



Photo. Engraved & printed at the Offices of the Survey of India, Calcutta, 1914.

Kinthup, the explorer, who first explored the course of the Tsan-po through the Great Himalayan Range, 1880—1883.

RECORDS

OF THE

SURVEY OF INDIA

Volume IV

EXPLORATIONS ON THE NORTH-EAST FRONTIER

DURING

1911-12-13

PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BURRARD, C.S.I., R.E., F.R.S.

Surveyor General of India



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KINTHUP, THE EXPLORER, WHO FIRST EXPLORED THE COURSE OF THE TSAN-PO THROUGH THE GREAT HIMALAYAN RANGE IN 1880-83. (FROM A PHOTOGRAPH BY LIEUTENANT G. BURRARD, R.F.A., MAY 1914)	Frontispiece.
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REPORT OF THE ABOR EXPEDITION SURVEY DETACHMENT, 1911-12, AND OF THE ABOR EXPLORATION SURVEY DE- TACHMENT, 1912-13.

BY CAPTAIN O. H. B. TRENCHARD, R.E.

1. Survey operations extending over two seasons, were carried out in the basin of the Dihāng river by a detachment with the Abor Expeditionary Force in 1911-12 and by a detachment with the Abor Exploration Party in 1912-13. This report deals with the operations of both detachments.

2. Dihāng is the commonly accepted name of that portion of the Tsan-po river on the Indian side of the main range of the Assam Himālayas, *i. e.*, from the Eastern end of the gorge through the range to its junction in the plains of Upper Assam with the Dibāng and Luhit rivers; these three rivers forming the Brahmaputra.

Strictly speaking the river is only known locally as the Dihāng by the Miris who inhabit small villages on its banks near the confluence of the three rivers; throughout the whole of its course in Abor country it is almost invariably known as the Siang; while in Pemakoi-chen the inhabitants use the Tibetan name of Tsan (Po or Chu = river).

It may be noted that all the local names by which this river is known are merely adjectival; translated into English they all mean 'The Big River'.

To avoid confusion the name Tsan-po will only be used in this report to denote the river in Tibet proper; the name Dihāng will be used to denote the whole of the remaining portion of the river on the Indian side of the main Himālayan range.

After the Tsan-po leaves Tibet, by cutting its way through the Himālayas from west to east, about longitude 95°, in a gorge by what must be from all accounts of considerable length and so utterly precipitous as to make it impossible for any man or animal to traverse it, it enters the country of Pemakoi-chen, through which it flows roughly speaking in a south-westerly direction. Pemakoi-chen may be described shortly as the portion of the valley of the Dihāng between latitude 29° (south of which it is bordered by the Abor country) and latitude 30° (north of which the country of Pomed is situated). The valley is a narrow one, of an average width of 30—40 miles, being bounded on the right bank of the river by the well defined main Himālayan range and on the left bank by the equally well defined and regular watershed between the Dihāng and Dibāng rivers.

The northern limits of Pemakoi-chen are at present somewhat vague; our knowledge of them is confined to the information collected by the Political Officer in charge of the Abor Exploration Party from the inhabitants of the Southern Pemakoiba villages which were visited by the party in 1912-13. The surveys now being executed in this area by Captain Morshead, R.E., should however define the boundary between Pemakoi-chen and Pomed.

The only important tributary received by the Dihāng in its course through Pemakoi-chen appears to be the Chimdrū Chu, draining a considerable

This volume contains a narrative report of the survey operations in North Burma (1911-13), in the Mishmi and Abor countries (1911-13) and in the Miri country (1911-12). Towards the close of the survey work in 1913, Captain Bailey and Captain Morshead made their way from the Mishmi country across the Dibāng-Dihāng watershed and reached the Upper Dihāng. A report of their journey is not yet ready and cannot be included in this volume.

The work of the Survey detachments in 1911-13 was supplemented by that of Captain Pritchard's expedition to North Burma in 1911-12 and by that of Captains Pritchard and Waterfield's expedition in 1912-13, but the reports of these expeditions are not included in this volume.

Some idea of the value of the survey operations on the North-East Frontier in 1911-13 may be gained from a consideration of the fact that 28,000 square miles of hitherto unexplored country were surveyed.

In the following table are summarised the principal changes in the maps of the North-East Frontier that have been rendered necessary by the recent surveys of 1911-13.

Table showing the main tributaries of the Irrawaddy and Brahmaputra and the geographical changes which have resulted from the recent explorations.

Approximate Longitude.	Tributaries of the Irrawaddy.
98 15	1. <i>The N'maikha</i> .—The head-waters of the N'maikha, viz., the Tarūn Wang and the Nam Tamai, drain the country north-east of Hkamti Long. The Nam Tamai has been moved 15 to 20 miles westwards. Some smaller tributaries on the left bank of the N'maikha rise further east than hitherto shown, thus shifting the Salween-Irrawaddy watershed, and the Salween itself 8 to 10 miles further east, between latitudes 27° 0' and 27° 45'.
97 45	2. <i>The Malikha</i> .—Its head-waters drain the Hkamti Long and are formed by the Nam Tisang, Namkiu, and Nam Lang. Of these the two former have been moved westwards.
Tributaries of the Brahmaputra.	
97 0 (at Rimā)	1. <i>The Luhit</i> .—Its course has been considerably changed; the river runs north and south along longitude 97°. The position of Rimā is now in longitude 97° 3', instead of 97° 30'.
95 45	2. <i>The Dibāng</i> .—The whole basin has been explored. The main characteristic of the Luhit and Dibāng basins is the great depth and precipitous nature of the gorges, giving rise to waterfalls of extraordinary height in the lateral streams, as they fall into the main valleys; (e.g. the Detza falls, 3,500 feet in the Dri valley).
95 0	3. <i>The Dihāng</i> .—Greatest change is here. The general position has been shifted 20 to 30 miles eastwards. The north-east bend of the river round Namcha Barwa is 60 miles east of its old position. The Nagong Chu of Tibet shown by A. K. as flowing into the Dibāng has been found to join the Dihāng. The identity of the Tsan-po and the Dihāng has been established.
94 15	4. <i>The Subansiri</i> .—Its principal tributary, the Kamla does not rise north of the main range. Contrary to former ideas, the Subansiri itself is now believed to rise north of the main range, and to be identical with the Char Chu discovered by the Pundit Nain Singh in 1871.
94 5	5. <i>The Rangūnadī</i> .—The main feature of interest in this basin is the Apa Tanang country:—a wide flat valley, densely populated, at an altitude of 5,000 feet with cleverly irrigated rice cultivation. Remarkable for its complete dissimilarity to any other portion of the Miri hills.

The most striking geographical result of the operations has been the discovery by the Abor Survey Party of the peak of Namcha Barwa, 25,415 feet high. This is the highest known peak east of Kinchinjunga, and its discovery has taken geographers by surprise. Immediately east of Kinchinjunga is the peak of Chumalhari (23,930) and further east in Central Bhutān stand the twin peaks of Kulhakangri (24,740), but no peaks above 20,000 feet had been found in the Himālayas of Assam east of longitude 93°. The discovery that Assam possesses a peak almost equal in height to Nandā Devī (25,645) marks an epoch in the history of Himālayan explorations. The great peak of Assam far surpasses in height all the snow peaks visible from Mussoorie and Simla.¹

In 1907, I ventured to suggest the following problem for the consideration of future explorers² :—

“The Sutlej in issuing from Tibet pierces the border range of mountains “within $4\frac{1}{2}$ miles of Leo Pargial, *the highest peak* of its region; the Indus “when turning the great Himālayan range passes within 14 miles of Nanga “Parbat, *the highest point* of the Punjab Himālaya; the Hunza river cuts “through the Kailās range within 9 miles of Rakaposhi, *the supreme point* of “the range. It will form an interesting problem for investigation whether “the Brahmaputra of Tibet has cut its passage across the Assam Himālaya “near a point of maximum elevation.”

The problem stated above has now been solved; the Brahmaputra in Tibet has been found to cut its passage across the Assam Himālaya at the base of *the point of supreme altitude*, the peak of Namcha Barwa.

Much public interest has been aroused in the supposed existence of very high falls on the river Dihāng. It has even been predicted that falls of 4,000 or 5,000 feet would be discovered, but there have been no grounds for this belief. The Dihāng drops from 9,000 feet to 1,000 feet in what appears to be a distance of about 100 miles, but the Sutlej drops from 10,000 feet to 1,000 feet and it possesses no falls. The Ganges drops from 12,000 feet to 1,000 feet and there are no falls upon it. The average gradient of the Kālī in Eastern Kumaun is perhaps greater than that of any other Himālayan river, but there are no falls upon it.

The lengths of Himālayan rivers are always considerably greater than we imagine. We find two points on the course of a river, 50 miles apart, and we calculate the average gradient, but if we take into account the numerous loops and sinuosities of the stream, the length becomes doubled or trebled. Throughout the Himālayas cascades are innumerable and it is quite common to see a vertical drop at the point where a tributary joins its parent river, but only two instances have been recorded of a vertical drop occurring on the actual course of a main Himālayan river. The Indus drops 20 feet in one place north of Kashmir, and the Dihāng has been stated by the explorer Kintup to have a small vertical fall in Tibet.

The success that attended the survey operations of 1911-13 on the North-East Frontier is to be attributed mainly to the perseverance of the officers and surveyors. The country is perhaps the most impassable in the world. The Karakoram and the Hindu Kush have presented great difficulties, and their forms have only been represented on maps by surveyors after much hardship

¹ This peak was seen by Explorer Nem Singh in 1879, and by Explorer Kintup in 1881, and by Captain C. L. Robertson, R.E., from the Mishmi side in 1900; but Lieutenant G. F. T. Onkes, R.E., and Lieutenant J. A. Field, R.E., were the first to determine its height in 1912.

² See Sketch of the Geography and Geology of the Himālaya Mountains and Tibet, page 160.

and privation. But in some ways the mountains of the North-East Frontier are more difficult than those of the North-West. They are pathless, trackless and covered in places by thick jungle. Throughout the year they are liable to be obscured by rain and mist and clouds, their rivers and streams are more permanently torrential. Though the reports in this volume say little of hardship, yet the Survey officers have had great natural obstacles to surmount. Their determination to push on to the sources of rivers and to the summits of passes and peaks, their ability and readiness to seize opportunities for survey work and the good spirit that has pervaded the detachments and enabled them to co-operate, have brought the operations to a successful conclusion. The satisfaction with which we regard the surveys of these hitherto unknown regions is clouded by the losses sustained; Captain Pritchard of the General Staff was drowned in the Tarūn in 1913, and Captain Pickthall of the Burma Military Police died of malaria in Hkamti Long.

REPORT OF THE NORTH BURMA MISSION SURVEY DETACHMENT, 1911-12, AND OF THE NORTH BURMA EXPLORATION SURVEY DETACHMENT, 1912-13.

BY CAPTAIN E. B. CARDEW, R.E.

