EXPEDITIONS TO THE HIMALAYAS

FOR SELECTION OF A SITE FOR

HIGH ALTITUDE RESEARCH STATION

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GOVT. OF INDIA • CENTRAL WATER & POWER COMMISSION
NEW DELHI.

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For Selection Of A Site

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HIGH ALTITUDE RESEARCH STATION

BY

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CENTRAL WATER AND POWER COMMISSION

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FOREWORD

The highest research station in the world today is on Pike's peak in Mt. Evans, Colorado, U.S.A., at an elevation of 15,180 feet. It carries on research on the physical aspects of science. The International High Altitude Research Station at Jungfraujoch, conducting physical, astronomical, and biological researches is at a height of 11,500 feet. It is learnt that a High Altitude Research Station is being investigated near Mexico city at a height of about 16,000 feet. India is planning a research station located still higher by 1,000 to 2,000 feet. in the Himalaya mountains. This station will be used for the study of cosmic rays, astronomy, astrophysics, high level meteorology, snow and glaciers, microbiology, Himalayan flora and fauna, ionosphere, etc. The idea, first conceived by the India Meteorological Department, took shape and grew rapidly on discussions with the other scientific departments of the Government of India. A party of six scientists was sent in 1948 to reconnoitre the area round about Badrinath in Central Himalayas. An account of this interesting trip, with the findings and recommendations, has been prepared by the author, being the leader of the party, and is given as Part I in this publication.

The report of the above survey was considered by the Board of the Council of Scientific and Industrial Research. As a result an Expert Sub-Committee was set up for submitting detailed recommendations to the Board for further consideration. As proposed by this Sub-Committee a party of three scientists visited Sikkim, Jumnotri and Baralacha La regions in eastern, central and western Himalayas respectively during May to September 1949, and another party of two went to Badrinath and Lokpal areas in September 1949, to survey that portion again. In order to make this publication self-contained the author has, with the permission of the writers, adapted Part II from the " Report of the Expedition Party which visited Lokpal and

Badrinath " by Shri S. D. Nigudkar and Shri O. N. Dhar, and has given a brief note of the findings of the party which visited Sikkim, Jumnotri and Baralacha La areas in Part III.

The Expert Sub-Committee then proposed that the party which had surveyed Sikkim, etc., should also visit the area between Badrinath and Mana Pass, where a very promising site was reported to be available by the other party, in order to make a comparative assessment of this region in relation to other areas. The Director General of Observatories, who is the Chairman of the Expert Sub-Committee is now taking steps for organising this expedition next summer. After the expedition is over, the Expert Sub-Committee will submit its final recommendations to the Council of Scientific and Industrial Research, who will then take steps to set up, in the first instance, a working camp which will, in course of time, develop into a research centre. 1953 may very likely, see important and useful scientific data being collected, for the first time, from the high levels of the Himalaya mountains.

The author is highly indebted to Sardar Harbhajan Singh, M.Sc., Assistant Meteorologist, C.W. & P.C. for helping him in all stages of the preparation of this publication. He is also grateful to fellow members of the first party for allowing him to make use of the photographs taken by them, and to the members of the second party for permitting him to adapt Part II from their detailed report.

New Delhi;
January 1952.

R. D. DHIR

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PART I

EXPEDITION TO BADRINATH AND KUARI PASS

(*JUNE-JULY* 1948)

Introduction

The India Meteorological Department had been considering for a long time the advisability of having a High Altitude Research Laboratory located in the Himalayas for the study of meteorology and astronomy. But later on the idea was extended to embrace other subjects of study and this was supported by the departments concerned. In the West such laboratories had already been established in various countries at various altitudes, and India, who claims the highest mountains in the world, has in fact the greatest opportunities for scientific research in various directions in the higher regions. Certain difficulties in the past, however, did not allow active steps to be taken in this direction. In the beginning of April 1948, Dr. S. K. Banerji, Director General of Observatories, brought the idea to the forefront.

Objectives

Dr. S. K. Banerji proposed to establish a scientific research colony in one of the valleys in the Himalayas at a height of about 12,000 — 14,000 feet and a combined High Altitude Research Laboratory at about 16,000 feet in a suitable locality near about from which studies could be carried on in respect of—

(a) Astronomical and astrophysical observations.

(b) Cosmic ray observations.

(c) Constitution of the upper atmosphere, study of meteors, mother of pearl clouds, etc.

(d) Geological and geophysical observations—the geology and the seismicity of the Himalayas would, no doubt, be most interesting.

(e) Snow and glaciers and their contribution to the Indian rivers.

(f) The meteorology of the Central Asian table-land, and in particular the influence of the huge mountain system on the meteorology of Eurasia.

(g) Study of flora and fauna of the high regions.

It was thought that mountains of northern India presented unique problems and opportunities for observations and research on the above subjects. A site near Badrinath was preferred in view of the fact that this region was traversed by trade routes between India and Tibet and there was a good road, a large part of which was motorable, up to Badrinath. From accounts of previous expeditions in these regions it was gathered that there were beautiful valleys round about, where a colony could be established. Also that even during the height of monsoon, fine spells with cloudless skies were common in this part of the country.

Talks at Delhi

In order to gather as much information as possible about various routes and possible sites, and also to get different views on the proposals, a number of meetings were arranged at Delhi. Notes on these meetings are attached as Appendices A, B, C and D.

The first one was held on the 10th April 1948, mainly to collect information from Shri S. S. Khera, Commissioner, Meerut Division, who had visited these high regions. He thought Mana Pass, being on Tibet border, might present political difficulties. He suggested two more sites, *viz.*, Baralacha and Lipu Lekh, out of which he preferred the former mainly because a considerable area of flat land is available at the required altitude. He gave very clear and detailed information about all the three sites.

The second meeting was attended, amongst others, by Professor M. N. Saha, Sir J. C. Ghosh, Professor H. J. Bhabba, and Professor S. P. Agharkar. Dr. Banerji stressed that good visibility being one of the main requisites, western Himalayas with less of rainfall were considered more suitable ; but Professor Agharkar suggested that for proper Himalayan studies two sites, one in the west and the other in the east would be necessary. It was finally decided that in any case the site towards Badrinath should be investigated first. Other considerations thought to be important, were easy accessibility and a clear view above 10 degrees with the horizontal.

The third meeting was with Shri J. M. Kohli of Survey of India. He was in charge of one of the survey parties which visited Badrinath area during the years 1936-38 and so had first-hand knowledge of the conditions there. In this meeting suitability of various sites in Badrinath and Niti vallies was discussed. It was felt that all attempts should be made to select a site near Badrinath which was easily accessible and where the residential colony could be located. Shri Kohli recommended the place of Lokpal which could be reached by making a detour from Joshimath-Badrinath route. This place is located at 14,000 feet and there was a beautiful lake there. The colony could be located here while the observatory on one of the high ridges surrounding it. From these discussions it was concluded that sites near Badrinath and Lokpal should be surveyed first and attention should be diverted to other sites only if they are not found suitable.

The fourth meeting was attended, amongst others, by Shri A. N. Khosla, Sir Shanti Swarup Bhatnagar and Dr. D. N. Wadia. It was

agreed that the main laboratories and colony for scientists should be located between 12,000 feet and 14,000 feet, and small structures for astronomical observations and cosmic ray work might be sited at a height of about 14,000 feet to 16,000 feet. A lower base camp at Joshimath (height 6,150 feet) was also thought of. It was finally decided that the party should first look out for suitable sites near Badrinath and then proceed to Lokpal, which from the maps promised to be an excellent site for the colony, etc., and select a site for the astronomical observatory at a higher elevation within easy reach from Lokpal. It was also suggested that, as the present expedition was of an exploratory nature, the party should restrict itself to an inspection of the sites near Badrinath and Lokpal. If Lokpal was not found suitable, a third site might be thought of. Sir Bhatnagar suggested Jumnotri as a suitable site, and this was included in the programme of the party, to be surveyed in case no other site was found suitable.

It was decided that the reports should be prepared by the expedition party as below—

(a) (i) Suitability of Site—Joint report.
(ii) Astronomy, Cosmic Ray, Mother of Pearl Clouds—Dr. R. Ananthakrishnan.
(iii) Biology—Prof. S. P. Agharkar.
(iv) Geology—Shri S. P. Nautiyal.
(v) Glaciers and Snow—Shri R. D. Dhir.
(vi) Meteorology (Radiosonde)—Shri R. V. Badami.

(b) Engineering aspects.
(i) Roads—Shri R. D. Dhir.
(ii) Buildings—Shri R. D. Dhir.

The joint report is attached herewith as Appendix E, while this is the individual report by the writer.

Sites Near Badrinath and Lokpal

There were many advantages, in addition to those mentioned in the above paragraphs, which prompted the party to search for a suitable site near Badrinath, and failing that near Lokpal. If a good site could be obtained near Badrinath for the astronomical observatory, the colony of scientists and the main laboratory could be located at Badrinath (height 10,300 feet) itself, which would be a very comfortable place to live at. Badrinath is a sacred place for Hindus and it has been estimated that 50,000 pilgrims visit this place every year. Therefore, the road even beyond the motor-head is not forlorn. In fact, during the pilgrim season this road is as frequented as any district road in the plains. There are P.W.D. bungalows every 8-10 miles, and P.W.D. gangs are working all the year round for maintenance of the road. The work of making the road motorable from Nandprayag (the present motor-head) to Joshimath is in hand and is expected to be completed by 1952. The U.P. Government has on hand at the same time, the project of making the road motorable to very near Badrinath. In addition to the P.W.D. bungalows, there are halting places called *Chatties* for the convenience of pilgrims

(*Yatris*) every two miles or so, where simple refreshment and even meals can be purchased. Thus, food is not a big problem along this route. There are postal and telegraphic arrangements, as also hospital and police *chowkis* right up to Badrinath.

The site at Lokpal is only two days' march from the main pilgrim route. Shri Kohli of the Survey of India, who suggested the site of Lokpal, said that Lokpal was a comfortable place to live at, as it was comparatively warmer for its height, being surrounded by high ridges, food supplies were available, the route was easy, and the site was in all respects ideal. The map showed that if the observatory were situated at about 16,000 feet near Lokpal no ridge nearby would subtend an angle higher than 10 degrees. The contours were rather wide apart indicating the possibility of sufficient flattish area being available for locating the observatory. Thus Lokpal was considered most likely to be the site required.

Composition of the Party

It was considered unwise to make the party too big. The best number was three but not less than six could serve the purpose of the expedition. In fact, Dr. Banerji wanted to include two engineers, as engineering aspects were many as well as important. He did not want to burden me too much, especially as I, being chosen as the leader of the party, had to discharge that duty as well. Shri B. K. Guha of the C.P.W.D. was chosen and though his Chief Engineer agreed in the beginning to allow him to go, he could not in the end spare him. Dr. Agharkar did not look his age (65 years) and did not hesitate to brave the hardships of hill climbing. He reached Delhi a day or two in advance of the date fixed for starting. Shri Nautiyal joined us at Sonla on the main pilgrim route.

Arrangements at Delhi

(a) *Equipment*—For the previous expeditions into eastern Himalayas a lot of equipment was purchased and taken to Darjeeling. After these expeditions were over, the equipment was despatched to Delhi in July 1947. But it did not reach the destination although a number of reminders were sent to the Railway Department, and even a special man from C.W.I.N.C. was sent to make personal contacts and enquiries and trace out how far the equipment had travelled on the correct line before disappearing. Ultimately the Railway Board was contacted. In the absence of the previous kit, fresh equipment was necessary for the impending expedition and the cost was estimated to be nearly Rs. 4,500. Fortunately two days before the final order for equipment was to be placed, most of the previous equipment was found and thus the revised estimate went down to Rs. 1,200 only.

We had no equipment for coolies. It was difficult and very costly to fit up as many as 50 to 60 coolies with full clothing. Since we were going, at the highest, up to 16,000 feet we did not think it essential to fit up the coolies at Government expense. But in case an expedition is to go to 18,000 feet or above it is always better to take almost as much care of the coolies as the expeditioners. If some coolies fall ill or dies the whole programme is delayed, sometimes for weeks together ; and generally the expedition party cannot

afford it in view of the food arrangements, or limited period of mountaineering season. But the high altitude expeditions will probably consist of fewer men requiring less number of coolies and correspondingly less expense on providing equipment for them.

To make certain that we were carrying the right sort of equipment, Shri Badami and Harbhajan Singh were sent to Meerut to contact and get advice of Shri Khera. His advice on the equipment question is given in Appendix F.

Since we had no boots of the right type special arrangements were made with Cooper Allens, Kanpur, for eight pairs of the ammunition boots with clinker nails, which besides being waterproof would provide a good grip during climbing and, therefore, reduce the possibilities of slipping down. In respect of food and other general stores also, we followed Shri Khera's advice to a large extent.

(b) *Porterage*—Shri Kohli of the Survey of India who had much experience of these regions, told us that the coolies of lower altitudes would not be able to stand high altitudes. Those engaged through the Deputy Commissioner, Pauri, from Kotdwara or Dogadda might do up to Badrinath, but not beyond. He suggested, therefore, that our advance representative should reach Joshimath a few days earlier and send some men to Niti and Mana for coolies. He also suggested that we should employ Kalu and Kaiser Singh. These people had good knowledge of the areas we proposed to visit. The former had been employed in Shri Kohli's party while he was surveying these regions about 10 years back, while the latter was one of those who accompanied Shri Frank Smythe to Kamet in 1931. Shri Smythe has lovingly described Kaiser Singh as a "scoundrel" in his book "Kamet Conquered". But at such a short notice we could not contact either of the suggested persons.

We had sent telegrams to the S.D.O., Chamoli, and the Deputy Commissioner, Pauri, to arrange for 40 coolies and 8 ponies at Chamoli and 10 coolies at Joshimath.

On the 26th May 1948 we got a reply that no coolies were available at any cost. This was probably because it was a pilgrimage season. The expedition appeared to be going phut. At once we sent Shri Badami as our advance representative to meet Deputy Commissioner, Pauri, to find the exact position and try to secure coolies.

Shri Frank Smythe has written as follows in his book.

> "Successful porterage depends on employing a body of loyal and willing men, on interesting them in the objects of the expedition, on treating them fairly, and feeding them well. No amount of bullying or slave-driving will make for successful porterage, and the smooth running of an expedition depends enormously on the work of the transport officer. Thanks to expeditions to Everest, Kanchenjunga and the Sikkim Himalaya, there exists now at Darjeeling a body of men trained in the peculiar problems, hardships and difficulties of high altitude mountaineering. These men are Sherpas and Bhotias, and they come from the

> valleys of northern Nepal along the frontier of Tibet. They are half-Tibetans, half-Nepalese, and are the hardest, toughest natural mountaineers in the world. They are born adventurers at heart, and whatever the hardships, difficulties or dangers, invariably come up smiling. To know them is to love them, and no expedition which intends serious mountaineering on the great peaks of the Himalayas should go without some of them as a backbone to its porterage."

So we had wired our Sirdar of coolies at Darjeeling to come up with five of his men and meet our representative at Pauri. We thought this was a sufficiently strong "backbone" to our porterage.

Shri Badami wired on the 29th that 40 coolies and 2 mules had been secured, and that our coolies from Darjeeling had also reached. He urged us to start without fail on the 3rd to fit in with the reservation of bungalows, etc., which he had arranged. He had met the local officials and had in consultation with them redrawn the programme of the party, a copy of which he sent us. In this he substituted Narayan Parbat for Nilkantha, as a better and easier climbed site from Badrinath. According to his programme we were to reach Delhi back on the 4th July 1948.

(c) *Food*—Arrangements for food which had been kept in abeyance, were restarted on receipt of Shri Badami's telegram. For our start on the 3rd the time at our disposal was very short and there was much to be done. Dr. Ananthakrishnan and Shri R. N. Banerji of the I.M.D. helped Shri Harbhajan Singh in the various arrangements. Shri Harbhajan Singh had some experience of previous expeditions to east Himalayas and had further been advised by Shri Khera. So he purchased what he thought was necessary for a team of six men.

We knew that possibly some sort of food might be available at *chatties* on the way, but specially nourishing food was necessary if the deterioration generally associated with high altitudes was to be avoided. The food of *chatties* was at best, a last resort to fall back upon in case of emergency. We recognised that fresh meat, fruit and vegetables were unsurpassable in maintaining strength and should be eaten as far as possible, and tinned food only reverted to when necessary. But then special scruples, tastes and fancies of each member must be considered. Two of us, *viz.*, Shri Ananthakrishnan and Agharkar were staunch vegetarians. Again Shri Ananthakrishnan and Badami belonged to South India where food is generally made hotter with chillies and other sour things. We did provide for lemon drops, dry fruit, chutney, etc., whatever was possible in the short time at our disposal — but found later on that we were far too short of the actual requirements. In heights palates must be tickled by dainties. Fortunately we had amongst us Shri Nautiyal who belonged to Garhwal, and had his official duties also in that district. He knew most of the people who mattered on our way, and could procure most of the things we wanted. Thus he procured fresh milk when Shri Badami was ill and later procured curds, and even pickles from the Secretary, Badrinath. Gradually other members of the party also became friendly with the local

people and local conditions. It was for these reasons that Dr. Agharkar and I, on being left behind at Joshimath for about 10 days, could satisfy every simple need of food or even of general nature from the local shops, etc.

Then there was the question of food for coolies. We believed we would be able to arrange for it from Chamoli. We had already wired to S.D.O., Chamoli, to arrange for 45 maunds of rice and 15 maunds of atta at Joshimath which was done through *Sarkari Baniya.*

(d) *Medical Outfit*—From my personal experience of the previous expeditions, I dictated to Shri Harbhajan Singh a list of medicines likely to be required by the party. He had his own experience by which he could add to the list. And then the chemist could substitute another medicine if one was not available. They were, however, not packed as they should have been with the result that some bottles leaked and had to be kept outside the box.

Journey by Rail

So, we left on the 3rd June. Dr. Banerji came to see us off at the station. He was happy to see that the party was at last leaving on the due date. As he bade us good-bye with a broad smile and good wishes, he encouraged us by reminding us that from the next day we would be in a better climate.

In spite of the extremely hard work done by Shri Anantha-krishnan and Harbhajan Singh the kit had reached the station rather late, and probably would not have been booked on the 3rd, but for two men from the I.M.D. who generally dealt with the station staff and were, therefore, friendly to them and were there to manage things and see that the whole kit was in the brake-van in time. The train left Delhi punctually at 6.45 P.M. We were rather excited and in a happy mood like a party going out for a picnic or a short stay in the hills, away from the burning heat of the plains. At 4 A.M. on the 4th June we reached Najibabad, which had once been the capital of Rohilkhand—the land of Rohilas. The train had been late by about one hour. We got up from our night-rest full of dust. It seemed a dust storm had been blowing for some time. On the platform one of the station staff, on learning about our destination was surprised. "Going to Badrinath? In this season when monsoon would soon overtake you?"

"No, monsoon is not yet indicated".

He shrugged his shoulders, not convinced.

"I wish you return safe," he said.

I thought we were on the whole lucky. We had difficulties which were surmounted without trouble, monsoon was not yet indicated, and the weather was fine. A small drizzle at Najibabad washed down the dust and cheered up our spirits. To quote again, "Luck is blessed and cursed, but without it mountaineering would be a dull mechanical pastime. Luck depends largely on weather, and what the weather has done or may do to the mountain. Bow, therefore, to luck, accept it and forget it, making sure at the same time that all other links in the chain are as strong as human ingenuity and fore-thought can devise."

We took tea at Najibabad and left in the connecting train for Kotdwara. We got first glimpses of green mountains when we were near Kotdwara. On both sides of the railway line *Amaltas* was growing. It was in the flowering stage. Yellow flowers, almost as numerous as the green leaves, presented a beautiful sight. The green mountains reminded us of what we were really after — the thrill of adventure, the difficulties and the mystery that lay in their midst. I was forcefully reminded of Shri C. F. Meade writing, "The mystery and thrill of travel is always upon one in the Himalayas, but the mystery is awful and the thrill is sometimes a shudder".

Beyond the Rail-head

We reached Kotdwara at 8 A.M. under a cloudy sky with sun trying to pierce through. Khoh river flowed near the station. It was almost dry at that time. Shri Nautiyal had thoughtfully sent Shri R. C. Sharma (Mechanical Supervisor, R.K.D.) to contact us at the station and help us in transport arrangements from Kotdwara. He also sent a note intimating that he would meet us at Pauri. Shri Sharma was very helpful in arranging for our short stay, etc., at the inspection bungalow.

Kotdwara itself is a malarial place and lacks in the ordinary facilities, specially good milk. But Lansdowne (5,600 feet), a little cantonment near Kotdwara, is very popular. Most of the officials live there. Kotdwara bungalow is well furnished and is situated about three furlongs from the station on a small hillock. Two large tents are usually pitched in the compound during the touring season. It commands a beautiful view of the hills beyond. It is in the charge of Executive Engineer, Nayar Project Division, Moradabad. He is in charge of a project for electrical development from a fall on Nayar river—a tributary of Ganges—near Marora Bara. Shri Nautiyal who was to join our party on the way had been, we learnt, attached to this project as a geologist for the last four years.

As we start from Kotdwara (1,250 feet), we go up to a watershed (about 5,100 feet) between Khoh and Nayar, and then descend into Nayar valley. Crossing Nayar at Sat Puli (about 2,000 feet) we rise again to Pauri (5,500 feet). From Pauri we go down to Srinagar (1,500 feet) and again rise to Karnaprayag (2,300 feet). Here we cross Pindar river and thence have a steady ascent right up to Badrinath.

We left Kotdwara later than expected on account of some engine trouble in the hired bus. We were scheduled to reach Dogadda, 10 miles away, by 1-30 P.M. but we started from Kotdwara itself at 1-40 P.M. and reached Dogadda at 2-15 P.M. On the way we went mostly along Khoh river, crossing it a number of times by steel bridges. The road was 12 feet wide with tarred surface, and was in excellent condition.

The policeman on duty at Dogadda stopped us. From Dogadda onwards only one-way traffic was allowed and there were timings fixed for the up and down buses. The time for up bus was over by 1-30 P.M. and now the down buses were on the way. He could not allow us to proceed unless we got special permission of the Deputy

FIG. 1

MAP OF GANGA BASIN (PART)

SHOWING

THE ROUTE FOLLOWED TO BADRINATH AND KUARI PASS

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Superintendent of Police or the Deputy Collector. Both of them lived at Lansdowne but could be contacted over a telephone, available in the police station at a little distance away. I went and tried the telephone. The Deputy Collector could not be contacted, but the Deputy Superintendent of Police allowed us to go at 4 P.M.

On receiving these orders the policeman said, "So you go by the next gate". We looked at him, not understanding what he meant. Then we learnt from him that by "gate" they meant loosely "the time for buses to pass". The following were the timings fixed for the "gates"—

Up			Down	
hours	hours		hours	hours
7	8·30	Dogadda	13·00	13·30
8·15	9·45	Gumkhal	12·15	12·15
9·30	11·00	Sat Puli	11·00	11·00
10·15	11·45	Amo.ha	9·30	10·15
12·45	14·15	Pauri	8·30	7·30
14·45	16·15	Srinagar	6·00	5·00

Thus we had to sit in the bus from 2-15 P.M. to 4 P.M. and felt bored. I thought how nice it would have been, had we been in time. I looked up at the driver with a blaming look. He understood but simply grinned, not having any sense of the value of time. We were restless and felt that Shri Sharma was to blame in not engaging a better bus.

It seemed we had to miss our afternoon tea. "It is the beginning", I said, "The first one or two days we shall take in getting used to the changed requirements while travelling in these regions, and then settle down, probably filling our thermos bottles with tea in the morning and putting some dry fruits in the pockets, to meet contingencies like this. This changing stage has to come in all expeditions". The last sentence was more for consoling ourselves than anything else. But as it turned out our servant Gaur Singh rose to the occasion and brought us tea from some shops a little distance away.

We left Dogadda at 4-30 P.M. We were making our way up in the bracing air of the hills and for a time we forgot the annoyance of being late. Road to Lansdowne branched off from Kotdwara-Dogadda road only one mile north of Dogadda. On the way we saw terraced fields getting ready for transplantation of rice as soon as the monsoon started. These fields had thatched huts scattered about them here and there. Pines started at a height of 3,500 feet and a little further up we saw a mango tree in full luxuriance. The hills opposite were beautifully terraced. Two miles beyond Dogadda, steep ascent started to a height of 4,000 feet. The road slope was about 1-8 to 1-12. The huts were covered with either thatch, tin sheets, or rough local slates. From 4,000 feet height, descent started. Descent is really more dangerous in hills as the natural tendency is to go down fast. But our bus driver was really an expert at his job. Many a time we felt nervous as the bus went

round winding along the hairpin bends on steep slopes. But not once did the driver show the least diffidence or make the least mistake. A little mistake on these roads would have meant a fall of over 1,000 feet into the valley below. On reaching the top we looked down below at the winding road which we had climbed and admired in our hearts the performance of the bus and the bus driver.

Twelve miles from Dogadda, we reached the watershed at "Ghumkhal" (height 5,000 feet). Then the descent started down to Sat Puli (1,500 feet), a crossing over Nayar which was also a "gate" point. This was a crossing in a broad valley. A number of homely hotels formed a line with a good wide level area in front. The hotels kept food ready at the time of "crossing of gate", and as we reached at a very unexpected hour, we had to get special arrangements made for our food. However, we liked the food as it was simple and clean. It had grown dark and the bus driver advised us to stay there for the night. "Now we shall reach Pauri at midnight, i.e., in 4 hours, and if we go in the day light we shall reach in 2 hours and a half. Tomorrow we shall start after "down gate" has passed, i.e., at about 10-30 A.M., and by lunch time we shall be at Pauri". We could understand that this way we would be delayed at Pauri by a day, and our programme and bungalow reservations would be upset. But there was a great risk in driving at night, and recollecting the sharp bends round the hill-edges, all of us excepting Dr. Agharkar were for passing the night at Sat Puli. We thought we would omit the stoppage at Nandaprayag and thus come up to our programme. But Dr. Agharkar was insistent and was willing to take the risk. After all we started but with reluctance. The driver said he was afraid the lights might go out, but that for his part he would be as careful as possible.

We reached the next "gate", 10 miles further at Amotha, showed our pass and moved on. Shri Harbhajan Singh had practically not slept in the train and even Dr. Agharkar had not slept well. It was getting on to 10 P.M. and I was also feeling sleepy. Already all of us were half dozing when suddenly I saw through my half closed eyes a strong flash of light in front, and then it was complete darkness. I at once realised that the bulbs had fused, and wished to God the driver would control the bus in time before it toppled down into the *khud* below. The bus stopped. For a few seconds none spoke, stunned as every one was with what had happened.

