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# The GEOGRAPHICAL JOURNAL

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## EVEREST: THE 1951 RECONNAISSANCE OF THE SOUTHERN ROUTE

ERIC SHIPTON

WHEN IN 1924 Norton and Somervill so nearly reached the summit of Mount Everest, it was generally believed that the next expedition, taking advantage of the lessons they had learned, would most probably succeed. For, just as the 1922 parties in attempting to climb the last 4000 feet to the top in a single day had completely underestimated the physiological difficulties of climbing at great altitudes, so it seemed that the failure of the 1924 expedition was due to a simple, avoidable cause. That year the climbers had gone high too soon and had become involved in struggles with the early spring blizzards, which had so far drained their strength that when the time came to launch their attempts upon the summit the climbers were already exhausted. In 1933 we were confident that by carefully nursing the climbers, and the Sherpas chosen to go high, through the preliminary stages and by the use of comfortable, double-skinned tents at Camps III and IV, it would be possible to place several successive parties at a camp above 27,000 feet with their reserves of strength largely unimpaired, and well able to overcome the last 2000 feet.

Once again we found that we had underrated the resources of our opponent. We had been led by the experiences of the previous expedition to assume that at the end of May and beginning of June there would be a period of some two weeks of calm weather before the monsoon wrapped the mountain in a blanket of snow. Moreover, we had not fully realized the extent to which even a small deposit of new snow upon the rocks of the final pyramid would render them unclimbable. Our experiences in the nineteen thirties showed all too clearly that such a spell of favourable conditions immediately before the monsoon could not be relied upon. Indeed, it did not occur in any of the three years when attempts were made during that decade. In 1933 we had perhaps a fleeting chance; but both in 1936 and 1938 the monsoon was upon us before we had even established a camp on the North Col.

Even now we cannot assess the chances in any given year of meeting with a sufficiently late—or as we used to think, “normal”—monsoon to ensure favourable conditions for reaching the top. We cannot say from the evidence we have, whether 1924 was an exceptional year, recurring perhaps only once or twice in a generation, or whether in the nineteen thirties we perhaps

encountered a limited cycle of unfavourable seasons. Whatever the answer, it seemed that the problem of reaching the summit of Mount Everest from the north had been reduced to this one vital question. Three times men had climbed to more than 28,000 feet, unaided by oxygen apparatus; we believed that the climbing on the last 1000 feet was no more difficult than that which had already been accomplished, but sufficiently difficult to demand good conditions of weather and snow; given these there seemed to be no reason for failure, without them success would not be attained. Had it been possible, the obvious solution would have been to send out a small party each successive year until the right conditions occurred. There would have been no lack of personnel, and the modest expense would have been amply justified by physiological and other scientific research. Unfortunately permission to do this could not be obtained from the Tibetan Government.

The attempt to climb Mount Everest, once an inspiring adventure, had become little more than a gambler's throw. To overcome this unhappy situation we had begun, as long ago as 1935, to consider the possibility of finding an alternative approach which would present a different kind of problem, one not so completely dependent for success upon the date of the monsoon.

From the mountains above the Kangshung Glacier, to the south-east, we had seen the ridge running up to the summit from the gap (the "South Col") between Everest and Lhotse. This clearly offered a much easier route up the final pyramid than that across the treacherous slabs of the North Face. It was broad and not so steep, while the dip of the strata would favour the climber. But was there any way of reaching the South Col? We had seen that the eastern side was impossible. The western side of the Col was unknown ground.

The Reconnaissance Expedition of 1921 had discovered in broad outline the geography of the south-western side of Mount Everest. The three great peaks of the massif, Everest, Lhotse (South Peak) and Nuptse (West Peak), together with their high connecting ridges, enclosed a basin which Mallory named the West Cwm. (Mallory had climbed a great deal in North Wales and for that reason he used the Welsh spelling of the word "combe".) Any approach to the South Col must lie up this hidden valley, which enclosed the whole of the southern aspect of Mount Everest.

On the 1935 Reconnaissance Expedition, when with no intention of attempting to climb Everest we had before us a wide field of mountain travel, our programme included an attempt to find a way to the West Cwm from the north. From the Lho La at the head of the Rongbuk Glacier, and also from a high col on the main watershed farther to the west, where we camped for two nights, we had close views of the entrance to the Cwm, a narrow defile flanked on the south by the great north face of Nuptse and on the north by the western shoulder of Everest. Between these lofty portals the glacier of the Cwm poured in a huge ice-fall, a wild cascade of ice blocks, 2000 feet high. The upper part of the Cwm was screened from view by a northerly bend in the valley, so that we could not see either the South Col or the south face of Everest; nor could we find a practicable route down the precipices on the southern side of the watershed which would have enabled us to reach the foot of the ice-fall.



Thus the possibility of finding an alternative route up Mount Everest from the south-west could not be put to the test, for the only way of approaching the mountain from that side was through the valleys of Solu Khumbu in Nepal. That country had long been forbidden to Western travellers and there was, in those days, no chance of obtaining permission from the Government of Nepal to send an expedition to that area. Since the war however the Nepalese Government began to relax their policy of rigid exclusion, and from 1947 onwards several mountaineering and scientific expeditions, American, French and British, were permitted to visit various parts of the Nepal Himalaya. In the autumn of 1950, Dr. Charles Houston and his father, together with H. W. Tilman, paid a brief visit to the upper valleys of the Khumbu district.<sup>1</sup> Houston and Tilman spent a day exploring the glacier flowing southward from the Lho La, but did not have time to reach the ice-fall.

In May 1951, Michael Ward proposed to the Himalayan Committee—the Joint Committee of the Royal Geographical Society and the Alpine Club which has organized all previous Everest Expeditions—that permission should be sought for a British expedition to go to Everest that autumn. His suggestion was energetically supported by Campbell Secord and W. H. Murray, formal permission was applied for and, on the assumption that it would be forthcoming, Murray began the preliminary work of organizing the expedition. I was in China at the time, and when I arrived home in the middle of June I had no idea of what was afoot; indeed nothing was further from my thoughts than taking part in a Himalayan expedition.

When it was suggested that I should be the leader, I did not at first take the suggestion very seriously for it seemed unlikely that permission for an expedition would be forthcoming. But within a few days it was learnt that, through the courtesy of the Nepalese Government and the good offices of Mr. (now Sir Christopher) Summerhayes, the British Ambassador at Katmandu, permission for the expedition had been granted.

The temptation to accept the Himalayan Committee's invitation was strong. For twenty years, ever since I had first known the Sherpas, I had longed, above all else, to visit their land of Solu Khumbu through which the expedition would travel. I had heard so much about it from the Sherpas; for, during our journeys together in other parts of the Himalaya and Central Asia, whenever we came upon a particularly attractive spot, they invariably said "This is just like Solu Khumbu," and the comparison always led to a long, nostalgic discourse about their homeland. It required only an intelligent glance at the map and a little imagination to realize that their praise was not exaggerated. We had looked down into the upper valleys of Khumbu from the peaks west of Everest. Almost unknown to Western travellers, it had become, to me at least, a kind of Mecca, an ultimate goal in Himalayan exploration.

All that we knew of the South Face of Mount Everest and of the western side of the South Col was that they must be approached up a formidable ice-fall and through a narrow defile which was probably menaced by ice

<sup>1</sup> H. W. Tilman, "Explorations in the Nepal Himalayas," *Geogr. J.* 117 (1951) 263-74.

avalanches from the hanging glaciers on the immense precipices above. Beyond the defile was the unknown Cwm, whose southern containing wall, the 25,000-foot ridge connecting Lhotse with Nuptse, obscured all but the very summit of Everest from the south. We estimated that the floor of the Cwm was about 21,000 feet high, nearly 5000 feet below the crest of the South Col. From the fact that, along the whole range, the mountains were far steeper on the southern side of the watershed than on the northern side, we inferred that the slopes below the col would not be easy. That was all we could guess. It did not present a picture upon which we could build great hopes. But the West Cwm was a freak of mountain architecture and there was no knowing what we might find there. I put the chances against our finding a practicable route at about thirty to one.

Clearly the expedition would only be a reconnaissance, moreover the time and money at our disposal were not sufficient to organize an attempt to climb the mountain. If, despite the long odds, we found a possible route, we naturally hoped to send a further expedition the following spring to attempt it; for we still believed that, despite its many disadvantages, the spring was the only time of year to tackle the mountain. A case had been argued for making the attempt in the late autumn; that is, after the monsoon instead of before it. So far as I know, this idea had not gained the support of anyone who had been high on the mountain, but it had never been put to a practical test. There were conflicting theories about the weather and snow conditions likely to be encountered in the autumn: there was little evidence on which to base these theories and what evidence there was seemed equally conflicting. By visiting the mountain after the monsoon we hoped to furnish answers to some of these questions.

The party originally comprised Bill Murray, Michael Ward, Tom Bourdillon and Alfred Tissières, one of the best known Swiss climbers, who happened to be doing research work in Cambridge at the time. It was also hoped that Campbell Secord would be able to join the party. Unfortunately, in the end, neither Tissières nor Secord was able to accompany the expedition. Murray and Ward sailed from Tilbury on 2 August 1951, taking with them all the stores and equipment. They reached Bombay on August 18. Bourdillon and I flew to Delhi arriving there on August 19. Two days before I left London a cable was received from the President of the New Zealand Alpine Club asking whether two members of the New Zealand Expedition which was climbing in the Garhwal Himalaya that summer, might accompany our party. I also received a request from the Geological Survey of India to attach one of their officers, Dr. Dutt, to the expedition. I welcomed these suggestions.

### *The march*

From India there are four ways of reaching Namche Bazar, the principal village in the district of Khumbu, where we proposed to make our base. The route from Darjeeling, generally used by the Sherpas, is long and very difficult during the monsoon. The route from Katmandu though easier is also rather long, while the cost in time and money of transporting a large quantity of baggage from India to the Nepalese capital is considerable. By far the quickest

Nuptse

Lhotse

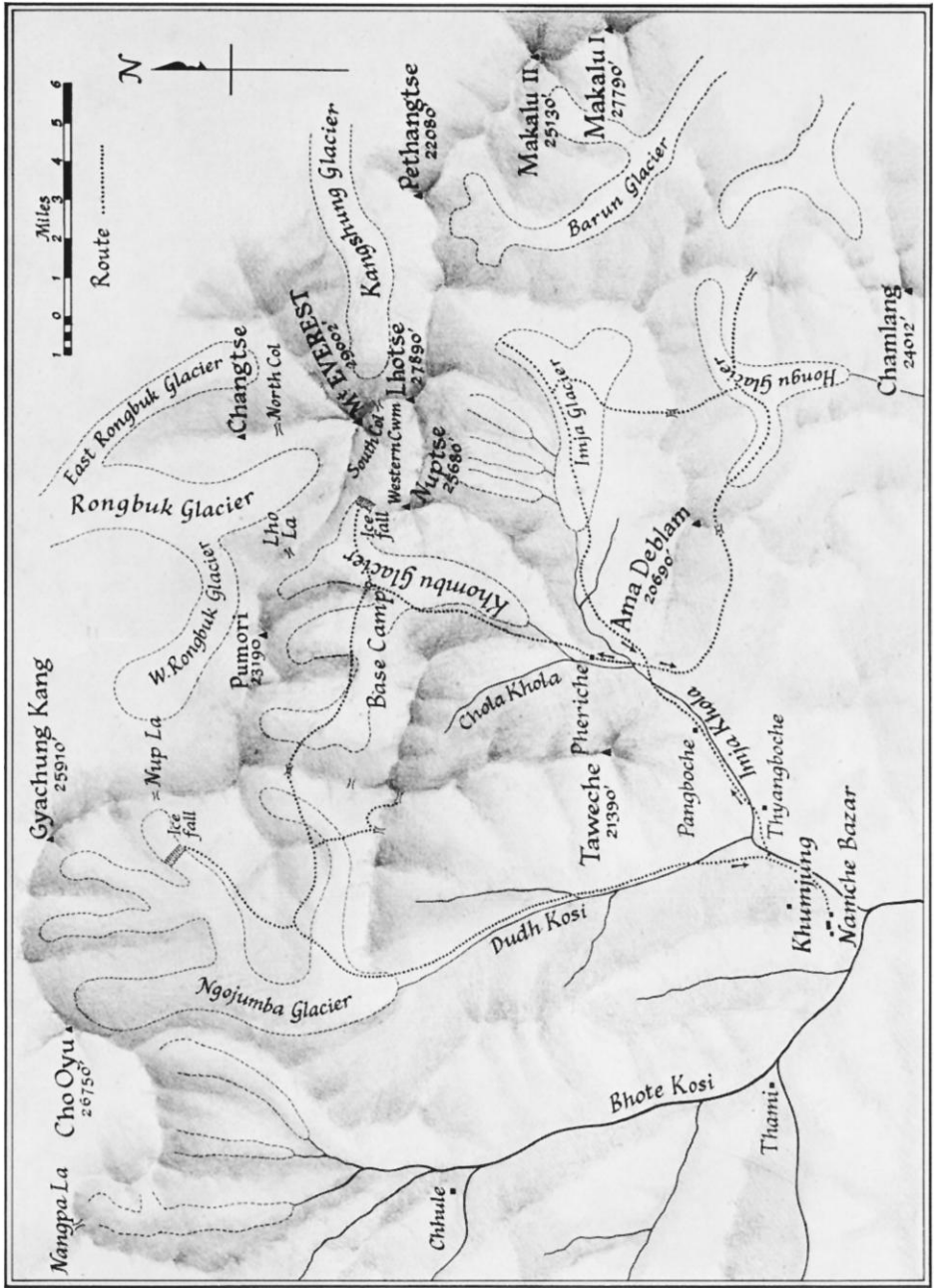
Everest



Phot. Copyright Himalayan Committee

Ice-fall leading into the West Cwm

*Panorama from the shoulder of Pumori*



way would be from Jaynagar, the railhead north of Darbhanga in Bihar. But we were advised that it would be impossible to get from there to the foothills by lorry during the rains, while to march through the hot, swampy country would be most unpleasant. So we decided to travel from Jogbani, another railhead in north Bihar farther to the east. Houston's party had gone by this route the previous year, after the monsoon was over, and they had succeeded in reaching Namche in a fortnight from Jogbani.

Bourdillon and I reached Jogbani shortly before midnight on August 24 and we were met at the station by a jeep belonging to the Biratnagar Jute Mills. It was raining hard, and judging by the sodden state of the ground all round the little station it seemed that it had been doing so for weeks. The road was so deep in mud that it took an hour to go from the station to the house of Mr. Law, the Chief Engineer of the Jute Mills, less than a mile away. This journey took us across the frontier into Nepalese territory. Mr. and Mrs. Law and Murray and Ward, who had arrived two days before, were waiting for us and we were given a wonderful welcome in this Scottish home. The following day Colonel Proud, First Secretary of the British Embassy at Katmandu, arrived. He had been sent by the Ambassador to assist us and to accompany us as far as Dhankuta. His help was invaluable. He had brought with him Lieutenant Chandra Bahadur, an officer of the Nepalese Army, whose services had kindly been lent to the expedition.