This account deals with operations extending over two seasons, carried out by detachments accompanying the civil officers Mr. J. T. O. Barnard in seasons 1911-12 and 1912-13, and Mr. F. V. Clerk in 1912-13. The civil officer's party, military police escort and survey detachment taking part in the operations were in 1911-12, styled alternatively as the Hkamti Long Expedition or the North Burma Mission, and in 1912-13 as the Hkamti Long Expedition and the N'mai Hkamti Expedition or, combined, as the North Burma Exploration Survey. All plane-table sections, records, etc., have been entitled by the latter of the above-mentioned alternative titles for each season.

2. Before the explorations of 1911-12 our knowledge of the basins of the Malikha and N'maikha was obtained from Previous Explorations and Surveys. the following sources:—

- (i) Wilcox and Burlton's journey in 1826, when they entered Hkamti Long by the Hpungan pass and travelled as far as Manchi (Man Se).
- (ii) Woodthorpe and Macgregor's journey to Hkamti Long in 1884-85 when they entered by the Chaukan pass and visited Langnu, Langdao and Putau.
- (iii) Errol Gray's journey, and the survey made by his surveyors, in 1885-86, when he entered Hkamti Long by the Chaukan pass and extended his travels into the Nam Tisang valley.
- (iv) Hobday's survey with a frontier expedition in 1890-91, which included a part of the Malikha valley up to latitude 26°.
- (v) Prince Henri of Orleans' journey from Talifu to Sadiyā in 1895-96, on which after passing near the junction of the Tarūn and Tamai rivers, he must have entered Hkamti Long just north of the Nam Hat, crossed the Nam Tisang and Namkiu valleys, and, it appears, passed into Assam by the Hpungan pass.
- (vi) Surveys made of the south-western part of the Malikha valley by surveyors Lachman Daji Jadu and Muhammad Naqi when with the Sana column in 1895-96.
- (vii) E. C. Young's journey from Yünnan to Assam in 1905-06, on which he crossed both the N'maikha and Malikha at about latitude 26° 15', proceeded north to Langnu on the southern border of Hkamti Long, and went on into Assam by the Chaukan pass.
- (viii) A survey made by surveyor Dan Singh who travelled with Pottinger in the N'mai Hkamti valley between latitudes 25° 45' and 26° 45'.
- (ix) Survey made by Mr. Hayat Muhammad and Surveyor Shaikh Muhammad Salik in the N'maikha valley between latitudes 25° 45' and 26° 15' on the Hpimaw expedition in 1910-11.
- (x) The expedition to Hkamti Long in 1910-11, when the route followed passed through the Hkahku tract of the Mali valley.

- (xi) Captain Bailey's journey from Pekin to Sadiyā in 1911 on which he followed a route which touched on the head waters of the N'maikha.
- (xii) A map published by J. Hansen of Paris, showing, amongst routes of various explorers, that of Grillières, who in 1903 travelled from the Salween into the Ahkyang valley at about latitude $27^{\circ} 15'$ and also up the Nam Tamai to about latitude $27^{\circ} 50'$; also that of Barcot who followed a route in 1907-08 which, near the headwaters of the N'mai Hkamti, coincides in part with the route followed by Bailey in 1911.

The map of Hkamti Long as shown on the old Survey of India sheets was apparently compiled from surveys made on the first three of the above-mentioned journeys, but it is not evident whether the surveyors with Errol Gray executed an entirely independent survey or added to that made by Woodthorpe, but the Survey of India map is practically identical with the map attached to Errol Gray's report. The map proved to be a generally fair representation of the country, but owing to an error in scale the extent of the country as shown was too great; in the detail the outlying parts of the survey were more in error than the central part, as was to have been expected from our knowledge of the route followed by the surveyors with Errol Gray. The map would not have been of sufficient accuracy for an extension of the survey to have been carried on from it without engendering large errors.

The areas covered by the surveys referred to in items (iv) and (vi) above have not been re-surveyed; slight alterations have had to be made to them to adjust them to the new work.

3. Our knowledge of the geography of the head-waters of the Irrawaddy has been considerably extended in the last two years; the northern parts of the valley of the Tarūn Wang are still unmapped and the extreme north of the valley of the Nam Tamai has been only approximately surveyed, but with the exception of these parts our knowledge is, geographically, fairly complete.

A part of the margin of the survey made on the North Burma Exploration adjoins that of the Mishmi Mission survey of 1911-1912 (*i.e.*, the part between longitudes 97° and $97^{\circ} 10'$); only about 15 miles of the range bounding these surveys was common to both.

Of the passes between Assam and Hkamti Long the position of the Kong Dzong pass was fixed in season 1911-12; the positions of the Chaukan and Hpungan passes were previously known, the latter however was crossed by the late Captain Pritchard in 1912, and its position as fixed by the surveyor accompanying him has been shown on the new survey.

The position of the Talok pass between the Luhit and N'maikha valleys was fixed in season 1912-13; the pass shown on the Mishmi survey of 1911-12 as the Talok should, it seems, be known as the Salti pass, and is said to cross over a subsidiary range; the relative positions of these two passes as shown by the combined surveys are believed to be correct.

The chief routes between Hkamti Long and the N'maikha valley have now all been surveyed. The most northerly is that over the Saunglam pass, the most southerly that over the Shingrup Hkyet (pass); between these other routes cross the divide at Waipyi Madim, Long Makhū Razi and Hpalik Razi

(madim and razi = hill) ; these routes do not cross over ' passes ' but cross the ridge at almost its highest points.

The surveys made by detachments accompanying the Civil Officers' parties include the Salween-Irrawaddy divide between latitudes 26° and $27^{\circ} 45'$, and on Captain Pritchard's exploration the survey of the range was continued up to latitude $28^{\circ} 18'$; the positions of practically all the passes over it (within these limits) have been fixed, including that known as the Yuragan pass over which Prince Henri crossed in 1895-96.

4. The triangulation on which the survey is based was first carried up in season 1911-12 from a side of the principal triangulation near Myitkyinā for about two-thirds of the distance to Hkamti Long, chiefly by the method of fixing stations by observations to known points. The whole of the triangulation north of 27° is dependent on a measured base and an azimuth observed near Putau, and an astronomical latitude observed at Chaopa Moi Long h. s. In 1911-12 no triangulation was carried beyond the Malikha valley, but in 1912-13 observations were made from two stations on the Mali-N'mai divide; the most northerly point now fixed by triangulation is Ti-Inku on the Luhit Irrawaddy divide, in latitude $28^{\circ} 12'$ and longitude $97^{\circ} 33'$, and the most easterly are two peaks on the Irrawaddy-Salween divide in latitude $27^{\circ} 35'$, and longitude $98^{\circ} 23'$.

Triangulation.

A peak on the Hpungan range called Noi Isong has been fixed by observations from four stations; this peak is identical with that called 11 or Phungan 5 of the triangulation of No. 6 Topographical Party of 1884-85; and the values obtained for the co-ordinates of this peak are $10''$ greater in latitude and $4''$ less in longitude than the former values.

The intersected point Noi Isong and the stations of origin of the triangulation, viz., Singleng Bum H. S. and Marau Bum H. S., are the only connections between previous triangulation and that carried out on the exploration.

5. The country covered during the progress of the exploration is for the greater part covered with jungle. In the Mali valley, however, in the tracts occupied by the Kachins, one sees in some places large expanses cleared for cultivation; the *taungya* clearings are, however, quickly covered with jungle when allowed to fall into disuse. Again in the flat part of the valley of the Namkiu (Malikha) in Hkamti Long, besides large expanses of rice cultivation, there are considerable areas of grass land, a large part of which appears, at one time, to have been under cultivation; the jungle here is also prevented from intruding by the large demand for firewood and bamboos, which necessities have now to be brought into Putau from distances of three or four miles.

Description of the country and people.

The N'maikha valley appears from comparative accounts to be less densely covered with jungle than the Malikha valley. The Ahkyang valley is a comparatively open country, which may be accounted for by its relatively dense population; the Tarūn valley, east of Hkamti Madim, and parts of the Adung Wang and Tadzu Wang valleys are also more open country.

The N'maikha valley appears from comparative accounts to be less densely covered with jungle than the Malikha valley. The Ahkyang valley is a comparatively open country, which may be accounted for by its relatively dense population; the Tarūn valley, east of Hkamti Madim, and parts of the Adung Wang and Tadzu Wang valleys are also more open country.

Travelling in the valleys of the Nam Tamai and Tarūn Wang becomes a difficult matter even after a short period of rain, and not only difficult but dangerous at times for loaded men; a few carriers, not accustomed to those parts, have been injured by falling from the track, and this is hardly to be wondered at when they have to proceed by a track where even an unloaded man would have to use both his hands and his feet, pulling himself up at places

by suspended canes, at others climbing notched bamboos, where a slip may result in a fall of fifty or a hundred feet. Travelling in the rainy season would be quite impracticable for any one not prepared to make use of the rope bridges, for after two or three days' continuous rain the rivers become too swift to permit of rafting across them.

The principal tribes met with in the country surveyed are the Kachins or Chingpaws (the latter being the name which the Assamese pronounce Singpho), the Shans, the Nungs and the Lisus.

The Kachin country was passed through with mule transport so that there was little need to requisition coolies, the Kachins would however probably make very good carriers when brought more under control and taught that they must work when called on ; when on their own business one sees them travelling well with quite respectable loads.

Kachins.

The country occupied by the Shans is limited to the flat part of the Nam-kiu valley, with the exception of a small and very recent settlement in the Tisang valley the jurisdiction or influence of the *Sawbwas*, however, extends considerably further eastward and even into the valleys of the headwaters of the N'maikha. The Shans of Hkamti Long are not men to be admired ; since their migration from the Mogaung district they seem to have lost all their manly qualities and now fear all their neighbours except the Nungs toward whom they act as petty tyrants. The Kachins find them an easy prey and take what they want from them (chiefly cattle) without meeting any serious opposition. Many of the coolies employed were Shans, the greater number of whom worked practically under compulsion ; their dislike to the work was perhaps partly due to their objection to their being placed on a level with, and having to do the same work as a Nung. The drawbacks one has to contend against with Shan coolies are that they require constant supervision, that they will if they get the chance, eat half as much again as any other man, and that one must be prepared to provide them with opium as soon as their own supply is consumed, as they are opium eaters to a man.

Shans.

The Nungs (or, as the Shans call them, Khunungs), make most excellent coolies as they are extremely hardy and work without compulsion. Many of the Nungs have good features, some of a somewhat aquiline type. Of those who have come more in contact with the Shans, some appear to have deteriorated in physique, especially those who have acquired the habit of eating opium. Although on the average the individual Nung is physically superior to the Shan, the latter has, it seems, when they have come in contact, always held the former in subservience. The policy of the Nungs of these parts has apparently always been to move away from their neighbours when hard pressed, or to submit to their exactions, rather than to withstand them.

Nungs.

