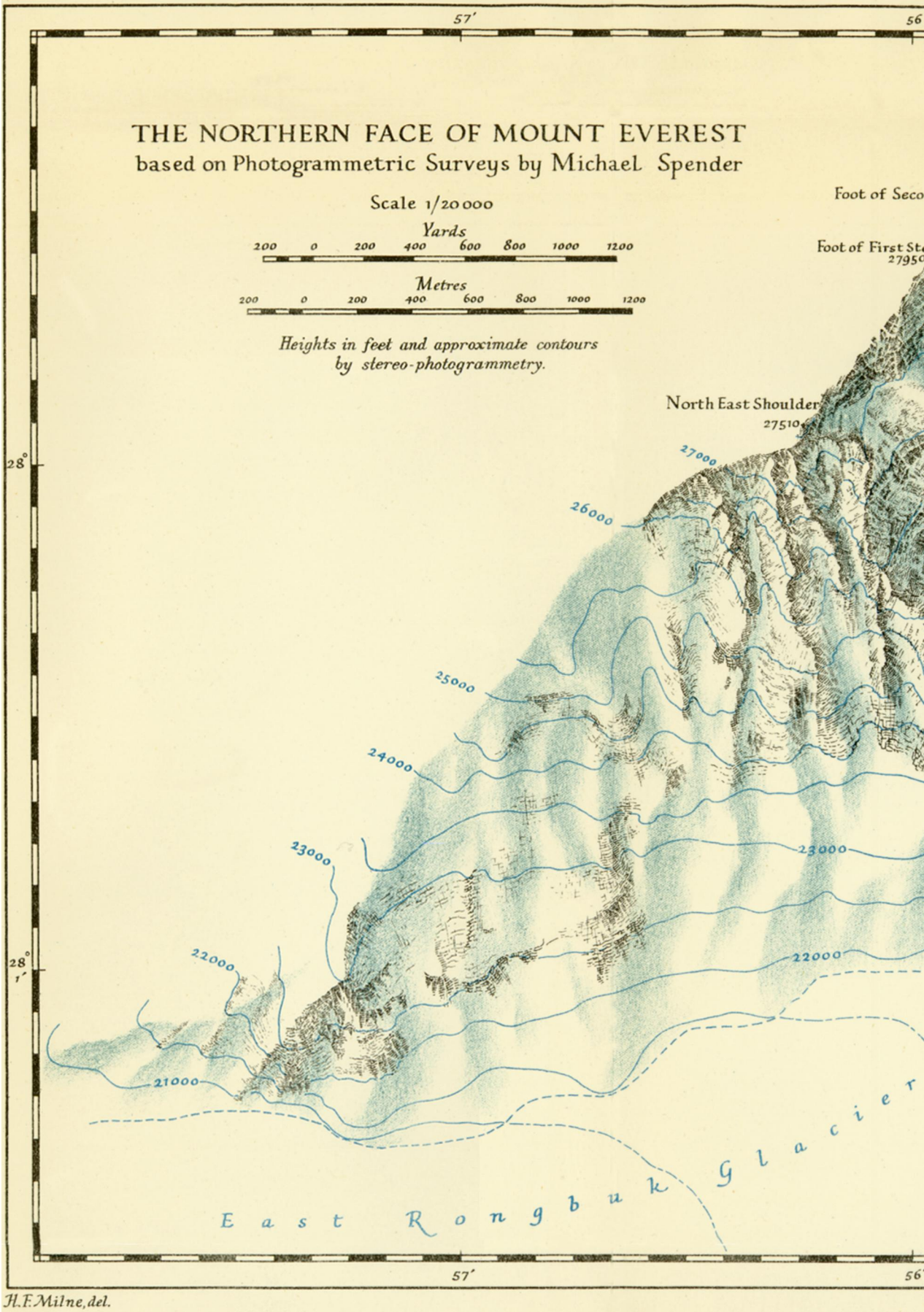

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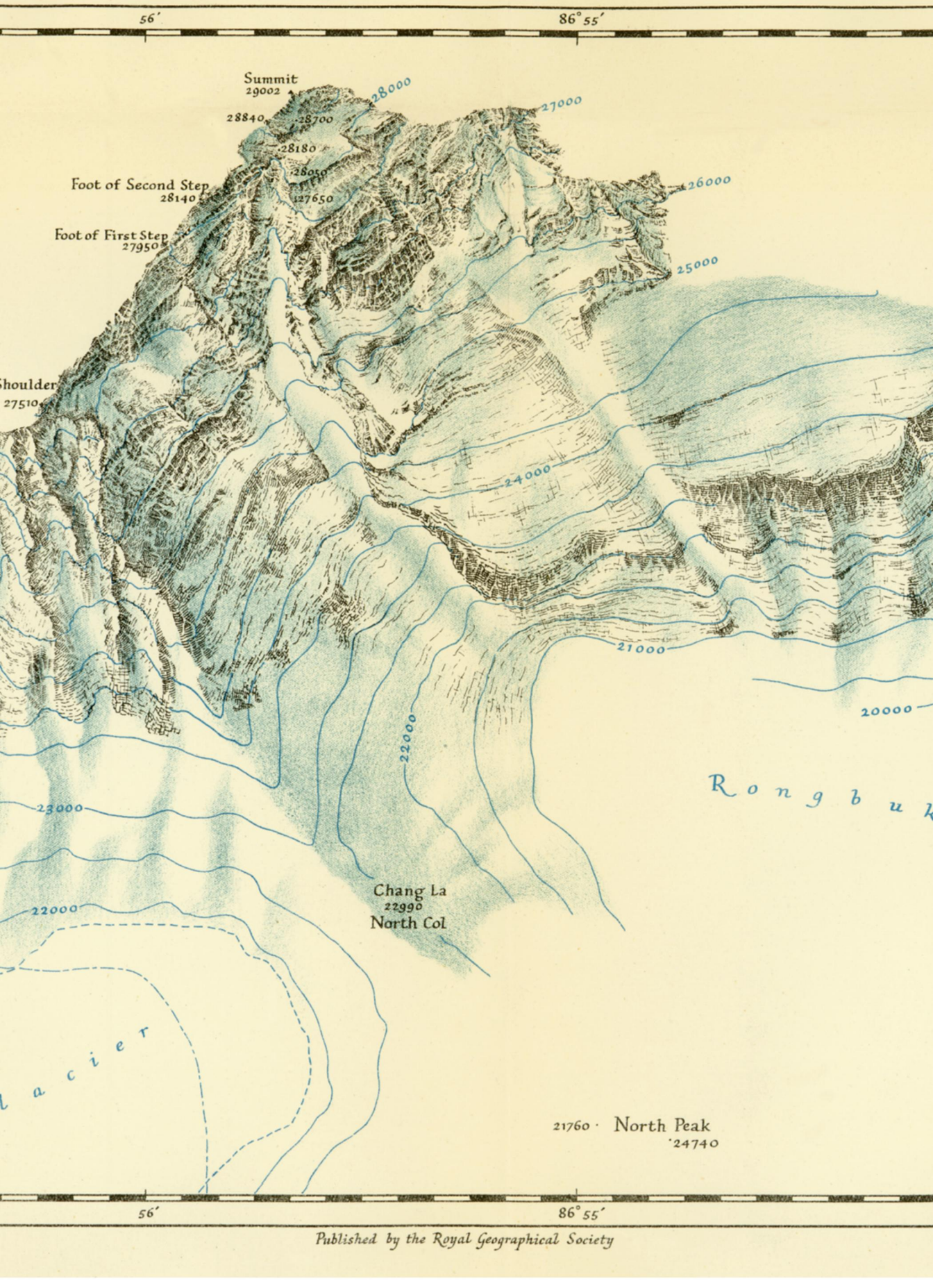

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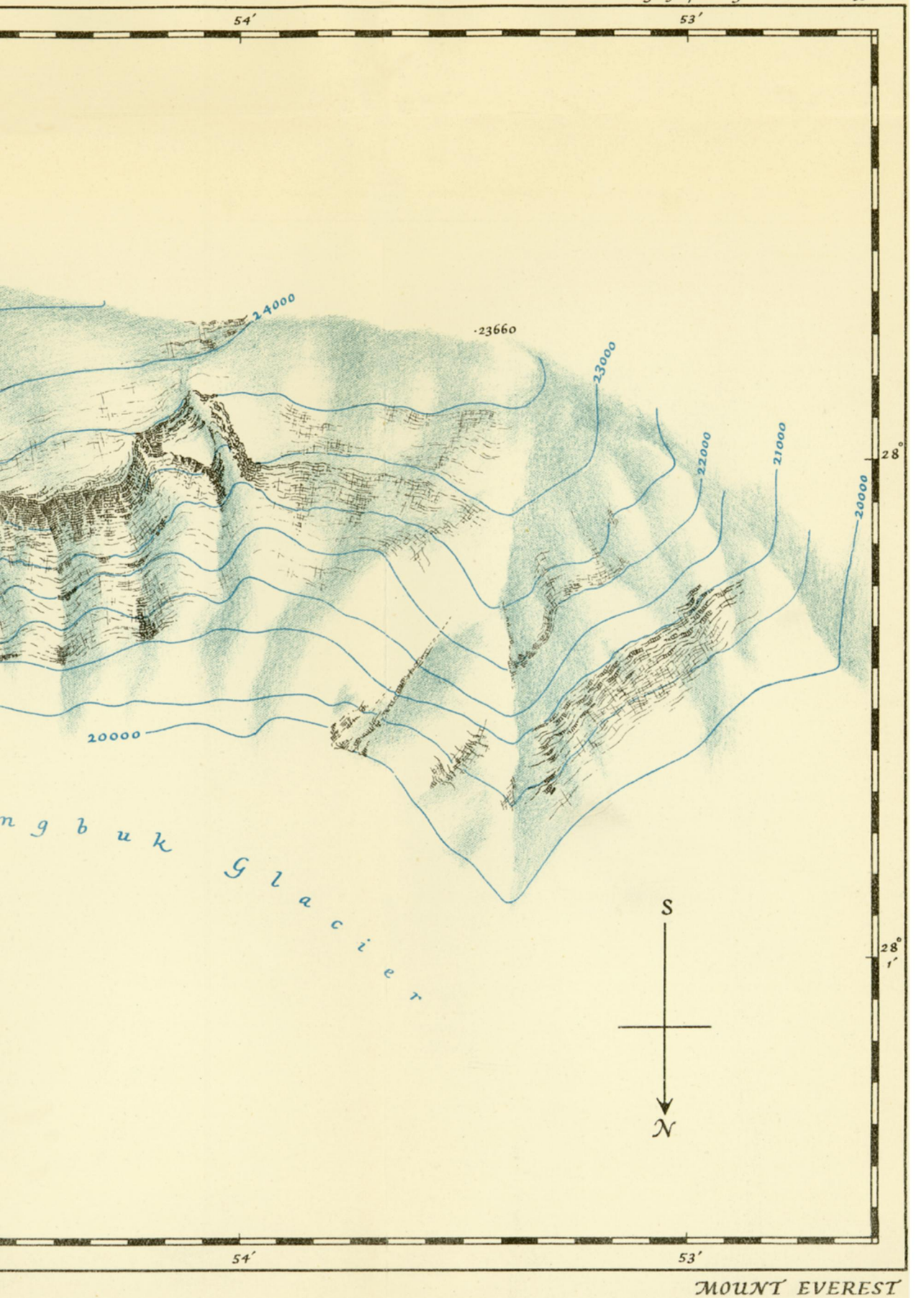

MOUNT EVEREST
Spender

country of saying "what was good enough for our grandfathers is good enough for us." It is not! You cannot in these days have a map that is too accurate. Geographers, geologists and geomorphologists—in fact every "geo-body"—want accurate maps. It is impossible to do scientific work properly on the old class of maps. We want to know much more about Everest, and once we get good maps we shall be able to learn more about it. The recent maps produced by Finsterwalder and others abroad are amazingly accurate and extraordinarily good. It is surprising what can be learnt from a close study of those maps. This is the first real chance we have had of doing this type of work.

The question of plotting now comes in. Mr. Spender says in his paper that he is chary about recommending this method of stereo-photographic survey to explorers from this country unless there is some probability of having the maps properly plotted afterwards. Well at present one is rather inclined to agree. We do this work now in India, yet we have to send our photographs to Switzerland to be plotted. Now this method is eminently suited to secret and confidential surveys: and in India some of our maps have to be confidential. Are we to compile these maps from material sent to Switzerland to be plotted? It seems to me that that is all wrong.

Many countries in Europe now have three or four of the instruments in constant use. We are told that this country cannot afford one. Portugal has one. There are many countries no bigger than Portugal who have them. What is the remedy? This Society cannot afford one off its own bat. Perhaps the Government of this country, which has already spent the cost of perhaps three in experimenting from first principles, might deign to buy one already made abroad! I do not know.

Then there is another difficulty. You must have trained engineers to plot these records. We are told that there is nobody in this country capable of doing it. I cannot believe that we cannot produce them. I refuse to believe it.

One last point, the question of spongy rubber as used for purposes of transport. I recommend you to read carefully the appendices in Mr. Spender's paper. They are extremely interesting. He suggests that I was a wise man when I thought of spongy rubber for protection of my instruments. It was not my idea. That, again, was one of the very many useful pieces of advice I had before I set out on my expedition from Mr. Hinks, who knows as much about this method as any man in this country, and as much as most in any other country. I can see no reason why, in addition to his many other duties, he should not find time to instruct three or four people in the use of this instrument when the country buys it!

The PRESIDENT: Mr. Thompson is a member of the Geographical Staff of the War Office. I am sure he has some useful comment to make.

Mr. THOMPSON: I am afraid I have not very much to say on the technical side, because I have had absolutely no experience of this type of mapping, all my experience being with mapping from air-photographs. I should however like to congratulate Mr. Spender on a most excellent piece of work. From what I have read of the method, the difficulty of choosing stations in ordinary country is bad enough, but in such excessively mountainous areas it must have exercised all his ingenuity. From the point of view of the usefulness of the method, I was recently over in France, and I was told by the Service Géographique de l'Armée that when they have two methods to choose from, the making of maps from air-photographs or from ground-photographs, they find that in hilly country, provided they do not get more than about 20 to 30 per cent. of dead ground in the terrestrial photographs, it is much more economical to use them. Their method in the Alps was to map the sides of the valleys with ground-photographs

and then fill in the dead ground, usually at the bottom of the valleys, with air-photographs flown up the valleys.

The other part of Mr. Spender's paper which interested me very much was that which referred to the use of the Leica camera. It would be interesting to know the kind of accuracy he was able to obtain with it. I would also like to ask what percentage of photographs were plotted in the Wild machine and what photographs have been plotted by other methods.

Mr. SPENDER: We have so far only had a couple of pairs of photographs plotted in plotting machines, one pair in Copenhagen and the other in Heerbrugg. That is all the work that has been done on the photographs. At the moment the survey is, so to speak, in abeyance.

We did not use infra-red photography in the Mount Everest region because, for the most part, the shots were comparatively short. In my experience infra-red photography is not worth considering unless you are photographing over a distance of at least 50 kilometres. Beyond that distance the infra-red method is most helpful; otherwise it renders photography more difficult. In the Mount Everest region we were of course up against much cloud, which could not be overcome by the use of infra-red photography. As for the air-photographs, they will no doubt be very useful when we come to putting together a map of the summit of Mount Everest itself. So far the map has not reached a stage in which the air-photographs have been called upon.

The PRESIDENT: If no other member of the audience wishes to make some observations I will ask Mr. Hinks to say a word or two before we conclude. You have heard the tribute paid by Professor Mason to his great knowledge of these abstruse questions, the photo-grammetric and the stereo-photogrammetric methods. Indeed, in regard to all matters of survey he is a great expert. I will ask you to excuse me now as I have an urgent appointment to keep. I will leave the winding up of the discussion to Mr. Hinks.

Mr. HINKS: I am indebted to the President for giving me the opportunity of speaking of the spasmodic interest which I have been able to take in the question of survey by photography, especially survey by the stereo-photogrammetric method. It was in 1924 that, having gone upon a mission for the Mount Everest Committee to Switzerland to arrange with M. Jacot-Guillarmod to come to London and to draw the map published in the Mount Everest book of 1924 and repeated in the book of 1933, I took the opportunity of going to see Heinrich Wild and the instruments which he had constructed at that time for stereo-photogrammetric survey. As a result of that visit, when Major Mason, as he was then, was planning the Shaksgam Expedition and inquired what the Society would do to help, it was soon arranged that the Society should buy a Wild Photo-theodolite and send it out for his use in the Shaksgam. It will be within the recollection of many present how extremely well Major Mason carried out those surveys and what very beautiful maps were produced of hitherto almost unmapped country.

Major Mason plotted the plates at Dr. Helbling's Vermessungs-Büro at Flums. We hoped that this experiment would stimulate more interest in this question in England, and that long before now we should have some means, perhaps connected with this Society, of being able to plot any pairs of photographs taken on one of the stereographic survey cameras. Indeed, in 1929, when the plans for the new part of our building were made, there was a certain room on the basement floor which was, at any rate in one's mind if not officially on the plans, intended as the place where one day there might be a stereographic plotting machine. But things do not move very rapidly in the way of converting people in England to this method.

Therefore I was exceedingly glad when Mr. Spender, on his return from the Great Barrier Reef, proposed to devote some years of his life to the study of these methods. How thoroughly he has done so the President has already described.

The question now comes: How is this knowledge going to be utilized to the best advantage? Here we are in 1936 apparently no nearer than in 1926, when Major Mason was in the Shaksgam, to having a stereoscopic plotting machine for use in this country. Mr. Spender has recorded in his paper that of the two pairs of photographs made on each of the photo-theodolites on which his map was based, one pair had to be sent to Heerbrugg to be plotted, and the other pair was taken to Copenhagen to be plotted by the kind permission of my friend Professor Nørlund.

That was all very well in 1927, but it is not at all satisfactory in 1936.

I feel that there is plenty of scope in this Society for an official whose duty it should be to establish here a more or less experimental but definite plotting department, that could make the best use of the photographs that will be continually pouring in in different ways, some badly taken, but some very much better taken if there is knowledge that they can be properly plotted. There is the mass of material mapped by the Mount Everest Expedition in 1935, and they will have mapped a great deal more in 1936. Those who took pictures in 1936 will want to be able to plot them. We want an officer on the Society's staff, aided by a draughtsman, who can deal with material like that.

A question was asked: What is going to be done with the Mount Everest Flight photographs? Mr. Spender partly answered that question. We have made here during the last year a sort of map of the southern face of the mountain from the Flight photographs, which is complete as regards horizontal detail but has no heights as yet. We are hoping that the work Mr. Spender has done will enable us to obtain approximate contours of that; and so by our method of fitting in one thing with another we shall eventually have, thanks to Mr. Spender's work, a reasonable map of both sides of the mountain.

I mention all these things only to show that if some one could find a way to provide the Society with the means for establishing a plotting machine, and to obtain some one, like Mr. Spender I hope, who could be a permanent member of the staff to carry on permanently work such as he has been doing during the last few months, it would be one of the best things the Society could ever do.

The President has left it for me to ask you now to accord a hearty vote of thanks to Mr. Spender, and at the same time congratulate him on the very admirable work which he and his colleagues did in photography on the Mount Everest Reconnaissance Expedition of 1935. We must thank also Professor Nørlund, the eminent Director of the Danish Geodetic Institute, for his kindness in releasing Mr. Spender to go on the Expedition, and in lending the Zeiss photo-theodolite which, with our own Wild, played principal parts in the enterprise.

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BOTANICAL AND GEOGRAPHICAL EXPLORATIONS IN TIBET, 1935: *A paper read at the Evening Meeting of the Society on 20 April 1936, by*

F. KINGDON WARD

TOWARDS the end of April 1935 I left Tezpur in Assam, and early in May reached the inner valleys of the Assam Himalaya. The climate here at 6000 feet is warm temperate, and the rainfall moderate, with long winter drought. Consequently the dense rain forest of the outer slopes is replaced by open forests of Oak, Pine, and Rhododendron.[1] Travelling leisurely over the hill ranges from one tributary of the Bhareli river to another, and halting here and there to explore the rich flora more fully, I reached Senge Dzong on May 28 (see Folding Map at the end of the *Journal*). I was now on the Se La range, which separates Assam from Mönyul, and still awaiting a permit to enter Tibet. At last, permission having been granted, on June 3 I was able to cross the Se La, a pass about 14,000 feet high. The monsoon had just broken. For the next few days I followed a new route, and crossing four more passes, each one higher than the last, had a hard struggle through rain and snow. The alpine flowers however compensated for any discomfort. From Senge Dzong to the Tibetan plateau, the country is lofty but deeply eroded, sparsely populated, and entirely uncultivated. The inhabitants are Mönba, and live on their herds; all grain is imported. Both men and women wear close-fitting, saucepan-shaped, black felt hats, something like those worn by the Persian peasants. Men's hats are distinguished by four short tails twisted from the rim: women's hats are fringed with tails. The women also wear ropes of immense amber beads hanging from their ears.

The first pastoral village I reached was Luguthang (or Lungdang) a small settlement of cold stone houses huddled together on a steep slope, above the tree line. The maps show Luguthang on the Mago chu, but this is incorrect. A high range called Zabu Pu divides the Mago river from the Lungdang Shung chu, which latter rises only a short distance above the village and flows independently to the Tawang river. Crossing this range by the Truker La, a rocky pass of about 16,000 feet, still under snow, I reached the Gorjo chu,

[1] *Pinus excelsa; Quercus Griffithii: Rhododendron arboreum* principally.

which has its source amongst the snow peaks of the Assam Himalaya. Thence crossing the low Chera La, a very steep descent brought me to the Dungma chu, and to Mago. Mago consists of two herd's villages, Dyuri and Nyuri, meaning left hand and right hand respectively, in allusion to their being situated one on the right the other on the left bank of the Goshu chu, which here joins the Dungma chu. The combined river rushes into a gorge, and about a mile farther on is joined by the Gorjo chu. There is no path down the Dungma chu from Mago. It may be noted that the names Dyuri and Nyuri are reversed according to our reckoning; Dyuri being on what we should call the left bank. The two villages together are known to the outside world as Mago. Captain Sherriff and Mr. F. Ludlow were here in 1934. Colonel Bailey and the late Major Morshead visited Mago in 1913, and later it was visited by Neville. The altitude is 11,800 feet (Bailey). Most of its trade is with Dirang Dzong, a large village in the valley below Senge Dzong, but reached by a different route from the one I followed *via* Luguthang. Just above Mago is a hot spring, the water, which smells strongly of sulphuretted hydrogen, bubbling up from under a rock at so high a temperature that it is impossible to hold one's hand in it. Nevertheless several species of Alga flourish. The local people have not troubled to build a bath, nor do they make any use of the water, either for medicinal or ablutionary purposes.

Beyond Mago there are no villages until the plateau is reached, though the herdsmen migrate in summer to a small hill station called Chunak—Black-water, so called from the black slate mud with which a glacier stream is charged. The houses though small are solidly built of stone, but are only occupied between June and October. Other smaller summer villages are Chumba and Lap, the last-named at an altitude of about 14,600 feet.

Continuing my journey northwards, I crossed the main Himalayan range by two high passes, the Tulung La and the Pen La, on consecutive days. Both are over 17,000 feet. After crossing the Tulung La, I left the forest region behind me and entered upon the dry treeless plateau. From the Se La to the Tulung La, the country showed every sign of intense glaciation, though I saw only a few small glaciers. North of the Pen La however there is no trace of glaciation.

On June 11 I reached Karta. There is a small monastery with hovels clustered round it, and a picturesque *chorten*, called the *labrang* (literally, office). Big houses, interspersed with ruins, are scattered over a shelving gravel terrace between two deeply sunken streams, the Tak chu from the Pen La, and the Hlanga chu from the east. These streams unite immediately below Karta, and are the true sources of the Subansiri, which thus rises at the extreme western end of the Assam Himalaya. Looking down the valley from above Karta, a fine snow peak 22,713 feet is seen to the east. I now found myself in a very arid region. All crops are irrigated, the water being brought from a distance of several miles. At this season the fields were brilliant yellow with mustard, and the irrigation channels blue with a charming "Sibirica" Iris. Trees—Poplar and Willow—grow only where they are protected from the wind and spoliation. Down by the river, in sheltered spots are Hippophäe trees. There is a sort of country club out in the fields, surrounded by a wall, behind which grow trees and flowers. Here I stayed two nights. Continuing

northwards I reached Tongme Gompa where the Loro Karpo chu from the west joins the Loro Nakpo chu, to form the Loro chu. The Loro Karpo chu flows eastward, parallel to the Himalaya, in a wide stony valley, but was now almost dry; we were across it before I realized it was a river at all. Most of it is drawn off to irrigate the crops at Tongme Gompa, but for two or three months there is more water coming down. I now turned east down the wide valley of the Loro chu. There is much cultivation here, and by the river dense thorn thickets of sage green Hippophäe; but the valley soon narrows to an arid gorge, and these fleeting signs of fertility disappear. About a mile east of Tongme Gompa is a *stupa* shaped rather like some of the pagodas in Burma; and across the valley is a fine view of the western end of the Assam Himalaya. I was much struck by the contrast between the large size of the valley here, which was both broad and deep, and the small size of the river. Farther west, the valley grows larger as the river shrinks. Formerly the valley was filled with gravel and a series of terraces show where the river flowed when there was more water in it. This present misfit is characteristic of many of the plateau rivers, and is accounted for by the gradually disappearing glaciers which feed them. In 1924 Lord Cawdor and I, travelling south from Tsetang to Tsona Dzong, had crossed one of the headwater streams of the Loro chu. It was the depth of winter, but even so the contrast between the wide stony valley and the paltry stream which flowed through it was notable.

I reached Chayul Dzong (or Chadze) on June 19, a squalid village of hovels in an arid valley, harassed by a perpetual wind. The monastery is worthy of a better background. This was to be my base, but a glance was enough to convince me that few plants grew on these hot dry rocks. Looking eastwards down the gorge however I saw high forested ranges muffled in cloud day after day, so Chayul Dzong was not far removed from a more genial climate. There was more life down by the river than might have been expected in so dry a region. Birds were plentiful in the Hippophäe thickets. I noticed hoopoes, chough, wagtail, kingfishers, rose finch, partridge, babbler, doves, rock pigeons, and several smaller birds. Along a low stone wall built to train the river, voles were common; and in a small pond I found frogs. Between 11,000 and 14,000 feet, it is only necessary to water the ground and almost anything will grow. Irrigation however is difficult in the deep main valleys, and so most of the population live in the higher valleys, above 12,000 feet.

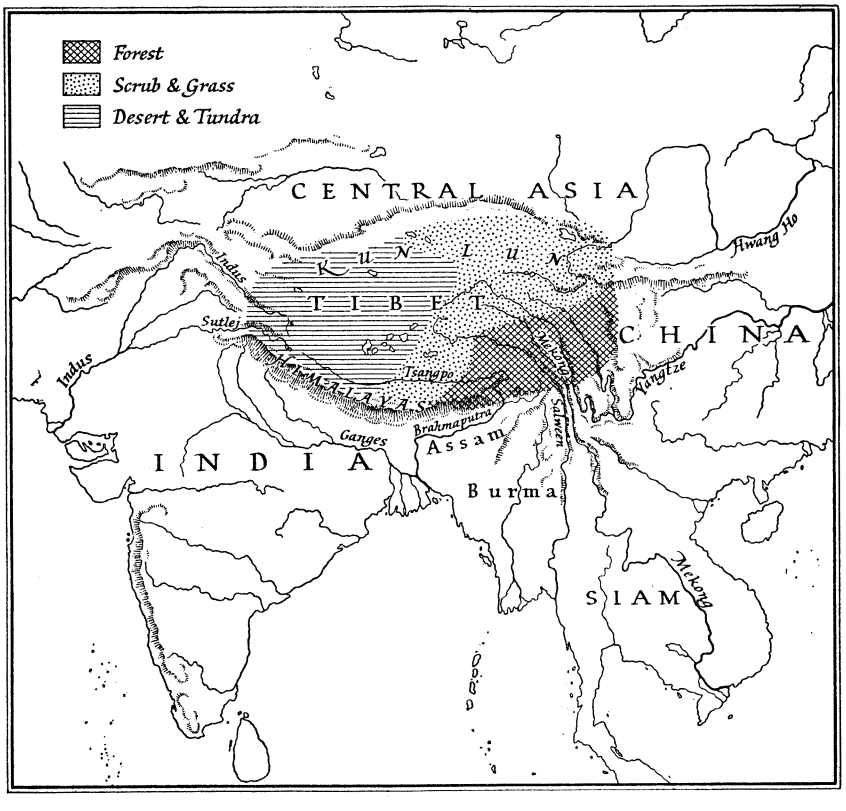
I was now in that extensive region of Southern Tibet, lying between the Assam Himalaya and the Tsangpo through which Colonel F. M. Bailey and the late Major Morshead had passed during their journey of 1913. Morshead had discovered that the Subansiri rose behind the Himalaya as far west as the 92nd meridian, and that it was the headwaters of this river which drained the plateau here.[1] It was not difficult however for the most part to avoid their routes. To naturalists it is virgin territory, so that as a botanist it did not matter if I followed in the footsteps of the pioneers. The only map I had with me was a copy of Morshead's reconnaissance survey on the 1/8-inch

[1] This had long been suspected, owing to the great size of the Subansiri in Assam. In the General Report, Survey of India, 1877–78, Captain Woodthorpe wrote: "That the Subansiri rises behind the high snowy peaks seen from Tezpur I think very likely from its size and velocity. . . ." Bailey and Morshead proved the truth of this surmise.

scale, which proved invaluable. This I used to check my own traverses across unexplored areas south of the Tsangpo.

I stayed only a few days at Chayul, and then set out on what I intended to be a month's journey.

My first march eastwards, down the Loro chu to Trön, was a long and hot one. Just above the Nye chu confluence, the road crosses to the right bank, and so continues for several miles. At the portals of a savage looking gorge, where the Loro chu appears to be (and probably is) entering the Himalayan range, the road returns to the left bank and becomes difficult. First it ascends



the cliff by means of a built-up path and rock ledges. Finally a vertical ladder, very awkwardly placed, and some 40 feet high, has to be climbed; luckily it is a real ladder, not just a notched pole. At one time there was an easier road at the foot of the cliffs; but the bridges are all broken, and the people have not troubled to repair them. In the evening we reached Trön, a village on both sides of the valley. Like Rima it is, or was, a penal settlement. A stone tower, in the base of which is a dungeon 12 feet deep, stands on the brink of the precipice. Condemned criminals used to be flung from the tower, but this punishment is now obsolete, though the dungeon is used. In winter jungle tribes come up the valley for salt. Some go to Sanga Chöling—these are called Chachu Or, and some to Chayul Dzong, these are called Chachu Kung; but

probably they are both clans of one tribe, the people who in Assam are called comprehensively Dafla (or possibly Aka). When the snow melts on the Himalaya, they also come over two passes, the Kashung La, south-east of Trön, and the Hla La, almost due south. Both passes are on the headwaters of the Kamla river, a large tributary of the Subansiri, which rises on the southern slopes of the Assam Himalaya. The salt is not a local product, but is brought from interior Tibet down the Nye chu. Before being sold to these Chachu (or Lopa) it is mixed with the dried sprigs of a common alpine cushion plant (*Arenaria polytrichoides*). This looks at first blush like sharp practice, but it is not. The Arenaria absorbs the water taken up by the hygroscopic salt; otherwise the Lopas, by the time they got back, would have none left, it would all have deliquesced. In exchange for the salt, the Lopas bring cane, skins, condiments, such as chilis and star anise (Illicium), and rice. Inter-village warfare is common amongst these savages, and whole villages disappear; but they give no trouble to the Tibetans, on whom they are entirely dependent for salt. It is unlikely that the Tibetans will penetrate farther east by the Subansiri headwaters.

From Trön I crossed the range to the north by a high and steep pass, the Drichung La, reaching Charme on the second day. The path follows a ridge instead of a valley, and we took yak transport. Above Trön we quickly reached a moister zone, and found many beautiful alpine flowers, including the rare anemone-like *Adonis brevistyla*, and *Primula Roylei*. From our first camp on the ridge above Trön we had a wonderful view into the yawning chasm of the Loro chu, buttressed by the spurs of the Himalaya. I also noticed a glacier west of us, on the same range. The Drichung La is very steep on both sides. Near the summit I found a new species of primula (*P. consocia*) and the charming dwarf *Meconopsis bella*. On the north side we descended a glaciated valley, but soon left it for a ridge. This was the first authentic signs of glaciation I had seen since crossing the Pen La. The Drichung La is about 17,000 feet.[1] From Charme I followed up the river to Sanga Chöling, the only considerable village in this part of the country. There are two fine monasteries. I was well received by the officials, one of whom had travelled with Sir Charles Bell some years previously. When I said I was a friend of Sir Charles' he could not do too much for me. I easily obtained permission to continue my journey to Tsari, a district I was anxious to visit for botanical reasons.

On the hot dry cliffs of the Char chu were great numbers of ugly black lizards. They attain a foot in length, and are found up to 12,000 feet. This lizard is common also in the dry Tsangpo valley, but does not occur beyond. In the very similar Salween valley (similar as regards its arid climate) a totally different genus is found. From Sanga Chöling I crossed the Cha La, 16,610 feet. In the narrow ravine above the Char chu, I was surprised to find forest, or at any rate trees (Conifers) growing on the cliffs, but we soon reached the

[1] I had no instruments with me. The heights given therefore are guesses, and I am fully aware of their crudeness, but a considerable experience of Tibet gives me some confidence in guessing. Moreover I had two useful standards of comparison—the nature of the vegetation, which to a field botanist is eloquent, and the heights of neighbouring passes over the same range, as given on Morshead's map.

alpine region, and a wealth of beautiful flowers. Looking back, I saw a fine snow peak, with one large and two small glaciers on the range south of Sanga Chöling; probably near the Le La, which is on the main route to Chayul Dzong. We reached Chösam, the first village in Tsari, in two days. After crossing the Cha La, although still within the Subansiri basin (the Tsari river flowing south-east) I was really over the second of the two fold ranges which lie between the Assam Himalaya and the Tsangpo. Takpa Shiri (commonly called Tsa Ri) is not, I believe, on the Himalaya but on the southernmost of these two lesser ranges.

Chösam, although a considerable village of stone houses, has no cultivation; it is another herd village. Not only is the Tsari valley, from Chösam eastwards, a typical ice-worn valley, but on the Takpa Shiri range immediately to the south are several short hanging glaciers. At Totsen the valley widens out into a great marshy meadow, now gay with millions of yellow *Primula sikkimensis* and violet iris. This is clearly a silted-up glacier lake basin. We covered the long march—about 18 miles—to Chickchar in a day; and I found the flora of this moist valley very similar to that of Tumbatse. Adonis was abundant. *Meconopsis betonicifolia* occurred lower down, where forest began, but was much less common than either *M. paniculata* or *M. simplicifolia*. Here I found the unknown *M. argemonantha*.

Chickchar boasts almost as many monasteries as houses. It exists by and for the pilgrim traffic. Although in ordinary years pilgrims are comparatively few, over fifty passed during the three days I spent here. Every twelfth year there is a special pilgrimage round Tsa Ri. The Tsari valley is much wetter than the other valleys to the south, lying just behind the Assam Himalaya in approximately the same longitude. It differs from them also in being ice worn instead of water worn. It is tempting to assume that the great glaciers have ploughed wide furrows through the ranges, thus letting in the moisture-laden winds from Upper Assam. But a moment's reflection shows that this theory is untenable. It was those same moist winds which nourished and kept alive the glaciers; and still do so to some extent. A small glacier hangs right over Chickchar. Some other explanation for the wetness of the Tsari valley must be sought. Pheasants are absurdly tame at Chickchar, and come right out into the open. They are never molested. A magnificent cock Harman's pheasant (*Crossoptilon harmani*) used to come out every morning within 50 yards of the house where I stayed, and call truculently. One afternoon (July 4) I walked right into a family of Harman's pheasants, the chicks, which were about two weeks old, running squawking in all directions; but the old birds made hardly any attempt to get out of the way. Even more tame are the grey rock pigeons.