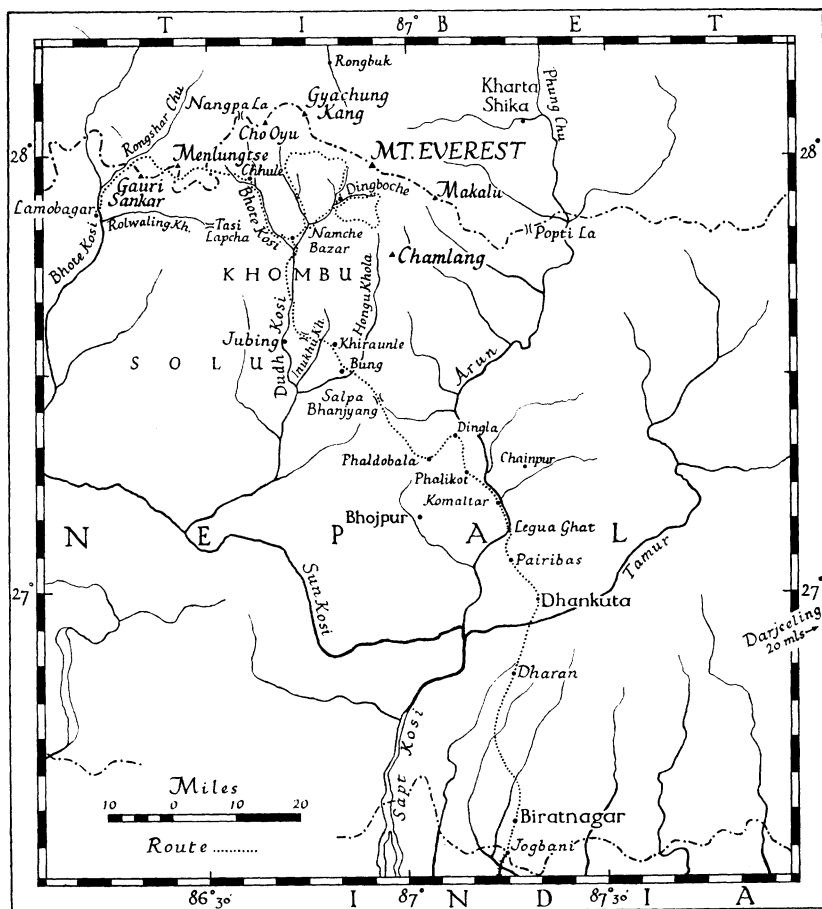
On August 25, too, Angtarkay arrived from Darjeeling. He is a very old friend of mine. We had been together on eight Himalayan expeditions before the war, and I had always regarded him as a man of quite outstanding character and ability. During the past few years he had set up a business in Darjeeling organizing treks in Sikkim for visitors. But he still went with major expeditions, though now as a Sirdar, or foreman. He was on the French expedition to Annapurna in 1950, and climbed to their highest camp. I had asked him to meet us in Jogbani to help with the transport to Namche, and later for work on the mountain. I had not seen him since 1939 when he was just a simple Sherpa porter, though a famous one, drawing the same pay as the others and carrying the same load. Now he had graduated to a different sphere. I was somewhat apprehensive of what I would find: for success tends to spoil these simple people at least as readily as it does the sophisticated. He had cut off the handsome pigtail that he used to wear and his clothes were distressingly smart, but I was relieved to find the same shy reticence and the same quiet humour that I remembered so well. There was no sign of dissipation and he looked no older: indeed he had changed remarkably little in the last twelve years. It was curious that, in spite of his constant contact with Europeans, he had learnt practically no English.

Angtarkay had brought with him from Darjeeling twelve Sherpas including a woman. They were all on their way to Solu Khumbu and were hoping to "work their passages" with us. We signed on four of them for the duration of the expedition and agreed to employ the others for the march at the same rates of pay as we gave to the local porters.

The next stage of our journey was a lorry drive of 30 miles to Dharan at the foot of the hills. We were told that with all the rain then falling the road would be impassable, and that we would have to wait until the weather

cleared. This was depressing news for there seemed to be no reason why it should ever stop raining. However, Mr. Law assured us that it would. In the meantime we were busy sorting out stores and equipment and packing them into 60-lb. loads for the march.

On the evening of August 26 it stopped raining and on the following morning a watery sun shone through the clouds. We set out in our hired



*The march through Nepal*

lorry at 2.30 that afternoon. At Biratnagar, two miles away, there was an hour's delay while the driver collected supplies of petrol and tinkered with the engine. The lorry was besieged by people wanting a lift to Dharan and by the time we left it was grossly overloaded. The road was in a deplorable state. Every few hundred yards the vehicle was brought to a standstill in deep mud and each time we had first to dig trenches to free the wheels and then to spread bundles of grass and jute husks over the mud. It took us more than two hours to cover the first six miles. However, though it started to rain

heavily again, conditions improved as we approached the hills. We reached Dharan long after dark, found a billet in an empty house and, after a long search, procured a meal in the bazaar.

The next morning we recruited coolies for the first part of the march. We found that the local practice was to pay coolies so much per seer (2 lb.) per stage. The men therefore preferred to carry 80-lb. loads instead of 60 lb., and we had to set about rearranging all our carefully packed baggage. While we were doing this a small boy came and asked if he could be signed on as "half a coolie." This tickled the Sherpas, and we gave him a box weighing 40 lb. He carried it so well that later I came to regret that all our team of porters were not small boys.

These matters occupied the whole of the morning and it was 2 o'clock in the afternoon before we began the first march. In a couple of miles we reached the foot of the mountains. Here, as elsewhere throughout the length of the Himalayas, they rose abruptly from the plains for about 5000 feet to the crest of the first range of foothills. We walked with our umbrellas up, for the sun was shining at last and it was very hot; but after a couple of hours we had climbed into low hanging clouds where the air was deliciously cool and fresh. We spent the night in a small village just below the crest of the first range. It rained heavily all night, but at dawn on August 29 it had cleared somewhat, and as we crossed the ridge we had a glimpse of the Everest and Makalu massifs, 75 miles to the north shining through a rift in the rain clouds. From the pass we descended 3500 feet to the Tamur River and then climbed a similar height up the other side of the valley to Dhankuta, where we were provided with a tiny rest house in a pleasant wood of tall pine trees. The following morning Colonel Proud started back on his return journey to Joghani and thence to Katmandu.

Though we had covered a considerable distance, those first two marches had been very easy. The path was wide and well constructed, the porters had gone well and it had not rained at all during the day. So far we had experienced nothing of the exasperation, the dismal toil of travel through the Himalayan foothills at the height of the monsoon. We soon began to suspect that it was not all going to be so easy. We had hoped that we would be able to persuade the Dharan coolies to remain with us, so that we could continue the march the very next day; but they refused and insisted on being paid off. What was worse, we had the very greatest difficulty in finding any fresh recruits. We sent the Sherpas into the bazaar and the Bara Hakim (the local governor) sent peons into the outlying villages to engage men. A few men arrived and agreed to go with us; but finding that we were not ready to start they drifted off again and disappeared. When this happened several times the situation began to seem desperate. By the time we had been in Dhankuta for forty-eight hours we felt as though we would never be on our way again. Various plausible explanations were advanced by the local authorities for the lack of coolies; none of them suggested a solution; a large military camp had been established nearby, and all the coolies were required to work there; owing to the recent disturbances in the country the peasants were frightened to go far from their villages; because of the lateness of the rains, work on the land had fallen into arrears with the result

that the demand for labour was unusually heavy; no one ever travelled far during the monsoon if he could help it. Looking back I would say that the last was the most likely explanation. We could get curiously little information about the route ahead, and none that was reliable. We decided that a place called Dingla was to be our next objective. The country beyond that was, locally, a mere legend. Each person we asked held a different opinion as to how we should get to Dingla; while estimates of the time it would take varied between one day and a week.

It is remarkable how, when the situation seems hopeless, a solution presents itself. At about noon on September 1 we suddenly found that there were no fewer than seventeen coolies who were willing, though somewhat half-heartedly, to talk business. We required twenty-five; but Angtarkay urged that we should start at once with these before they had time to change their minds, and that he should follow with the remaining eight when he could get them. I was reluctant to split the party at such an early stage, but it was obviously the wisest course to follow. Furthermore the news that the expedition had moved on would certainly have a quick psychological effect upon the local carriers, who would immediately begin to think that they were missing a good thing.

Before starting we went to say goodbye to the Bara Hakim and to thank him for his help and hospitality. He had just received a message from Jogbani to say that the two New Zealanders who were to join the expedition, E. P. Hillary and H. E. Riddiford, had arrived there. This was good news for until then we had had no word of their whereabouts; we sent messages back to them and started on our way. In the evening we reached a ridge, some 6000 feet high, overlooking the vast basin of the Arun River, where we spent the night in the little village of Pairibas. Angtarkay arrived early the following morning. As we had expected, he had found no difficulty, once we had gone, in recruiting the remaining eight porters. Our march that day took us 5000 feet down to the banks of the Arun.

At dawn on September 3 we walked along a wide shore to a place called Legua Ghat where there is a primitive ferry. A light mist hung low over the great river; this began to disperse as soon as the sun was up and we saw far away up the valley the gleam of snow peaks. The ferry consisted of a tree trunk hollowed out to make a clumsy canoe. It had a crew of three, two paddlers forward and a steersman aft, and could take seven passengers at one time, or an equivalent weight of baggage. As soon as the boat was cast off from the bank it was swept down by the current at an alarming speed. The paddlers worked furiously to get their frail craft across the river with a minimum loss of distance; for after each crossing it had to be towed laboriously back along the shore. The river was about 300 yards wide and though there were no rapids for a mile or so downstream, which allowed a substantial margin of error, the operation required considerable skill. It took from 7 a.m. until 2 p.m. to complete the ten double crossings necessary to transport ourselves, our coolies and our baggage across the river.

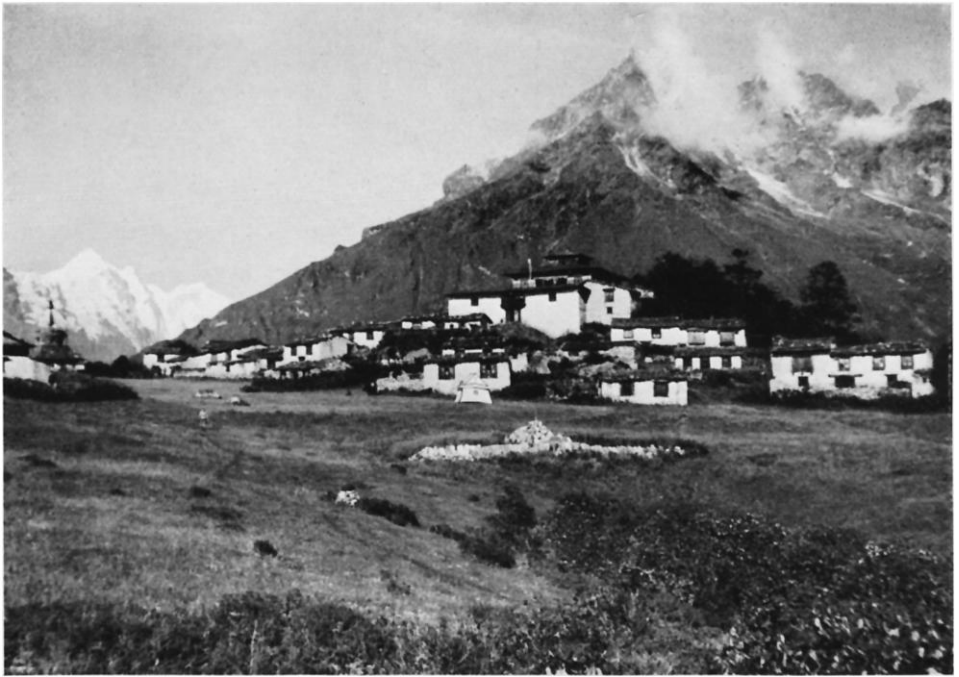
We were now less than 1000 feet above sea-level, and when we resumed the march that afternoon the heat was intense. There was no clearly defined route across the vast forested slopes of the valley. We made our way through

*Hillary pauses for breath on the ice-fall*

*Phot. Copyright Himalayan Committee*





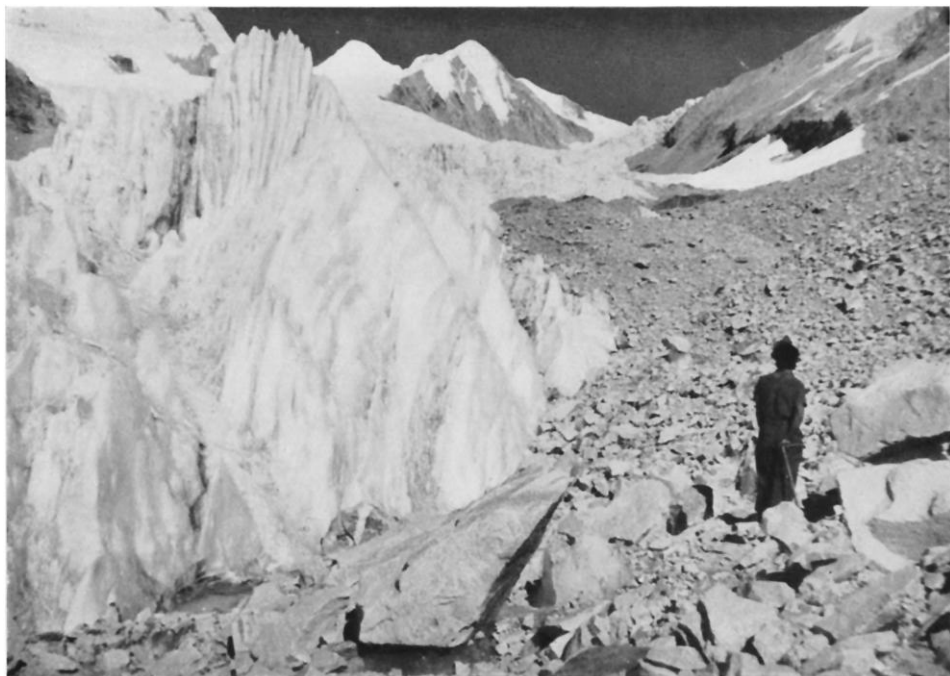


*The monastery at Thyangboche*



*Standing: Shipton, Murray, Bourdillon, Riddiford; seated: Ward, Hillary*

*Photos. Copyright Himalayan Committee*



*The Nangpa La (19,050 feet)*



*Photos. Copyright Himalayan Committee*

*Stratified glacier ice in the Hongu basin; the peak behind is unnamed*



*The village of Thami above the Bhote Kosi, peaks of the Kangteke group in the distance*



*Phots. Copyright Himalayan Committee*

*Ward standing beside the line of tracks*

steep rocky nullahs along a series of tiny tracks which, branching and intersecting, connect the scattered hamlets. Often the tracks were so obscure that we lost them. The porters, carrying 80-lb. loads, went very slowly; even so their speeds varied a great deal and it was impossible to keep them together and, with such a diversity of tracks, we soon lost contact with some sections of the party. At nightfall on September 3 we reached a hamlet called Komaltar. Though it was only  $4\frac{1}{2}$  miles in a direct line from the ferry, it had taken nearly five hours to cover that distance. Nine of the local porters bivouacked in a stream-bed half a mile short of the hamlet and came in early next morning. The rest failed to turn up, and after sending back in search of them without success, we concluded that they had taken a different route. They reached Dingla more than a day after us.