The Lisu is of a Mongolian type, and although called by the Shan a Chenung, *i.e.*, a Chinese Nung, he has no resemblance to a Nung. The Lisus are of an authoritative and independent disposition, and like the Shans, treat the Nungs as their servants. A number of Lisus were employed as carriers in the Ahkyang valley and being sturdy men they made good coolies, but they did not work willingly and had to be constantly watched to prevent their running away.

Lisus.

A small but interesting clan were met with in the Seinku Wang valley. They have very recently migrated from Tibet and according to one account they were eager for news of the Dalai Lāma ; in their shrines were seen many small clay images, and they use rosaries made of hard brown seeds, like small beans, threaded on strings.

6. The personnel of the Survey detachment of season 1911-12 is given in

Operations during 1911-12.
 PERSONNEL.
 Lieutenant E. B. Cardew, R.E., Assistant
 Superintendent in charge.
 Lieutenant W. E. Perry, R.E., Assistant
 Superintendent.
 Mr. Hayat Muhammad, K. S., Sub-Assistant
 Superintendent.
 Surveyors :—
 Shaikh Muhammad Salik.
 Sheo Lal.
 Nain Singh.
 Khan Muhammad.
 Karim Bakhsh.
 and 44 khalasis.

the margin. This detachment assembled in Myitkyinā early in November (except some of the surveyors, who joined later) in order to have time for some preliminary triangulation prior to the setting out of the expedition, which was to leave Myitkyinā early in December.

During November Lieutenants Cardew and Perry made observations from Singleng Bum H. S. and Nkai Bum h. s.

and fixed several peaks on the Kumon range and near the proposed line of advance, the furthestmost being some 70 miles north of Myitkyinā. The computations for these were completed before the expedition started.

The Survey detachment left Myitkyinā on December 9th, but the complete expedition was not ready to leave Weshi, three marches north of Myitkyinā, till December 19th.

During the march to Putau no halts were made for survey purposes, the object being to arrive in Hkamti Long as early as possible, in order to have the maximum time available for the more important work to the north and east. Plane-tabling was kept up along the line of advance, and as only one board could be employed this work was allotted to Mr. Hayat Muhammad. He was able to carry on his plane-tabling up to latitude 27°; north of this the continuity of the work was broken, this being due to the nature of the country passed through and to restrictions imposed for military reasons. Lieutenants Cardew and Perry carried on the triangulation up to latitude 26° 50' by means of five stations fixed by observations to known points. From the northernmost station at Bumbkang a few rays were observed to hills in Hkamti Long.

Putau was reached on January 13th and Mr. Barnard at once commenced making arrangements with the Shan *Sawbwas* for collecting coolies and supplies for carrying on the work.

In order to fix new points for the survey, Lieutenant Cardew cleared a station on Chaopa Moi Long and Lieutenant Perry one on Ho Ngam On, from which hills it was thought that known peaks in Assam would be visible. The position of Chaopa Moi Long was however fixed by an observed latitude combined with an observation made from Bumbkang, and as the Assam peaks could not be identified with certainty, the relative positions of the two stations were fixed from a measured base near Putau, combined with azimuth observations. From these two stations the main hilltops of the Namkiu-Nam Tisang watershed were fixed, which provided sufficient points for the surveyors to start. This preliminary work was not completed till February 5th, the observations having been much delayed by bad weather.

During this period Mr. Barnard had arranged with Captain Oldfield (the

officer in charge of the escort) that parties of military police should proceed eastwards to open up the tracks across the Tisang valley to render them fit for mule transport. One party went out under Captain Pickthall and one under Subadar Harkraj Limbu, and their work was most useful, as it enabled rations to be sent out later with greater facility than would have been the case if only cooly transport could have been used. During this period also Mr. Hayat Muhammad retraced the last two or three marches of the road by which the expedition had come, and was able to fill in some of that part which was left unsurveyed on first coming up.

All the surveyors started out from Putau on February 7th; Mr. Hayat Muhammad and Surveyor Sheo Lal went

Distribution of work.

into the Tamai valley by the Saunglam pass, the latter worked up the valley and the former down the valley and up that of the Tarūn; Surveyor Shaikh Muhammad Salik went into the N'maikha valley by the Hpalik Razi route; Surveyor Khan Muhammad surveyed the upper parts of the Nam Tisang and Nam Hat valleys; Surveyor Nain Singh surveyed the Namkiu and Nam Lang valleys; Surveyor Karim Bakhsh surveyed the southern part of the Namkiu valley and also made a large scale survey of a site proposed for an outpost. Unfortunately February and March are not the most favourable months for survey work in those parts, and the surveyors who went into the Nam Tamai or N'maikha valley were so delayed by the weather that they had less than a month for work and in this period there was very little fine weather. The surveyors returned to Putau about March 26th.

Lieutenants Cardew and Perry each made two more triangulation stations but the weather was very unfavourable, and from the last station visited by each no results of practical use were obtained.

Surveyor Nain Singh, in his survey of the Namkiu valley, went up to the Kong Dzong pass by the route from the village of Lihpu; as he was the only member of the expedition who traversed this route his description of it was given to Captain Kemmis (Intelligence Officer with the expedition) for inclusion in the intelligence report.

The possibility had been considered of sending surveyors, on the journey back through the Malikha valley, by slightly divergent routes, but the start on the return journey was delayed unexpectedly for four or five days so no great deviation could be made, as the rations were only just sufficient when going by the direct route; on two occasions Mr. Hayat Muhammad made detours of a day's march, and was able to add considerably to the work done on the way up.

Theodolite observations were again made at Bumhakang with a view to improving the connection of the triangulation, but good observations could not be made on account of the haze.

The return journey from Putau to Myitkyinā was completed in twenty-seven days, including three halts of a day each, Myitkyinā being reached on April 29th.

7. In 1912-13 one survey detachment accompanied Mr. F. V. Clerk

Operations during 1912-13.

PERSONNEL.

With Mr. Clerk :-

Surveyors :-

Ram Prasad.

Tara Singh

and 4 khakasis.

for the survey of the N'maikha valley (south of the junction of the Ahkyang), and a second detachment accompanied Mr. J. T. O. Barnard to add what was possible *en route* to the survey of the

With Mr. Barnard:—

Lieutenant E. B. Cardew, R.E., Assistant Superintendent in charge.

Mr. Hayat Muhammad, K.S., Sub-Assistant Superintendent.

Surveyor:—

Nain Singh.

Amar Singh

and 14 khalasis.

Malikha valley to extend the survey of the headwaters of the N'maikha and to survey the Ahkyang valley. The personnel of these detachments is given in the margin.

Surveyors Ram Prasad and Tara Singh left Myitkyinā on September 1st and proceeded to Laukhaung where preparations were being made to advance up the N'maikha. After leaving Latk-

Mr. Clerk's detachment.

haung they went on to Hkrangkao from

the neighbourhood of which place they started their work about the 15th. They proceeded northwards by routes on the east of the main valley and surveyed the upper parts of the Ngawchaung, Mawng and Laking valleys. They then went up the Mekh valley, Tara Singh surveying the upper reaches of the Mekh, while Ram Prasad completed the valley of the Akung Rame, the large northern affluent of the Mekh Kha. From a pass the latter sketched a small portion of the Salween valley, but was unable to make any intersections.

They arrived near the junction of the Ahkyang about January 25th and on their return journey came down the main valley of the N'maikha, completing and revising the survey, and arrived at Hkrangkao about April 1st; they thence returned to Myitkyinā, reaching that place on April 27th.

From Laukhaung and northwards these surveyors worked with coolie transport, for which they engaged coolies locally at various villages *en route*.

The detachment which was to accompany Mr. Barnard assembled at Myitkyinā on October 7th with orders to be ready to start on the 10th; the

The main detachment.

start actually did not take place till October 26th. Owing to the large number of

transport mules employed to carry rations, the escort and transport had to be divided into two parties, the second party being two days' march in rear of the first; the whole of the survey detachment were with the civil officer in the first party.

The route taken to Putau was exactly the same as that followed the previous year, so that the only work possible on this part of the journey was small additions and revisions to the survey of the previous season. Some additional triangulation was done by Lieutenant Cardew, by which two more peaks on the Mali-N'mai divide were fixed (near the junction of the Ahkyang river with the N'maikha) which were of use in co-ordinating the work of the surveyors of the different detachments.

During the march to Hkamti Long the escort were considerably hampered by sickness, and much to the regret

Death of Captain Pickthall.

of everyone, Captain Pickthall (second-

in-command of the escort) succumbed to fever; by the time the whole expedition arrived at Putau the casualties from sickness had, in addition, amounted to one sub-assistant surgeon and five non-commissioned officers and men. Fortunately there were no serious cases of sickness in the survey detachment.

Putau was reached on November 29th and it was then found that the crops

Putau.

were not fully harvested; a delay on this account was feared, but sufficient coolies

and rice were collected for a start eastwards to be made by December 7th.

Mr. Barnard set out for the N'maikha and the Ahkyang valley by a route running roughly due east from Langtao, which was opened up for mule transport, and during the season Mr. Morrison (Assistant Engineer, Public Works Department) constructed a track, practicable for mules, over the Shingrup Hkyet and nearly down to the N'maikha. Mr. Hayat Muhammad accompanied Mr. Barnard, and during the season made considerable additions to the survey in the Tisang valley and the N'maikha valley, and surveyed the whole of the Ahkyang valley. For a short period he travelled with Mr. Clerk who travelled up the N'maikha and into the Ahkyang valley; he also met the surveyors of Mr. Clerk's party and examined their work to ensure a correct connection.

Distribution.

Mr. Barnard and Mr. Clerk encountered some opposition from a Chinese party who were exploring the Ahkyang valley but this did not seriously retard the survey work. Mr. Hayat Muhammad returned to Putau with Mr. Barnard's party on March 28th.

Surveyors Nain Singh and Amar Singh left Putau on December 7th with Captain Moir (Assistant Commandant, Military Police) who went by the route across the Nam Tisang, to Tasaku which had been partially cleared for mule-transport in the previous season; he extended the track to Tasewang where a depot was formed as it was found impossible to get the mules over the divide. A rather serious delay occurred after reaching this depot, owing to the muleteers refusing to push on with the convoy which was following with a month's rations. Nearly a fortnight was lost over this, as it was useless for the surveyors to go on without a full month's supplies to start with. However by January 10th they were able to start, and after crossing the divide Surveyor Nain Singh started up the Tarūn and Surveyor Amar Singh up the Tamai, and in spite of a good deal of bad weather they were able to complete the survey of the area as required by the instructions of Government, and even to go slightly beyond this; it was unfortunate that the time lost by the convoy prevented these surveyors from extending their work further; Surveyor Nain Singh was also unfortunate in being held up by snow on Hkandam Madim for over ten days. These two surveyors returned to the depôt at Tasewang on March 15th, and thence returned to Putau with Captain Moir.

Captain Cardew also proceeded by the Tasewang route carrying the triangulation up to the Mali-N'mai divide; for four weeks he had to employ his coolies, none others being available, for putting out an advanced depot on the Tarūn and forwarding supplies for surveyor Nain Singh's party. He returned towards Putau in March, visiting the previous season's stations to complete the connection of the triangulation, and arrived there on March 25th.