From Chickchar I went some miles down the forested valley to the last Tibetan, or rather Tibetanized, village called Migyitun. Below Chickchar the valley changes its appearance, the river falling very steeply, broken by terrific rapids. Pilgrims to the sacred snow lake Tsoga near Migyitun stay in a sort of monastic inn. A large glacier torrent from the snow peaks to the north-east enters the Tsari river here. It is a long day's march eastwards to Tsoga, over three passes. From the last pass, about 17,000 feet—there was snow on it—a fine range of snow peaks, their glaciers entering the lake below,

Gorge of the Loro chu seen from above Trön, Assam Himalaya in cloud

Meadows at Chickchar, Tsari

came into view. There is nothing very remarkable about Tsoga however, which is an ordinary glacier lake, half filled up. The water is not even blue, as the mud has no time to settle before the water flows out through a valley to the Tsari river below Migyitun. But the view of it from the pass is certainly impressive. My coolies having acquired merit by walking round the lake, we returned to Migyitun and marched up the valley again half-way to Chickchar. From this point I turned north, with the object of reaching the Tsangpo by a new route. Crossing the Bimbi La,[1] an easy pass not much over 15,000 feet, we descended to a considerable river, flowing in a deep valley from the south-west. Towards the north-east, down stream, I noticed a snow peak with glaciers, while immediately north of the river were more snow peaks. A day's march down the valley brought us to a village called Ken, or Sumbatse. In the foreground, across the river, a conspicuous rocky ridge divided it from another equally large river (Ka chu) to the east. We were again in a drier region, characterized by rosette and fleshy leaved plants and few trees; but it was the height of summer and there were many beautiful flowers, such as blue larkspur and *Dracocephalum*, pink *Androsace*, and violet *Onosma Hookeri Wardii*.

On July 14 a half-day's march brought us to Kyimdong Dzong, only a few miles from the Tsangpo. Here I was welcomed by a grave-looking courteous *dzongpön*. Instead of going straight to the Tsangpo I decided to continue my explorations, and to cross the Lang La, and reach Lilung. Turning eastwards again up a cultivated valley, I crossed the pass at its head, and came to the sources of the Lilung chu. The weather was very wet, which ruined the view; but I could see glaciers on the snow peaks above Ken, part of the Himalayan range, to the south-east of the Lang La. The Lang La, though steep on both sides for the last 1000 feet, is not a difficult pass. A long march down the alpine valley brought us to Nepar, where the stream from the Lang La joins the larger Ne chu. Though we were not in a specially wet region these alpine valleys north of the Himalaya get their share of rain in summer, and are vivid with coloured forms of *Primula alpicola*. It was interesting to observe that *Primula Florindae* had now definitely replaced *P. sikkimensis* in bogs. East of Nepar is a sacred mountain of no great height, called Trashi Gola, in the district of Tsari Sama. A few hours' march down the Ne chu brought us to Barang Shiga and Molo, where another large stream, the Sama (or Lagong) chu, joins in to make the Lilung Chu, which is the largest tributary the Tsangpo receives on the south bank for very many miles. From Barang Shiga to Lilung on the Tsangpo is a long march by a rough track. It took us ten hours. About 8 miles from Lilung the slates and sedimentary rocks of which these two fold ranges we had crossed are built, at last gave place to granite. On the cliffs *Lilium Wardii* was just coming into bloom, its lovely pink flowers scenting the path. This is the farthest west it has been recorded, and probably its western limit.

The gorge of the Lilung chu is well forested with Picea and Larch; lower down, large trees of *Quercus Ilex* appear. As the Tsangpo is approached

[1] Kinthup crossed the Bimbi La in 1883, whence Totsen (Tsoga) village was reached, "where there is a monastery and a big lake . . ." It is unlikely that this refers to the Tsoga above Migyitun. Records of the Survey of India, Vol. VIII, Part II.

however mixed forest gives place to almost pure Pine forest (*P. tabulaeformis*). From Lilung eastwards even the dry Tsangpo valley is fairly well wooded, forest presently approaching the river bank, and even bed; but there are still sand dunes, partly clothed with sand-binding grasses. In places the valley is deliciously green with crops, which need no irrigation. The road down the Tsangpo—as in 1924, I kept to the right bank—is long and winding, with many detours to cross tributaries. It is surprising that the Tibetans do not make use of their magnificent waterway, which for miles, though swift, is unbroken by rapids and quite fit for boats. Lopas, who come over the mountains to work in the fields, would be available for hauling boats upstream, at any rate during the high-water season. From Lilung to Tsela Dzong, a distance of 60 miles, there is not a single impediment to navigation. One is forced to the conclusion, rather borne out by experience, that there is no serious traffic in the Tsangpo valley.

On July 22 I reached Tsela Dzong, where I stayed three days. Eleven years had brought no change here. I visited some of my old haunts, where in 1924 I had collected many fine plants—a rather melancholy proceeding. I found here the striking yellow-flowered *Morina Coulteriana*, which grows also round Simla. These are not true alpines, but plants which grow at comparatively low altitudes. The main valley for some miles above the Gyamda chu confluence is fully 2 miles wide, and the river, which is extraordinarily placed, corresponds. Even at this season of high water there were islands in midstream, and sand dunes at the confluence. The Tsangpo valley east of Shoka is obviously glaciated; and when looking down it, with the river out of sight, I had the curious illusion that it slopes to the west. From Tsela Dzong I saw the snow cone of the Namcha Barwa over the Temo La range, not often visible at this season. Looking towards the north-east—that is in the direction of the river's course—I was aware of a great arc of snow peaks beginning with Namcha Barwa and its satellites in the south, continuing through Gyala Peri and Markandro and the snow peaks above Lunang, and curving through the great range above Tongkyuk and the Po Yigrong.

Sir Sidney Burrard stated some years ago that there was conclusive evidence that the Tsangpo formerly flowed in the opposite direction, that is from east to west.[1] He based his argument on the number of its tributaries which flow in a direction contrary to the main river, and cited the Kyi chu, Nyang, Rang, and Shang. To these may be added the Kyimdong chu, then unknown. But Burrard did not know quite what to do with his river when he had transferred it to western Tibet. He was anxious to dispose of it through the Himalaya. If however it was a smaller river then than it is now, it may quite easily have lost itself in the Tibet lake basin, then much larger than it is to-day. The difficulty is that if the Tsangpo flowed westwards the Gyamda river must almost certainly have done the same; and though there is no a priori reason why it should not have done so, neither is there any direct proof that it did. The great lake-like expanses of the Tsangpo valley at Pe and at the Gyamda river confluence, the arrangement of the great snow peaks in an arc from north to south, the westward flow of the Namcha Barwa glaciers, and the

[1] 'A Sketch of the Geography and Geology of the Himalaya Mountains, and Tibet,' by Colonel S. G. Burrard, F.R.S., and H. H. Hayden, B.A., F.G.S. (First Edition).

immense gravel terraces and moraines at Kyikar, thinning out westwards, are facts which lend colour to Burrard's theory.

In 1924 from a hill-top near Tsela Dzong I had seen what appeared to be a great range of snow peaks to the north distant perhaps 50 or 60 miles. Later, from another hill-top even better situated, Cawdor and I had obtained an extensive view of this range: for range it certainly was, not a few isolated peaks. We made two attempts to locate it more exactly, in August, and December, but without much success. It happened that the summer of 1924 was unusually wet, and although we caught sight of snow peaks and glaciers from the Nambu La and Pasum Tso, more or less where we supposed the range to be, we were never very sure of its location, extent or direction.[1] I now decided to make another attempt, and took the road to Tumbatse, which had been our base in 1924.

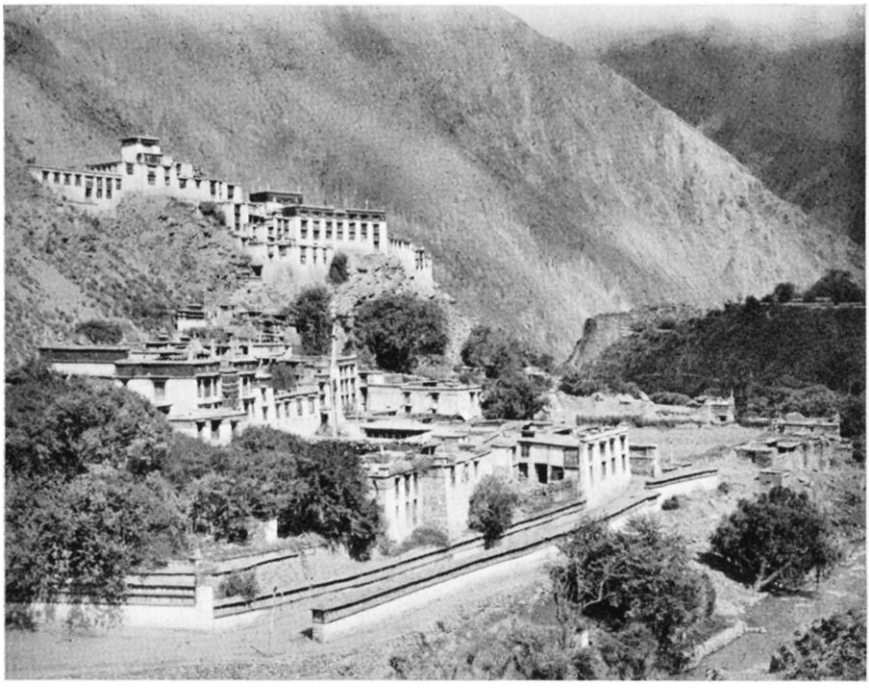
From Temo Gompa I crossed the Temo La in fine weather and from the Rong chu again saw snow peaks to the north, which I reckoned to be not more than 30 or 40 miles distant. As Tongkyuk is almost exactly 20 miles from Tumbatse, I would on arrival there at least be "warm"—as children say. At Tongkyuk I was met by a smart military-looking *dzongpön*, who had arrived from Lhasa only a few days previously on special duty. Formerly, he told me, he had been Chief of the Lhasa Police. He was shortly going to the Po-Yigrong, and when I expressed a wish to go to Showa, he discouraged the idea, saying that Pome at this time of year was an unhealthy place—which was likely. However he said I might go to the Pasum Tso or to the Po-Yigrong if I liked. This was just what I wanted, and after a day's delay at Tongkyuk I started for the Po-Yigrong.

Two years previously the Tongkyuk river had come down in flood, carrying away the road and every bridge, and tearing out the sides of the valley 30 or 40 feet above the normal level. It had not done much damage—Tongkyuk itself is built on a rock, 200 feet above the river—because there is not much here to damage; but it must have been a wonderful sight while it lasted. This district on the edge of Pome is very sparsely populated. The people are not true Poba, nor do they resemble the people of the plateau. They call themselves simply Rongpa (literally, valley-dwellers). While we were here numbers of Kampa pilgrims on their way to Lhasa passed through Tongkyuk. They had come down the Yigrong gorge and over the Sobhe La in order to reach Temo Gompa, working in the fields for a few days at each village through which they passed in order to earn their keep. In the last days of July I started up the Tongkyuk valley with ponies and porters. Two miles above the village of Paka, where a large glacier torrent flows in from the north, we camped at the mouth of a comparatively small stream rushing through a narrow glen, and next day we began the steep ascent through the forest to the Sobhe La. One would have supposed that the wide valley of the Paka chu was the obvious route—indeed I had been told as much in 1924. Actually the Paka chu is blocked at its head by glaciers, and the path up the next valley might easily be missed. Above the forest we came to meadows of tall flowers, amongst which two species of wild onion (*Allium*) were conspicuous. One of these had handsome heads of purple flowers. I had expected to find the

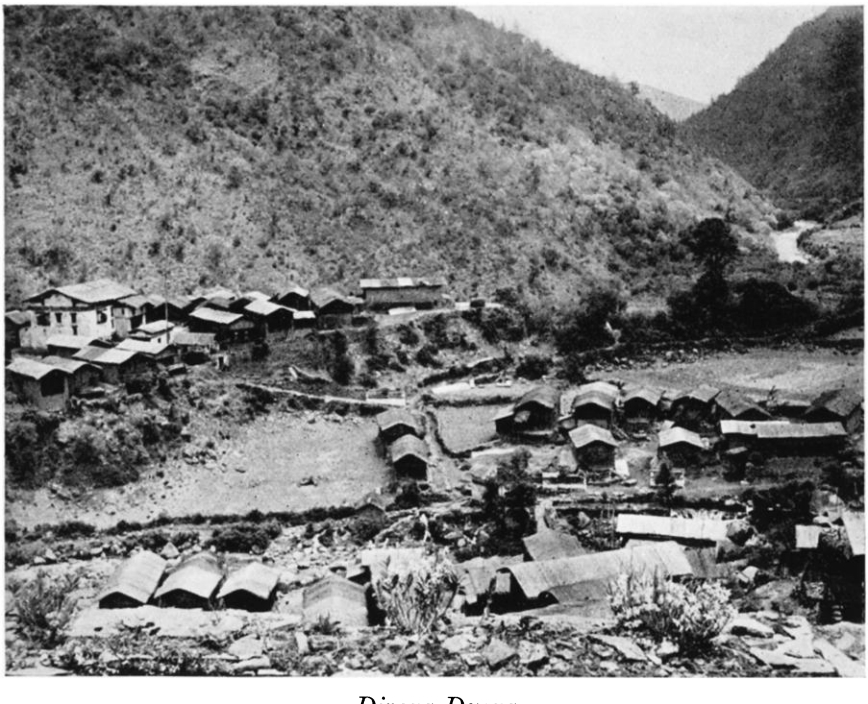
[1] *Geogr. J.*, February 1926.

Tibetan climate suitable to lilies, and hoped there would be many species of those fine plants. Actually there are only two, *Lilium giganteum* and *L. Wardii*. But the peculiar Tibetan alpine climate has helped to evolve two endemic lily-like genera, namely *Notholirion* and *Nomocharis*. Instead of lilies, another genus of bulbous plants, namely *Allium*, shows considerable development in Tibet; and in the course of this journey I found no less than ten species, several of them beautiful plants.

By the afternoon of August 1 we were in a broad glaciated valley, beneath the snow peaks. The last doubt vanished. In front of me was the snow range I had come to seek. Our little camp was girdled by peaks and small hanging glaciers, the farthest 3 or 4 miles distant. The evening was fine, and we could see the pass at the head of the valley, between two snow peaks. The dawn was suspiciously clear, every peak and six glaciers being visible. However I expected to reach the pass within three hours, before the clouds came up. Actually it took us four hours of hard going over moraines; the last few hundred feet were very steep, and before we reached the pass clouds had gathered round the snow peaks. We looked over into a valley full of mist, but the veil lifted momentarily, and through a dark ravine I caught sight of the Po-Yigrong to north-north-east steeped in sunshine, with cultivation on the far side, and two lofty snow peaks beyond that. From here the river looked rather like a lake. The Sobhe La is certainly over 16,000 feet, and is a difficult pass; nevertheless it is much used, especially by pilgrims from Pome on their way to Lhasa during the summer. The south side, as I have said, was steep, but the north side was precipitous, and a hard snow slope at about 70° did not make it easier. A cautious climber would surely have roped his party here; but the Tibetans cheerfully traversed diagonally across the snow face, where pilgrims had already trodden a narrow track, though a slip meant certain death. The descent was more arduous than the ascent had been, and extraordinarily steep for 1000 or 1500 feet. We met a small party of pilgrims on their way up. They prefer this difficult short cut to the two days' journey down the Po-Yigrong, and thence up the Tongkyuk river, in the rainy season. A woman was carrying a tiny baby in a basket on her back! At last the slope eased off on to a grassy shoulder overlooking a deep gulley filled by a glacier from the eastern peak above the Sobhe La. Descending the lower part of the glacier we reached a very boggy meadow into which four glaciers discharged. No less than three alpine Rhododendrons were in full bloom here. On a slight mound in the midst of this marsh was a herd's hut. We squelched through the marsh for half a mile, crossing several quick streams. A large glacier from the western peak almost completely blocked the exit from the marsh, and the combined streams, squeezed between the end of the moraine and the cliffs on the other side, rushed out of the meadow and fell with a roar into the forested valley below. The path continued very steeply down the moraine, now clothed with shrubs. After descending about 1000 feet we crossed to the right bank of the turbulent torrent, and continued the steep descent through Rhododendron and Fir forest. After crossing several glacier torrents we camped at dusk in a clearing where grew sheaves of the beautiful purple lily called *Notholirion campanulatum*, with *Astilbe*, *Rodgersia*, and other big-leafed woodland herbs. We reached the broad valley next day,



Sanga Chöling



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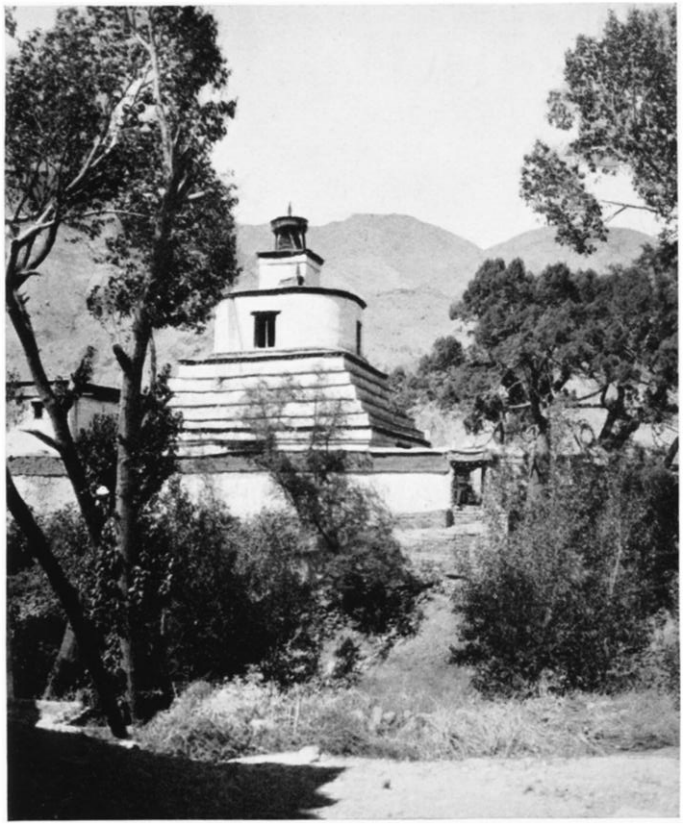
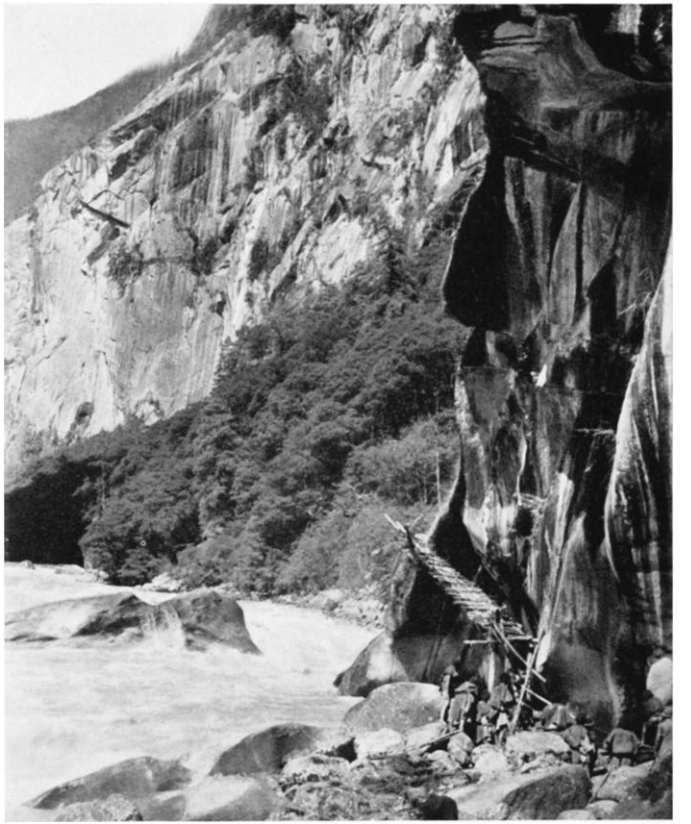


The 'labrang,' Karta



Bridge-building in the gorge of the Yigrong

passing from mixed Conifer to Tsuga forest where epiphytes smothered the trees, and finally to forests of *Pinus excelsa*. This valley or plain, called simply Po-Yigrong,[1] is 3 to 4 miles long, and a mile wide, clearly a filled-up glacier lake basin. We turned west and halted at the village of Temo Chamna, close to the river. On the left bank are several villages and a *dzong* called Tongbe, but no *dzongpön*, the district being under Tongkyuk. At the head of the plain is a small monastery, Samling Gompa. The size and speed of the river surprised me. It flows from west-north-west almost due east for about a mile, then turns more to the south; the south-east end of the plain was hidden from view by a spur. At the north-west end a large tributary enters, flowing through a gorge from a group of snow peaks. The plain is in fact enclosed by snow mountains, the glaciers from the northern range being visible from Temo Chamna, as those around the Sobhe La would be from the other bank; only the view from there would be even finer. What a magnificent base this plain would make for a well-equipped expedition to explore thoroughly the difficult and mysterious Po country!

To the north, a group of high bare granite peaks like those seen from Shugden Gompa in 1933 was conspicuous; and towards the south-west was a similar group, continuing the range in that direction; but these are only outliers of the great snow range. The fact that there are snow peaks, or rather a snow range, on both sides of the Po-Yigrong, suggests the possibility that we are really dealing with two distinct ranges. I can hardly believe that the Po-Yigrong has cut a 100-mile gorge diagonally across a single axis. If Namcha Barwa and Gyala Peri stand on separate ranges, as they must unless we believe the Tsangpo has cut a diagonal gorge across the Himalayan axis, the snow peaks N. and S. of the Po-Yigrong also do so. The main range with the highest peaks certainly lies south of the river. Nevertheless there is a chain of snow peaks parallel to, and north of the river also; and while it is permissible to make suggestions as a result of what I saw, obviously no final pronouncement on so intricate a problem can be expected as the result of a rapid pioneer journey. The river was strewn with dead timber, whole trees sticking up out of the sandy bottom. Several short coracle-like dugouts were drawn up on the bank, and fishing nets were spread out to dry. Whenever a big flood comes down part of the plain, more particularly on the flat right bank, is inundated. It was now under crops however and the corn was already ripe. The altitude of Po-Yigrong cannot be much over 7000 feet, and the temperature in my tent at 4 p.m. was still 77° F. Cattle are kept.

On August 4 we started up the Po-Yigrong, and crossing a very large torrent, we quickly reached the end of cultivation. Ascending a pine-covered moraine we entered a deep forested gorge. Almost immediately we began to climb, and from this point to Talu we caught only an occasional glimpse of the river. But we heard it. When we did see it, it was a furious mass of foam;

[1] The Po Yigrong was discovered by Bailey and Morshead in 1913. Earlier maps of the Tsangpo bend based on Kinthup's journey, though showing a possible Po-Yigrong, are so inaccurate that the river can hardly be said to exist. Being unable to cross it at its junction with the Po-Tsangpo, they marched two days up the right bank and crossed it at the southern end of the same plain which I reached at its northern end. I heard it always called Yigoong, or Yigung, though occasionally the "r" was just sounded. Naturally, I have not altered Bailey's spelling.

there appear to be vertical falls, though of no great height, between Talu and the plain. The walls of the gorge are absolutely sheer, and on the north side many hundred of feet high. We passed through forests of magnificent oaks and other broad-leaved trees, with Tsuga and a big tree Rhododendron as we got higher. The next two nights we camped by large glacier torrents which came rushing in from the south-west, and therefore had their sources near the Sobhe La. I had caught a glimpse of snow peaks in this direction from Temo Chamna, but the fact that three great torrents entered the Yigrong within a few miles of one another indicates that there is a group of big peaks just west of the pass. Two high-level terraces afforded good camping grounds by the torrent the first night; but the thick forest which covered them made it very confusing to remember which terrace was which, and wandering away from the camp I had some difficulty in finding it again. On the third morning we stood on a cliff and looked down on another opening in the valley, with intermittent cultivation for over a mile on the left bank, and three villages, numbering at least fifty wooden houses. Below us a rope bridge spanned the river. The crossing took some time. Had the river been a foot higher we could not have crossed at all. Even here the current was running at a good 10 knots. We continued a short distance up the left bank and halted at the village of Talu. The whole valley with its three villages (there are few houses on the right bank) is called Tage. The weather was wet and cloudy and I was not sorry to halt here for a day while porters were being collected for the next lap.

On August 8 we continued our journey, soon reaching the head of the valley and plunging once more into a forested gorge. Just before entering the gorge we crossed a big stream from a snow peak called Tamchokpa to the north-west; there is a village of the same name a day's journey up the valley, but no through route. We now began to see snow peaks on both sides of us quite close, and presently we passed a steep glacier on the right bank, whose foot was within about 1500 feet of the river. The forest here was composed almost entirely of Pines (*P. excelsa* and *P. tabulaeformis*) and Rhododendron; but on the sheltered side Tsuga was also common. About 4 miles from Talu we reached the small village of Ba, above which the river, making an S bend between snow peaks, again becomes turbulent. That night we camped at the foot of a great water-worn granite cliff, where the river was in frantic turmoil, leaping down a steeply sloping bed choked with huge boulders.

The next day's march was not unlike that of the previous day; but in the evening we reached a small village opposite a glacier. The pine forest suggested that we might be approaching a drier region, and certainly I had no reason to grumble at the weather, as we had almost as many fine days as wet ones. But here I found *Rhododendron megacalyx*, which is rather indicative of a wetter climate. The flora was indeed very rich, and the great number of species kept me fully occupied. It is a fact of considerable interest that the flora of the southern Himalayan slopes in the Simla region and farther north-west, crosses the great range somewhere to the west of Sikkim, to reappear on the northern Himalayan slopes in Eastern Tibet. Not only so, but this same flora spreads north of the Tsangpo, and is found on the range I was now exploring. Eastwards it extends into the mountains of China.

August 10 was wet and we did not get very far. First to a small village called

Boyu, where we changed porters; then on to a larger village called Shonggyi, at the junction of a big stream from the north. Shonggyi stands opposite to a fine snow peak and glacier nearly due south which descends very close to the river. The north valley is strewn with large erratics, and up it I could see snow peaks and glaciers. The snow peaks north of the river are farther away than those to the south, and the glaciers have retreated farther. The gorge of the Po-Yigrong seems to be entirely water eroded; it shows no evidence of ice action, but the lake beds of Yigrong and Tage are proof that at any rate glaciers reached the main valley from both sides. They may have flowed down it. The river is degrading its bed very rapidly on the steep pitches between the levels, and we passed bare granite cliffs, now high and dry and under gravel and conglomerate beds which at no remote date must have been scoured by it. Obviously all traces of ice action would quickly be worn away. One pictures a chain of lakes connected by falls or steep rapids flowing from the ends of glaciers, like the Pasum Tso lake chain, part of which still persists.

Next day after a short march through a gorge staggered like a sap, and a long climb up to a shoulder, we reached the big village of Ragoonka on a sloping terrace, which undoubtedly marks the level of an older glacier valley. The shoulder is an ice shelf left intact by the river while cutting its bed through the old glacier floor. A small hanging glacier on the rocky range to the north just above the village emphasized this. To south and west the view was very different. Here were great snow peaks rising from the depths of the gorge. The highest peaks and largest glaciers lay to the south. The river makes a sharp bend round the spur on which Ragoonka is built, and is joined from the south by a stream flowing in a very deep gorge between the snow peaks. At the head of this valley is the Ba La, beyond which lies the Pasum Tso. The Ba La therefore crosses the main range; and from Ragoonka to the Pasum Tso is five marches. Both gorges, especially that of the Po-Yigrong, looked absolutely impassable from above. Ragoonka is an important place. The well-built houses, some eighty in number, of timber on stone foundations, stand at the top of the sloping shoulder amongst tiers of cornfields. At the foot of the slope is a wide cultivated terrace, bounded by the river cliffs. I counted a hundred people working in the cornfields, and the total population must be about four hundred. I stayed in a leaky room, one of several round the courtyard of a small decayed monastery. Five soldiers, who had been ordered down river to meet the *dzongpön*, called on me. They were fine upstanding men armed with neglected pre-war rifles. The weather had turned wet and the snow peaks were for the most part hidden in cloud. When we started westwards again on August 13 the rain had ceased. I noticed that the Ragoonka porters carried axes and long coils of new yak-hair rope, and we took on three extra men. Descending very steeply the opposite side of the spur, we reached the river once more and travelled along the bank beneath high cliffs. Glaciers from the southern range petered out only a few hundred feet above the river, and a snow bed in a gully actually reached the water. Under the glaciers the rapids were fiercer than ever. From a spur I had a good view down the gorge to a snow peak opposite Ragoonka. After marching about 7 miles in six hours we camped on a grassy flat beneath high bare granite cliffs. The next day's march began with a stiff climb up the cliff for

1000 feet or more, followed by an awkward descent down ladders (notched poles) and rough going over boulder slopes to the river again. But the gorge was growing ever narrower and steeper, and we soon had to climb again. Now came a very awkward traverse across a smooth granite face, which immediately below fell sheer to the river. How the six round holes had been ground in the hard rock I could not imagine; they would take one's toes, no more, the rest was balance. To a non-climber it was giddy work watching the porters with 40-lb. loads on their backs step nonchalantly across leaning very slightly inwards; giddier work crossing oneself, even with the adventitious aid of a rope! Towards evening we reached the most formidable part of the gorge. The cliffs towered up for thousands of feet, till scarcely any sky could be seen, and they were very bare. There seemed no way either through or over. The rapids were tremendous, and the thunder of them filled the gorge, echoing from cliff to cliff. A hidden path zigzagged up a cleft in the rock, behind a dense screen of bamboo; it brought us to a dizzy gallery built round the face of a buttress. Again I marvelled at the ingenuity of the primitive workmen who had engineered this remarkable road: it was like a scenic railway at a fun city—without the fun. The gallery (of timber) continued for 300 feet, tacked on to a bare vertical cliff, and then we reached firm rock again well inside the portals of this amazing gorge. Two possibilities were now open to us. We could descend to the river again, and if the water was sufficiently low, clamber round the scalloped cliffs by means of a "bridge"; or we could leave the gorge by continuing the climb for some thousands of feet, crossing the mountains, and descending to another river. The latter route was said to be longer by a day; but as the bridge referred to would probably need a good deal of repairing, if not rebuilding, there might be little in it. We decided to examine the river first, and descending once more, we reached the water's edge. The scene was certainly awe-inspiring even for this part of Tibet, where that adjective is apt to be overworked. I could plainly see the tilt of the river bed for some distance; it was like looking uphill. Only at intervals the gradient was broken by an escarpment, or the whaleback of a projecting rock over which the vast volume of water just dropped with a thud, or rose and leapt, or poured round in two girdling streams, as though forced from a hose pipe. Immediately in front rose the overhanging cliff, against which surged great waves. A wooden gallery sloped up the face and disappeared round a corner; the lower end of it hung 12 feet above the water-level, and was reached by a notched log, lashed to some staging. But the staging itself was 30 or 40 feet from where we stood on safe ground, with heaving deep water between. The rest of the bridge had been washed away. We camped close by, cutting out a nest in a dense growth of bamboos, and that evening the Tibetans spun a 100-foot rope of split bamboo. Early next day the bridge building began. Whole trees were felled and by midday we had crossed the gap on sticks, and reached the gallery. Round the corner we found a bay beneath us, the water heaving waist deep against the cliff. Now the bamboo rope came in. Two men crossed the bay with the end of the rope, fastened it to a pole driven into the ground, and men and loads slid down the improvised rope bridge. During the last hours of daylight we made better progress, still hemmed in by huge cliffs, but keeping close to the river. Presently we turned

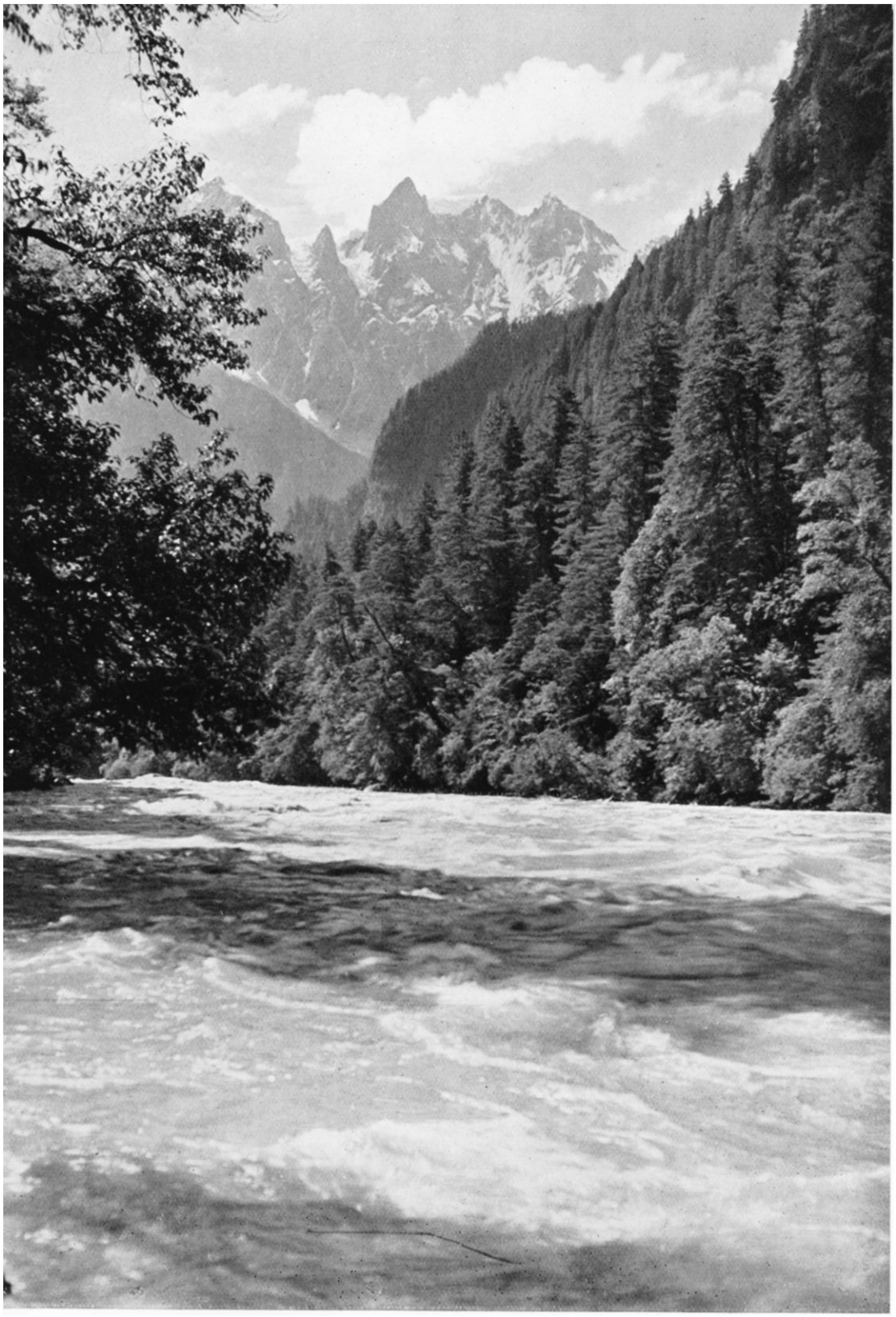
abruptly north-west, with snow peaks visible to the south-west at the angle again, climbed high up a cliff above violent rapids, and descended to a broad arid valley. The river, now 80 yards wide, flowed tranquilly but swiftly. The contrast was complete: we were out of the gorge. Ahead of us the high, bare granite mountains and wide flat valley, with sand banks dividing the river, were typical of dry Tibet; the wind was both dry and hot. The altitude would be 11,000 or 12,000 feet, not more. I found a striped toad (*Bufo viridis*) in a thicket here. Behind us the river plunged steeply into the bowels of the mountains. Next day we soon reached a rope bridge, and crossing to the right bank presently reached Nyo (Nyöme). Just above the rope bridge, from a deep slit in the mountains on the left bank, the Alado chu peacefully enters the Po-Yigrong from the east; a snow peak was visible.

Had we crossed the mountains from the lower end of the gorge we should have descended to the Alado chu. There is a road up this river which, after crossing the Alado La, joins the Gyalam at Lharigo Dzong. Another road to the west, the one we followed, joins the Gyalam at Laru, a few miles north of Gyamda. The Kampa pilgrims we met at Tongkyuk had come this way from Kam. There is no road northwards other than that up the Alado chu. It is now evident why the Gyalam between Gyamda and Alado makes its big northward arc: namely, to miss the difficult Po-Yigrong country. The chord made by the Laru–Nyo–Alado route is not exactly a short cut, but is certainly used both by traders and pilgrims, as is the route down the Yigrong gorge itself. Nye is a considerable but scattered village, at the west end of a mile-wide cultivated valley, 2 or 3 miles long. There are several villages on both banks, joined by a wooden bridge. The valley is dry and hot, all crops being irrigated—though it poured with rain while I was there. The large houses are built of stone, with wooden roofs, and there is the usual stone-flagged courtyard, surrounded by noisome rooms in which the workers live. I spent the night in the little monastery. Between Temo Chamna and the end of the Yigrong gorge below Nye, the river receives eleven large tributaries on the right, or south bank, but only eight on the left or north bank. The southern or south-western tributaries are for the most part larger than the northern tributaries, proving that here at any rate the main portion of the snow range lies to the south of the river. In this stretch I saw only three rope bridges, including the one at Tage. The first cantilever bridge is at Nye.