For 7 or 8 miles we kept fairly close to the banks of the Arun, sometimes following a stretch of shore. The tropical forest and the dense undergrowth, the birds, the brilliantly coloured locusts, butterflies and other insects were typical of the deep river valleys of the eastern Himalaya. We wore only shorts and sand-shoes, with umbrellas to protect our heads from the heat. Whenever we came to a safe breakwater, we used to plunge straight in and sit down for a few moments. The water was deliciously cool, though the refreshing effect did not last long. Even the Sherpas who are afraid of water, and who normally never immerse their bodies, began, at first timidly then with great zest, to follow suit: all except poor Lhakpa, the woman, who looked on with obvious envy.

On the afternoon of September 4 we climbed 3000 feet up through lovely country to a cluster of villages called Phalikot, and next day a relatively short march took us to Dingla, a large scattered village perched among woods and terraced fields on a high ridge which commanded sweeping views across the Arun basin and, when the weather was clear, of the great snow ranges to the north.

At Dingla we again had great difficulty in recruiting porters. The Dhanakuta men had been engaged as far as Dingla and refused to go any farther. We were delayed for four days. On September 8 Hillary and Riddiford arrived. We now required forty local coolies for, besides the baggage brought by the New Zealanders, we had bought a quantity of rice and flour in case of a possible shortage in the country beyond. At last, on the evening of September 9, after long and exasperating negotiations, enough men had been engaged. We gave them an advance of pay, and they promised to be ready to start soon after dawn the next day. But the next morning it was raining very heavily and they did not come until noon. However, after a couple of hours of tumult and confusion we managed to allot them their loads and get them off.

Our next objective was the Salpa Bhanjyang, a 12,000-foot pass to the north-west leading over from the Arun basin to that of the Hongu Khola. The direct route was impassable owing to some steep mountain streams which were in spate and had swept away the bridges crossing them. This meant that we had to make a long detour to the south-west so as to reach the crest of the high watershed ridge, which we then followed to the pass. The detour cost us several extra days marching. It was particularly annoying

to discover that, if we had known this before, we could have reached the ridge much more quickly by travelling direct to it from Dhankuta via Bhojpur.

On September 10 we made our way along the path leading towards Bhojpur. This was easy and fairly level but we had started so late, and the porters went so slowly, that by nightfall we had only reached the village of Phaldobala 4 miles away. The next morning the porters refused to go on, saying that their loads were too heavy. According to the local custom we had contracted to pay them by weight and for this reason they had in the first place chosen to carry 80 lb. each rather than 60 lb. This meant that we had once again to rearrange all the loads and also to recruit more porters to carry the surplus. These operations, made no easier by the rain, occupied the whole of that day.

On the march to Dingla it had rained mostly at night and the days had been fine. This happy arrangement could not be expected to last and by now it was raining for most of each day. We set off again on the morning of September 12 and climbed to the crest of the high, narrow watershed ridge. For three days we made our way slowly along it in a northerly direction, unable to see anything of our surroundings because of alternating spells of heavy rain and equally drenching Scotch mist. After a while we lost all sense of direction and distance; it was a curious sensation, blindly following this narrow crest, the ground on either hand falling steeply into the silent, forested depths below, while rocky peaks loomed, one after another, ahead. The undergrowth was infested with leeches; on a single twig a score of the creatures could be seen, stiff and erect, like a cluster of little black sticks, ready to attach themselves to our legs and arms and clothing as we brushed past.

The way consisted of a continuous series of long, steep climbs and descents. It was very hard work for the porters for the track was slimy with mud and they slipped constantly, losing their balance under the shifting weight of their sodden loads. We spent the nights in little cowherd's shelters, mostly deserted, which were interspersed along the ridge. They kept out most of the rain, and fires lit inside discouraged the leeches from entering. Without them our lot would have been a great deal worse. One evening at sunset the mists slid down below the ridge, and for a while we saw, across a wide gulf of cloud, the great range of ice peaks.

At the Salpa Bhanjyang, which we reached on the morning of September 15, we joined the route used by the Sherpas travelling between Khumbu and Darjeeling. Angtarkay told me that when he was last there, in December 1947, it was so deep in snow that he had taken three days to cross it and that several Sherpas had died attempting to do so. It was a great help at last to have someone in the party who knew the way. From the pass we descended steeply for 7000 feet to the Hongu Khola. At the village of Bung on the farther side of the valley we heard that the bridge across the next big river, the Inukhu Khola, had been washed away, and we had to choose between making a detour of three days to the south, or attempting to build another bridge ourselves. We decided on the latter alternative.

From Bung we crossed another pass, about 10,600 feet high to Khiraunle which stands about 1000 feet above the Inukhu Khola. Here we were told that several villages in the neighbourhood had been smitten by an epidemic of

some virulent disease which killed its victims in four days. From a description of the symptoms it seemed probable that it was bubonic plague. There was a village straight across the valley where fifty people had died during the past fortnight. The intervening gorge was so narrow that, though the place was the best part of a day's march away, we could with the naked eye see people moving about in it. We studied their movements with field glasses and saw that they were engaged in some activity which the Sherpas declared was a burial ceremony.

But the village of Khiraunle also provided some less depressing news. The local people were engaged in building a temporary bridge across the Inukhu Kholā to take the place of the one that had been washed away, and this would be ready early the following morning. That day was the worst of the march. Heavy rain fell almost continuously. A way had to be cut through the dense undergrowth to enable the porters to climb down the precipitous slopes of the gorge to the point where the new bridge was built. This was only a few hundred yards downstream from the old bridge, but the intervening distance was impassable along the river bed. The new structure was a very flimsy affair, built in two sections, each spanning a formidable cataract and connecting one bank of the river with a central island. Each section was composed of two slender tree trunks lashed together with green bark, and a bamboo handrail that would not have withstood a pressure of ten pounds. The river was rising rapidly and before everyone was across waves were splashing over the logs. Not long afterwards both sections of the bridge were swept away, leaving the bamboo handrails flapping crazily in the spray.

We then had to climb a steep cliff to regain the track. In doing this we disturbed a hornets' nest. Not having been attacked myself I was mystified by the ensuing confusion and panic until the party had re-assembled on the track, 300 feet above the river. Two of the coolies had been stung so severely (one claimed seven stings) that they were already suffering from acute fever. Several others had swollen faces and eyes, while one man had disappeared. His load was located near the hornets' nest and we thought that he had fallen down the cliff in his attempt to escape. I sent Angtarkay on to a village 2000 feet above to get help, while Bourdillon, Ward and I climbed down the cliffs again and searched along the shore for the missing man, expecting to find his broken corpse. He had not however fallen and eventually he was found in a high fever sheltering in a cave. All the victims of this curious encounter recovered overnight.

The next day, September 19, we crossed another 10,000-foot pass which took us into the valley of the Dudh Kosi. On the evening of September 20 the weather suddenly cleared and the monsoon seemed to have ended. After ten days of perpetual rain and mist the clear air and warm sunlight were delicious. The forest was no longer oppressive but light and green; the waterfalls sparkled as they cascaded down the huge precipices flanking the wide valley, threads of silver hanging from the ice spires 12,000 feet above our heads.

We were now in the country of the Sherpas, and a form of "Channel fever" animated Angtarkay and his companions. At each village through which we passed they were greeted by a crowd of their friends who took

them off to some house to be fed and wined to the accompaniment of eager chatter and full-blooded laughter. Of course we came in for our share of this hospitality, which doubtless contributed to the magic of the scene. I began to wonder if, when eventually we reached our objective, any of us would be in a fit state to climb.

The valley split into two narrow gorges. The path, by a remarkable series of log platforms and ladders built in the cliff, followed the right-hand branch for half a mile, the lovely snow peak of Taweche framed between the vertical sides of the canyon, then climbed, zig-zag, for 2000 feet to the intervening ridge. Here, in a little fold in the mountainside, was Namche Bazar 12,200 feet above sea-level. We arrived there in the afternoon of September 22; the journey from Jombang which we had expected to cover in a fortnight had taken us nearly four weeks.

Namche Bazar, which consists of about sixty houses, is the most important village in the district of Khumbu; for it is the last place of any size on the principal route from eastern Nepal to Tibet and is therefore a centre of trade between the two countries. It is the small metropolis of the Sherpas who have close connections, both commercial and religious, with Tibet. They are themselves of Tibetan origin, and are indistinguishable from the people of the great plateau to the north of the main range. They wear the same kind of clothes and have the same religious beliefs and customs, and, though they have a language of their own, they can all speak Tibetan. They lead a semi-nomadic life; each family owns a house and land in several villages at different altitudes, and they move *en masse* from one village to another according to the seasons, to sow or harvest their fields of potatoes and barley. For this reason it is common to find a village temporarily deserted while the inhabitants are working at another at a different level. They graze their sheep and goats and yaks in the high valleys, often several days' march from their villages.

We were given a great welcome in Namche, where we spent two days sorting out our stores and equipment and arranging for supplies of local food. I met many old friends from former expeditions, most of whom brought flacons of *chang* and stood by urging us to drink.

We were provided with a house. Nearly all Sherpa houses are built on the same pattern. They are oblong, two-storied stone buildings, with carved wooden window frames and lattice windows. The front door leads into a dark stable, through which one has to grope, pushing past the oxen and yaks, to a steep wooden ladder leading to a short, narrow passageway on the upper floor. A right-hand turn at the top of the ladder leads to a latrine, a small dark room, with a hole in the middle of the floor which is otherwise deeply covered with grass or pine needles. The other end of the passage leads to the living room which occupies three-quarters of the upper floor. The alcove between the walled-in ladderway and the front wall is used as a kitchen. The fireplace is set on the floor, and an iron frame is used for holding the cooking pots above the fire. Beyond this is a couch reserved for the women. In the front wall to the right of the fireplace there is a line of windows. Beneath this a platform raised about a foot above the floor is covered with carpets and rugs. Here the men sit, cross-legged behind a low wooden



table. The seat of honour is at the end of the platform nearest the fire. The opposite wall, devoid of windows, is lined with shelves, full of great copper basins, wooden bowls, china cups, bamboo churns and other cooking and eating utensils. The far end of the room is cluttered with bags of grain, ropes, wooden ploughs, mattocks and other farm implements. Beds are made up on the floor as they are required. Some houses belonging to well-to-do people have a room beyond, furnished as a small Buddhist shrine.

### *The ice-fall*

We left Namche on September 25, taking with us supplies for seventeen days. In that time we hoped to make a thorough reconnaissance of the great ice-fall, if possible to climb it into the West Cwm, and to see whether or not there was a practicable route from there to the South Col. If we found a route we would then send down for more supplies, carry a camp into the Cwm and climb as far as possible towards the Col. If as we expected there proved to be no practicable route, we would undertake an extensive exploration of the main range, the southern side of which was almost entirely unknown. We had engaged another five Sherpas whom we equipped for work on the mountain, bringing the number up to ten. One of them was Angtarkay's young brother, Angputer, whom I had last met in 1938 when as a lad of fourteen he had come across to Rongbuk from Namche and had carried a load to Camp III (21,000 feet) on Everest. Another fifteen men had been engaged to carry our baggage and supplies to our Base Camp at the head of the Khombu Glacier.

We followed a path across the steep mountainside, 2000 feet above the gorge of the Dudh Kosi, from which we had climbed three days before. On the way we met a very old friend of mine, Sen Tensing, whom I had first met in 1935 when he had come across to Tibet to join the Reconnaissance Expedition. His peculiar appearance in the clothes we gave him had earned him the name of the "Foreign Sportsman." In the years that followed he had been my constant companion in various parts of the Himalaya and Karakoram, and in 1936 I had taken him to Bombay; an adventure which he evidently still regarded as one of the highlights of his career. He had heard news of our approach while herding his yaks in a valley three days' march away, and had hurried down to meet us, bringing gifts of chang, butter and curds. He came along with us, and for the rest of the day he regaled me with memories of the past.

After some miles the path descended into the gorge. We crossed the river by a wooden bridge and climbed steeply through the forest for 2000 feet to the monastery of Thyangboche, built on the crest of an isolated ridge which divided the Dudh Kosi from a large tributary valley known as the Imja Khola. The ridge was shrouded in mist that evening and, as it was growing dark when we reached the monastery, we saw nothing of our surroundings. The monks welcomed us and we found that a large Tibetan tent had been pitched for us on a meadow nearby.

During the past few days we had become familiar with the extraordinary beauty of the country, but this did not lessen the dramatic effect of the scene which confronted us when we awoke next morning. The sky was clear; the

grass of the meadow, starred with gentians, had been touched with frost which sparkled in the early sunlight; the meadow was surrounded by quiet woods of fir, tree-juniper, birch and rhododendron, silvered with moss. Though the deciduous trees were still green there were already brilliant splashes of autumn colour in the undergrowth. To the south the forested slopes fell steeply to the Dudh Kosi, the boom of the river now silenced by the profound depth of the gorge. To the north-east, 12 miles away across the valley of the Imja Khola, stood the Nuptse-Lhotse ridge, with the peak of Everest appearing behind. But even this stupendous wall, nowhere less than 25,000 feet throughout its 5-mile length, seemed dwarfed by the slender spires of fluted ice that towered all about us, near and utterly inaccessible.

We stayed in this enchanting spot till noon, and we visited the monastery during the morning. With its cloistered courtyard, its dark rooms smelling of joss sticks and the rancid butter used for prayer lights, its terrifying effigies, its tapestries and its holy books bound between boards, it resembled most Tibetan monasteries in all save its setting. In the centre of the main room or shrine there were two thrones, one for the Abbot of Thyangboche, the other for the Abbot of Rongbuk. At that time the former was away on a visit to his colleague on the northern side of the great mountain, Chomo Lungma (Everest). Hanging in one of the windows of the courtyard, we were amused to find an oxygen cylinder which had evidently been retrieved from the East Rongbuk Glacier by the Sherpas of one of the early Everest Expeditions. It is now used as a gong which is sounded each evening at five o'clock as a signal for all the women who happen to be there to leave the monastery.