Then we came out and looked round. We were on a straight piece of road ascending towards Pauri. The road was cut from the hill side on the left and there was a stream flowing in the valley on the right. Beyond the stream on the opposite cliff two lights shone. Every one was thinking about the gravity of the situation, and as to what was to be done next. Gradually we started talking. I asked the driver if he had any spare bulb and on getting a reply in the negative we felt we had no alternative but to sleep on the road. This being settled we tried to cheer ourselves up by small jokes. Only Dr. Agharkar kept silent. We three spread our beds on the road near the cliff, while Dr. Agharkar sat on his bed-roll, his elbows on his knees and his head on his palms, deep in thought. He could

have lashed the driver and the cleaner at that time—such was his annoyance with them. Ultimately with a big sigh of resignation, he also spread his bed.

In the meantime the driver and the cleaner had found two bulbs from somewhere, and were now busy fitting them up. After a little time more, the lights were ready. Dr. Agharkar was for pushing on again, but I decided not to do so. We were tired and soon fell asleep.

I was dreaming some happy dreams when two cold drops fell on my face and brought me to half consciousness. Only when I turned a little, felt hard ground below, and opening my eyes, found myself facing a high mountain, I realised where I was. Dark clouds had gathered and rain had started — thunder was heard, and lightning shone at intervals. We had to get up and wind up our beddings. The servants threw the beddings into the bus, and we sat up in the bus, yawning and feeling heavy in body and mind. It was 2 A.M.

" Terrible, what a luck ! " was all that one of us said. The driver sat in his seat and asked the cleaner to crank the engine. So we started again. The bus lights seemed to be piercing the pitch darkness as we trudged along at a slow pace. The driver was probably as half asleep as I was. I was still thinking about the imprudence of our start, when the bus stopped with a jerk. " Kunu ", the driver called out to the cleaner. At the same time Dr. Ananthakrishnan saw something dark moving towards the bus and shouted, " O, wild buffaloes ". I looked out and almost whispered in reply,

" No, just ordinary buffaloes ".

Probably the cleaner saw the black animals moving in the darkness and did not dare come out of the bus. The driver again called out " Kunu ".

And Kunu replied,

" Keep quiet. I won't come out. I don't want to be caught by a ghost ".

We smiled and tried to persuade him to come out and crank the bus, but he did not budge. On the other hand he said,

" It is a matter of a short time now before daylight will appear. Then we shall move on."

It was 3-15 A.M. at that time.

So we sat there on hard seats till 4-40 with rain drizzling outside, too sleepy to talk and too cramped and uncomfortable to sleep. At 4-40 A.M. the cleaner was good enough to get down and crank the bus. We started again.

We thought the twilight was not enough and it was unsafe to drive without lights, but in spite of our repeated warnings the driver did not switch on the lights.

" I can see the road all right ", he replied. Probably he feared the bulbs would fuse again.

We reached Pauri (height 5,500 feet) at 6-40 A.M. The Assistant Sirdar from Darjeeling, Pinjo Bahadur greeted us at the bus stand and gave me Shri Badami's note. Shri Badami had been obliged to go ahead to Chamoli along with Shri Nautiyal and all the available coolies except three. With some difficulty we went to the dak bungalow and decided to stop there for the day to rest our wearied nerves.

Shri S. P. Kothiyal (Divisional Superintendent, Industries & Supplies, Pauri, Garhwal) met us and rendered us a lot of help. He suggested another site, Kuari Pass (height 12,200 feet) near Joshimath. The maps showed this might be a good site. Time permitting we decided to go to Kuari Pass.

We had so far secured 39 coolies and 9 mules. Therefore, we wired to S.D.O., Chamoli, to secure 15 coolies more. We could not meet the S.D.O., Pauri, as he had gone away on tour on some urgent work. The Deputy Commissioner was already on tour. We spent the day very usefully, however, in spreading out all the equipment and distributing it to the various members. Also we appropriated one Darjeeling cooly to each member. So, ultimately we had to stop at Pauri for a day and delay our programme ; a situation to avoid which we had tried our best and taken so much risk the previous night.

Pauri is the headquarters of Garhwal District. Its height lends it a bracing climate and invigorating air. The place is tolerably big, and being not connected by railway, the things are in general much dearer than in the plains. But apricots, potatoes and onions are local produce and are as cheap as at Delhi. There are three High Schools and one Intermediate College here. The buildings are not bad, one we saw being six storeyed. Of course the roofs are low as is usual in hills. We were told that the next place where we would be able to get vegetables and fruits would be Joshimath and, therefore, we tried to purchase sufficient for us to hold on till Joshimath. From Pauri we got a beautiful and uninterrupted view of a long line of Himalayas clad in perennial snow.

The next day dawned fine. We expected to have to travel till the evening and noon meal was uncertain. Therefore, we had to take what we could at 8 A.M. We could not eat much, not being used to such an early meal. We started at about 9-45 A.M. by the first "gate". Along this route "gates" are provided at the following places : Dogadda, Ghumkhal, Sat Puli, Amota, Pauri, Srinagar, Rudraprayag, Gauchar, Karnaprayag and Nandaprayag.

We engaged a bus and a truck, as we had to carry coolies also with us. The General Manager (Shri Umanand) of the Motor Owners' Union Ltd., Pauri, Garhwal, was quite obliging. But our bus-driver seemed rather rash and less intelligent than the cleaner He was driving too fast and we were urging him to slow down. At 11-15 A.M. our bus stopped. The cleaner looked into the engine examined it for a few minutes and then shook his head.

"Won't it go" ? I asked.

"Not : its clutch has burnt out", he replied.

We looked at one another, and thought of our bad luck. Srinagar was as yet three miles off. We were at about 2,000 feet height and on the whole we had to descend 500 feet to reach Srinagar. But the local ascents were to be climbed. There was no alternative but to make the coolies push the bus while we walked. They had to push it till the final descent started about 1½ miles off. As we walked along, the sun was very strong and we were perspiring. I felt thirsty and tried my tea with which we had carefully filled up our thermos bottles but found its taste awful. I asked for water and was told that it had finished, and I would now get water only at Srinagar. I felt very bad.

"**The clutch is burnt out**". *We had to push the bus for a mile and half in hot sun.*

About one mile short of Srinagar there was Kirtinagar which was a junction point of the pilgrim route from Hardwar. The pilgrims from Hardwar have to trans-ship here as there is no motorable bridge over the river. This was in fact one of the reasons of our selecting the route *via* Pauri.

We reached Srinagar after all, sent a wire to the General Manager of the bus service, copy to the Deputy Commissioner, for a relief bus and decided to leave in the evening in case the relief bus reached by 6.30 P.M. In the meantime we took food and saw the place.

Srinagar is a beautiful spot. It is on the bank of Alaknanda. The valley is over 3/4 mile wide. It was old District Headquarters of Garhwal. The town is much bigger than Pauri—in fact the biggest on this route. All necessary provisions are available—only a little dearer than at Delhi. Medicines, toilet and general household necessities can all be had. Had we known this fact, we would

have purchased much of the stuff from here instead of from Delhi and would have saved the cost of transport.

Relief bus arrived at 5.0 P.M. but the driver refused to go till the morning as it was not safe to drive in the dark. So we had to stay in the dak bungalow for the night and lose another day. The truck which was carrying the coolies was much ahead, and had gone on to Karnaprayag. But it had carried away the beddings and some other general articles of Shri Ananthakrishnan and Shri Harbhajan Singh. They naturally felt worried. But Dr. Agharkar and I offered them part of our beddings, etc., and passed the night comfortably.

The next day broke with bright sunshine. We got ready to go at 8.0 A.M. but were told that we had missed the morning "gate". Now we won't be able to go before 12 noon. We, therefore, went to bathe in Alaknanda. The water was about 50°F and we could not stay in it for more than a few minutes. This was really snow water whose level showed diurnal cycle, as the snow-melting starts in the morning, reaches its maximum rate at about 2 P.M. and then goes down, practically stopping after sunset.

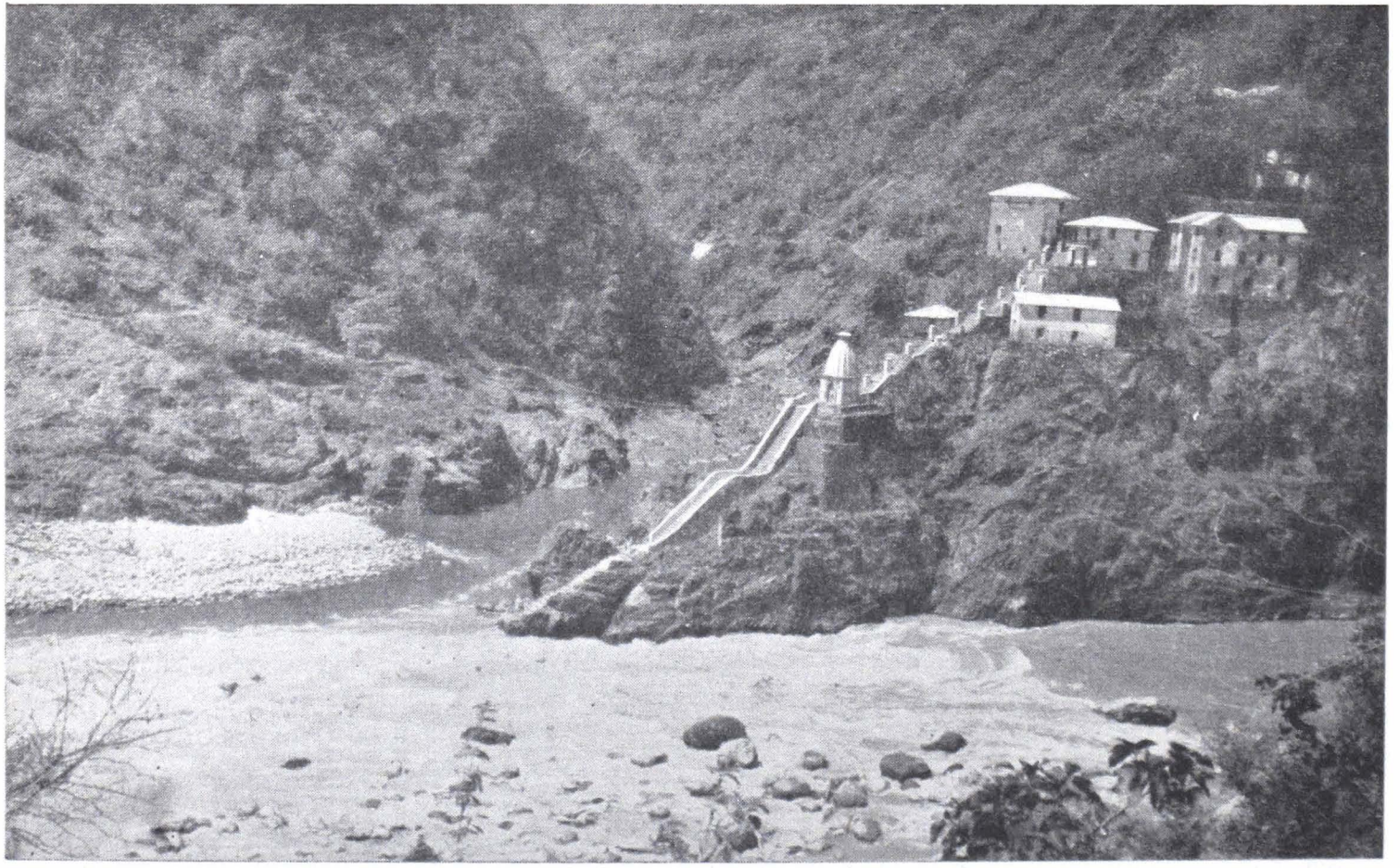
We started at 12 noon. The road was extremely bad and dangerous. It was newly made and the width was very narrow at places. Some bends were dangerously short. The valley narrowed down and widened out alternately. On the way we met a member of the interim Government of Tehri Garhwal who was travelling with family but was stranded on the road because of a tyre-burst. We, therefore, took him in our bus.

We reached the next "gate" point, Rudraprayag, at about 2.15 P.M. Here Kalinadi or Mandakini meets Alaknanda. Water of Kalinadi is dark green and that of Alaknanda brownish. At the corner made by their confluence there is a temple with steps leading down to water. Kalinadi has a light wooden suspension bridge over it. We had to start from here at 3 P.M.

On the way to Karnaprayag the Alaknanda valley opened out at Gauchar which is a small place with shops, dwelling places and some good bungalows. A Middle School was at the time under construction. The landing ground is along the road. Gauchar means a grazing ground for cows, and this place has been so named probably because this is the only good wide pasture land in these hills. The land is roughly rectangular. We measured and found the biggest dimensions to be 1,200 feet (East-West) × 700 feet (North-South). The angles which the surrounding hills made were judged to be roughly as below—

East—15°-20°
West—20°-25°
North and South—25°-30°

The height of Gauchar is 2,500 feet. It is seven miles short of Karnaprayag. It would seem from its dimensions that only small planes like a Tiger-moth might be able to land, but not the bigger planes like a Dakota.



Junction of Alaknanda and Kalinadi at Rudraprayag—*Notice the temple at the corner between the two rivers with steps leading down to water.*

From Gauchar the hills became steeper and as high as 2,000 feet. The scenery was grand and awe-inspiring.

We reached Karnaprayag at about 5 P.M. Here Pindar river meets Alaknanda. There is, over Pindar river, a good permanent suspension bridge but it is too light to carry bus traffic. They have in addition to this, another set of abutments and a pier constructed for a temporary fair-weather bridge of wooden beams, which allows bus traffic. But that bridge is removed on 20th May and is put up again after the rains. Therefore, after 20th May trans-shipment is necessary. Our bus on the other side of the river had not arrived and the bungalow of Karnaprayag was not available. So we awaited.

We saw *yatries* trudging along with rods in their hands. They were mostly old or middle-aged women with faith-writ-clear on their faces. They started early morning at about 5.30, walked about 10 miles till noon and then stopped for rest and food in *chatties*. They again started at about 4 or 5 P.M. and covered another 4 or 5 miles by the evening. I wondered at their ability to walk so much day after day. It is their admirable faith, unbending will and persistence that keeps them going such long distances. At Karnaprayag we saw an old man leading back, almost carrying, an older lady who could hardly walk. She was simply staggering, and yet was gradually making her way forward — probably satisfied at her heart to die on the way if she had to, now that her pilgrimage was over and she had seen God at the temple and bathed in the holy waters at Badrinath.

Here we met Shri R. P. Jhaldiyal, Assistant Engineer, P.W.D., Karnaprayag, Garhwal. He told us that a new suspension bridge at Karnaprayag had been approved to replace the present light one, and would be under construction next working season. When that would be ready no trans-shipment at Karnaprayag would be necessary. This proposal of new bridge was in fact a part of the bigger scheme to make the road motorable up to Joshimath. He said the road was ready almost up to Chamoli but for the bridges. By 1950 the bridges also were expected to be ready. The road up to Joshimath would be ready probably by 1952. The final plan was to construct a motorable road up to Pandukeshwar.

In the opinion of Shri Jhaldiyal no hill of 16,000 feet height near Badrinath would be climbable as the ascent was very steep and difficult. He said that Badrinath experienced snow from 30 to 40 feet and none lived there in winter. He thought Lokpal was also no good for our purpose, as the valley was narrow and cliffs round about very steep. He recommended Kuari Pass to be the most promising place. We could reach the ridge at 12,000 feet height and then could go along it up to the desired height.

As regard the air-field, he told us that there was a scheme of an air-field about one mile beyond Badrinath but this also would be used in fair weather only.

At 7 P.M. the bus came down. Trans-shipment of our kit was easy with our coolies. Road from Karnaprayag to Sonla was wider and comparatively better, but some of the bends were too sharp. The driver was very good and we reached Sonla at 8.45 P.M. safely.

Shri Nautiyal, the geologist of the party, was waiting for us at Sonla. He seemed to possess a great deal of knowledge about all the localities in this region. He is in fact a Garhwali and has been serving there for over four years. He told us that our delay had upset all arrangements, otherwise he could have brought us in the departmental bus, and we would not have had any trouble. He was very emphatic in bringing home to us the foolishness of our taking risk in travelling at night time from Sat Puli. "Even during the day there are risks, but night travelling is nothing short of death-defying adventure", he said. About our return journey he opined that in case the rain made the road slippery, he would advise the party to walk down to Pauri or even Dogadda. That meant about 150 miles walking and taking about a fortnight. He suggested that in that case Kuari Pass-Nainital road would be shorter.

We had a good square meal there after facing all the troubles for the last three days, and a good sleep to follow.

We got up next morning quite refreshed. Our cooly Sirdar, Ang Tarkay by name, all luggage, coolies and mules were there. We distributed the load amongst the coolies and resolved to start after lunch.

I knew a little of first aid and acted as the doctor of the party. We arranged the kit so that the most necessary things were near at hand in our rucksacks. Also we provided some refreshment like dry fruits in our pockets and tea in our bottles. In such expeditions so many factors are involved that even after taking the greatest possible care, we must provide for the contingency of some small link in the arrangements going wrong unexpectedly and throwing out the whole programme.

Beyond the Motor-head

We went in bus up to Nandaprayag and thereafter walked up to Chamoli, a distance of nine miles.

The map showed that beyond Mana village, Alaknanda was a small stream. It joins a bigger stream, Saraswati, at Mana but retains its name below the junction. This seems peculiar in the case of names given in older times to the Himalayan streams. It seems the names went by the sacredness rather than by the sizes of the tributaries. Prayag is the local name for a junction point of streams. The following are the points where various streams join Alaknanda—

At Mana	...	Saraswati
At Badrinath	...	Rishiganga
At Vishnuprayag	...	Dhauli river
At Nandaprayag	...	Nandakini
At Karnaprayag	...	Pindar
At Rudraprayag	...	Mandakini or Kalinadi
At Devaprayag	...	Bhagirathi

It is from Devaprayag (a little distance below Srinagar) that the stream assumes the name of holy Ganges and goes down to Hardwar. Alaknanda comes from Satopanth and Bhagat Kharak glaciers and Bhagirathi comes from Gangotri glaciers.

On our way from Nandaprayag to Chamoli we met Dr. Garola, M.L.A., and interim Minister of Tehri Garhwal and also Shri Har Gobind Pant, M.L.C. We found Dr. Garola a jolly good fellow, and we kept merry all the way along.

Chamoli bungalow was about 800—1,200 feet above the main road and climbing this extra height after nine miles walk was tiring. Shri Badami was waiting for us at Chamoli.

Chamoli is a much smaller and less important place than what one would infer by looking at the map except that the Tahsildar lives there. No provisions for men or fodder for horses is available. Procurement of food for the mules presented another problem. We contacted the Tahsildar but he pleaded his helplessness. Ultimately he said, "You are going to Pipalkoti. Try there, for it is impossible here. I have instructed my patwari at Pipalkoti to arrange for coolies for you, and in case he does so, you should better discharge these mules. Otherwise you have to send two mules back for fodder to Nandaprayag, where fodder from Pauri will come. There is no other alternative". This meant a further delay of five days to get fodder for the mules.

Chamoli bungalow was well furnished. It was in the charge of P.W.D. (Roads & Buildings). But there was very little water available. We had to stop there till noon time next day since we had to cash our drafts. At the same time Shri Ananthakrishnan had some fever. In the morning we learnt that *asthi* party carrying Mahatma Gandhi's ashes was reaching Chamoli at 9 A.M. and was to leave for Pipalkoti the same afternoon *en route* to Badrinath. But since the *asthi* party was to stay in a *chatti,* that did not clash with our programme of staying in the bungalow.

I felt that Shri Harbhajan Singh had too much of work if he was to look to coolies' arrangements as well as to the mess. Therefore, with the consent of the members, I transferred the arrangements of coolies to Shri Badami.

Dr. Ananthakrishnan felt better by noon and we started at 2.45 P.M. Dr. Agharkar and I had horses and others were on foot as per their wishes. I felt Dr. Ananthakrishnan should also have a horse, and I told him so, but he felt it was unnecessary.

At Pipalkoti the hill nearby is evergreen and has very good grass for sheep. It has been proposed to have a sheep-breeding centre here. At present all wool comes from Tibetan sheep which, if brought down to India, would die in summer. They want to have a cross between Tibetan and Indian sheep so as to have good qualities of both.

We stopped at Pipalkoti (4,000 feet) for the night and were on our way to Gulabkoti the next morning. We passed Gurur Ganga on the way 4 miles beyond Pipalkoti.

Some Mythological Associations

We heard beautiful Hindu mythological stories associated with the route we were following. After the great battle of Mahabharat in which only six warriors survived, Pandvas felt sick of all materialistic ambitions. They put Prikshat, the grandson of Arjuna on the throne and went, in company with their wife Draupadi, to the hills. Of course they knew all the different routes through Himalayas, but they chose the Badrinath route for their last journey. I expect some *chatties* must have existed even at that time where they must have rested. They did rest at Pandukeshwar, for here there is a high hill with a flat top called Pandu Chowki where Yodhishtar is believed to have played at dice. They went about 10 miles beyond Badrinath and reached Satopanth glacier. They must have undergone lot of hardships as Yodhishtar is said to have lost one of his toes — probably by frost bite. They ultimately perished in the region of Satopanth glacier. It is not known how many days it took them to reach Badrinath.

The Badrinath temple was demolished about 1,200 years ago either by the ravages of time or by some Vidharmic cult and the image was thrown into Alaknanda river. Then Shri Shankracharya got some divine inspiration, he went there and found the image in Narad-kund. He installed it in Gurur-Gupha near Tapt-kund where it remained for about 700 years when the Maharaja of Garhwal removed it to the present temple, built by him at the instance of Shri Varadrajacharya. The gold canopy of the temple is said to be a gift of the well-known Rani Ahilya Bai.

The route is divided into four parts and each part has its own sanctity. From Nandaprayag to Gurur Ganga, the route is called Sathul Badrikashram, from Gurur Ganga to Vishnuprayag it is Suksham Badrikashram, from Vishnuprayag to Rishiganga it is Atisuksham Badrikashram and from Rishiganga to Saraswatiganga it is Shudha Badrikashram.

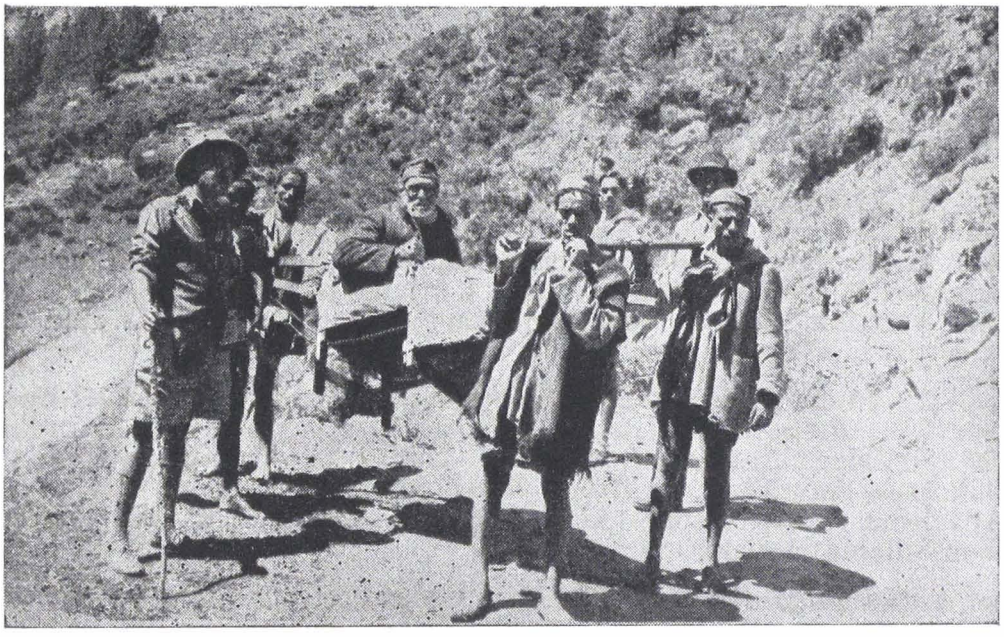
At Joshimath there is an *ashram* called Jotirmath, one of the four famous *maths* established by Shri Shankracharya. In its vicinity there is the ancient Shiva temple with Nandi bull (supposed to be Shiva's conveyance) in front. This temple is shaded over by a mulberry tree several hundred years old, under which Shri Shankracharya is said to have sat and written Upnashid Bhashya (Commentary on Upnashids).

It is said in Mahabharata that Lord Krishna visited the hermitage of Manu and Pandvas in their exile and lived with Arjuna for a considerable time in Badrikashram. In their previous incarnations Arjuna as Nar and Krishna as Narayan performed austerities on these mountains. The grammarian Vararuchi remained here for some time and obtained material for his Paniniya Grammar after propitiating Mahadeva. Later, Rishis, headed by Vyas, came to Badrikashram to learn religion from sage Parasar. Vedas were collected together and divided into four separate parts at Vyas Gupha at Mana, near Badrinath. The various Puranas were also compiled here.

On the Trail

Trade with Tibet is carried on in this region mostly by hill goats. They are small stunted animals with a lot of hair. Each goat can carry about 10 seers. They take rice to Tibet and bring back wool.

Apart from walking there are three ways employed by *yatries* for covering the distance, viz., horse, *dandi* and *kandi*. A *dandi* is a palanquin carried by four to eight persons according to the weight of the person carried. The person carried sits in a reclining position and feels quite comfortable. The charges are from three to four rupees per person employed on carrying the *dandi*. Only rich people can afford such an expense.



Surely you will hate to travel like this in plains. But in the mountains the " **Dandi** *" is a rich man's transport. The occupant is Shri Yagya Narain Padhya, M.L.A.*

Kandi is a basket in which the person to be carried sits, rather cramped up, and is carried by a cooly on his back. Only weak, light persons can be so carried. This is a comparatively cheaper mode of conveyance, though it does not look elegant.

Seven miles from Pipalkoti we came across a bad landslide where the baggage had to be trans-shipped, as loaded mules could not go along the narrow path, improvised through the debris, of the land slide. So they were unloaded, taken across and reloaded. The landslide was at the junction of Patalganga with Alaknanda. It presented an awful appearance. Huge loose stones were lying all over the slope, many of them looking dangerously balanced in their positions, and ready for the slightest reason to roll down, and none

knew when any of them would slide down and crush the person who happened to be walking along the narrow trail below.

There was in fact a sign-board at the start of the landslide that the passage was closed for horses and mules, etc., but the alternative route was over the mountain involving a detour of over three miles and a climb of about 3,000 feet. Therefore, we risked it and went by the forbidden route.

Awe-inspiring landslide near Patalganga—*Notice huge loose boulders ready for the slightest reason to roll down and crush the mules walking along the narrow trail below*

We reached Gulabkoti (5,300 feet) at 12 noon and found that the *asthi* party was in occupation of the bungalow. The party was led by Shri Chandiwalla. There were four persons in the bungalow and the rest in the *chatti* below. We talked to the people in the bungalow and found them very good and unassuming. They left at 3 P.M. for their onward journey, and we occupied the bungalow.