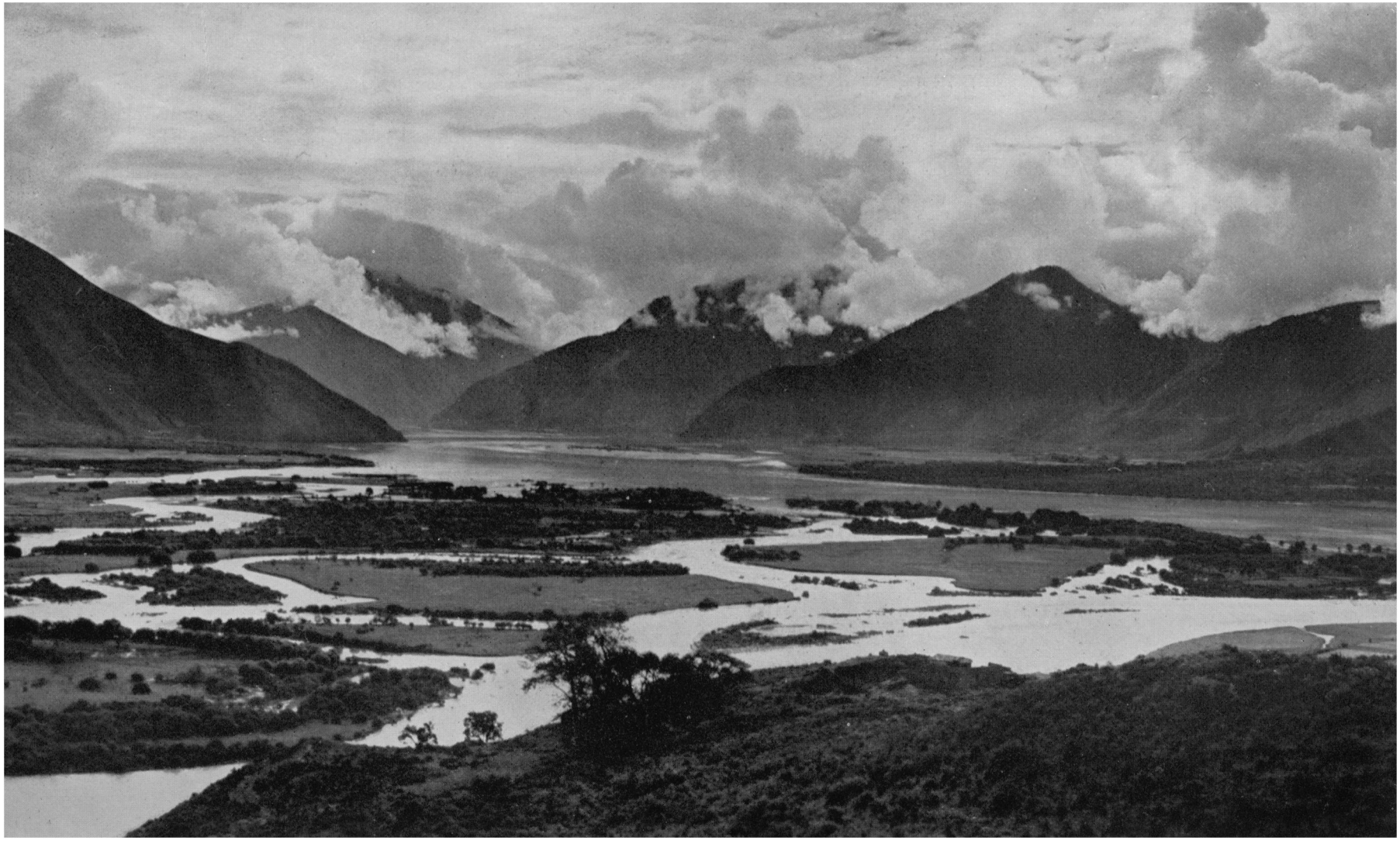
Above Nyöme the Po-Yigrong (now called Nyo chu) becomes an ordinary boisterous mountain torrent, rushing between forested mountains. The dryness of Nye is due to local wind; there is plenty of rain in the neighbourhood. Squirrels are common in the mixed forest which fills the valley above Nyöme. The path is rough. Passing through the villages of Tor, and Kongma (where we slept) we reached Nyotö Sama at midday on August 18, and again the valley completely changed its appearance. For the last time it widened out, the forest ended, and the river meandered through flat meadows. The plain was about 2 miles long, and contained several clusters of stone houses with wooden roofs. One village on the right bank of the river stood at the foot of a steep terminal moraine, now covered with trees; the glacier above descended to within half a mile of the plain. But the finest sight of all was the great glacier which descended into the main valley from the south, completely

blocking it. Below the glacier foot was a small lake. That this glacier, reinforced by lateral glaciers, had reached the end of the plain in recent times—probably a few centuries ago—was obvious. Even the terminal moraine at Nyotö Sama which had held up the original lake, was still visible. Thus the Po-Yigrong displays a chain of four basins threaded on a narrow gorge. The topmost basin still contains a glacier, above which is a typical alpine valley with more glaciers at its head. There can be no doubt that the basins are lake basins, and that each one of them contained a glacier at no remote date; probably these glaciers remained stationary for a considerable time and represented the last phase of the glacial period before the final (present) retreat set in. The question then arises: was the entire Po-Yigrong gorge occupied by a glacier some 75 miles long? From what I saw at Ragoonka and Shonggyi, I am of opinion that it was, though as I have already remarked the gorge shows no visible sign of ice action. In this connection however the following points must be borne in mind. The present rate of retreat of the glaciers, whatever it may be, is no measure of the past rate. The larger the glacier, and certainly the lower down it was, the faster it disappeared when once the retreat was sounded. There has probably been a progressive slowing down of the retreat. The alpine valleys would retain their glacial shape and glacial remains long after the lower valley had lost both; and that for three reasons: (1) the alpine valleys are protected by snow, and by the freezing of the streams for six months in every year. (2) They were of course the last to lose their glaciers, which have not yet disappeared. (3) There is no forest, which has a conservative effect and certainly helps to mask the debris of glaciers. Add to this that the links between the chain of lakes are the steepest pitches, and the rushing torrent does the rest. It is obvious that the gorge must quickly take on a water-worn look. Travelling up the valley past a monastery perched on a spur, past two cascades falling from hanging glaciers over the boundary cliffs of the overdeepened valley, we came almost to the foot of the great glacier, and started to climb above it by a very steep path. When overlooking the glacier foot we traversed for some miles, emerging at dusk into a meadow, opposite the point where the glacier poured into the main valley from a constellation of magnificent peaks. It had begun to rain, and clouds blotted out the view. A wall of séracs marked the flank of the glacier, and we looked on to a tumbled sea of ice rising steeply in front of us and passing out of sight below. The glacier then descended 1000 feet or more into the valley we had just left. We were behind it; and the river passed right under it. Above the glacier herdsmen tended their flocks in the wide wet pastures.

Next day we continued up the valley, past several herds. In the afternoon we camped beyond the highest tents at the foot of the Lochen La, and 6 or 8 miles above the great glacier. At this point we could ford the Po-Yigrong, which had its source in another large glacier less than 2 miles distant. The head of the valley is in fact clasped by a ring of ice. One glacier reaches the floor of the main valley, and flows lopsidedly down it for a mile; several smaller glaciers stuck on the cliffs above converge on it in a semicircle. Behind these rise a group of terrific sharp peaks. Thus I had reached the source of the Po-Yigrong; but apart from that I had only a rough idea of my whereabouts; nor would any existing map of this part of Tibet have helped me, though I



The gorge of the Yigrong: great snow range in background



regretted not having with me a copy of the reconnaissance survey we had made in 1924. That would have told me a good deal, as I was to discover two days later.

The ascent out of the valley to the Lochen La is steep, the last few hundred feet over bare rock; close to the pass a small detached glacier is fast dwindling to a mere snow bed. I climbed to a peak above the pass commanding a view all round, but a blizzard of snow blowing up from the other side rather spoilt things. A low stone wall had been built across the saddle to protect travellers caught as we were. Beyond the glaciated Po-Yigrong valley far away in the east I saw snow-covered mountains buried in yeasty clouds. The highest visible peak, perhaps 23,000 feet, was not more than 2 or 3 miles distant to the north-west. The view southwards and westwards from the pass was restricted. We descended by a series of abrupt steps into larger and larger glaciated valleys, first south then west, then south again, and finally west; at the head of each valley were snow peaks and glaciers.

When we resumed the descent on August 21 we quickly reached a valley which looked vaguely familiar, and turned upstream north-westwards. A horseman who accompanied us from camp turned down the valley bound for Shoga Dzong. This then was the valley Cawdor and I had come up from Drukla Gompa in 1924; we had crossed the Pasum Kye La at its head, and reached the Atsa Tso, on the Gyalam. The topography of the region now becomes clearer. The Pasum Kye La crosses the Po-Yigrong range just west of the source of the Po-Yigrong. I had already suggested that the stream which flows eastwards from the Atsa Tso is the source of the Po-Yigrong. This proves to be incorrect, though it is quite possible and even probable that this stream joins the Po-Yigrong lower down.[1] Nor is the Po-Yigrong range here the watershed between the Salween and Tsangpo systems. We did no more than cross our track of 1924, ascending westwards to a hanging valley. In pouring rain we camped above the tree line at about 15,000 feet.

On August 22 we crossed the Tse La over a rocky ridge; this pass and the Lochen La are both about 17,000 feet. From the top I observed snow peaks and glaciers to east and north-west, quite close. We descended into a fairly broad valley, occupied as usual by herds. Next day we reached a village—Nyemna—and shortly after the Gyalam at Laru, through which we had passed on our way from Atsa to Gyamda in 1924. I was now convinced from the snow peaks which formed the northern flank of the valley above Laru, that the Po-Yigrong range extended westwards, north of Gyamda; though this requires further confirmation. Hence the Gyalam must cross it on the way to Atsa as shown on our map of 1924. There are certainly snow peaks immediately west of the Laru–Gyamda road, as well as immediately to the south-west of Gyamda; and all these peaks may lie on the one great range. Gyamda had not altered for the better in eleven years. The one shop it then boasted—kept by a Chinaman, had closed down; but a new bridge has been built over the river. I could buy nothing in Gyamda itself; but at this season big Lhasa-bound caravans from eastern Tibet pass through almost daily, and we bought

[1] The tributary which joins the Po-Yigrong at Nyöme from the west may be this stream; or possibly it is the large stream from the north-west which enters the plain at Temo Chamna.

Confluence of the Gyamda chu with the Tsangpo at Tsela Dzong

some brick tea. We now enjoyed several days of fine sunny weather, though I was sorry it had not come while we were on the passes.

There are two direct routes from Gyamda to Takpo and Tsari followed by traders and pilgrims, one *via* the Sho La, the other a little farther west *via* the Ashang Kang La. I chose the latter. On August 28 I started westwards again up the valley of the Gyamda chu, and when a few miles out on the Lhasa road, observed a snow peak on the range to the south of us. The valley however is deep, and I could see nothing of any snow peaks to the north, though the fact that we crossed two big tributaries flowing from that direction indicated the presence of a high range. The granite so conspicuous round Gyamda was now replaced by metamorphics, perhaps due to contact between the igneous rocks of the Po-Yigrong range and the sedimentary rocks of the Lhasa region.

For two days we followed the road to Lhasa through a broad well-wooded valley, the stony river terraces, which are very conspicuous, affording little opportunity either for grazing or cultivation. On the third day we turned abruptly south up a wide valley to a small village called De. Continuing a few miles above the village, we camped with the herds on a grassy plain.

A long march up the valley, almost due south, on the last day of August brought us at dusk to the highest camp. There were snow peaks and glaciers both to north and south, but they are not above 20,000 feet altitude. On September 1 we crossed the Ashang Kang La, a high bare saddle covered with loose rocks of arkose. Just below the pass on the north side the valley divides; and the more westerly branch crosses the range by another pass, the Gechi La, which leads into the Chögorche valley. I had intended to follow this route in order to visit the "rainbow" lake above Chögorche, mentioned by A. K.; but hearing that the ministers of Tibet were in summer residence at Chögorche, I altered my course.

From the Ashang Kang La I looked down a long ice-worn valley enclosed by high sierra-like ridges; there was a small lake at its head. The scenery was grim. We camped again with the herds, and next day before continuing our journey towards the Tsangpo, visited a sacred lake called Gaylam Tso, in a hanging valley. This is a place of pilgrimage, and some of the Lhasa ministers had visited it from Chögorche only the previous month, and set up a shrine flanked by tall poles at one end of the lake. It is an ordinary glacier lake. A long march down the alpine valley nearly due east, brought us into a larger glaciated valley, with signs of cultivation, and again we turned south. It was dark when we reached the wretched village of Nye, where I rested a day. There were numerous Tibetan hill partridges here (*Perdix hodgsoniae*), a bird common in the scrub-covered alpine valleys of south-eastern Tibet.

On September 4 we marched south and south-west down the narrow wooded valley between high granite cliffs. The gradient was irregular, rapids alternating with quiet lake-like expanses, where drowned trees were conspicuous. The path was overgrown and apparently not much used, but we had no climbing. Having covered about 15 miles in ten hours, we reached a small village, Sham, at dusk. There are houses on both sides of the river. Here the high scarped cliffs were definitely forested with Pine. A few hours' march next day brought us to the Tsangpo valley opposite Tromda, whence the Takpo road continues up a valley to Guru Namgye Dzong. The rock

had changed abruptly again from granite to metamorphic, and there were no trees, except in the villages; but the dryness was confined to the main valley and its immediate precincts. An almost forest climate prevails within 2 miles of the river on either side. Fifty miles downstream the outer plateau passes definitely into the river gorge region, forest growing actually by the river.[1] But just here the Tsangpo valley itself is still arid, owing to the fierce winds which scour it. Sand hills—they are hardly dunes, often only high sand slopes—occur frequently and support a characteristic flora. All crops are irrigated. The river winds its way through the hills almost as though it were crossing a flood plain; but the current is swift. A sudden furious squall assailed us with rain, lightning and wind of gale force. It passed on down the valley, and within an hour all was peaceful again. We crossed the river in a sort of wooden box, sculled by one man, and reached Tromda on the ninth day from Gyamda. Here I was compelled by sickness to rest two days. Hares abound in the thorn scrub which covers much of the flat sandy bank; and I saw big fish leaping in the muddy river.

On September 8 we set out again, travelling up a stream from the south, and passing the picturesque little monastery of Ganden Rapden sunk in a welter of unsavoury hovels, ended the short day's march at Guru Namgye Dzong, about 6 miles from the Tsangpo. The original *dzong* was superbly sited on a spur rising abruptly from the narrow valley. It is now in ruins, and the modern *dzong* stands by the stream. Paper is made here from the bark of a shrub said to come from farther west, though what shrub would grow on the dry plateau farther west and not here (even if no one took the least trouble to cultivate it) it is difficult to imagine. Guru Namgye Dzong, though a tiny place, has some status: it controls the Tsari valley, which has no *dzong* of its own.

Our next march was a longer one, up the dry, but not arid, valley to the last herdsmen's village of stone houses. There was no cultivation. The weather had turned cold, and it was bleak here at about 14,000 feet, with snow on the range ahead. On the way we passed the quaint little monastery of Boomda Semung. By taking this route we had to cross two passes in order to reach Sanga Chöling; but the Kongma La and the Cha La (previously crossed on July 1) are very close together and on the same range; we should have crossed them both in one day had I not turned down the Tsari valley in order to revisit Chösam. However there was an alternative route to Sanga Chöling, crossing only one pass, the Karpo Ra La: in other words a single-fold range separates the Char chu from the Tsangpo, and our having to cross the Bimbi La in order to reach the Tsangpo from Tsari does not vitiate the fact. The Bimbi La crosses a spur, not the main range; we were already over the northern fold range when we reached the Tsari valley after crossing the Cha La, in July.

The Kongma La, 17,520 feet, is an easy pass. It had previously been crossed by Bailey and Morshead in 1913. Very heavy rain greeted us on the other side, and it was a wet, cold, and tired party that reached Chösam at dusk. I did a day's botanizing here, and then crossed the Rip La over the Takpo

[1] See "A Sketch of the Botany and Geography of Tibet," *Journal of the Linnean Society*, September 1935.

Shiri range—part of the northern fold range just referred to. Here I was amongst glaciers and deeply ice-graved valleys again. At the village of Yüto—one occupied and two empty houses where pilgrims put up—we spent the night before crossing the rather formidable Takar La, about 17,000 feet and steep on both sides. Descending from the Takar La we reached the valley below the Cha La, where we had camped on June 30. There were more alpine flowers here now than in June, and the banks were blue with Gentians and *Cyananthus*. Next day we arrived back at Sanga Chöling. Only the southern fold range now separated me from my base at Chayul Dzong. The ordinary route is over the Le La, a three-days' journey. I decided to cross the unknown Mo La, taking four days.

Travelling westwards a short day's journey up the dry Char chu valley, we reached the small village of Bung. Here we crossed to the right bank, and turning up a well-wooded side valley, where we saw Harman's pheasants, we ascended glacier-worn rocks and high screes to the Mo La about 17,000 feet. The valley divides below, the other branch leading to the Dongyu La, an alternative pass to the Nye chu. On the screes we saw a number of Himalayan Snow-cock (*Tetragallus himalayensis*). These birds when frightened run up hill, calling shrilly, then suddenly rise and plane very fast down into the valley below. In summer at least they are not found below 15,000 feet, keeping to the apparently bare screes and jagged ridges. Right on the Mo La a sudden snow squall blinded us for a few minutes. The view to the north was restricted by the nearness of the northern fold range, but far away to the south-west the Assam Himalaya rose into view. In the foreground a snow bed nestled against a high rock peak, but I could see no glaciers. The slate rocks were highly contorted.

A long march down the narrowing valley brought us at nightfall to a large village with scores of narrow cultivated terraces on both banks of the river. Daylight—a bright sunny morning—showed Dikiling to be a prosperous-looking village situated in an arid valley at about 13,000 feet. We soon reached the Nye chu, a western tributary of the Loro chu. It is a muddy river with a rapid stream. The hot valley is extensively cultivated, with numerous small villages perched up on the gravel cliffs. Though the houses were poor looking, almost every village boasted a fine monastery or at least a *chorten*. The outstanding example is Shangtze Gompa. Above this point is the district of Nye, below that of Chayul. The Nye chu is a typical treeless plateau valley, with river terraces cut in the flanks, and miles of irrigation channels. We turned eastwards down the river, presently reaching Potung Yangze. The contrast between the wretched hovels which comprise the village, situated in a grove of hoary old poplars of great bulk, and the splendid monastery astride the sharp ridge which overlooks it, is extreme. A torrent comes tumbling down here; up it is the route to the aforementioned Dongyu La.

The valley of the Nye chu now changes its appearance, growing narrower and rapidly steeper as it turns abruptly south. Here it is cutting its way across the strike of the strata, and also across part of the southern fold range. The path became more difficult and the last march proved arduous. Towards evening, having descended many hundred feet, we reached the Loro chu, and shortly afterwards Chayul Dzong; the country was even barer and more

scorched than at the end of June, in spite of such summer rain as it had received. Evidently the drying effect of the wind had more than compensated for any rain. I had been absent just ninety days, and had covered roughly 800 miles mostly through unexplored country, and in regions which hitherto had been a closed book to the botanist. My botanical collection numbered about six hundred species, chiefly alpines.

Resting only a few days to pack my collection, I started back for India on September 27, retracing my steps to Karta. I had a little difficulty in getting transport, and it was October 3 before we were able to leave Cha, a small village above Karta. The weather was brilliant, the sky cloudless, but I was hardly prepared so early in the winter for the low temperatures we experienced. At three o'clock in the afternoon we crossed the Pen La, and met a bitter wind. We had to camp at nearly 16,000 feet, and though the wind died down in the night, the temperature inside my tent at dawn was 16° below freezing-point. However on the following day we crossed the Tulung La, and were over the Great Himalaya. From the Tulung La I observed a snow range to the north-west in the direction of Tsona Dzong. Immediately east of the pass is a ring of snow peaks, about 19,000 feet high, with squat glaciers which formerly descended far down the valley. Cold as it was there were pheasants calling from the screes at 15,000 feet. We reached Mago on the 5th, the herds were just leaving Chunak. I decided to return to Dirang Dzong by the so-called main road. After crossing the Chera La above Mago (whence Gori Chen, 21,450 feet, was visible) we continued up the Gorjo chu and next day crossed the easy Tse La, 15,550 feet. The Gorjo chu, which below the Chera La is a boisterous torrent, flows peacefully in a wide glaciated valley higher up. The southern slopes of the range are steep. Passing two small glacier lakes we soon reached a stream lined with rhododendron and deciduous shrubs. Camp was pitched on the fringe of the fir forest, at a regular halting stage. After a white frost which curled and stiffened the leaves of the rhododendrons, we climbed steadily to another pass, the Pang La, which brought us on to a ridge. At the southern end of the ridge was the Poshing La and a cruel descent for the yak, down a gigantic and disrupted stone stairway. A freezing mist made things more unpleasant. The steep descent continued until we were well into the forested Himalaya, when we camped on an open shoulder, commanding a magnificent panorama to the south and west. On October 11 we reached the first residential area since leaving Mago: a miserable monastery called Lagam. Continuing the descent towards the western branch of the Bhareli, we arrived at Tembang, a large Mönba village, after dark.

Another long march on the fifth day out from Mago brought us to Dirang Dzong. It seemed very hot down here after the cold of Tibet. From Dirang Dzong I retraced my steps over the Manda La and two lower passes to Shergaon. Travel throughout the pine-clad minor valleys of the Assam Himalaya was easy even in the middle of October, and the country was so dry it might have had no rain for weeks. Shergaon was warm by day but we had frost at night. I learnt that it was impossible to cross the Pankim La for two months, so I turned eastwards towards the Bhareli, reaching Rupa on the second day. Just above Rupa the stream breaks through a gorge of crystalline limestone (dolomite), where a distinct flora prevails. A beautiful

slipper orchid (*Cypripedium*) was in flower on the cliffs. *Cupressus torulosa*, a somewhat rare Himalayan conifer, not known east of Nepal until Dr. N. L. Bor, I.F.S., discovered it here a few years ago, was scattered about, and several other plants caught my attention. From Rupa I continued eastwards to the Koyutsum village of Jamiri, passing abruptly from the pine-oak forest of the inner valleys, to the Indo-Malayan rain forest of Assam, though there is no visible barrier. From Jamiri I was able to turn south again and crossing the last range at under 6000 feet we reached the Bhareli river on October 26. We were now almost on the plain. Two days later we crossed the mythical "inner line" into administered territory; and Tezpur was reached at the beginning of November after a journey lasting six months.

The principal geographical results of my journey and the conclusions to be drawn from them may be summarized as follows:

I. Between the Assam Himalaya and the Tsangpo are two lesser ranges of fold mountains, composed mainly of sedimentary rocks. These ranges can be traced from the 92nd to the 94th meridian, east of which they disappear. Both ranges are intermittently elevated above the snow line though the peaks probably nowhere exceed 20,000 feet. The many glaciers have long since disappeared. Takpa Shiri stands on the southernmost range; it is not on the main Himalayan range. The high peaks immediately east of the Trigu Tso observed in 1924 probably stand on the northern range.

II. These fold mountains are composed of slates, phyllites, schists, and limestone, with numerous quartz veins, and are highly contorted. Examples of this contortion are particularly well seen immediately north of the Rip La, north of the Mo La, and in the gorge of the Char chu below Sanga Chöling. On the sierra-like ranges the strata are often vertical and the sharp saw-edged spurs present one precipitous and one sloping face.

III. The Loro chu and the Char chu both flow along cracked anticlines, as is shown by the rocks dipping away from the rivers on both sides. The strike of the rocks is approximately east–west. These valleys are not glaciated, though the short tributary valleys from north and south are glaciated in their upper courses.

IV. North of the Tsangpo, between the same meridians, 91°–94°, is a single range separating the basin of the Tsangpo to the south from those of the Gyamda and Kyi rivers to the north. There are snow peaks and small glaciers on this range also, but it has been much more extensively glaciated in the past. It has little in common with the fold ranges to the south however, for it is composed mainly of igneous, not sedimentary, rocks; towards the summit of the range the rock is sometimes arkose, formed directly from the decomposition of igneous rock. Possibly, as suggested in an earlier paper,[1] it is a continuation of the range north of Gyantse, which may cross the Tsangpo in longitude 92° 30′. The general direction of this range, where it has been observed, is north-east–south-west, that is parallel to the main Himalayan range. East of Tsetang, four passes, the Kumba La, Gechi La, Ashang Kang La, and Sho La, connect the Tsangpo valley with the Gyalam (or China road) between Lhasa and Gyamda. These passes are used by traders between

[1] *Geogr. J.*, February 1926.

Takpo and the north and by pilgrims visiting Tsari. The Ashang Kang La was the only one explored in 1935. I crossed the Kumba La in 1925.

V. Broadly speaking the evidence of former glaciation in Tibet, south of the Salween river, decreases from east to west. There is ample evidence of glaciation on the transverse ranges which cross the plateau north of the Himalaya, at least as far west as the 90th meridian; but none whatever for the glaciation of the plateau itself, though it formerly enjoyed a moister climate.

VI. I was able to extend considerably the known areas of most intense glaciation in south-eastern Tibet, to north, south, and west. Thus the whole of Tsari has been glaciated: the mountains between Tsari and the Tsangpo, the range north of the Tsangpo referred to under IV above, and the upper Po-Yigrong basin. It is hardly an exaggeration to say that during the maximum advance of the ice the whole of south-eastern Tibet between the meridians of 90° and 100°, and the parallels of 28°–32°, was covered by an ice sheet, so large and numerous were the glaciers. This represents an area of about 150,000 square miles, and it was by far the largest (more or less) continuous ice sheet north of the Himalaya.

VII. One inevitable result of the retreat of the glaciers has been a diminution in the volume of the rivers which they feed. This is well seen in the headwaters of rivers like the Subansiri, particularly the Loro chu. The vast accumulation of gravel in the valley below Karta was laid down by a much larger stream than the present one, as the size of the boulders moved also testifies.

VIII. The following five passes south of the Tsangpo were crossed and explored for the first time. Over the southern fold range, the Drichung La and Mo La. Between Sanga Chöling and Tsari, the Rip La. Between Tsari and the Tsangpo, the Bimbi La and Lang La.

IX. Beyond Migyitun and the Tsari river the sacred lake Tsoga, and the snow peaks and glaciers overhanging it, were discovered. These peaks are probably on the main Himalayan range.

X. North of the Tsangpo, from west of the 94th meridian to east of the 95th stretches a great range of snow mountains comparable in height with those at the eastern end of the Assam Himalaya. Its distance from the Tsangpo varies from less than 25 miles in the neighbourhood of the 95th meridian to over 50 miles farther west. This range, in the portion explored between Gyamda and Tongkyuk, trends approximately east–west, and converges on the Assam Himalaya towards Namcha Barwa. There is no record of its having been observed from the north; but in 1924 Lord Cawdor and I obtained an extensive view of it from Tsela Dzong at a distance of about 50 miles. I propose to call it the Po-Yigrong range, since the part explored lies in the Po country.

XI. This range is composed mainly of igneous rocks. There is no evidence however, other than its igneous composition, that it is an eastward extension of the range I crossed between the Gyamda river and the Tsangpo. It seems more likely that its westward extension lies north of Gyamda, where it forms perhaps the northern watershed of the Gyamda river system.

XII. Its glaciers give origin to the following rivers: Yigrong and Tongkyuk rivers entirely; Gyamda river (eastern branch) entirely or mainly; tributaries

of the Gyamda river, *viz*. Drukla chu, Pasum chu, and a few smaller left-bank tributaries.

XIII. The main part of the Po-Yigrong range lies south of the Po-Yigrong, and the highest peaks stand between that river and the Pasum Tso drainage. But the snow peaks north of the Po-Yigrong might also be on the same range, if the range has a double crest line. The Po-Yigrong appears to have cut its valley athwart the range.

XIV. The following passes in order from east to west are on the main range: Sobhe La, Ba La, Lochen La, Tse La, Pasum Kye La. The Sobhe La, Lochen La, and Tse La were crossed for the first time, and the Ba La roughly located. Lord Cawdor and I discovered and crossed the Pasum Kye La in 1924. The Nambu La, crossed in 1924 and again in January 1925, is not in the main range.

XV. The high peaks occur in groups. One group stands opposite and south of Ragoonka; another group which gives origin to a large glacier blocking the Po-Yigrong valley is near Nyotö; a third, at the extreme head of the valley. The height of no peak is known. From the size of the glaciers and the levels to which they descend it is safe to say that the highest peaks exceed 23,000 feet. All the glaciers seen are, and have long been, retreating. Nevertheless they rank with the largest known north of the Tsangpo.

XVI. I followed the gorge of the Po Yigrong westwards for nearly 100 miles, discovered the large villages of Temo Chamna, Tage, Ragoonka, Nyöme, and Nyotö, and found the source of the river in a group of glaciers just south of Atsa. The only *longitudinal* glaciers observed are at the source of the Po-Yigrong. I counted over forty transverse glaciers descending to the Po-Yigrong between the Sobhe La and the Lochen La. In 1925 I suggested that the stream which flows eastward from the Atsa Tso might prove to be the source of the Po-Yigrong. This is now known to be incorrect, though it is quite possible that the Atsa Tso flows into the Po-Yigrong system lower down.

XVII. The gorge of the Po-Yigrong is comparable with that of the Tsangpo itself in depth, though not in length.

XVIII. There is only one route out of the Po-Yigrong gorge northwards, namely that up the Alado [1] chu from Nyo. This route crosses the Alado La, and two other passes and connects with the Gyalam east of Atsa at Alado.

XIX. The east and west continuations of the range are unexplored, but eastwards it certainly extends through Pome. Gyala Peri and Markandro, the latter peak discovered in 1924, appear to be directly connected neither with this range nor with the Assam Himalaya. Gyala Peri is almost due north of Namcha Barwa, at a distance of 16 miles, so that it can hardly stand on the main Himalayan range which is here particularly narrow. There is more evidence to connect these peaks with the "Ladakh" range than with the Himalaya; they may stand on the eastward extension of the range already referred to as separating the Tsangpo from the Gyamda and Kyi rivers, which in turn may continue the "Ladakh" range. Namcha Barwa is 45 miles due north of the Dihang, and 120 miles from the foot of the Himalaya in Assam. As the fold range must have some extension northwards from its

[1] Alando as pronounced to me; I have not altered the present spelling.

crest line, the width of the Himalaya, to include both Namcha Barwa and Gyala Peri, would be about 200 miles. Even where it is broadest, the Himalayan range does not exceed 125 miles from north to south.

XX. The Po-Yigrong range is not, at least in the region explored, the Tsangpo–Salween watershed, which lies farther north. This region appears to be a region of maximum elevation, both for the Assam Himalaya (Namcha Barwa, Sanglung) and for the ranges north of it—the Gyala Peri and Po-Yigrong ranges.

XXI. Crossing the plateau of Tibet are great ranges of mountains separated by wide shallow troughs. In eastern and south-eastern Tibet more ranges emerge than entered it in the west, they are closer together and less parallel than the central Tibetan ranges. It appears that some of the original wide ranges have been split by longitudinal glaciers, and the work of dissection completed by rivers. But some of the eastern Tibetan ranges may originate there. Before the geography of Tibet can be understood the difficult task remains to rebuild the original ranges as they were upraised, combining the parts correctly. The Po-Yigrong range bears much the same relation to the eastern Himalaya that the "Ladakh" range (in long. 76° E.) bears to the western Himalaya.

XXII. The Po-Yigrong range defines the boundary between the forested Po country to the south and the dry grazing plateau country to the north. It fulfils farther east the function of the Assam Himalaya in the west, that of a rain screen.

XXIII. The Gyalam nowhere touches the main course of the Po-Yigrong, but is separated from it by the great snow range which I crossed. In the most recent map of this part of Tibet published by the Survey of India, corrected to 1929 (sheet 82 1/M) two streams are shown between the meridians of 94° and 95°, meeting at Alado; the Sya chu from the east, the Nok chu from the west. These are shown as the sources of the Po-Yigrong. They can be however no more than the sources of a tributary, since the main stream flows from the west, some distance south of Alado. From Nyöme three passes have to be crossed before Alado is reached. This might mean either that the two streams first mentioned do not flow to the Po-Yigrong, or that the Alado chu flows in a deep and narrow gorge, as in fact I saw it doing. The big stream which flows past Pungkar and Drukla Gompa is the one I crossed between the Lochen La and the Tse La; it rises amongst snow peaks round the Pasum Kye La, which separate it from the Atsa Tso. My journey definitely links up these peaks with Namla Karpo, the high peak identified in 1924, and those round the Sobhe La north of Tongkyuk, all of which stand on the one range—the range Cawdor and I saw north of us in 1924. The snow peaks near the Ashang Kang La probably lie on another range.

XXIV. There remains the possibility that the Po-Yigrong range is the eastward extension of the Ninchinthangla range, which Burrard suggests, reasonably, is continued eastwards. But in longitude 93° E. that range is 120 miles north of the Tsangpo whereas the Po-Yigrong range is nowhere more than 50 miles distant. The Littledales crossed the Ninchinthangla range north of Lhasa; but Nain Singh, who traced it for 150 miles, found that it trended north-eastwards, forming the watershed between the Tsangpo and the

Tibet lake-basin. Thus in longitude 94° E. it is a long way north of where I crossed the Po-Yigrong range. The two cannot be identified.

XXV. The botanical results are of exceptional interest and throw considerable light on the origin and distribution of the Tibetan flora. I was able to confirm the separation of the flora into two zones, a "dry" flora and a "wet" or forest flora corresponding to the two main divisions of the country, namely the main plateau and the dissected plateau or river gorge region.[1] The "dry" flora is further divisible into a plateau flora proper (either "cold dry," or "warm dry") and an alpine flora on the transverse ranges; these botanical divisions corresponding with the physical features of the country. The "wet" flora is likewise divisible into forest filling the gorges themselves, and an alpine flora on the enclosing ranges. Finally the unity of the Tibetan flora has been again demonstrated, and its similarity to that of western China and the Himalaya established. The botanical results are however fully dealt with elsewhere.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: My Lords, Ladies and Gentlemen,—The older I grow the quicker time seems to go. It seems to me only the other day that we welcomed Mr. Kingdon Ward here on his return from his previous journey of 1934, after which he read us a paper entitled "The Himalaya East of the Tsangpo." In thanking him for that paper you joined me in expressing the hope that it would not be long before he set out again. He has now returned after another fine trip, having been away a year during which he has covered a great deal of ground, this time not in the Himalayas but beyond the mountainous country north of the Tsangpo. Those of you who were present at his lecture of November 1934 will recall the beautiful photographs that he showed us, and I am sure are looking forward very keenly to what he is going to present to us this evening.

It is quite superfluous for me to take up time with any introduction of Mr. Kingdon Ward. As you know, he is a Gold Medallist of the Society, and is a familiar figure on our platform. I ask him now to read his paper.