It was on December 23rd that news was first obtained of Captain Pritchard's party from Surveyor Khan Muhammad, who arrived in Putau having come by the Kong Dzong pass. Captains Pritchard and Waterfield later came over the Talok pass and down the Tamai and reached Putau on January 8th. They afterwards proceeded up the Tarūn, and in order that their surveyors should have the latest available work to continue from, it was arranged that Surveyor Nain Singh should give them a trace of his work when they passed him, as he would then be about to return.

Captain Pritchard's Party.

Altogether an area of 10,000 square miles was surveyed mostly on the scale of four miles = 1 inch ; the area triangulated being approximately 8,750 square miles.

Outturn.

The whole detachment having re-assembled at Putau in the last week of March they started with the civil officer on the return journey to Myitkyinā on April 5th. The most direct route was again followed, Myitkyinā being reached on April 29th.

REPORT OF THE MISHMI MISSION SURVEY DETACHMENT, 1911-12.

By CAPTAIN C. P. GUNTER, R.E.

1. Orders were issued for a Survey Detachment to accompany the Mishmi Political Mission which had been sanctioned by the Secretary of State to form part of a general scheme of operations along the North-East Frontier in connection with the Abor expedition. The portion of the frontier allotted to the Mishmi Mission extended from the Yamne-Sesseri watershed on the west to the Luhit-Namkiu divide on the east, containing the whole of the Mishmi Hills.

Programme of work.

PERSONNEL.

Captain C. P. Gunter, R.E., in charge.
Lieutenant H. T. Morshead, R.E.
Mr. Abdul Hakk, K.S.
Surveyor Alla Ditta.
Sub-Assistant Surgeon Ishwari Persad Sharma.
Ward orderly Chamman Singh and 32 khalasis.
In January Surveyor Anwar Singh with 4 khalasis joined the Nizamghat Column.

2. The detachment was formed on September 20th and the various members joined in Calcutta or Gauhati arriving in Kobo on the 8th October where the detachment had been ordered to proceed.

3. After spending ten days at Kobo in pouring rain the detachment proceeded to Sadiyā, the head-quarters of the mission. Here a halt of a fortnight was utilized in surveying the plains round Sadiyā, and on the 1st November the march to the hills *via* Tamei Mukh was commenced; but it was not until the 25th November that actual plane-tabling was started, by which time rations had been collected for the advance of the main column into the hills. Survey work was carried on independently of the movements of the main column, each plane-table being given a small escort so as to enable him to be free to move when he wished.

Commencement of operations.

The main column returned to Sadiyā by the third week of February 1912 and survey operations closed by the 5th of March.

4. The main column followed the old Mishmi path from Sadiyā to Tamei Mukh through the villages of Tashianliang and Salamgam and thence up the right bank of the Luhit as far as the Yepak river. The Chinese had planted a wooden boundary post at Menil Krai close to the Yepak river; beyond this the Mission did not go, but the survey was carried on as far as Samā village about 20 miles further up the Luhit valley.

A small detachment had been left at Nizamghat and it was the intention of the Political Officer to try and find a way back to the Dibāng river from the Yepak across the mountains to the north and west, and join the Nizamghat column up the Dibāng; but the nature of the country made this impossible and the column returned to Sadiyā by the same road as it had come. A small detachment with a surveyor explored the Delei and Dou valleys and separate escorts enabled the Ghalum, Lati, Lang, Tawa and Kharem valleys to be surveyed. The surveyor with the Nizamghat column surveyed up the Dibāng as far as Idipo village some few miles beyond the point reached by Captain Robertson in 1899-1900.

5. The country surveyed was of a most inhospitable and mountainous character; the main ranges, varying from 15,000 to 17,000 feet in height, drop in a distance of 4 or 5 miles to the level of the main valley (about 4,000 feet)

at Samā. The slopes of the gorge through which the Luhit cuts its way are often nearly 40° and the general fall of this river is over 40 feet a mile in the distance of 90 miles from Samā village to Tamei, where it debouches into the plains; it is practically a torrent for the whole of this distance.

Description of the country.

North of Dong village, the Dati falls a distance of 3,000 feet in three cascades into the main river.

It is almost impossible to climb out of the Luhit valley except up large streams such as the Ghalun, Lati, Delei, etc.; small streams such as the Namti, Yepak, Shet-ti, etc., are mountain torrents and quite impassable.

The mountain tops are a series of rock pillars, sometimes 200 or 300 feet high joined together by snow covered ridges. The shape of the main ridges prevented any view being obtained of the Tibet highlands supposed to exist to the north. The greatest difficulty experienced by the Survey was caused by the rainy climate and continual mists and clouds which were prevalent even on the finest days. During the four months only 38 days were experienced without rain.

The plains between Sadiyā and the hills, and the first range of hills up to the Tiding river, are covered with dense forest, as are also the hills between the Kharem river and the Luhit river as far as the Hali river; from here eastwards the forest grows thinner and from Minzong onwards consists almost entirely of fir and rhododendron. Above 10,000 feet there is very little forest growth, and the mountain tops appear to be entirely rock and precipice.

In January the snow line often came as low as 7,000 feet for a few days at a time, but 10,000 feet was usually the limit of snow.

A Miju Mishmi village consists usually of one or two long wooden houses built on piles; several families live in each house, they have dirty habits and are exceedingly poor. At first sight it appears wonderful that human beings can find a living at all in these wild mountains, but at the bottoms of the valleys where there is soil it is very fertile; crops of millet are also grown on hill-side clearings. Up the Delei valley the villages of Taroān Mishmis often have 20 to 30 houses, and they appear to be more prosperous and possess cattle and pigs.

6. The transport was entirely Nāgā coolies who were excellent in the low hills but proved quite useless above the snow-line, and were not properly clothed to stand intense cold.

Transport.

7. Triangulated points were carried as far as the Delei river watershed but the survey of the main valley beyond Minzong was carried out by means of a subtense-bar theodolite traverse, the azimuth being checked from snow-peaks to the south.

Triangulation.

8. The detachment completed 3,370 square miles of detail survey on the $\frac{1}{4}$ -inch scale, 1,010 square miles of $\frac{1}{4}$ -inch reconnaissance survey, 384 linear miles of 1-inch plane-table traverse, 22 linear miles of subtense-theodolite traverse and 21 linear miles of time and compass traverse. The triangulation fixed three new stations of observation and eighteen intersected points besides three interpolated stations with the object of testing the plane-table work near

Results.

Minzong: a small area round Walong and the Yepak camp was surveyed and mapped on the 2-inch scale.

The area surveyed has been provisionally mapped on the same scale in one sheet which includes also the former survey by Captain C. L. Robertson, C.M.G., R.E., in 1899-1900, a survey of the Nam Dapha valley by Ram Prasad who accompanied Captain Pritchard in 1912, and the Sesseri valley with new information as regards villages and streams compiled from the Nizamghat column report, 1912, the whole comprising 22 one-inch sheets falling in degree sheets 82P, 83M, 91D&H, 92A&E.

The map produced included 690 place names of which 370 were villages.

9. The principal places of interest fixed by the Survey were:—

- (a) Tibetan villages of Samā, Kahao and Rimā.
- (b) The Talok Dakhru 11,000 feet, the pass on the Luhit-Nam Tamai divide over which an easy track leads from the Luhit valley to the Nam Tamai.
- (c) The Kong Dzong pass leading from the Ghalum valley to Hkamti Long.
- (d) The G'lei Dakhru 12,820 feet over which a road leads from the Delei valley into the Rong Thod Chu.
- (e) The Kue Dakhru about 14,000 feet through which a road connects the Delei valley with the Ithun valley.
- (f) The trade route used by the Mijus leading from Wadong in the Luhit valley across the Lang valley joining up with the pilgrim road from Paras Ram Kund to Chongkham in Hkamti.

Other places of interest were:—

- (g) The Dati Falls where a stream falls 3,000 feet in three cascades into the Luhit river.
- (h) Tilam opposite Dong village where there is a spring of clear hot water.
- (i) Twin peaks Kakro and Chhichhadia heights 17,150 feet and 17,172 feet, two huge rock pinnacles between which a track is said to lead connecting the Dou valley with the Luhit down the Tho Chu.
- (j) Glo Hawei, a small lake about $\frac{1}{2}$ mile long and $\frac{1}{4}$ mile wide in the Kharem valley at an altitude of 3,890 feet.

10. The general health of the detachment was good but the weak ones amongst the khalasis soon felt the strain of hill climbing and remained behind at

Health.

various intermediate posts.

REPORT OF THE MISHMI EXPLORATION SURVEY DETACHMENT, 1912-13.

BY MAJOR C. P. GUNTER, R.E.

1. On the 12th September 1912 the Surveyor General issued orders for me to proceed to Calcutta and take charge of the detachment which would be detailed to carry on survey operations in continuation of last year's work in the Mishmi Hills: all arrangements for the field season to be made pending final sanction from the Government of India. Telegraphic orders were issued on the 6th October to proceed without delay with the detachment to Assam.

On the 10th October the whole detachment as detailed in the margin left Calcutta with all the necessary equipment, instruments and data. On the 13th October we arrived in Sadiyā; it took the whole of the 14th to get the kit across the Brahmaputra and on the 15th the

PERSONNEL.

Captain C. P. Gunter, R.E., in charge.

Lieutenant H. T. Morshead, R.E.

Mr. Abdul Hakk, K.S.

Surveyor Shaikh Muhammad Salik.

Sheo Lal.

28 khalasis (Hazaribagh.)

Joined later in Sadiyā, Sub-Assistant Surgeon
Zulfikar Hyder and a Ward orderly.

camp was pitched and instruments, etc., distributed.

2. The programme of work formulated by the Government of India for the detachment was as follows:—

Programme of work.

- (a) Surveys to be made of the Dibāng valley in continuation of the work done last season: of the Dri river to its source: of all the inhabited valleys leading into either the Dri or Dibāng rivers: and of the Sesseri valley to connect with the Mishmi and Abor surveys of last season.
- (b) In order to give the survey officers a clear appreciation of the points regarding which the acquisition of geographical knowledge is of the first importance, the following detailed instructions were communicated:—

To discover the course of the Dibāng river, and whether the Nagong Chu is one of its tributaries. To fix the main range of the Himālayas, north of the Dibāng river basin and the subsidiary ranges in the basin, particularly with reference to their junction with the range bordering the Taroān and Miju Mishmi country on the north-east (*i. e.*, the watershed between the Rong Thod Chu and the Delei).

As the extent of the Dibāng valley was entirely unknown and the whole country unexplored, it was impossible to know what area we might be called upon to survey. The Government of India had sanctioned a party of two Imperial officers and two surveyors, but in order to be in a better position to complete an area of larger extent than expected and knowing that one surveyor can only deal with one valley at a time in the Mishmi Hills I asked for the services of a third surveyor and this was granted.