We had proposed a double march for the day which meant starting again at about 3.30 P.M. But Shri Harbhajan Singh got some temperature, headache and heaviness of stomach. Dr. Ananthakrishnan and Shri Badami also felt tired. Therefore, we dropped the second march. We did not want to tire out ourselves or the coolies while we were yet on the approach road. It was, we thought, prudent to conserve our energies for the work at our destination. As our programme stood, we were going to take about 75 per cent of the time on our journey to and from the various sites and only the remaining 25 per cent at the sites for finding out their suitability from various points of view. Therefore, we required our energies to do full justice to our work after reaching the sites.

Mahatma Gandi's Asthi at Gulabkoti bungalow. *His ashes are being carried to holy Badrinath and Mansarowar*

At Gulabkoti we saw trees of Tun which give fine rose coloured timber, very useful for furniture, being light and strong.

During our stay at the various bungalows we did not find enough number of chairs and, therefore, we used some of our boxes to sit on. Fortunately every bungalow had a table which we used as our dining table. We had to place it in the verandah or outside under some tree, as each bungalow had only one room and a small dressing room which were hardly enough to accommodate our beddings. At Badrinath, however, we had neither a dining table nor chairs and therefore we kept the dishes on the dressing table and took buffet meals.

At Chamoli, Pipalkoti and Gulabkoti, no water for bathing was available and, therefore, most of the party members had to forego their bath, while one or two managed to have some sort of sponge-bath. During the marches in hills we cannot have all the facilities of a well settled home in the plains and we have got to do the best of the situation. There were so many flies in every bungalow that it was impossible to keep them away from food. In spite of our best efforts we had to relax our scruples to a great extent.

Our kit reached Gulabkoti but the boxes carrying provisions were left behind. Our Sirdar Ang Tarkay could offer no explanation. In fact we had found him much more efficient during our previous expeditions in Nepal, and it seemed that he did not feel, much responsibility now because of the ready excuse he had that Dotiyals did not obey him. This brought home to us the advisability of having all coolies from one place under one Sirdar.

We left Gulabkoti next morning and reached Joshimath (6.150 feet) before noon. On the way we came across another landside, and had to climb up and down the hill on the other side. I went

down the hill-side to photograph the landslide and got an experience of the stinging nettle on the leg; the uncomfortable sensation lasted till the evening. While at Simla I had been shown another plant growing by the side of stinging nettle, whose leaves if crushed between fingers and rubbed on the skin removed the uneasy sensation. But I could not recognise this antidote here and had to suffer for some time.

Joshimath is a nice bungalow about 100 feet above the level of the town and 1,500 feet above Alaknanda. From the bungalow we can see the winding road going down to the junction of Dhauli with Alaknanda, called Vishnuprayag. In front rise mountains about 1,000 feet higher than Joshimath. The hill just opposite the bungalow is called Hathi Parbat after its shape. Joshimath is the place to which all the temple priests, etc., from Badrinath move down during winter. We had travelled so far from west to east and now had to turn left and go towards the north. There are in fact three ranges of Himalayas, lower or outer, central, and the upper or inner range. We had so far been in the lower range and from Joshimath we were going to enter the central range. The central range continues to about 10 miles beyond Badrinath. Then the upper range begins. The central range has steep southern slopes on which snow can hardly stay; and whatever snow sticks. it melts away quickly on account of the sun being strong on the south. The upper range has gentle northern slopes and, therefore, glaciers abound in that region.

There is a rest house attached to the temple at Joshimath and we were invited to stay there. But we found the bungalow quite comfortable and refused the invitation with thanks.

A member of the Badrinath temple committee suggested another peak named Gorsaon near Joshimath which we might investigate. It seemed everybody had some peak or the other to suggest but the question was how to investigate them all in the limited time at our disposal. We had not yet left the idea of investigating Kuari Pass, and then going down to Almora and Nainital *en route* to Delhi. Shri S. P. Nautiyal favoured going to Gorsaon before proceeding further. But we thought it best to see Badrinath and Lokpal first as per our programme and leave the remaining peaks to be investigated or not, in the light of our experience at the above two places.

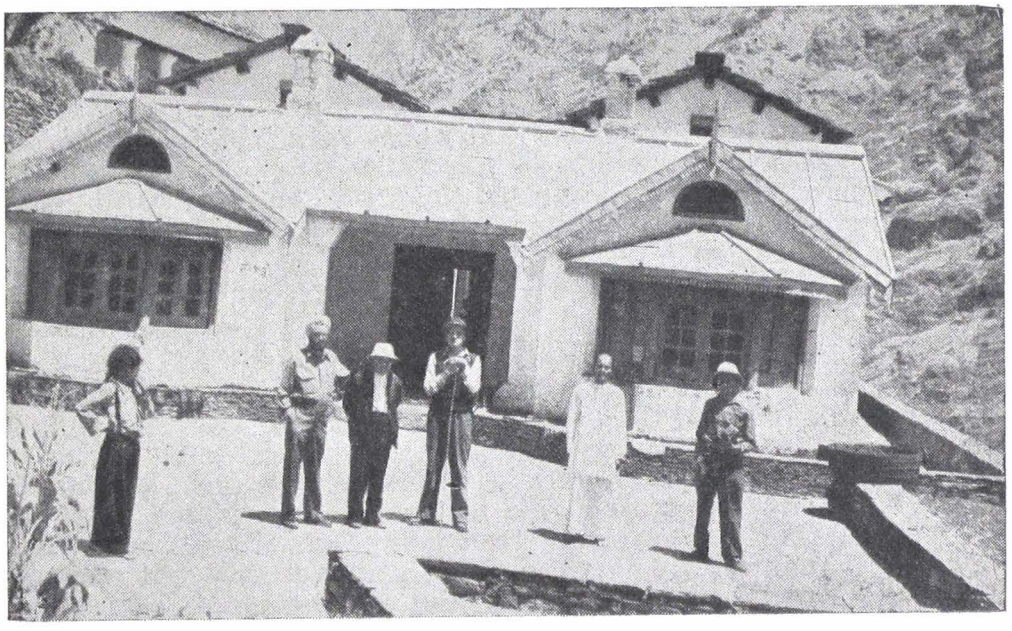
A little later the Ex-Rawal of Badrinath temple who lived at Joshimath at the time, came to see us. He was the Rawal when Shri Frank Smythe had visited Badrinath. Shri Smythe has described him in his book as follows.

> "The Rawal is the high-priest, and his house stands between the temple and the Alaknanda river. He was short of stature and a typical plainsman in appearance. He had come from Madras, and, to judge from the heavy European overcoat he was wearing, found it chilly living close to the snows. He is the keeper of the temple and temporal ruler of the Badrinath district. He greeted us shyly and eyed us a trifle askance, and small wonder, for our appearance was positively terrifying. I saw his dark eyes fixed themselves fascinatedly on Birnie's red

beard. However, in a minute or two he appeared to realise that we were not quite so villainous as our appearance warranted, and invested us with the garlands of flowers which had been awaiting our arrival."

He had been Rawal for over 20 years. But since about 7 years back he lived with his family at Joshimath. We found him an unassuming, quick witted, and frank person of about 50 years who made very jolly company. His name and address is Shri Vasudev Nambudri, Ex-Rawal, Joshimath, Garhwal. Talking of the days when he was a Rawal, he said, " O, I was a real Rawal. During my time I enjoyed immensely. Now since the time this temple committee has been constituted, Rawalhood is no good ".

We halted at Joshimath for the next day. At night it started raining but it cleared up in the morning. The Ex-Rawal had invited us for tea. So we went to his place.



Ex-Rawal's house at Joshimath. *From left to right :—Rawal's daughter, Harbhajan Singh, Agharkar , Nautiyal, Rawal, Ananthakrishnan.*

While we were there, a woman of about 40 years came up and greeted the Ex-Rawal. The Ex-Rawal could not recognise her and asked her for an introduction. She was from Bangalore, and had come to Badrinath twice before, once in company with the Maharani of Kashmir. She had lost her husband about two years before and since then she passed her time in religious acts. About a month back she had a dream in which God appeared before her and said that she should go to Badrinath and stay there for 10 days. She was, therefore, now on her way to Badrinath to have *darshan* of the deity. She wanted a chit from him to the present Rawal to allow her 10 days stay at Badrinath temple. The Ex-Rawal said that a chit was not necessary and that she could stay there as long as she liked. The story of this woman gave up a little glimpse of the mental attitude with which *yatries* went to Badrinath.

From Jotirmath we can see the beautiful Kamet peak in its full majesty. One who has not seen the snow clad mountains from a short distance cannot feel the sublimity and grandeur of these peaks.

On the 12th June 1948, we made arrangements for food for coolies (25 maunds of rice and atta). Out of this 13 maunds was to go with us to Badrinath and the rest was to be stored for eight days at Phaiya, from where we were to turn to Lokpal. Similarly one snowgauge and one raingauge meant for Lokpal were to be stored at Phaiya. Thirteen maunds of provisions were carried from Joshimath on goats and sheep and they did it as well as any coolies or mules could.

From Joshimath we descended to Vishnuprayag. The road with gentle slope was about two miles long. We, however, took to a short cut which was shorter but steeper. Only Dr. Ananthakrishnan went by the longer route. We found on reaching the bottom that Dr. Ananthakrishnan had reached there in a shorter time. At the same time the steep descent had told on our knees, which started paining. In hills it is really not advantageous, while either going up or going down, to take to shorter and steeper cuts.

From Vishnuprayag the hills on the sides of the valley became higher and grander. The valley was very narrow in the beginning but widened out after about two miles. The path at certain places was 3 to 4 feet wide, and looking down into the stream 700 to 800 feet below, made one dizzy and liable to lose balance and fall down. One should in such cases keep his eyes on the foot-path to have a feeling of security.

We stored the materials at Ghat Chatti, one mile short of Phaiya, as there was no room available at the latter place; and reached Pandukeshwar (6,450 feet) at 11 A.M., not at all tired, probably because of the cooler weather. Near Phaiya we saw a narrow path passing over a dangerously hanging bridge across the Alaknanda. This was leading to Lokpal.

Dangerously hanging bridge near Phaiya on way to Lokpal

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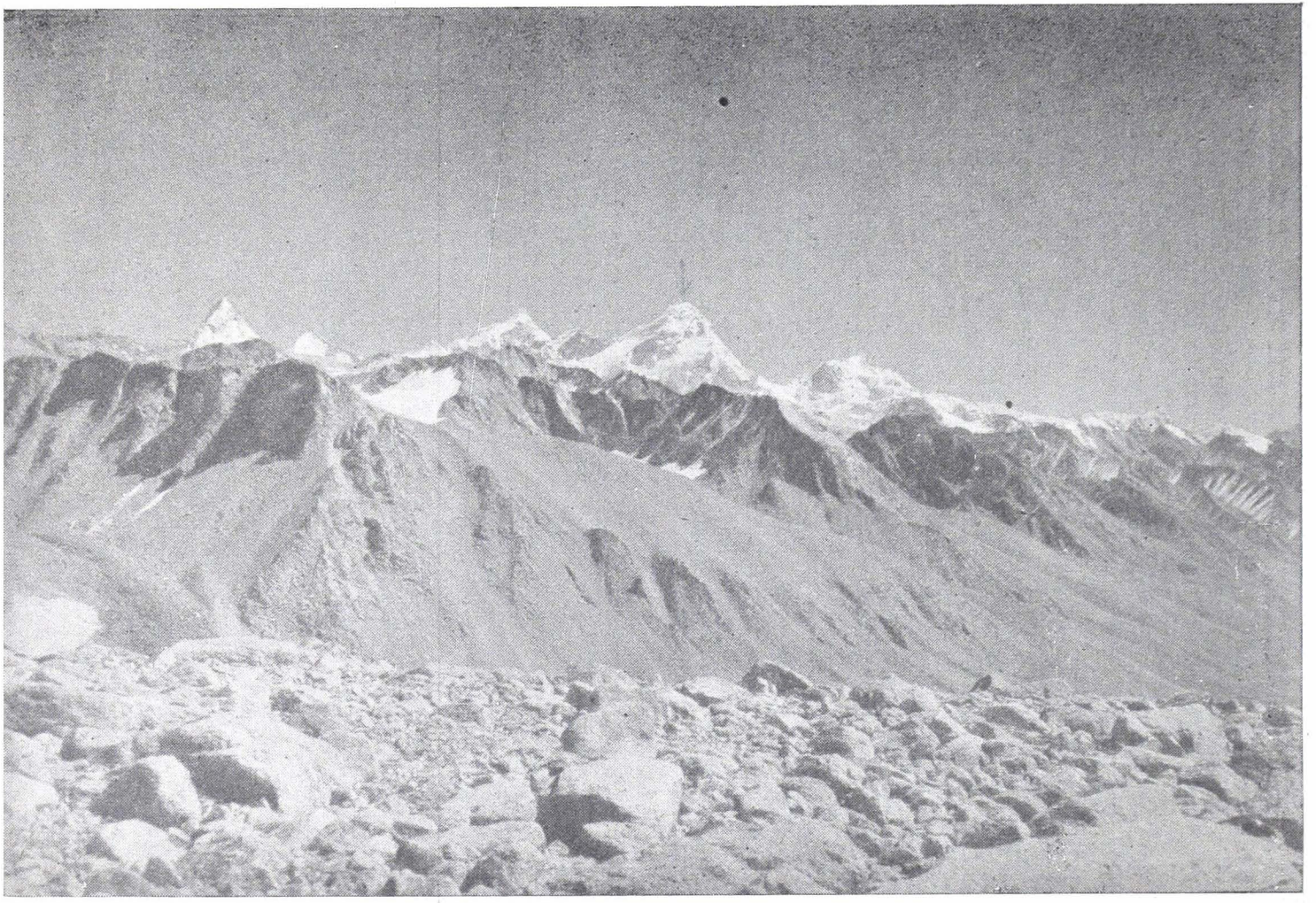
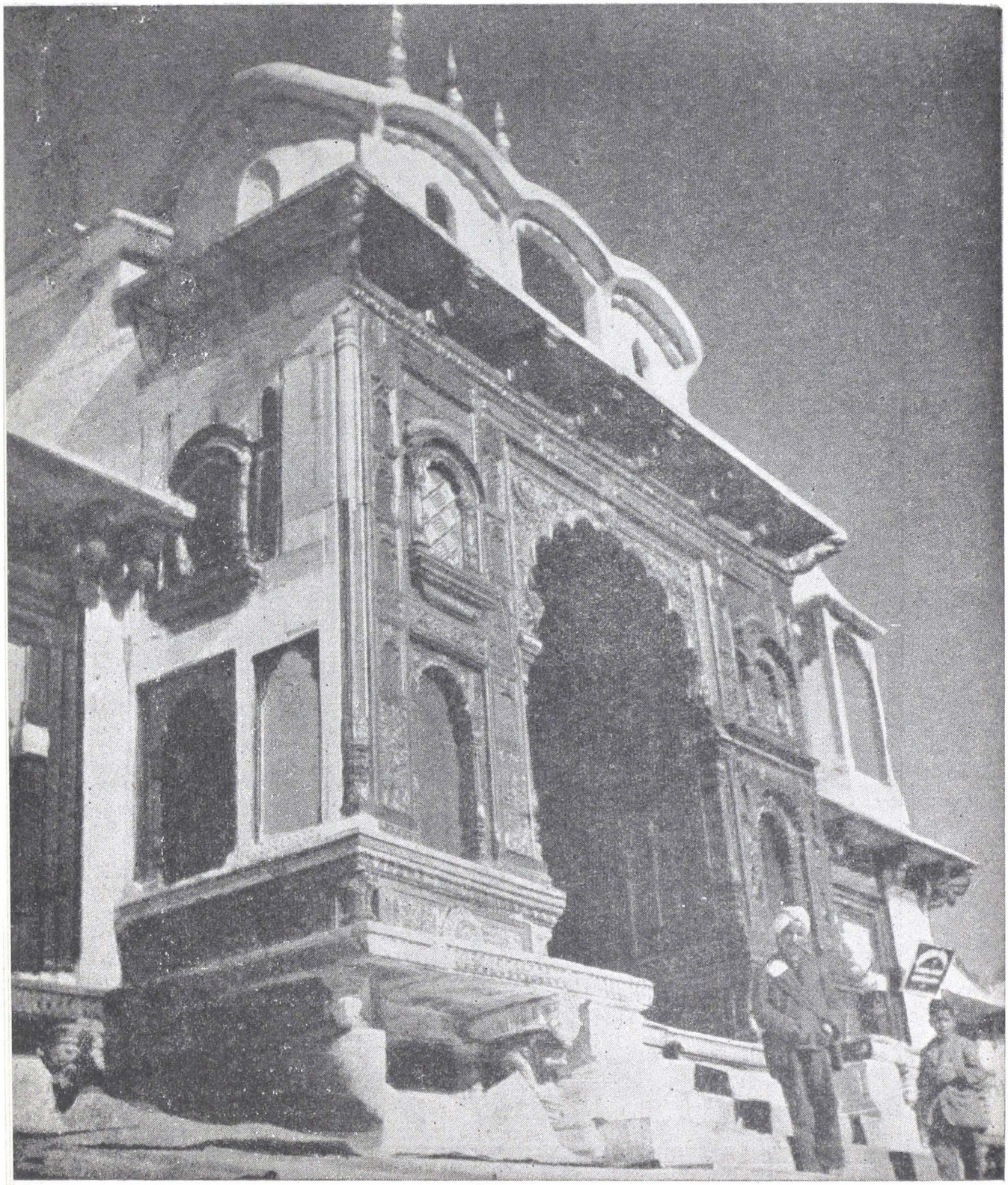


Famous **Mount Kamet** *(25,447 feet) towering above the snow covered chain of mountains*

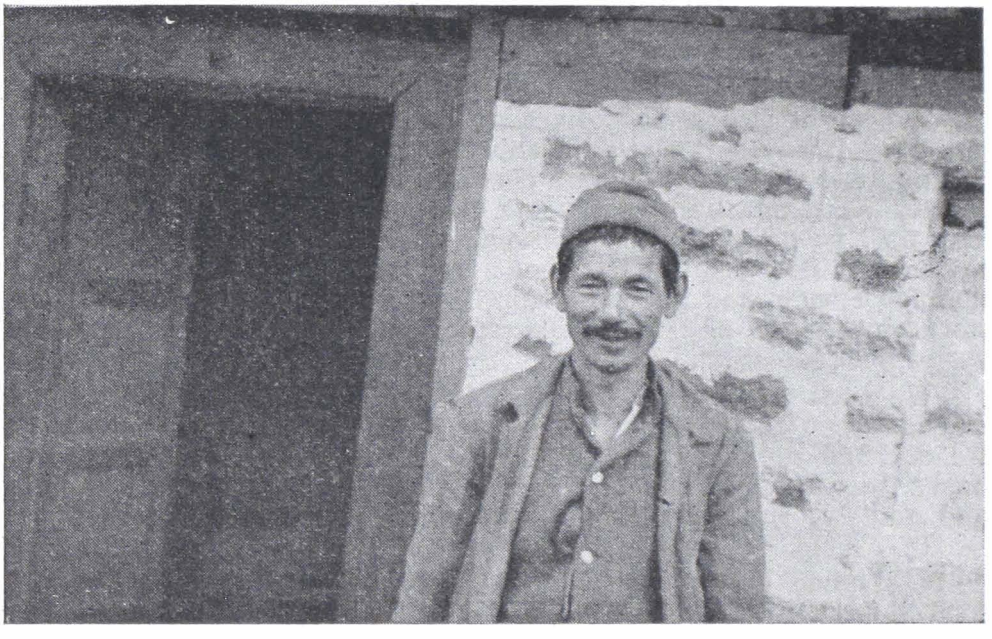
A grand view of **Badrinath** *from the approach road*



Ornamental gate of Badrinarayan Temple

We were glad at Pandukeshwar to be able to get some fresh milk, though at an exorbitant rate of Rs. 1/8/- per seer. It had a peculiar smell, probably because, as we thought, it had not been well boiled. Everyone except Dr. Ananthakrishnan took it, and by next morning everyone except Dr. Ananthakrishnan had something wrong with his stomach. Everyone consumed two pills of sulfaguanidine, to remove the trouble. We found this medicine to have a wonderful effect in case of stomach troubles, usually experienced in hills. We had taken 100 pills with us and the last pill was consumed before we left Pauri on our return journey.

We left next morning for Badrinath. By 9.15 A.M. we were at Hanuman Chatti (8,250 feet), six miles from Pandukeshwar. Here by chance we met Shri Kaiser Singh who once accompanied Shri Smythe to Kamet peak. He looked very much older now. He had, he told us, his herds of goats and cows to look to and, therefore, could not join our party. He said that he had visited Lokpal and Kuari Pass a number of times, and tried to assure us that the visits to these places would not at all be difficult.



Kaiser Singh of " Kamet Conquered ". *He says he is too old now for Himalayan adventures*

About a mile beyond Hanuman Chatti steeper incline started, but really stiff ascent was experienced for a distance of about one mile near Badrinath. About half a mile from Badrinath town, the valley opens out (this point is the highest—10,500 feet—on this route) and Badrinath town is seen with dome of the temple as the most prominent point.

On the way we saw a number of snow bridges where the river-flow had made its way through the snow avalanches which had come down the gullies.

At Badrinath

The immersion ceremony of Gandhiji's ashes had just finished and the party was returning from the Alaknanda (popularly known as Ganges in these parts) when we reached Badrinath.

The temple committee had reserved two rooms for us in the rest house very near to the temple and we stayed there.

We had a bath in Taptkund. This is a hot sulphur spring on which a tank about 14 feet square has been constructed. We were afraid the water was too hot, but once one got in one could stay there for any length of time. But we were told not to be in water for more than five minutes or else we were liable to get headache. Actually two of us got headache after the first day's bath. The temperature of this water is about 130°F. and the discharge about one gallon per second.

For our lunch we were sent *bhog* from the temple. It was good and clean but had too many chillies in it. Since it was a change from the stereotyped food that we had been taking for the last one week, we relished it. By now Dr. Ananthakrishnan was hungering for pickle. Next morning our Sirdar Ang Tarkay brought some dark-looking mango pickle from the bazar. Dr. Ananthakrishnan was very glad to see it but was soon disillusioned when he tasted it and found it to be sweet.

We learnt that nobody lives at Badrinath in winter. As a rule the Rawal moves down to Joshimath early in November, leaving behind one chowkidar. Even the latter moves down on the first snowfall. In unusual years when the snowfall is very late the last man may go down by the beginning of December, but that is about the limit. They come back about the beginning of April, clear the temple of snow and get ready for the pilgrims. The pilgrim season starts from 10th of May. The snow accumulation at Badrinath varies between 25 and 40 feet.

We went to the town to meet Shri G. P. Nautiyal, the journalist. He had been recommended to us as a "mine of information" and we did find him very well-informed. He owned a shop dealing in books, pictures, and shilajit, etc. He gave us a lot of information and sold us a number of copies of his book "Call of Badrinath".

We went to the temple at 7 P.M. and had *Darshan* of the deity. It had grown chilly by this time. So we came back, took food and, tired as we were, went to sleep.

Shri Badami got up next morning with fever on him. He, however, dressed, went to the temple and then in company with Dr. Ananthakrishnan went to select a suitable site for the rain and snow gauges. On return he felt worse and had to be confined to bed for the next 36 hours.

Shri Harbhajan Singh and I went to Shri G. P. Nautiyal and wanted to know more about Lokpal. He gave us a guide to one Mangal Singh Chowhan. (His address is : Village Bhyundar, P.O. Pandukeshwar, Garhwal). This man was a resident of Bhyundar, a village five miles short of Lokpal. He told us that one could not stay at Bhyundar, much less at Lokpal, for more than three months at the most in the year, i.e., from middle of June to middle of

September. The hill tops near Lokpal would, he told us, naturally be habitable for a still lesser period. The road was at that time open, but no horse or mule could go. Lokpal got heavier snowfall than Badrinath. Under these circumstances, we thought, it would be better to drop Lokpal unless a seasonal observatory was required. We sent a telegram to the Director General of Observatories, as below—

Dated : 15-6-1948.

Meteors, New Delhi.

Enquiries show depth of snow Badrinath and Lokpal localities twenty to forty feet and whole year observatory not practicable above ten thousand feet aaa Party proposes to select site for seasonal observatory from April to October aaa Information from inhabitants Lokpal indicate Lokpal habitable July-August only aaa Hill tops nearby habitable still shorter period aaa Propose omitting Lokpal aaa Investigating Narayan Parbat site seventeenth aaa Propose also investigating some sites further north and near Kuari Pass aaa Kindly wire approval care postmaster Badrinath

Dhir, and Ananthakrishnan

and his reply was—

New Delhi,

Mister Dhir care Postmaster Badrinath

Your telegram fifteenth aaa Seasonal observatories will have very limited value and therefore not likely received favourably by scientists aaa Agree investigation sites further north near Kuari Pass aaa Living and working over snow covers during certain months need not be completely ruled out provided houses can be built which will not be buried in snow aaa in high altitude observatories in other parts of world scientists live and work over snow aaa in view suggestions of Kohli and Smythe desire visit Lokpal if accessible before that is ruled out.

Meteors

In the light of the above instructions we decided to go to Lokpal. We engaged a guide and instructed him to meet us on the 20th June 1948, at Pandukeshwar on our way from Badrinath to Lokpal. We contacted Chowdhri Ganga Singh, the *pujari* of Lokpal. He had a shop at Badrinath and was glad to give us all the information we wanted. We were not encouraged by what he told us, but we made up our minds to go there.

Shri Kothiyal's brother went up to Narayan Parbat and brought us information that there was no good area available at a height of 14,000 feet, but we wanted to satisfy ourselves by going there. The next day Shri Badami was ill and Shri Nautiyal had something also to do. So we postponed the trip for a day.

Dr. Agharkar went with his pony and a cooly to examine any suitable sites towards the north beyond Mana. He came back in the evening with full satisfaction that no suitable site existed towards the north unless of course we were prepared to reach Mana Pass. Next day Shri Harbhajan Singh and I went up the Narayan Parbat. At 12,000 feet there was a good piece of land where a colony could easily be located. An area of about 1,600 feet × 450 feet could easily be occupied. No difficulty of water supply could be apprehended as a little stream of crystal clear water flowed nearby. But there was the greatest danger of avalanches, for this site. In 1947, this

very place was the scene of avalanches which, coming down, destroyed at least a quarter of Badrinath. But if this was not a good site for the colony, the colony could be located at Badrinath. The main point was about a suitable site for the observatory at a height of 14,000 feet to 16,000 feet. We found that at that height there was not sufficient area for an observatory and the angles which the surrounding peaks subtended varied between 10° and 29°. Therefore, we had to reject this range.

Shri Nautiyal went to the mountain opposite, known as Nar Parbat or Kuber Bhandar but he also could not find a suitable site. The main difficulty was the high angles which the other peaks made.

Next day Dr. Agharkar had pain in the stomach and Shri Harbhajan Singh had cold and headache with some fever. I had stomach trouble though I was not confined to bed. Dr. Ananthakrishnan was dead tired with the previous day's climbing up and down, and could not think of getting out of his bed. Shri Badami had still some after effects of illness in that he had no appetite and was getting weaker. We sent for the doctor and passed the day resting in beds.