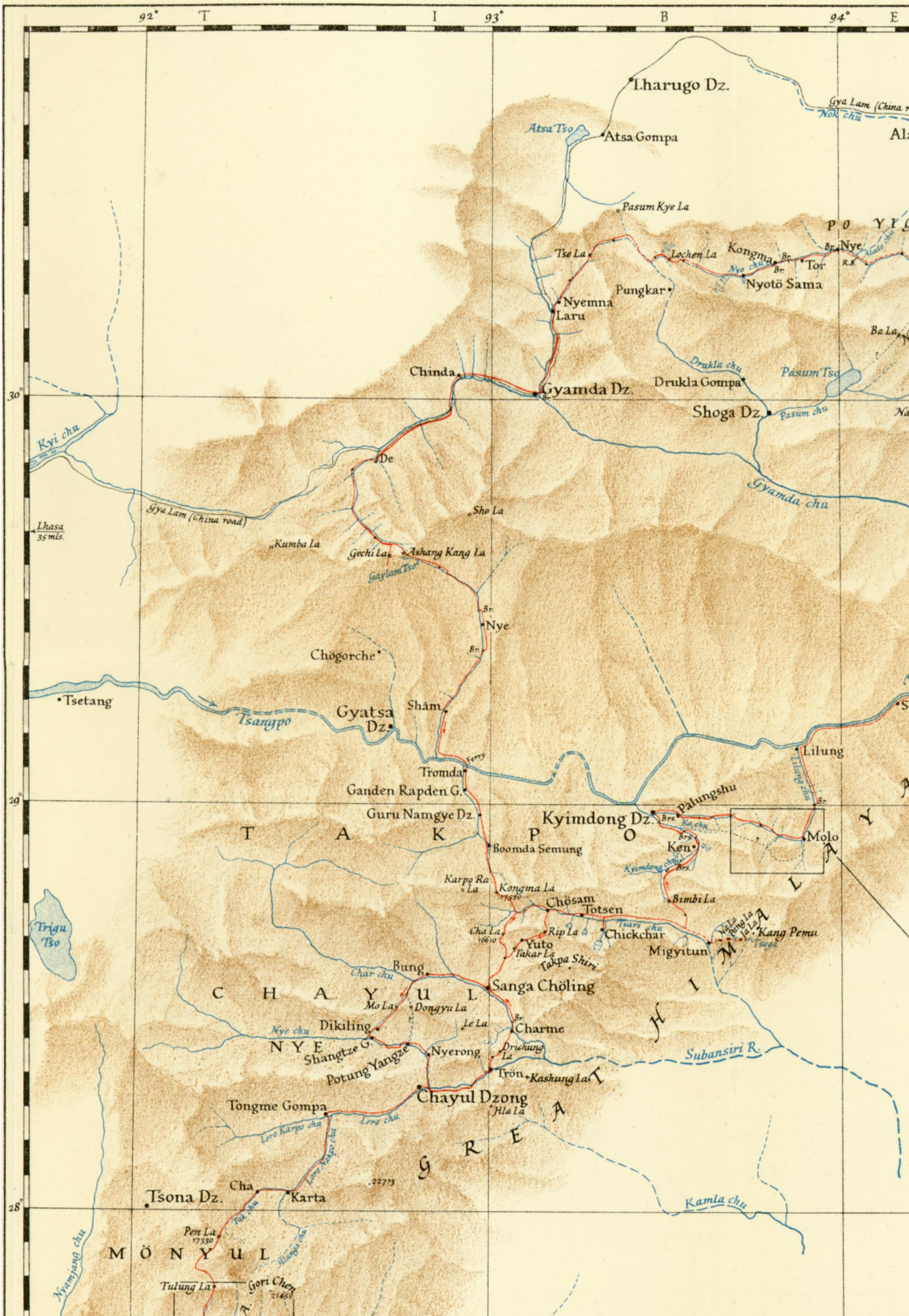
Mr. Kingdon Ward then read the paper printed above, and a discussion followed.

The PRESIDENT: This evening Lord Aberconway has honoured us by his presence. Those who have been reading their newspapers regularly during the past few days will perhaps suppose that he has come to tell us something about the trials of the *Queen Mary*, but it is not in that connection that he is with us. He has come as President of the Royal Horticultural Society, and it is in that capacity that I ask him to come on to the platform and make some observations on the most interesting paper to which we have listened.

Lord ABERCONWAY: Mr. President, Mr. Kingdon Ward, My Lords, Ladies and Gentlemen,—I feel diffident in coming on to this platform, for I have not the honour to be a Fellow of this learned Society, and I am in no way a learned person. My only qualification is that I am a great admirer of Mr. Kingdon Ward and all his works.

I have been privileged to be the recipient of lavish portions of the seeds which he has collected in distant lands; collected not, as he would modestly lead you to believe, by strolling through flowery meads in pleasant weather with the sun shining, but, as I know from him, very often collected under the most horrible conditions, when wet days succeeded wet days, with nothing to live in but a

[1] "A Sketch of the Botany and Geography of Tibet," *Journal of the Linnean Society*, September 1935.



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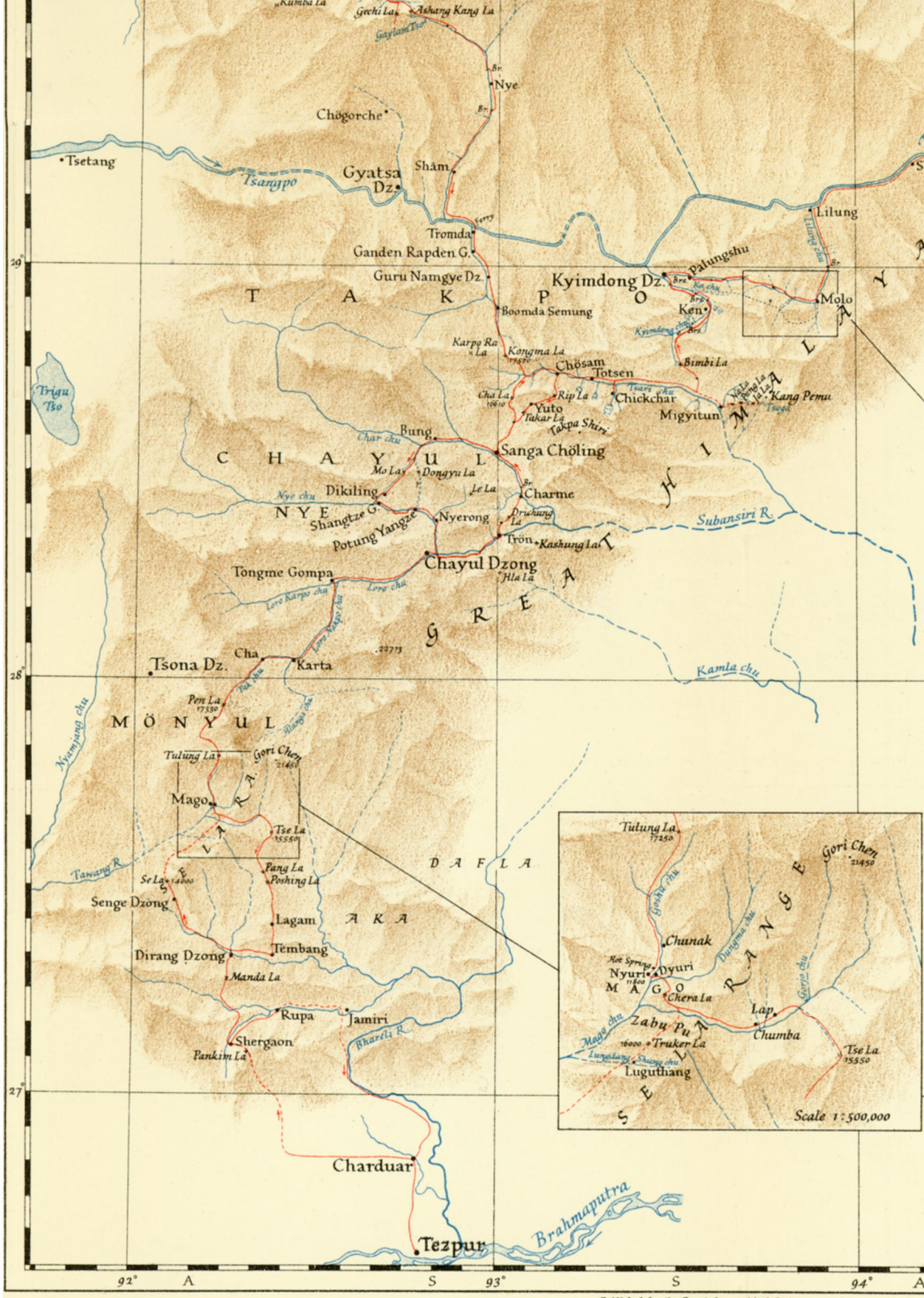

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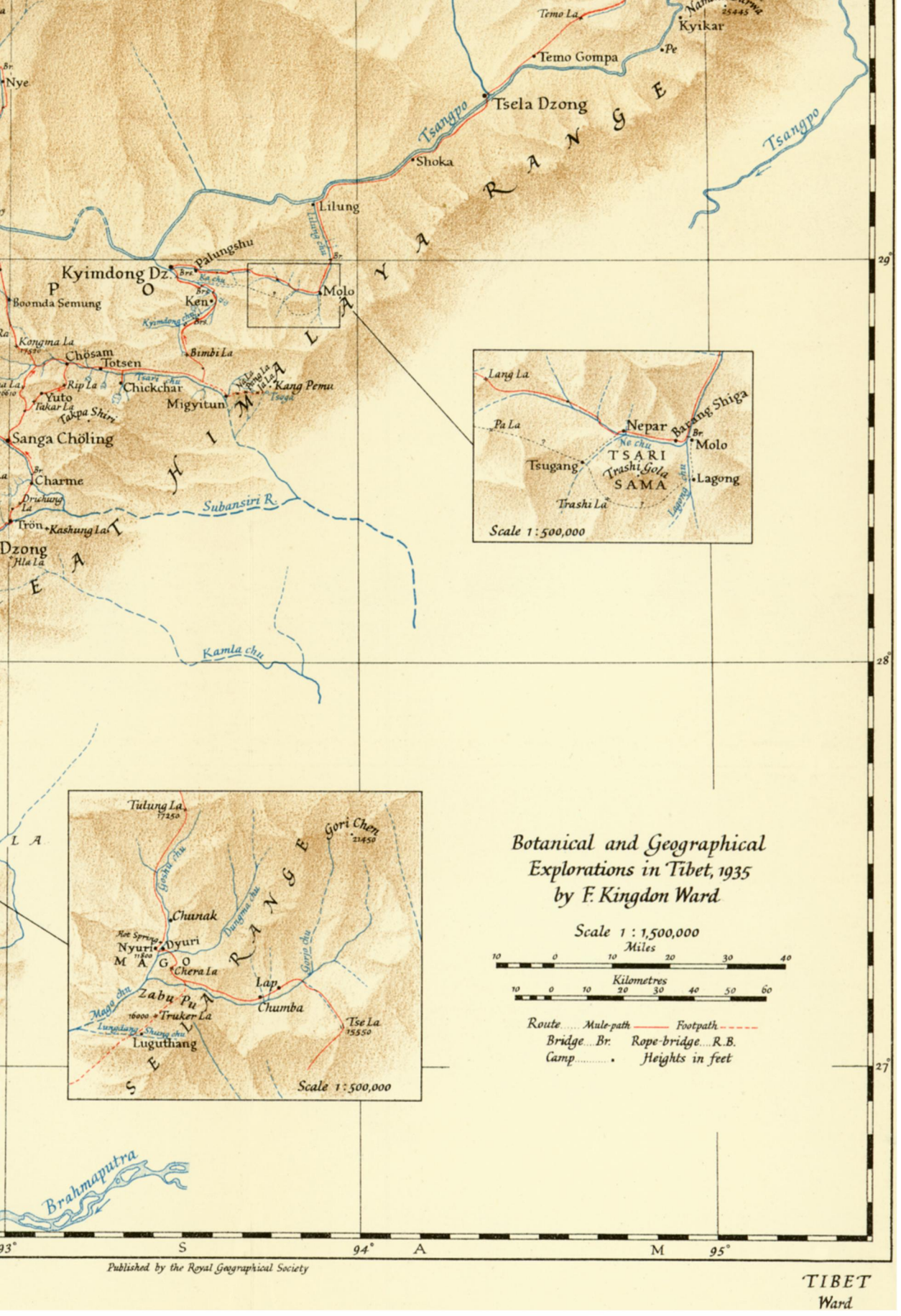
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Botanical and Geographical Explorations in Tibet, 1935 by F. Kingdon Ward
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Published by the Royal Geographical Society
TIBET
Ward

hut whose roof was chiefly holes and where it was impossible to get dry. We who take an interest in plants are most grateful to Mr. Kingdon Ward for all that he has done for us.

I have received the products of many botanical expeditions, but I do not think that any botanical explorer has in one year given us a richer harvest for our gardens than did Mr. Kingdon Ward when he returned from the expedition of 1924, when he first explored the mysteries of the Tsangpo gorge. I believe too that that expedition of his was almost as prolific of new facts for geography as it was prolific of new plants for our gardens. There he found his wonderful *Meconopsis betonicifolia* or "*M. Baileyi*"; there he got countless primulas and countless dwarf rhododendrons. Each year that he goes afield he finds further treasures for our gardens.

There is always one difficulty in connection with plants from Tibet. They, as a rule, like a wet summer and a dry winter. They grow in winter in conditions of frost and snow, where they are frozen, where no rot can attack their roots. The woody plants, the shrubs and rhododendrons, do quite well in our climate if they have a certain amount of water during a very dry summer, because they are not plants that are likely to rot in our mild wet winters. When however you come to the Meconopsis tribe, to the Primula tribe, and the Gentian tribe, you find both that our summer is very dry for them—they suffer unduly even if they are plentifully watered in summer—while our winter is too wet for them and they are apt to rot off at the root.

That lovely yellow primula which Mr. Kingdon Ward showed on the screen but did not name to us, the germs of which I hope are contained in one of his packets of seeds—I regret to see him shake his head, and I fear he left the flower and returned by another route—is the kind of primula which is so lovely on a slide but by the look of it I think, even if he had collected it, would have been difficult to keep in a wet winter. It would have had to live unhappily under a pane of glass, and even then would probably not have survived.

But of all explorers I envy an explorer like Mr. Kingdon Ward, the results of whose explorations we can see every day now in some gardens, and I hope in the future we shall see in even more gardens. We see gardens enriched by the blue of his Meconopsis and gentians, the yellow of his primulas and the scarlet and purple of his rhododendrons, and we shall all be able to enjoy just in one small corner of our gardens one little peep into that glorious country covered with entrancing vegetation of which Mr. Kingdon Ward has given us to-night so excellent an account and representation.

The PRESIDENT: I now ask Mr. Ramsbottom to come on to the platform, if he will be so good. He is Keeper of Botany in the Natural History Museum, South Kensington, and must have interesting comment to make on our lecturer's collections.

Mr. J. RAMSBOTTOM: As you, sir, said, it seems but a very short time since Mr. Kingdon Ward gave his last lecture here. On that occasion I was privileged to say certain things about him, and I am afraid that what I say now may be something on the same lines.

When Kingdon Ward left England last he was rather hoping he would be granted permission to go into Tibet. He went for a short trip to the head-hunting country and then, having a chance to get over into Tibet, he went there. I had a wildly enthusiastic letter from him telling me that he had done it, and you have seen from the wonderful photographs he has shown that he really did do it.

Lord Aberconway has just said what we all know—although not so well as Lord Aberconway does—that horticulture in this country has benefited from the seeds which Mr. Kingdon Ward has brought back from his expeditions.

Now, though fully appreciative of this, it is the other part of Kingdon Ward's story about which I have to speak. When he began his lecture he said he went into Tibet to see what plants were there, how they got there, and how to get them out. There are two ways of getting them out. There is the one in which he sees a plant and goes back and gets the seeds—unless he goes by another route. That is the aspect which appeals to most here and an aspect which you know of.

The other aspect is that on every journey Kingdon Ward has collected plants which he has pressed and which have gone to some of the herbaria in this country. Following his last three or four journeys, the plants he has dried have come to the Department of Botany of the British Museum. Those dried plants are, in their way, just as beautiful as the photographs he has shown. One of the things that always surprises me about Kingdon Ward's travels is the magnificence of his photographs. I cannot think how he can obtain such wonderful photographs under such bad conditions as generally prevail. And moreover it also surprises me that he can bring back from his expeditions such wonderfully preserved plants. Dried plants will rot very quickly if they become damp: they are also very liable to damage by insects. If any here are interested in the collections I shall be very pleased to show them at the Natural History Museum. They are extremely beautiful plants, though of course not so beautiful as the plant you would grow in a garden—even a herbarium botanist is still a botanist and prefers to see a plant growing. Nevertheless if you are interested in dried specimens, Kingdon Ward's plants are exceedingly well preserved, no matter what your criterion is. When you consider his climbing of ladders in precipitous places, treading on snakes, and so on with collections of plants, you will wonder, as I always do, how he manages to bring the collections home.

Then Kingdon Ward said he went because he wanted to know what plants were there. In spite of all that has been said and written on the distribution of British plants we do not yet really know our own British flora completely, much less do we know the flora of places such as Tibet, some parts of which botanists have never trodden. I do not know whether I am right, but I think that Kingdon Ward is the first traveller to have visited certain parts of Tibet.

The question of getting a knowledge of the flora of Tibet is related to the problem of working out the relation of the Tibetan flora across to the Chinese flora and down to the Siamese flora.

Well, when one starts talking of Kingdon Ward one is apt to go on rather longer than one ought, but if I may add something to show the appreciation that botanists as botanists have of the work on geographical botany that Kingdon Ward has accomplished, I should like to say that the Linnean Society of London has appointed Mr. Kingdon Ward to give the Hooker lecture which is delivered every five years. He will give that lecture on April 23.

The PRESIDENT: I regret that, so far as I know, there is no one present who can speak on the geographical aspect and achievement of Mr. Kingdon Ward's journey. You will have noticed, as I did, that he said nothing as to his own arrangements for his daily bread—what he carried, whether he lived as a Tibetan, and, if not, how he lived. Before I sum up I would like him, if he will, to enlighten us a little on that subject.

Mr. F. KINGDON WARD: The essence of travelling rapidly in Asia is undoubtedly to travel light, though I do not profess to compete with Mlle. Maillart and Mr. Peter Fleming, who are able to cross Asia with two men, a boy and a donkey. I was however travelling pretty light.

I had when I left India twenty-four loads, a load being never more than about 50 lb. These included two boxes of stores, a couple of tents, my bedding

and that of two permanent servants with me, and of course a vast quantity of drying paper for plants. After travelling for about a month and having reached a convenient base in Tibet I dumped half my loads, put them in a sort of local cloak room as guarantee that I was returning there, and set out with twelve loads on a journey which I thought would keep me absent for about a month. I was actually absent for ninety days. Of those twelve loads two or three were botanical drying paper; I had also my bedding and that of my servants, tents, and a few cooking pots and stores. For the most part, my servants and I lived on the country. It is always possible to get butter and milk in Tibet, and the older I get the more easy I find it to live on milk. In fact, in my fiftieth year I lived chiefly on milk just as I did in my first year.

We did not get very much meat. At the higher altitudes the people do not keep chickens, and there is no other domestic bird which lays edible eggs. Yak are very common in Tibet especially at high altitudes, but they are too valuable to be killed for food. Occasionally a yak dies, and then meat is available.

On the whole, I think if one is sufficiently interested in one's work one does not bother much about meals. When alone one is apt to put such things into the background and, in any case, to hurry over them. It must be remembered that I had none but local interests. I was completely cut off from news of Europe; I had no letters from my family, and nothing to read except 'The History of Tom Jones' and Shakespeare. One cannot always be reading Shakespeare and I read 'Tom Jones' twice. Meals were not very interesting. I just hurried through them and then settled down to do my botanical work.

When you have no trained collectors with you and are travelling almost continuously it is not possible to train people to collect, so you have to do all your own, of course perpetually changing the drying paper and writing the field notes on specimens. That takes up a great deal of time. What with making arrangements for getting transport, writing up my field notes, collecting and drying specimens, one or two hours for meals and a few hours' sleep, my days and nights were, on the whole, pretty full.

The PRESIDENT: I am sure you all agree that the lecturer's little appendix has been very interesting and enlightening. I remember saying two years ago, when he was last with us, that although he undertook his expeditions primarily for botanical purposes, he had a keen eye for geography and never came back without some useful geographical achievement. As you will have realized, his last expedition was by no means an exception. It is gratifying to know that he has been able to locate and follow along a range which so far as I know, and I think so far as anybody knows, has not been seen previously by any European. We congratulate him heartily on that.

I know nothing of botany, but from other aspects of natural history I do know how trying it is and what intense labour and enthusiasm is needed to keep one up to attending to one's specimens after a long day's march; and not only that, but to the examination of them for days afterwards in order to see that nothing is going wrong. As you heard from Lord Aberconway and Mr. Ramsbottom, Kingdon Ward has excelled himself in that direction on this last expedition, with wonderful success.

I realize from the way in which he has held his audience throughout the evening and delighted them with those nice touches of humour which crop up every now and then, how greatly you have all enjoyed his lecture, and I ask you to thank him enthusiastically. I am sure we have not heard the last of him as an explorer, and we cordially wish him health and all else that is needed to enable him to pursue his most valuable voyages of discovery.

THE QUETTA EARTHQUAKE: *A paper read at the Evening Meeting of the Society on 8 June 1936, by*

C. P. SKRINE

AT the time of the earthquake of 31 May 1935 I held the appointment of Political Agent, Kalat and Chagai, in the Baluchistan Administration. My summer headquarters were at Mastung, a busy little township which has for centuries housed the Hindu traders who minister to the economic needs of the otherwise exclusively Muhammadan population. The Mastung *niabat* boasts the richest lands in all the province of Sarawan and its wheat is as renowned for its fine-milling qualities as its fruits and vegetables are for their size and flavour. It is ruled over by a *mustaufi* or district officer of the Khan of Kalat, whose wide but thinly populated territories comprise about three-quarters of British (as opposed to Iranian) Baluchistan. Its broad, flat-bottomed valley, some 5600 feet above the sea, adjoins the bleak uplands of Quetta 32 miles to the north, from which it is separated by a rocky chain culminating in the towering crags of Chiltan (10,850 feet). From the *lak* or pass by which the Quetta–Kalat road crosses the ridge the view southwards is impressive; in the middle distance the apricot orchards and mulberry groves of the Mastung group of villages lie like cloud-shadows upon the plain, and in the far south you can see on clear days the blue Harboi hills which screen the secluded uplands of Kalat, ancient home of the Ahmadzai Khans of the Brahui Confederacy.

On that fateful Friday night I had motored into Quetta to dine with a friend and see a film. The Baluchistan capital was at the height of its spring season. A week of official and private gaieties centring on the King's Birthday celebrations was about to begin. Four or five hundred British civil and military officers and their women-folk were next afternoon to meet a similar number of prominent local Indians at the annual garden party given by the Agent to the Governor-General and Chief Commissioner, Sir Norman Cater, at the Residency, famous for its lawns and the beauty of its rose gardens. The King's Birthday was to be celebrated on the Monday with a march-past befitting the second greatest military station in the British Empire; several open-air dances, including one for four hundred guests at the Residency, were coming off during the next few days; polo, tennis, cricket, aquatic sports, and other activities were in full swing. The weather was of the perfection which dwellers in the highlands of Baluchistan take as a matter of course in early summer and autumn; the winter snows and spring rains had been exceptionally copious, grazing was plentiful, and a bumper wheat crop was about to be harvested. Trade was improving and the influx of summer visitors from Sind and the Punjab greater than ever. Altogether, prospects in town and country were bright, and the summer season which had opened auspiciously with the Jubilee Celebrations in early May bade fair to be the happiest and most prosperous that Baluchistan had enjoyed for years.

At about half-past twelve I returned alone to Mastung, a full hour's run over hilly country in the dark. The Residency there was a long, roomy bungalow embellished by two squat machicolated towers of (apparently)

solid masonry, standing on a flat-topped mound above a most delectable and productive garden. Some 300 yards to the west stood the somewhat smaller house of my Assistant with its garden round it. I was the only European in Mastung that night, my Assistant and his wife having, fortunately for them, left for the week-end that very afternoon. My wife, no less luckily, was spending the summer in Kashmir. I remember going to bed, dog-tired, at about a quarter to two. In previous years I had been in the habit of sleeping out of doors long before the end of May; but the weather was exceptionally cool and I was still using a large, high-ceilinged bedroom on the eastern side of the house. The next thing I knew was that I was out of bed in my pyjamas and bare feet, groping about in pitch darkness with one idea in my head, "Get under a doorway." The air was full of acrid dust and I could scarcely breathe. I cannot say for certain that I heard any sound of earthquake or felt the ground move, but I have a vivid recollection of a faint distant clamour of human voices from the direction of the town. This ceased abruptly and was followed by silence as of the tomb. My bed had been within easy reach of a double doorway leading from the large, lofty bedroom into an empty, low-roofed sun-room. I had already nearly reached the double doorway when I awoke, and had thus, as it turned out, literally sleepwalked into safety, for my bed was already under the massive debris of the ceiling and main roof of the bungalow, while the sun-room (originally a veranda which had been built in) remained standing. This prompt action of the subconscious mind was the more remarkable in that I had had no previous earthquake experience whatever.[1] In mortal fear I groped my way over broken glass and fallen wardrobes to the outer door and tried to open it, but it had jammed. The open windows were protected with strong wire gauze, and I had for a moment the sense of being trapped and at the mercy of any further shocks which might occur. Somehow I managed to break a pane of glass in the door without cutting myself, and putting my head through shouted for help. To my relief, a Gurkha sentry of the guard came up. He seized my hands and pulled me through, and I stood leaning on him for a few moments, completely unnerved. Soon my servants came in the darkness from their quarters with a lantern. Their small and solidly built houses had only partially collapsed and no one had been seriously hurt. They found a blanket and a pair of native shoes for me, and when the dust had cleared we crept round the house at a safe distance and saw in the starlight what had happened. The place was a ruin. Nearly

[1] Another possible explanation of my curious experiences may be that I woke up and made for safety when my bed began to shake, but the noise and mental shock caused loss of memory of the few seconds immediately succeeding them. Cases of amnesia in such circumstances are not unknown. Similarly, the deathly silence which so impressed me may have been due to the dulling of my senses by intense excitement. Professor D. B. Langford, in his account of his experiences on the Manazuru peninsula in the Yokohama–Tokyo earthquake of 1923 (*Bull. Seismol. Soc. America*, vol. XIII, p. 135), describes how he and a companion watched a 300-foot cliff above them collapse without hearing a sound. "The apparent silence of the crumbling cliff," he says, "has struck me several times since. It is possible that the intense excitement dulled our senses." Mr. H. Weightman, I.C.S., who had an even narrower escape than mine when his bungalow collapsed at Quetta, told me that the silence immediately after the shock was so intense as to give him the impression that everybody in the world except himself was dead.

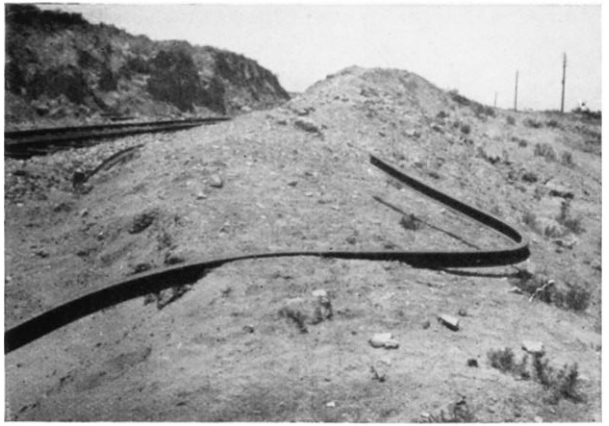
all of the roof and some of the inner walls had collapsed; the two squat towers mentioned above had crashed, the east one on top of my private office and part of the drawing-room, and the west one on my wife's bedroom. If she had been in it at the time she could not possibly have escaped being buried in a few seconds 8 feet deep in broken masonry and twisted girders. Likewise, if the east tower had fallen more to the north, or the west tower more to the east, the doorway under which I took refuge must have been crushed as well as the bedroom, and I should almost certainly have perished. All the interior of the house was a chaos; the rooms were nothing but heaps of bricks mixed with beams splintered to matchwood and heavy iron girders lying about like spillikins. Even so, the ruin was not so complete as that of my Assistant's bungalow, which I saw later in the morning. That had been simply flattened out by the roof settling down over the crushed walls like an extinguisher. No human being sleeping in it could possibly have escaped; the watchman told me that the place was flat within a few seconds of the shock. Three of Captain Bazalgette's four dogs were however dug out alive, two the same day and the third, a beloved dachshund, no less than five days later.

Clad in pyjamas, a battered Burberry, and my bedroom slippers I made my way through the garden to the clerks' lines and was much relieved to find them all safe, collected in panic-stricken groups outside their ruined houses. One had lost his wife, another a child, a third his servant, no more. The hill on which the clerks' quarters, club, library, etc., were built seemed to have been less badly shaken than the rest of the town, of which scarcely one brick remained above another. Forming ourselves into parties for rescue work, we who had escaped so lightly pushed on into the town. The first thing I noticed was the silence. Why were there no groups of frightened inhabitants standing about in knots, why no shouting and excitement? Never shall I forget the horror with which I realized that there was scarcely anybody left alive to shout—the majority of the people were buried under the ruins, and the few survivors were either too dazed to make a sound or were trying to pull their folk out of the debris. The work of rescue was made no easier by the minor earthquakes which followed each other in quick succession throughout the rest of the night. Every now and again, as we frantically pulled and scraped at some pitiful bundle of clothes and tortured flesh pinned down by wall and rafter, the terrible deep thunder of earthquake would be heard again and the ground would shake and sway, sending us scuttling out into the open like bolting rabbits.

By dawn it was clear that the whole town was in ruins with 60 or 70 per cent. casualties, mostly dead. The only doctor, a Sub-assistant Surgeon, was doing what he could for the scores of injured who were being brought to him, but his instruments and medicines were buried in the ruins of his dispensary and he was desperate. The telegraph line was broken, so there was obviously nothing for it but to try to get into Quetta for help. It did not occur to any of us that the state of Quetta could be anything like that of Mastung and that help would not be immediately forthcoming. Accordingly I returned to the Residency, salvaged a pair of trousers and a shirt from the remains of my dressing-room, and examined the garage. Much to my relief, the office lorry and two big touring cars were not seriously damaged, though battered

1. Hindu quarter at Mastung

2. The Residency, Mastung: showing in the middle the author's bedroom

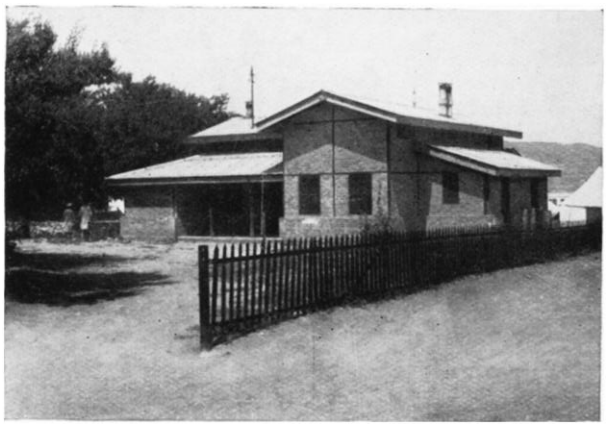


W. D. W.

3. Twisted rail near Mastung

W. D. W.

4. Bridge on the Quetta–Mastung road



W. D. W.

5. Quetta: earthquake-proof bungalow in Lytton Road

W. D. W.

6. Quetta: incomplete Railway Hospital

by falling bricks. But the building had partially collapsed and the doors were jammed, and the only car we could get out and start was the little Austin Seven tourer, from which we had to rip its tattered hood. In this at a quarter-past seven my head mechanic, Haji Gul Muhammad, my bearer, Ahmad Din, another driver and I sallied forth with pick and shovel. Before starting I "shot" the ruined Residency and other scenes with my cine-camera, which to my great joy I had discovered undamaged in the porch, with nearly 50 feet of unexposed film in it. These pictures, and others I took on the road and at Quetta the same day, came out very well and form a unique record of the morning after the earthquake.

It took us an hour and a half to clear with pick and shovel a narrow track for the car out of Mastung and its environs, the walls and buildings having in many places fallen across the road. Everywhere was desolation. The only living beings visible were a few apathetic men and women wandering about among the ruins of their homes, and a few injured lying under the trees with no one to look after them. Five miles down the road we nearly upset into a fissure in the road; for about a mile the earth was cracked in many places and though none of the cracks were deep we had to shovel in quantities of stones and earth before we could get the car across. Then came a bridge which was badly knocked about and obviously very unsafe; we had to dive into the ravine it crossed, dash the sand at the bottom, and crawl up the bank on the further side, making a road for the car as we went. Then came the pass, where the roadway, to our surprise, had not fallen down the hillside, though we had to hug the inner ditch to avoid the cracked outer edge. The precipices of Chiltan towering 4000 feet above us were still raining down boulders, the dust from the rockfalls flying up in great clouds which made the whole mountain smoke like a volcano. With painful anxiety we reached the top of the pass, whence Quetta is visible 15 miles away in clear weather. What were we going to see? Our worst fears were confirmed when we looked across the void and saw a huge, sinister, pale brown cloud brooding over the distant town. Never shall I forget the shape of that cloud. The morning breeze and the smoke of fires had caught it up into a peak at one end, giving the impression of an awful misshapen hand stretched over the city. We pressed on as fast as the little car would carry us along the last 16 miles into Quetta. Any remaining hopes we might have had were dashed to the ground by the sight of the first bungalow we passed 4 miles out of Quetta on the Sariab road. It was nothing but a crumpled roof lying on top of a heap of bricks and broken timber, and all the other villas we passed, residences of retired officials for the most part, were the same. Nowhere was any sign of life to be seen. Then came a most welcome sight. The railway line to India runs parallel to the Sariab road at a distance of about half a mile. There, scudding southwards, was a rail-motor trolley! There was somebody alive in Quetta, then, after all. I heard afterwards that it was the Divisional Superintendent, Mr. Bean, proceeding most hazardously down the line to see whether it had been destroyed in the Bolan Pass, as might well have been the case. He got as far as Kolepur at the head of the Bolan, and his telegrams to Simla and Lahore were, I believe, the first intimation the Government of India received of the disaster. The slightness of the damage done to the main

line was one of the most providential as well as remarkable features of the earthquake.

We made our way to the suburb in which lived Gul Muhammad's brothers. Gul shouted in Brahui to a neighbour he saw in the road. I could not understand the reply, but there was no doubt as to its nature; Gul burst into tears and I had to seize the wheel to prevent the car running into a ditch. The houses where the two families lived had been completely flattened out. Not one brick stood above another. The three men got out and went clambering over the ruins while I sat under a tree, overwhelmed with the pity and horror of it all. Under the same tree were two women and a man, apparently uninjured, but dazed and beaten. They were the only survivors of a family of eighteen, in which all the children had been killed as well as some of the adults. The man with a pathetic attempt at hospitality brought a turned-up packing case for me to sit on. I felt I ought to follow Gul over the mounds and help him with his relatives, but I simply could not face the spectacle of their sorrow. When the three men came back, they told me that Azim and Amir Bakhsh and their wives had escaped with injuries, but the former had lost two of his three little boys including Muhammad Nur, the apple of his eye, and Amir Bakhsh all his three daughters. Promising medical assistance and food as soon as possible I got into the car again and drove through scenes of awful desolation to the Civil Lines.

Here, in shady Gymkhana and Lytton Roads, hardly a house could be seen standing. Through the trees, in the midst of flower gardens and orchards, bungalow after bungalow of my colleagues of the Civil Administration lay in ruins. My relief was unbounded when I came to the big two-storeyed Residency and found it standing, though badly knocked about, and the Agent to the Governor-General, Sir Norman Cater, standing with two or three friends on the lawn, calm and collected though grave, and immaculately turned out as ever. He had escaped from the house a few seconds before the heavy porch and double-storeyed veranda had crashed in ruin, killing three of the Gurkha guard. Tents had already been pitched under the great spreading planes, the nucleus of what afterwards developed into a camp for civil officials. I anxiously asked after my other friends in Civil Lines. The Irrigation Engineer with his wife and child, I was told, were crushed dead beneath the fallen roof of their house; a newly married Political couple who had just returned from their honeymoon, together with the bride's mother, were buried under the ruins of their bungalow in Lytton Road and almost certainly dead; two other Political officers and the Civil Surgeon had lost children; the Revenue Commissioner had been dug out alive but badly hurt from his completely flattened bungalow, in which a guest of his remained, almost certainly dead. Two ladies had been badly injured and the Civil Surgeon had a double fracture of the thigh, while another officer had received serious head injuries and would have to be invalided home. Other European casualties, including military officers and their wives and permanent residents of Quetta, were not known but estimated at 200 including 100 deaths; among these I afterwards found the names of several friends and acquaintances. The Indian death-roll was appalling and was already known to include many distinguished retired Government officials and men of substance in the town,

some of them men whose friendship I valued highly. The whole of Quetta had already been placed under martial law and rescue work had been in progress since 3.30 a.m.

My place was obviously back at Mastung, so after exchanging escape stories with surviving friends at the Residency I took my leave of the A.G.G. and drove round Quetta to see for myself the extent of the catastrophe. I went first to Cantonments. I found that by an extraordinary and most merciful dispensation the earthquake area came to an end about half a mile beyond the line of the Habib Nullah, the open drain which divides the City and Civil Lines from Cantonments. The houses, including Flagstaff House, immediately to the north of this boundary were as badly hit as any in Civil Lines; the next line of bungalows was definitely less affected, and beyond Hibbert Road I could find no external signs of serious shaking except fallen chimneypots. The Garrison Church, half a mile within the cantonment area, was standing and above all the British and Indian Military Hospitals were undamaged; this was particularly fortunate as the Civil and Mission Hospitals had been razed to the ground and most of the patients and staff killed.