From Thyangboche the way led gently downwards through the woods and across the Imja Khola at a point where the river plunges as a waterfall into a deep abyss, overhung by gnarled and twisted trees with long beards of moss waving in the spray. Beyond the village of Pangboche we left the forest behind and entered highland country of heath and coarse grass. We spent the night of September 26 at Pheriche, a grazing village then deserted, and next morning turned up into the Lobujya Khola, the valley which contains the Khumbu Glacier. As we climbed into the valley we saw at its head the line of the main watershed. I recognized immediately the peaks and saddles so familiar to us from the Rongbuk side: Pumori, Lingtren, the Lho La, the North Peak and the west shoulder of Everest. It is curious that Angtarkay, who knew these features as well as I did from the other side and had spent many years of his boyhood grazing yaks in this valley, had never recognized them as the same; nor did he do so now until I pointed them out to him. This is a striking example of how little interest Asiatic mountain peasants take in the peaks and ranges around them.

Two days were spent moving slowly up the glacier and getting to know the upper part of the valley. The weather was fine each morning, but each afternoon we had a short, sharp snowstorm. We had some difficulty in finding water along the lateral moraine, but eventually we found a spring in a little sheltered hollow on the west bank of the glacier at the foot of Pumori, and established our base camp there at an altitude of about 18,000 feet. Later we found that the spring was fed from a small lake a few hundred feet above. There was a small heather-like plant growing on the moraine which served

as fuel and supplemented the supplies of juniper that we had brought from below.

On September 30 Riddiford, Ward and Bourdillon, with two Sherpas, Passang and Nima, crossed the glacier to reconnoitre the lower part of the ice-fall. Hillary and I climbed one of the buttresses of Pumori so as to study the ice-fall as a whole and, in particular, to examine the position of the hanging glaciers on either side of the gorge leading into the Cwm and plot the areas of potential danger from ice avalanches falling from these. We reached a height of just over 20,000 feet. It was a wonderful viewpoint. We could see right across the Lho La to the North Peak and the North Col. The whole of the north-west face of Everest was visible, and with our powerful binoculars we could follow every step of the route by which all attempts to climb the mountain had been made. How strange it seemed to be looking at all those well-remembered features from this new angle, and after so long an interval of time and varied experience; the little platform at 25,700 feet where we had spent so many uncomfortable nights, Norton's Camp VI at the head of the north-east spur, the Yellow Band and the grim overhanging cliffs of the Black Band, the Second Step and the Great Couloir—they were all deep in powder snow as when I had last seen them in 1938. Straight across from where we stood, Nuptse looked superb, a gigantic pyramid of terraced ice.

But the most remarkable and unexpected aspect of the view was that we could see right up to the head of the West Cwm, the whole of the west face of Lhotse, the South Col and the slopes leading up to it. Indeed a view from the interior of the Cwm itself could hardly have shown us more. We estimated that the floor of the Cwm at its head was nearly 23,000 feet, about 2000 feet higher than we had expected. From there we could see that there was a perfectly straightforward route up the face of Lhotse to about 25,000 feet, whence it seemed a traverse could be made to the South Col. This long traverse would only be feasible in good snow conditions, and at present conditions were obviously anything but good.

The sudden discovery of a practicable route from the West Cwm to the South Col was most exciting. But we had come here to study the ice-fall and this occupation soon sobered our spirits. The total height of this frozen cataract was about 2000 feet; a rough transverse corridor divided it into two equal sections. The glacier descends from the Cwm in a left-hand spiral, so that the lower section of the ice-fall was facing our viewpoint while the upper half was largely in profile. With the field glasses we picked up two figures on the lower part; from their movements we recognized them, even at that distance, as Riddiford and Passang. Of the others there was no sign. We heard later that they had taken a different route across the lower glacier and had been forced to turn back by a mass of ice pinnacles before reaching the foot of the ice-fall. Riddiford and Passang had made splendid progress, though they were obviously having to work very hard in the soft snow. By 2 o'clock they had reached a point about four-fifths of the way up the lower section. Here they stayed for an hour and then returned.

Such excellent progress by a party of only two at the very first essay was in itself most encouraging. But from where we were standing it looked as though the corridor above them was in danger of being swept throughout its

length by ice avalanches falling from a great line of hanging glaciers on the left-hand wall of the gorge; it looked indeed as though the surface of the corridor was composed entirely of avalanche debris. The right-hand side of the lower ice-fall and of the corridor were clearly menaced from a mass of hanging glaciers in that direction, while our profile view of the upper ice-fall made it look very ugly. There was an easy way round the upper ice-fall to the left, but this was obviously a death trap.

One of the many reasons why an attempt upon a great Himalayan peak offers so very much less chance of success than climbing a mountain of Alpine size is that a great part of the route has to be traversed again and again by parties of laden men carrying supplies to the higher camps. All objective dangers must be judged from this standpoint. The risk, say, of walking for ten minutes under an unstable ice-tower, which might be accepted by a party of two or three unladen mountaineers, is obviously increased a hundred fold in the case of large parties of heavily laden men passing over the same ground dozens of times. The rules of mountaineering must be rigidly observed.

It now seemed that we would be faced with a most difficult decision: to abandon this wonderful new route to the summit of Everest that had appeared like a vision, this chance that we had scarcely dared to hope for, not because the way to it was beyond our powers but because on a small section of the approach the party, and particularly the Sherpas, must repeatedly be exposed to the risk, however slight at each individual exposure, of extermination.

When we met Riddiford in camp that evening he was much more optimistic about the difficulties on the upper part of the ice-fall, but he had not been in a position to judge the avalanche danger. On the following day, October 1, while Bourdillon and Angtarkay repeated our visit to the Pumori ridge and climbed to a point some 300 feet higher, Hillary and I made a reconnaissance from another angle. This time we went up to the head of the glacier and climbed again to about 20,000 feet on a ridge of the peak bounding the Lho La on the west. From here, although we could not see into the Cwm, we had a much better view of the upper part of the ice-fall and of the corridor. We saw that, at this time of year at any rate, the avalanches from the left swept rather less than half the length of the corridor, and that a crossing made at about its centre would be reasonably safe. We could also trace a good route through the upper part of the ice-fall.

On October 2, Riddiford, Hillary, Bourdillon and I, with three Sherpas, Passang, Dannu and Utsering, took a light camp up to the foot of the ice-fall with the intention of making a concentrated attempt to climb from there into the West Cwm. At this time Murray and Ward were both still suffering from the effects of altitude and remained at the Base Camp for further acclimatization. The next day the weather was bad; it snowed gently most of the day and we stayed in our tents. The air about us was absolutely calm. At about 10 o'clock we heard a dull roar which sounded like an Underground Railway train. At first we thought it was a distant avalanche somewhere high up in the Cwm. We were quite accustomed to the thunder of these, falling intermittently all around us, from Nuptse, from the great ice cliffs of the Lho La and from the ridges of Pumori. As a rule the noise did not last more than a minute or two at a time. When after a quarter of an hour this distant roar

was still maintained, we began to think that somewhere far away an entire mountainside must be collapsing. After an hour however even this theory seemed hardly tenable, and eventually we came to the conclusion that it must be caused by a mighty wind blowing across the Lho La and over the ridges of Everest and Nuptse. It went on throughout the day. No breeze ruffled the canvas of our tents.

The morning of October 4 was fine and very cold. We started soon after it was light. One of the difficulties of working on the ice-fall, particularly at this time of year, was that the sun reached it so late in the day. At first we were moving over hard ice, but as soon as we reached the icefall we were up to our knees in soft snow. Our feet became very cold, and once during the morning Hillary and Riddiford had to remove their boots, which were designed for their summer expedition and were only large enough for two pairs of socks, and have their feet massaged back to life. With Riddiford's tracks to follow we had no difficulty in finding our way through the maze of crevasses and ice walls. After three and a half hours' steady going we reached his farthest point. Here Bourdillon, who was also still suffering a good deal from the effects of altitude, decided to stop and await our return. The place was just beside a prominent ice-tower which was thereafter known as "Tom's Serac." As the sun was now up, he would be able to keep warm enough.

Indeed our trouble was now exactly the reverse. With the scorching glare of the sun on the fresh snow, and the stagnant air among the ice-cliffs it was rather like working in front of a furnace. This, combined with the altitude, very soon drained our energy and robbed all movement of pleasure. We shed all our upper garments except our shirts, but even so we poured with sweat, and before long our panting produced a tormenting thirst. The going now became far more complicated and laborious. Threading our way through a wild labyrinth of walls, chasms and towers, we could rarely see more than 200 feet ahead. The snow was often hip deep so that, even with so many to share the labour of making the trail, progress from point to point was very slow. The choice of one false line alone cost us an hour of fruitless toil.

But technically the climbing was not difficult, and even if it had been we had plenty of time for the job. By the middle of the afternoon we seemed to be approaching the top of the ice-fall. We had decided to turn back not later than four o'clock in order to reach camp by six, when it would be getting too dark to see. Even that was running it rather fine since it did not allow for such accidents as the breaking of a snow bridge; and to become involved in such a complication after dark would be to run considerable risk of frostbite.

From the last line of seracs we looked across a deep trough to a level crest of ice marking the point where the glacier of the Cwm took its first plunge into the ice-fall, like the smooth wave above a waterfall. The trough was really a wide crevasse, partly choked by huge ice blocks, some of which appeared none too stable. Crossing it was the most delicate operation we had encountered.

By 3.50 we reached the final slope beyond the trough, less than 100 feet below the crest, from which we expected to have a clear view along the gently sloping glacier of the Cwm. We had to climb this diagonally to the

right so as to avoid a vertical brow of ice directly above. Passang, whose turn it was, took the lead; Riddiford followed and I came next. When we were on the slope it became obvious that the snow was most unstable and must be treated with great caution. By this time Passang had advanced about 60 feet. Suddenly the surface began to slide downwards, breaking into blocks as it went. Passang, who was at the upper edge of the break, managed with great skill to dive over it and ram his ice axe into the snow above. I was only a few yards from Hillary who had a firm anchorage on an ice block at the beginning of the slope and I was able without much difficulty to scramble off the moving slope back to him. Riddiford went down with the slope, and was left suspended between Passang and me, while the avalanche slid silently into the trough. It was a nasty little incident which might with less luck have had rather unpleasant consequences.

It was now high time to retreat. Going down was of course almost effortless compared with the labour of coming up. We had the deep trail to follow and we could jump or glissade down the innumerable little cliffs, each of which had cost a great deal of time and hard work to climb. It was after 5.30 when we reached Bourdillon who had had a longer wait than he had bargained for, and was by now getting both cold and anxious. Soon after we had started down, the ice-fall became enveloped in mist. Later, this broke behind us and we saw, high above the darkening Cwm, the north face of Nuptse, a golden tracery of ice lit by the setting sun. We reached camp as it was getting dark, very tired after a strenuous day.

We were well satisfied with this reconnaissance. It was rather disappointing at the last moment to be denied a view into the Cwm, from the top of the ice-fall, though in fact it would not have shown us much more than we had seen already. But we had climbed practically the whole of the ice-fall in a single day despite abominable snow conditions and the fact that over by far the largest and most difficult part we had been working our way across entirely new ground. In time the route could certainly be greatly improved, and the climb would then be done in half the time and with less than half the effort. We thought that the snow conditions would probably improve; but even if they did not, the final slope could certainly be climbed and safe-guarded by suspending lifelines from above. Finally, at this time of year at least, the route seemed to be reasonably free from the menace of ice avalanches. We had little doubt that with a few days' work we could construct a safe packing route up the ice-fall into the West Cwm.

We decided however to wait for a fortnight before attempting to do this. There were three seasons for this decision. The first was to allow time for snow conditions on the ice-fall to improve. Secondly, we had seen that there was still an enormous amount of monsoon snow lying on the upper slopes of Lhotse and Everest which would make it impossible to climb far towards the South Col, to say nothing of the possible risk of large snow avalanches falling into the Cwm from above. While we knew that at altitudes of 25,000 feet and above this snow would not consolidate, we had reason to believe that by the beginning of November a great deal of it would have been removed by the north-westerly winds which were already becoming established. Finally, half the party were badly in need of acclimatization before they could undertake

any serious work, even in the ice-fall. We spent the fortnight making journeys into the unexplored country to the west and south.

On October 19 Hillary and I, who had been working together during this fortnight, returned to the Base Camp on the Khombu Glacier. We had expected the others to get back on the same day, but they did not arrive until nearly a week later. On October 20 and 21 we took a camp to the old site at the foot of the ice-fall. This time we brought with us a large twelve-man double-skinned dome tent designed for the Arctic. It was well worth the labour required to level a sufficiently large area of the ice surface on which to pitch it for, after the tiny mountain tents we had been using hitherto, it was positively luxurious and, having more room, we found it a great deal easier to get off to a really early start in the morning. On October 22 we started work on the ice-fall. Snow conditions had improved slightly, but a number of new crevasses had opened up across our former route and these caused us a little trouble to negotiate. However, by the end of the first day's work we had made a solid and completely safe route up as far as "Tom's Serac." Near this we marked out a site for a light camp from which to work on the upper part of the ice-fall, but we decided that for the present we would continue to work from our comfortable camp below.

Next day we started early, taking with us Angtarkay and Utsering. It was a glorious morning. With every step of the way prepared, we climbed without effort, breathing no faster than on a country walk at home, and reached "Tom's Serac" in one hour and twenty minutes. We paused there for a brief rest that we hardly needed, while the sun climbed above the great Nuptse-Lhotse ridge to quicken the frozen world about us. We were in a mood of exultant confidence, for we expected that very day to enter the great Cwm.

But immediately above the serac we ran into difficulties. A broad crevasse had opened across our former route and it took us an hour and a half, and a lot of very hard work, to find a way across it. This check, though a salutary warning against over-confidence, was not serious, and it was not until we were over the crevasse that the real trouble began. Here, about 100 yards from the serac, we found that a tremendous change had taken place. Over a wide area the cliffs and towers that had been there before had been shattered as though by an earthquake, and now lay in a tumbled ruin. This had evidently been caused by a sudden movement of the main mass of the glacier which had occurred some time during the last fortnight. It was impossible to avoid the sober reflection that if we had persisted with the establishment of a line of communication through the ice-fall and if a party had happened to be in the area at the time, it was doubtful whether any of them would have survived. Moreover the same thing might happen on other parts of the ice-fall.