3. On arrival at Sadiyā we found that no orders had yet been issued by the civil authorities for the formation of the exploration party and that Mr. Dundas, who was to have control of the two exploration parties in the Aber

and Mishmi country, had not yet received sanction to proceed with his arrangements. This was a severe blow to us as we realized that at the earliest the expedition could not be ready to leave Nizamghat, the advanced base, until the end of November. So in spite of the experience gained last year and the reports of all officers, in which it was urged that any operations in the Mishmi country should commence as early as possible in October, we were actually going to start at least a month later this year than we did last.

• 4. The work was distributed as follows :—

(a) Lieutenant Morshead to undertake all the triangulation of as much of the area as was possible for one man to do.

Distribution of work.

Captain Gunter to do the plane-tabling of the main valley and other valleys if necessary to the north.

Mr. Abdul Hakk the plane-tabling of the Sessleri valley, foothills west of the Dibāng river and the Ahui river.

Surveyor Shaikh Muhammad Salik to accompany Captain Morshead and help in clearing, etc., the first three hill stations, and then do the plane-tabling of the side valleys west of the Dibāng river. Surveyor Sheo Lal to carry out a large scale plan survey of Sadiyā itself, which was specially asked for by the political officer, and then the plane-tabling of the side valleys east of the Dibāng river.

Both Captain Gunter and Mr. Abdul Hakk were to carry 3" theodolites in case they might be in a position to help with triangulation.

(b) It was determined to make use of the present fine weather to push on at once with triangulation from the nearer range of hills, north of Sadiyā, using local labour. On October 18th Lieutenant Morshead, Mr. Abdul Hakk and Surveyor Shaikh Muhammad Salik left Sadiyā with bullock carts, accompanied by Mr. Ballantine, the Assistant Political Officer, *en route* for Nizamghat. The political authorities had issued orders for local labour from the nearer villages to be collected and be ready to go into the foothills. We foresaw that the success of the operations would depend almost entirely on the triangulation which Lieutenant Morshead would be able to accomplish during the fine weather in October and November from three stations on the first high range, so that every endeavour was made to enlist the sympathy of the political officers to help us in getting local labour to enable us to start work at once. The political officers were most anxious to push on our work and did everything they could ; but unfortunately Mr. Ballantine, the Assistant Political Officer, was called away from Nizamghat at a most critical moment and in consequence the Mishmi coolies did not turn up to take Captain Morshead and party into the hills.

The road to Nizamghat was found to be very much overgrown with jungle and the party did not arrive there until the 23rd October taking six instead of three days. On October 26th Abor coolies from Dambuk village arrived to accompany Mr. Abdul Hakk and enable him to survey the foothills round Dambuk.

(c) *Dambuk Party*.—This party, consisting of Mr. Abdul Hakk and 25 Military Police sepoy's under a Subadar, crossed the Dibāng in boats; during this operation one sepoy was drowned and several rifles lost owing to the upsetting of a boat, so it was decided not to continue the march but return to Nizamghat. On November 1st the same party again crossed the Dibāng and marched to Dambuk, 40 Abor coolies meeting them at the river opposite Nizamghat. Mr. Abdul Hakk continued plane-tabling along the foothills, on the 3rd he reached the Sesseri river, on the 4th Memosipo village and returned to Nizamghat on the 7th November. During this week he completed 300 square miles of new country and fixed the position of several large Abor villages which had not been visited by any Government official for many years. Dambuk proved to be a very large and prosperous village of 400 houses, and the other Abor villages were, Memosipo 100 houses and Siluk 200 houses. Although these Abors were friendly and did not actually interfere with the work, they did not put themselves out in any way to help Mr. Abdul Hakk, and it was only the presence of a strong escort which persuaded them to work for very high wages. Plane-tabling of the valley and lower hills was completed up to the Siku-Sibya watershed and a junction made with the Abor survey.

5. It had been settled that the triangulation should be started from Sajuba Hill (Sita h. s. height 11,649 feet) east of the Mahu pass and a lower hill called

Triangulation commenced. Breliangun (9,809 feet) west of the pass. A few Mishmis having turned up on the 28th October Shaikh Muhammad Salik started clearing the road to the Mahu pass but it was not until November 6th that sufficient Mishmis arrived to take on Lieutenant Morshead who started observing from Breliangun h. s. on the 10th and from Sita h. s. on the 13th. Bad weather had now commenced, and on the 19th snow storms necessitated a retirement from the bivouac at 10,250 feet below Sita h. s., causing the death of one Mishmi by being frozen and the abandonment of further observations. This was a very unfortunate beginning for the triangulation and was brought about entirely through the Mishmis not coming into Nizamghat when ordered on the 25th October. On the death of the man at Sita h. s. every Mishmi bolted and left Lieutenant Morshead and party to get back to Nizamghat as best they could; this was accomplished after much difficulty by short marches and continually returning for kit left behind at each stage. The result of the observations from these two stations was of great interest as not only were many points fixed on the northern watershed of the Dibāng basin but also Pemakoi mountain and some new peaks on the same range; and we now had a rough idea as to how far the Dibāng basin extended northwards.

At the beginning of November a company of Sappers and Miners and Pioneers arrived in Sadiyā and at once went off to Nizamghat to cut a road over the Maya Cliff, an obstacle which blocked the approach up the Dibāng gorge some 4 miles north of Nizamghat. After making 10 miles of mule road and bridging the Ahun and Absun rivers the Sappers and Pioneers were sent up the Lulit valley. On the 20th the first batch of coolies, 50 in number, arrived

in Sadiyā, but it was not until the first week of December that the coolie transport was complete and the whole force consisting of Major C. Bliss, Commanding Escort, Captain G. A. Nevill, Political Officer, Captain F. M. Bailey, Intelligence Officer, Captain Kennedy, Medical Officer, 4 British Officers, 350 Military Police and about 1,100 coolies assembled at Nizamghat. On November 28th, after completing and handing over to the political officer the 6-inch plan survey of Sadiyā, I left Sadiyā with Surveyor Sheo Lal for Nizamghat, moving with bullock cart transport. On December 2nd, Lieutenant Morshead left Nizamghat for Ede h. s. (6,340 feet), on the west bank of the Dibāng, and after completing his observations returned to Nizamghat on the 8th.

6. On December 4th Mr. Abdul Hakk accompanied the Sessleri Column which left Nizamghat for the survey of the Sessleri Valley under Captain F. M. Bailey, Political Department. About 100 Abor coolies came to Nizamghat to carry the rations of the party as far as Angatsi village and this was a great help as it enabled the party to advance by full marches for three days. On the 5th the camp on the Sessleri, east of Dibāng, was reached; on the 6th camp was pitched on an island in the middle of the river bed just above the junction of the Egadi stream, the next day Angatsi was reached after marching along the right bank of the river and crossing over a couple of miles south of Angatsi; beyond Angatsi the meeting daily convoy was established and the Abor coolies returned to their homes. On the 9th Ihili was reached. On the 10th the march was continued up the Siku river, the last fixing up the Siku being made on the 12th in some fields belonging to the Damro Abors, at a height of 3,840 feet. From here a track leads over the Baisha pass to Damro which can be reached in one march. Returning on the 13th Ihili was reached and on the 14th the party marched up the Sessleri to Ewalin, reaching Ardai village on the 15th, here a halt of one day was made to enable Mr. Abdul Hakk to climb a hill 8,643 feet and sketch in the head-waters. From Ardai village two tracks lead over the Sessleri-Ahui watershed into the Ahui valley at an elevation of 9,480 feet and 8,200 feet and Captain Bailey was anxious to continue the advance over one of these passes into the Ahui, but as it was rumoured that the Ahui Mishmis were not friendly and as they had never been visited before, the force at Captain Bailey's disposal at the head of his line was deemed not sufficiently strong, especially as the main column could not possibly reach the Ahui river in time to act as a containing force and cover his advance down that valley. On the 19th December therefore the party commenced the retirement, reaching Angatsi on the 19th. On the 20th Captain Bailey followed the main valley route *viā* Dambuk to Nizamghat while Mr. Abdul Hakk followed the high level track to Katopu reaching there on the 20th; here he remained one day owing to bad weather, in order to complete his work and on the 22nd returned to Nizamghat *viā* Simi village; thus bringing to a close a very successful little expedition. The Mishmis up the Sessleri were very friendly and anxious to help in every way; they appeared to be quite overawed by the Abors of Dambuk and could do nothing without their permission.

7. Shaikh Muhammad Salik who had already cut in points on distant ranges on my board from Sita h. s. Breli-angun h. s. and Ede h. s. left Nizamghat on

First advance up the main valley.

December 4th and resurveyed the main Dibāng valley as far as Kronli village. On December 9th Lieutenant Morshead accompanied by Captain Nicolay with an escort proceeded up the Dibāng river and crossing it at Kronli on the 12th climbed to Arundi h. s. (6,283 feet) completing his observations by the 16th.

On December 17th I left Nizamghat with Surveyor Sheo Lal and marched up the Dibāng taking over my board from Shaikh Muhammad Salik at Kronli on the 21st and started plane-tabling up the main valley. By December 27th the whole detachment was at Imbolin village ready to carry on work ahead. We had now got to the furthest point reached by the party that explored this valley last year and there was much speculation as to what the country was like on ahead, whether Mishmis would be friendly, etc., as no European had as yet seen the country north of the Ichi river and the Mishmis south of this river professed absolute ignorance of what there was north of it. In the meanwhile the supply of rations had completely broken down and it was decided that no forward movement of the main column could be undertaken for some time to come. Major Bliss, commanding the force, however was able to arrange for the feeding of small advanced parties, if they moved slowly, so as to enable the triangulation to be carried on without interruption. All coolies except those necessary for Captain Morshead and a few to enable my own party with two other British officers and some 30 sepoys to advance, were sent back with Mr. Abdul Hakk and the two surveyors to Nizamghat. By using Mishmi labour it was found possible to advance with this small party.

8. Captain Nevill, Political Officer, with Captain Nicolay and some 30 sepoys, crossed the Ichi river on December 30th and established an advance post at

Small advanced parties move forward.
 Angolin village. After completing his observations at Ehundi hills (7,364 feet) just above Imbolin, Captain Morshead moved forward on the 3rd January and reached his 9,000 feet camp on Achi hill on the 7th, seven days were spent clearing the station. On the 5th January I managed to collect some Mishmi coolies and by their help and by using the small meeting convoy which had been established, I left Imbolin and reached Angolin on the 7th.

New country seen from Achi hill.

On the 10th I moved up Achi hill and with Captain Morshead got a good view of the Matun, Dri and Tangon valleys on ahead of us.