Returning to the Civil area, I found myself in Bruce Road, the Piccadilly of Quetta. Though prepared, I could hardly believe my eyes. Scarcely two or three of the familiar shops were recognizable, and none were standing. Soldiers were on guard at many points and others were clambering about the ruins on rescue work, accompanied by a few—a very few—inhabitants. That was what struck me most forcibly. In this crowded city, in the middle of the day, with none of the houses inhabitable, only handfuls of people here and there could be seen. The rest were all there—under the great mounds of bricks and plaster and wood and iron sheeting. The appalling thought was that many of them must still be alive and, except for those lucky ones whom the toiling soldiers might rescue, must die a lingering death. I heard afterwards that the troops did dig out many hundreds of living persons from the ruins during the course of the next three days, as well as 3000 or more corpses. At least 4000 injured were treated at the Indian Military Hospital. Burials were to begin at 3 p.m. under military supervision; there was no possibility of separate graves, and trenches were being dug in selected areas outside municipal limits. Smoke from the funeral pyres of dead Hindus could already be seen ascending at several points. With a heavy heart I turned the nose of the car southwards and, picking up poor Gul on the way, drove back to Mastung.

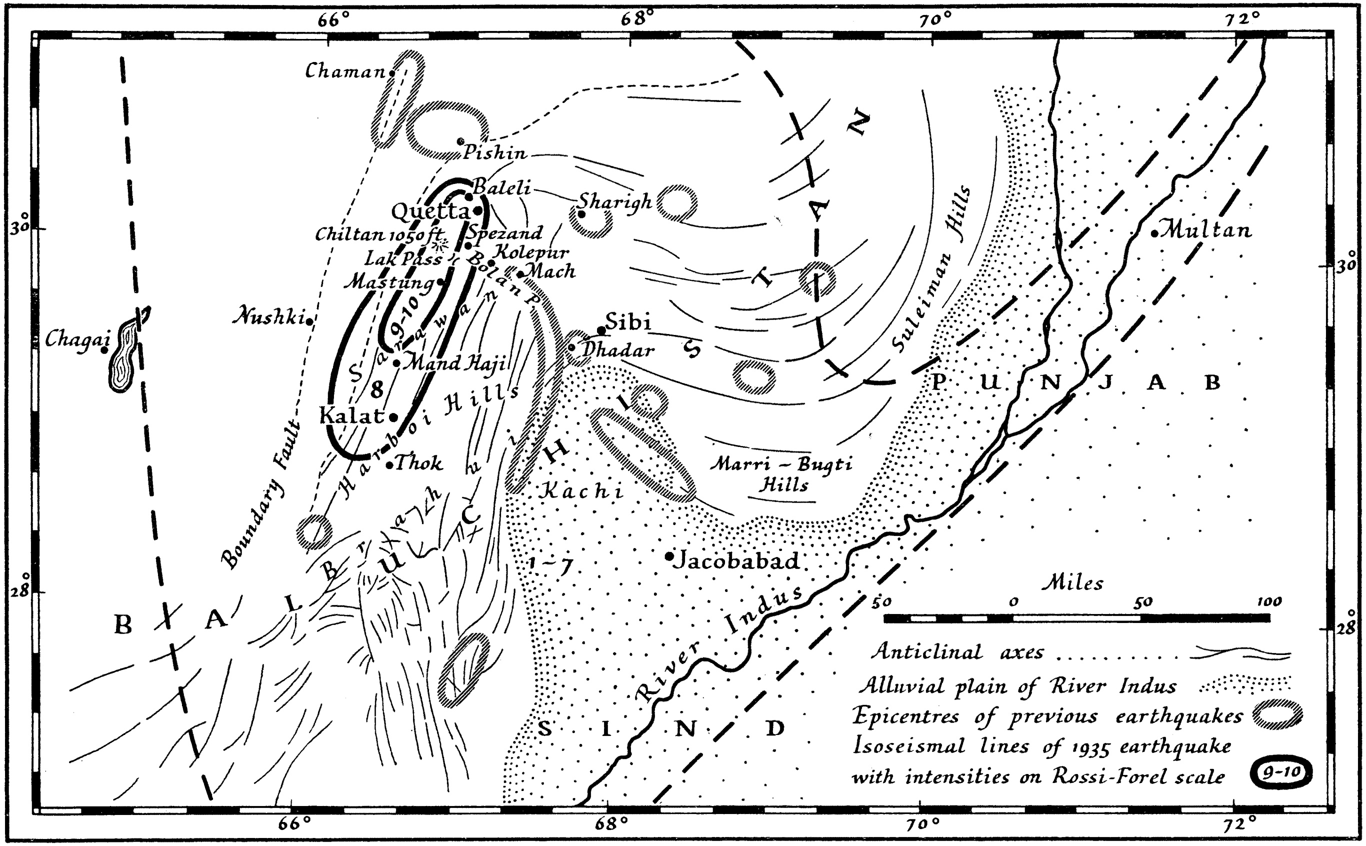
By six o'clock I was back at my ruined headquarters, to find that my excellent servants had salvaged some bedding and other necessities as well as a little food for me and were themselves encamped under the trees. That night I was joined by my Assistant, Captain Bazalgette, and very glad I was of his company in my tent in the rose garden which was to be our home for the next few weeks. The evening and night were punctuated by earth-tremors of varying degrees of noise and violence. The next few days were spent by us working at fever heat in cooperation with the surviving Kalat State officials to convert chaos into some sort of order. We found that some 1125 persons had been killed in and around Mastung alone and another 2000 in the rest of

the earthquake area of the Kalat State. The bulk of the survivors needed only encouragement and what little assistance we could give them in the burying and burning of their dead and in the salvage of their property. All, Hindu traders and Muhammadan agriculturalists alike, worked with remarkable energy after the first shock had passed off. But hundreds were severely injured, and as I have already said there was only one small dispensary with an Indian doctor in charge to look after them. Hundreds more were destitute and had to be fed and sheltered. Last but not least, Mastung and other bazaars had to be protected by reinforcements of frontier militia, brought from far-off posts on the Afghan and Persian borders, against the marauding bands which roamed around the countryside. We did our best, but our resources were quite insufficient to cope with the situation, and had it not been for the prompt response of the military authorities at Quetta, the plight of Mastung and neighbouring villages from Kanak in the north to Mangochar in the south, a distance of some 58 miles by road, would have been sorry indeed.

It is time however that I turned to the scientific aspect of the earthquake, which perhaps interests this Society more than administrative details of the work of relief, salvage and reconstruction. Not being myself a seismologist—having in fact had seismology almost literally thrust upon me—I must content myself with bringing to the notice of Fellows the admirably lucid "Preliminary Geological Report on the Baluchistan (Quetta) Earthquake of May 31st, 1935," compiled by Mr. W. D. West, Assistant Superintendent, Geological Survey of India, as a result of his investigations in the earthquake area during the month following the disaster.[1] Mr. West had already been in Quetta some days when at my invitation he came to Mastung and spent five or six days touring round the affected area in Kalat State. I was fortunately able to spare the time to accompany him on more than one of his expeditions, notably to the fissure shown in Plate 8 and to the mud volcano, Plate 7. At Mr. West's request, detailed questionnaires were put to a considerable number of witnesses, including Brahui and Dehwar cultivators from numerous villages on the outskirts of the earthquake area, and the replies received were of material assistance to Mr. West in determining the limits of the epicentral zone. The "Preliminary Report" should be read with chapters I, II, VII, and VIII of Mr. West's "Report on the Baluchistan Earthquakes of August 25th and 27th, 1931."[2]

The diagrammatic map opposite, which is based on the maps appended to Mr. West's reports, shows the isoseismal lines of the 1935 earthquake together with the positions of the epicentres of the fifteen recorded earthquakes which have shaken Baluchistan since the middle of last century. It will be noticed at once that they are grouped in a curious way round a sharp re-entrant which exists in the mountain system of the province. The mouth of the Bolan Pass and the town of Sibi, only 450 feet above the sea, are at the head of this salient; the hills on its western flank rise to nearly 10,000 feet in the Kalat territory, while those on the eastern side are considerably lower, but still very rugged and precipitous. Now the mountains of Baluchistan are

[1] *Memoirs of the Geological Survey of India*, Calcutta, 1935, pp. 203–240.
[2] *Op. cit.*, vol. LXVII, Pt. 1, Calcutta, 1934.


Chaman
Pishin
Baleli
Quetta
Sharigh
Chiltan 1050 ft.
Spezand
Kolepur
Lak Pass
Bolan P.
Mach
Mastung
Nushki
Chagai
9-10
Sarawan
Mand Haji
Sibi
Dhadar
8
Kalat
Harboi Hills
Thok
Boundary Fault
Jhalawan
Kachhi
Kachi
1-7
Jacobabad
Marri - Bugti Hills
Suleiman Hills
Multan
BALUCHISTAN
PUNJAB
SIND
River Indus
Miles
50 0 50 100
66°
68°
70°
72°
30°
28°
Anticlinal axes
Alluvial plain of River Indus
Epicentres of previous earthquakes
Isoseismal lines of 1935 earthquake with intensities on Rossi-Forel scale

merely a southward branch of the great Tertiary system, of which the Himalayas are a part; and it is now generally accepted that the folds in these mountains "have been formed by the movement of the old stable mass of Central Asia towards the stable mass of Peninsular India, resulting in the compression of the soft marine rocks in between to form the mountains." Mr. West thinks that the re-entrant mentioned above may have been caused by a wedge of continental India jutting north-westward under the alluvium of the Indus Valley, which has held up the movement of the folds to the south-east. This process must result in a condition of special strain, and it is in just such a region that earthquakes might be expected to occur. Of the earthquakes prior to 1935 shown on the map, those of 1892 (Chaman), 1909 (Kachi), and 1931 (Sharigh and Mach) were all severe. That of 27 August 1931 destroyed Mach, Dhadar, and other villages with the loss of over 100 lives, and severely shook Quetta without causing any deaths.

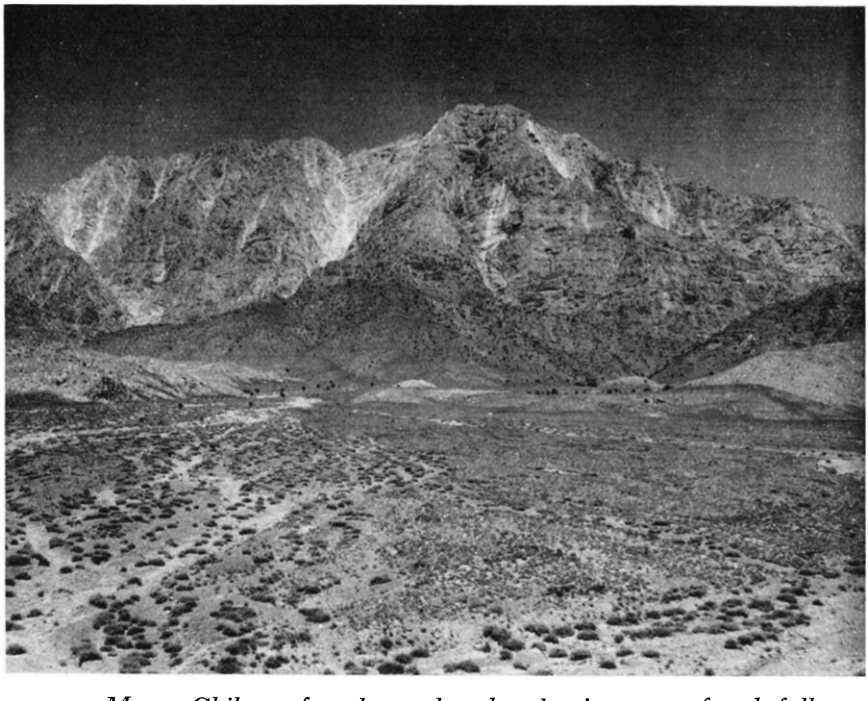
Mr. West judges the maximum intensity of the Quetta earthquake of 1935 to have reached 10 on the Rossi-Forel scale at various points within an area about 68 m. long by 16 m. wide extending from Baleli just north-west of Quetta to Mand-Haji about 20 m. north of Kalat.[1] This area, marked 9–10 on the map, may be taken as the epicentral zone, and the focus of the 1935 earthquake may be located beneath its major axis and at a comparatively shallow depth (probably less than 5 miles). Mr. West writes with the utmost caution at this stage, but he evidently leans to the view that this earthquake was due to movement along a hitherto unsuspected thrust fault deep in the Earth's crust. In this connection special interest attaches to a remarkable line of fissuring in the ground which Mr. West visited first with me at a point some $2\frac{1}{2}$ miles west of Mastung. He describes it as extending on and off for about 65 miles, from the south side of Chiltan to near Kalat. Over the greater part of this distance it took the form of a crack or network of branching cracks in the soil. "Where the effect had evidently been most severe, just west of Mastung," he says, "the ground on the west side of the fissure had subsided abruptly about $2\frac{1}{2}$ feet, though a little farther south the subsidence was on the east side. In some places, instead of a subsidence or a gaping crack, the ground had been heaved up, the elevated portion being a foot or more high and several paces wide, indicating compression of the soil. To account for these varying phenomena, it seems likely that the motion of the ground during the earthquake was one of alternate compression and tension. Where the line of fissuring crossed the railway track that runs from Spezand to Nushki, at about 2 miles west of Mastung Road station, the track had been uprooted and the rails crumpled exactly along the fissure, although the latter was here comparatively insignificant" (Plate 3). As it could only be traced where the soil is of an alluvial nature, and no fracturing of solid rock was found, Mr.

[1] More than three-fourths of this area lies within the thinly populated territories of the Khan of Kalat, and it is only because the British Indian portion at the northern end included the capital of the province, Quetta, with a summer population of about 65,000 that the mortality was so high. At least 24,000 persons died in Quetta itself and another 3000 in neighbouring villages, while some 3250 more were killed in the Kalat State. From the point of view of lives lost, the earthquake must be accounted the most disastrous that has visited India within historic times.

7. The mud volcano at Thok

8. Fault scarp near Mastung

9. *Mount Chiltan (10,850 ft.) before the earthquake*



10. *Mount Chiltan after the earthquake, showing scars of rock-falls*

West considers this fissure to be a purely surface phenomenon affecting only the alluvium and not penetrating the solid rock beneath. He admits however that it coincides both in direction and in position with the long axis of the epicentral area, *i.e.* with the line of maximum disturbance. The inference, which Mr. West evidently hesitates to draw without further investigation, is that this is one of the comparatively rare cases of the formation of a "fault-scarp" during an earthquake. Well-known instances of this phenomenon, which is of the greatest importance in connection with the tectonic origin of earthquakes, include the fault-scarp formed in the Mino-Owari earthquake of 1891, the Assam earthquake of 1892, and the earthquake in Eastern Greece in April 1894. These fault-scarps or lines of fissuring are described in his 'Origin of Earthquakes,' by Dr. Charles Davison, one of whose most important contributions to seismology was his demonstration of the fact that most earthquakes are caused by sudden movements of the underlying rocks along an existing "fault" or crack in the Earth's crust. Usually these earthquake faults are so deep that they leave no trace on the surface, but in certain circumstances they do, and some of the surface phenomena in the cases mentioned above closely resemble those of the Chiltan–Mastung–Kalat line of fissuring. Dr. Davison writes as follows about the Mino-Owari fault in Japan: "When the vertical displacement in the plains or valleys was small, the path of the fault was marked by a rounded ridge of soft earth from one to two feet in height, which closely resembled what might be produced by the burrowing of a gigantic mole. When the displacement reached a height of several feet, the fault-scarp formed a cliff which, being of earth, soon crumbled down into a slope." [1] Again after the earthquake in Eastern Greece, in 1894, "a fissure was traced for a distance of about 34 miles running in an east-south-east and west-north-west direction through the epicentral district, and varying in width from an inch or two to more than three yards. That it was a fault and not an ordinary fissure, was evident from its great length, its uniform direction, and its independence of geological structure." [2] In Baluchistan itself, within 50 miles of Mastung, movement along the well-known Chaman fault revealed itself after the 1892 earthquake in a fissure or fault line traceable for 120 miles.[3] In the last case crumpling of the railway line took place very similar to that observed by Mr. West and myself near Mastung Road railway station.

The fault-line (if it is one) of the Quetta earthquake would if extended northwards pass under Chiltan, a conspicuous mountain rising to a height of 10,850 feet and composed mainly of limestone. On the morning of the earthquake and again after the violent after-shock of 3 p.m. on June 2, vast clouds of dust were for several hours observed rising from the sides of Chiltan. These were due to rock-falls on an enormous scale, one of which is clearly visible in one of the telephoto "shots" of my 16-mm. film. Plates 9 and 10 clearly show the difference in the aspect of the mountain before and after the earthquake. The white marking is due to the chipping and scraping effect

[1] Davison: 'Origin of Earthquakes,' p. 72.

[2] Davison: 'A Study of Recent Earthquakes,' pp. 340–1.

[3] *Mem. Geol. Surv. Ind.*, XXVI (1893), p. 57; *Geogr. J.*, vol. 9, p. 402 (1897).

of the rockfalls on the black oxidized surface of the cliffs laying bare the unweathered limestone beneath.[1]

Another interesting phenomenon which I heard about from Brahui tribesmen and took Mr. West to see was a "mud volcano" at a place called Thok, 12 miles south of Kalat and more than 30 miles beyond the southern end of the epicentral zone (Plate 7). The neighbourhood is desert except for a spring and the shrine of a local saint about a mile away. The mud buildings of the shrine collapsed on the night of May 30–31, killing fourteen out of the seventeen persons sleeping there. The survivors told me that a neighbouring hillock burst with a loud roar, and when day dawned clouds of smoke (probably steam) were rising from it and hot mud oozing in large quantities from a crater at the top. The flow continued until noon on May 31. Mr. West, describing the hillock in his "Preliminary Report," said that he recognized at once that it was an old "mud volcano" which had burst into eruption again. "The old mud," he says, "was a dirty brown colour, whereas the new mud was a bluish-grey, so that the new flows showed up very clearly against the old. At their edges the flows were mostly less than a foot thick, though they were probably thicker near the vent." The maximum breadth of the mud-flow, which when we saw it had dried up and caked with the appearance of lava, was 300 yards and the height of the hill about 100 feet. These "mud volcanoes" are common on the Arakan coast of Burma, and are also found along the Mekran coast of southern Baluchistan. The term is really a misnomer, as they are not thought to be connected with volcanic activity. Hobbs [2] definitely places them in the category of earthquake phenomena and mentions similar exudations of plastic mud during the earthquake of 12 February 1902 at Chemakha, in Russian Turkistan. The mud formed high hillocks of pasty material surmounted by craters, and these in turn were disturbed and fractured by subsequent movement on the same fault planes.

A feature of the Quetta earthquake was the complexity of the ground-motions. Several witnesses say that they felt horizontal shaking both from north to south and from east to west, as well as vertical movement. Four stone monuments examined by Mr. West in the Quetta cemetery were found to have rotated on their bases, one to the extent of no less than 43° anti-clockwise.[3] The movement also varied from place to place, but was everywhere rapid, "like a dog shaking a rat," as a Brahui villager near Mastung graphically described it to me. The most interesting account of the actual shock comes from an officer who happened to be marching with his men on night operations 4 miles north of Quetta on the Baleli road. The main shock, according to this account, "came from the south, and may have been preceded very slightly by the sound, which resembled the sound heard in an Underground station as a train approaches in a tunnel, rapidly increasing to a roar.

[1] The "smoking" of Chiltan on May 31 and June 2 seemed to support the belief, universal among the local population, that the mountain had become a volcano and that the overwhelming of the survivors by its eruptions was only a matter of time. This belief greatly facilitated the task of the military authorities in evacuating the surviving population to Sind and the Punjab.

[2] 'Earthquakes,' p. 134.

[3] Possible causes of this interesting type of earthquake phenomenon are discussed by Davison, 'A Study of Recent Earthquakes,' pp. 293–6.

Those who did not lie down at once were either flung down or were just able to stagger about. The ground heaved as in a rough sea, or in the way a small boat behaves in the wake of a larger steamer. The direction of the waves was mainly from south to north, but occasionally from east to west. The motion subsided gradually, fading away towards the north-west, accompanied by the sound of falling rocks." [1] Others present described also how the trees on either side of the highway swayed violently to and fro until their branches swept the ground. A motor-driver in the employ of the Khan of Kalat told me that he was driving into Quetta on the night of the earthquake and had reached a point about 11 miles from the town, when the car suddenly got out of control and he had the utmost difficulty in bringing it to a standstill without overturning into the ditch. He then realized that the earth was shaking violently. Looking up, he and his companions saw flashes of light running along the flanks of the mountains on both sides of the valley.[2]

A point in connection with the earthquake which is not mentioned in the "Preliminary Report" is that it occurred at new moon. I understood from Mr. West that the idea that earthquakes occurred more frequently at new or full moon was no longer regarded seriously. There is however a considerable body of opinion in favour of lunar periodicity, and of tidal stresses as a secondary or contributing cause of earthquakes. The question is discussed very fully, with a complete bibliography, by Professor Leo Cotton in his paper on "Earthquake Frequency and Tidal Stresses," in the *Bulletin of the Seismological Society of America*, vol. 12 (1922).

Of more practical interest, perhaps, is the question of the possibility of further earthquakes and their location in Baluchistan. We have already seen that all the earthquakes which have been recorded in the province during the last eighty or more years have had their epicentres in or near the curious re-entrant in the alignment of the mountains, the apex of which is the Bolan Pass (see map facing p. 420). Actually they have all occurred within a radius of 140 miles from Dadar, a village in the Kalat State 16 miles west of Sibi. But, as Mr. West points out, the focus of an earthquake has never occurred at the same place as that of a previous one. Each major shock has relieved the stresses which have been accumulating in the underlying rocks in that area. If the "seismicity" of Baluchistan were connected with volcanic activity it would be a different matter. But there is no sign of volcanic activity nearer than the almost extinct Kuh-i-Taftan, 400 miles to the west. In all probability therefore Quetta is one of the safest places within the earthquake area for a considerable time to come. But there is no certainty in the matter, and in deciding, for compelling reasons into which I need not enter here, to rebuild the cantonments and civil lines on the old sites the Government of India have taken other factors also into consideration.[3] The first of these is the great progress which has recently been made in Japan and the United States

[1] West: "*Preliminary Report*," pp. 212–3.

[2] Luminous phenomena have frequently been reported in earthquakes, but the evidence is not definite enough to furnish data for an explanation. In the present case the most likely explanation would seem to be sparks from the friction between moving rocks on the steep, dry hill-sides.

[3] See Government of India Press Communiqué of 23 December 1935.

along various lines of research connected with " earthquake-proof" building. In chapter VII of his "Report on the Baluchistan Earthquakes of August 25th and 27th, 1931," already cited,[1] Mr. West summarizes the conclusions arrived at in those countries and applies them to Baluchistan. Further lessons to be learned from the 1935 earthquake are to be found in the "Preliminary Report," section 11. It has been proved in Japan and America that by applying certain principles of construction and using suitable materials, it is possible to build houses of two or more storeys up to a maximum height of 100 feet which are capable of resisting the most violent shocks hitherto recorded.

The main principle is rigidity. It has been found that in most earthquakes the period of oscillation of the ground is one to one and a half seconds; accordingly, buildings must be constructed with a much shorter period, say 0·5 or 0·6 seconds, so that the whole structure will move as one unit. Foundations, especially in loose alluvial ground, should be of solid concrete at least 3 feet thick. The shape of the building should be compact, with few irregularities such as long unsupported wings, high gables, copings, tall heavy chimneys, towers, porches, and so on. Internal walls should run in both directions, and be so united with the external walls that they form one piece with them. Roofs should be light, with the weight evenly distributed along the walls. Above all, the walls supporting the roof should be strong and homogeneous, as nearly "monolithic" as possible. In this connection Mr. West has much to say on the subject of the "mud mortar," or rather paste made with sand or powdered bricks instead of lime, the use of which has become almost universal in Baluchistan during the last fifteen or twenty years. After the 1931 disaster Mr. West wrote: "The custom in Baluchistan of using large limestone blocks set in mud mortar is about as unsatisfactory a method of construction from an earthquake point of view as could possibly be devised. It lacks completely any sort of homogeneity, and when an earthquake occurs the heavy blocks simply slide over the mud mortar, and the wall collapses. . . . There can be little doubt that an earthquake of the severity of the Kangra Valley earthquake of 1905, or even one considerably less severe, would lay in ruins the

[1] Mr. West cites the following American and Japanese authorities: H. M. Hadley, "Earthquake-proof Building Construction as revealed by the Japanese Earthquake," *Bulletin of the Seismological Society of America*, 14, p. 6 (1924); H. D. Dewell and Bailey Willis, "Earthquake Damage to Buildings," *op. cit.* 15, p. 282 (1925); Tachu Naitu, "Earthquake-proof Construction," *op. cit.* 17, p. 57 (1927); H. M. Engle, "The Earthquake Resistance of Buildings from the Underwriter's Point of View," *op. cit.* 19, p. 86 (1929).

In addition to the above, J. H. Freeman's recent paper on "Data for Construction of Earthquake-resisting Structures" (*op. cit.* 20, pp. 67 ff. (1930)) will be found of particular interest. The writer emphasizes the uncertainty of the data on which the prevailing standards of earthquake-proof construction are based, and urges the necessity of establishing strong-motion accelerometers of simple design in all earthquake areas. He describes recent Japanese shaking-table experiments, and researches into such questions as the natural or "preferred" vibration of the ground in particular localities, the behaviour of tall buildings artificially oscillated, and the measurement of infinitely small earth-tilts with a view to the possible prediction of earthquakes in the neighbourhood of known faults. The Ishimoto tilt-meter, it seems, can measure a tilt of one-thirtieth of a second of arc, which is equivalent to one-tenth of an inch on a radius of 1 mile!

greater number of the buildings in Quetta, so poorly are they built." [1] This prediction proved only too correct. The manner in which the houses we lived in crumbled away like so much dust under the weight of the roofs was a revelation to most of us who went through the Quetta earthquake.

For future building, Mr. West recommends a frame of steel girders with walls of hollow concrete blocks.[2] In this connection it may be mentioned that after the 1931 earthquake one department, the North-Western Railway, with commendable foresight decided to reconstruct their damaged buildings on earthquake-proof lines. Several bungalows, one of which is seen on Plate 5, were built of vertical and horizontal rails with a panelling of bricks. Another method tried was to make brick walls of normal thickness and reinforce them with expanding metal laid horizontally between the bricks at every fourth course. None of the completed earthquake-proof bungalows of the North-Western Railway fell, or were even appreciably damaged.

Another factor which influenced Government in their decision to rebuild Quetta on the same site was the remarkable degree of immunity enjoyed both in 1931 and in 1935 by the north-eastern portion of the cantonment area, which is situated upon dry alluvium. The only serious damage done to cantonments was in a belt about half a mile wide immediately adjoining the city and civil lines, and even here there was a rapid decrease in intensity towards the north-east. Throughout the earthquake area destruction was at a maximum on water-filled alluvium. This phenomenon, which has been observed in most great earthquakes, is explained as follows in the "Preliminary Report": "In water-filled alluvium the pore spaces are filled with water, and the rigidity of the water transmits the shock with full force. But in dry alluvium the pore spaces are occupied by air, and this has a cushioning effect on the shock, damping it out considerably." [3]

It was accordingly decided [4] during the cold weather following the earthquake to clear completely the site of ruined Quetta, leaving a framework of roads, drains, and electric and water mains on which the plan of a new and better city could be laid out. The width of many of the roads will be increased; stringent building regulations will be laid down and enforced; the lay-out of the city and the designing of government buildings will be entrusted to experts in town-planning and earthquake-proof construction whose services have already been engaged. The work is proceeding apace; with the help of huge drag-line excavators, scores of motor lorries, and a narrow-gauge

[1] *Mem. Geol. Surv. Ind.*, LXVII, p. 80.

[2] West, "Preliminary Report," 1935, p. 234.

[3] *Ibid.*, p. 230. See also *Bull. Seism. Soc. America*, 23, pp. 43–56 (1933), for an account of the Long Beach earthquake of 10 March 1933. This earthquake was very similar in area, intensity, and effects to the one with which we are dealing. The following passage is worth quoting: "As on previous occasions, much of the spectacular damage was due (1) to bad natural ground or grading—made land, or deep water-soaked alluvium or sand; and (2) to bad or unsuitably designed construction—bad foundation structures, little or no provision against the stresses caused by earthquakes, bad or unsuitable materials, bad workmanship, or some combination of these factors. . . . More than usual this earthquake 'picked on the cripples.' The amount of the structural damage was out of proportion to the energy and violence of the shock."

[4] Government of India Press Communiqué of 23 December 1935.

railway the old Quetta is being dumped bodily into borrow-pits in the surrounding desert. In its place it is hoped to create a new Quetta on modern scientific lines with adequate protection not only against possible future earthquakes, but against malaria and other epidemic diseases. A crore of rupees (£750,000) has already been spent, and the cost of reconstruction is estimated at about a crore a year for at least seven years.

Thirty thousand people killed, thousands more seriously injured, untold ruin and misery caused to the survivors, eighty million rupees lost to the Indian taxpayer—all done in twenty seconds, because man does not yet know how to locate strains in the crust of his planet and predict their breaking-point.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: My Lords, Ladies and Gentlemen,—I think most of you know Mr. Skrine quite well. He has received an Award of this Society and has been frequently on our platform. Wherever he has been in the course of his service, alike in Central Asia, Turkestan, and Persia, he has always been at pains to study the country from a geographical point of view. He is also a skilful photographer as those of you will have realized who saw the film he recently showed the Society. He is the son of a great traveller who came across Asia fifty or sixty years ago, and it is a pleasure to welcome here Mrs. Skrine, his mother, who has flown over from Paris in order to be with us to-night.

Mr. Skrine is going to give us an account of his experience during the Quetta earthquake. We also have with us Sir Norman Cater, who was Agent to the Governor-General at Quetta at the time and himself had a very narrow escape. I hope that he will give us a brief account of his own experience, and there are others in the audience who will do likewise.

I now ask Mr. Skrine to deliver his lecture.

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

Sir NORMAN CATER: I have been asked to say a few words as to my personal experience in the Quetta earthquake, and it is just as well to lay emphasis on "few." If I once began talking about the Quetta earthquake I could go on for hours.

As to my own personal experience in the earthquake, I can hardly tell you anything. It was my fortune, or misfortune, during my time as Agent to the Governor-General to experience two earthquakes, one in 1931 and the one about which you have heard this evening. I would however like to contradict a report which appeared in at least one English newspaper that in the earthquake of 1935, which happened at 3 o'clock in the morning, I was entertaining a gay party of guests. Actually I was fast asleep. My first conscious recollection was "Well, this is another earthquake and it is very much worse than the last one. The sooner I get out, the better." I tried one door which led to the verandah. It was jammed. Then I managed to get out through the porch which had fallen down, and how on earth I got out alive I simply cannot tell you. After that I went to the bazaar and saw that the whole place was wrecked. However I cannot now go into all that.

There were three crowning mercies of the last Quetta earthquake: firstly, that the water supply was not affected; secondly, that the railway stood up to it; and thirdly, that the cantonment was unaffected and we had the assistance, as you have heard, of the military. You must all have read, and heard too, what General Karslake and his soldiers did for us. It is perfectly certain that but for

them there would have been far greater loss of life. There would have been a terrible outbreak of looting and disorder, and an almost inevitable outbreak of epidemic disease. We were saved from all that by the soldiers.

But let us also remember what was done by the civilians of Quetta. When I say civilians I mean Indian as well as British, and non-official as well as official. There were some who succumbed to the strain. That cannot be denied. I am the last to criticize if some did suffer from the reaction, but for one who did there were ninety-nine who rallied round and volunteered their services and did everything they possibly could.

You may perhaps have formed from the pictures some idea of the magnitude of the disaster which befell Quetta but, as I have said to many people, no one can realize what happened that night unless they were there and saw and experienced it. Those who came to the Residency within an hour or two of the earthquake and volunteered their services were people who had lost their relatives, lost their houses and their all and, with scarcely an exception, they came forward and tried to do their best not only then but during the weeks that followed. Let us remember that. As I say, it was not only the British but Indians also who volunteered in that way. So if the Quetta earthquake was a disaster of the first magnitude it was also one more example of the way in which British and Indians can and do work together for each other's welfare.

The PRESIDENT: I am sure it would be of interest to you to hear some comparison between the type of earthquake at Quetta and the similar calamity which occurred at Messina some years ago. I will ask Admiral Sir William Goodenough to say a few words on that subject from the tablets of his memory.

Admiral Sir WILLIAM GOODENOUGH: You may be interested to hear some comparison between this tremendous upheaval at Quetta and that at Messina, both of which caused such a great amount of human suffering. It always surprises me that there is not a greater change of formation of the actual Earth's crust in view of the immense pressures that are exerted by Nature on such occasions. I was at Messina within forty-eight hours of the great earthquake. We were naturally warned to exert the greatest possible vigilance as there would probably have been great changes in the soundings and depths of water. There were actually not any at all. When one thinks of the great stresses and pressures put on things, sufficient to part the *Exmouth's* $2^{1}/_{2}$-inch chain cable by some sudden jerk, this is astonishing.

It is interesting to recall that the houses in Messina and on the coast opposite were, curiously enough, not built to withstand earthquakes. They were very high. It appeared as if the whole movement was, as it were, on a hinge, for as we walked along what had been streets and were then covered with rubble we could see where the houses had apparently moved one way and back again; the front wall had fallen out and the whole place had opened like a child's dolls' house. Where the bed had not fallen out of the room into the street one could see a man's coat and trousers hanging on it.

Mr. Skrine spoke of those who had been for many hours entombed at Quetta and found unhurt. I remember one case particularly of a woman entombed in Messina. There was a stream of water running through the spot where she lay which had been formed into a sort of big cave. The woman was rescued after thirteen days. Not only was she alive though much emaciated, but her child, born whilst the woman was entombed, was alive and perfectly well.

There is one remark I would add, sir, and I hope I shall not be taking something from your speech. Sir Norman Cater spoke of three crowning mercies of the Quetta earthquake. There was one other which I am sure we all feel with great pride, that was that there were men like Sir Norman, like General

Karslake and others there to show great courage, devotion and absolute self-sacrifice without any thought of themselves.

The PRESIDENT: It has been a great privilege, as I am sure you will all agree, to have heard at first hand the individual experience of these two British officers who, fortunately, survived the earthquake. As Sir Norman Cater said, it is quite impossible for anybody really to comprehend the awfulness of the tragedy unless he or she was on the spot. As Admiral Goodenough has just remarked, such happenings at any rate provide an object lesson, and innumerable opportunities for courageous and selfless assistance to others in distress.

I now ask you to join me in thanking the lecturer. As you have realized, aided by his remarkable photographs he has been able to put before us, as far as anybody possibly could, a thoroughly realistic idea of the terrible tragedy. Please join me in thanking him very heartily.

THE MOUNT EVEREST EXPEDITION OF 1936: *A paper read at the Afternoon and Evening Meetings of the Society on 2 November 1936, by*

HUGH RUTTLEDGE

ON the last occasion on which I had the honour to address the Royal Geographical Society my task was to describe the fourth expedition to Mount Everest. That expedition reached a point within about 1000 feet of the summit, and we felt fairly sure that only the extreme and possibly unprecedented rigours of that particular season prevented a complete success. We thought, and with good reason, that Everest had shown herself at her very worst, and that it was unlikely that weather alone would stop a future expedition. We were wrong; the mountain had more shots in her locker, and in laying before my audience the results of this year's expedition I have the invidious task of describing how a party of exceptional competence met with weather not experienced by any previous expedition and was unable to reach a height greater than that attained by the reconnaissance of 1921.

The Tibetan Government's permission to try again was unexpected so soon after the attempt of 1933, but it did not find the Mount Everest Committee unprepared. Unhappily it arrived too late in the season to permit of a full-dress expedition in 1935, but there was time in that year for work which many of us considered a necessary preliminary to a really well-organized assault. That explains the reconnaissance which was led by Shipton last year, of which I will recapitulate the objects:

1. To collect data about monsoon snow conditions at high altitudes and investigate the possibility of a monsoon or post-monsoon attempt.
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.
4. To try out new men as possible candidates for the main expedition and to secure for them preliminary acclimatization.
5. To try out new designs of tents and other equipment; and also new ideas for provisioning high-altitude expeditions.
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.