With regard to our immediate problem however, we hoped that the collapse of the ice had left the new surface with a solid foundation, though it was so broken and alarming in appearance. Very gingerly, prodding with our ice-axes at every step and with 100 feet of rope between each man, we ventured across the shattered area. The whole thing felt very unsound but it was difficult to tell whether the instability was localized around the place one was treading or whether it applied to the area as a whole. Hillary

was ahead chopping his way through the ice blocks when one of these, a small one, fell into a void below. There was a prolonged roar and the surface on which we stood began to shudder violently. I thought it was about to collapse, and the Sherpas, somewhat irrationally perhaps, flung themselves to the ground. In spite of this alarming experience it was not so much the shattered area that worried us as the part beyond, where the cliffs and seracs were riven by innumerable new cracks which seemed to threaten a further collapse. We retreated to the sound ice below and attempted to find a less dangerous route. Any extensive movement to the left would have brought us under fire from the hanging glaciers in that direction. We explored the ground to the right, but here we found that the area of devastation was far more extensive. It was overhung moreover by a line of extremely unstable seracs.

We returned to camp in a very different frame of mind from the joyous mood in which we had climbed the lower part of the ice-fall only a few hours before. It seemed obvious that although it might be a permissible risk for a party of unladen mountaineers, working on long ropes and taking every available precaution, to attempt the ice-fall (and even this was doubtful) we would not be justified in trying to climb it with a party of laden porters whose movements are always difficult to control. It looked as though, after all, we were to be faced with the decision which we had dreaded three or four weeks before; to abandon the attempt to reach the Cwm, not because the way was difficult but because of a danger which by the very nature of its underlying causes was impossible to assess with any certainty. This does not however mean the total abandonment of the route; for the condition of ice-falls is subject to considerable seasonal variation, and it is not unreasonable to expect much better conditions in the spring than in the autumn. Nevertheless it was a bitter disappointment not to be able to proceed with our plan of carrying a camp through into the Cwm and making a close examination of the route to the South Col. We agreed to defer the final decision until we had made another reconnaissance of the ice-fall with the whole party.

The following day we again climbed the ridge near the Lho La. The view was not very encouraging for we could see no way of avoiding the shattered area, which was in fact a belt stretching right across the glacier, though the upper part of the ice-fall above the corridor so far as we could see was undisturbed. On October 26 the rest of the party arrived back at the Base Camp and next day we all climbed the ridge of Pumori from which Hillary and I had first looked into the West Cwm on September 30. We saw that a certain amount of monsoon snow had been removed by the north-west wind from the peak of Everest, though the north face of the mountain was still in an unclimbable condition. There was no obvious change in the snow conditions inside the Cwm, on Lhotse, or on the South Col.

That evening we reoccupied the camp below the ice-fall and on October 28 all six of us, together with Angtarkay, Passang and Nima, set out for the ice-fall once more. Our chief object was that the others should examine the situation for themselves so that we could come to a united decision; though Hillary and I, too, were anxious to have another look at it. We arrived at the shattered area by the time the sun had reached us. Only minor changes had



taken place in the past five days, and this encouraged us, with great care, to cross it and make our way over the delicately poised seracs beyond. Passang and Angtarkay made no secret of their apprehension, and constantly pointed out to me that it was no place to take laden men. Beyond the corridor we found that the upper ice-fall was in a fairly stable condition, only one serac having collapsed across our former route. By ten o'clock we reached the final wall dominating the ice-fall. The steep slopes below this were in the same dangerous condition as they had been at the beginning of the month; but a fin of ice had become detached from the wall and, while other routes were being explored, Bourdillon succeeded in cutting steps up this which enabled us to reach the top of the wall. This was a fine effort for it involved his cutting his way through a deep layer of unstable snow into the ice beneath. By keeping to the edge of the fin he was able to avoid any risk of a snow avalanche, but as the whole thing overhung a profound chasm into which it might collapse it was as well to avoid having more than one man on it at a time.

We now stood above the ice-fall, on the lip of the West Cwm, and we could look up the gently sloping glacier, between the vast walls of Everest and Nuptse, to its head. But we soon found that we had by no means overcome all the difficulties of entry into this curious sanctuary. A little way farther on, a vast crevasse split the glacier from side to side, and there were indications of others equally formidable beyond. To cross these in their present state would have taken many days of hard work and a good deal of ingenuity, and unless we could carry a camp up to this point we were not in a position to tackle them. I have little doubt that in the spring they would be a great deal easier. We sat for nearly an hour contemplating the white, silent amphitheatre and the magnificent view back across the Khombu Glacier to Pumori, Lingtren and the peaks beyond the Lho La. Then we returned down the ice-fall.

The fact that we had now climbed the ice-fall without mishap made the decision to abandon the attempt to carry supplies through into the Cwm all the more difficult. We discussed it at great length. The next day Ward and Bourdillon climbed the ridge near the Lho La to satisfy themselves that there was no alternative route, while Hillary and I paid one more visit to the ice-fall. Angtarkay and Passang were still convinced that it would be madness in the present conditions to try to carry loads through it, and unfair to ask the Sherpas to do so. There was nothing for it but to submit, hoping that we would get another chance in the spring.

### *Exploratory journeys*

Our failure to make a safe route up the ice-fall, and so to bring camps and supplies through into the West Cwm, disappointing though it was, had one great consolation, for it allowed us more time than we might otherwise have had to explore some of the great areas of unknown country along the southern side of the main range. During the period between our two visits to the ice-fall we divided into two parties. Murray, Riddiford, Bourdillon and Ward made their way westward from the Base Camp, up a long tributary glacier which took them past Pumori and along the southern side of the watershed. Apart

from the exploration of the area, their chief object was to find a pass across the range to the north, which the Sherpas had told us about. We assumed that it must lead over to the West Rongbuk glacier and it was hoped that the party might be able to climb Pumori from there. I was particularly interested in this alleged pass in view of our failure in 1935 to find any route across this part of the range. They found however that no such pass existed.

From the head of the tributary glacier they crossed a col which led them into the upper basin of the Dudh Kosi at the head of which they found themselves in a mighty cirque formed by the two great mountains of Cho Oyu (26,867 feet)<sup>1</sup> and Gyachung Kang (25,910 feet). On the eastern flank of this cirque was the Nup La which had been reached by Hazard from the Tibetan side in 1924. For two days they climbed towards this col up an ice-fall, a good deal more difficult than the West Cwm ice-fall though much less dangerous, before they finally gave up their attempt to reach the watershed. Then they descended the Ngojumba Glacier and the Dudh Kosi valley to Namche.

Meanwhile Hillary and I explored the country to the south of Mount Everest. Our chief objective was to find a way through the tangle of ranges to the Kangshung glacier which flows from the eastern flanks of Everest, and so to link up with the explorations of the 1921 Reconnaissance Expedition. In this project we were stimulated by the Sherpas' statement that at the head of the Imja Khola there was a pass leading over to Kharta in Tibet. We took with us a young man called Ang Dorje who knew that valley well and who was most insistent that the pass existed. The upper basin of the Imja is contained on the north by the Nuptse-Lhotse wall and on the east and south by dozens of unnamed peaks between 20,000 and 24,000 feet high. When we reached its head we saw at once that there was no practicable way across the mountain to the east. Ang Dorje was not in the least abashed, and merely said that he had supposed that we, as mountaineers, would find a way. Turning southwards however we succeeded with some difficulty in crossing a col about 20,000 feet high over into the basin of the Hongu Khola, where we camped on the shores of a big lake. We looked across a wide basin to the peaks of the Chamlang massif. We were now well beyond the country known to the Sherpas. We found evidence that the Hindu Nepalis from the south penetrated with their flocks to these lofty valleys.

We crossed the Hongu basin to the eastward and found a pass (about 20,300 feet) leading over to the great Barun glacier flowing south-eastwards at the foot of Makalu (27,790 feet). From here, if we had had another three days' food with us, we could undoubtedly have reached the Kangshung. Another tantalizing project that presented itself, if only we had had the time and resources to undertake it, was to descend the Barun and to plunge into the great unexplored gorges leading down to the Arun River. But once embarked upon this game of mountain exploration in these remote ranges there is no end to its fascinating possibilities.

All this time the weather was fine and the period spanned the full moon. The nights were very cold. The mornings were sparkling clear; each afternoon cloud welled up out of the valleys and wrapped the peaks, each evening at sunset it dissolved. It was then, in camp, that we saw this stupendous

<sup>1</sup> Earlier editions of the Survey of India map give the height as 26,750 feet.

country at its best, for each peak in turn was framed in shifting mist, its golden tracery of ice glowing in deep relief; no longer a mere part of a mountain massif but floating in sublime isolation. Before the cloud had quite vanished, the moon would climb above some lofty crest, and presently all the peaks were there again, frozen against the night sky.

Returning across the Hongu basin we crossed a third pass, also about 20,000 feet, on its western rim just to the south of the beautiful peaks of Ama Deblam which, as we had hoped, took us back into the valley of the Imja Khola. Finally we crossed a high ridge running southward from Nuptse and so back to our Base Camp on the Khombu Glacier.

Our third field of activity was the Gauri Sankar range which we set out to explore at the beginning of November after work on the ice-fall had been abandoned. We went north-west from Namche along the valley of the Bhote Kosi. At Thami, Hillary, Riddiford and the geologist Dutt, who during October had been carrying out extensive geological investigations over a wide area, turned up a valley to the west and crossed the Tasi Lapcha. This pass though involving some difficult ice climbing was known to, and occasionally used by, the Sherpas. It led through a mass of spectacular granite peaks over a northerly offshoot of the main range into a most remarkable gorge known as the Rolwaling, running westward under the southern precipices of Gauri Sankar. The rest of us continued along the Bhote Kosi to the little grazing village of Chhule. From here Murray and Bourdillon, taking four days' food with them, went on to visit the Nangpa La, the pass by which the trade route crosses from Solu Khombu to Tibet. It is approached on either side of the watershed up a long glacier and is situated in an extensive icefield at an altitude of more than 19,000 feet. It is, so far as I know, the highest pass on any trade route in the world. It carries a considerable volume of traffic throughout most of the year, and deep grooves worn in the glacier ice bear witness to the passage of countless yaks. No ponies are taken across; not because it is too high, for ponies are used extensively in the Karakoram Pass which is not much lower, but because of a curious superstition that if anyone attempts to take a pony across not only will the pony die but the owner will also perish. It is by way of the Nangpa La that the Sherpas have their intimate contact with Tibet; large numbers of them cross it each year not only to trade, but to make a pilgrimage to the Rongbuk Monastery. From near the pass, Murray and Bourdillon saw a possible way of climbing Cho Oyu.

From Chhule, Ward and I made our way westward into a group of high mountains whose position in relation to the main range was difficult to determine. After some time spent in reconnaissance we found what seemed to be the only way through them, over a col which we subsequently named the Menlung La. Travelling very light and taking enough food for a week, we crossed this col together with Sen Tensing. It led over to a large glacier system, the main ice-stream of which was flowing southward; which suggested that we were still on the southern side of the main range. However when we came to explore our new surroundings we found that we were in a vast amphitheatre, in many respects very like the Nanda Devi basin, in the centre of which, completely isolated from the main massif, stood a

most lovely peak of pale granite. It was the highest peak of the range, being somewhat higher than Gauri Sankar. We named it "Menlungtse." We found that the waters of the basin drained to the north-west and plunged directly into a system of tremendous canyons the main artery of which we identified as the Rongshar. It is one of those remarkable rivers which, like the Arun, rise far to the north on the Tibetan plateau and have cut their way clean through the great Himalayan range. It is certainly one of the most spectacular gorges I have seen. We also succeeded in reaching the crest of the main range south of Menlungtse at a point about 19,500 feet high. From here we looked straight down 7000 feet into the Rolwaling. Sen Tensing told me that this name was a Sherpa word meaning the furrow made by a plough. We were surprised to find that there was a way down the huge precipices into the gorge.

It was on one of the glaciers of the Menlung basin, at a height of about 19,000 feet, that, late one afternoon, we came across those curious footprints in the snow which have caused some public interest in this country. We did not follow them farther than was convenient, a mile or so, for we were carrying heavy loads at the time, and besides we had reached a particularly interesting stage in the exploration of the basin. I have in the past found many sets of these curious tracks and have tried to follow them but have always lost them on the moraine or rocks at the side of the glacier. These particular tracks seemed to be very fresh, probably not more than twenty-four hours old. When Murray and Bourdillon followed us a few days later the tracks had been almost obliterated. Sen Tensing, who had no doubt whatever that the creatures (for there had been at least two) that had made the tracks were *Yetis* or wild men, told me that two years before he and a number of other Sherpas had seen one of them at a distance of about 25 yards at Thyangboche. He described it as half man and half beast, standing about 5 feet 6 inches, with a tall pointed head, its body covered with reddish brown hair but with a hairless face. When we reached Katmandu at the end of November, I had him cross-examined in Nepali (I conversed with him in Hindustani). He left no doubt as to his sincerity. Whatever it was that he had seen he was convinced that it was neither a bear nor a monkey, with both of which animals he was of course very familiar. Of the various theories that have been advanced to account for these tracks, the only one which is in any way plausible is that they were made by a langur monkey, and even this is very far from convincing, as I believe those who have suggested it would be the first to admit.

These various exploratory journeys gave us an intimate knowledge of a stretch of 60 miles of the Great Himalaya Range, in a country hitherto practically unknown to western travellers. This form of mountaineering, the exploration of unknown peaks, glaciers and valleys, the finding and crossing of new passes to connect one area with another, is the most fascinating occupation I know. The variety of experience, the constantly changing scene, the gradual unfolding of the geography of the range are deeply satisfying, for they yield a very real understanding, almost a sense of personal possession, of the country explored.

(The text of the above paper is taken from 'Everest reconnaissance 1951, by Eric Shipton; to be published by Messrs. Hodder and Stoughton Ltd.

in the autumn of 1952, with over sixty plates. It is, of course, a fuller account of the Expedition than was contained in the spoken address given by Mr. Shipton at the Evening Meeting of 4 February 1952 which resulted in the following discussion.—*Ed. G. J.*)

## DISCUSSION

### *Evening Meeting, 4 February 1952*

Before the paper the PRESIDENT (Mr. J. M. WORDIE) said: The speaker tonight is Mr. Eric Shipton who has made no less than ten expeditions to the Himalaya, of which five have been to Mount Everest. There is probably no one else in this country so well qualified to speak about Everest as is our lecturer this evening.

*Mr. Eric Shipton then read his paper*

Professor G. I. FINCH: I am not going to attempt to add anything to the most interesting discourse which Mr. Shipton has given us. I ask you to look with me a little into the future, with a view to helping Shipton and his friends to climb Everest by the South Col, which we all sincerely hope they will attempt in 1953.

I am convinced from the photographs I have seen and, above all, by Mr. Shipton's clear, sober description and careful balancing up of potentialities of the route and all its objective dangers, that he has found in the West Cwm a practicable route to the summit. I am also convinced that most if not all of the upper part, above say 24,000 or 25,000 feet, is probably more suitable for an assault on a mountain of the height of Everest than the route which we have known hitherto, leading up the North Col and the north side of the mountain.