Next day Dr. Agharkar felt better, but was still very weak. He made a suggestion that he and I might stay at Pandukeshwar while the others might go to Lokpal. But nobody was yet feeling normal and no final decision could be taken. Dr. Agharkar thought that this general deterioration in the health of the party was due to the combined effect of altitude, tinned food, etc. Another suggestion was then made that Dr. Agharkar, Shri Harbhajan Singh and I should investigate Kuari Pass while the other three investigated Lokpal. Then we could meet at Joshimath and decide which way to go ; *via* Pauri or *via* Almora. This was accepted by all and we made up our programme accordingly. The provisions were divided and coolies were given the necessary instructions.

Next morning Dr. Ananthakrishnan got up feeling very tired. Shri Badami had still his trouble of sluggish liver due to which he had always had a feeling of vomiting. But they wanted to go to Lokpal. Shri Nautiyal suggested very easy marches in view of their weak physical condition.

The party had got fed up with the troubles at Badrinath and would have moved down on the 19th ; but the bungalow at Pandukeshwar was not available. We had to stay a day longer at Badrinath. Shri Badami and Dr. Agharkar remained busy for the first half of the day in the *sharadha* ceremony of their forefathers. Dr. Ananthakrishnan was also busy in some religious rituals.

By evening we were feeling tired and done up and, therefore, decided that under these conditions it was impossible to stand the difficulties of visiting Lokpal. So we sent a telegram to the Director General of Observatories, as below—

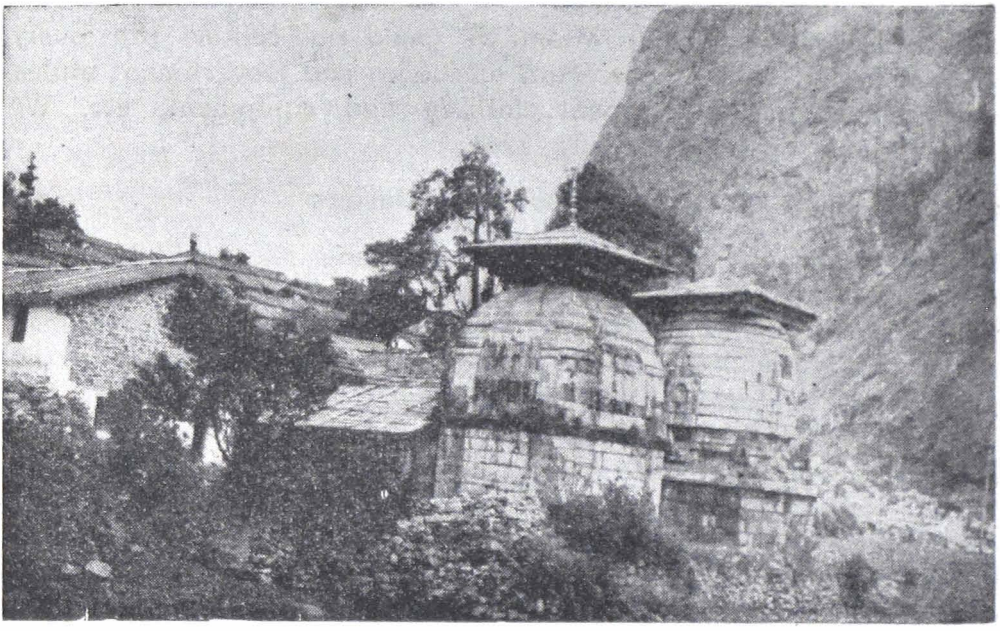
Meteors, New Delhi

Your telegram aaa in view further information collected about Lokpal, difficult access and failing health of party, Lokpal dropped aaa No good site further north aaa Investigating Kuari Pass aaa Letter follows

Expedition Party

We left Badrinath after all with a sigh of relief. On our way near Badrinath, Seth Shankar Dutt Bahuguna (address in summer : Badrinath and in winter : Nandaprayag, District Garhwal) gave us breakfast. He was a nice man and had gardens both at Badrinath and at Joshimath where apricots, peaches and apples grew. In his garden we saw a tree of Bhoj Patra. Thin layers of the bark of this tree become dead and are taken away. Other layers then appear from below. This Bhoj Patra (layers of bark) is mentioned in Ramayana as forming the clothes of Shri Rama when he went to the jungles.

We reached Pandukeshwar at about 2 P.M. We had forgotten about flies at Badrinath but were forcefully reminded of them when at Pandukeshwar a swarm of them attacked our food. We saw the temple at Pandukeshwar but had nothing much to do there in other respects.



Temple at Pandukeshwar—*the Pandavas halted here on their way to Badrinath*

Next day we came down to Joshimath. I had caught cold at night at Pandukeshwar. In the morning as I walked a little I felt my cold better. I thought walking would do me good and might even cure me completely. I, therefore, walked six miles down to Vishnuprayag. On reaching Joshimath I went direct to the hospital and took some APC powder. But a little after reaching the bungalow I felt I had temperature and my going to Tapoban or Kuari Pass was out of question. Dr. Agharkar also decided to stay behind to look after me, and also for the reason that there was nothing special for him to do at Kuari Pass. So we stayed behind.

My fever left me after two days but the cold in the nose did not leave me for one full week. I consulted the doctor if I could go to join the party at about 13,000 feet but he refrained me from doing so.

We met Ex-Rawal a number of times during our stay at Joshimath. He is not a personality and hardly inspires any feelings of piety or holiness. He tries to have a joke at everything and everybody—be it the Prime Minister of India, the local Tahsildar, or the idol at Badrinath.

Dr. Agharkar had some appointments at Poona and, therefore, could not wait at Joshimath longer than the 28th June. He, therefore, left alone for Delhi while I stayed behind awaiting the return of the party. The party returned on 2nd July. They had found some good sites which have been described in the joint report at Appendix E.

We started back on the 3rd July and reached Pauri on the 6th. We had to halt there for two days, to meet the Deputy Commissioner, and the Deputy Collector whom we could not contact previously. We had also to settle the account of coolies and Government mules, and pack up the Government clothing and equipment, etc. We reached Delhi on the 10th July 1948.

Proposals about Research on Snow and Glaciers

It has already been stated that no suitable site could be found on Alaknanda river for having an all time observatory for astronomical observations at the desired height of 14,000 feet to 16,000 feet. So far as research on snow and glaciers is concerned, most of the work has to be done in the field. For snow work the surveyor has to take observations at the snow courses, which are to be located at different altitudes and measure the stream discharge. Temperature, rainfall and snowfall observations have to be collected by separate observers at the meteorological stations. Then all this data has to be put into proper form, analysed and correlated, which can be done at the main laboratory proposed to be constructed near the scientists' colony. For other research work like rate of evaporation or of melting as a function of the temperature has also to be done in the field on the glaciers themselves. This data also can be studied and analysed in the main laboratory.

During the preliminary meetings at Delhi a suggestion was made that we might have two high level observatories instead of one—one in the western Himalayas and another in the eastern Himalayas. The conditions of rainfall, altitude, nearness to Equator, etc., vary greatly from west to east, and the results based on the observations in the west may not apply to conditions in the east. The argument was accepted but in view of the extremely heavy cost of establishing such observatories, it was felt that one observatory should be good enough to start with. Extending the argument

further, specially in the case of snow survey, we might have a network of a modest type of observatories in the Himalayas. These observatories may be located at different altitudes in all the main river basins. At least for some years observations may be taken at all these observatories, and then it will be easy to decide which observatory or observatories represent the Himalayan conditions, so that those ones could be extended and developed. So far as work on snow is concerned this arrangement would be ideal. In the percentage system of snow surveying the value of normal snow cover is correlated to the value of normal stream discharge. In American practice this relation is assumed to be of a simple straight line form. It is yet to be seen whether this assumption holds in the case of Himalayan streams, or the relation is more complicated. It is also certain that the relation which holds in the case of one Himalayan catchment will not hold in the case of another, as the snow conditions differ enormously from catchment to catchment. There is at present no known method of determining this relation except by actual observations on snow and stream discharge in each catchment. Therefore in order to cover the whole Himalayas each main catchment will have to have its own snow courses where regular observations are taken and analysed separately. We have got five main streams emanating from Himalayas, viz., Brahmputra, Kosi, Gandak, Ganges and Sutlej, and each one of these must be treated separately. Snow survey work has already started in Kosi and it is possible now to start it in Ganges catchment. The other three can also be taken up in due course.

As regards research on glaciers, work at two observatories, one in the west and another in the east, may probably be sufficient. Therefore, in the first instance work could be concentrated at one observatory wherever it is located, and no network of observatories is required.

In case of Ganges, Alaknanda may form a good representative stream where snow survey can be developed. The discharge of Ganges at Hardwar, from where the plains start, is made up of two main sources, viz., Alaknanda and Bhagirathi. It is not certain that the results of snow survey on Alaknanda will serve for Bhagirathi as well. Therefore, while carrying on detailed snow survey work on Alaknanda as proposed below, we must at the same time measure discharge of the two branches separately as well as their combined discharge at Hardwar, and try to compare and correlate each one with the snow observations in Alaknanda. This will show whether snow survey in only Alaknanda catchment will do for the whole Ganges, or whether Bhagirathi requires separate snow survey courses.

The following are the proposals for snow survey work in this catchment—

(a) *Snow Courses*—Snow comes down to near Pandukeshwar where people live throughout the year. Generally snow at Pandukeshwar does not accumulate to an appreciable extent and, therefore, the snow survey sites should start from some site above this village. Temple at Badrinath and Post Office open on the 10th May every year but the temple employees come here much earlier to clean up the snow and get ready for the pilgrims. Normally they come here about the middle of April. Therefore, snow surveying should start on the 1st April at the latest and preferably on the 15th March. It should continue till the snow has melted, i.e., up to about 15th May. The snow survey sites should be located at the following places—

(i) Near Hanuman Chatti (8,360 feet) where nearly level ground is available (Panpatia glacier).

(ii) Near Khiraun village (nearly 9,000 feet) along Khiraunganga.

(iii) At Badrinath (10,300 feet) near the P.W.D. rest house (Nilkanta glacier).

(iv) Near Mana village (10,350 feet) near the junction of Alaknanda and Saraswati (Bhagat Kharak and Satopanth glaciers).

(v) Near Ghastoli in Arwa Valley near its junction with Saraswati (height 13,110 feet) (Arwa glacier).

(b) *Temperature Stations*—One temperature station has been established at Badrinath and another may be established at Pandukeshwar. A thermograph may be installed at Ghastoli.

(c) *Rain and Snow Gauges*—A self-recording snowgauge which has large capacity and can record continuously for a long period should be installed at Badrinath in addition to the ordinary one already fixed there as its capacity is not sufficient for the amount of snowfall there. A raingauge has already been established at Badrinath. Self-recording snowgauge should also be installed at Ghastoli while an ordinary one at Pandukeshwar.

(d) *Discharge Sites*—They should be located at the following places—

(i) On Khiraunganga near its junction with Alaknanda.

(ii) On Alaknanda just below the junction of Khiraunganga with it.

(iii) On Rishiganga near its junction with Alaknanda.

(iv) On Alaknanda after the junction of Rishiganga with it.

(v) On Alaknanda near Mana village, before the junction of Saraswati with it.

(vi) On Alaknanda near Mana village, after the junction of Saraswati with it.

(vii) On Arwa river near Ghastoli, before its junction with Saraswati.

(viii) On Saraswati near Ghastoli, after the junction of Arwa river with it.

(ix) On Dhauli river near Vishnuprayag.

(x) On Alaknanda near Vishnuprayag but after the junction of Dhauli river.

(e) *Sno-cat*—Sno-cat cannot be used in this valley as (i) path is too narrow ; at places it is about three feet only ; and

(ii) there are many suspension bridges on the way which cannot be crossed by the sno-cat.

(f) *Research*—Research work can be done in this valley on the following lines—

(i) Work on evaporation from snow and glaciers at different temperatures can be done from Badrinath or Mana village on Satopanth and Bhagat Kharak glaciers. Distance from Mana is about 6-7 miles and from Badrinath 7-8 miles.

(ii) Telephoto camera can be fixed at Badrinath in the compound of P.W.D. rest house from where Nilkantha peak is wonderfully clear. From the photographs taken the percentage of snow may be judged.

(iii) Work on the rate of melting of snow as a function of temperature can also be attempted from Badrinath or Mana on the glaciers nearby.

(iv) Percentage relationship may be established between the measurements of snowgauge and of snow.

From item Nos. (ii) and (iv) percentage relationship may be established from photographic or snowgauge measurements and actual snow surveying may become unnecessary.

(g) *Comparison of Tamur and Alaknanda Catchments*—Alaknanda valley is better for snow survey than Tamur because of—

(i) facility of transport to snow surveyors ;

(ii) snow being available at lower altitude ;

(iii) many flat places being available for snow courses ; and

(iv) snowfall being heavier in this region.

Therefore, there is greater possibility of arriving at some conclusive results about the suitability of American practice of snow surveying as applied to the Himalayas.

Remarks on Engineering Aspects

Neither a suitable site was found near Badrinath which area we investigated carefully, nor from the information gathered from the local inhabitants, was Lokpal expected to be any better. I fell ill unfortunately at Joshimath, a day before we had to go to Kuari Pass with the result that I had to stay behind. The members of the party who went there found some suitable sites whose particulars find a place in the joint report. It is felt that more sites will have to be investigated before selecting the best one. The suitability will be decided mainly on the basis of four requirements mentioned in the joint report though the engineering aspects cannot be ignored, forming as they do, a substantial part of the expenses to be incurred on the scheme.

The astronomical observatory is to be situated at an altitude of 14,000 feet to 16,000 feet while the scientists' colony and the main laboratory at 12,000 feet to 14,000 feet. In case the observers cannot live at the observatory throughout the year, they can stay at the colony below and go up daily to the observatory for observations. For doing so a road is necessary to connect the two, and for the period that the road will be under snow some arrangement like the funicular railway is required. From the information gathered it is found that the snow accumulation is as much as 25 feet to 40 feet at these altitudes and it is felt that the provision of funicular railway will present almost insurmountable difficulties. If at all it is possible to construct it, the cost will be prohibitive. Therefore, either the observers must live in the observatory during the snow period and have communication with the colony and other parts of India by radio communication or else both observatory and the colony should be located near each other on the same plateau at an altitude of about 14,000 feet. Both these alternatives will obviate the necessity of daily journeys by road or railway.

There are so many perennial streams with falls in these regions that once the site for the colony is selected, it is almost certain that a suitable fall within a reasonable distance will be found, where hydro-electric power could be developed. Similarly water supply will not present any great difficulties. Of course suitable arrangements will have to be made to see that water does not freeze in water pipes, etc., during cold periods.

So far as buildings are concerned the height of 14,000 feet as suggested above will be more suitable, as a height of 16,000 feet is

at most places under permanent snow. If all the buildings are located at one place at 14,000 feet, 20 acres area would be quite enough. The design and estimate figures will depend on the depth of snow. Obviously if the depth of snow is 40 feet, the lower 40 feet of the buildings will not be very useful during winter unless they are provided with artificial ventilation. The height of storeys in hills is generally not more than 10-12 feet. The foundations will have to be designed according to the height of the buildings and the kind of soil available.

As regards the air-field, the dimensions required increase with altitude. At 10,000 feet the dimensions will be about 5,000 ft. × 300 ft. It is very difficult, if not impossible, to find a flattish area of such dimensions at such altitudes. But I feel this point must be taken up after the site has been selected from other considerations. After all we can fall back on the use of a helicopter. In fact, considering the type of country, a helicopter will probably be the most suitable type of aircraft at about 10,000 feet.

Below are given further remarks about the engineering aspects so far as Badrinath site is concerned. Though no suitable site could be found near Badrinath, still the ideas formed are described below for the sake of record and future reference if necessary.

(a) *Buildings*—Buildings round about Badrinath are covered either with local slates or with galvanised iron sheets. All the buildings get covered by snow. Therefore, they are designed for additional snow load. The angle of the slanting roofs varies from 25° to 33°. But this cannot be guide for the observatory roof which has to be designed to remain snow-free. The mountain slopes indicate that snow can stay at a slope as much as 70°. Of course there are boulders and some growth on the mountain slopes, which hold the snow. Therefore, on the whole 60° angle might be a good guide.

(b) *Road*—One trip on a hill road will convince any engineer of the futility of giving any figures of cost per mile with a claim that they would fairly approximate. A figure could be mentioned only when the survey of the alignment has been made. And even then the figures are liable to vary much during actual construction. The cost may work out to anything between Rs. 80,000 to 200,000 a mile depending on the conditions.

(c) *Electricity*—The temple committee has already got a scheme prepared for current from Rishiganga by an engineer from Madras. I contacted the Secretary for the purpose and he directed me to contact his predecessor, who in his turn referred me back to his

successor. This scheme was received by me from Secretary, Badrinath and is given in Appendix G.

(d) *Airfield*—On my special request Shri K. C. Mathur, Executive Engineer, Garhwal, has sent me a copy of the report and survey that he submitted to his Superintending Engineer. These are at Appendix H.

Suggestions for the Future

"Assimilation of the experiences and lessons of previous expeditions is the first duty of an organizer of a Himalayan expedition." Almost every expedition party suggests precautions which must be observed by the subsequent expeditioners. Excellent and fairly exhaustive advice will be found in the publication "Kamet Conquered" by Shri F. Smythe. However, considering that this particular expedition consisted not of mountaineers, as was the case with Shri Smythe's expedition, but of Government Officers drawn from various departments, I believe that the experience gathered in the particular circumstances — time and duties — can be of great use to similar expeditions in future. I, therefore, set down the main points which, I consider, must be borne in mind by future parties to Garhwal, which might hereafter be organised by the Government.

An expedition into the Himalaya is an adventure in itself. There are so many odds against, that even after making the most careful arrangements about every conceivable thing, one is faced, during the actual day to day progress, with innumerable problems requiring easy grasp, ingenious resourcefulness, and quick decision. The first and foremost requirement is as detailed a knowledge of the local conditions as possible. The maps do give some geographical information but much more is required. A serious effort should be made to contact people with recent personal knowledge of the locality and it must be remembered that the information they impart has a considerable personal element in it, specially if the informer had had only a short visit to the locality. Knowledge from local inhabitants would be more reliable, but such reliable information is generally not easy to get. In some cases, such as the Badrinath side, a local man has published a book giving details of routes, distances, difficulties of the various sites, etc., and such a publication would be invaluable. Generally the expeditions in Himalayas are a source of trouble and anxiety to the officials administering the territory', and the lesser the burden put on them the easier it would be for the future expeditions in the same locality to get help from them. This burden could be reduced to a minimum if all the available information about the locality is gathered beforehand.

Opinions differ about the best size of the party. On the whole it is agreed that the smaller the party, the easier the arrangements. Two or three has been found to be the best number. But the party cannot be reduced below the number required for the purpose of the expedition. Shri F. Smythe states with regard to the spirit among the party members, "Himalayan mountaineering depends on unselfish teamwork, and unselfish teamwork depends on having a team of men who are temperamentally in phase. Your friend in civilisation may become your enemy on a mountain; his very snore assumes a new and repellant note, his tricks at the mess table, the sound of his mastication; the scarcely concealed triumph with which he appropriates the choicest tit-bits, the absurd manner in which he walks, even the cut of his clothes and the colour of the patch on the seat of his trousers, may induce an irritation and loathing almost beyond endurance. None of these things may matter at sea-level and the success of an expedition depends on their not mattering in mountains.

"The ideal team is one which includes different interests, paradoxical though it may sound. It is profound truth that men sharing identical interests seldom get on well together in the wilds. If they do, it is as much of a miracle as a happy marriage. Wide divergence of opinion seldom matters; it is the small divergence of opinions that count for so much".

I have quoted at length because our experience in the hills was exactly in line with the above. I believe this point should never be forgotten when selecting men for the expedition.

As regards the age, again opinions differ. In the various expeditions in which I have participated there were men varying in age from 22 to 78 years, and every one did well, considering the circumstances. It is really not age that matters so much as the manner of acclimatising resorted to. It is possible for human body to acclimatise itself to heights as high as 25,000 feet if the process of acclimatisation is gradual. No acclimatisation is supposed to be necessary up to 10,000 feet but we found that it would pay if a party stays for about two or three days at about 6,000 feet. Beyond 10,000 feet acclimatisation in the shape of stoppage for two or more number of days may be required every 2,000 to 3,000 feet till about 20,000 feet is reached.

The best period for an expedition into Himalayas is generally May to June, and again September to October, because of the heavy rains during the intervening months of July and August. But in case the expedition is to go to high altitudes above 16,000 feet, the rains will not matter. In fact for such altitudes July and August would be better, as the snow would be at its lowest and crevices

in glaciers would be visible. From the biological and other considerations also, these months would be very suitable as the flowers would be in full bloom and the mountain surfaces would in general be green. So on the whole the time of expedition must suit the purpose of the expedition, and altitude to which the party has to go.

Along certain routes, e.g., Badrinath route, there is the convenience of public buses up to a certain point. But if the traffic along the mountainous country is only one way at a time it will avoid unnecessary delay if the correct timings of the buses each way are already ascertained. If a bus is reserved for the party it must be made certain that it is in a good mechanical order. In our Badrinath expedition we were actually delayed for two days because of these two elementary points.

Good arrangements of porters cannot be over-stressed. We found that Dotiyals, the local tribe of coolies, are weak and slow in their movements. They lack that flare for adventure which makes the Darjeeling coolies an asset to the expedition. It is said that Bhutias of higher regions on this side also have the same broad grin and love of adventure as Darjeeling coolies. At any rate, we found our coolies from Darjeeling at the same time comparatively more trustworthy and intelligent. It would, therefore, be advisable to get all the coolies from Darjeeling for the future expeditions. This would mean extra expense on their transport from and to their home, but one will be more than compensated by their greater powers of endurance, reliability and the certainty that the programme would be stuck to. On the whole it would be better if coolies of the same origin with one Sirdar are employed. Howsoever submissive and easily cowed Dotiyals may appear to be even they have their tribal pride, and it is seldom that coolies from two different places can pull on amicably. We had any amount of faith in the good nature of our Sirdar Ang Tarkay but we found that even he tried to run down Dotiyals and the latter resented it. They had their own Sirdar who was always on the alert to see that his men were treated at least on the same level as those from Darjeeling.

If the coolies could be fed on the local country food it would be an ideal arrangement. It would put down the porterage very considerably. In the other case more coolies are required to carry food for their fellows, and these "more coolies" have themselves to be fed. The kind and extent of food available for coolies must be ascertained before estimating the cost likely to be incurred on porterage.

PART II*

EXPEDITION TO LOKPAL AND BADRINATH

(SEPTEMBER-OCTOBER 1949)

Introduction

The proposal of sending an expedition to Lokpal and Badrinath was discussed in a meeting between Shri A. N. Khosla, Chairman, C.W.P.C., Shri R. D. Dhir, Director of Hydrology, C.W.P.C. and Dr. S. K. Banerji, Director General of Observatories on 16th August 1949. It was decided to send Shri O. N. Dhar and Shri S. D. Nigudkar, Professional Assistants, C.W.P.C., by the first week of September for the double purpose of reviewing the Lokpal and Badrinath areas from the point of view of High Level Research Station and for setting up a few snow courses in that locality.

Organisation and Itinerary

The party left Delhi on the 12th September 1949 with expedition equipment, meteorological instruments, etc., by rail for Kotdwara. From Kotdwara the party went to Pauri and thence to Chamoli by motor transport. The bulk of the coolies were engaged at Chamoli but they were found unfit for going to high altitudes. So the party had to depend mainly on the few coolies taken from Darjeeling and Pauri. From Chamoli onwards the party walked, a distance of about 200 miles, to get a thorough idea of the Lokpal and Badrinath areas. The party first went to Lokpal from Joshimath along Bhyundarganga and spent twelve days in surveying that region. Then they went to Badrinath and spent ten days in surveying the region up to Mana Pass. They returned to Delhi on the 4th November 1949. The itinerary of the expedition is given in the Appendix I.

Survey of Sites for High Altitude Research Station

(a) *Lokpal*—The eastern watershed of the upper Alaknanda catchment is bound by the Great Himalayan Range which runs north-south in this region and is known as Zaskar Range. In the south-

* This part has been adapted from 'The Report of the Expedition Party which visited Lokpal and Badrinath to select a suitable site for High Altitude Research Station and a few snow courses in the Alaknanda Catchment' by Shri S. D. Nigudkar and Shri O. N. Dhar.

east portion of the catchment the glaciers of Gauri and Hathi Parbat peaks of this range feed Bhyundarganga. From this range between the two peaks of Gauri and Hathi Parbat a ridge runs westwards. As this ridge approaches Bhyundar valley it branches off in two directions. One branch turns north-west and culminates in a sharp escarpment known as Saptashring (16,580 feet). The other turns south-west and ends with the Bandarpata point (15,110 feet). The two branches of the main east-west ridge thus form a horseshoe, the outer slopes of which fall down to Bhyundarganga stream about 7,000 feet below, but the inner slopes of the horseshoe join at 14,000 feet altitude to form the small valley of Lokpal. It has lovely lake in the middle known as 'Hemkund'. This lake is fed from the perpetual glaciers of the main ridge running in east-west direction.

Lokpal valley is only about 3½ furlongs long and 1½ furlongs wide. Most of the valley is under water. About an acre of land on either side of the outlet of the lake, is free from water. There is a *Dharamsala* on the right side of this outlet and a *Gurdwara* on the left. A small stream rises from this lake and joins Bhyundarganga near Gangaria; two miles below. The Lokpal is considered holy by both Sikhs and Hindus. Pilgrims visit this place in the months of June to September when the valley is clear of winter snow. There are no permanent residents at Lokpal. Even the *Gurdwara* priest accompanies pilgrims visiting the shrine and returns the same evening. There is no jungle near about Lokpal and the firewood is required to be carried from Gangaria. The valley is open on the west and affords a grand view of Nar Parbat Ridge and Nilkantha peak near Badrinath. The lake is surrounded by overhanging cliffs except on the south. The slopes on the south lead to Bandarpata point. Out of the surrounding points two were climbed by the party during their five days' stay at Lokpal in the first week of October 1949. They are described below—

Site No. 1—*Saptashring* (16,580 *feet*)—On 3rd October this point was climbed. A steep slope towards north to north-east of the lake leads to a saddle about 2,000 feet above the lake. From this saddle a zigzag climb over slopes covered with stones, brings one to a small terrace 400 feet below the top. It is grim ridge at the top consisting of rocks and boulders delicately supported over each other. It was a difficult climb up to the last 400 feet of the top over the cascade of rocks and boulders. There is hardly sufficient area for astronomical dome at the top. The angles subtended by the surrounding peaks are as follows—

Peak	Height (feet)	Direction	Angle subtended
Hathi Parbat	22,070	East	12° 19′
Gauri Parbat	22,010	East	13° 45′
Shoulder of ridge running East-West	18,760	East	15° 24′
Nilgiri	21,240	North	9° 17′

The Lokpal Valley *is only about* 3½ *furlongs long and* 1½ *furlongs wide, with a lovely lake, called Hemkund in the middle. The lake is sacred both to Hindus and to Sikhs. Notice a* Dharamsala *on the left and a* Gurdwara *on the right in the picture. The surroundings are picturesque. The area remains covered with snow from October to May*

No observations could be taken on the south and west as the clouds had come up. However, these sides are open and there is no major peak nearby to obstruct the view above horizon. The main disadvantage of this site is that the Great Himalayan Range is too close on the eastern side to obstruct the view above horizon to a considerable extent.