The days spent on Achi hill were full of interest as we were fixing on the map of the world rivers, peaks and valleys which had not been seen or even heard of by Europeans: the views too were very fine and impressed on us the utter wildness of the country. Returning to Angolin on the 14th, I joined the advanced party with Captain Nicolay and by the help of Mishmi coolies, reached Etalin village, at the junction of the Dri and Tangon rivers, on the 17th. Captain Morshead completed his observations at both the Achi stations (10,433 feet and 9,560 feet) by the 18th and joined us at Etalin on the 20th of January. In order to allow of rations being collected at Etalin, it was necessary for the advanced party to make a halt here of a fortnight. Captain Mor-

Halt at Etalin.

head was seedy and required a rest and also had a week's computation work to do, so I took his coolies and started up the Tangon river on the 21st. The wet weather had now commenced in earnest and from this time onwards there were very few days on which one could set up the plane-table without having to protect it by means of a water-proof sheet stretched tent-wise on poles. I

went three marches up the Tangon and returned to Etalin on the 26th. All the Mishmis up this river appeared very friendly and anxious to please, but the curiosity of some of the ladies anxious to get their first view of a European was rather trying, especially when one was struggling to bathe and dress in a 30-lb. tent. On January 30th, Major Bliss and the other officers having arrived at Etalin, a conference was held to settle the future programme. The conclusions come to were :—

“Continue the main advance up the Dri valley as far as the Matun confluence and thence follow the Matun valley; the main column under Major Bliss to complete this valley and its tributaries whilst another column under Captain Nicolay was to go up the Emra valley: it was found that there were not enough coolies to maintain more than two survey parties and a triangulation party working simultaneously. I was to continue the plane-tabling up the Dri and Matun whilst Mr. Abdul Hakk accompanied the Emra column: Surveyor Sheo Lal to accompany me in case it might be found possible to survey some side valleys during the advance, while Shaikh Muhammad Salik remained at Nizamghat until it would be possible to free coolies from the main line and enable another side valley to be explored.”

During January a regular meeting system of convoys had been arranged from Nizamghat onward and rations were now being rapidly collected at Etalin for the main advance and at Angolin for the Emra party. On February 1st Captain Morshead left Etalin for Iliyi hills (9,928 feet) and completing observations on the 5th went by a short cut to Yuron village on the 6th.

9. On the 5th I accompanied the advanced party of the main column up the Dri: the going was slow as the road was very bad, progress being only some 5 or 6 miles a day, and we arrived at Yuron on the 9th, having established a meeting convoy system with Etalin. On the 11th Captain Morshead left Yuron for Tondondi hills (9,627 feet) and on the 14th I accompanied the advanced party to Ilupu village near the junction of the Dri and Matun; on the 15th the Emra party having collected sufficient supplies started up the Emra valley crossing the Dri river by a Mishmi suspension bridge at Aprunyi village. At

Halt at Ilupa junction of the Dri and Matun rivers.

Ilupu it was necessary to halt a week to enable supplies to come up and also to await the main body of the escort which had now been ordered up from Nizamghat. As no information about the country up the Dri could be obtained except that there were Tibetan villages there, peopled by Pohs, who were very fierce and went for every one on sight with a drawn sword, the Officer Commanding the Force did not consider it safe to proceed without a large escort; during the halt I moved about with a small escort and managed to survey a large tract of country and cut in many useful points on ahead. The country here was mostly cleared of jungle up to 7,000 feet elevation along main spurs which greatly simplified plane-tabling. On Tondondi hills Captain Morshead had a bad time as it snowed almost continuously, but one fine day enabled him to complete a large portion of the observations he wished to take and so, as the main advance had commenced, he thought it best not to waste any more time on this hill, and so left it on the 26th February following up the main column which he joined at Mipi post on the 1st of March.

10. On February 19th the main body of the escort arrived, and an advance was commenced on the 20th and continued by short marches up the Matun

Advance up the Matun river.

valley; I joined the main column on the 23rd and moved with it. On the 26th we reached the Imu stream and from a high spur obtained a view of the Tibetan village of Mipi, a very small insignificant hamlet, it appeared, and so it was arranged to cross the Matun next day and visit the village. The main column crossed the Matun on the 27th by means of a temporary foot-bridge (made by the Mishmis who had accompanied us) and on the 28th Mipi village was reconnoitred and found to contain only harmless Kambars and not the fierce Pohs that the Mishmis had given us to understand were there: on

Post established at Mipi.

March the 1st a post was established at the junction of the Matun and Andra rivers, just beyond Mipi village. Here a week's halt was necessary to collect rations for a further advance: a few fine days here enabled me to do a lot of plane-tying from several high fixings and Captain Morshead cleared and observed from a station in the vicinity, but unfortunately the weather did not allow him to see any new snow-peaks, nor could he get a view of the main range to the north up the Adzon river nor up the Andra. During the halt at Mipi Captain Bailey who is a good Tibetan scholar, managed to extract a good deal of useful information from the Tibetans about the Tsan-po and country north of the Andra and Adzon watershed, and it was here that the plan took shape of his crossing over into the Chimdru valley with Captain Morshead to unravel the mystery of the "falls" and course of the Tsan-po between Chamkar and Rinchengpung. It was interesting to discover that the name Pemakoi (Tibetan for promised land) which has been entered haphazard over different areas of the old maps of this part of the world, really refers to this valley of the Matun. Seven years ago some thousand Tibetans from Chimdru, on the strength of a prophecy that this was their promised land, came over the Andra and Yonggyap passes into Mipi and turned out the few Mishmis whom they found in the Matun valley. It did not take them long however to discover that this was not the land flowing with milk and honey that they expected and that the country could not maintain them. They had already left many dead along both the Andra and Yonggyap routes. Apparently all who could soon made up their minds to quit and return to Tibet, which they did by way of the Yonggyap, Dri and Jairu passes leaving many hundred dead along the various routes. A small party of 80 souls who were either too old or too feeble to travel, remained behind and with them a few able-bodied men: these now form the community of 60 who live in Mipi. The weather now was quite hopeless and the snow line had descended to 6,000 feet so that further triangulation was abandoned; fortunately I had managed, during the advance up the Matun, to fix a few points up the Andra valley, sufficient to enable plane-tying to be continued up that river. A conference was now held and it was settled that as the Tibetans were found to be such a small community and so

Arrangements for work in March and April.

friendly it was deemed safe to diminish the escort with the main column and so enable a party to proceed up the Tangon valley earlier than was expected. News from the Emra party had also reached us that they would be back at Etalin by the middle of March, it was therefore arranged that this same party should on completing the Emra work proceed up the Tangon valley;

in the meanwhile rations were to be collected at Etalin for this trip. The main column was to split up into two parties, one to go up the Andra and one up the Adzon and continue road making simultaneously. The points of importance to be fixed in this neighbourhood were the Andra and Yonggyap passes and the survey of the Andra, Yonggyap and Adzon rivers; Surveyor Shaikh Muhammad Salik was therefore called up to help me and Surveyor Sheo Lal was to go down the line to Etalin and undertake the survey of the Tangon valley while Mr. Abdul Hakk with a 3" theodolite would accompany the Tangon party and extend the triangulation in that direction.

11. On the 5th March Captain Hensley started up the Andra valley with his party road-making and a few days later the Adzon (Matun) party left Mipi road-making and laying out posts up the Adzon valley. On the 7th I proceeded up the Andra plane-tying and was followed a few days later by Captain Morshead and Captain Bailey, as soon as the former had done all he could from Mipi h. s. (7,056 feet). The advance up the Andra was very slow and difficult owing to incessant rain and snow and bad ground, only 3 or 4 miles a day being the progress made. On the 10th we got as far as it was possible for the Nāgā coolies to go and were snowed up in this camp at 7,000 feet altitude, for five days. The last fixing up this valley was made at an elevation of about 9,000 feet at a distance of about 130 miles from Nizamghat. It was intended that Captains Bailey and Morshead should make a dash for the Andra pass from the last post and fix it by means of a time and compass traverse, but the snow fall was so heavy that it was impossible for them to move. On the 16th the return journey was commenced in snow and sleet. Captain Bailey, however, instead of returning, moved up the Andra a few miles and found shelter in a cave where he remained several days waiting for the snow to stop, he eventually managed to get in another few miles of the track to the Andra pass and this proved most useful as it dispelled all doubt as to which valley the path actually followed. This trip up the Andra was the most mournful of the whole expedition, for, in addition to the disgusting weather conditions, we were continually coming across the remnants of the cooking pots, clothes and dried bones of the Tibetans who had died in this valley from exhaustion and starvation on their way from Chimdru to Mipi. On the 19th March we found that the road up the Adzon had been made for some 20 miles and that all was ready for our immediate move up there.

Surveyor Shaikh Muhammad Salik was ready here and on the 21st March the party under Major Bliss proceeded up the Adzon while Captain Hensley went down the line to the Dri-Matun junction to make arrangements for the rations and escort necessary for the trip up the Dri river.

12. Owing to the excellent road made by Lieutenant Lane the marching up the Adzon was very easy and a great relief after the Andra experience. Shaikh Muhammad Salik went up the Yonggyap valley to try and locate the Yonggyap pass, but in this he failed as he was driven back, after reaching an altitude of 2,000 feet, by heavy snow. Captain Morshead accompanied me with the idea of running a theodolite traverse up the narrow gorge of the Adzon, fixings were not to be expected as it was absolutely impossible to climb any of the hills on either side. The dense jungle however made such a traverse quite out of the question and so I had to have recourse to a range-finder traverse instead.

Captain Morshead returned to Mipi on the 27th, on his way to Agidzu h. s. (10,426 feet) with a view to fixing more points up the Dri valley. By the 29th of March I had continued traversing as far as the deep snow and precipitous nature of the river bed would allow me to go, and after making a last fixing at 8,850 feet in the stream at a distance of 141 miles from Nizamghat started the return journey. Luckily when at the lake on the way back we had a fine day, all the snow peaks shewed up and enabled me to cut in a lot of important details. On March 29th Shaikh Muhammad Salik returned to Mipi on his way to the Elon valley to put in a portion of the Mipi-Emra road not seen by me. On the 2nd April the whole party had returned to Mipi and on the 4th the retirement commenced.

13. It is now convenient to turn to the Emra party and their fortunes. Leaving Aprunyi on the 16th February the party under Captain Nicolay

Emra River Party. moved slowly up the valley by short marches, cutting their way through the

jungle along the Mishmi path and road-making as they went. They reached as far as one march beyond Asonli, the furthest village up the valley and returned to Etalin post on the 18th March. Continuous rain and snow made progress very difficult and Mr. Abdul Hakk was able to survey only the actual valley itself as far as he had gone; the sketching in of the snow ranges at its head was impossible owing to continuous bad weather. On account of continuous rain survey work was impossible until the 18th, so that Captain Nicolay was able to get ahead of Mr. Abdul Hakk and establish two posts. On the 20th of February Mr. Abdul Hakk after completing the work in the valley as far as Aihini climbed to 6,500 feet to try and cut in the distant main ranges; he then continued plane-tabling under very unfavourable weather conditions until the 28th, catching up the road-making party on the 21st. On February 28th a 9,000 feet hill was ascended and a view of the watershed west of the Emra was obtained. The last fixing up this valley in the river bed was at 4,459 feet at the Eken river on the 4th of March at a distance of about 100 miles from Nizamghat. The snow line now descended to 5,000 feet and it was snowing so continuously that it was decided to abandon any further advance up the valley and, if necessary, sketch in the head-waters of the Emra from the high range at Dshindi h. s. and Ayandi peak after the snow had diminished in May.