But there is one very large measure of help which I should like to see offered to Shipton and his party. What is wanted is some way of converting the ascent of the great ice-fall from a pack route (which it will have to be if they are going to carry all their own equipment up into the great basin of the West Cwm) into a climber's route—a climber's route whereby they will not have to carry or pack anything up through that broken ice-fall but will merely have to climb it under what I might call ordinary Alpine climbing conditions. The party should be supplied with all the stores they need by means of air drops into the basin of the West Cwm. It's a matter of expense. But if you do not incur that expense you are risking men's lives in continually moving up and down and packing heavy weights; and having therefore to move slowly up through that ice-fall to the West Cwm.

The South Col is obviously a practicable proposition, with a reasonable measure of objective risk. I am not saying there is no risk; there is a risk in the ice-fall, but it is a reasonable measure of objective danger which a responsible party can undertake provided they are lightly loaded and able to move fast. The risk entailed in the packing of heavy loads over the ice-fall, by necessarily slow-moving porters, is altogether another matter and should not be incurred. I therefore hope that Shipton's party will be provided with a reliable air-lift for stores into the great basin above the ice-fall.

The PRESIDENT: We all wish Mr. Shipton every success, not only in the attempt he is to make this year on Cho Oyu, but in the greater venture which will be made in the year following. It is hoped that the Nepalese Government, which gave permission for the reconnaissance in 1951, will be willing also to give permission for the bigger party in 1953.

# THE SURVEY OF INDIA SINCE THE SECOND WORLD WAR

BRIGADIER G. F. HEANEY

IN CONSIDERING a title for this paper my first thought was to call it "The Survey of India since the partition of India." Further reflection showed that this would be misleading; it would indicate that the big changes in policy in the employment and organization of the Survey of India were the result of the termination of British rule and the partition of India. In fact they were not, but have resulted far more from economic and world conditions arising since the war than from political changes in India itself. The partition of India and the termination of British rule altered the area of responsibility of the Survey of India and caused serious difficulties by the departure of experienced British officers; it did not however affect the general lines on which the Survey of India was working, except perhaps to increase potential demands for cadastral surveys from areas which had formerly been ruled by Indian princes. Of this I shall have more to say later.

## *The history of the Survey of India*

Except just round the foreign settlements on the coast, no land surveys in the modern sense of the word had been made before the Franco-British wars of the Carnatic, in the days of Dupleix, and before the coming of Robert Clive to Bengal in the middle of the eighteenth century. The interior of India was then known only from travellers' tales. During the extension of British influence in the latter half of the eighteenth century British surveyors gave a good start to surveying by route traverses and astronomical fixings. These were mostly made by military officers marching with troops or on political missions. By the year 1800 political stability had been achieved in south India and this permitted the beginning of scientific survey work. Two great surveyors, William Lambton the geodesist, who in 1802 began the geodetic triangulation of India, and Colin Mackenzie who in 1815 became the first Surveyor General of the whole of India, laid the foundations on which the work of the Survey of India has since developed. Both were Army officers.

Mackenzie began systematic detailed surveys and aimed at completing one area and producing topographical maps on the 1-inch to a mile scale before moving on to the next. Revenue surveys on large scales were started in Bombay about 1812, and in Bengal some ten years later. These revenue surveys became of increasing importance and gradually developed into the elaborate field-by-field cadastral surveys that formed a distinct branch of the Surveyor General's department during the latter half of the nineteenth century. After Lambton's death, his work was carried on by George Everest,<sup>1</sup> who in 1830 started the Great Trigonometrical Survey of India in its modern form and attracted to its service the first of a succession of very able officers, mostly military engineers, who not only extended the principal triangles

<sup>1</sup> Whose name was subsequently given to the mountain.

throughout the length and breadth of the country but introduced and developed the important geodetic activities of high precision levelling and tidal, gravity and astronomical observations which have ever since remained important activities of the Survey.

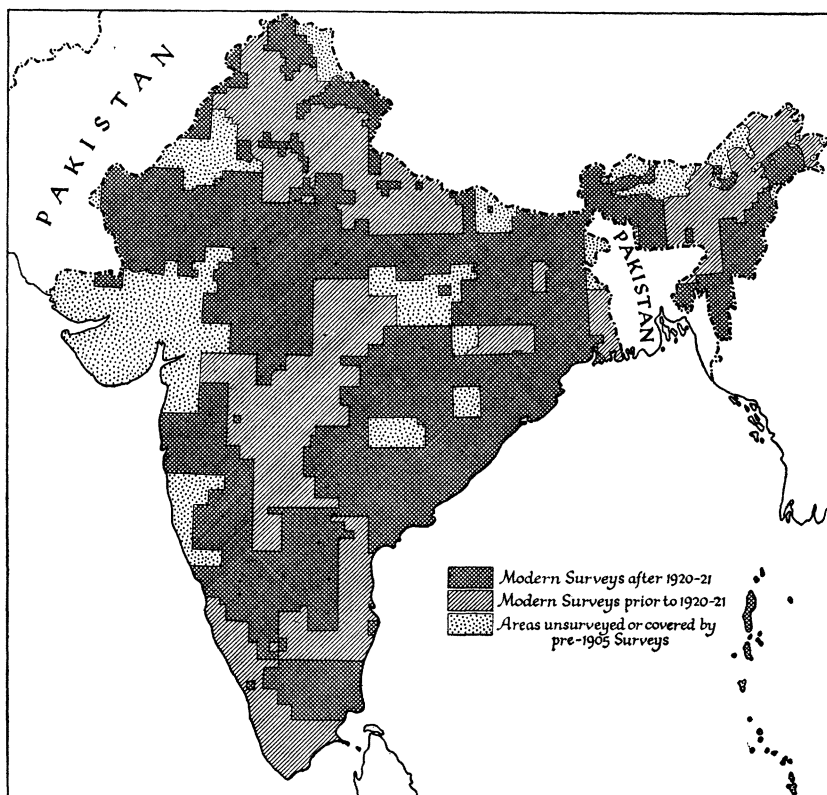
In the interests of economy, every effort was made in the nineteenth century to draw general maps from the revenue surveys; purely topographical surveys were in general confined to the less inhabited portions of the country. As the revenue surveys made no attempt to indicate the topography of uncultivated land, and as there was no attempt to cover the whole of India with a continuous topographical survey, large areas were left blank or mapped in patches. The only continuous map was the  $\frac{1}{4}$ -inch to a mile 'Atlas of India.' Soon after 1860 Thomas Montgomerie, who had been responsible for the survey of Kashmir, inaugurated the regular employment of special surveyors for trans-frontier exploration. These surveyors, often in disguise, penetrated northwards through the mountain barriers on the frontiers of India and brought back route surveys of Tibet and other little known lands beyond. In 1867 the Surveyor General's department, which was divided into trigonometrical, topographical and revenue branches, was officially designated the Survey of India.

Early in the twentieth century a strong demand was made, more especially by the army and the various engineering departments of the Government, for better maps. As a result a large increase had to be made in the establishment of the Survey of India, and to provide for the enormous amount of work required for the programme of new topographical surveys, it was reluctantly decided to throw responsibility for all revenue surveys on to the local or provincial governments. Looking back, this decision seems to many of us unfortunate; but the urgency for new topographical surveys was so great that something had to go. A new topographical survey was begun in 1905 with a view to covering India with contoured maps, published in colours, on the scale of 1-inch to a mile. The intention then was to complete this new survey in twenty-five years and to revise it at twenty-five-year intervals. A short time later it was decided that surveys on the scales of  $\frac{1}{2}$ -inch or even  $\frac{1}{4}$ -inch to a mile would be adequate in the less developed parts of the country.

From 1905 until 1939 the chief preoccupation of the Survey of India was the execution of this new programme of surveys and mapping. Shortage of money and the diversion of part of the resources of the department to other types of work delayed progress, which after 1939 virtually came to a standstill owing to the war. The result was that when India was partitioned in August 1947, about 180,000 square miles of what then became India, including Hyderabad, but excluding Kashmir, were not covered by modern style surveys; and about another 340,000 square miles were covered by modern style surveys more than twenty-five years old, many of them badly in need of revision. Since then Kashmir has acceded to India and the figures given above must be increased. By the end of the war it was also beginning to be felt that a larger scale than 1-inch to a mile was required for topographical maps in areas likely to be of commercial or strategic importance and a decision was made to provide  $\frac{1}{25,000}$  scale topographical surveys in such areas. (Fig. 1.)

Towards the end of hostilities in the Second World War, it became evident

in India that, owing to the growth of population and the loss of Burma rice, increased agricultural production would be one of the main necessities of the country in future. This position was later aggravated by the loss of wheat, cotton and jute growing areas to Pakistan. As a result, a very large number of multi-purpose projects, some of which were new and some of which had been investigated before but pigeon-holed, came under active consideration. There was an immediate demand for surveys in connection with these projects and



*Fig. 1. The progress of topographical survey*

this demand fell almost entirely on the Survey of India—as being the only organization with a staff capable of undertaking the work.

The close of the war and the subsequent partition of India gave a great stimulus to geodetic and geophysical work. This has largely taken the form of demands for high precision levelling to provide basic data for irrigation and power projects and for gravity surveys to assist exploration for oil by geophysical methods. There has also recently been renewed interest in tidal observations, the data on which tidal predictions are based being in many cases old and inadequate. The increase in civil aviation after the war also made it apparent that special aeronautical maps would soon be required, although for



a time this demand was met by the supply of maps prepared for the air forces during the war.

Summarizing what has been said above, the situation facing the Survey of India after the war was :

- (a) A very large area of the country was still not covered by the series of 1-inch contoured surveys which had been begun in 1905; and a demand was already making itself felt for topographical maps on a larger scale.
- (b) There were pressing demands (i) for surveys for multi-purpose projects, chiefly on the 4-inch to a mile scale with close contouring; (ii) for gravity surveys to provide a basic framework on which detailed investigations could be made by others; (iii) for high precision levelling to control the project surveys; and (iv) for new tidal observations and modern methods of tidal computation.
- (c) A new commitment had been undertaken for the production of special maps for Civil Aviation.

#### *The cost of surveying since the war*

At this point I must make a digression. The surveyor like most other people is largely governed in his methods and organization by economic considerations. In the past, one of the sources of justifiable pride of the Survey of India was in its plane-table surveyors. These men, who generally had little education, were recruited on very low pay and were equipped with very simple instruments. By rigorously eliminating unpromising pupils, a large body of plane-tablers was built up which carried out admirable topographical surveys, especially on small scales. Each plane-tabler had a squad of about five *khalasis* (survey labourers) to do chaining, carry instruments, etc., and who, before the war, were paid an average wage of about Rs.14 per month. The plane-tabler himself received on an average about Rs.70 a month. Local transport was also usually very cheap and easily procured. The result was that small scale topographical surveying by plane-table in India was very inexpensive.

The rise in the cost of living since the war and the introduction of the New Pay Code early in 1947 has completely altered the position. The plane-tabler who before the war cost Rs.70 now costs an average of Rs.130 per month, while the cost of keeping a *khalasi* in the field has jumped from Rs.14 to about Rs.75 per month. The cost of local transport has gone up in similar proportions. And, in common I believe with workers throughout the world, the plane-tabler is not prepared to work such long hours as he did in the past. The result of all this is that, far from being cheap, plane-table surveys now cost about four times what they did before the war, and we have been forced increasingly to turn to other methods.

Since 1925 the Survey of India had been using air photography for survey purposes. On the old North West Frontier its use was forced on us owing to the inaccessibility of the area to plane-table surveyors. Elsewhere the practice was to use graphical methods of plotting to obtain the outline of topographical features from the photographs, while contours were generally obtained by ground work. Here, too, we were taking advantage of cheap

labour; but as this is not now obtainable for survey work, India in common with most other countries will in future, so far as can be seen, carry out more and more of its work by air survey methods using automatic plotting instruments such as the Multiplex and Wild A-5 and A-6. For some years past the Government of India has had a contract with a firm which specializes in air survey and air photography for survey purposes to supply the department with the photographs it requires. The Survey of India has recently installed three tables of Multiplex plotting equipment, and hopes to install more plotting machines in the future. These should reduce costs by cutting down considerably the amount of ground work required and increasing the output per man.

### *Events at the partition of India*

No account of the Survey of India in recent years would be complete without some reference to the events of 1947 when British rule terminated and India was partitioned.

For some months prior to the change which occurred on 15 August 1947, the shadow of great impending political changes affected all considerations of policy and planning. I remember listening to the radio with a group of others at the club one evening in June 1947 in Dehra Dun. The Prime Minister of India Mr. Jawaharlal Nehru, Mr. Jinnah for the Muslim community and Sardar Baldev Singh for the Sikhs all made speeches announcing their acceptance of the plan for the partition of India. Somebody remarked to me "It looks as though you will have to get moving pretty soon." This proved to be somewhat of an under-statement. Within a few days I received a telegram from the Government of India instructing me to put up detailed proposals, within what seemed a very inadequate time, for the complete partition of all assets, including personnel, of the Survey of India between India and Pakistan. We certainly had to act quickly, though our problems could have been no worse than those of other all-India departments.

We were fortunate in having a survey office established in Murree in the northern Punjab, in the area which is now Pakistan, and so had some nucleus on which to build there. As far as possible, all personnel opting for Pakistan were transferred before August 15, and so avoided moving during the period of maximum disturbance in northern India shortly afterwards. I think I am correct in saying that there was no loss of life amongst Survey of India personnel as the result of the communal riots following partition. In Delhi we had some anxious times with certain of our Muslim staff who did not wish to go to Pakistan. It became necessary to transfer them out of Delhi, and they asked to go to Calcutta which was then quiet. Their Hindu colleagues were very good in lending them clothes to disguise themselves; they were taken down to the station dressed as Hindus, complete with sacred cords, and were shepherded to an inconspicuous place in a third-class compartment in the train, where it was hoped their obvious agitation would not betray them. At the last minute, just as the train was about to leave, a party of formidable-looking bearded individuals armed with long swords entered their compartment to the great consternation of the disguised Muslims. Considerable apprehension was felt about the possible fate of our people after the train

started, but we were glad to receive a telegram a couple of days later announcing their safe arrival in Calcutta.

For the Survey of India, the effects of partition on personnel were for a time almost crippling. The majority of the British officers who were holding the senior posts left within six or seven months. Among the lower paid technical staff there was a very high proportion of Muslims, nearly all of whom went to Pakistan, and this left us with a great shortage of plane-tableers, traversers, draftsmen and map reproduction technicians. We found ourselves for a time quite unable to meet the majority of demands made for surveys. In August 1946, just a year before partition, the Government had sanctioned a considerable increase in the establishment of the Survey of India in view of the increased demands for its services. The loss of our British and Muslim personnel made our establishments look very empty. A recruiting programme was undertaken but this had the effect of accentuating the shortage for a time, by removing some of our more skilled remaining personnel as instructors.