Site No. 2—Bandarpata point (15,110 *feet*)—This point is towards south and only about 1,200 feet above the Lokpal lake on Bandarpata ridge overlooking the steep gorge of Bhyundarganga. This was climbed on 4th October. The slopes leading to this point are gentle. The southerly winds form wind-packed snow which may avalanche in winter on some of the slopes. There is a terrace (150 yds. × 100 yds.) which can be a suitable site for laboratory. The crest is knife-edged and covered with grass. It is highly precipitous towards the south. The slopes go down 7,000 feet in a mile and a quarter to Bhyundar village. The angles subtended by the surrounding points are as follows—

Peak	Height (feet)	Direction	Angle subtended
Nilkantha	21,640	West	5° 43′
Nar Parbat	19,210	Northwest	9° 5′
Saptashring	16,580	North-Northeast	10° 45′
Shoulder of ridge running East-West	18,760	East-Northeast	16° 42′
Gauri Parbat	22,010	East-Northeast	12° 56′
Hathi Parbat	22,070	East	13° 30′

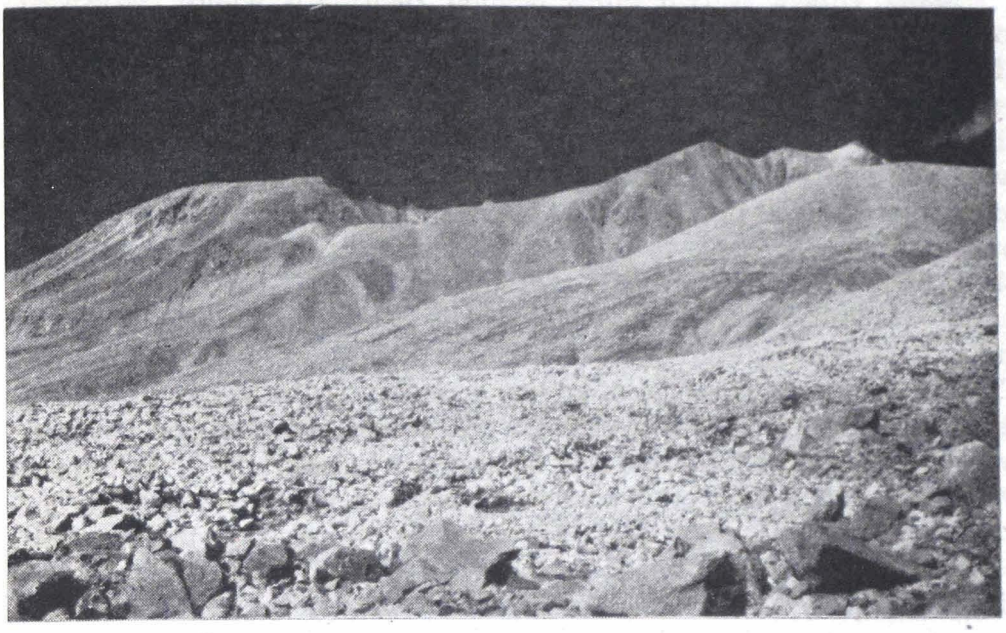
South and west are open. Towards north the peaks subtend angles which are less than 10°, but towards east, the east-west ridge running up to the Great Himalayan Range subtends angles which are greater than 10°. This site, therefore, does not provide an unobstructed view of the horizon over a large sector of the circle (from 14°—114°).

General points regarding site 1 and 2 near Lokpal—

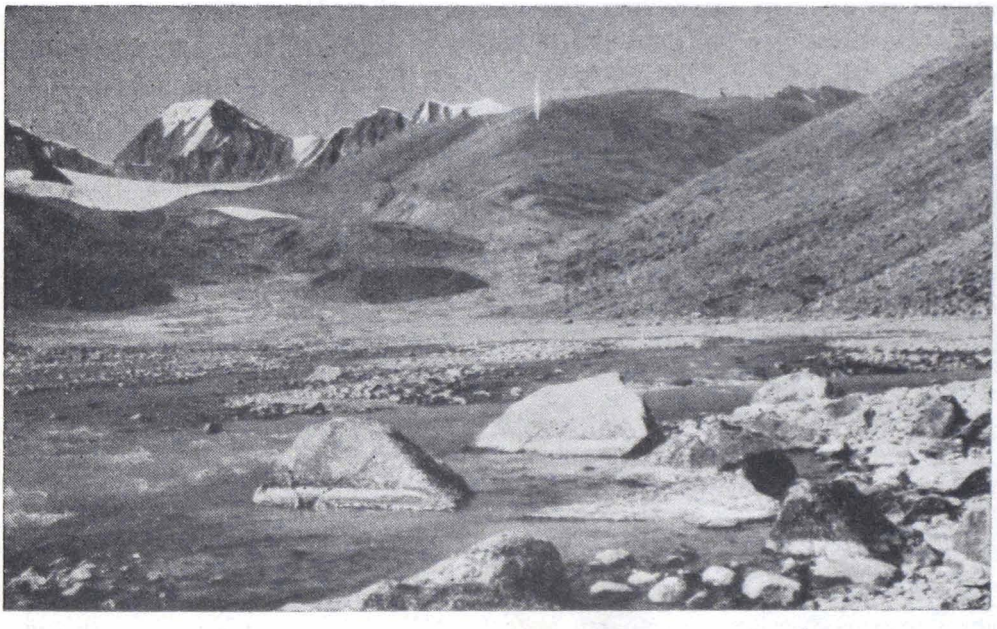
(i) Both the sites near Lokpal do not command an unobstructed view all around the horizon.

(ii) The ridges are knife-edged and it is not possible to locate any building at the top, not even astronomical domes without blasting the tops to level the required area.

(iii) It remained cloudy for most part of the party's stay at Lokpal. This may be due to Lokpal being on the southern side of the Great Himalayan Range. It is also likely to get more number of cloudy days in a year than stations further north on the other side of the Range.



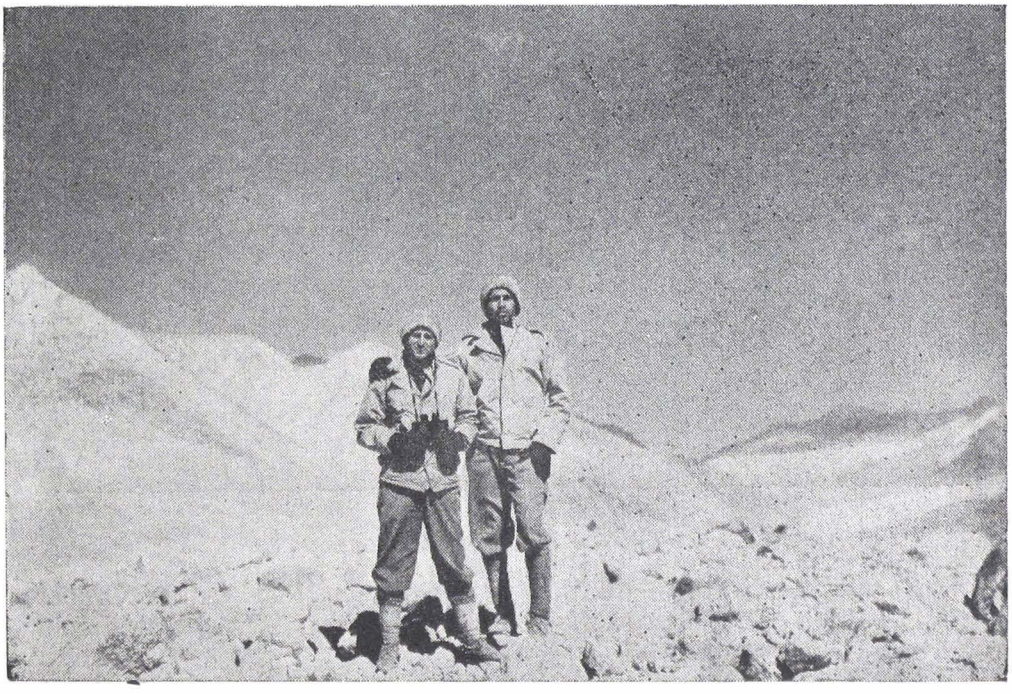
Do not mistake this for a desert. These are rounded tops with gentle slopes of Himalayas near India-Tibet border; really welcome after endless chains of craggy hills



A view of the site proposed for the **Research Station,** *from a distance*

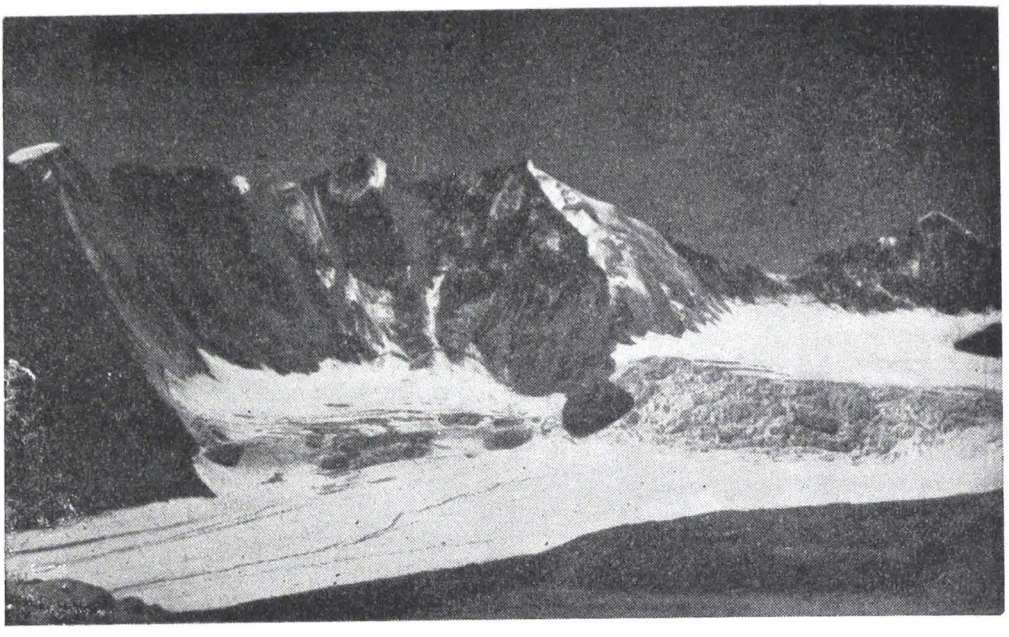
(b) *Saraswati Valley*—Shri J. Banerji, I.F.S., ex-Project Officer, C.W.P.C., who led the expeditions to Sikkim, Jumnotri and Baralacha Pass, was of the opinion that Saraswati valley up to Mana Pass should also be surveyed. Accordingly, the party visited that valley in the second week of October after the return from Lokpal.

Mana village is two miles beyond Badrinath where Saraswati joins Alaknanda river. Eight miles beyond Mana and at the junction of Arwa stream with Saraswati, there is a triangular level stretch of ground known locally as Ghastoli (13,000 ft.) This is inhabited by shepherds in summer. The valley beyond this point is wider with the sandy hill-tops. The hills here have greater resemblance to Tibetan mountains. Except grass, vegetation such as thorny bushes or shrubs cease to exist beyond this altitude. Mana Pass is about 16 miles from this place. Traders going to Tibet by this route camp at a place five miles south of the Mana Pass. The camping ground is known as Tarai. It is at a height of 16,500 feet a.s.l. From Ghastoli to Tarai, it is an easy ascent, as the route lies along the bank of the Saraswati stream. At places the route is covered with stones and gravel from the nearby glacial moraines. In winter when the valley is covered with snow one can easily ski down from Tarai to Mana village. Saraswati valley is bounded on the west by a ridge which runs north-south from Mana Pass. This ridge divides the glacier systems of the two main tributaries of Ganga viz., Bhagirathi and Alaknanda. Very near to Mana Pass on this ridge is a peak called Tara. A small ridge running towards south from this Tara peak ends in a flat mountain top (18,070 feet) just above Tarai camping ground. As Saraswati river takes a bend here the mountain top overlooks the Saraswati valley. This mountain top is the only flat isolated point suitable for the High Level Observatory in this valley. The description of the site is given below—



*Shri Dhar and Shri Nigudkar on the "**Top**" which they discovered*

Solitary rounded "Top" among the innumerable pointed cliffs. *This "Top" (18,050 feet above mean sea level) is a promising site for the High Level Research Station. Notice the river Saraswati flowing between the hills*



A river of ice near the "Top" ready for the scientists for glaciological studies

Mountain Top (18,070 feet) near Tarai—From the camping ground the top of the mountain is only 1,600 feet high. The slope is gentle as it runs over a mile and quarter up to the top. A zigzag motorable road can easily be constructed. The slopes are covered with grass. Near the top at 17,750 feet altitude there is a quadrangular level ground, gently sloping towards south. It is approximately 25 acres in area. Towards west of this terrace stands a small buttress, 320 feet high. On this buttress, there is a level ground of dimensions 160 yds. × 75 yds. Here an astronomical dome can be built while the main laboratory building can be constructed on the lower terrace. The western face of this mountain top is covered with glacier ice. The slopes are here precipitous up to Tara Bank glacier which sweeps the snow from the Bhagirathi-Alaknanda catchment divide and encircling the mountain top ends in glacial wells and terminal moraines at Tarai. The angles subtended by the surrounding peaks at the Mountain Top are given below—

Peak	Height (feet)	Direction	Angle subtended
Shoulder of ridge connecting to Tara Peak	19,030	8° from N.	9° 39′
Mana Pass saddle	18,400	38° from N.	0° 51′
A point 3·0 miles towards E-NE ..	20,610	77° from N.	8° 49′
Mt. Kamet, 15·0 miles towards E-SE ..	25,447	116° from N.	5° 26′
Saraswati valley	..	149° from N.	0° 17′

Peak	Height (feet)	Direction	Angle subtended
A point 3·2 miles towards S ..	19,160	173° from N.	3° 10′
A point 3·6 miles towards S-SW ..	20,110	205° from N.	5° 43′
A point 2·4 miles towards W-SW ..	20,070	245° from N.	9° 22′
A point 3·8 miles towards W-NW ..	20,960	293° from N.	8° 50′
Low saddle 1·6 miles towards NW ..	18,500	322° from N.	3° 9′

From the above table it is seen that the Mountain Top provides an unobstructed view all around the horizon.

Scientists' Colony—Scientists' colony can be located at Ghastoli (13,100 feet) which is 11 miles from the Mountain Top and 10 miles from Badrinath. From Badrinath local coolies can go to Ghastoli and return on the same day. There is a waterfall three miles south of Ghastoli on Thoni stream which can be used for generation of electricity.

Points in favour of Mountain Top (18,070 feet)—

(i) The 21-mile route from Badrinath to the Mountain Top is easy and rises gradually.

(ii) Badrinath is a famous place of pilgrimage. There is likelihood of motorable road being constructed up to this place.

(iii) Government of U.P. has already undertaken a survey of the waterpower in the valley with a view to generate hydro-electricity for power supply to Badrinath town.

(iv) There is a hospital at Badrinath.

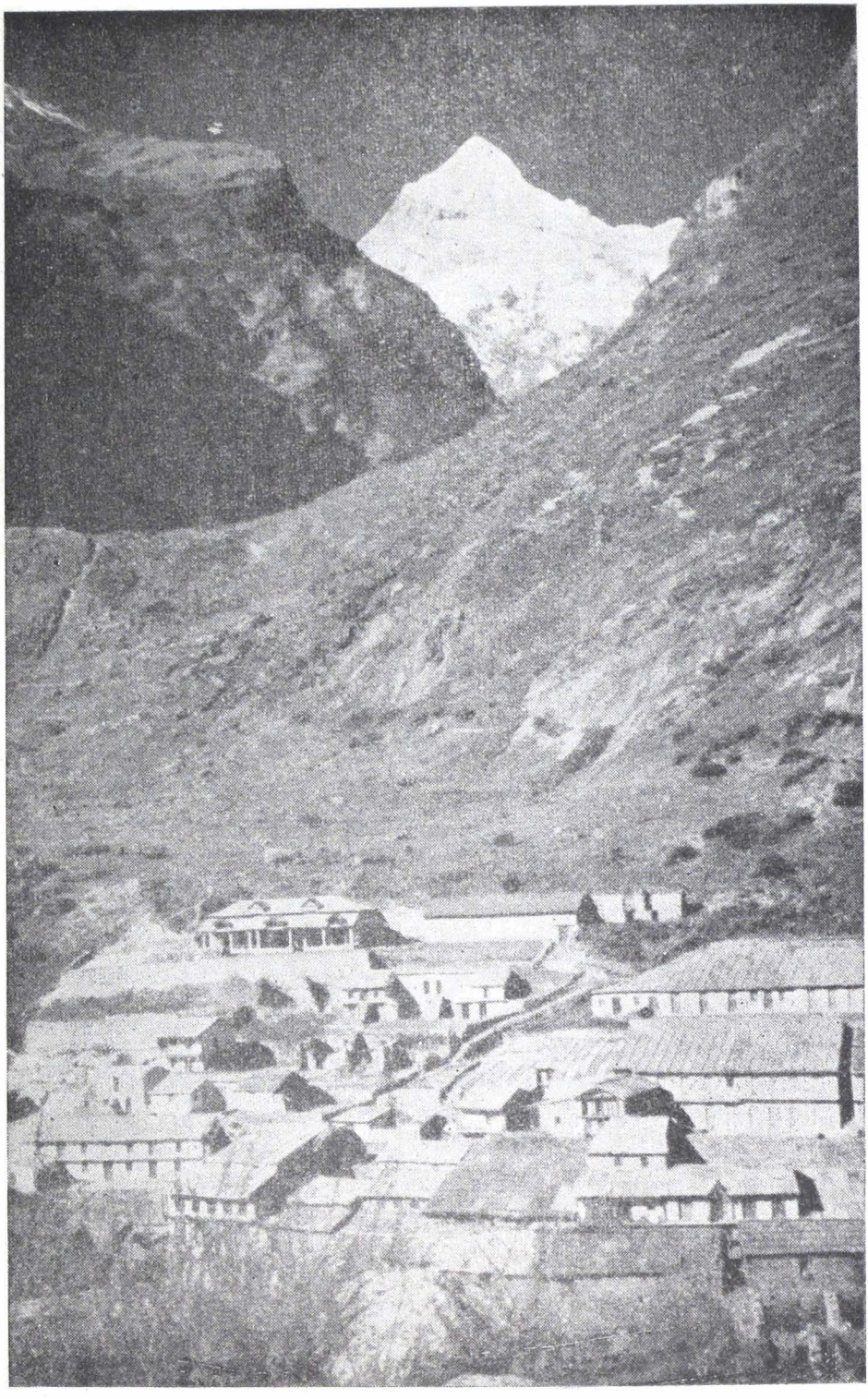
(v) There is a landing ground between Badrinath and Mana village where small planes can land.

(vi) The site is situated on the important trade-route to Tibet and Central Asia. The site is only 40 miles from Joshimath which is the proposed motor-head by 1952.

(vii) The mountain is barren and glacial fields are just by the side of it.

(viii) Moisture from south does not penetrate beyond Badrinath. Thus sky remains clear for a longer time at Mountain Top. In the middle of October, the party saw clouds rising in the evening for an hour only and dissipating away after sunset, while at Badrinath clouds covered the sky before 2 P.M. and it used to remain cloudy for the rest of the day.

(ix) The sky was deep blue and visibility was excellent at the Mountain Top.



Nilakantha Peak (21,640 feet)—*The Queen of the Central Himalayas. Badrinath town in the foreground*

(x) There is no neighbouring peak which subtends an angle greater than 10 degrees.

(xi) Higher altitudes for cosmic ray research are easily accessible from this place.

(xii) A beautiful panoramic view of the Mount Kamet (25,447 feet) along with a cluster of peaks round about it, is obtained from this place. This, as well as, Nilkantha near Badrinath will no doubt remain a great attraction for mountaineers all over the world.

(xiii) This will be the highest research station in the world.

Points against Mountain Top—

(i) The observatory and the scientists' colony will be rather far away from human habitation.

(ii) The forest level in this region is only 9,000 feet. This will give rise to fuel problem. In pilgrim season Badrinath experiences an acute shortage of fuel.

(iii) Tibet border is only five miles away.

Snow Surveying in Upper Alaknanda Catchment

The party visiting Lokpal and Badrinath region for the selection of a suitable site for High Altitude Research Station was also assigned the work of selection of a few snow courses in the Upper Alaknanda catchment.

In winter the upper Alaknanda valley experiences heavy snowfall. People staying at Badrinath and Mana village move down to lower altitudes by the middle of November and return in early May when the winter snow melts away. Snow survey at Badrinath and above would indicate the snow accumulations in this valley in winter. Three courses were, therefore, selected in this valley and one in Bhyundarganga valley. An ideal snow course is one situated in forest which acts as wind shield. In the Upper Alaknanda valley it has not been possible to get such a site on account of the fact that there are absolutely no forests above 9,000 feet and the lowest snow course, at Badrinath, is at 10,250 feet. Big rocks and boulders with black and white concentric circles painted on them have been used as snow markers. Snow courses have been selected near the main route for easy location by future parties.

In three snow courses in Alaknanda valley are one at Badrinath, second near the source of Alaknanda and the third on the bank of Saraswati at Ghastoli. Brief description of these snow courses and the one in Bhyundar valley is given below :—

Badrinath Snow Course—This is situated on the plain ground opposite to the Badrinarayan temple but on the other side of the river and about 100 yards north of P.W.D. rest house. It is at an altitude of 10,250 feet. On its eastern side there is a mountain slope which gently rises to 3,000 feet above the ground level. On its western side Alaknanda flows down while north and south are open. The two lines along which snow sampling observations are to be taken are at right angles to each other and approximately run in north-south and east-west directions. On the north-south line 24 observations can be taken at intervals of 25 feet each, while on the east-west line 11 sampling observations can be taken with the same intervals.

Vasudhara Snow Course—This course is about five miles from Badrinath and three miles from Mana village. It is situated on a piece of level ground about half a mile from Vasudhara water-falls towards Mana village. The height of the snow course is about 11,500 feet. On the north the snow course is protected by a mountain range, which rises about 2,000 feet from the ground level, while the river Alaknanda flows on its south. East and west are open. One line, along which snow sampling observations are to be taken, is in north-south direction and the other intersects it at an angle of 66 degrees. On the north-south line there are 19 sampling points while on the other line there are 13 sampling points at intervals of 25 feet.

Enchanting 400 feet high Vasudhara Waterfall north of Badrinath.—*One can sit here for hours without being bored.*

Ghastoli Snow Course—Ghastoli is the name given to a level stretch of ground at the junction of Arwa stream with the Saraswati river, about 10 miles upstream from Badrinath. It is at an altitude of 13,000 feet. The route to Mana Pass passes through this snow course. The eastern side of this course is bound by a cliff, 2,000 feet high from the ground level while on the west Saraswati flows. North and south are open. The two sampling lines run north-south and east-west and cut each other at right angles. On the north-south line about 24 snow sampling observations can be taken while on the east-west line only nine observations can be taken, the interval in both cases being 25 feet.

Bhyundar Valley Snow Course—In this valley one snow course is selected at Gangaria camping ground which is at an altitude of 10,088 feet. Near the snow course there is a *Dharamsala* for pilgrims visiting Lokpal. The snow course is about 8 miles from Pandukeshwar where the Bhyundarganga joins Alaknanda river. It is bounded by trees on three sides and by a lofty cliff on the fourth side. The two sampling lines run north-south and east-west cutting each other at right angles. On the former line 14 snow sampling observations can be taken while on the latter line seven observations can be taken at a uniform interval of 25 feet.

Discharge Site on Alaknanda River—For forecasting runoff of a stream from seasonal snow cover it is essential to know the river discharge of the stream during snow-melt season. In the Upper Alaknanda catchment and in Bhyundar valley it was very difficult to get any good discharge site due to the river flow being disturbed by rocks and boulders. Only one discharge site could be selected on Alaknanda river just near the Mana village. This discharge site is situated about one furlong downstream from the suspension bridge near Mana village. The height of the discharge site is 10,280 feet and the total discharge as determined on 20th October 1949 was 1,417 cusecs.

PART III

EXPEDITIONS TO SIKKIM, JUMNOTRI AND BARALACHA LA DURING 1949

At a meeting of the Expert Sub-Committee for High Altitude Research Station held on 25th March 1949, at the Meteorological Office, Lodi Road, New Delhi, it was decided that a small party of three scientists should carry out a rapid reconnaissance of Sikkim, Jumnotri and Baralacha La areas and submit a statement of comparative merits of the various sites visited. The party consisted of the following—

(1) Mr. J. Banerji (C.W.P.C.), Leader.
(2) Dr. R. Ananthakrishnan (I.M.D.), Astronomer.
(3) Dr. A. C. Joshi (Govt. College, Hoshiarpur), Biologist.

During 1949, they visited the following regions—

(a) Sikkim Himalaya	May-June 1949.
(b) Jumnotri	June-July 1949.
(c) Baralacha La	August-September 1949.

Sites Surveyed in Sikkim Himalaya

The party left Delhi for Siliguri (North Bengal) which is the railway-head for entering into Sikkim and Darjeeling district. From Siliguri railway station an all-weather motorable road runs up to Gangtok, the capital of Sikkim, which is 75 miles away. The party started from Gangtok on foot for Thanggu in north Sikkim to cover a distance of 62 miles in five days. Dak bungalows exist at every stage of the journey up to Thanggu. The track and the dak bungalows are maintained by P.W.D. for the convenience of tourists. In order to have a comprehensive picture of the Sikkim it has been divided into three zones—south, central and north Sikkim. No suitable sites could be found in south or lower Sikkim as the average annual precipitation in this zone is very heavy (about 100 inches) so that the mountain ranges remain enveloped in clouds for a large number of days in the year. About the central Sikkim, the party found that the mountain tops were very craggy and precipitous. Moreover, all these peaks are situated south of the high Khangchengyao-Chomo Yummo wall which acts as a barrier to south-west monsoons. Though precipitation may not be heavy this territory becomes a maze of swirling clouds during rainy season.

Having rejected the two lower zones the party's efforts to find out a suitable site were concentrated around Thanggu, as no suitable sites could be located south of this place. They found an excellent mountain top (16,630 feet) towards the north-west of Thanggu, three miles away from it as crow flies, but if joined by an easy gradient path, at a distance of about six to seven miles. At the top there is a flat area of three acres where observatory buildings can be constructed. The horizon is open and no neighbouring peak subtends an angle greater than 10 degrees. Water will have to be carried from a stream about 2,000 feet below the top. This site has one disadvantage that it is to the south of Chomo Yummo wall and hence may not get as many cloudless days as sites further north will, but certainly be far less clouded than any site in the central zone.