The Mishmis up this valley proved to be friendly but all the usual military precautions had to be taken throughout. The village of Ahalin was formerly in the Matun valley, but the Tibetans on their arrival at Mipi some seven years previously drove them out. The inhabitants of the Emra valley appear to be the only Mishmis who have established trading relations with the Mipi Tibetans. They had no communication with the Dihang people over the pass at the head of their valley, the last attempt made by them in this direction resulting in the annihilation of the whole party except one man.

14. On March 21st a party under Captain Nicolay with Captain Nevill,

Tangon River Party. Political Officer, left Etalin post to explore the Tangon river. Mr. Abdul Hakk and

Surveyor Sheo Lal accompanied it, the former to extend the triangulation and give points to the latter to carry on plane-tabling as far up the valley as possible, both up the Tangon and Edza rivers. The important points to be fixed were the Kaya pass, the main watershed of the two rivers, and to ascertain whether the Trem river, the head-waters of which were seen by Mr. Abdul Hakk last year,

flowed in to the Edza river or eastwards into the Rong Thod Chu. On the 23rd March, Mr. Abdul Hakk went up Anoya h. s. (6,240 feet) completing his observations on the 24th and Surveyor Sheo Lal started plane-tabling. On the 26th of March they started the climb to Ahongon h.s. (8,006 feet) completing observations on the 28th. On the 1st April both men went up Apongon h.s. (8,625 feet) and finished observations on the following day. On the 4th Chiyangon h.s. (10,284 feet) was cleared and observations completed on the 5th: the camp was pitched at 10,000 feet altitude in rhododendron and bamboo jungle and melted snow was the only water available; two nights were spent in this camp. Continuing plane-tabling up the valley both officers worked together and visited all stations at the same time so that the theodolite observations could be utilized at once by the plane-table. On April 9th Ekingon h. s. (11,532 feet) was visited and observations completed, the camp on this hill where two nights were spent was at 10,500 feet and water was obtained by melting snow in cooking pots. The pine and spruce forest reached as far as 8,500 feet, and above this to the very tops of the ranges bamboo and rhododendron were met with. On the 16th Marungon h.s. (9,926 feet) was reached the observations being completed in one day. The 19th April found them on Atuniyangon h.s. (11,354 feet) where observations were again completed in one day; this was the furthest station up the Tangon river, the snow line all this time being at about 9,000 feet altitude: the camp on this hill was at 10,000 feet in spruce and rhododendron forest and again the only water available was from melted snow. In spite of all the climbing done no view had yet been obtained of the main watershed nor had the end of the valley been seen. The weather all this time was very bad and continued rain and mist made survey operations almost impossible. On account of the bad weather Mr. Abdul Hakk decided to turn back and complete the Edza valley with the idea of returning to the Tangon in May when there would be more chance of getting fine weather and the snow line would have receded making the ascent of higher peaks possible. On the 20th of April the last fixing up the Tangon was made at 9,000 feet in river bed at a distance of about 130 miles from Nizamghat; here the party was turned back by heavy snow and the return journey commenced on the

Last fixing up the Tangon.

21st. On April 27th Tangon hill was ascended and observations taken at the lower station (9,482 feet). On the 29th the upper station (12,913 feet) was visited and observations completed on the 30th, the camp here was maintained at 12,500 feet in thick spruce and small bamboo forest, this forest continuing right up to the top of the peak where large trees were found, the only water available was from melted snow and altogether four nights were spent in this camp. From this hill a good view of the Edza main watershed and head-waters was obtained and also the whole of the Ithun-Edza divide was seen: the Makhri and Ipi head-waters were also seen from this station, but it was very disappointing to find that no view could be got of the Tangon head-waters or of the Kaya pass. Leaving here on the 1st May, Kado, the last post up the Edza, was reached on the 2nd at an altitude of 7,800 feet. On the 3rd the climb up Kelingon h. s. (13,773) feet was commenced and camp was pitched at 10,200 feet, on the 4th camp was moved up to 12,500 feet and from here work was carried on. From this station the main watershed of the Tangon was visible and one ray was also obtained to the Kaya pass. Wishing to get another ray to the Kaya pass and a still better view of the main ranges it was determined to

climb another higher hill to the north. On the 8th this higher peak was climbed and proved to be 15,073 feet. Unfortunately Sheo Lal had a bad fall on the summit of this peak and dislocated his thumb, he was obliged therefore to return to the 12,500 feet camp. Mr. Abdul Hakk nothing daunted pitched his camp on a convenient piece of ground just 100 feet below the summit and remained there one night. In spite of the exposed situation in deep snow and the intense cold the Gurkha coolies were prevailed upon, mostly through Mr. Abdul Hakk's good example, to remain at that high altitude and enable the necessary observations to be made. Mr. Abdul Hakk had taken over Sheo Lal's plane-table and cut in the main range at the head of the Tangon and confirmed the position of the Kaya pass. Unfortunately the peaks to which rays had been taken from Kelington h. s. (13,773 feet) were never seen

Main ranges seen from hill 15,073 feet.

from the 15,073 feet station owing to clouds which most annoyingly clung to them. On the second day so many coolies and khalasis were suffering from snow-blindness and frost-bite that it was found absolutely necessary to go down the hill as fast as possible to have the sick men attended to. There was no water or wood at the top camp, the snow was melted and wood had to be brought up from the 12,500 feet camp both for cooking purposes and for building shelters. Most unfortunately, owing to the main bridge over the Ithun river having been washed away, all men were on short rations and this exposure to cold and damp at such high elevations must have been most trying and the greatest credit is due to Mr. Abdul Hakk and the surveyor for their courage and determination to complete their work in spite of the greatest hardships. On returning to Kado camp on the 11th May the whole party commenced the retirement to Nizamghat, a distance of 110 miles where they arrived

Return to Sadiyā.

On the 29th they started for Sadiyā where they arrived on the 31st May.

15. We now return to the main column which had left Mipi on the 4th April and was retiring down the Matun.

Dri River Party.

On the 7th I left the column at Maron camp and cut across the downs to Akolin village on the left bank of the Dri where Captain Hensley had collected his force and rations ready for the exploration of the Dri river, which was crossed by a Mishmi cane suspension bridge. The rest of the column retired to Angolin post and here under Major Bliss made arrangements for the exploration of the Ahui river. On the 9th April the Dri party under Captain Hensley commenced the march up this valley. Surveyor Shaikh Muhammad

Ange Valley Survey.

Salik accompanied us as far as the Ange river where he left us on the 10th April for the survey of its valley and tributaries. He had with him a small escort of 3 sepoy and 18 coolies and managed to penetrate two marches up the gorge of this very wild and precipitous valley; continual bad weather hampered plane-tabling and it was not until the 21st April that he completed his work comprising 200 square miles of precipitous mountain sides and snow ranges and started down the line to Etalin post with a view to joining the Ahui party.

We continued our march up the Dri valley, crossing the Ange river by a Mishmi suspension bridge, and by moving half marches established a meeting con-

Advance up the Dri.

voy system as we advanced, large enough to carry one day's supplies for the whole party. On April 11th we passed Dembuen, the last village up this valley and from here managed to obtain a couple of Mishmi guides to show us the way to the Aguia pass reported to be at the head of the valley. The important work to be accomplished was the fixing of this Aguia pass and the main watershed at the head of the Dri and its tributaries. Up to Dembuen the marching had been quite easy along flat ground close to the river bank, but from here onwards the jungle became very thick and necessitated much labour in clearing even a two foot track. The valley contracted to a gorge with a few hundred yards of flat ground on each side of the river flanked by precipices rising straight up to a height of 2,000 feet to 4,000 feet. At the commencement of the march on the 11th I made my last reliable fixing (by resection from triangulated points) close to the village of Acheshon at a height of about 5,500 feet and from here onwards the survey of the valley was carried on by means of a range-finder plane-table traverse, checked at intervals by resection from previously fixed points. The gorge for 40 miles was so restricted and shut in by precipices on both sides that it was found impossible to climb out of the valley anywhere until the river bed had attained an altitude of nearly 10,000 feet; the several side streams flowing into the main gorge were a very fine sight as they were in full flood and leapt the 3,000 feet wall of rock in three or four magnificent cascades falling on to the narrow flats on the river bank with a tremendous noise. The last camp up the valley at the junction of the Jairu stream, nearly 8,000 feet altitude, was reached on 19th April in pouring rain; the weather throughout had been hopeless, continuous rain day after day, but luckily it cleared on the 21st and so I followed up the river bed for about 4 miles and made a last fixing at a height of

Last fixing up the Dri.

just under 10,000 feet near the river bank, on the snout of a snow avalanche and at a distance of 142 miles from Nizamghat. In a distance of $1\frac{1}{2}$ miles the river had risen from 7,500 feet to 9,500 feet in a series of cascades and falls. A very fine view was obtained of the Aguia pass and head-waters of the Dri and as deep soft snow made further progress impossible, after sketching as much as was visible, I returned to camp. The next day the rain came down again and it was decided to retire from this inhospitable spot and leave it free for the "Takin" to wander about in at their leisure. The Mishmi guide informed us that there was a track leading to Chimdru up the Jairu stream, but we found no signs of it. On the track up the Dri just opposite the junction of the Jairu we found a palisade of pine logs with loop-holes carefully cut, the Mishmi told us that this was constructed a few years back to protect Mishmis, going along the Aguia pass track from the attacks of Tibetans who used to frequent the Jairu valley. Captain Morshead who had reached Agidzu h. s. (10,425

Captain Morshead at Agidzu h. s.