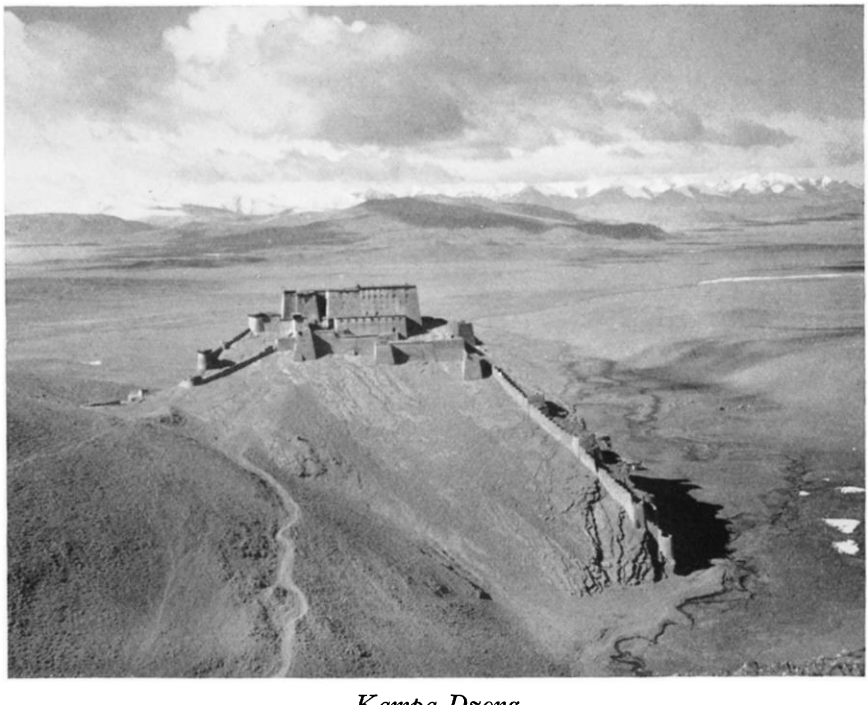
Those of you who were present here when Shipton read his paper on December 2, or who have studied that paper in last February's number of the *Geographical Journal*, are well aware with what skill that reconnaissance was conducted, and how much additional knowledge it contributed. From the point of view of climbing the mountain the principal results obtained were an enhanced knowledge of monsoon snow conditions; the trial under high altitude conditions of five new candidates, of whom three were found to acclimatize well; an improvement in equipment; and an excellent survey of the north face by Mr. Spender, with fixation of its salient features.

It was made clear to the Tibetan Government that this reconnaissance was part of the main expedition which would start in 1936, and this enabled us to double the amount of work which would otherwise have been possible. Few climbers can spare the time to visit the Himalaya in two consecutive years; yet it was desirable to test as many candidates as possible among the mountains, for experience has shown that a man's climbing record is not a complete guide to his abilities on an expedition, so Smythe spent part of the summer in the Alps trying out new men. The result was that by the end of October we had a considerable amount of practical data on which to base our selections, and a party was eventually assembled which for general ability, experience, and homogeneity could hardly be bettered. The Mount Everest Committee gave the leader very full discretion, and for his part he lost no opportunity of consulting Smythe and Shipton in the first place, and other members of the party as it came into being. The size of the party was brought down from sixteen in 1933 to twelve this year; of these, nine had been to Mount Everest before, and one (Oliver) had climbed Trisul. Of the remaining two, Humphreys, our senior medical officer, had much experience of expeditions; Gavin was the only member without experience outside Switzerland, but his performance with Smythe during the summer and the extraordinarily good report given him by the medical board of the Royal Air Force secured him a place; of which I may add that he showed himself entirely worthy.

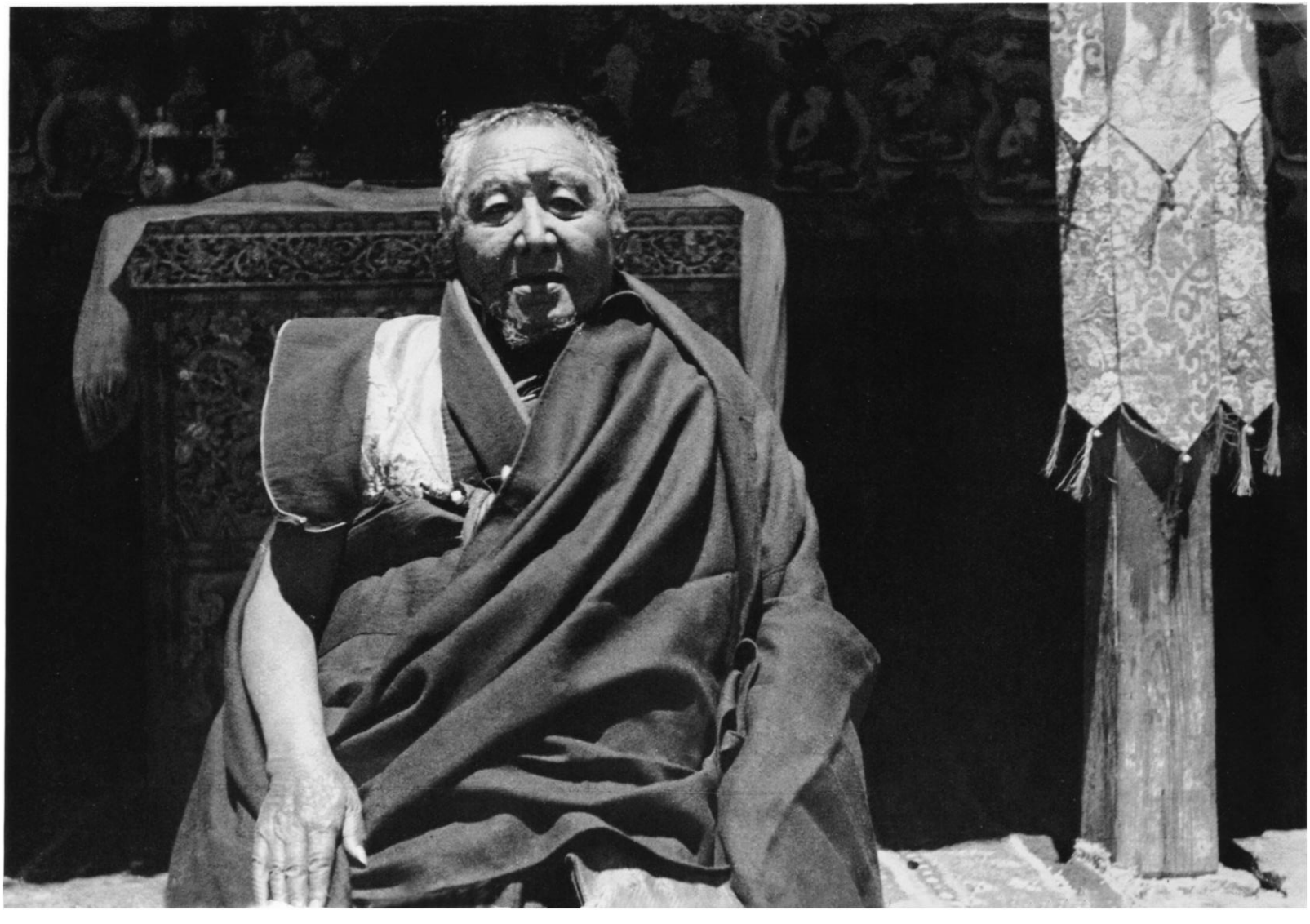
Each successive expedition is able to add something in the way of improved technical detail to its equipment and its food supply. Here I need but mention a new kind of arctic tent which was intended to mitigate the extreme rigours of life at Camp V, and the provision of pressure cookers. Special mention should however be made of oxygen apparatus; Sir Leonard Hill has continued to press with force and ability his view that little if any real acclimatization can be attained above 21,000 feet; and that, although we know that exceptional men can reach a height of 28,000 feet without artificial oxygen supply, conditions above that may bring about a sudden and most dangerous alteration in a party's climbing power. Having heard Sir Leonard Hill's opinion, we consulted the experts at the Royal Air Force establishment at Farnborough, and they most kindly cooperated in various tests conducted in the pressure chamber there. Their experience, though not entirely relevant to our case, seeing that the pilots on whom their tests are usually made are quite unacclimatized, indicated that changes in a man's condition due to failure of oxygen supply may be very sudden. The upshot was that, with the most generous and practical assistance of Sir Robert Davis, a new form of oxygen apparatus was taken out, of which Warren has made a special study. Many experiments were made with this apparatus during the expedition, but we never had the opportunity to test it at very high altitudes. So far as it went, it gave encouraging results, though some of our best men still think that the mountain can be climbed without it and that the risks of carrying so much weight on difficult ground or of a sudden breakdown of the apparatus more than counterbalance its value.

This year the expedition was brought out in echelon, as it were, to obviate waste of time and money. Morris was out first, and his perfect knowledge of Nepali and understanding of hillmen enabled him to collect the finest body

Kongra La



Kampa Dzong



The Lama of Rongbuk

of porters that could possibly be desired. Sixty-five of these men were to accompany us throughout the march; but two recruiters were also sent into Nepal to arrange for more than one hundred additional men to join us at Rongbuk on our arrival there. No praise can be too high for the conduct and ability of these men. Several of them, especially those brought direct from Nepal, were as wild as hawks, and I well remember Morris' cry of delight during an inspection in Tibet when his knowledge of ethnology convinced him that he had discovered a living Neanderthal man. They knew nothing of ice slopes or of snowcraft, but they had the natural strength, ability, and spirit of the true hillman, and with a stiffening of porters who had been to Everest before they refused to be intimidated by any conditions or any difficulties. This time we promoted old and tried hands to the position of sardar or under-sardar with the most happy results. Given responsibility, these men saw to it that the recruits were kept in order, revelling in a discipline which in their younger days they had themselves often ignored; and they were given charge of specific portions of equipment and stores, with such success that at the end of our long march to the Base Camp only two or three tins of soup were missing, and those had probably fallen out of a disintegrating box.

Allotment of work was made at a very early stage: Smythe and Wigram managed the Mess; Morris and Oliver the transport; Shipton the porters; Kempson the postal arrangements; Humphreys and Warren, besides their medical duties, dealt with physiology, the oxygen, botany, etc.; and Smijth-Windham found a most able understudy for the wireless in Gavin. Wyn Harris, undeterred by the miseries of account keeping in Tibet in 1933, resumed this thankless task. I must not forget to mention our lively and extremely capable interpreter, Karma Paul, who has been with every expedition except the first; nor Jemadar Lachhman Singh Sahi of the 1/3rd Q.A.O. Gurkha Rifles, who was with us in 1933, and Lance Naik Lilambar Rana and Lance Naik Gopal Gurung of the 2/3rd Q.A.O. Gurkha Rifles, specially selected by Morris for work with the transport and arrangements of camps. Jemadar Lachhman Singh gave Wyn Harris invaluable help in bookkeeping, and the other two were always willing to do whatever was asked of them. All stores were assembled at Kalimpong, where we received that practical help and most kind hospitality which make us consider Mr. and Mrs. Odling as valuable members of Mount Everest Expeditions. The real march was begun on March 19 from Gangtok, where we experienced similar hospitality and goodwill from His Highness the Maharaja of Sikkim and from Mr. B. J. Gould, Political Officer in Sikkim.

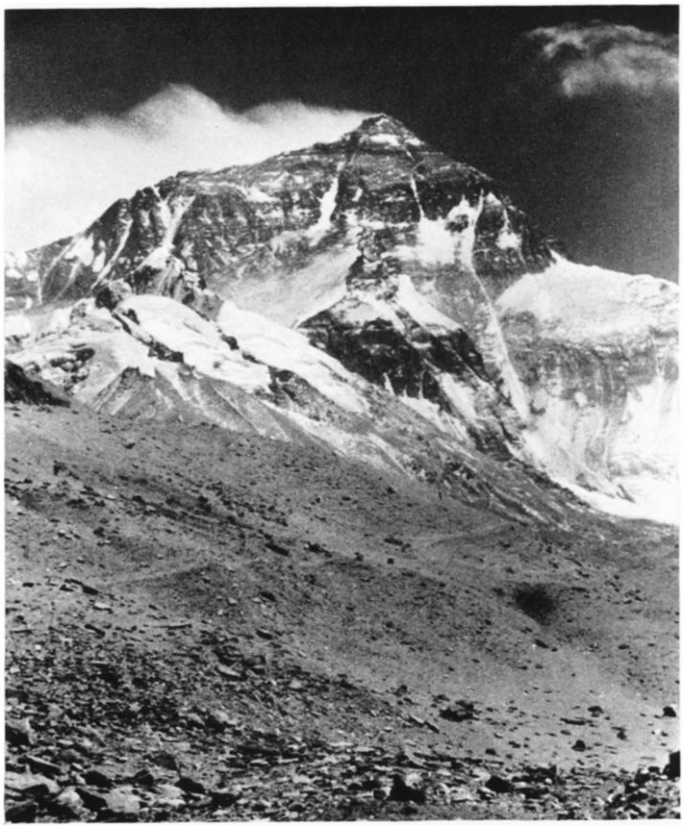
Before leaving, a complete and detailed plan of assault had been worked out at a staff meeting attended by Smythe, Shipton, Wyn Harris, and Kempson. These staff meetings were a great help; they enabled the leader to collate the views of the most experienced men and, while not forgetting his own responsibility to make definite decisions, to obtain the greatest measure of general consent. Mountaineering parties do not, or should not, require the methods of dictatorship. It had been decided, after considerable inquiry, to risk crossing the two high passes in the north of Sikkim direct to Kampa Dzong in Tibet. We knew that these two passes, the Sebu La and Kongra La, were not in any way difficult or dangerous. The Maharaja of Sikkim saw to it that

tracks and bridges were repaired, and that adequate transport was forthcoming; the rest was easy. So we left the beautiful green valley of the Teesta river for the narrow gorges, the stony mule tracks of upper Sikkim, and ultimately the rolling downs of the Tibetan plateau.

A deliberate halt of some days was made at Thangu, the last rest-house in Sikkim. Here, at a height of about 13,000 feet, it was thought that we might acquire some preliminary acclimatization and find our mountain legs. A height limit of 18,000 feet was imposed, lest enthusiasm should outrun discretion and bring on staleness. Incidentally, this halt gave Morris the opportunity to recover at least partially from a severe attack of malaria which had overwhelmed him at Lachen and very nearly brought about his summary return to India. The passes were crossed on April 2 with a refreshing absence of distress, a contrast to the misery experienced there last year. By this route we had saved ourselves from the appalling spring conditions on the Phari plain and saved at least five marches. Marching across the plateau this time was almost unalloyed pleasure; the weather was comparatively warm, and our welcome was not even comparatively so, for we found old friends among the Tibetan officials who seemed positively pleased to see us again.

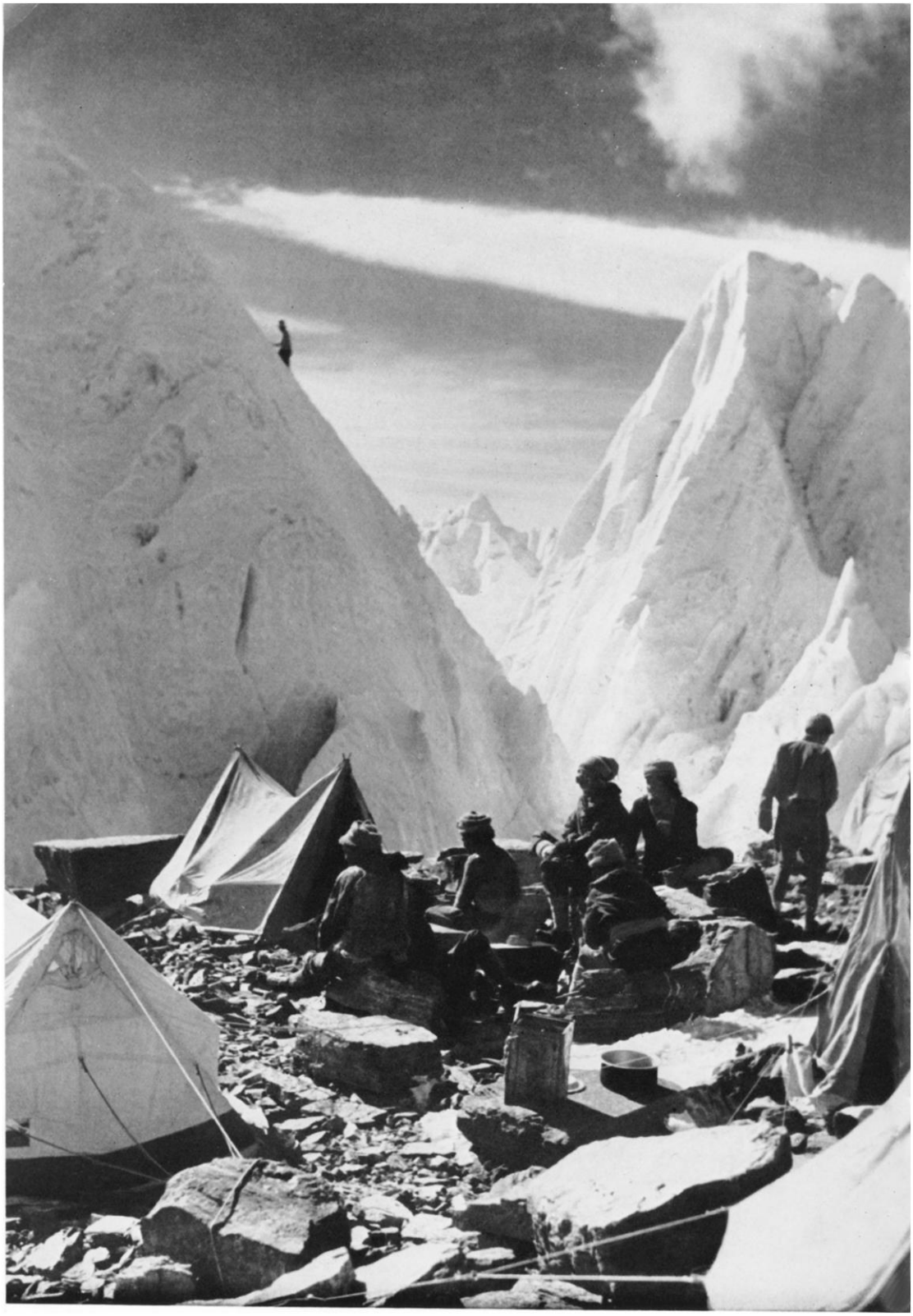
At Kampa Dzong there was a display of horsemanship and shooting; the riders were arrayed in medieval costume, and their object was to gallop past a small target fixed on a stick and to hit it either with gun shot or with a stone. The latter appeared to be the more dangerous weapon of the two; indeed, I have never seen the equal of Tibetans at stone throwing. At Tenkye Dzong the people probably remembered our Olympic games of 1933. They turned up in considerable force to watch and participate in when possible our games of football with the men. At Shekar Dzong we were most cordially greeted by the same Dzongpen as before. He even lunched with us, finding about as much difficulty with our knives and forks as we had had with his chop-sticks, and commenting favourably upon the cleanliness of our service. Fortunately he did not inspect Chun-Chun's arrangements for washing dishes round the corner.

Although we were experiencing splendid weather on this march, we had on several occasions observed disturbed conditions over the Everest region, and I do not think that an earlier arrival at the base camp would have been profitable. However on April 26, when we reached Rongbuk, the mountain looked absolutely magnificent, and in the best condition for climbing except that a strongish wind, estimated at between 40 and 50 m.p.h., was blowing a great plume of snow and ice away to the south-east. The old Lama of Rongbuk, though he shows unmistakable signs of advancing age, gave us a splendid reception. This time we felt that he was really pleased to see us; he gave us tea, blessed both us and the porters, told us to be very careful, and was convinced that we were going to have fine weather. This latter opinion, I may add here, had been offered in a more cautious way by the meteorologist at Alipore when I visited him in February. He then said that there were no indications that we were to have an abnormally early monsoon; western disturbances from the Persian side might give very bad weather in the Everest region at intervals, but for short periods only; the monsoon, when it did come, should take between a fortnight and three weeks to pass up from Ceylon to Mount



Mount Everest in good condition

Mount Everest in bad condition



Camp II

Everest; on the other hand, what he called the equatorial current in the Bay of Bengal seemed to be rather strong and might increase the rain-bearing capacity of western disturbances, but it should split up in the neighbourhood of Orissa, one part going towards the United Provinces on the west and the other towards Assam on the east. On the whole it seemed likely that we should get better weather than in 1933, and there was quite a chance that there would be an interval of comparative quiet between the first arrival of the monsoon and its full establishment.

All this was very encouraging, and no time was lost in getting to work to establish the camps on the East Rongbuk glacier. Everybody was well; there were none of the sore throats which had been so troublesome on the last occasion. The old Base Camp was complete by April 27. We had decided to make Camp I our real base this year, but to retain the old names of camps, to avoid confusion. Smijth-Windham decided to have his wireless base at Camp I also, so for the next four days very heavy work was demanded of the entire porter corps, several of whom made double journeys with extra heavy loads. But not a man broke down or grumbled.

Smijth-Windham got into wireless communication with Darjeeling from Camp I on April 30, and was immediately informed that a disturbance might be expected. The same evening snow fell. This did not worry us, as disturbances are always to be expected at this time of year. Little did we think, as the mountain turned from black to white, that never again should we see her as she must be if success is to be attained. It was observed at the time that the snowfall was not accompanied by a heavy north-west wind and we carried on with the work, experiencing very little discomfort. Camp II was made at a place observed by last year's reconnaissance, in the central trough of the glacier, a far better place than that used before, and on the direct line to Camp III. I remember that on our first night there the approach of high-altitude conditions was shown by our failure to see much humour in the short-comings of our cooks. But this was a minor matter, and on May 7 and 8, that is to say within twelve days of our arrival at the Base Camp, Camp III was in full occupation as our advance base.

Our original plan, worked out in detail at Gangtok, had been to make Camp IV on the North Col on May 22 and to commence the assault up the north ridge on the 25th. The condition of the party however was so good that it was decided to try and have Camp IV completely organized by May 15, and to commence the assault on the 18th. The first part of this plan was successfully carried out; Smythe, Shipton, and Warren made a preliminary reconnaissance of the North Col slopes on the 9th. They found that the ice formations had changed considerably since 1933 and that it was no longer possible to attempt the direct route of that year, principally because the ice-wall appeared to have doubled in height. Accordingly they began work away to the right and cut steps up the first 500 feet direct. From that point it would be necessary to make a long traverse—a thing no one likes doing on slopes of this character—and then force a way direct up to the crest. On May 13 Smythe, Oliver, Wigram, and Gavin with ten first-rate porters made the whole route up to the crest, fixing ropes over a great portion of the route. This was a desperately hard day's work, but it was so well done that next day

Wyn Harris and Kempson had no difficulty in escorting forty-six porters, half of whom had never been on an ice slope beforh, and established Camp IV on the crest. The old ledge of 1933, some 240 feet down, had now disappeared.

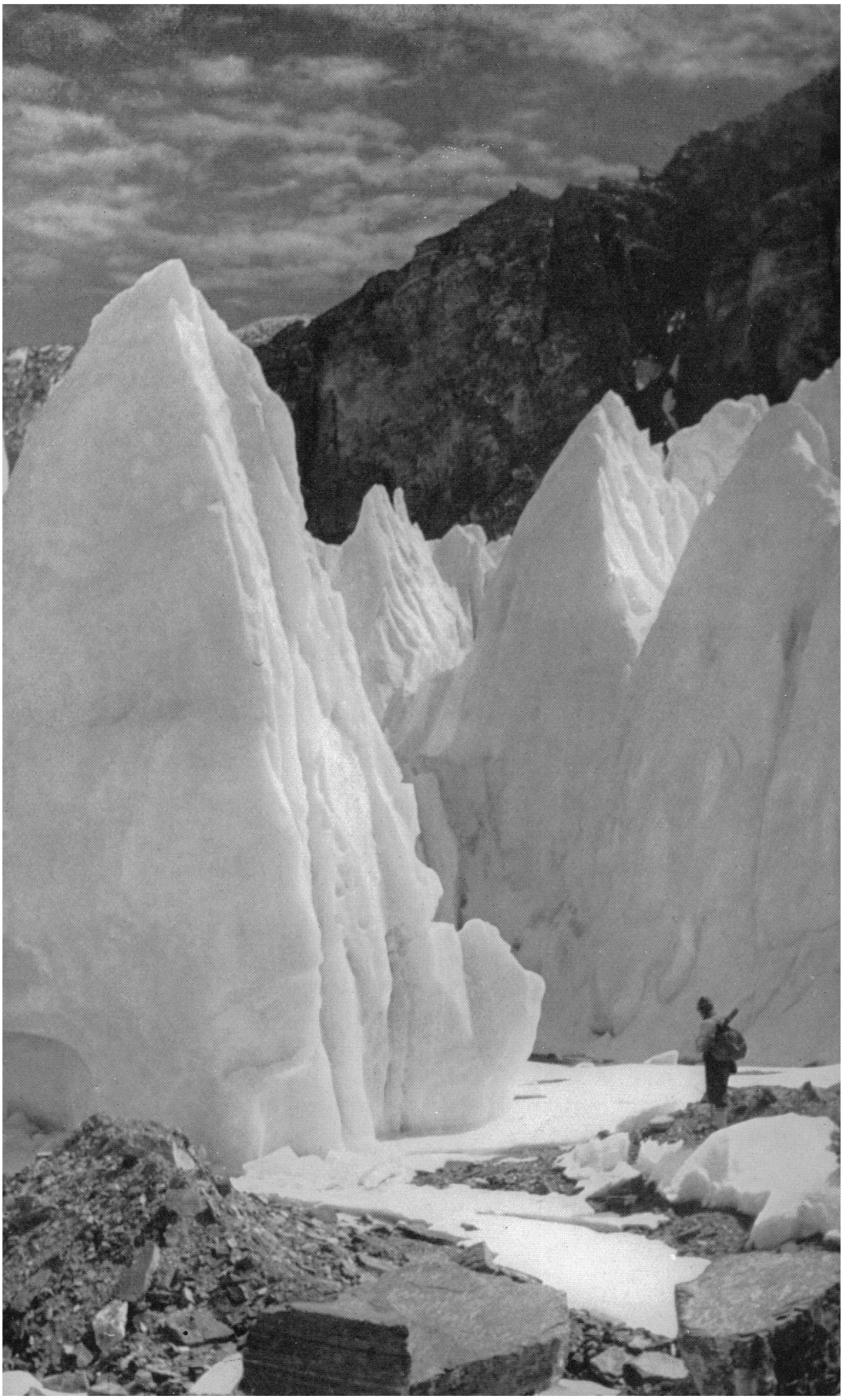
They returned to Camp III, which by the way was placed this year 500 feet higher and much nearer the foot of the North Col than before, the same evening. Next morning, May 15, Smythe and Shipton occupied the North Col with fifty-six men, of whom forty-two remained to establish the higher camps. It should be observed that all this had been done without anything like the exposure, danger, and distress which the work entailed in 1933. There was practically no wind and everybody was in splendid form. That was the end of our good fortune. There was not a great deal of snow on the mountain at this time, but what there was showed no tendency to disappear and was being steadily added to evening by evening. We positively longed for the north-west wind which alone could remove the snow. Day after day was unhealthily warm, with slight breezes from the east. Smijth-Windham's high-altitude light wireless sets were working splendidly, so that I was in constant touch with Smythe. The wireless telephone exchange at Camp III had been set up and was being worked with great skill by Gavin.

Morning and evening Smythe said that conditions were getting worse and that he did not advise any attempt to establish Camp V yet; and on the 18th he gave his opinion, supported by Shipton, that it would be useless to hold the camp any longer for the present. There were about 2 feet of snow on the North Col itself, and any amount higher up; and some of the porters were showing signs of strain. In any case we knew that a prolonged stay on the North Col would be of benefit to nobody. Smythe brought his party down the same evening; watching them from below, we could see that every mountaineering precaution was being taken lest an avalanche should occur, especially on the dangerous slopes of the traverse. It was a great relief to have the whole party down safe.

The climbers had now been at or above Camp III for eleven days, and it was obvious that the mountain would not be climbable for some time, even should the north-west wind get up. It was accordingly decided to exchange the comparative discomfort as well as the altitude of Camp III for the milder conditions of Camp I. I had already begun to notice that when a party cannot be kept fully occupied at these altitudes the strain of merely living there seems to take more out of them than if they have definite and continuous work to do. An immediate improvement in health was at once observed at Camp I. During our stay higher up Morris had had to be brought down from Camp II, where he was desperately ill with a renewal of his malaria; and Humphreys at this time was a good deal worried by a sore throat. However, Camp I was a very cheery place indeed until next morning, May 20, when Alipore reported by wireless that conditions favourable for the formation of the monsoon in the south of the Bay of Bengal had been observed.

Up to this moment we had not had the slightest reason to suppose that the monsoon would be even heard of before the end of the month; so this news was a most disagreeable shock. The staff met at once, and although we had only come down from Camp III the day before, we decided that we must

The trough of the East Rongbuk Glacier



return immediately and place ourselves in position to make at least one attack before the monsoon arrived, even if this meant tackling the North Col and the slopes beyond while there was more snow on them than we liked. It was just possible that what is called the Chhoti Barsat, or first portion of the monsoon, might exhaust itself upon the Darjeeling foothills and never reach us, and that there might then be a quiet interval during which we could continue the assaults without interruption. The party was ready for anything, and by the 24th we were again in full occupation of Camp III. The prospect there was anything but reassuring; indeed, dismal prospect speedily immerged into grim certainty. Incredible as it may seem, the monsoon rushed up from Ceylon to the Everest region in four days instead of the usual fortnight or three weeks, and hit us hard on the evening of the 24th. I am assured on good authority that this phenomenon has never been observed before. The only explanation can be the total failure of the normal north-west wind to stem the current.

Camp III was anything but a pleasant place of residence during these days; and the North Col was obviously unapproachable. I find from my diary that, for lack of anything better to do, I made the tentative suggestion that we might go round and have a look at the west side, which Mallory had rejected in 1921. Those members of last year's reconnaissance who had seen it did not think that anything could be done there, so the proposal was dropped for the moment; and on receipt of a definite warning from Alipore that a severe storm was on the way a second retirement to Camp I was ordered, and accomplished on the 28th through a quite sufficiently unpleasant blizzard. But the mountain had not yet finished amusing herself at our expense; next morning we awoke to find for the first time a really strong north-west wind blowing. This was the most welcome of all possible changes, and we lost no time in going down on to the Main Rongbuk glacier, from which the mountain could be seen. Snow was being blown in enormous sheets off the great north face in a way which promised a complete clearance in two or three days. We hurried back to lunch and were met by a delighted Smijth-Windham, who produced a wireless message to the effect that the monsoon showed signs of weakening and had been driven off towards Assam. Whatever the wind, we could not neglect this opportunity, and the party rose as one man for the third ascent to Camp III.

But it was not to be so easy as that. At the very moment of our starting the north-west wind appeared to hesitate, and by the time we had reached Camp II very heavy snow was falling, and Mount Everest was completely weatherbound until the morning of June 3, when we had to make the best of the fact that the north-west wind resumed its activities simultaneously with the arrival of a weather report that we might now expect the monsoon from the Arabian Sea as well as from the Bay of Bengal. Camp III was just a wilderness of snow, and the North Col looked like a stage set for the Ride of the Valkyrie, with snow instead of smoke flying up in great columns into the sky. However at least this snow was being blown about and not just lying idle with a view to avalanching, and on the morning of the 4th, Smythe, Shipton, and Kempson made a cautious examination of the lower slopes, finding them very much better than they expected, although of course all the steps and ropes had long

Camp III and the North Col

ago been covered up. After a thorough discussion at a staff meeting it was decided that, if the very greatest precautions were taken, it was justifiable to try again to occupy Camp IV with an assaulting party.

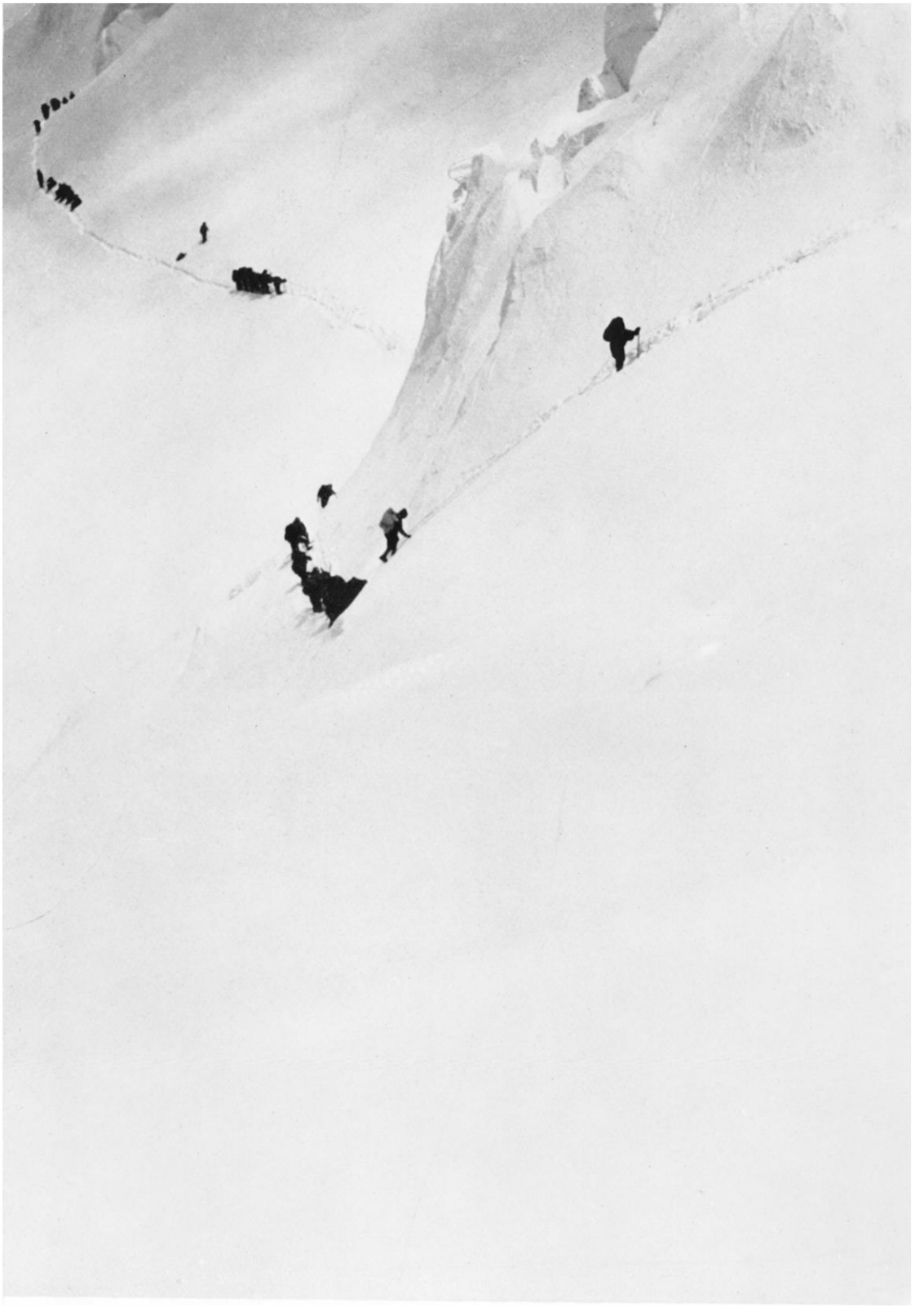
This last effort was most carefully planned in view of the obvious danger from avalanches. The whole climbing strength of the party was to be used, the men working in pairs in turn. Smythe, my second in command, was placed in charge of the operations, and would accompany each pair of climbers, deciding at each stage of progress how much further it would be possible to go. The porters were divided up into small parties under control of Shipton. These parties were to move in succession as the route was made. There was to be no hesitation about a retreat if the conditions were too bad. A very cold night was a promising beginning. Wyn Harris and Kempson were off very early to tackle the first 500 feet. They were not reassured by finding the debris of a small avalanche across their route, but after a careful discussion with Smythe, who had now joined them, it was decided to complete this section. Smythe then went on with Warren and Wigram and they reached a crevasse which marked the beginning of the traverse, the state of which would of course decide for or against the venture. Meanwhile Oliver and Gavin halted the leading party of porters a little lower down and Shipton was still further below with the remainder.