About 16 miles from Thanggu is Chungo Kering, a peak 18,050 feet high. This stands on the edge of a glacial lake, Gayum Chhona (16,200 feet), and will be another very good site for the observatory. The mountain top affords an unobstructed view of the horizon. Angles subtended by Khangchengyao and Chomo Yummo are less than seven degrees. A strong wind blows constantly across the top which can be harnessed to generate wind-power. The ascent up to the top is easy and there is enough flat ground at the top for construction of observatory buildings. Sky conditions were good but in May 1949, the party noticed it slightly hazy due to presence of water vapour.

For both the sites in north Sikkim, Thanggu should be the base. A good road can be constructed from this place to the foot of the observatory along the wide glacial basins. The journey from the base to the observatory will be a matter of hours by jeep and by sno-cat when snow bound. Hydro-electricity can be generated lower down the valley and transmitted to Thanggu for the scientists' colony.

Sites Surveyed in Jumnotri Region

The party visited this region during June-July 1949. The rail-head close to this region is Dehra Dun and motor-head is Chakrata, 69 miles away.

Base for any site in this region should be at Kharsali (8,000 feet) or Rana (5,700 feet) village. Both these places are about seven to eight days' march. The ridges around these two important villages of this region are craggy and precipitous with very small flat ground at their tops. Also, being very close to the Great Himalayan Range, no unobstructed view of the horizon could be obtained from the tops of these points. The party investigated a peak, 17,180 feet high, near Kharsali and two peaks near Rana village, 15,706 feet and 13,554 feet high. They found that the higher peaks were very difficult of access and the lower peak was too low compared to easily accessible peaks in other regions of the Himalaya.

This region, therefore, has no point of advantage in its favour for location of the High Altitude Research Laboratory and the party could not recommend any site.

Sites Surveyed in Baralacha La Region

The party toured Lahaul valley (Baralacha La region) towards the end of August and the beginning of September 1949. From Pathankot, the rail-head, to Manali, the motor terminus in Kulu valley, they covered a distance of 201 miles in three days. In order to enter Lahaul in Chandra Bhaga valley one has to cross over Rohtang Pass (13,050 feet) in the Pir Panjal range. About five days' march from Manali is Keylang (10,383 feet), the most important town and the official headquarter of the valley.

Little moisture enters Lahaul valley across the Pir Panjal range. The result is that Lahaul enjoys an almost rainless summer climate though the snowfall in winter is very heavy. Sites in Lahaul valley are, therefore, preferable to those in Pir Panjal range.

The trade route from Lahaul to Ladak passes over Baralacha La (16,047 feet). The last village on this route is Darcha (10,840 feet). Further up at Patsio (12,464 feet) there is a rest house but no village. Patsio is about two days' journey from Keylang and Zingzingbar is about one day's march from Patsio. Two miles to the north of Zingzingbar and four miles south of Lahaul-Ladak boundary there stands a mountain, 16,000 feet high, which will be a good site for the observatory. There is about three to four acres of undulating ground at the top. A large hanging glacier clings on to one side of the mountain. One gets unobstructed view of the horizon from the top. Besides this, there are two more sites near Baralacha La but they do not possess flat area at the top, sufficient for construction of large buildings. This site (16,000 feet) near Zingzingbar is considered as the best in the region. Wind-power can be generated at this place as strong breeze blows constantly across the mountain top.

One disadvantage of this valley is that it is cut off during winter months (November to April) due to heavy snowfalls in Rohtang Pass. However, this is made up by the fact that the large well populated town of Keylang affords all the necessities of life. It has a post office, a hospital, a police station, a forest office, a revenue office and wireless transmitting station. The wireless transmitting station maintains contact with Simla. The scientists' colony for this region should be Keylang though Patsio with its large rest house can also serve the purpose.

There are many streams with ample discharge coming down the steep hillsides. It will be possible to harness any of them for hydro-power for the scientists' colony at Keylang.

APPENDIX A

Note on the talks held in the library of the Meteorological Department, Lodi Road, on the 10th April 1948, on the subject of a suitable location for a High Level Combined Observatory.

1. PRESENT—

Shri S. S. Khera (Commissioner, Meerut Division);

Shri M. D. Mithal, Shri R. D. Dhir and Shri Harbhajan Singh (C.W.I.N.C.);

Dr. S. K. Banerji, Dr. S. C. Roy, Shri Krishna Rao, Dr. L. S. Mathur, Shri C. P. Menezes, Shri S. D. Bose and Shri C. R. V. Raman (I.M.D.).

2. Dr. Banerji explained the objectives. They are as follows—

The station should be such that it would be suitable for astronomical work, study of cosmic rays, high level micro-biology, study of snow, etc. For the sake of astronomical and cosmic ray observations the high level observatory should be at a height of 16,000 to 18,000 feet and the residential colony based at a height of about 10,000-12,000 feet. The observatory should have an unobstructed horizon, specially towards the north and south, no neighbouring peak or object should subtend an angle more than 5° or at any rate of more than 10°. There would be advantage if a site satisfying the preceding requirements could be found in the region between Badrinath and Mana Pass, as this region is contemplated for snow surveys in order to assess the contribution from snow to the discharge of the Sutlej and the Ganges. Suitability of the site for human health and comfort, accessibility by motor transport, availability of water and food, and production of electricity by wind or water-power were also important requirements. In the Himalayas at 16,000 feet and above there are strong westerly winds almost throughout the year, and wind-mills could be used for power generation.

3. Shri Khera said that there were quite a number of sites which would satisfy the necessary requirements. The main problem was, in his opinion, not to hunt out for such a site, but to decide which site out of many would be the best. The Survey of India might be consulted. If he restricted himself to a range from say 75° to 80° longitude, he would straight away suggest three possible sites—

(a) *Baralacha Pass (approx. 32°44′ N 77°25′ E) in Kangra District.*— This is at 16,000 feet. Spots at 17,000 to 17,500 feet would be found nearby. It is a large plateau, offering quite unobstructed view. The skies are

exceptionally clear, particularly at night. It lies on the ancient "trans-continental highway" between North Asia and India.

The motor base is Manali; five days' march from here on foot or on pony leads to the station; one has to cross a lower pass on way from Manali to Baralacha.

A suitable living station is Zingzingbar (13,000 feet), there are other stations at lower levels not far away. There is plenty of water; no dearth of food supplies.

Shri Khera thinks that human acclimatisation to altitudes is by steps; one who can live easily at 5,000 feet can do so up to about 9,000 feet; the next step is 9,000-12,000 feet, the third 13,000 to 15,000 feet.

(b) *Mana Pass* (18,400 *feet*) (31°05′ *N*, 79°24′ *E*)—This is on the Tibet border and there might be considerable political difficulties. Otherwise the site was nearly as good as (a) above.

The motor base is at Chamoli. There is again five days' march from here to Mana. The going would be easy till Badrinath, but much more difficult afterwards.

(c) *Lipu Lekh Pass* (17,900 *feet*) (30°13′ *N*, 81°00′ *E*)—This is on the great pilgrim route to Mansarowar and Kailash. It is a typical black Himalayan pass—gentle slopes on the north, steep declivities southwards.

The motor base is Almora, and 12 days' march from here to the pass.

4. Of the three sites, he thought, the first, namely, Baralacha, was the best. Shri Gill, who previously took some cosmic ray observations from this site, would be able to furnish more details.

5. These sites are not far away from Himalayan glaciers, and would be suitable for glacier studies. From Baralacha, one could go to the Karakorum range, which is an abode of many glaciers.

6. For transport from motor-heads provision of jeep might be considered for use along improvised tracks.

7. For production of electricity, wind-mills would be better than hydro-electric generation.

8. There would be no difficulty in getting the required land.

9. SUPPLIES—

This will not present serious difficulty. Sheep were easily available. But we should provide six months' dump at the observatory in the event of any working personnel getting cut off in winter due to snowfall.

10. The best age group for high level work, from his experience, is 30 to 40 years. Young men are apt to be impulsive and may soon get their hearts affected and suffer a breakdown due to over-strain.

11. Healthy people can live comfortably at heights of 12,000 to 15,000 feet. Lung troubles are rare, but extremely dangerous when occurring. A few cylinders of oxygen should be provided for the treatment of such cases.

12. He advised despatch of small parties to each of the three locations mentioned above to report on the sites. These parties may go in May and be scheduled to spend six weeks on the survey of a site.

APPENDIX B

Minutes of an informal meeting held in the library room of the Meteorological Department, Lodi Road, New Delhi, on the 18th April 1948, to discuss the preliminary steps for the establishment of a Combined High Level Observatory.

1. PRESENT—

Prof. S. P. Agharkar	
Prof. H. J. Bhabha	
Sir J. C. Ghosh	
Dr. J. N. Mukherji	
Prof. M. N. Saha	
Shri M. D. Mithal	C.W.P.C.
Shri R. D. Dhir	C.W.P.C.
Dr. S. K. Banerji	I.M.D.
Dr. S. C. Roy	I.M.D.
Dr. S. K. Pramanik	I.M.D.
Shri C. P. Menezes	I.M.D.

2. Dr. Banerji suggested that Prof. Saha may conduct the discussion and this was agreed to.

3. Prof. Saha thanked the Meteorological Department for the initiative they had taken in proposing a High Level Observatory of the type of Jungfraujoch in Switzerland and for calling this meeting.

4. Dr. Banerji said that the Meteorological Department had in mind for a long time a High Level Station for meteorological and astronomical purposes, and the original idea was that Srinagar or another station in Kashmir would be a good location. Sometime ago the idea was extended to embrace other subjects of study besides meteorology and astronomy and this had received the support of many scientists. The main point in an Himalayan Observatory, besides the interests of taking observations at high-levels, was that there was very good visibility and little precipitation in the Western Himalayas above 16,000 feet. The principal subjects that would come under the project were—

(i) Study of snow and glaciers, and their contributions to the rivers of India (in which the C.W.I.N.C. are deeply interested).

(ii) *Astronomical and Astrophysical Observations*—The Meteorological Department is planning to set up an astronomical observatory with a large-size telescope and to instal a coronograph; a high-level station with very clear skies would be ideal for these purposes.

(iii) Cosmic ray studies.

(iv) *Meteorology*—The aerology of the Central Asian table-land, in particular, the influence of the huge Himalayan system on the meteorology of Eurasia, are of great importance.

(v) *Observations of Meteors, Mother of Pearl Clouds, etc.*—Professor Stormer has recently written to Dr. Banerji saying that he would be glad to have these observations from a High Level Station in this part of the world.

(vi) *Geological and Biological Observations*—The geology and the seismicity of the Himalayas are problems of great interest. The flora and fauna of this region are also of special attraction to biologists.

5. He said that the final plan of the observatory would depend on the site. The main point for consideration of this meeting was the choice of site. The C.W.I.N.C. would like the site near one of their locations for snow survey.

6. Professor Agharkar said that sites in the Eastern Himalayas should not be forgotten; properly speaking, for Himalayan studies, at least two sites would be necessary; one towards the west and one towards the east. He would, therefore, suggest two sites, one near Badrinath and another in the Sikkim Himalayas.

7. Prof. Bhabha observed that we should first concentrate on one observatory; after that had been done, we could think of another one.

8. A general discussion then followed regarding the sites that should be investigated, and the concensus of opinion at the end of the discussion was as follows—

(i) the area round about north of Badrinath should be investigated first; and thereafter the area near Baralacha Pass;

(ii) the same party should be asked to investigate both the sites; as this would secure a uniform outlook in respect of both;

(iii) the party should proceed in May next;

(iv) the composition of the party should be as follows—

Two Officers from the Meteorological Department (for Meteorology and Astronomy);

Two Officers from the C.W.I.N.C. (for Snow surveys and Glaciers study);

One Officer (Geologist)—regarding whom Geological Survey of India, whose representative could not unfortunately be present at this meeting, should be approached;

One Biologist.

9. Prof. Bhabha said that it was not necessary to enlarge the party by including representatives of other sciences. The main point about the investigation of site was to select a spot with good *seeing*, meteorological and living conditions and if the spot was, from this point of view, suitable for astronomy, it would also be suitable for cosmic ray work, etc. In this context, he would remark that an unobstructed angle of five degrees was rather an exaggeration, a clear view from above 10 degrees would be sufficient. Prof. Saha, Prof Bhabha and Dr. Ghosh stressed that easy accessibility of site was an important consideration. Scientists from Universities would be able to visit the observatory if accessible in a day or so from the plains, but not otherwise. Accessibility by air was among the foremost points to be investigated.

10. A representative from the Survey of India might not be necessary, so as not to increase the size of the party. Dr. Banerji said that the Surveyor General had promised him to make available all the results of surveys, ordinary or aerial so far made by his Department.

11. It was unanimously agreed that Prof. Agharkar be requested to join the party as its Biologist. Prof. Agharkar would be deputed from the National Institute of Sciences and the Institute would meet his travelling and daily allowances.

12. Regarding the procedure for meeting the costs of the party, it was agreed that the pays and allowances of the various members of the party should be met by the Department to which the representative belonged.

13. The expenses incurred in organising the party—apart from pay and allowances of members—should in the first instance be met jointly by the C.W.I.N.C. and the Meteorological Department. It may, thereafter, be possible to ask for Departments taking part in the survey to meet a proportionate share, or suitable share, of this expenditure.

14. Dr. Mukherji suggested that clear terms of reference should be drawn up for the survey party. It was agreed that this would be done by the Meteorological Department in cooperation with C.W.I.N.C.

APPENDIX C

Note on the talks held in D.G.O's room on the 7th May, 1948 to study the orography of the sites provisionally selected for the Combined High Level Observatory in the Badrinath area.

1. PRESENT—

Dr. S. K. Banerji, Shri C. R. V. Raman } I.M.D.
Shri J. M. Kohli, Survey of India
Shri R. D. Dhir, Shri Harbhajan Singh } C.W.I.N.C.

2. Dr. Banerji briefly explained the objectives. He said that for the High Altitude Observatory, it would be preferable to go to that part of the Himalayas where transport system was best developed. It was for this reason that the Badrinath area was preferred. It would be necessary to have a flat hill top if possible for the proposed multi-purpose research station of this kind; the location should be such that it is suitable for the study of all the subjects; its height should be about 17,000 feet, and it should be possible to set up a colony for the scientific workers at a lower level, say 12,000 feet, not far away from the observatory site.

3. Shri Kohli said that he was in charge of one of the survey parties which surveyed this area during the years 1936-38 and that he has an intimate knowledge of the orography of the locality. The road between Joshimath and Badrinath is blocked during winter due to snow, sometimes to a depth of 10 feet, cutting off communications. It is for this reason that none stays at Badrinath throughout the year. He said, if necessary supplies were stored at Badrinath, it would be possible to stay there even during winter. Even now some villagers belonging to Mana do stay in their houses during winter to guard their belongings.

4. The suitability of the various sites, provisionally selected by Shri Dhir after discussion with Dr. Banerji, were discussed one after another mainly from the point of view of approach. Mr. Kohli was of the opinion that rock walls or ice walls often made certain ridges unsurmountable. As far as possible, only such peaks as can be approached easily should be selected.

5. Shri Kohli suggested Lokpal for consideration. This is reached by taking a detour route from Phaiya on the main track from Joshimath to Badrinath and going along the Bhyundarganga. It is a place of religious importance to the Sikhs who are building a *Gurudwara* there.

It is situated near a beautiful lake, Hemkund, and is surrounded on all sides by ridges ranging from 16,000 to 17,000 feet. Lokpal itself is at a height of 14,000 feet. The observatory can be located at a suitable site on the surrounding ridges. The highest point that can be reached is Saptashring, 16,580 feet. Lokpal would be an ideal location for the colony as it is protected from winds on all sides; the place itself keeps warm; fuel is available in plenty and food supplies can be drawn from Joshimath. There are no rock walls or ice walls; the approach to the observatory located on one of the surrounding ridges would be easy. Shri Frank Smythe has described this as "The Valley of Flowers".

6. The suitability of a site near Mana Pass itself was then discussed Dr. Banerji said that from the point of view of the fact that people have to live near the Observatory, Mana Pass has to be dropped as there are no suitable localities nearby at lower elevation where the colony can be established. A site, close to Badrinath, should be preferred as the colony could then be established at Badrinath. A site (co-ordinates 9748 in ½-inch sheet 54 N/NW) to the south-west of Badrinath located at a height of about 17,950 feet appeared to be the best from the point of view of approach, and it was certainly worth trying. It was agreed that this site should be inspected first and then the one at Lokpal.

7. Shri Kohli also mentioned another site (co-ordinates 0159 in ½-inch sheet 53 N/NE) located at a height of about 15,600 feet which is just at a distance of half a day's journey from Badrinath. He said that it would be possible to obtain plenty of space at Badrinath for building the colony. Building materials like stones, sand and wood would be available.

8. A few sites on the road to Niti Pass were also examined. But in view of the difficult accessibility of the sites in this locality, it was decided that they should be inspected if the two sites mentioned in para 6 are found unsuitable. Shri Kohli said that it was desirable to obtain from the Survey of India details of places actually visited by the surveyors and which would, therefore, be definitely accessible. He suggested that it would also be helpful to have the services of a Surveyor who has experience of this locality.

9. He then gave a few general ideas about availability of coolies, acclimatisation, and general precautions that are to be taken during these expeditions. He said that the local coolies at Chamoli would not be of much use and it would be necessary to send advance information to Mana or Niti and draw coolies from these places. He insisted on the necessity of having a trained climber in the party. Shri Kesar Singh from Bumpa, mentioned in Shri Symthe's book "Kamet Conquered", would be very useful, if he is available. Shri Kohli said that up to 10,000 feet one would go easily but later one had to stay at each stop for a day or two to get himself acclimatised. After reaching 15,000 to 16,000 feet it was easier to go to greater heights. For temporary sicknesses at high altitudes, pure lime juice, if necessary with plenty of sugar, was the best remedy.

10. Regarding the best time for undertaking the expedition, Shri Kohli said that it was rather dangerous to go in May as all the snow would not have melted away and walking over glaciers covered with this unmelted snow would be dangerous and difficult. In his opinion August and September were the ideal months for reconnoitering over glaciers. September would be quite dry and there would not be any temporary snow and all passes would be open. He said that the party should go either in June or in the middle of August. It was decided that the party should start on the 1st of June so as to reach Badrinath by the middle of June. A new programme would be drawn up in the light of the discussions.

APPENDIX D

Minutes of a meeting held in Shri A. N. Khosla's room in the Central Secretariat, New Delhi, on the 26th May, 1948 to discuss the details of programme of the expedition party proceeding to Badrinath area to select a suitable site for a Combined High Level Observatory.

1. PRESENT—

Shri A. N. Khosla, *Chairman,* C.W.I.N.C.

Shri Shanti Swarup Bhatnagar, Council of Scientific and Industrial Research.

Dr. D. N. Wadia, Ministry of Works, Mines & Power.

Shri R. D. Dhir, C.W.I.N.C.

Shri S. K. Banerji. } I.M.D.
Dr. R. Ananthakrishnan. }
Shri R. V. Badami. }
Shri C. R. V. Raman. }

2. Before taking up the agenda, Dr. Wadia wished to give his impression about the suitability of a site at the height of 15,000 to 16,000 feet for the proposed Combined High Level Observatory. He said that he had experience of the conditions at these elevations and felt that it may not be possible to have an extensive flat area for the observatory at the height at which it was proposed to be set up. He said that such flat sites are exceedingly rare at these altitudes and that the area would be under snow for seven to eight months in the year.

Sir Bhatnagar said that the Scientific Laboratory should not be above 12,000 to 14,000 feet. He said that this height would be quite suitable for cosmic ray work and if it was necessary we may go to higher elevations for particular studies. He remarked that the main structures should be between 12,000 and 14,000 feet and only very simple structures should be at higher elevations.

Dr. Banerji said that his idea was to locate the main laboratories and colony for scientists between 12,000 and 14,000 feet and small structures for astronomical observations and cosmic ray work at a height of 16,000 feet or a little higher. He explained the advantages of choosing a site near the lake at Lokpal in the Bhyundar valley, one of the sites to be investigated by the party. He said that the colony for scientists and the main laboratories could be set up at Lokpal itself (about 14,000 to 15,000 feet) while small structures could be had on the top of a suitable neighbouring ridge. That will mean provision of road from colony to ridge for a height of about 1,500 feet. Unless the site is so selected that

we can readily go to a height of 16,000 feet or above, for astronomical, cosmic ray and other observations, we shall not be taking full advantages of the workable high altitudes provided by the Himalayas. If we choose a lower height, we shall be just copying what other countries are doing. He said that he was contemplating to have the building specially constructed on English design with adequate heating arrangements. In reply to a question by Rai Bahadur Khosla as to whether it was necessary to have the colony for scientists at 14,000 feet, Dr. Banerji said that he has already in contemplation a base camp at Joshimath which is only at about 6,000 feet. Scientists can go to Lokpal, take observations and come down to Joshimath to work out the results.

A general discussion then followed about the height of the snow-line at this part of the year. Dr. Banerji said that in June, in this part of the Himalayas, he expected the snow-line to be at 15,000 to 16,000 feet though there may be pockets of snow here and there along the route in shaded areas.

3. Sir Bhatnagar mentioned that it would be desirable to examine the availability of a suitable site near Jumnotri in the upper reaches of the Jumna. A two to three-day march from Mussooree *via* Dharasu takes one to Kharsali from where Jumnotri is easily reached. Kharsali is at about 14,000 feet and the neighbouring peaks rise up to 16,000 feet. Sir Bhatnagar spoke at length about the facilities for transport, availability of food, etc., in this locality. He said that nights would be absolutely clear and it may be suitable for astronomical observations also. After discussing the relative advantages of this site when compared with other sites in view near Badrinath and at Lokpal, it was decided that the site near Kharsali might be investigated in September, preferably by the same party to secure uniformity of outlook ; if it is not possible to do this in the course of the present trip.

4. A general discussion then followed regarding the sites to be examined by the expedition party. The consensus of opinion at the end of the discussion was as follows—

(1) Selection of Lokpal is very promising.

(2) The higher elevations within easy reach from Lokpal should be investigated.

(3) The party should first proceed to Badrinath and look for suitable sites in the neighbourhood ; then proceed to Lokpal and if this site is found suitable from all points of view, astronomical, meteorological, glacier studies etc., a longer stay than projected would be made and the suitability of the site examined from all points of view.

5. The composition of the party was agreed to generally. Sir Bhatnagar raised the question of the most suitable age for the members of the party. He felt that Prof. Agharkar was rather too old to be a member of the expedition party.

Dr. Banerji stressed the importance of an engineer accompanying the party for preparing estimates for the construction of roads, buildings, possibility of an air-field, etc. He suggested that Shri R. D. Dhir be selected as the Leader and Dr. Ananthakrishnan, the Deputy Leader of the expedition party. This was agreed to.

6. As regards the programme of the party, Dr. Banerji said that the trip to Niti side may have to be modified in view of Sir Bhatnagar's suggestion. Rai Bahadur Khosla said that this should be left over to the leader of the party. Time permitting, a trip to Kharsali site may be

taken up after exploring the suitability of the sites near Badrinath and at Lokpal. Sir Bhatnagar said that for the present, as the expedition was only of an exploratory nature, the party may restrict to an inspection of the sites near Badrinath and Lokpal. If Lokpal is not suitable a third site may be thought of.

7. Dr. Ananthakrishnan said that for astronomical observations one should spend some time at each site and that observations should be taken over an extended period. It is only then that the suitability of the site from astronomical point of view can be determined.

8. The questionnaire for the party drawn up by Dr. Banerji was then discussed in detail. At the outset, Sir Bhatnagar insisted that convenience for human habitations at these elevations should be investigated. He and Dr. Wadia pressed for selecting the site for scientists' colony between 12,000 and 14,000 feet. Sir Bhatnagar felt that the local Garhwalis would be of immense help in constructional work.

Dr. Wadia was doubtful whether a suitable air strip will be available in these regions. He, therefore, said that the possibility of Helicopter plane landings should be investigated. Helicopter service would maintain communications between the High Level Observatory and India even when communications are cut off during the winter months. He said that in addition it would be necessary to develop wireless service. Dr. Banerji said that wireless service had already been included in the questionnaire; the other point for Helicopter service would now be included.

9. As regards the establishment of the observatory, Dr. Banerji said that it was proposed to set up raingauge, snowgauge and thermometers at Badrinath and Lokpal and train local observers for taking observations. If a particular site was found suitable, extended meteorological observations would be taken later on the recommendations of the party.

10. Sir Bhatnagar desired that the names and addresses of some local people should be obtained so that later expeditions can again contact them. Local influence should be utilised as far as available.

11. Dr. Banerji then spoke about the possibility of funicular railways at these elevations. Both Dr. Wadia and Dr. Bhatnagar pointed out that owing to excessive snow accumulation during winter months, there may be difficulties in working this system.

12. It was agreed that reports would be prepared by the expedition party as laid down below—

(i) (a) Suitability of Site	Joint report.
(b) Astronomy, Cosmic ray, Mother of Pearl Clouds ...	Dr. R. Ananthakrishnan.
(c) Biology	Dr. S. P. Agharkar.
(d) Geology	Shri S. P. Nautiyal.
(e) Glacier and Snow	Shri R. D. Dhir.
(f) Meteorology, Radiosonde ...	Shri R. V. Badami.
(ii) Engineering aspects.	
(a) Roads	Shri R. D. Dhir.
(b) Buildings	

APPENDIX E

Report of the survey party which visited Badrinath and Kuari Pass localities to select a suitable site for a Combined High Altitude Research Laboratory.

PART A

1. Introduction

A proposal for selecting high level station in the Central Himalayas for the establishment of a research laboratory for studying snow and glaciers, cosmic rays, astronomy, astrophysics, microbiology, high level meteorology, Himalayan flora and fauna, etc., was mooted by the India Meteorological Department in 1947. After discussions with various Departments and scientists it was decided to send out a survey party consisting of six scientists to select suitable sites for the proposed laboratory. The party selected consisted of the following members—

Shri R. D. Dhir	...	Officers from the C.W.I.N.C.
Shri Harbhajan Singh	...	
Dr. R. Ananthakrishnan	..	Officers from the India Met. Deptt.
Shri R. V. Badami	...	
Shri S. P. Nautiyal	...	Officer from the Geological Survey of India.
Prof. S. P. Agharkar	...	Officer deputed by the Board of Scientific and Industrial Research.

A questionnaire for the survey party was prepared by the D.G.O. (Enclosure 1) and was discussed at a meeting (Enclosure 2) held under the chairmanship of Rai Bahadur A. N. Khosla, Chairman, C.W.I.N.C., on 26th May 1948 which was also attended by Sir S. S. Bhatnagar, President, Council of Scientific and Industrial Research and Dr. D. N. Wadia, Director of Minerology, Ministry of Works, Mines and Power. It was decided that Shri R. D. Dhir be appointed as the leader of the party and Dr. R. Ananthakrishnan as the deputy leader. It was also agreed that reports should be prepared by the expedition party as laid down below—

(a) (i) Suitability of Site ...	...	Joint report.
(ii) Astronomy, Cosmic Ray, Mother of Pearl Clouds	...	Dr. R. Ananthakrishnan.
(iii) Biology ...	...	Shri S. P. Agharkar.
(iv) Glacier and Snow ...	...	Shri R. D. Dhir.
(v) Geology ...	...	Shri S. P. Nautiyal.
(vi) Meteorology, Radiosonde	...	Shri R. V. Badami.