After a short period of uncertainty the Government of India agreed that the pre-partition establishments should, with one or two unimportant modifications, apply to the India remaining after partition. This was in effect a second increase in the establishment of the Survey since the war, as the area now to be covered was considerably smaller than it had been. The effect of this double expansion, combined with the loss of senior officers, resulted in the promotion of officers to senior positions which a few years previously they could never in their wildest dreams have aspired to occupy. In those very disorganized times due consideration could not, unfortunately, always be given to merit, and not all those promoted have proved themselves worthy. The most remarkable feature of this rapid promotion has however been its illustration of the adaptability to responsibility of many individuals. It would be incorrect to say that there have been no lapses from proper standards of technical or administrative efficiency, yet the results of these promotions have certainly been much better than most people expected. More recently the Government of India has enforced a policy of rigid selection of those best qualified for promotion, without undue regard to seniority, and this has given openings for many very promising junior officers. By the end of 1948 the corner had been turned and the efficiency of the Survey was definitely improving.

#### *The composition of the Survey of India*

Before the war the majority of executive officers (those in charge of field Survey Parties, Drawing Offices, etc.) and the higher administrative officers, were commissioned officers of the Royal Engineers. These constituted the Class I Service; below this was a service of junior gazetted officers recruited in India from college graduates; this was the Class II Service. Below this again were Upper and Lower Subordinate Services of technicians. The former were recruited from those with educational qualifications of not less than Intermediate standard; the latter had no particular educational qualifications and comprised the bulk of the plane-tableers, traversers, levellers and other field staff.

An interesting development has been the attitude of the independent Government of India towards the employment of regular military officers of

the Corps of Engineers in the Survey of India. For some time before the termination of British rule there had been a tendency in certain government quarters to deprecate the employment of military officers in civil departments such as the Survey of India; and shortly before partition it was decided that the composition of the Class I service would be 37½ per cent. military officers, 37½ per cent. directly recruited civilian officers, and 25 per cent. officers promoted from lower services. Since partition however, the armed forces have shown an increasing interest in the Survey of India and it has now been decided that the Surveyor General of India shall always be a military officer and that 50 per cent. of the Class I service shall in future be recruited from military officers, at the expense of the quota of directly recruited civilians. It has also been decided to keep a Military Survey Service in existence in peace time.

Before the war the Survey of India was responsible for military survey preparations, the link with the Army being a staff captain at Army Headquarters in the Military Intelligence Branch of the General Staff. The new Military Survey Service is very small and has inadequate personnel to carry out more than a limited amount of technical work, and such staff duties as the Army requires in peace time. The bulk of military survey and mapping requirements are therefore still met by the Survey of India. To secure coordination and make the best use of the limited resources available, the Surveyor-General of India is, in peace time, also the Director of the Military Survey Service. Under him on the military side is a military staff paid entirely by the Army. In order to provide the Military Survey Service with trained survey officers the Survey of India will arrange to post back its military officers periodically for tours of duty with the Military Survey Service.

#### *The spelling of geographical names*

One of the responsibilities of the Survey of India is for the spellings of geographical names; and during the last few years this has been a constant source of concern. In the days of British rule the *Gazetteer of India* was the authority for the spelling of all names appearing in it, and it was the responsibility of the Surveyor-General to bring to the notice of the authorities the need for any changes in *Gazetteer* spellings. If a name did not appear in the *Gazetteer of India* the authoritative spelling was that appearing on a modern Survey of India map. The normal way of obtaining this spelling was to get the best version of the name spelt in the local script, obtain the concurrence of the local civil authorities and then to transliterate this into Roman script according to the recognized system of transliteration. This was all right for names written in the Urdu or Devanagri scripts used in northern India. A weakness of the system was that there were no standardized systems of transliteration applicable to some Indian languages, especially those of southern India such as Malayalam, Telugu and Tamil. As English was very largely used in southern India the usual practice was to apply to the Provincial authorities, ask them for the spelling in Roman characters and accept that.

Another difficulty has arisen from the fact that when the Hunterian system of transliteration was adopted in about the 1880's certain well-known geographical names were allowed to remain unchanged, although it was recog-

nized that they were not correct transliterations of the spellings in the local script. Examples are the names Ganges, Delhi and Cawnpore, which if correctly transliterated should be Ganga, Dehli (from the Urdu) and Kanpur respectively.

Under the newly approved Indian Constitution the aim is to adopt Hindi, written in the Devanagri script, as the national language of India in fifteen years. It seems certain however that, for some time at least after that, it will still be necessary for the Survey of India to produce editions of the maps of India in the Roman script. From the time of the adoption of Devanagri as the national script, the authoritative spelling for any Indian geographical name will be the Devanagri version of it, and the Roman version will be this name transliterated into Roman characters according to the recognized system of transliteration. As we have just seen however, there is no recognized system of transliteration into Roman of many Indian scripts; still less are there recognized systems for transliterating all the Indian scripts into Devanagri. Until these systems of transliteration are agreed on, any attempt to change names in Roman script now might merely result in the name having to be changed again on the adoption of Hindi as the national language.

In view of this, and of the seriousness of changing a name already well known throughout the world, the Central Government in India has been very cautious about adopting any changed spellings of names. Unfortunately the Provincial (now State) governments have been by no means so cautious, and shortly after partition some of them set about issuing revised spellings of many names in their territories without apparently recognizing the difficulties that might be involved, or without consulting the Surveyor-General. Certain Central Government departments, such as Posts and Telegraphs, followed suit. Had these changes in spelling been merely to correct obvious errors in such existing spellings as Cawnpore for Kanpur, not much harm would have been done. Unfortunately, some of the revised spellings are just as wrong as those they sought to correct; and many of them are not even consistent among themselves. For example, many southern Indian names terminate in what the British spelt "patam," such as Vizagapatam and Seringapatam. This word should really be "patnam" (meaning "town"). In the revised spellings issued by the State government this is variously rendered "patnam", "patnam" and "patinam" and, in the absence of standardized systems of spelling and transliteration, it is impossible to say which is correct; all one can say is that all three can hardly be right.

Central Government departments have now agreed not to alter further names or adopt new spellings without consulting the Surveyor-General, and so have all the State governments with one exception; so it is to be hoped that before long something will be done to systematize spellings. I think it fairly certain that some of the changed names, such as Kanpur, will be adopted but I would not like to hazard a guess about the future spelling of names such as Delhi.

#### *Survey work carried out since the war*

I now propose to give a brief account of the survey work carried out since the war. I include some details of the project surveys as the scope of the

projects may be of interest. The main survey work on which the Survey of India has been engaged can be conveniently divided into the following classes: (a) Regular topographical surveys for standard Survey of India map series on the 1/25,000 and 1-inch to a mile scales; (b) geodetic and geophysical survey work; (c) project surveys; (d) cadastral surveys; and (e) training. I give below some account of each of these classes of work.

*Regular topographical surveys.* Owing to the urgency of demands for other work, little progress has been made since the war in the completion of the programme of topographical surveys begun in 1905. A few thousand square miles have been surveyed in Bombay State where the existing maps were from uncounted surveys upwards of seventy years old. A beginning has also been made on the 1/25,000 series in Kutch, in connection with the new port of Kandla.

*Geodetic and geophysical surveys—geodetic triangulation.* The whole topographical survey programme of the Survey of India is based on the network of geodetic triangulation largely completed in the last century. Many of the stations of this triangulation were on brick towers which have since fallen down. Other stations have been lost; and there is now a definite danger that sections of this geodetic framework may be completely lost. We were fortunate in getting a set of Bilby portable steel towers from American disposals shortly after the war; I have often wondered just why the American forces brought these Bilby towers to India, as they certainly never used them there, but I am very glad that they did. The towers were tried out on the triangulation in connection with the fixation of the East and West Bengal boundary astride the Ganges, where they have proved a success. We shall also use them largely in connection with the rehabilitation and strengthening of the geodetic triangulation framework; it is hoped to begin a regular programme in the near future. Since the war we have re-observed and strengthened some geodetic triangulation in Kutch where it was urgently needed in connection with surveys for the new port of Kandla. We have also begun a new geodetic series which will cover the Andaman Islands. This work, which should have been finished early in 1952, had to be discontinued in 1951. It is interesting to note that precise observations for latitude and longitude in the seasons 1950-51 have resulted in a correction of +30" to the previously accepted longitude of Chatham Island, the datum station for the latitude and longitude of the Andaman Islands. The extension of the high precision level net has made some progress and has been given considerable stimulus by the demand for levelling for irrigation projects.

*Tidal observations.* The demand during the last few years for the development of the Indian Navy and mercantile marine has focussed attention on the need for improved tidal predictions for Indian ports. The Survey of India has been making tide predictions for many years for many of the ports on the Asian shores of the Indian Ocean, but the observations on which predictions are made are generally old, and were often somewhat inadequate in the first place.

We are now installing a number of automatic tide gauges at the more important ports. A field party has also been employed for the last couple of seasons doing twenty-nine-day observations at numerous new ports, and this

will enable tide tables to be prepared for them also. Our tide predicting officer was sent to the Tidal Observatory at Liverpool in 1949 for a course in the latest methods of prediction; and we have accepted the view of the Director of the Liverpool Tidal Observatory that our present tide predicting machine, which has been in use since 1888, is inadequate. We have accordingly ordered a new machine with forty-two components and hope it will be ready for use this year.

*Magnetic survey.* We had hoped to resume work on magnetic observations, but unfortunately funds have not permitted the establishment of a new magnetic observatory near Dehra Dun in place of our old one which was rendered useless by the encroachment of buildings and electric power lines.

*Gravity observations.* As I have already noted briefly, gravity observations have received a great impetus since the war as there is a strong desire on the part of the Government of India to exploit oil and mineral resources to the full. A couple of years ago we purchased a modern gravimeter and have been carrying out observations in areas which the geologists consider promising for mineral prospecting. The function of the Survey of India in this work is to provide a network of gravity stations throughout India which can be used by geologists and others engaged in mineral and oil prospecting, as bases for their detailed work in particular areas. We hope to purchase in the not too distant future a gravimeter of another type which it is felt may be more satisfactory for the particular type of work we require.

*Project surveys.* I have referred above to the great demand for project surveys and the location of the principal surveys we have undertaken in this connection is shown in Figure 2. The most common type of project is for a combination of purposes, such as the generation of hydro-electric power, irrigation, flood control and soil conservation. The normal scheme of such projects is for the erection of a dam in a river gorge and the use of the impounded water for irrigation and the production of electric power. In the preliminary investigations, the work required of the surveyor is to outline the area that will be flooded if a dam is made at a selected location and of a given height. Contoured maps or contoured air photo-mosaics are therefore required to enable the engineers to estimate the volume of impounded water. A large-scale survey, generally on a scale of about 1/2400, is also required of the dam site. The third and much the largest task is to survey the area to be irrigated. Generally maps of the commanded area are required on a scale of 4 inches to the mile, with contours at 1- or 5-foot intervals; and a large number of bench marks have to be sited at regular intervals on the ground. The object of these maps and surveys is to enable the engineers to make a preliminary siting of their canals and distributaries on the map, and to do the final layout on the ground.

The main surveys of this kind that we have carried out recently have been in connection with the following projects:

(1) *The Mahanadi project*, near Sambalpur in Orissa. This whole project envisages the construction of three dams at Hirakud, Tikkapara and Naraj. The first named has priority and the survey work is complete, and work has already begun on the construction of the dam. The objects of this project are flood control in the Mahanadi delta, the generation of electric power, the

irrigation of about 900,000 acres, and an improvement in navigability of the Mahanadi river itself. I understand that the work on the Hirakud portion of the project is scheduled to be complete within five years.

It is interesting that there was much local opposition to this scheme, not only as might have been expected from those who would lose their lands and homes through flooding by the reservoir, but also by those whose lands would be irrigated. Their argument was that their taxation would go up, they would have to work harder to pay it, and would in many cases have to

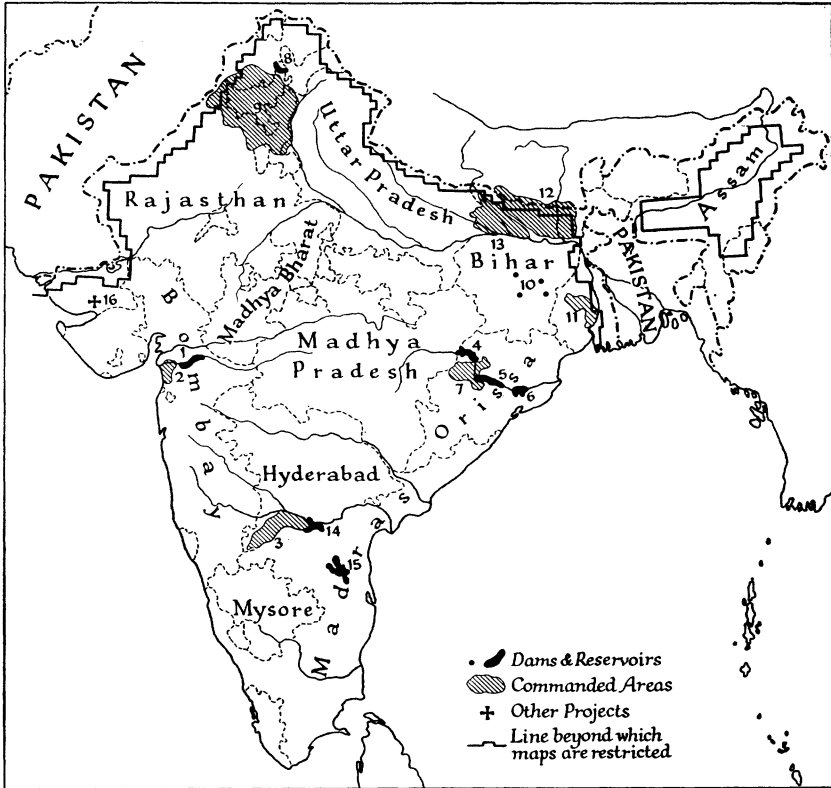


Fig. 2. Project surveys <sup>1</sup>

grow two crops in a year where one had previously been enough for their needs. The opposition took the form of removing bench marks, and in some areas about a quarter of the bench marks set up in one year were found to have been removed when work was resumed the next year.

<sup>1</sup> The projects numbered in Figure 2 are the following: 1. Kakarpara dam and reservoir; 2. Kakarpara commanded area; 3. Tungabhadra commanded area; 4. Hirakud dam and reservoir; 5. Tikkarpara dam and reservoir; 6. Naraj dam and reservoir; 7. Hirakud commanded area; 8. Bhakra-Nagal dam and reservoir; 9. Bhakra commanded area; 10. Damodar valley; 11. Damodar valley commanded area; 12. Kosi commanded area; 13. Gandak Barrage commanded area; 14. Kistna dam and reservoir; 15. Pennar dam and reservoir; 16. Kandla port development.