At once it became evident that the snow on the traverse would never hold. Smythe who, as he has told me since, felt that if we did not reach the North Col on this day we should never get there again, made up his mind there and then to try a very difficult line of ascent straight up to the crest. A frontal assault of this nature would certainly be safer than a traverse, and all Smythe's fighting instincts had been roused by our recent disappointments. But this frontal attack was too much for even mountaineers of this calibre; immediately ahead soared two frightfully steep walls of ice, between and beyond which was almost equally steep snow of the very worst description; altogether at least 400 feet of extremely difficult going. I very much doubt if this could have been climbed at the much lower altitude of the Alps; certainly it would have been impossible to bring the porters up. After a very little step-cutting Smythe realized that the game was up and quite rightly gave the order to retreat. Shipton, in frightful anxiety for his beloved porters, had already started them downwards. The retreat was conducted with very great skill, and I for my part shall never forget watching it.

All that evening and next day we were stormbound—this was our one really violent gale of the year. As the tents shook and trembled under the gusts, physical activity had to give place to argument, of the full-flavoured kind which perhaps only high altitude conditions can produce. I missed the cream of it as I was busy writing in my tent. Besides, I should have to make an eventual decision and was better away from the heat of battle. Next morning, when all the snow of this region seemed to be in the air at once instead of on the slopes, Wyn Harris came into my tent with an air of purpose and begged that in the event of the wind falling a little he and Shipton should be allowed to go and have one final look at the slopes, just to see if they had been swept clear. I agreed to this; both men were supremely competent mountaineers and knew exactly what they were up against. They were clearly

Camp IV

The North Peak from Camp IV



Traversing the North Col

determined that the quality of those slopes in these conditions and at this time of year should be ascertained for good and all.

After lunch there was a slight lull and they set off. Smythe and I watched their progress through a little opening in my tent, closing this up at intervals when the gusts were desperately bad, and finally going over to Gavin's arctic tent when the wind became intolerable. Progress was unexpectedly rapid up the first 500 feet, and we began to hope that things were not too bad after all. Then they came to the crevasse and halted to rope up before examining the traverse. Shipton led out across what seemed to be good, hard, compacted snow, well attached to the ice beneath; it held his boot nails well and was not very steep. Wyn Harris had just begun to move in his turn when a sharp crack sounded some 200 feet up. There was a moment's dead silence and then the slope began to move, breaking up as it did so into the blocks of ice characteristic of windslab avalanche. Only a few yards down the slope ended in the brink of a 400-foot ice precipice. Shipton was instantly thrown on to his back and carried down among the ice blocks. Wyn Harris, making a desperate effort, leapt back towards the lower lip of the crevasse and drove his axe deep into the hard snow; as he did so his left hand, which held the coils of rope, was crushed against the axe head and he had to let go momentarily to let the rope run out to its full length. He remembers being thrown on to his back, recovering his feet in a flash, and again jamming the axe into the snow with the rope round it; he was just free of the avalanche. As the rope tightened, Shipton, who had begun to slide from a point roughly on the same level as Wyn Harris, was gradually pulled in the arc of a circle towards the edge of the avalanche, but of course below Wyn Harris. Just when it seemed that the straining rope must pull the axe out of the snow and Wyn Harris with it, the avalanche slowed down and stopped close to the brink of the ice precipice. It is of course impossible that Wyn Harris could by his action have arrested the fall of many hundred tons of ice, but it may be that there was a slight easing off of the slope just before the drop and that Wyn Harris by taking his own weight and that of Shipton and the surrounding ice blocks off the avalanche contributed to its halt. Certainly he did the right thing at the right moment. Shipton was completely winded, and both men were naturally a good deal shaken, but they pulled themselves together and descended to safety without further incident.

There was of course no further argument; the North Col had had the last word. Camp III was completely evacuated and Camp I reached next day. I think we all knew that the mountain was finished with for the year. Transport had already been ordered up from Shekar Dzong, and it was thought that we might employ the interval before its arrival by going up the Main Rongbuk glacier and examining the west side of the North Col, more as a piece of interesting exploration than as a serious attempt to reach the Col by this route. The very next day, June 8, the entire party set off. I wanted Smijth-Windham, who had had a very busy time at Camp I, sending off no less than five hundred wireless messages, to take a holiday. He entirely agreed, provided he could take with him one of his light wireless sets for further experiment. Our first camp at about 18,000 feet was a joy to look upon—green grass at 18,000 feet and in the middle of it a lark's nest with two eggs in it. We

pushed on next day to what was called North Face Camp, near the south-west shoulder of the North Peak, at about 19,000 feet, and next morning went out on to the open glacier towards the Lho La to obtain a view of the Col. That view came suddenly and most dramatically. The slopes to the Col rise out of a little glacier bay, and are not properly visible until you are well out on the glacier. Instead of the very long and steep approach which we had expected, we saw an icefall which could certainly be negotiated, leading up to a not difficult *bergschrund*, and above that perhaps 800 feet of pretty steep snow or ice flanked to the right by ribs of rock not patently unclimbable. This was worth tackling at once, and the climbers made off across the glacier without delay. Unfortunately clouds came down very soon after, and the tired men who returned to the North Face Camp that evening were only able to report that they had forced the icefall without difficulty and gone very close to the *bergschrund*, but had been unable to see anything beyond that.

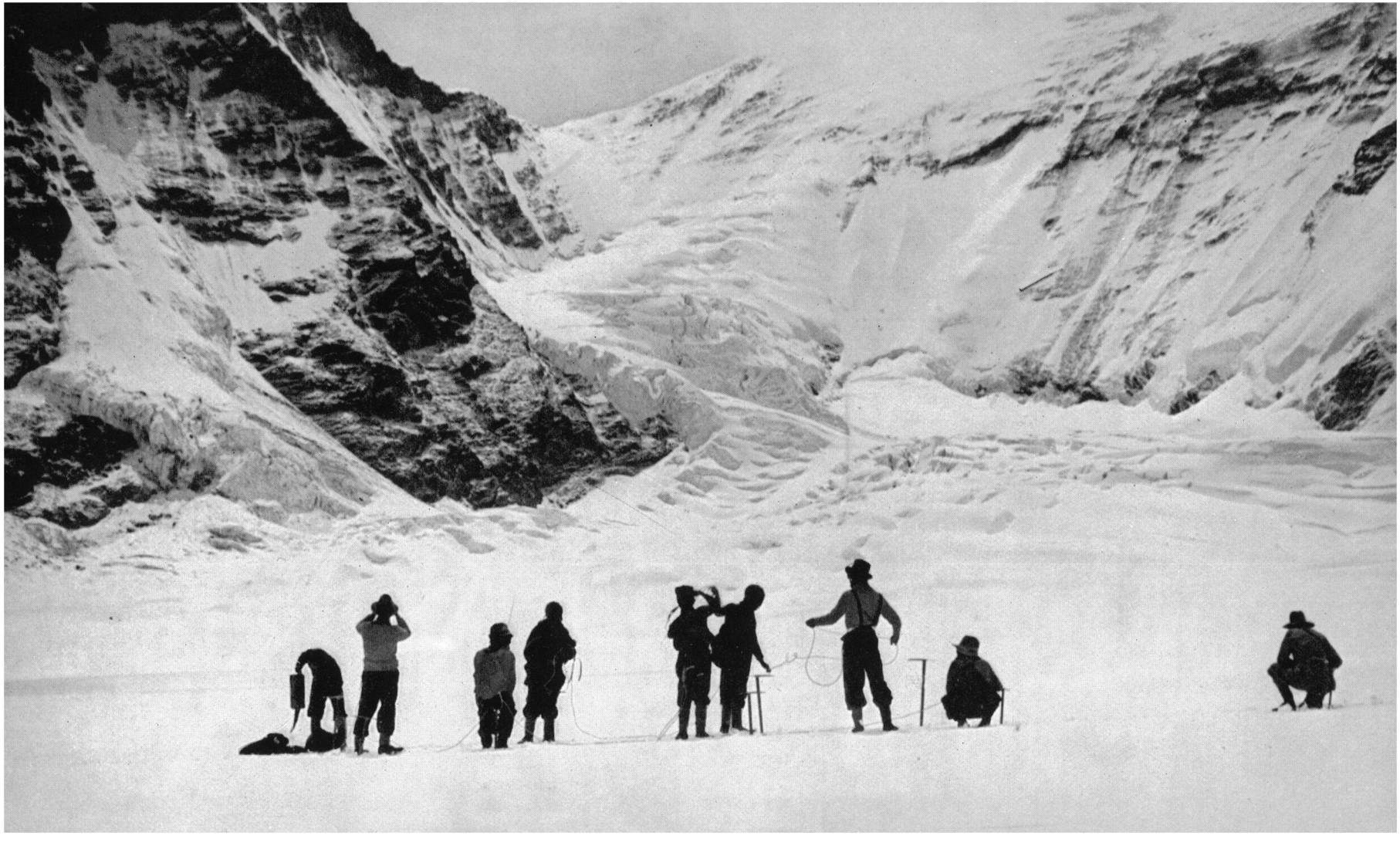
The mornings at this time were invariably fine, but snow fell very heavily each evening and the mountain was deep under it. Further examination of the slopes did not call for the full strength of the party, and Shipton had always been anxious to renew his attack on the North Peak which had been defeated last year. Accordingly it was arranged that Smythe and Wyn Harris should take a light camp up through the ice fall and close to the *bergschrund* and examine the slopes from there, Smijth-Windham and I remaining at the North Face Camp while Shipton and the other climbers should return up the East Rongbuk glacier and attempt the North Peak, from which an exceptionally good view of the north face of Everest might be obtained.

The now violent monsoon deprived both parties of success; Smythe and Wyn Harris spent a night near the *bergschrund*, just out of reach of the incessant avalanches from the North Peak, and next morning were able to form a clear impression of the possibility of ascent, though at the time they could make no further progress. They are of opinion however that this route is perfectly practicable in good conditions; that it is definitely safer from avalanche, especially windslab avalanche, than the east side; and that there appears to be no particular risk of rock-falls. Further a lodgment could probably be effected on the rock ribs to the right. If this route were made and properly roped by a good party in the early stages of another expedition it might be used as a preferable alternative to the other; at any rate it should provide a safe means of descent to a party cut off by the monsoon on the mountain. Shipton's party meanwhile had bad luck similar to that of last year, and were stopped by deep and impossible snow at about 23,300 feet.

This was really the end; we reassembled at the Base Camp and left for home on June 17. I wish it could have been possible to complete some of the survey work so well begun during last year's reconnaissance; but I had been specially requested by the Tibetan authorities to keep to the routes laid down in our passport, and the repeated thanks we received on our return march for having done so indicated how much this meant to them. I honestly think that our willingness to conform to their wishes has left a good impression, and that as far as they are concerned there is quite a good chance of our being permitted to go to Mount Everest again at no distant date.

A full technical discussion on such information as this sorely tried expedition

The final slope of the crest of the North Col



has been able to gather for the common stock would be out of place here, but several members of the Expedition have written appendices on their special subjects, of which they will give a brief account if the President calls upon them. It may suffice for me to say that we have now the nucleus of an absolutely first-rate party; that we have explored *au fond* the iniquities of the east side of the North Col; that we have made a sufficient examination of the west side to feel justified in recommending it as an alternative route; that we know a little more about the use of oxygen; that further physiological data have been obtained; and lastly that our examination of the final pyramid, though not alas by actual contact yet by telescope and binoculars, has made us fairly certain that this can be reached by Norton's route and that a choice of three possible ways to the summit presents itself. For my part, I must now cease from active participation in this great venture; but I can never forget the way in which my comrades took the rough with the smooth and made even failure a happy memory. Some day I hope they will return, and that fortune will favour them with fairer conditions; then I am sure they will reach the summit.

APPENDIX I: SELECTION AND TRAINING OF PORTERS

C. J. MORRIS

This year it was decided that the bulk of the porters should be enlisted in Sola Khombu, and that they should join the expedition direct from that place at the Base Camp. There was no doubt that as many suitable men as were required would be forthcoming; but in order to guard against this arrangement not proving entirely satisfactory some sixty porters were enlisted in Darjeeling, to form the nucleus of the corps. I think some such arrangement will always be necessary since an exceptional fall of snow on the Nangpa La might hold up a Sola Khombu party's arrival at the Base Camp for as much as two weeks, thus causing considerable disorganization to the climbing plans. The problem cannot be solved by ordering the party to arrive at a date earlier than it would normally be required, owing to the difficulty of feeding it, unless some special arrangement were made to overcome this. It should moreover be noted that if the porters are enlisted direct from Sola Khombu no sort of selection is possible; and while the great majority will be, as was the case this year, men in every way suited to the needs of the expedition, quite a number have perforce to be enlisted who would certainly not have been selected had they presented themselves for enlistment in Darjeeling. It is also desirable that as many of the porters as possible should get used to wearing their boots before serious work on the mountain commences. This is only possible when porters are enlisted in Darjeeling; but in any case most of the sardars and a certain number of other men will always be required to supervise the transport during the march across Tibet. In this connection it may be noted that a convention has somehow arisen that Mount Everest porters should carry no loads during the march. This appears to be unnecessary; and while it is obviously not in the best interests of the expedition that these men should carry heavy loads across Tibet, it is in the interests of their training that they should at all times carry something or other.

The system of organizing the porters into sections, each under the command of an under-sardar, was most satisfactory and was appreciated by the men themselves, amongst whom there was always keen competition to gain the coveted

The North Col from the west

stripe. Some members criticized this system as being too military; but any one who has had to deal with 150 or so entirely untrained and undisciplined men will quickly realize that some such method is necessary, even if only for the purpose of moving the porter corps from one place to another.

A head sardar, whose chief duty is to see to the porters' feeding arrangements and to ensure that every man does his fair share of work, will always be necessary, but the question of a transport officer, with no other duties, now seems open to question. Many of the younger members now consider a transport officer to be not a luxury but an actual encumbrance; but it should be remembered that a great deal of work goes on behind the scenes, of which they, quite rightly, have no knowledge since it is the transport officer's duty to relieve them of unnecessary trouble; and because everything seems to run smoothly there is a tendency to minimize the importance of the transport officer's duties. The route and methods of conducting expeditions across Tibet to the Base Camp are now well known, and many of the climbers of this year's expedition (and the same will probably apply in the future) have themselves had practical experience of the problem. From most points of view many of these are perfectly well able to supervise the transport and the porters. There are however occasions when it is vitally necessary that some member of the expedition should be able to speak to the men in their own language: this is a very different thing from the smattering of Hindustani which most keen members sooner or later acquire. Moreover the effect is never the same when conversation has to take place through the medium of an interpreter. The men themselves feel very strongly on this point, and will work much better when they know that if necessary they can make a direct appeal to some member of the party. If some climber can be found who knows Nepali or Tibetan really well, then I think there is no need to have a special transport officer. Until such time however even in a small party the appointment of a transport officer does seem to be most necessary, and the retention of such an appointment is in the best interests of the expedition as a whole.

APPENDIX II: TRANSPORT

C. J. MORRIS

As soon as the route was settled arrangements were made to forward the whole of our stores from Kalimpong to Kampa Dzong in batches of roughly one hundred mule loads at a time, thus enabling the climbing party to march through Sikkim unencumbered by the large quantity of transport which would otherwise have been the case.

The roads through Sikkim are for the most part extremely narrow, and unless transport is despatched along them in echelon, as was done this year, there is always liable to be much congestion and even partial disorganization, especially when, as is often the case at the time Mount Everest expeditions normally set out, there is a lot of down traffic. The methods adopted this year for despatching the transport proved entirely satisfactory and should be adopted by future parties.

As soon as we reached Kampa Dzong the whole of the stores were sorted out and checked in detail, all members of the expedition helping in this necessary but extremely laborious work. A certain number of boxes were opened and their contents checked against the detailed list in the stores book. In every case these were found to agree; and since over one hundred boxes were checked in this way it was reasonable to suppose that we were at least starting off from Kampa Dzong with everything intact.

Apart from the actual provision of transport animals, the officer in charge of transport is chiefly concerned to prevent loss and theft on the march across Tibet. In the past losses have occurred in this way, and the matter has always caused considerable anxiety lest some particular box containing, say, important items of high-altitude equipment, go astray. In order to minimize loss it was decided to delegate responsibility to the porter under-sardars. Each under-sardar was given a number of men to serve under him; and before leaving Kampa Dzong each under-sardar was allotted a definite number of store boxes. These boxes were handed over, the nature of their contents explained to the under-sardar; and he was permitted to put his own marks upon them in order to aid recognition. This having been done, each man was told that he was personally responsible for his boxes until such time as we reached the Base Camp. During each day's march both he and the men serving under him were to accompany the boxes, and at least some members of each section were never to let them out of their sight. If, as is often the case in Tibet, any particular party of animals was unable to reach camp by nightfall, then the men in charge were also to camp with the transport, sending a man on to the camp to say what had happened. Whenever circumstances permitted under-sardars were ordered to check their boxes daily, and to report the non-arrival of any particular package. During the first few days it appeared likely that we had lost at least a quarter of our entire stores; but a check by various members of the expedition disclosed the fact that this was not really the case, and the supposed losses were due to the sardars' inability to read numbers, or even to count correctly. This difficulty will always arise until the Sherpa takes to education; but provided a certain amount of help is given them, and advantage taken of halt days to carry out a general check, the methods adopted this year should prove entirely satisfactory. As it was, our total losses on arrival at the Base Camp were found to be nothing more than a few tins of soup; and it seemed likely that these fell out on the way.

In order to facilitate the work on the actual mountain it is essential that all those concerned should know exactly what any particular box or package contains. For this reason it is important that as few people as possible should have access to the boxes during the march; and that anything issued or removed from a box should be entered *at the time* in the store book concerned. It seems almost unnecessary to mention a simple routine matter such as this; but in actual practice it is so often neglected, and liable to cause such endless confusion and delay on the mountain, that I feel it essential to place it on record. For the same reason keys should be given only to those members who are actually required to deal with boxes; otherwise indiscriminate opening of boxes takes place, no record is kept of stores expended, and by the time the expedition reaches its base the store book is completely valueless.

APPENDIX III: WIRELESS

W. R. Smijth Windham

This is not the place for wireless technicalities, but I will endeavour to state as briefly as possible what were the wireless arrangements, and what in general are the advantages and disadvantages of taking wireless on a Mount Everest expedition.

I returned to England early in December 1935, and was told to carry on with the organization of the wireless in accordance with my own ideas. I regarded the main function of the wireless as being the means of rapid transmission of weather forecasts from their source at Calcutta to those who would use them,

namely, the climbers. It will be simpler if I deal with this in three phases: Calcutta to Camp I; Camp I to Camp III, and Camp III upwards.

Firstly, I arranged for a station to be established at Darjeeling which was the nearest point in civilization with the necessary facilities. It was excellently run by two N.C.O.s (Sergt. Frawley and L/Cpl. Maudsley), and was equipped with a telegraph circuit by which weather and other telegrams could reach the station quickly, and with W/T whereby messages could be retransmitted to me at Camp I.

The plan was for Ruttledge to be at Camp III. I would have liked to be there too, but there was one big disadvantage—Camp III was liable to evacuation owing to bad weather. I chose Camp I, which is quite high enough when one considers swinging the starting handle of a charging engine on a cold morning.

The equipment at Camp I consisted of a specially modified Norman Lyon charging engine, which supplied power to a bank of accumulators presented by Messrs. Young, from which was driven an Eddystone short-wave transmitter, which put some 50 watts into the aerial on a frequency of 7 mcs. per sec. An Eddystone short-wave receiver was to receive signals both from Darjeeling and from Camp III.

So far so good. Then came the difficult problem of communication with Camp III. No member of the party besides myself had any experience of wireless. The obvious solution was a field telephone circuit, but it would have cost over £150. The only alternative was wireless, very portable wireless with limited power, probably involving the use of the key rather than the microphone. I bought a Marconi battery-driven transmitter and receiver for Camp III and a similar transmitter for Camp I, and forthwith enlisted Gavin as my disciple. He, with Ruttledge, Humphreys, and Oliver, were made to attend morse classes, and his enthusiasm was such that by the time we reached Everest he erected and took sole charge of the Camp III wireless in a manner quite above criticism. We became known to the porters as the Bijli Sahibs; the more erudite of them even used the term Wahlis Sahibs.

If all went well, our weather forecast would reach Camp III from Alipore in, say, two hours. But it would still be useless to the assault party high up on the mountain if it could not reach them by the same evening. The requirements were extreme lightness and simplicity. Fortunately these could be met by the use of wireless working on ultra-short wavelengths (5 metres). Fortunately, too, the layout of the mountain is right, for these radiations are very similar to light rays, and require a straight uninterrupted path. Sets were designed by Eddystone with an all-in weight of 28½ lbs., and two specially light ones for Camps VI and VII weighed only 15 lbs. They could be erected in about three minutes, they transmitted speech, and in use required only the operation of one knob, the send-receive switch.

I may leave to the imagination the tiresome details of packing and shipping, the harassed checking of boxes at Darjeeling, and the daily anxieties of the march, with its bumping and boring, its bucking off of fragile loads, and its muleteers who use one's petrol cans as firebricks, and pass to Camp I, where Gavin and I started unpacking on April 27. As exercise I commend to you the driving of iron mast-pickets into rock with a 7-lb. hammer at 18,000 feet.

By May 1 we were through to Darjeeling; by May 9 Gavin had worked to me from Camp III, and when Smythe and Shipton occupied the North Col they found the 5-metre wireless to Camp III as good as a domestic telephone, or so they said.

There is little more to add, save that when the party went up the main Rongbuk Glacier to examine the North Col from the west, I accompanied them with

skeleton equipment. I used the Marconi transmitter whose range is given by the makers as 5 miles. By fitting an aerial with a specially high angle of radiation I was able to send signals over the North Peak, which was immediately above us, and bounce them down to Darjeeling on the other side, 110 miles away. Reception was good, too, particularly from the B.B.C. I remember well eight of us, in my six-by-four tent, listening to every word of the commentary on the first Westchester Cup match. My point is that should the western route be decided upon as the line of attack on a future expedition, the North Face Camp will form an even better wireless H.Q. than did Camp I this year.

That brings me, in conclusion, to the pros and cons of wireless on Himalayan expeditions and on Mount Everest in particular. It is a very controversial question, but I feel it is important that a future leader should have all available information before making his decision. Taking the objections first: The wireless this year cost roughly £1000. Of this £500 was spent on equipment and the other £500 went on transport and on personal clothing, messing, fares, etc., for me. The total might have been less had I had more time in England before starting, and might have been cut down by a less comprehensive wireless plan. But one must guard against spoiling the ship for a ha'p'orth of tar. Also, I understand that the proprietors of the *Daily Telegraph* gave an extra £500, on condition that the reports from the expedition were sent by wireless, and gave £500 extra towards the cost, so that the net expenditure amounted to about £500.

Secondly, it has been and is being argued that every member of the expedition should be a potential starter for the summit: this on the ground not only of cost but also, it is said, of reducing numbers in order to make the party less unwieldy in its march across Tibet. I leave it to be decided whether the general is to go over the top, bayonet in hand; certainly if he does he need have no experts behind him, for he will have committed himself irrevocably.

Thirdly, in certain cases wireless bulletins have undoubtedly increased the anxiety of relations; but I am doubtful how much weight should be given to a disadvantage of this kind.

Now for the advantages. Is wireless useful? In six weeks I dealt with 549 messages, of which about 350 were weather messages, about 120 were on expedition business, including press, and 80 were private. This takes no account of the many messages concerning supplies and porters which passed between Camps I and III, or of tactical messages between Camps III and IV. The evacuation of Camp IV was carried out after full discussion by wireless telephone with the leader at Camp III.

Secondly, are weather messages useful? Although in a year like this they served mainly to intensify the general gloom, I think the answer must be Yes. But a word of warning is necessary here. The Indian meteorological authorities have repeatedly stressed that they cannot help Everest if Everest does not help them. Without an observatory north of the Himalaya they must rely on information from the mountain. That involves a wireless transmitter and therefore a wireless operator. Now it has been suggested that wireless might be taken without a wireless operator. In my view that would lead nowhere. If you sacrifice a wireless operator you must sacrifice a great measure of reliability not only in the actual working of the wireless, if indeed it works at all, but also in the weather forecasts, for if there is nobody to observe the Everest weather and transmit details to Alipore, Alipore in turn cannot make forecasts.

There is only one question to decide here, whether to take full wireless equipment with a wireless specialist who might well know something about meteorology too, or to take nothing at all. That is the question, and if I told you my answer you would accuse me of being biased.

APPENDIX IV: PHOTOGRAPHY

F. S. SMYTHE

Everest has been photographed so often that from a topographical standpoint little remains to be done on the Tibetan side of the mountain, though of course the scope of the stereo-photogrammetric survey of the district could be extended indefinitely. The main objects of photography are to bring back a record, personal and topographical, of an expedition in which must be included a record of the meteorological and snow conditions on the mountain.

Of recent years the development of the miniature camera which uses 35 mm. film and takes thirty-six exposures on one film has greatly assisted mountaineers and explorers to whom bulk, weight, and ease of manipulation are first essentials. The production of film of fine grain which enables such photographs to be enlarged satisfactorily to about 12 by 10 inches and reproduced as good lantern slides has rendered such apparatus and film particularly suitable. At the same time larger films are still more suitable where greater enlargements are desired, and the best camera in my opinion is the 6 by 9 cm. "Etui," which weighs only 1 lb. (as against about 2 lb. of the "Leica" type of miniature camera) and which uses film packs. The sole disadvantage of such a camera as opposed to a miniature camera is the necessity of changing film packs more frequently, a chilly operation at high altitudes and one calculated to reduce the number of photographs taken, a point lamentably evident in the few photographs taken by expeditions above the North Col.

The 1936 expedition was equipped with various cameras ranging from miniature size to quarter-plate, and with these excellent results were obtained on Kodak "Panatomic" film, a film of panchromatic quality well suited to mountain photography.

Light values are not easy to estimate, and the tendency has always been to under-exposure during the march through the Sikkim valleys, where water vapour reduces values, and to over-exposure on Everest, where the value is very high. Exposure meters are of little value owing to the varying proportion of ultra-violet light as height is gained, but it should be possible to evolve a compensating table to aid the photographer who uses a photo-electric exposure meter.

Filters are necessary during the march through Sikkim and across Tibet if the best results are to be obtained, but are not so desirable above the snow-line as they tend to over-correct sky tones. Examples of this will be found among the photographs taken by former expeditions, in which the sky appears unnaturally dark. These photographs are often effective but do not represent landscapes accurately, and accuracy is an ideal to be aimed at in photography on Everest. The best mountain negative is one not too dense and with detail present in shadows and high lights, particularly the latter if a soot and whitewash effect is to be avoided, a common failing of mountain photographs.

The most common criticism of Everest photographs is that they convey little idea of the scale of the mountain. This is inevitable but can be remedied to some extent by careful composition and the juxtaposition of a tent or human figure in the foreground or middle distance. Unless a special effect is desired or the photograph is to be purely a topographical one, a human figure does add to the interest, especially to those who have not seen Everest.

The mere pointing of the camera at a scene of grandeur and beauty, coupled with the correct exposure, is not enough, and the result is too often disappointing. Balanced composition is perhaps more important in mountain photography than in any branch of photography, and the photographer, who would like to

do justice to his subjects, would do well to spend some time studying the principles of composition; in this a visit to an art gallery is an illuminating experience, as precisely the same principles apply in landscape painting. The aim of the photographer must always be to lead the eye forward, as it were to a climax, and this is only accomplished by correctly balancing foreground with middle distance and background and by correctly apportioning sky to landscape. For instance the insertion of a single pine tree in the foreground of a mountain picture against a background of mountain transforms an otherwise dull picture into something artistic and beautiful. There are no trees on Everest, but some kind of foreground object is usually available.

Thanks to the generosity of Kodak, Ltd., it was possible this year to obtain a cinematograph record of the expedition. This was taken on supersensitive panchromatic film and the apparatus employed was a "Special Cine-Kodak," two "K" models and one "B.B." model "Cine-Kodak." In addition, a quantity of Kodak "Kodachrome" film was employed, thus enabling the first cine pictures of an Everest Expedition in colour to be obtained. Before our departure I was warned by Kodak, Ltd., not to use "Kodachrome" film where an important picture could not be duplicated in black and white, as the film was then in its experimental stage, and it was doubtful if it would remain unaffected by climatic changes, in particular the damp heat of India during the monsoon season. Some of the film was ruined by climate, but a greater proportion processed well. It was found to require a greater exposure than originally recommended, and I would now suggest an exposure of between eight and sixteen times more than that necessary for the supersensitive panchromatic film. No filter except a haze filter for distant views is required for this film and, except that it demands a greater accuracy of exposure owing to its lesser latitude as compared with black and white film, it is as easy to handle as the latter. It is also worth noting that although it is not yet possible to duplicate this film in colour excellent black and white copies can be made from it.

As regards the supersensitive panchromatic film, red Wratten filters were employed, and though good results can be obtained without them I would unhesitatingly recommend them to be used during all stages of an expedition. In this connection it should be pointed out that the quality of a cine film is necessarily somewhat different from that of a "still" film, and any tendency to over-correct skies is preferable to under-correction when the film is projected on to a screen. Elaborate apparatus is unnecessary and the numerous appliances on the "Special Cine-Kodak" were never employed. Thus the camera was unnecessarily heavy.

Telephoto lenses are essential. They enable the complimentary picture of a middle distant or distant picture to be taken, a function of all good cinematography, and the camera therefore should be fitted with a turret head so that the telephoto lens can be brought into use without delay or the necessity to fiddle with cold fingers.

The importance of a good stand cannot be over-emphasized. If it is worth taking a film at all it is worth while using a stand on every possible occasion. On a large screen, such as is employed in the Society's Hall, the slightest tremor is brought into prominence, and at high altitudes where breathing is more rapid, or after muscular fatigue when the body is unsteady, it is impossible to take steady pictures without a stand, or some form of support.

APPENDIX V: SNOW CONDITIONS ON THE NORTH COL

F. S. SMYTHE

From the point of view of danger the ascent of the North Col from the head of the East Rongbuk Glacier presents considerable problems, and a study of the history of this route shows how diverse are the conditions with which climbers must contend.

In 1921 the Col was reached without incident towards the end of the monsoon season, though Mallory in his account mentions frozen avalanche snow. In the light of subsequent experience however it is probable that the party exposed themselves unknowingly to considerable risk.

In 1922, shortly after the monsoon had broken, seven porters lost their lives in an avalanche.

In 1924 no avalanche occurred except for a minor snow slip during the rescue of some porters who were marooned by pre-monsoon snowstorms on the Col.

In 1933 the party on one occasion retreated owing to a snow formation resembling a windslab, and Camp IV, which was on a ledge some 300 feet below the crest of the Col, had to be moved on to the Col owing to the risk of an avalanche overwhelming it from above. A reconnaissance after the monsoon had broken disclosed dangerous conditions.

In 1935 a large avalanche occurred shortly after the establishing of Camp IV which involved a considerable portion of the route.

In 1936 after the abandonment of Camp IV prior to the monsoon the slope was heard to crack at one place. The same thing was heard later on another part of the slope after the monsoon had broken when an attempt was made to re-occupy Camp IV, and finally Wyn Harris and Shipton narrowly escaped disaster when an avalanche was detached during a reconnaissance of the route.

All the major avalanches so far observed on the North Col have been of the slab type. The upper stratum of snow has slid off *en bloc*, breaking up into minor blocks as it did so. This is characteristic of the windslab, for the formation of which the east face of the North Col is peculiarly suited. The prevailing wind is from the west or north-west, and even during the monsoon when the prevailing air current is from the south it would appear that it passes over the 19,000-feet Col known as the Lho La to the west of Everest and is then deflected against the west slope of the Col. Thus the snow is blown over the crest of the Col and settles on the lee side. This, though one of the conditions necessary in the formation of windslabs, is not the only condition. It has been established by scientific experiments in the Alps that a certain percentage of humidity is also necessary. Mr. G. Seligman gives this as about 85 per cent. No measurements of humidity have been taken at or above 22,000 feet on Mount Everest, but the available evidence points to the fact that whereas before the monsoon air current reaches Everest the percentage of humidity is less than 85 per cent., after it reaches Everest it exceeds 85 per cent. during the greater part of the monsoon. From this, and the evidence already known, it would appear certain that whereas it is justifiable to ascend the North Col from the east prior to the incidence of the monsoon current, it is unjustifiable to ascend it after its arrival.

The problem however is not so simple as it sounds. By "arrival of the monsoon" expeditions in the past have assumed this to mean the first heavy precipitation of snow on Everest which is not quickly removed by the north-west wind and which is accompanied by a marked rise of air temperature. From the point of view of safety or danger on the slopes of the North Col such an assumption is wrong. Monsoon precipitation may be preceded by a rise of air temperature and humidity slight enough not to be noticed by a party unequipped

The North Face Camp

with measuring instruments yet sufficient to induce avalanches. Thus, a party might continue the ascent in good conditions on the upper part of the mountain yet be overwhelmed by an avalanche on their descent of the North Col. Such a possibility makes careful observation essential, and if the same route to the North Col is to be followed by future expeditions I would strongly recommend the taking of instruments which should be under the charge of some competent person.

In 1936 I believe such conditions as already described did actually occur, as when Shipton and I made the descent of the North Col after abandoning Camp IV the snow was in a dangerous condition and on one occasion cracked ominously beneath me as I was exploring it ahead on a rope. As even a small avalanche is likely to involve a party in disaster owing to ice-cliffs which are almost everywhere below the route, no precaution to avoid such danger can be too elaborate.

A windslab is the most difficult of all snow conditions to detect. The climber is lulled into a sense of false security by apparently firm snow which may be so hard on the surface as to necessitate step cutting. Such a condition obtained when Wyn Harris and Shipton made their reconnaissance which nearly ended in disaster and the avalanche which occurred was a typical windslab. For the past few days, and particularly during the morning before this incident, a strong north-west wind had been blowing. This was sweeping the face of the North Col almost horizontally, and I for one had no fears for the party and was of the opinion that the wind so far from forming windslab was consolidating the snow into a safe crust. In this I was mistaken.

It cannot be too strongly urged that Everest climbers should visit the Alps during winter whenever possible so as to gain experience in windslab avalanches. Only through such experience is it possible to detect a windslab. A windslab can be detected both visually and by the feel of the snow. In appearance the snow is smooth but rippled by wind at the edges of the slab. In feel, though it may, as already noted, be hard, it possesses a curiously velvety texture which is particularly noticeable when ski-ing.

Though it may be safely assumed that the avalanche which nearly overwhelmed Wyn Harris and Shipton was an ordinary windslab such as is common during winter in the Alps, the far larger avalanche which occurred in 1935 was a more complex affair. The monsoon then was well advanced and air temperatures and humidity had been high for some weeks. The slab was fully 6 feet thick and covered a considerable area; the avalanche must have weighed tens of thousands of tons. During their ascent the party found the snow reasonably firm and apparently safe. The night temperature at Camp IV was low, yet the avalanche occurred, it is thought, early the following morning. Had the snow been wet and sticky the party would have turned back, for wet snow avalanches such as are common in the Alps during spring and summer are easy to detect, and the party was a competent one, and one member at least, Kempson, had had considerable experience of Alpine winter snow conditions.

Shipton's theory is that weeks of monsoon weather had rotted the snow, but this is not a sufficient explanation. It may be that the avalanche was a combination of windslab and waterlogged snow. It cannot have been formed of purely waterlogged snow, otherwise, as already mentioned, it would have been detectable and the low overnight temperature would have held it *in situ*. There is the possibility that it was detached by an abrupt movement of the ice-fall on which it rested—a possibility that deserves consideration when ascending the east side of the North Col and one which militates against this route. From the available evidence it would appear to have been of a similar type of avalanche to that which overwhelmed the seven porters in 1922, though on that occasion the

The west side of the North Col from the high camp

snow was considerably softer and the climbers were sinking several inches into it.

It is possible that the avalanche was a windslab which formed some time previously, but that it was not one which readily avalanched of its own accord. Subsequently it was covered by monsoon snow and the weight of this plus a movement of the ice-fall eventually dislodged it. I have on one occasion seen such a condition in the Alps when climbing on ski the Schilthorn above Mürren. In this case a windslab had become covered by several inches of new powdery snow. The latter appeared quite safe as it was loose and crystalline in texture. Nevertheless the hidden windslab beneath cracked, but fortunately did not come away. It is difficult to imagine any more treacherous and incalculable form of avalanche than this. Neither visually nor by feel was it detectable, and the only possible clue in dealing with such an avalanche is previous knowledge that a windslab has formed coupled with knowledge of the direction of the wind during the snowfall which resulted in the formation of the slab. Neither in my case nor Shipton's was such knowledge available, and this in itself is sufficient proof that the North Col is very dangerous during the monsoon season and should be left severely alone.