(b) Engineering aspects.

(i) Roads ... ...
(ii) Buildings ... ... } Shri R. D. Dhir.

2. Organisation and Itinerary

The party was to have left Delhi on 1st June 1948; but as information was received from the Deputy Commissioner, Pauri, Garhwal, that there was likely to be some difficulty in procuring the required number of coolies and mules for the party, because of the great demand for them by the pilgrims proceeding to Badrinath in this season, Shri R. V. Badami a member of the party, had to leave in advance on 27th May 1948 to Pauri to contact the Deputy Commissioner and make the necessary arrangements personally. After receipt of telegraphic intimation from Shri R. V. Badami on 31st May 1948 that the necessary transport facilities had been arranged, the rest of the party, excluding Shri S. P. Nautiyal, who joined the party at Sonla on 7th June 1948, left Delhi on the afternoon of 3rd June, 1948. About 40 mounds of luggage which included two sets of meteorological instruments for installation at suitable sites, a three-inch astronomical telescope, warm clothing and camp equipment, supplied by C.W.I.N.C., and provisions for about one month etc. were carried with the party. For transporting this luggage over the regions beyond the rail and motor-heads, nearly 50 coolies and nine mules were engaged.

The party spent about a month in the Himalayas investigating sites in the neighbourhood of Badrinath and Kuari Pass. The detailed itinerary of the party is given in Enclosure 3. After investigating sites near Badrinath, the party reached Joshimath on 21st June 1948. At Joshimath Shri Dhir had an attack of influenza necessitating his stay there. Prof. Agharkar decided to stay at Joshimath to look after him. The remaining four members of the party under the leadership of Dr. Ananthakrishnan left for Kuari Pass to examine suitable sites for the laboratory in that neighbourhood expecting to return to Joshimath by 28th June 1948. Prof. Agharkar decided to return to Delhi in advance of the party and left Joshimath on 28th June 1948. Shri Dhir who had practically recovered from his illness was weak and was not strong enough to join the party at higher altitudes. He therefore, continued to stay at Joshimath awaiting the return of the party. The party returned to Joshimath on 2nd July 1948 and left for New Delhi the next day.

3. Acknowledgements

The party wishes to acknowledge with thanks the help and assistance rendered by the following persons during the various stages of the expedition—

(a) Deputy Commissioner, Pauri, Shri M. A. Qurashi, I.C.S.;

(b) Shri Pratap Singh Chauhan, S.D.O., Pauri, who rendered substantial help for the recruitment of coolies and procurement of foodstuffs for coolies.

(c) Shri Purshotam Bagwari, Secretary, Badrinath Temple, for arranging accommodation for the party during the stay at Badrinath and for various other acts of help rendered.

Names of persons who may be contacted by future parties for help are given in Enclosure 4.

PART B

Basic Requirements for Selection of Sites

According to the questionnaire, the basic requirements for the selection of sites are—

(a) *Altitude*—

(i) The altitude of the high level observatory should be between 14,000 and 16,000 feet.

(ii) The colony of scientists should not be at a level higher than 14,000 feet.

(b) *Area*—

(i) An area of about 10 acres of nearly flat land for the astronomical observatory, cosmic ray and other laboratories, as far as possible on the barren top of a mountain ;

(ii) 15 acres of nearly flat land for the location of the scientists' colony.

(c) *Angle*—

No neigbouring mountain peaks should subtend an angle exceeding 10 degrees from the site for the astronomical dome.

(d) *Accessibility*—

Easy accessibility from the scientists colony to the observatory.

If a site satisfying the above basic requirements is available, then additional requirements such as communications, transport facilities, generation of electric power, site for an air-field or air-strip, estimates for buildings, etc., have to be looked into, in some detail.

The various requirements mentioned above were kept in view while investigating the sites.

PART C

1. Badrinath and Neighbourhood

(a) *Narayan Parbat*—

Latitude—30°46′.

Longitude—74°27′.

Height a.s.l.—19,570 feet.

The Narayan Parbat consists of a series of ranges running in a north-east to south-west direction. Starting from Badrinath (10,350 feet) the climb is steep for the first 2,000 feet and thereafter generally more gradual. During the climb up to a height of 15,000 feet fairly flat but undulating areas were encountered near about 11,000, 12,000 and 13,000 feet. Above 12,000 feet extensive areas of glacial moraines and snow fields of varying dimensions are met with. The angles subtended by the neighbouring peaks as measured from 12,000 feet are—

Unbasikhund (towards south) — 26°.

Ridges towards west culminating in Narayan Parbat peak — 28°.

Kuber Bhandar (towards east) — 26°.

Peaks towards north — 12°.

Even at higher elevations the angles met with were not very much different from the above. In the winter months there is considerable accumulation of snow on the mountain slopes with risk of avalanches.

In fact, the avalanches which came down the slopes of the Narayan Parbat ranges during March to April, 1947 caused considerable damage to houses and property at Badrinath. In the circumstances, it was felt. that the site was unsuitable from our point of view.

(b) *Nar Parbat (Kuber Bhandar)* —

Latitude—30° 44′.

Longitude—79° 35′.

Height a.s.l.—19,210 feet.

The Nar Parbat range lies on the eastern side of the Alaknanda. The hill sides are steeply sloping and there does not exist flat terrain like that of Narayan Parbat. No suitable sites could be found for the location of the observatory.

(c) *Sites North of Badrinath*—An attempt was made to see whether any suitable sites were available to the north of Badrinath with negative result.

2. Lokpal

At the meeting held in the Central Secretariat on 26th May 1948 (Enclosure 2) it was felt Lokpal would be a promising site for the location of the high level observatory and that higher elevations within easy reach from Lokpal should be investigated. In conformity with this, prior to leaving for Badrinath, arrangements had been made from Joshimath for despatch of necessary foodstuffs for coolies etc. to Ghat Chatty near which the foot path branches off to the Lokpal side. The set of meteorological instruments meant for Lokpal were also stored in a hired room at Ghat Chatty. Immediately after reaching Badrinath on 14th June 1948, a guide was fixed up to accompany the party to Lokpal and he was instructed to contact the party at Pandukeshwar on 20th June 1948 during the return journey of the party from Badrinath.

Both on the way to and during the period of stay at Badrinath the health of almost every member of the party suffered breakdown, in some cases more than once. Local enquiries made at Badrinath about Lokpal from persons who had returned from that place only quite recently elicited the information that the place was difficult of access. After crossing the Alaknanda by a rickety rope bridge near Ghat Chatty and covering a distance of about ten miles up the Bhyundar valley one reaches Ghangariya. From this place a steep ascent of 3,000 feet across terrain covered with thorny bushes with no proper path leads to Lokpal (14,200 feet). It was understood that there are no residents at Lokpal at any time of the year. The last inhabited village in the valley is Bhyundar about 5 miles from Lokpal and even here people stay only in July and August. Lokpal valley itself is only about 3½ furlongs long and 1½ furlongs wide, in the middle of which is situated the lake, Hemkund. The surrounding mountains are very steep and difficult of climbing. Inquiries also revealed that no flat areas of appreciable extent were likely to be available on the mountain tops. Snowfall at Lokpal and neighbourhood is very heavy in winter and parts of the lake were frozen even in the month of June. Also, by the time the party had reached Badrinath, weather conditions had taken an adverse turn which added to the difficulties that would have to be confronted if Lokpal was to be attempted. In the circumstances, and especially because of the poor state of health of the members of the party, it was unanimously decided to drop the visit to Lokpal and to proceed instead to the Kauri Pass site where sites satisfying our requirements were likely to be available.

3. Kuari Pass and Neighbourhood

(a) *Sites*—During the period 22nd June 1948 to 2nd July 1948, the following sites were investigated in the neighbourhood of Kuari Pass.

(i) *Site No.* 1 (*Pangarchula Peak*) —

Latitude	.. 30° 25′ 30″N	Topo Map, half-inch No. 53 N/S.E.
Longitude	.. 79° 35′ 30″E	
Height a.s.l.	.. 15,040 feet	

The site is 5¼ miles south-southwest of Tapoban as the crow flies. Pangarchula peak stands clear from its surroundings which are gradually rising ridges with low peaks and saddles. The northern slope of Pangarchula hill is covered with large accumulation of glacial moraines. The southern face ends in a rugged escarpment. Snow patches of varying dimensions are encountered on the northern slope beginning from about 14,000 feet right up to the top. The top of the peak consists of undulating ground running roughly in a south-east to north-west direction about 300 feet in length and 10 feet wide. Nearly 80 feet length of the top towards the south-east side is free from loose boulders. The undulation can be levelled up. However, the area realisable after levelling may not be very much more than what is required for an astronomical dome only.

The angles of elevation of the more important snow-clad Himalayan peaks visible from the top of Pangarchula are—

Badrinath (23,190 feet)—NW 3°.

Nilkantha (21,640 feet)—NNW 3°.

Hathi Parbat (22,070 feet)—NNE 3½°.

Towards south-west all visible peaks are below the horizon.

No definite information regarding the period when the mountain top will remain covered with snow or of the seasonal variations in the depth of snow is available. However, during our visit towards the end of June we found numerous patches of snow of depths varying from 3 to 5 feet between 13,000 feet and the top of the peak. There is no glacier on the mountain top. No water-power resources are available nearby. For working a power station at the top using the motive force of wind, meteorological observations over a period of one year or more are necessary before definite conclusions can be arrived.

The northern slope of the hill range ending in Pangarchula peak has numerous gently sloping areas of large extent beginning from about 10,000 feet right up to 14,000 feet. These areas are quite suited for the colony of scientists and other laboratory buildings with ample scope for further expansion.

The approach to Pangarchula up to 14,000 feet from the base colony between 10,000 and 14,000 feet can be made by a zigzag motorable road. Above 14,000 feet right up to the top, the ascent lies over a vast field of glacial moraines and it is very difficult, if not impossible, to construct a motorable road. In our opinion, the only alternative is to have a funicular railway. The road from the scientists' colony to Pangarchula is likely to remain under snow for nearly six months in the year.

(ii) *Site No.* 2—The site is situated almost midway between Pangarchula peak and Kuari Peas at a height of 14,000 feet on a ridge (Lat. 30° 26′ 30″ N ; Long. 79° 34′ 45″ E). The northern side of the ridge consists of a number of gently sloping terraces of large extent quite suitable for

locating the scientists' colony. The southern side ends in a steep escarpment. The ridge is undulating and extends over 1½ miles in a northwest-southeast direction. The top of the ridge is rather narrow and for construction of astronomical buildings, etc., levelling will have to be done up to suitable depths over the required area.

Excepting Pangarchula towards south-east which subtends an angle of 12 degrees, the rest of the peaks which are visible in other directions subtend angles which are less than 6 degrees. In the sector, SSE to NW all peaks are below the horizon.

A zigzag motorable road can be built from the scientists' colony to the observatory site.

Excepting isolated patches of snow in protected places, the approach to the site was completely free from snow during our visit.

(iii) *Site No.* 3 (*Ghorsoan Peak*)—

Latitude—30°29′ 30″ N.
Longitude—79°34′ 45″ E.
Height a.s.l—12,458 feet.

Ghorsoan peak is nearly five miles towards the south of Joshimath as the crow flies and can be easily connected with that place by a zigzag motorable road. The top of the peak slopes gently towards the north and north-west and, on levelling up, will provide ample space for the astronomical dome and other buildings. Five hundred feet below the peak on the northern side lies a vast stretch of meadow known as Aulibugyal (pasture land). The meadow is undulating. There are, however, a number of nearly flat areas at lower elevations beginning from 8,000 feet which are suitable for the scientists' colony.

The angles of prominent peaks visible from the site are—

Badrinath	.. ..	NW 6°
Nilakantha	.. ..	N-NW 7°
Hathi Parbat	.. ..	N-NE 7°
Dunagiri	.. ..	E-NE 6°
Trisul	.. ..	SE 7°

A motorable road can be constructed from the scientists' colony to the astronomical observatory.

(b) *General Points for Sites* 1, 2 *and* 3—The approach to all the three sites will be from Joshimath side by zigzag motorable road.

There are no permanent residents above the village of Tugasi at an elevation of 8,800 feet about 4 miles from Tapoban. Above this elevation there are thick reserved forests up to about 12,000 feet beyond which are numerous pasture lands frequented by shepherds during the months of May to September.

During the winter months both the colony as well as the observatory will be cut off from the rest of India due to snow accumulation and the only means of communication will be by W/T system. Details for this may be considered after the final selection of site.

Provisions for six months will have to be stored for the colony of scientists. The type of provisions to be stored will depend upon the choice of personnel posted there.

Bhutia ponies are the most suitable for use in the mountains. The pasture lands above 12,000 feet will be most suitable for their maintenance.

No suitable sites for landing grounds are available near sites, 1, 2 and 3.

(c) *Recommendations*—Of all the three sites investigated, the party is of the opinion that the Ghorsoan peak site is the most suitable one on account of easy accessibility, better living conditions, large areas on the top as well as on the hill slopes where the scientists' colony can be located. Despite the fact that the height of the peak is about 1,500 feet less than the minimum limit set before us, it satisfies the other requirements of angle and space.

PART D

Installation of Meteorological Instruments

Of the two sets of meteorological instruments carried by the party, one set was installed at Badrinath and the other at Tapoban. Part-time observers were selected and trained at both these places.

PART E

General Remarks

From our experience of conditions obtaining in the western Himalayas during the present tour, it appears worthwhile to outline the following general remarks—

(a) Sites satisfying all the basic requirements are difficult to find particularly in the neighbourhood of Badrinath. It is possible that if one goes further north towards the Tibetan border such sites may be available. However, in this case, accessibility will be more difficult.

(b) It is desirable to investigate the sites on the Niti side in view of the fact that Joshimath will be the terminus of the motorable road by 1951.

(c) Living conditions are extremely hard above 12,000 feet. The quantity of snowfall in the western Himalayas at elevation above 10,000 feet is considerable. At the proposed elevations the main laboratory and even the scientists' colony will be snow-bound for a considerable part of the year. The effect of continuous exposure at high altitudes leads to physical and mental fatigue and it is doubtful whether scientists can live and work at these altitudes throughout the year even if modern conveniences are provided.

(d) Some subjects included in the programme of work of the high altitude research laboratory such as study of Himalayan flora and fauna involve field work which is only possible during the period April to November.

*(e) At high altitudes, it is easier to make arrangements for scientists who are accustomed to non-vegetarian diets.

(Sd) R. D. DHIR.	(Sd) R. V. BADAMI.
(Sd) HARBHAJAN SINGH.	(Sd) S. P. NAUTIYAL.
(Sd) R. ANANTHAKRISHNAN.	(Sd) S. P. AGHARKAR.

*I do not agree with this statement—S. P. AGHARKAR.

ENCLOSURE 1

Questionnaire for the party of scientists proceeding to select sites for a High Altitude Research Laboratory

(1) The essential condition for the site is that it should be as high as possible where scientists can work, provided modern working conditions are made available. Experience of other countries and also the experience that we have so far gained in India by excursions in the Himalayas is that scientists can work fairly comfortably at a maximum altitude of about 18,000 feet. The altitude of the High Altitude Laboratory should be between 14,000 to 16,000 feet.

(2) It should preferably be a mountain top with fairly extensive area. If there is undulation, the undulation should not be such that it cannot be levelled up. For the location of the observatory, an area of about 10 acres should be aimed at.

(3) Previously on the Badrinath route an air service was operating; taking off from the air-field at Hardwar and landing at the air-field at Gauchar, which is very near Chamoli. An examination should be made whether it should be possible to develop an air-field near the observatory site or the residential colony of the scientists. Recently, there has been a talk in the newspapers of an air-field at Badrinath. Details about these should be obtained. If an air-field has definitely been fixed up and it can be used for our High Altitude Laboratory, nothing more need be done. But if nothing has been fixed up, an examination should be made of any suitable nearby locality not exceeding an altitude of 12,000 feet, where an air-field can be developed. For an air-strip, we will require a plot of land at least 1,200 yards long at a height not exceeding 12,000 feet. If not available, what other possibilities can we have? Can helicopter land?

(4) The site for the High Altitude Observatory should be such that no neighbouring mountain peak subtends an angle exceeding 10 degrees.

(5) Details regarding the snow cover on the mountain top should be obtained. How long will the mountain top and the side would remain covered with snow; what will be the depth of snow from time to time? The major part of the selected site should be over barren mountain top and not over glaciers. On the mountain top there are to be—

(i) Astronomical buildings.

(ii) Laboratory for cosmic rays.

(iii) A biological laboratory.

(iv) A laboratory for study of snow and glaciers.

(v) A high altitude meteorological observatory.

(vi) A research unit for the Himalayan flora and fauna.

(vii) Seismological station.

The astronomical and seismological buildings will have to be separate ones. The other activities may probably be all combined in a compact building.

(6) A power station working with wind mills will have to be fixed up on the mountain top to work a system of storage batteries with large capacity delivering about 110 volts. Alternatively, if waterfall nearabout the site can be used to generate electricity, the matter should be explored The power supply will be needed for keeping the laboratory buildings warm and also to provide illumination to the domestic colony of scientists.

(7) The most essential consideration in selecting site for the High Altitude Observatory should be its approach from the colony where scientists will live. The colony of scientists should not be at a level higher than 14,000 feet. It should be possible to construct a motorable road from the colony to the hill top; alternatively funicular railways. For the colony of scientists, provision need only be made initially for housing about 12 scientists and also about four visiting scientists from India or abroad. This number may increase in course of time. So the site which is to be selected for the colony of scientists should be such that future expansion can take place. An area of about 15 acres will be preferable so that the scientists can have some gardens of their own. Initially, the plan should be to provide a compact building on English design which can be heated centrally by oil plants or by electricity. The building should provide accommodation for about six residential scientists and four visiting scientists. In addition, family accommodation for another six scientists will also have to be planned. There should also be separate accommodation for class IV Government servants.

(8) The zigzag motorable road from the colony to the hill top will have to receive careful examination and the colony with reference to the hill top should be so located that the road becomes the minimum in length and its working cost should also be minimum.

(9) With regard to the buildings on the mountain top, the plan will have to be such that there is no heavy accumulation of snow on the roof of the structures and, if there is any such accumulation on the astronomical dome it will prevent taking astronomical observations. It is understood that in high altitude stations, if the slope of the roof is so arranged that it is roughly about 50 degrees to the horizontal, there is usually no snow accumulation. Since we have no experience of the accumulation of Himalayan snow, ideas should be formed of the best slope which will keep off snow accumulation on the roof.

(10) The feasibility of a rope trolly up to the hill top on electric power should also be considered. It will probably have to be of the funicular type, one bucket going up and the other coming down, and may be constructed in four or five stages. To keep down costs, the buckets need not carry more than two or three persons.

(11) Details about living conditions throughout the year will have to be determined by local enquiries. If it is considered that the station is likely to be cut off from the rest of India owing to the roads being blocked by snow accumulation, the essential communication system between the station and the rest of India will also have to be examined. This communication system should involve provision of wireless transmitters and receivers at the colony. The details for this should also be worked out.

(12) What provisions will be required to be stored to enable the men to work continuously throughout the year will require to be determined. The nearest medical assistance available should be found out. It may be possible to get the Medical Department interested in micro-biological studies in this high level station, in which case one of the scientists will be a medical officer who will be able to look after the ailments of the scientists and their families.

(13) For snow survey, it will be necessary to maintain permanently some ponies for the party to move from the headquarter station to areas where snow surveys will be made. Arrangement for this also will have to be looked into.

(14) There should be a small workshop attached to the colony and a fairly big size room for storage of various equipments.

(15) The Meteorological Officers will set up raingauge, snowgauge and thermometers in Stevensons Screens at Badrinath, Lokpal and near about Niti, select part-time observers, who are likely to remain there throughout the year, and fix up their allowances.

(16) Rough estimates of cost should be determined for following items—

(a) Construction of road from colony to observatory site.

(b) Wind-mills.

(c) Storage batteries with spares.

(d) If road not motorable from colony to observatory, then construction of moving buckets (one up and one down on rope system) in three or four stages.

(e) Water-supply system.

(f) Construction of observatory buildings on mountain top.

(i) Astronomical Dome for a 30-inch refractor with Schmidt attachment and attached block for Solar studies.

(ii) Main observatory in a single block or two blocks with a room each for biological laboratory and general laboratory, cosmic ray, radiosonde and meteorological work, snow-glacier study and river-discharges.

There should be one W.C. and bathrooms.

(g) Scientists' colony—

(i) Seismograph buildings.

(ii) Library building.

(iii) General laboratory, one room for biological laboratory, one room for meteorological work, one room for astronomy and cosmic ray, one room for geology, one room for snow and glacier, one room for general stores, two W.C.'s and bath-room.

(iv) Residential accommodation, non-family accommodation for six scientists and four visiting scientists (austerity type) and blocks for 18 class IV Government servants—all buildings are to be English design with provision of heating system (oil or electrical).

(v) One compact building for storage and provisions.

(h) Base Station at Joshimath—one office building (two or three rooms) and two or three residential quarters.

(17) Names of local people.

(18) If Lokpal is found suitable for High Altitude Station the party should find out details for working a temporary station with two full-time observers of the grade of Meteorological Assistants for one year. For this purpose, it will be necessary to find out a suitable place where they can live and work. And also details will have to be worked out what provisions will have to be stored and what other facilities will have to be given to the two observers.

ENCLOSURE 2

Minutes of the meeting held in Rai Bahadur A. N. Khosla's room in the Central Secretariat, New Delhi, on 26th May, 1948 to discuss details of the programme of the expedition party proceeding to Badrinath area to select a suitable site for a combined high level observatory.

1. Present—

Rai Bahadur A. N. Khosla, Chairman, C.W.I.N.C.

Sir Shanti Swarup Bhatnagar, Council of Scientific and Industrial Research.

Dr. D. N. Wadia, Ministry of Works, Mines and Power.

Shri R. D. Dhir, C.W.I.N.C.

Dr. S. K. Banerji.
Dr. R. Ananthakrishnan.
Shri R. V. Badami.
Shri C. R. V. Raman.
} I.M.D.

2. The following conclusions were reached—

(i) As the mountain top above 16,000 feet will remain covered with snow for several months, the observatory should not be at an altitude higher than 16,000 feet.

(ii) The colony for scientists should be between 12,000 feet to 14,000 feet. Small structures for astronomical observatory and cosmic ray work could be at a height of 16,000 feet or a little higher.

(iii) The selection of Lokpal in the Bhyundar valley (one of the sites to be investigated by the party) is very promising.

(iv) The higher elevation within easy reach of Lokpal should be investigated.

(v) The party should first proceed to Badrinath and look for suitable sites in neighbourhood; then proceed to Lokpal and if this site is found suitable from all points of view (astronomical, biological, meteorological, cosmic ray, glaciers studies, etc.) a longer stay than projected would be made and the suitability of the site examined from all points of view.

(vi) As the expedition was only of an exploratory nature the party should now restrict itself to an inspection of the sites near Badrinath and Lokpal. If Lokpal is not suitable and if time permits, the availability of a suitable site near Jumnotri in the upper reaches of the Jumna should be investigated, by taking a trip to that place *via* Dharasu and Kharsali.

(vii) The site near Kharsali might be investigated in September, preferably by the same party, to secure uniformity of outlook, if it is not possible to do this in the course of the present trip.

(viii) As it was not desirable to be in the Himalayas during July after the break of the monsoon, and in view of the difficult accessibility of the sites near Niti, the proposed trip to this site may be dropped.

3. For astronomical observations one should spend some time at each site and observations should be taken over an extended period. It is only then that the suitability of the site from astronomical point of view can be determined.

4. The party will consist of six officers made up of two representatives from the Meteorological Department, two from C.W.I.N.C., one biologist and one geologist. Shri R. D. Dhir of C.W.I.N.C. will be the leader and Dr. R. Ananthakrishnan of I.M.D. will be the deputy leader of the expedition party.

5. The party should investigate the conveniences for human habitations at these elevations.

The possibility of an air-strip at least 1,200 yards long, near about the observatory site, at a height not exceeding 8,000 feet may be investigated. As it is doubtful whether a suitable air-strip will be available near the observatory site, the possibility of helicopter plane landings should be investigated.

In addition, it would be necessary to install a wireless transmitter and a receiver.

The names and addresses of some local people should be obtained, so that later expeditions can again contact them.

6. Owing to excessive snow accumulation during winter months, there may be difficulties in working a system of funicular railways at these elevations. Roads with small motor transport will probably be the only means of access from scientists' colony to observatory site.

7. It was proposed to set up raingauges, snowgauges and thermometers at Badrinath and Lokpal and train local observers for taking observations.

If suitable site for the observatory can be found, arrangements for taking extended meteorological observations would be made on the recommendations of the party. The party should make recommendations regarding temporary accommodation of observers, and provision of stores.

8. The questionnaire for the party, as amended by the above decisions was prepared.

9. Reports would be prepared by the expedition party as laid down below—

(a) (i) Suitability of Site—Joint Report.

(ii) Astronomy, Cosmic ray, Mother of Pearl Clouds—Dr. R. Ananthakrishnan.

(iii) Biology—Dr. S. P. Agharkar.

(iv) Geology—Shri S. P. Nautiyal.

(v) Glacier and Snow—Shri R. D. Dhir.

(vi) Meteorology (Radiosonde)—Shri R. V. Badami.

(b) Engineering aspects.

(i) Roads—Shri R. D. Dhir.

(ii) Buildings—Shri R. D. Dhir.

ENCLOSURE 3

Itinerary of the Expedition Party

Date	Arrival/ Departure	Place	Distance (miles)	Remarks
3-6-48	D	Delhi (700′)	..	By rail.
4-6-48	A	Kotdwara (1,250)	..	Do.
5-6-48	D	Kotdwara	66	By motor.
	A	Pauri (6,000′)		
6-6-48	D	Pauri	19	Do.
	A	Srinagar (1,900′)		
7-6-48	D	Srinagar	49	Do.
	A	Sonla (3,000′)		
8-6-48	D	Sonla	3	Do.
	A	Nandaprayag (2,000′)		
	D	Nandaprayag	7	On foot.
	A	Chamoli (3,800′)		
9-6-48	D	Chamoli	10½	Do.
	A	Pipalkoti (4,350′)		
10-6-48	D	Pipalkoti	8	Do.
	A	Gulabkoti (5,300′)		
11-6-48	D	Gulabkoti	10½	Do.
	A	Joshimath (6,150′)		
12-6-48		Halt at Joshimath.		
13-6-48	D	Joshimath	8	Do.
	A	Pandukeshwar (6,450′)		
14-6-48	D	Pandukeshwar	11	Do.
	A	Badrinath (10,350′)		
15-6-48 to 19-6-48		Halt at Badrinath to investigate sites over Narayan Parbat, Kuber Bhandar and to north of Badrinath and for installation of meteorological observatory at Badrinath.		
20-6-48	D	Badrinath	11	On foot.
	A	Pandukeshwar		
21-6-48	D	Pandukeshwar	8	Do.
	A	Joshimath		
22-6-48	D	Joshimath (6,150′)	7	Do.
	A	Tapoban (6,300′)		
23-6-47		Halt at Tapoban.		