(2) *The Kosi project.* This relates to the construction of a very high dam in the gorge where the river Kosi leaves the hills in Nepal. The proposed dam is to have a height of about 780 feet, which I think would make it the highest dam in the world, and the main purpose of the scheme is flood control of the Kosi (Bihar's Yellow River) which floods annually, and frequently causes untold devastation in the plains of Bihar by changing its course. In addition to the high dam, a barrage is to be constructed a few miles lower down. Survey work on this project was stopped in August 1950 and I am not sure when construction work will begin. The dam would be uncomfortably close to the epicentre of the very severe Bihar earthquake of 1934 and the rate of silting would also be likely to cause difficulty.

(3) *The Bhakra-Nangal project.* This envisages a dam about 680 feet high across the river Sutlej in the Punjab, near the point where it leaves the hills, and another dam at Nangal about 8 miles downstream. Survey work on the areas to be irrigated by this scheme has been going on intermittently for many years but has recently assumed very high priority; work on the Nangal dam is already under way. From this an extensive canal system will take off and eventually, should the whole scheme come to fruition, large quantities of electrical power will be available as far afield as Delhi; the irrigation will transform arid areas like Hissar district in the East Punjab, which suffer from chronic shortage of rainfall and periodic famines.

As most of the area which will be served by the Bhakra project is not fully cultivated, the main task of the surveyor is to divide this land into rectangles of 3000, 100 and 25 acres respectively. At the corners of these rectangles stones are embedded, the heights of which are fixed by levelling. The survey work thus serves the double purpose of dividing the land into a system of rectangular plots and covering it with a close network of bench marks. It is anticipated that power will be available from this project by 1952 and that 6.6 million acres of land will be irrigated, 1.6 million acres of which are now waste land. The whole scheme is scheduled to be completed by 1955-56.

(4) *The Damodar Valley project.* This was originally intended for flood control but now has developed into a multi-purpose project envisaging several storage dams with hydro-electric plant in the valley of the Damodar. Some of the first surveys for this project were done at the end of the war by a military survey unit largely manned by Survey of India personnel awaiting demobilization. Recently, surveys of the area to be irrigated have been undertaken on contract by a private firm specializing in air survey and the Survey of India is also taking up some of the work.

(5) *The Tungabhadra project.* This is a joint enterprise by Madras and Hyderabad and will result in the irrigation of about 300,000 acres in the State of Madras and another 670,000 acres in Hyderabad State; in addition a large amount of electrical power will be generated. The Survey of India has carried out surveys of a very large area in the State of Hyderabad and it is hoped that the whole scheme will be complete by 1954.

I have mentioned a few of the main undertakings, but the Survey of India has also worked since the war on numerous other projects of which the more important are the Tista project (which was abandoned after the partition of Bengal), the Gandak project which will irrigate large areas in Bihar, and

the Kakrapar project on the river Tapti in Bombay. A project of a different kind which deserves some mention is the development of the port of Kandla at the eastern end of the Gulf of Kutch. Considerable survey work was required and surveys of the Rann of Kutch are now being asked for in connection with the exploitation of ground water in the region.

### *Cadastral surveys*

I noted towards the beginning of this paper that after the reorganization of the Survey of India in 1905 the responsibility for cadastral surveys passed entirely to the Provincial governments. Speaking as a surveyor I do not think that the result was a success, though it may have been inevitable in the circumstances of the time. The consequence has been that little was done by the provinces after 1905 to establish or preserve the survey marks which could have been used as starting points for fresh surveys. The staffs of Provincial survey departments are often unqualified for anything but the most rough and ready surveys and much of their work would not stand up to examination. So far this state of things has caused little serious harm, though on occasions it has led to much expense. For instance, in the fixing of the disputed portions of the boundary between East and West Bengal we had to discard any attempt to use provincial survey data for the framework on which the boundary was to be fixed, and had to go back to the geodetic triangulation stations. Some of the new State governments are however beginning to realize the need for more attention to accurate survey work and are tending to turn to the Survey of India for advice and assistance.

Many of the former princely States, which have now been either consolidated or merged into the former Provinces, had no proper land-revenue settlements; and so have very large cadastral survey tasks in front of them and no adequate survey staffs to carry them out. The Survey of India has been so short of staff itself since the war that it has not been able to render the help required, but its advice is frequently sought; and all States, with one or two exceptions, have accepted the regional Directors of the Survey of India to be their advisers on survey matters. It is hoped that as the officer situation eases in the Survey of India it will be possible to second officers to the States to assist them with their survey problems. A beginning has been made with the State of West Bengal, to which we have lent a Survey Officer who continues to work under the technical direction of the local regional Director of the Survey of India.

### *Training*

Prior to the partition of India, the training of surveyors was carried out in the Abbottabad area in the North West Frontier Province as this had a climate which enabled field work to be carried on for practically the whole year. After partition the training of plane-tablers was moved to the Bangalore area, where the country is suitable for most types of survey work and the climate permits of outdoor work for most of the year.

The training of officers is now carried out under the orders of the Director, Geodetic and Training Circle, at Dehra Dun. All Class I and Class II officers go through a very complete course of training on joining and have,

at the end of it, to sit for an examination of the standard of the Intermediate Examination of the Institution of Surveyors (India). For those who pass, courses are held at Dehra Dun during the summer to prepare them for the final examination of the Institution of Surveyors. By thus insisting on a thorough theoretical and practical training at the outset of their careers it is hoped to raise the general technical standards of officers.

### *Trans-frontier exploration*

For the last century and a half surveyors and explorers based on India have played a very large part in central Asian exploration. The area north of India has long provided the adventurous with a field for exploration and with the opportunity for filling important blanks on the map. Non-official explorers and travellers could count on the support and assistance of the Survey of India. Though their governments did not encourage strangers, the countries immediately north of what is now India were not regarded as potential routes of approach for an aggressor and few or no restrictions were put on the publication of maps covering the northern Indian frontiers and beyond, from Kashmir in the west to Assam in the east, and any new information about these areas was made public.

Now the situation has changed. Faced with uncertain political conditions in the countries to the north, the Government of India has been obliged to restrict all maps on topographical scales which cover the northern frontiers and beyond. (See Fig. 2.) Such maps will not be available, as in the past, just for the asking nor will it be possible for the explorer beyond the northern borders to publish his results for the information of all the world. It is a sad thought that the days of trans-frontier exploration of the Survey of India are gone; but in a rapidly changing Asia it seems inevitable that it should be so.

No paper of this sort would be complete without some reference to the future of the Survey of India. We have keen and promising young officers coming on, and there is no doubt that the Government of India increasingly appreciates the work of the Department. Given good and progressive leadership and enough money, there seems to be no reason why the Survey of India should not maintain its position as one of the great survey departments of the world, and continue its contributions to science.

## DISCUSSION

### *Afternoon Meeting, 11 February 1952*

The CHAIRMAN (Brigadier M. HOTINE) said: For the benefit of those who have not yet heard of Brigadier Heaney I should like to say that he has recently retired from the post of Surveyor-General of India and that he is going to speak to us on the work of his department since the Second World War. His work covered the difficult period following the partition of India, so that he had to reorientate the work of the department over that period.

### *Brigadier Heaney then read his paper*

Brigadier SIR CLINTON LEWIS: As an old member of the Survey of India I have been much looking forward to Brigadier Heaney's paper. He has told us

of the problems of the hand-over but has left us to infer his own personal difficulties as first head of the Department under the new regime; I know they have been considerable. He has told us about the current work and the special surveys which have been undertaken since the war. I should like to say a word or two of the old days, the heyday of the programme of regular topographical survey.

India has perhaps more variety of country than any area in the world of comparable size. I spent my first field seasons down in the far south, in the then unexplored forests of Travancore. We were surveying the catchment area of the Periyar dam where the elephant grass was 10 feet high and, quite unaccountably, one might find oneself in the middle of a herd of elephants a hundred strong or more. The natural reaction was to make for the nearest tree, not that that was much good because anything small enough to climb was small enough for an elephant to knock over. Elephants in the herd are however docile and move off when one makes enough noise. In the forests the trees were so high that pigeons on the topmost branches were out of gun-shot range—or I should say, out of my gun-shot range.

At that time Burma was part of the Indian Empire and we surveyed the Irrawaddy delta, where the jungle is probably as impenetrable as anywhere in the world. Fortunately we did not have to penetrate it, as we did the survey from the air. Quite different again was the Indian desert, the shifting sand dunes of Bikaner and Jaisalmer; in some places the wells were over 400 feet deep. The biggest contrast of all is of course in the Himalaya, the Karakoram and the Hindu Kush, about which we have heard so often in this hall. Between the wars, regular surveys were undertaken in Chitral, Garhwal, Kumaon and Sikkim. This led to the training of a selected band of Indian surveyors, not only in high mountain plane-tabling, but also in the craft of the climber and, as we have been told, many of our surveyors accompanied private expeditions to the mutual advantage of the Department and the explorers. We now learn that much of the northern frontier region is unfortunately closed for reasons of security.

We had a great regard for the Indian plane-tabler, and indeed for all the Indian personnel of the Survey of India; I think the *khalasis* of those days were tougher than now. When we were in camp, some of them would be sent out once a month with the surveyors' mail and pay packets and they would think nothing of covering 200 miles in three or four days; 50 or 60 miles a day at a steady jog-trot through the night with a few hours' rest in the middle of the day, taking their meals from the wayside villagers. In those days government messengers could demand meals from villagers as an immemorial right. Nowadays they usually proceed by country 'bus. Then there was the *tindal*, the headman of the *khalasis*, one of whose jobs was to run the check lines. He would be shown a distant point, a prominent tree or hillock 3 or 4 miles away, to which he was to run his chain. The terminal point was out of sight half the time, but he would keep a perfectly straight line and laboriously record in his notebook the points at which it crossed roads, streams and so on. When at the end you checked the work, he made a point of giving all the distances from memory and never referred to the notebook unless some discrepancy in the surveyor's work came to light.

The Indian surveyor had a great sense of loyalty. In the areas we surveyed there might be many hundreds of square miles of dense forest and it would have been easy to "fake" the remoter parts; he would know that an inspecting officer could not go everywhere, especially where communications were almost non-existent. In high mountains it would have been much easier to sketch in

what he could see and guess what was round the corner, rather than climb a high peak or a difficult glacier. Yet, by and large, there were few lapses of that kind. We tried to build up a tradition of integrity and I hope and believe that the Government of India will uphold and foster that tradition in the future. That goes for Pakistan also.

Professor KENNETH MASON: I have enjoyed Brigadier Heaney's lecture very much indeed. It is twenty years since I left the Survey of India and I was there for twenty odd years before that. Much of my service was, under a kindly Government with kindly Surveyors-General, in the disputed part of Kashmir which is one of the most pleasant countries in the world to survey. I spent seven years there and I have travelled in the eastern Himalaya also.

I should like to make one or two points, not so much on the survey side because it is not the Surveyor-General's Department which is concerned; I have in mind the danger inherent in some of the big schemes in the eastern part of India and the Ganges plain. One great danger is that of trying to harness the waters of such a river as the Tista, which has changed its lower course half a dozen times in four hundred years, at one time flowing into the Brahmaputra, at another time into the Ganges. I hope the engineers in India realize the great changes that will take place when they try to control a river of that type. Flood and scour are immense forces with rivers having a Himalayan and monsoon regime. I have also in mind the Ganges itself; its lower course, too, has changed considerably during the last four hundred years. In early Tudor times it came down the Hoogly past the present site of Calcutta. It is, I believe, only since 1787 that it has taken approximately its present course.

Then there are the engineering projects for the rivers of eastern Nepal. Why put up enormous "Boulder Dams" on those rivers in an unstable earthquake zone? There are two or three big thrust planes in the outer Himalaya here and, it is believed, a new boundary fault. I should have thought it most dangerous to build high dams in that area. The annual rainfall at Darjeeling is 122 inches a year, of which over 100 falls in three months. In the catchment of the Kosi there must be an average of 80 inches of rain falling in the three months when glaciers are still melting; I cannot conceive how all this water is to be controlled behind a dam. Fortunately it will not be the Surveyor-General's business if the dam gives way. Nor can I really see why there is any need for a project of this kind at Damodar; I believe Brigadier Heaney said that it was for the purpose of draining and controlling the water rather than for irrigation.

Brigadier HEANEY: It was originally a control scheme but the present Government have enlarged its scope to cover power and irrigation.

Professor MASON: Why irrigation? In the eastern plains of northern India the endeavour is always to get water off the land because there is too much; in the north-western plains water has to be conserved because there is too little. There does not seem to be much object in spending vast sums of money in that connection.

I do congratulate the Survey of India on maintaining their manifold activities, tidal, magnetic and so on, all just as before, and I also congratulate the Surveyor-General on having made such a magnificent job of it.

Mrs. HALEY: Will the Colombo Plan, inaugurated by the United Nations, finance any of these projects in India as a part of South-east Asia?

Brigadier HEANEY: That is a little out of my province. I understand however that the Government of India is obtaining funds from the World Bank for some of the projects. I do not think that the Colombo Plan has got to the extent of allocating funds for definite projects but I imagine that the Government of India will ask for funds in due course.

Mr. C. PAPE: Has the Survey of India moved its headquarters to Hathibarkala or is it going to do so?

Brigadier HEANEY: The Surveyor-General's headquarters, comprising the purely administrative offices of the Department, were in Delhi from 1941 until 1950, when they were moved to Mussooree. They have now moved down to Dehra Dun and are situated in the old Geodetic Branch compound and not in the Hathibarkala estate.

Mrs. SHAW: It was not clear from what the Surveyor-General said whether the senior officers of the Survey of India were recruited from the British or the Indian Army.

Brigadier HEANEY: For many years the system of recruitment was to take three officers from the Royal Engineers (who are British Service) and one British officer from the Indian Army. Between the two wars, when it was desirable to Indianize as much as possible, the recruitment of Indian instead of British officers from the Indian Army was begun; when the Corps of Indian Engineers was formed, the recruitment of Indian officers was confined to that Corps. The result was that when the last war broke out the majority of military officers in the Survey of India were Royal Engineers, there were also a few British officers from the Indian Army; we also had two Indian officers from the Indian infantry. It was soon after the outbreak of the war that Indian officers from the Corps of Indian Engineers were posted to the Survey.

Mrs. SHAW: What is the present proportion of English officers; is it the intention of the Government of India to continue to employ them?

Brigadier HEANEY: I cannot work out the proportion! There are now two British officers in the Survey of India and there will be only one in a few months' time. It is certainly not the intention of the Government of India to retain more British officers than are absolutely essential; I think they will eventually do without any.

The CHAIRMAN: It is now abundantly clear to all of us that the Survey of India has accomplished an enormous amount of work during the last few years, work of a most diverse nature. It is amazing that the Survey has been able to carry on with its purely scientific work, as well as work on the projects about which we have heard, during a period when the Survey might have been forgiven for spending a good deal of time on what I first described as reorientation and re-administration. It only remains for me to ask you to thank Brigadier Heaney for his most interesting lecture.