To sum up, there is no doubt that a route should be made if possible up the west face of the North Col. This face being on the windward side of the Col is certain to have safer and more easily calculable snow. Windslabs are unlikely, though it is not impossible for them to occur on a windward face. If a rock rib is followed the climber need ascend no more than 300 feet of snow, and if the worst came to the worst and an avalanche occurred he has a better chance of escape as there are no ice-cliffs below him.

It is probably more difficult than the east face and may take a longer time to force. If the next expedition arrives a month earlier at the base camp there will be ample time for this, and the ascents and descents in making the route will serve to acclimatize the party, for it is certain that acclimatization is better gained through a number of ascents and descents than through residence at any particular altitude.

This does not rule out the possibility of the eastern route. This may be assumed safe in pre-monsoon conditions except after a heavy snowfall, but a route on the west side of the Col, even if not used to the exclusion of the eastern route, would serve as an alternative route in the event of the arrival of the monsoon air current finding the climbing party on the upper part of the mountain or in position to attack at Camp III. In 1936, when much of the snow was swept from the mountain by a north-west gale after the first monsoon precipitation and the party was in the unfortunate predicament of being unable to attempt the summit owing to dangerous conditions on the east face of the North Col, it is probable that the west side of the Col was practicable.

Finally, it should be emphasized that Himalayan snow cannot obey different laws to Alpine snow, but that its study is complicated by swiftly changing and more varied conditions in which a greater range of solar temperature and changing air temperatures and humidity due to the monsoon play the principal part. And allied to these factors high winds and heavy snowfalls must be added.

I have dealt only with the practical aspects of snow conditions on the North Col and have endeavoured to outline the problem as seen from the mountaineer's standpoint. I leave those more expert than I to add to our theoretical knowledge of an intricate subject. There is a considerable literature, and I would especially bring to the attention Mr. G. Seligman's book, 'Snow Structure and Ski Fields.'

APPENDIX VI: HEALTH

DR. NOEL HUMPHREYS

The problem of climbing Mount Everest, which is really the problem of the last thousand feet, resolves itself into the double problem of health and weather. The problem of getting permission to enter Tibet, that of finding a route to the mountain, that of the organization of the expedition, have all been solved. The expedition this year went like clockwork. The mountaineering difficulties of reaching 28,000 feet had been overcome on three occasions by previous expeditions and the way beyond this to the summit has been seen and the technical difficulties are considered well within the capacity of experienced mountaineers. Of the two factors, health and weather, the latter is outside our control, but the former was a matter of great consideration by the Everest Committee and the leader of the expedition.

Whether without the aid of artificial oxygen it is possible to climb, or even remain conscious, above 28,000 feet is still unknown. From experiments in decompression chambers it is found that consciousness is lost at or before an atmospheric pressure corresponding to that height, and it may be more than a coincidence that this is the exact height at which three parties of Everest climbers have had to turn back. Some mountaineers however point out that experiment cannot exactly simulate conditions in the field. In the decompression chamber the subjects are introduced to rarefied air without previous acclimatization, whereas climbers on Mount Everest have been living for weeks at a height of approximately half that of the mountain they are on their way to attempt. Moreover it has been remarked that no Himalayan climber has actually become unconscious from the effect of height, whereas in decompression chambers some subjects become unconscious at a pressure corresponding to a much lower height than has been reached on Mount Everest. It is possible therefore that loss of consciousness in the decompression chamber is due to change of atmospheric pressure rather than the amount of pressure. Unfortunately the weather factor this year prevented the health factor, at very high altitudes, coming into play.

That there is steady physical deterioration at altitudes above 21,000 feet was the opinion formed by scientific experiment, and has been confirmed by the experience of Mount Everest expeditions, including that of this year. It is also known that simultaneously with deterioration there is adaptation to the conditions. These simultaneous processes may be compared with those manifested by the drug addict, who, while steadily deteriorating physically, is yet adapting himself to withstand the effects of larger and larger doses. The rate of deterioration would appear to be constant for any one climber at any one height, but the discovery of former Everest expeditions, confirmed by experience this year, was that the rate of adaptability could be increased. Climbers who had been on previous expeditions to the mountain acclimatized more quickly than those who were being tried out for the first time. Moreover on any one expedition each successive excursion above Camp I showed an increased speed of acclimatization.

Unfortunately there is no known method of forecasting the speed of acclimatization for any individual climber untried at great heights, and this makes the selection of a team for the expedition a difficult matter. The method adopted was first to appoint climbers who on previous expeditions had shown a good power of acclimatization to heights. For the rest of the team, from among a large number of first-class climbers preference was given to those with outstandingly good medical reports, and from among those preference was again given to those with Himalayan experience. The medical tests were made by the medical staff

of the Royal Air Force who are accustomed to make examinations with a view to ascertaining a candidate's fitness to withstand the effect of great height. After the team was selected further precautions were taken. The members were vaccinated and inoculated against typhoid. X-ray photographs were taken of their jaws in order to detect any latent abscesses, at the apices of the teeth, which might flare up when vitality was reduced by living at a great altitude. A number of teeth were extracted as a result of the X-ray reports, and this treatment would appear to have been justified as only one tooth had to be extracted during the expedition and this from a member who had joined from abroad and so escaped the careful examination of candidates joining from England. Among the Europeans there was only one case of serious illness: benign tertian malaria, which was successfully treated.

The medical equipment taken was based on the experience gained on previous Everest expeditions and was ample and comprehensive. Surgical instruments were taken which would enable us to perform major operations, if necessary. The size of our medical equipment was influenced by our intention of doing what medical work offered among the native population of Tibet, and this work took up a good deal of the time of the medical officers, but was very satisfactory in the goodwill it occasioned. On the march over Tibet there was almost no sickness among the members of the expedition. There were certain alimentary disturbances, occasioned probably by mica in the drinking water. A few of the Europeans suffered very slightly from mountain sickness when first reaching the plateau of Tibet. Sore throats started before we reached Base Camp. At Camp III however the effects of height were felt by every member of the expedition, who all suffered from some of the following complaints: headache, sore throat, breathlessness, lassitude, loss of appetite, nausea, vomiting, insomnia, indigestion, diarrhoea, and such visual disturbances as diplopia and "blacking out." These were the effects of height on exceptionally healthy people. Few complaints could be treated successfully. Headaches yielded to aspirin, and insomnia to chloral hydrate, but no treatment was successful with the throats, many of which were badly ulcerated.

Whenever it seemed that the snow conditions on the North Col would prevent useful work from Camp III, the expedition was withdrawn to Camp I where an improvement immediately set in. It was very noticeable that each time the expedition returned to Camp III acclimatization was more rapid. After our final retirement from Camp III muscle wastage was very marked, and even the 250 miles' march back to Sikkam left our muscles smaller than when we had entered Tibet, three and a half months before.

APPENDIX VII: PHYSIOLOGY

C. B. WARREN

The journey up to the higher camps on Mount Everest calls forth individual physiological adjustments which are of peculiar interest not only for study, but also for the practical bearing which they have upon the success or failure of the whole venture. It is coming to be realized that the climbing of the mountain is now almost as much a physiological problem as a mountaineering feat. Questions which still have to be answered are: At what altitude does deterioration set in? Does further acclimatization take place above the level at which the body shows signs of deterioration? Is it possible to climb to 29,002 feet without using oxygen?

As a result of experiments with animals which were kept at low atmospheric

pressures for a considerable time, Sir Leonard Hill and Argyll Campbell came to the conclusion that it was useless to attempt to acclimatize to altitudes greater than 21,000 feet; above this altitude their animals eventually died, and when examined were found to have dilated hearts and fatty degeneration of all their organs. As a result of experience gained on the last three expeditions we are coming to acknowledge that the physiologists may have been right after all when they put the greatest altitude at which man can live and thrive at this same level; for since the expedition of 1933 it has become a principle that the longer a climber is kept above Camp III (21,200 feet) the more does he deteriorate.

In these circumstances it may not be out of place to reconsider the whole problem from the physiologists' point of view, and to consider once again whether their advice on the matter of oxygen should not be given greater consideration in the future.

The first stages of the march to the mountain carry one steeply and rapidly from the plains of India to the high Tibetan tableland; there is a rise of some 16,000 feet in the first 70 miles. During this period of the expedition the more acute signs of mountain sickness are likely to be prevalent, and these are—shortness of breath and a feeling of suffocation on the slightest exertion, blueness of the lips, ears and fingers, headache, and vomiting. At such a time the emergency methods of acclimatization are being brought into play, but the slower and more permanent adjustments, such as the increase in the red cells of the blood, have not had time to come into action.

Both this year and during the Reconnaissance of 1935 it was noticeable that people suffered from the altitude most acutely on reaching Tangu. In a report on "The Medical Aspects of the 1935 Reconnaissance Expedition" I said: "At Tangu (12,000 feet up) frequent are the records of distress in the visitors' book left by parties visiting the bungalow and passes in the neighbourhood. And our own experiences showed that even those accustomed to such changes can succumb: for all seven members of the expedition suffered in varying degrees from symptoms which were due to the altitude." And this year the only place at which vomiting occurred as a symptom due to altitude was Tangu. Here we waited for several days before tackling the pass (Kongra La, 16,000 feet) into Tibet, with the result that we presented a far less pitiful spectacle than the party of 1935 did when making the same crossing.

Once the pass has been crossed the route to the mountain runs for some 200 miles across comparatively level country, but all the time at altitudes greater than 13,000 feet. Here conditions are ideal for stimulating more permanent acclimatization. In most members of the party the blood count had increased by at least 20 per cent. before reaching Base Camp (16,600 feet), and in some cases had even advanced to 30 per cent. above the normal level. And with the advent of these changes had come relief from the urgent symptoms: the lips were no longer livid, our headaches passed away, and the breathing was no longer deep and rapid and there was no longer a feeling of suffocation on exertion. Indeed we arrived at Base Camp feeling almost as well as at sea-level; in fact Wyn Harris, who had come straight from Africa to join the expedition, was a great deal fitter on arrival at Base Camp than he was when he started from Gangtok.

A characteristic which has been described as being peculiar to native peoples who dwell permanently at high altitudes is the shape of the chest, which is deeper and of greater capacity than that of persons living at sea-level. A greater capacity of the chest would mean that a greater area of the lung was exposed to aeration. In order to see if our own lungs increased their capacity as we went

higher we measured the vital capacity of the lungs. To do this the subject is instructed to inspire as much air as possible. When his chest is full to bursting point he is made to blow out the air into a gas meter until he can expel no more. The volume of the gas expelled is measured by reading a dial. In some members their vital capacities had increased by the end of the expedition by 27 per cent. This is another of the slower adjustments by which acclimatization can be assisted.

It is obvious that there is a limit to such processes as that just mentioned, and it is of importance to us to try and discover the altitudes at which these compensatory processes are still taking place, and where they cease. It is also important to know just where the destructive processes of deterioration begin to set in. Is acclimatization still going on when this happens?

After the first attempt to get above the North Col this year we all retreated to Camp I after being up at Camp III for a period of eleven days because it was thought that the strength of the party would improve with a period at a lower level. Morris and Smijth-Windham were both at Camp I, and they told me afterwards that we all looked thin and ill when we first came into camp. It was also noticeable that people began to eat with their accustomed appetites as soon as they got down to 17,700 feet at this camp. In every case except one there had been a loss in weight, though this was much less marked than in 1935, when we spent longer above this altitude. In 1935 there was even a gain in weight, in one instance as much as 9 lb., after five days spent at Rongbuk.

At Camp III sore throats were prevalent, and on retreating to lower levels there was generally a marked improvement in these, though they did not in most cases clear up completely.

From all Mount Everest expeditions there have been reports of altitude sore throats, and both this year and last year, at one time or another, almost every member of the party suffered. From the point of view of keeping the climbers fit for their task the problem of their prevention is a major one. There is no doubt as to the cause of the condition. Normally the throat and nose contain bacteria which are harmless: the "normal buccal flora." But by breathing the unusually dry air of the north side of the mountain through the mouth instead of the nose (for when you are panting for breath mouth-breathing is the rule) it escapes its one chance of being moistened, and the result of this is that the cells lining the upper respiratory passages over which it passes become dried up. In this state they are liable to invasion by the normal buccal flora. In some cases the throat was actually ulcerated; whilst in most instances the sufferer was left with an irritating cough. With Shipton the infection spread to his larynx, so that he lost his voice and could only issue orders in a hoarse whisper. There was a noticeable improvement in the sore throats as soon as the moisture-laden clouds of the monsoon began to pour over the passes on to the East Rongbuk Glacier. When climbing in Garhwal on the southern slopes of the range these throats were not a common feature of life at high altitudes.

The application of liquid paraffin with a spray so as to form a protective film over the throat would seem to be a rational form of treatment, but this was tried and found to be inadequate. The best method to insure that the air breathed was properly moistened would be to wear a mask of the Matthews' respirator type when taking exercise high up. With this mask the moisture in the expired air is condensed on a pad of copper gauze, and with inspiration the air taken in is moistened and at the same time warmed by passage through the gauze. It would only be a matter of training to get used to wearing the respirator; it need not be worn all the time.

What further evidence have we that deterioration may be taking place at

21,000 feet? The pulse rate may give us some indication as to what is happening. The "basal pulse rate" is the number of beats per minute of the pulse when taken the first thing in the morning with the subject lying quietly in bed. In normal circumstances the frequency remains very constant for each individual. Any effort, such as turning over in bed, will send the rate up. It was found that in only two of the eight climbers tested was there no appreciable increase in the basal pulse rate up to altitudes of 21,200 feet. In five out of eight the frequency was constant below 17,700 feet (Camp I). And in one of the eight it was constant below 16,600 feet.

This year no one was exposed to the strain of going really high, so dilated hearts were not to be expected. Only once was the whole party examined, and that was after coming down from Camp III for the first time. On that occasion there was no evidence of strained hearts. But when going back up to III later on, at a time when I was ill with a sore throat, I did notice that my own heart was making extra beats.

So much for altitude deterioration. Have we any evidence that acclimatization is still going on at 21,000 feet? To begin with, let it be said that we all felt much less distress when at Camp III on our second and third visits than we did the first time up there. Our only other evidence is derived from the blood counts. Between the time of our first visit to Camp III and our final return to the Base Camp at the end of the expedition there was in most cases further increase in the red cells and the haemoglobin content of the blood. So this much at least can be said, that our later stays at 21,200 feet did not prevent the blood count from continuing to rise.

In conclusion, the evidence which points to deterioration taking place at 21,200 feet is: Loss of appetite, with wasting and loss of weight which is rapidly regained on going to lower levels; an increase in the basal pulse frequency which is only present above 16,600 feet; in animal experiments, the inability to prevent them from ultimately dying with fatty degeneration of their organs; and possibly the occurrence of undetected extra systoles of the heart.

And that which would lead us to believe that some acclimatization is still going on is: That the climbers were less distressed on their later visits to Camp III, and that living at Camp III did not prevent a further increase in the red cell counts of our blood.

APPENDIX VIII: THE OXYGEN PROBLEM

C. B. WARREN

The carriage of oxygen in the blood and its function

When a man goes to a high altitude he has to breathe an atmosphere which contains less oxygen than there is at sea-level, though the proportion of oxygen to nitrogen remains the same: that is, oxygen still forms 20 per cent. of the atmosphere. What has altered is the barometric pressure, so that the pressure exerted by each of the gases composing the atmosphere has altered also. Oxygen passes from the air in the lungs into the blood, which is circulating through those organs as a result of the pressure exerted by the gas. The amount taken up depends upon the pressure at which the gas is delivered to the blood. If the partial pressure of oxygen in the breathed air is reduced as it is at high altitude (and in low-pressure chambers at sea-level), then less of it is taken up, the blood leaves the lungs less fully saturated with the gas and so has less to deliver to the tissues. The tissues must be supplied with oxygen at a definite pressure if their life and function is to be maintained. It is lack of oxygen to the tissues which

gives rise to symptoms, and which calls forth the adjustments which are made by the body in order to adapt itself to the new environment. When the partial pressure of oxygen in the breathed air is reduced beyond certain limits, symptoms which have nothing to do with the bodily adjustments, but which are directly attributable to the diminished pressure, are met with. For instance, if an airman rapidly goes to a great altitude he will lose consciousness without warning. The same thing happens if he is put into a closed chamber at sea-level from which the air is rapidly exhausted.

In 1875 Tissandier and his companions made their famous ascent in a balloon from Paris. At 26,500 feet Tissandier lost consciousness. He recovered to find the balloon descending, but his two companions were dead. It has been suggested that such an accident might happen on Everest if a climber went beyond the present highest point reached. But I do not think such a thing would be possible when we consider what happens when the oxygen pressure is reduced more slowly. He is more likely to be exposed to another kind of danger. With a more gradual onset of anoxia the train of symptoms is as follows: The intellect and the senses become dulled without the subject being aware of what is happening. Visual acuity is diminished and sensation impaired. The subject may be in danger and not realize it; or he may realize his danger and yet be incapable of deciding upon a line of action which would put him in safety. Finally there is paralysis of the legs and arms, and ultimately loss of consciousness. On the extreme heights of Everest the climber is likely to be brought to a standstill by the fatigue in his muscles (or if you like actual paralysis) long before he would lose consciousness. He would however be exposed to dangers due to mental impairment, such as the failure to realize the danger of his position and carelessness in his movements on difficult ground. Apart from the fact that it may not be possible to reach such an altitude as 29,000 feet without oxygen, I think that the dangers consequent upon mental impairment form the strongest argument in favour of its use on the last lap.

The apparatus, and its use on the mountain

Whatever the type of apparatus used, its object is to increase the pressure of oxygen in the alveolar spaces of the lungs. This object can be achieved in one of two ways.

In the original types of apparatus the outside air was breathed from a bag to which oxygen gas was added from a cylinder at a fixed rate. The disadvantages of such a method are that much of the oxygen is wasted by being expired from the dead spaces of the lungs into the outside air; that there is an uncomfortable drying of the throat; and that moisture and heat are lost from the body in the breath. That the apparatus is wasteful of oxygen can be seen from the following: In order to put up the partial pressure of oxygen in the air at 30,000 feet from 53 mm. of mercury to 110 mm. it can be calculated that oxygen must be supplied at the rate of 9 litres a minute. Now a partial pressure of 110 mm. of mercury is equivalent to an altitude of about 12,000 feet. So in order to bring a man down to this level it would be necessary to supply him with oxygen at this rate. But the body only uses oxygen at the rate of 0·5 a litre per minute at rest and 2 litres per minute (perhaps a little more during severe exercise) during exercise.

An apparatus of this type was taken out this year. It contained two cylinders of "vibrax" steel, each containing 750 litres of oxygen, and the reduction valve was set to deliver 6 litres a minute, though it was capable of adjustment to deliver any other quantity. With such an apparatus the supply then was 1500 litres, and this delivered at a rate of 6 litres a minute would last for just over four hours. Its weight was approximately 30 lb.

In another type of apparatus, instead of air being breathed to which oxygen is added, oxygen only is breathed and the carbon dioxide in the expired breath is absorbed by passing it through a canister containing soda-lime. The breathing circuit is completely enclosed, so that nothing is exhaled into the outside atmosphere. Such an apparatus is similar to that used in rescue work down coal mines and in submarine-escaping apparatus. Its advantages would seem to be that no oxygen is wasted, that heat and moisture are not lost by breathing into the external atmosphere, and that the pressure of oxygen breathed is the same as that of the external atmosphere (*i.e.* approximately 250 mm. of mercury at 30,000 feet), a pressure which is well above the partial pressure of oxygen in the atmosphere at sea-level.

The apparatus therefore should theoretically bring the climber at 30,000 feet down to sea-level conditions.

Such an apparatus was designed and made for us to use on the mountain this year by Siebe Gorman, the well-known firm of submarine engineers. Two sizes of this apparatus were taken. The smaller of the two weighed 25 lb. and carried a cylinder made of vibrax steel of 500 litres capacity. If oxygen was being used by the body at the rate of approximately 2 litres a minute, as it might be during muscular exercise, this supply would last just over four hours. The larger apparatus weighed 35 lb., carried a cylinder of 750 litres capacity, and on the same basis would provide oxygen for a period of six hours. The reduction valve in this breathing gear was set to deliver half a litre a minute, or the amount of oxygen required by the body when at rest; but by means of an automatic valve a greater supply could be released from the cylinder as required during exercise.

The re-breathing apparatus has been criticized on the following grounds: that there is no advantage in bringing the climber down to sea-level conditions, nay, such a change may even do harm; that soda-lime absorbs moisture, so that there is a loss of fluids from the body through the breath; and that nobody would tolerate having a mask over their face at 28,000 feet. In answer to such criticisms I would first of all point out that the most important means of acclimatization in the body is the increase of the red cells and haemoglobin in the circulation, and in the acclimatized person, even on coming down to sea-level quickly, it is a matter of weeks and not days before his blood count begins to fall. If this then is the case it seems unlikely that, by breathing oxygen at the normal pressure for a few hours on end, his acclimatization would be seriously affected. I can see no reason why he should be any the worse after wearing the apparatus, except possibly subjectively and by contrast. Then with regard to the moisture which might be absorbed by the soda-lime, it must be remembered that the patent absorbing materials such as "protosorb" (which was used in this apparatus) are frequently used nowadays in oxygen tents, and for this reason are designed to be practically non-hygroscopic. And lastly, as far as the intolerance to a mask over the face is concerned, the reply is: that with the proper oxygen supply given by such an apparatus the climber would not be at 28,000 feet but at sea-level, and that we found that after a very short time with the apparatus we were perfectly well able to tolerate it. Furthermore it may even have an advantage in that it protects the face from the wind. This year the all-enclosed breathing apparatus was tested both at home in the low-pressure chamber and in Tibet on the mountain. The trials at home were not as thorough as was desirable on account of the limited time at our disposal, and those on the mountain were not made at a sufficiently high altitude to warrant any important conclusions being drawn from them. But this much should be stated, that it was used once on the North Col slopes and resulted in a complete disappearance

of the usual muscular fatigue and lassitude which are usually experienced at such an altitude. Furthermore it was worn by several of us to make ascents of over an hour's duration above base camp, and we none of us suffered any ill effects when it was taken off at the end of the trial. And at Tangu, before any one was properly acclimatized, I used it to climb for at least 1000 feet up the hillside behind the bungalow, and yet with 35 lb. on my back I was able to climb much more rapidly than two of my companions who were going without it. Because of these remarks I do not wish it to be thought that I advocate this as the ideal apparatus, though it does seem to me to offer advantages over anything so far produced. If one has got to carry 30 lb. on one's back up the last 1000 feet, why not carry an apparatus which is going to produce maximal efficiency? But must such an apparatus weigh 30 lb.? I think that, given more time, the weight as it stands at present could be reduced considerably without changing the principles on which it works.

The final question which arises is how should the apparatus be used on the mountain? Personally I think that to try and make the ascent with it from below Camp V is impractical; I would favour its use on the last lap only. It has been suggested that oxygen might be used in camp and at night only, in order to do away with deterioration. In principle this sounds all right, but I do not think that in practice one could tolerate sleeping in it. Furthermore, if one really believes, as some of us who consider the matter from the physiological as well as the mountaineering aspect do believe, that it is impossible for a man to reach 29,000 feet without artificial aid, then such a method of administration achieves nothing towards the attainment of the summit.

A point which requires consideration is whether a six hours' supply will be sufficient to carry a climber to the summit and down again from the highest camp. Shipton has estimated that without oxygen the last 1000 feet will take about sixteen hours. Now even with 30 lb. on one's back it should be possible to climb at the rate of 500 feet an hour over quite difficult ground when at moderate altitudes. We know that this can be done in the Alps, and in the Himalayas I have climbed up difficult rocks at 21,000 feet with a 20-lb. rucksack on my back. If we can perfect an oxygen apparatus, then, which will bring the climber down to sea-level when on Everest, even though it does weigh 30 lb. and has only a six hours' supply, he should be able to get up and down again within this time, always provided that the rock climbing above the couloir is not supremely difficult, and that the first part of the route has been properly explored by a preliminary reconnaissance party, perhaps equipped with oxygen also, so that no time is wasted in route finding. But in any oxygen attempt two things must be borne in mind: that the climber must turn back in time to allow enough oxygen for the descent to the highest point he has been able to reach without it, and that twice as much oxygen is used during climbing as when descending, so that the cylinder should be one-third full when he starts to come down.

APPENDIX IX: COLLECTING

Dr. Noel Humphreys

When we left Sikkim on March 19 it was early spring. Willow, daphne, magnolia, primula, and other plants were already in flower. Reaching the tableland of Tibet however we dropped back into winter and with the exception of one species of very small primula we were not to see another flower until a month later. Tibet was frost-bound and wind-swept; honey-coloured plains with distant indigo hills, steely-blue sky and curiously opalescent atmosphere. Not

a blade of green vegetation was to be seen. On April 17, marching to Kyishong, we saw a butterfly, but we saw no more until May 20 on our return from Camp III to Camp I. By this date the vegetation in the neighbourhood of the camp was green, but as yet no flowers were out. On May 25 the first flower was seen, a saxifrage, and two days later a primula was found in flower. From then onwards most days, when the ground was free from snow, yielded a new flower. Insects and spiders became common, and during the few days before we returned to Camp III we took the opportunity to make such entomological and botanical collections as were possible.

Our next opportunity of collecting was at Lake Camp by the West Rongbuk glacier, which we reached on June 8. This was at an enchanting spot with level green turf, a lake and a winding stream. The turf was, as far as we know, an isolated patch; we had seen no other turf above Chödzong. It was at Lake Camp that the lark's nest was discovered, perhaps the highest nest that has ever been found. Here we were able to make a small collection of plants and insects, though there as yet few flowers were out. A small meconopsis was much in evidence but was nowhere more than in bud. It was at this camp that we started plants growing in boxes. These had to be roped for lifting and for transport as porter-loads and, later, by pack animals.

Once the attempt on Everest was abandoned it was decided that the whole expedition should return to Sikkim as quickly as possible so as to save the expense of a prolonged stay in Tibet. We returned therefore by double marches, travelling up to 25 miles with an ascent of 4000 feet in a day's journey. Collecting was difficult on these journeys as the baggage often arrived after dark, and even then there was delay before tents could be erected. In the evening there was almost invariably a strong wind which made it impossible to press plants or write labels in the open, and in the only tent available there was not room to kneel upright. A constant source of worry was the boxes of growing plants. These were often kicked off the pack animals or crushed, or the contents of the boxes shaken loose. Such boxes had to be re-planted next morning during the short time while it was light before the pack animals started off. Even when Sikkim was reached the plants needed constant care until they were delivered to the Royal Botanic Garden at Edinburgh.

Seeds were collected whenever possible, but these were even scarcer than flowers. Among the few we found were the previous year's seeds still clinging to a clematis which appeared to be the only species of climbing plant in the part of Tibet that we went through. This plant we afterwards saw in flower and there were three forms, apparently co-specific, with flowers nearly black, yellow, and bronze. One of the first shrubs we encountered on our way back was a rose with sweetly scented cream-coloured flowers, and lower down we found the plant in fruit and were able to collect seeds.

All too soon we reached Sikkim and our collecting stopped. We had been racing home just as the Tibetan flora was coming into flower, and it was tantalising to leave behind us most intriguing plants which some of us would never see except in bud.

DISCUSSION

Before the paper at the Afternoon Meeting the PRESIDENT (Professor HENRY BALFOUR) said: It is an extreme privilege on the first occasion on which I take the chair at a meeting of this Society to find that the lecture we are about to hear is of such importance and great general interest. I feel tempted to refer to the high honour which has been conferred upon me, but as chairman of the meeting it

is my duty to further the proceedings and not to delay them. So without even the usual preamble I will proceed to the business in hand.

Mr. Hugh Ruttledge is already well known to the Society not only for the work that he has done in the Himalaya and on Mount Everest, but also as one of the Society's Gold Medallists. That in itself is sufficient introduction.

Without delaying proceedings further I will ask Mr. Ruttledge to give his account of the latest assault upon Mount Everest.

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

The PRESIDENT: Mr. Smythe has a few supplementary remarks he would like to make with regard to the photography and the snow conditions, of which he made a special study.

Mr. F. S. SMYTHE: I would like to preface my remarks by acknowledging the expedition's debt of gratitude to Messrs. Kodak, who supplied the film you have seen and the apparatus with which it was taken; also the still films which we used on the expedition. The film was super-speed panchromatic, and you have just seen the Kodachrome film. It is necessary to give the latter about four times more exposure than the ordinary super-speed panchromatic film.

(Mr. Smythe then dealt briefly with snow conditions on the North Col. See Appendix V.)

Mr. W. R. SMIJTH-WINDHAM: Having been on two expeditions, that of 1933 and this year's, both led by Mr. Hugh Ruttledge, I want to start by saying how extremely fortunate we were as a party to have him as a leader. I am sure that the Mount Everest Committee will have an exceedingly difficult task to find another of his calibre to lead a future expedition, but I wish them luck.

(Mr. Smijth-Windham then gave an account of the problems connected with wireless arrangements on the expedition, treated in Appendix III.)

The PRESIDENT: I would have liked very much to invite onto the platform all the members of the expedition, not only for the sake of hearing what they can tell us in regard to details, but also for the sake of seeing them as they really are. You have seen them on the film and in the photographs, and three of them have revealed themselves on the platform. As far as I can make out there is a good deal of difference between the two versions. I must however bring this interesting meeting to a close. I should however like to say that, as a result of the account to which we have listened, it appears clear that for the future we can rely perfectly upon physique, endurance, pluck, mechanism, and all those other necessaries without which success cannot be achieved. There is one great problem however still to be solved, which I suppose will remain the principal crux, that is weather-conditions. But if the last expedition, like the previous expeditions, has ended in disappointment to those who have taken part in it and who have been robbed of success, at least one can say very definitely that Mr. Ruttledge and his colleagues have added several important rungs to the ladder which eventually will lead to the top. On this account, for the work which they have done with so much enterprise, pluck, and endurance, I am sure you will like to express your thanks to them; and to Mr. Ruttledge in particular, for having given us this lucid, straightforward account of the events of the expedition.

Before the paper at the Evening Meeting, the PRESIDENT (Professor HENRY BALFOUR) said: We have an extremely interesting evening in front of us, and I am not going to delay the proceedings by making any preliminary remarks. It is of course quite unnecessary for me to introduce our lecturer. Mr. Ruttledge is thoroughly well known to all of you by name and to a great many of you personally. As a Gold Medallist of the Society he is guaranteed. I call upon

him to give his account of the last expedition which has aimed at the conquest of Mount Everest.

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

The PRESIDENT: I ask Mr. Smythe to continue his remarks and particularly to tell us something more with regard to snow conditions.

Mr. F. S. SMYTHE said: I should like, first of all, to say how great was the privilege of again serving under Mr. Ruttledge. You have heard a great deal about our unworthy selves, but he has given very little idea about himself. I do not think that any leader ever had a more unpleasant task than Mr. Ruttledge this year, because he had to exercise that judgment and discretion in the face of adverse circumstances which is so difficult when conditions seem possible and yet are unjustifiable. That always seems to me to be the test of leadership, and this is the second expedition that Mr. Ruttledge has brought back to England alive.

(Mr. Smythe then resumed his account of his observations of snow conditions on the North Col, printed as Appendix V.)

The PRESIDENT: You would, I think, like to hear something with regard to the medical side of the expedition, so I hope that Dr. Noel Humphreys and Dr. Warren, the medical officers with the expedition, will add a word or two.

Dr. NOEL HUMPHREYS described the precautions taken to secure the health of the expedition and their success (see Appendix VI). He continued: We were ready for any emergency, but nothing happened, or almost nothing. This may of course have been partly due to all the precautions taken. We were however very anxious to show our skill, and about the middle of the expedition at Camp I we thought we had an opportunity. One of the porters was found groaning and curled up round a stone. He could not be straightened out because he was in such pain. He was examined carefully by the medical staff, who thought it a very serious case. We called for volunteers to go up to Camp II to bring down surgical appliances. The man passed into a state of coma. The surgical equipment came down in the middle of the night, but it was then too dark to operate, At the first grey light of dawn I went to see the patient. He was not there. Fearing that we might stop him, he had got up early to carry a load to Camp II, and was already on his way.

Dr. C. B. WARREN: As far as the physiological side of the expedition is concerned I might mention that the only word that was taboo from the start was "deterioration." We have heard a great deal about it in the past, and I think that what was said after the 1933 Expedition was probably true: up to altitudes of 21,000 feet one can remain comparatively well, eat well and sleep well, and not lose weight. Once one gets above 21,000 feet one begins to go downhill gradually, to lose weight and appetite, besides other minor happenings.

(Dr. Warren then discussed the physiological side of the expedition and the problems involved in the use of oxygen, as set out in Appendices VII and VIII.)

The PRESIDENT: I hope Sir Percy Cox will add a few words. He is Chairman of the Mount Everest Committee.

Sir PERCY COX: I feel great compunction, after we have listened with the liveliest interest to the leader's account of the expedition, to come on to the platform and turn to the dry bones of Committee business.

As many of you know, from the birth of the Everest ambition there has existed what is known as the "Mount Everest Committee," composed of representatives of the Alpine Club, the Royal Geographical Society, and, latterly, of the Himalayan Club. The functions of this Committee have been to seek the necessary funds for the expedition in view and to supervise the business affairs connected

with the organization of it. In so doing they clearly take a good deal of responsibility. The Committee, in name, remains permanently in being: that is to say, it is a standing committee, and when, after an interval, which may be short or long, fresh permission is received for another expedition to enter Tibet, the personnel of the Committee is reconstructed and it starts functioning again. I was nominated to the present Committee as a representative of the Royal Geographical Society, and, I suppose in deference to my grey hairs, I was asked to take the Chair; so that I have been closely associated with the affairs of the present expedition from the start.

The first duty of the Committee, apart from getting to work to collect funds—and a large sum is needed for a properly equipped expedition—is to choose a leader and allow him to choose his team, subject of course to the concurrence of the Committee. On this occasion the Committee invited Mr. Ruttledge to lead again, and as leader he chose his team. I am bound to say that I do not think we could possibly have had a better or more satisfactory leader or a finer team of young climbers. Unfortunately, as you have heard, we had no luck with the weather and again we did not succeed.

When the business of this expedition is wound up the present members of the Committee will, as I have explained, disperse, and the Committee will be reconstituted by the bodies represented, as soon as permission to go to Tibet is again granted.

We are of course always in a state of chronic hope of receiving such permission, but it may be a year or it may be ten years before it comes; so that anything I say now does not commit the next Committee in any way.

I would like here to pay most grateful tribute to all the Services or Departments of State who have given us most cordial co-operation. The Royal Air Force gave us the benefit of their exacting medical examination of all the candidates, and also allowed us to send the members of the team to Farnborough to be put through their high-altitude tests. The War Office were extraordinarily helpful in making it practicable for officers to obtain leave to join the expedition, and even when possible to spare them on duty.

The India Office, the Viceroy, and the Government of India have all vouchsafed us the most sympathetic co-operation all through, and I cannot be too expressive of the profound gratitude which, as a Committee, we feel towards the Government Departments for the help we have received from them.

As regards Mr. Ruttledge, the despatches which he sent home periodically during the course of the expedition were excellent and his judgment as leader, in the very difficult circumstance of failure and not of success, has been thoroughly sound throughout, and the Committee are most grateful to him for the way in which he led the expedition.

Let me now congratulate him on returning with his team complete and all well, and may I assure him that I, at any rate, feel honoured to have been associated, as Chairman of the Committee, with the expedition of this fine team. Nothing more could have been done than was done to achieve success, and it was solely the bad luck in the weather which denied it to them.

But I devoutly hope that I may live to see the mountain conquered, and there is another man here to-night, Sir Francis Younghusband, who, I am confident, feels the same.

The PRESIDENT: It is now, I regret, necessary for me to bring these proceedings to a close. We have had a most interesting evening and have listened to an account of a very strenuous endeavour to effect the conquest of Mount Everest, which has been an objective for so long. Again that attempt has not met with the success which it deserves, but if those who took part in the adventure feel

disappointed at the result, they can at any rate feel proud of having added considerably to the knowledge and experience which will eventually bring success. The experimental work has continued. We know more about the human physiological reactions. We know more about the necessary instruments which ought to be carried, and more about the snow conditions. Very probably the only factor which prevented success was the weather, which has been behaving throughout like a grim and vigilant duenna keeping watch and ward over her protégée, the virgin peak of Everest. The main problem in the future will be how to circumvent, or perhaps catch napping, that stern duenna.

Amongst the factors which will always be instrumental in bringing about final success are those absent heroes, the Sherpa porters. It is not possible to speak too highly of them. In asking you to show your appreciation of our lecturer and of his companions on this expedition, I would ask you to put in an extra round of applause for those porters.