Itinerary of Expedition Party—continued.

Date	Arrival/ Departure	Place	Distance (miles)	Remarks
24-6-48	D A	Tapoban .. .. .. Khulara camp (11,450′)	6	On foot.
25-6-48	D A	Khulara Camp .. .. .. Kauri Pass Camp (12,300′) ..	2	Do.
26-6-48	D A	Kuari Pass Camp .. .. Pangarchula Base Camp (13,600′) ..	6	On foot. (Kuari Pass, Site No. 2 was investigated).
27-6-48	D A	Pangarchula Base Camp .. .. Kuari Pass Camp		On foot (Pangarchula peak, Site No. 1 was investigated).
28-6-48	D A	Kuari Pass Camp .. .. Ghorsoan Base Camp (11,300′) ..	7	On foot.
29-6-48		Investigation of Ghorsoan Peak Site No. 3.	5	Do.
30-6-48	D A	Ghorsoan Base Camp .. .. Tapoban	8	Do.
1-7-48		Halt at Tapoban to instal meteorological instruments.		
2-7-48	D A	Tapoban .. .. .. Joshimath	7	Do.
3-7-48	D A	Joshimath .. .. .. Pipalkoti	18½	Do.
4-7-48	D A	Pipalkoti .. .. .. Nandaprayag	17½	Do.
5-7-48	D A	Nandaprayag .. .. .. Srinagar	52	By motor.
6-7-48	D A	Srinagar .. .. .. Pauri	19	Do.
7-7-48 and 8-7-48		Halt at Pauri.		
9-7-48	D A	Pauri .. .. Kotdwara	66	Do.
9-7-48	D	Kotdwara		By rail.
10-7-48	A	Delhi		Do.

ENCLOSURE 4

Names of people who may be contacted by future parties

1. Shri M. A. Qureshi, I.C.S., Deputy Commissioner, Pauri.
2. Shri K. C. Mathur, Executive Engineer, Pauri.
3. Shri Pratap Singh Chauhan, Sub-Divisional Officer, Pauri.
4. Shri Barathral, President, Garhwal Motor Transport Union, Pauri.
5. Shri S. P. Kothiyal, Divisional Superintendent of Industries (Wool), Pauri.
6. Seth Sankar Dutta Bahuguna, Nandaprayag, Joshimath and Badrinath.
7. Shri G. P. Nautiyal, Journalist, Nandaprayag and Badrinath.
8. Shri Vasudevan Nambudiri, Ex-Rawal, Joshimath.
9. Shri Parshotam Bagwari, B.A., LL.B., Secretary, Badrinath.
10. Shri Gopal Dutt, School Master and Observer, Meteorological Observatory, Tapoban.

APPENDIX F

Hints on Equipment by Shri S. S. Khera

Shri S. S. Khera gave the following hints for climbing the mountains.

The party should always move in two, preferably three, and while crossing glaciers *roping* was very essential. Good ropes (Manila type) should be used by the party. For climbing mountains, regular ammunition boots of the latest type should be used. They are available with Cooper Allens, Kanpur. Clinker nails should be sent from Delhi to Kanpur and they could be fixed to the boots by Cooper Allens. For walking on level ground tennis shoes will be preferable. He desired that the minimum equipment should be taken and suggested the following from Delhi—

1. Tents—four, accommodating two persons in each.

2. Powdered egg ; condensed milk and sugar ; *gur* and *satu ;* canvas water buckets ; degchi sets for cooking ; multi-vitamin tablets ; five tins of dry fruit like almonds, raisins ; asperin ; gloves ; socks (eight pairs each) ; ankle patties ; shirts ; canvas shoes ; wind proof jackets (cheap ones for coolies also at Rs. 9 from Delhi) ; sleeping bags (alternatively 3 blankets each) ; soap (6 oz. each) ; ruck sacks ; mugs ; bowl ; good first aid box ; sulpha drugs ; quinine ; tea 1 seer ; white vaseline ; *masur dal* and dark glasses (some spare ones to replace breakage) ; no kerosine oil should be carried. Candles and match boxes should be carried in plenty. Thermos flasks unnecessary ; cooker, fuel, etc., need not be carried.

Coolies should be paid handsomely to keep them contented. The coolies from Mana Pass are hardy and better suited to do the climbing in the higher ranges.

APPENDIX G

Copy of the letter from an engineer from Madras to the Secretary, Badrinath Temple giving an hydro-electric scheme for Badrinath town.

I arrived there on the 18th ultimo and had discussions with you for three days of my stay at Badrinath. During our discussions with regard to the flow of water of river and springs which could likely be utilised as motive power for generating electricity, you and I had been up to Charnpaduka side in the company of Shri Gupta, the District Engineer of Garhwal, Dr. Kundan Singh, the Educational Chairman of District Board, and other distinguished persons of Badrinath. We had long discussions on the utilisation of Rishiganga springs' water and had a proper survey of the naturally uninterrupted flow of springs. I must say that the water of springs flowing down from the Charnpaduka side has got to be admitted as the best source of water for utilising as motive power for generating electricity. There is no possibility of any flood water, and there are no obstructions in the continuity of the flow of water of the springs, hence there is no necessity of erecting any dam or storage—an expensive item in the construction of a hydro-electric generating station. One small storage 6 ft. × 6 ft. × 4 ft. will be required to be constructed on top of the hill as was suggested by Shri Gupta also.

The best site for the construction of power house building was located down below the hermitage at the foot of the hill. The head of water as obtained at this place was about 144 feet and there was water in the springs to run two sets at a time of 100 kW each. But for the present, I would suggest to fix up one small set of 25 kW, 220 volts D.C. compound-wound generator, just enough to meet the minimum demand of Badrinath people. The length of the hill from the proposed storage on top of the hill down to the power house site is about 300 feet. One ordinary covered drain of cement 6-inch square should be constructed from the storage all the way down to 200 feet; after that 100 feet G.I. pipes of 2 inches to 6 inches diameters to be fixed right down to the power house. The dimensions of the required power house building will be 30 ft. × 16 ft. It will provide attendance of retiring rooms and future extensions of plants. The cost of all items of hydraulic side including the power house building as estimated by the District Engineer on the spot, will be Rs. 5,000 only.

Total Initial Cost

An approximate amount to be invested being Rs. 30,000 is shown in the capital account (see Enclosure 1). The item of Rs. 2,000 being the cost of meters is separated from the total of capital expenditure simply for the reason that the meters will be purchased and issued to big and

medium consumers on monthly rent of Re. 1 each meter, i.e., about 100 meters will be purchased for Rs. 2,000 and a revenue of Rs. 100 per month will be earned from meters. I have not shown this income in the revenue account.

Annual Revenue

The statement of revenue is given in Enclosure 3. I have taken into account income for four months only and expenditure for twelve months.

(a) *Income*—To make sure of the possible revenue, it has been calculated from these different angles, viz., (i) present consumption of kerosine oil for lighting purpose, (ii) the minimum calculated 500 light points and other power appliance, e.g., heaters, etc., to replace charcoal, etc., for heating rooms, and (iii) the lowest possible expected consumption both from lights and other appliances. Each of these is discussed below.

(i) Present consumption of kerosine oil for lights—

The Temple spends every season Rs. 600 on the purchase of kerosine oil and Baba Kalikamliwala about Rs. 400; the actual expenditure on kerosine oil of other residents is not available. However, in my calculation, instead of full six months' consumption, I have taken only four months' consumption into account and shown the equivalent revenue in Enclosure 3 amounting to Rs. 9,080.

(ii) Minimum 500 light points by five hours daily use and other electric appliances by 11 hours daily use. Revenue expected Rs. 9,300 (see Enclosure 3). But if the consumers require more power, it can be supplied to the extent of another 5 kW during light time of five hours. This increase in consumption would yield a revenue of about one thousand rupees in four months. In the same way if the consumption during other calculated 11 hours increases it can be met to the extent of another 15 kW which would increase the revenue to about Rs. 7,000.

(iii) Lowest expected consumption both from lights and other appliances—Revenue expected Rs. 7,200 (see No. C of Enclosure 3).

From the above it will be seen that the recurring expenditure for full twelve months is Rs. 6,860 and the expected revenue even on the minimum basis, i.e., lowest minimum consumption of light and other appliances is Rs. 7,200; this leaves a net profit of Rs. 340 a year.

But if the management wants, it can purchase and store heaters, bulbs and other ordinary electrical articles for sale to the consumers and charge 10 per cent more on the price of each such stored article. This will not only add a little more revenue to the management but will also prove useful and cheaper to the consumer.

(b) *Expenditure*—The electric demand in Badrinath will be only for six months but it is not possible to engage the electric staff only for six months. No employee would like to enter such employment. It has therefore, been thought proper to engage the staff on full salary for six months and allow them to go home for remaining six months on half pay and a provision has been made to provide them with travelling expenditure for going home and joining duty.

I have given the lowest possible annual recurring expenses amounting to Rs. 6,860. I have shown the salary of an engineer in the expenditure, but this can be eliminated if the works can be managed and supervised by any other responsible employee of the temple. Thus the expenses will come down to Rs. 5,060 only.

Conclusions

In conclusion, I must say that electrification of Badrinath town is a lucrative small project and it can bring a handsome return even if it is taken into hand at this time of dearness as there is not any perceptible loss in the investment for this small project when compared with the revenue gained by it. Further, this will surely create future prospects for the development of the electrification scheme and the town simultaneously. If the initiation of the scheme is put in proper hands it will be possible to get the material at cheap cost, and in some cases it may even be possible to get them free of cost because Badrinath is one of the principal dieties of Hindus and many rich persons might like to help the project.

ENCLOSURE 1

Capital Account

No.		Particulars	Rs.
A	1	To plant consisting of 25 kW, 220 V., D.C., compound-wound generator directly coupled to water turbine and complete with switch gear and connecting wires and tools	15,000
	2	To building complete with pipe line including the construction of the same as roughly estimated by Mr. Gupta, District Engineer of Garhwal	5,000
	3	To transmission and distribution in town, cost at Rs. 2,500 per mile, for approximately 2 miles length	5,000
	4	To internal wiring of the temple and temple buildings including service connections	500
	5	To transporting charges of machinery and materials up to the site ..	2,000
	6	To construction charges of the plant, switch gear and distributing mains	1,500
	7	To preliminary expenses	1,000
		Total ..	30,000
B	1	To meters	2,000
		Total ..	2,000

ENCLOSURE 2

Technical Details of Hydro-Electric Scheme

Assume 40 h.p. or 25 kW.

(1) Voltage (generation)—220 D.C.

(2) Voltage (distribution)—220 D.C., 3 conductors (1 wire for street lighting).

(3) Size of wires—Hard drawn B.C. No. 1, 2, 6 and 8 s.w.g.

(4) Ground wire—G.I. No. 8 s.w.g.

(5) Distance and spacing between conductors—12 inches to 15 inches.

(6) Stay wire—G.I. No. 7/8 s.w.g. and G.I. 7/8 inch bow roads and thimbles.

(7) L.T. insulators on each cross arm with 3 units shackle and pin type.

(8) Size of poles (wooden)—25 feet and 30 feet long and each of 1 foot diameter on the bottom and 4 inches to 6 inches diameter on top.

(9) Cross arms (wooden)—3′ 6″ × 6″ × 6″.

(10) Cross arms support (wooden)— 2′ 6″ × 3″ × 2″.

(11) Binding wire G.I. and B.C. No. 14 and No. 16 s.w.g. each.

(12) Miscellaneous—G.I., M.S. and W.I. sheets and bolts and nuts of assorted sizes.

(13) 220 D.C., 25 kW compound-wound generator direct coupled to the water turbine and complete with necessary controls and connection wires with the switch board or, if available at reasonable cost, one 440 volts D.C., 25 kW generator for 3 wires distribution direct coupled to water turbine, etc.

(14) Switch board for the above generator fitted with one automatic circuit breaker and two extra switches, one 5 amps. switch for the local circuit and the other 10 amps. switch to control street lighting.

(15) Materials for the construction of power house building forebay, and pipe line as estimated by Shri Gupta, the District Engineer of Garhwal.

ENCLOSURE 3

Annual Revenue

EXPENDITURE			INCOME		
No.	Particulars	Amount	No.	Particulars	Amount
		Rs.			Rs.
1	To salaries and wages of the establishment —		A	By sale of energy equivalent to the amount of kerosine oil consumed by the minimum number of consumers for four months—	
	2 switch board operators at Rs. 40 p.m. each for six months	480		I Temple at Rs. 100 p.m.	400
	2 switch board operators at Rs. 20 p.m. each ..	240		1 Baba Kalikamliwala at Rs. 70 p.m.	280
	2 helpers at Rs. 20 p.m. each for six months ..	240		30 big consumers at Rs. 20 p.m.	2,400
	2 helpers at Rs 10 each ..	120		100 medium consumers at Rs. 10 p.m. ..	4,000
	1 Fitter and Electrician at Rs. 80 p.m. for six months	480		100 small consumers at Rs. 5 p.m.	2,000
				TOTAL ..	9,080
	1 Fitter and Electrician at Rs. 40 p.m. for six months	240	B	By sale of energy for minimum number of 500 of electrical lights, each light of an average power of 40 watts, burning 5 hours per night and charged at the lowest rate of Re. -/8/- per unit for Badrinath.	
	2 Line Coolies at Rs. 20 p.m. each for six months	240		500 × 40 × 5 = 100,000 watts or 100 units of Rs. 50	
	2 Line Coolies at Rs. 10 p.m. each for six months	120		50 × 30 × 4 = Rs. 6,000 for 4 months	6,000
	1 Engineer-in-charge at Rs. 200 p.m. for six months	1,200		By sale of energy for the remaining 11 hours of the day at 10 units per hour consumed in heaters and other power appliances and charged at the minimum power rate of Re. -/4/- per unit.	
	1 Engineer-in-charge at Rs. 100 p.m. for six months	600		10 × 11 × 30 × 4 = 13,200 units for 4 months.	
	TOTAL ..	3,960		13,200 × ¼ = Rs. 3,300 for 4 months	3,300
2	To lubricants and repairs	500		TOTAL ..	9,300
3	To stationery and contingency	100	C	By sale of energy at minimum average consumption of 10 units per hour for 16 hours a day for the mixed load of power and light at the average charge of Re. -/6/- per unit.	
4	To travelling expenses of staff for going home and joining duties at the closing period of six months	500		10 × 16 × 30 × 4 = 19,200 units for 4 months.	
5	To interest at 3 per cent on Rs. 30,000 ..	900		19,200 × 6/16 = Rs. 7,200 ..	7,200
6	To depreciation at 3 per cent on Rs. 30,000 ..	900		TOTAL ..	7,200
	TOTAL ..	2,900			
	GRAND TOTAL ..	6,860			

APPENDIX H

Copy of the report on the construction of airfield at Mana by Shri K. C. Mathur, Executive Engineer, Garhwal

About 1-1/3 miles to the north of Badrinath near Mana village, there is a flat piece of land, which is only likely site available near Badrinath for construction of an airfield.

I attach herewith a plan (Fig. 22) showing the plot of land available. In this plan I have marked out two landing strips (A) and (B). Strip (A) is 2,300′×600′ and strip (B) is 3,300′×300′. Greater lengths for 600′ and 300′ widths are not available.

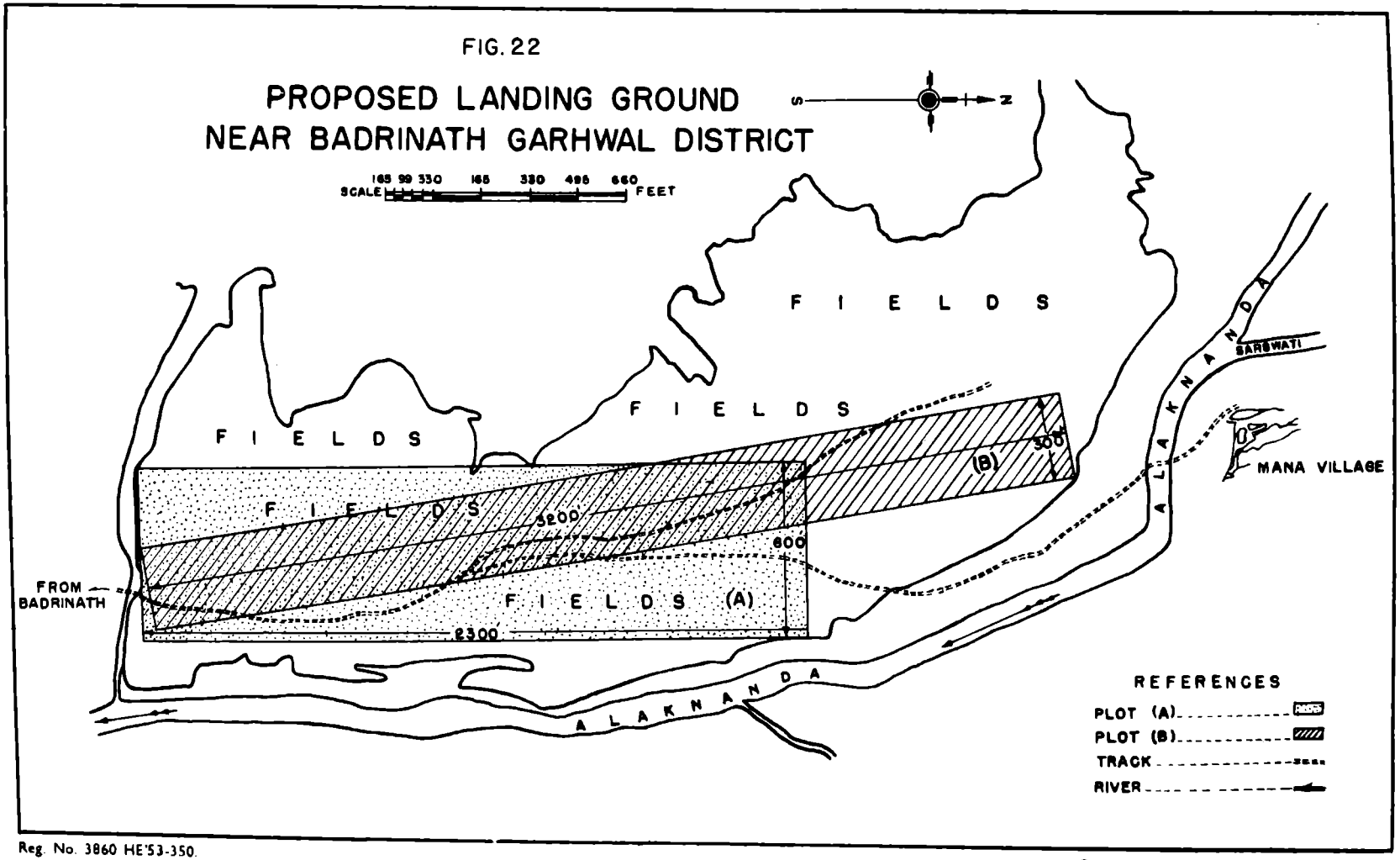
I do not know the minimum size of the airfield required for passenger aircrafts to land at an altitude of about 10,500 feet R.L. which is obtained at the site in question. I, however, understand that at higher altitudes a considerably longer landing ground is required. On this point the Civil Aviation Department will have to be consulted to find out if the length available is at all sufficient for landing aircrafts at this high altitude.

The directions of the landing strips will be north-south which is also the direction of the prevailing winds. The river also flows north to south and the valley is open for sufficiently long distances at both the ends.

On an average about 50 to 60 feet of cutting will have to be done in the higher portions of the plot and the same amount of filling done in lower portions. The total cost of cutting, filling and necessary retaining walls will be approximately Rs. 25 lakhs. The type of rock met in the plot of land is earth and big boulders.

FIG. 22

PROPOSED LANDING GROUND NEAR BADRINATH GARHWAL DISTRICT



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APPENDIX I

Itinerary of the Expedition Party which visited Lokpal and Badrinath

Date	Arrival/ Departure	Place	Distance (Miles)	Remarks
12-9-49	D. (A.N.)	Delhi (700 feet)	..	By rail.
13-9-49	A. (F.N.)	Kotdwara (1,250 feet)	..	Do.
14-9-49	D. (F.N.)	Kotdwara	66	By motor bus.
	A. (A.N.)	Pauri (6,000 feet)		
15th and 16th Sept.—Halt at Pauri for the preparations				
17-9-49	D. (F.N.)	Pauri	62	Do.
	A. (A.N.)	Karnaprayag (2,600 feet) ..		
18-9-49	D. (F.N.)	Karnaprayag	20	Do
	A. (A.N.)	Chamoli (3,800 feet)		
19-9-49	Halt at Chamoli to recruit coolies.			
20-9-49	D. (F.N.)	Chamoli	10	On foot.
	A. (A.N.)	Pipalkoti (4,350 feet)		
21-9-49	D. (F.N.)	Pipalkoti	10	Do.
	A. (A.N.)	Gulabkoti (5,300 feet)		
22-9-49	D. (F.N.)	Gulabkoti	9	Do.
	A. (A.N.)	Joshimath (6,150 feet)		

Itinerary of the Expedition Party which visited Lokpal and Badrinath—continued.

Date	Arrival/ Departure	Place	Distance (Miles)	Remarks
23rd, 24th and 25th Sept.—Halt at Joshimath for preparations and purchases.				
26-9-49	D. (F.N.)	Joshimath	9	On foot.
	A. (A.N.)	Pulna (6,800 feet)		
27-9-49	D. (F.N.)	Pulna	6	Do.
	A. (A.N.)	Gangaria (10,088 feet) ..		
28-9-49	D. (F.N.)	Gangaria	2	Do.
	A. (A.N.)	Lokpal (14,000 feet) ..		
29th, 30th Sept. and 1st 2nd, 3rd Oct.		Halt at Lokpal for installation of Meteorological Observatory and investigation of sites for High Level Research Station.		
4-10-49	D. (F.N.)	Lokpal	2	On foot.
	A. (A.N.)	Gangaria		
5-10-49	D. (A.N.)	Gangaria	3	Selected one snow course at Gangaria in the forenoon.
	A. (A.N.)	Bhyundar (8,400 feet) ..		
6-10-49	D. (F.N.)	Bhyundar	5	On foot.
	A. (A.N.)	Ghat (5,800 feet)		
7-10-49	D. (F.N.)	Ghat	7	Do.
	A. (A.N.)	Joshimath		
8-10-49		Halt at Joshimath for purchases and preparations.		
9-10-49	D. (F.N.)	Joshimath	8	Do.
	A. (A.N.)	Pandukeshwar (6,450 feet) ..		
10-10-49	D. (F.N.)	Pandukeshwar	11	Do.
	A. (A.N.)	Badrinath (10,250 feet) ..		
11-10-49		Halt at Badrinath for preparations of the expedition.		
12-10-49	D. (F.N.)	Badrinath	5	On foot. Selected a snow course at Vasudhara.
	A. (A.N.)	Vasudhara (11,800 feet) ..		

Itinerary of the Expedition Party which visited Lokpal and Badrinath—continued.

Date	Arrival/ Departure	Place	Distance (Miles)	Remarks
12-10-49	D. (A.N.)	Vasudhara	3	On foot.
	A. (A.N.)	Mana Village (10,500 feet) ..		
13-10-49	D. (F.N.)	Mana Village	8	Do.
	A. (A.N.)	Ghastoli (13,100 feet) ..		
14-10-49	D. (F.N.)	Ghastoli	5	Do.
	A. (A.N.)	Danrau (14,790 feet) ..		
15-10-49	Halt at Danrau to investigate site for High Level Research Station.			
16-10-49	D. (F.N.)	Danrau	6	On foot.
	A. (A.N.)	Tarai (16,450 feet)		
17-10-49	D. (A.N.)	Tarai	8	Investigated site at 18,070 feet near Tarai in the morning.
	A. (A.N.)	Danrau		
18-10-49	D. (F.N.)	Danrau	5	Selected one snow course near Ghastoli in the afternoon.
	A. (F.N.)	Ghastoli		
19-10-49	D. (F.N.)	Ghastoli	8	
	A. (A.N.)	Mana Village		
20-10-49	D. (A.N.)	Mana Village	2	Fixed one discharge site on Alaknanda near Mana Village in forenoon.
	A. (A.N.)	Badrinath		
21st and 22nd Oct. 49	Halt at Badrinath for inspection of the Meteorological Observatory and selection of Snow Course.			
23-10-49	D. (F.N.)	Badrinath	11	On foot.
	A. (A.N.)	Pandukeshwar		
24-10-49	D. (F.N.)	Pandukeshwar	8	Do.
	A. (A.N.)	Joshimath		

Itinerary of the Expedition Party which visited Lokpal and Badrinath—concld.

Date	Arrival/ Departure	Place	Distance (Miles)	Remarks
25-10-49	D. (F.N.)	Joshimath	8	Inspected Meteorological Observatory at Tapoban.
	A. (F.N.)	Tapoban		
	D. (A.N.)	Tapoban	8	
	A. (A.N.)	Joshimath		
26-10-49	D. (F.N.)	Joshimath	9	On foot.
	A. (A.N.)	Gulabkoti		
27-10-49	D. (F.N.)	Gulabkoti	10	Do.
	A. (A.N.)	Pipalkoti		
28-10-49	D. (F.N.)	Pipalkoti	10	Do.
	A. (A.N.)	Chamoli		
29-10-49	D. (F.N.)	Chamoli	20	By motor bus.
	A. (A.N.)	Karnaprayag		
30-10-49	D. (F.N.)	Karnaprayag	21	Do.
	A. (A.N.)	Rudraprayag		
31-10-49	D. (F.N.)	Rudraprayag	41	Do.
	A. (A.N.)	Pauri		
1st and 2nd Nov. 49—Halt at Pauri for settling accounts with the coolies and packing of equipment.				
3-11-49	D. (F.N.)	Pauri	66	By motor bus.
	A. (A.N.)	Kotdwara		
4-11-49	D. (A.N.)	Kotdwara	..	By rail.
	A. (A.N.)	Delhi		

APPENDIX J

List of Abbreviations

1	U.P.	..	Uttar Pradesh
2	P.W.D.	..	Public Works Department
3	C.P.W.D.	..	Central Public Works Department
4	C.W.I.N.C.	..	Central Waterways, Irrigation and Navigation Commission
5	S.D.O.	..	Sub-Divisional Officer
6	I.M.D.	..	India Meteorological Department
7	a.s.l.	..	Above mean sea level
8	D.G.O.	..	Director General of Observatories
9	C.W.P.C.	..	Central Water and Power Commission
10	W/T	..	Wireless Transmission
11	R.L.	..	River Level

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