feet) on the 15th April took five days to clear the hill top being continually interrupted by snow storms. The view from this station was very disappointing as none of the peaks at the head of the Dri, which he was specially anxious to fix, were visible. He left Agidzu on the 12th and marched to Aeolin post meeting us at a camp beyond Dembuen village on the 15th. Here we arranged that the best thing for him to do was to return to Yuron post and from there take rations, etc., for a prolonged stay on the range where he made the stations of Dshindi and Karundi; this we thought would be favourably

situated for a view not only up the Emra valley but also to the head-waters of the Andra, Adzon and Dri rivers. We also settled that after completing observations at Deshindi h. s. he would proceed to Mipi where Captain Bailey would be waiting for him prior to their starting for their exploration into Tibet over the Andra or Yonggyap pass and ultimate visit to the Tsan-po falls and return to Sudia *viâ* Tawang. On the 18th he camped with Captain Bailey on the right bank of the Dri at Epalin village, having crossed by a Mishmi suspension bridge, and on the 21st camped at 8,400 feet close to the hill where he was going to make Karundi h. s., while Captain Bailey marched up the Matun valley to Mipi village. On the 22nd of April he cleared Karundi h. s. (11,267 feet) and on the 23rd cleared and erected a pole on Deshindi h. s. (12,027 feet). Continual and heavy snow storms interfered with work and it was not until the 7th May that he managed to take a round of angles from Karundi h. s. In the meanwhile I had come down the line with Captain Hensley's party to Yuron post which we reached on the 27th April. Here Captain Hensley halted in order to make arrangements for the supply of rations up at our Karundi hill camp. On the 28th I crossed the Dri by the Epalin bridge and reached Captain Morshead's 9,000 feet camp on the 29th and did some work from Karundi h. s. Both Deshindi and Karundi were clear hill tops of pure snow some 12 feet deep and it was impossible to camp higher than 9,000 feet owing to the continuous snow storms and violent wind. Heavy rain and snow kept us imprisoned in our tents for six days when it cleared a little on the 6th enabling me to do some useful work in the lower portions of the Emra valley not visited or seen by Mr. Abdul Hakk. On the 7th snow peaks were visible up to 7 A.M. and a few theodolite observations were taken from Karundi. The 8th was a fine clear morning and we went up Deshindi h. s., but clouds hid all snow peaks by 8 A.M. and as it was a 3,000 feet climb over snow the whole way, there was not much time for observations as one could not start before day light. On the way up we had a fine view of Pemakoi and neighbouring peaks, but by the time we reached the station the whole Pemakoi range was hidden in cloud. We had very bad luck in that the peaks that were visible from Karundi were just the ones that were in cloud when we visited Deshindi and *vice versa*, and in consequence we failed to fix the few magnificent snow peaks of which we had glimpses at the head of the Dri valley. On the 28th April I received urgent appeals from Major Bliss to close down work and return to Sadiyâ owing to the hopelessness of the weather and shortage of rations, and again on the 5th May, a letter from him reached me reporting that the Ithun bridge had been carried away by floods and that all persons were to be put on short rations and that he could not send up any more rations until the Mishmis had constructed one of their suspension bridges across the Ithun. This I knew to be probably a long job and as we had rations sufficient to carry us on to the 16th May only, that must be the date on which we must reach Echindon where more rations could be obtained. We agreed therefore that the 10th May was the very latest date for us to remain at this camp as Echindon was six marches away. The 9th and 10th were cloudy and occupied in doing triangulation computations and by combining my plane-table rays with several theodolite single rays we managed to fix a few more distant peaks on the main ranges. The 11th was a fine morning and I went up Karundi hill and completed as far as was possible the survey of the main watershed north of the Andra and

Adzon rivers and as much as was visible of the head-waters of the Emra. By 10 A.M. three of Captain Bailey's coolies reached us from Mipi and with the help of three more of our coolies (it had taken several days of persuasion and promises of "bakshish" to induce these men to consent to go) Captain

Captain Morshead leaves for his Tibet exploration. Morshead equipped with a 3" theodolite and small plane-table left Karundi for

Mipi on his adventurous journey to unfold the secrets of the Tsan-po gorges. It was his intention to carry on triangulation as he went and keep up a plane-table survey on the 8-mile scale. On the 12th I marched down to Yuron post and with Captain Hensley reached Echindon post on the 17th May. Leaving

Retirement from Yuron.

him there to join the proposed one day raid up the Ithun valley, I continued the march down to Sadiyā where I arrived on the 22nd May. The march back from Mipi to the Ahsun river, one march short of Nizamghat, was a

Excellent coolie track constructed up the main valley. revelation in showing what can be done in the way of road-making by a few

sepoys and coolies under the guidance of efficient and keen British officers. With the aid of only a very few iron picks and shovels, with kukries, daos and picks made of hard wood, an excellent two-foot coolie track, with a good gradient and good surface had been constructed for 90 miles, down into deep gorges and then climbing over high spurs, which often necessitated twice in one march an ascent and descent of 3,000 feet through dense jungle. The track ran along the precipitous rocky hill-sides with galleries crossing the vertical face of a cliff and ladders up slippery rock faces twenty or thirty feet in height; so that instead of crawling along hanging on by one's hands to roots of trees, as was often necessary when advancing up the valley in December and January at a rate of 4 and 5 miles a day, now in May we returned jauntily by marches of 10 to 12 miles in length along a comparatively easy road which would be no disgrace to a civilized hill station. It was undoubtedly due to this good road that the supply of rations and communications was kept up intact for so many months without interruption in spite of the continuous heavy rain which was experienced from February to May.

16. We may now turn to the operations of the Ahui River Party. Owing

Ahui River Party.

to the rise in the Dibāng river it was found that the only means of crossing it was by a Mishmi suspension bridge: the nearest foot-bridge to the Ahui river of this description over the Dibāng is the one opposite Aprunyi village. It was therefore decided to cross by this bridge and going one march up the Emra valley strike across the Ahui-Emra watershed from Aihini village and enter the Ahui valley returning by the same route. On the 24th April, the party under Major Bliss with Captain Nevill, Political Officer, left Etalin and crossing the Dibāng at Aprunyi marched up the Emra to Epini post and crossing the Emra at Aihini climbed the watershed and crossed it at 7,000 feet elevation, establishing a post at Dupo village in the Bhui valley on the 1st May. Surveyor Shaikh Muhammad Salik who had reached Etalin on the 25th of April after the Ange river had been completed, left again on the 26th and joined the party on the 29th at Etalin village in the Ahui valley. On the 29th news had reached Major Bliss that the bridge over the Ithun river had been washed away by high floods and that rations could not be got across: he therefore with the Political officer left at once for the scene of the disaster and handed over the charge of

the party to Lieutenant Lane. The advance up the valley was continued by half marches at the same time establishing a meeting convoy system capable of carrying a day's rations for the whole party; the surveyor kept up with the party the whole way as far as Chepwe which was reached on the 8th May the furthest post up the valley; here he left the main party and with an escort of five sepoy continued plane-tabling up the valley for two marches and getting several fixings on a long spur from 8,700 feet up to 10,980 feet elevation, the head-waters, main watershed and Abroka pass were successfully cut in; his highest fixing in the river bed was at about 6,500 feet at a distance of nearly 120 miles from Nizamghat. Returning to Chepwe on the 13th the whole party

Furthest fixing up the Ahui.

retired on the 14th and reached Aokan. From Aokan Lieutenant Lane with the surveyor and a small escort climbed to Chunmunli hill (12,243 feet) reaching the top on the 14th after a long day's march. Unfortunately continuous rain and snow prevailed the whole time they were up this hill from the 15th to 18th and they were unable to get even a glimpse of the Emra head-waters and main watershed which they had gone up to see. On the 18th Lieutenant Lane received a letter from me in which I told him that I had managed to sketch in the main watershed at the head of the Emra and so on the 19th they left the hill top and returned to Dupo. The camp was pitched at a height of about 12,000 feet near the summit of the hill; a thin small bamboo, sticking out through the snow, was the only jungle growth at the camp site, wood was brought up from a spot about 500 feet lower down where there was rhododendron and oak forest, water was obtained by melting snow.

Leaving Aokan on the 20th the party reached Etalin on the 23rd and marching straight through reached Sadiyā on June 1st. Several large villages of 60 and 80 houses were found up this valley and the Mishmis proved very friendly. The road up the Ahui as far as the village of Chepwe was found to be rather easier than most of the Mishmi paths, but from here onwards the track over the Abroka is difficult and very rocky. There are four different passes from the Ahui to the Emra valley, two passes to the Sesserri valley at 8,200 feet and 9,478 feet elevation and one pass into the Inlu valley height 7,500 feet. The inhabitants of the Ahui valley seldom communicate with villages on the east bank of the Dibāng due probably to the fact that there is no means of crossing the Dibāng direct from the valley except by means of a single strand rope-bridge near the village of Engapo.

17. The full survey detachment having now arrived in Sadiyā, the equip-

Return to recess.

ment and instruments were packed up and sent to Calcutta, ordnance stores returned to Allahābād arsenal, and all menials paid off by the 3rd of June. On June 4th the whole detachment left Sadiyā and crossed the river Brahmaputra in the launch *Rover* and on the 5th entrained at Saikhoa Ghat for their various destinations. The superior establishment was attached to the office of the Superintendent, Eastern Circle, and arrived in Shillong on the 6th and 7th of June where the mapping of the field work was to be undertaken.

18. The whole programme as laid down by the Government of India was completed and the work done may be recapitulated in a concise form as follows:—

Work done.

(a) The course of the Dibāng river has been traced to the source of each of the five large rivers which constitute the main Dibāng: the

Nagong Chu is not one of its tributaries but flows in a north-westerly direction from Shuiden Gom-pa and according to Tibetan information, obtained at Mipi village, joins the Tsan-po (Dihāng) some 11 or 12 marches north of Rinchengpung.

- (b) The whole basin of the Dibāng except the Ithun valley, has been surveyed and the main watersheds from which all the rivers in the Dibāng emanate have been fixed; these watersheds are some 280 miles in length, of this 190 miles have been rigorously surveyed and 90 miles sketched in accurately enough for geographical purposes. The watershed forming the exterior boundary of the Mishmi country has therefore been completely surveyed connecting with the Abor survey on the west and the North Burma survey on the east: this again also completes the programme of work as laid down by the Surveyor General to be carried out by the Mishmi Mission Survey in 1911-12.

The areas completed by the party are :—

Detail survey $\frac{1}{4}$ -inch scale	8,523 sq. miles.
Reconnaissance survey $\frac{1}{4}$ -inch scale	945 „ „
	Total $\frac{1}{4}$ -inch scale
	4,468 sq. miles.
Plan survey 6-inch scale	4 $\frac{1}{2}$ „ „

The number of heights including both clinometric and triangulated is 1,050 which gives an average of nearly one height to every 4 sq. miles of survey so that the contouring should be a good representation of the ground.

In order to give an idea of how much actual work may be expected from surveyors on such expeditions as these, I enumerate below the length of time spent on plane-tabling by each individual.

Duration of expedition from arrival in Sadiyā to departure from Sadiyā is eight months :—

Major Gunter	4 $\frac{1}{2}$ months.
Mr. Abdul Hakk	6 $\frac{1}{2}$ „
Surveyor Shaikh Muhammad Salik	3 $\frac{1}{2}$ „
„ Sheo Lal	3 „

The chief reasons contributing to the inability of utilizing the services of surveyors continuously were :—

Supplies and transport were not ready until six weeks after the arrival of the survey party.

The necessarily slow progress of a large force entering a difficult and wild country due to road-making, etc.

The necessity of establishing a daily convoy system in touch with the base during the advance. The paucity of coolies, even after advanced ration bases had been established, did not allow of more than two plane-tabling parties and one triangulation party working simultaneously.

19. The whole of the area under survey was triangulated by Captain Morshead, and he fixed peaks on the entire main watershed except those portions north and east of the Dri river and north of the Tangon river. This is

a fine record for one observer without help of any sort from a recorder or computer, under such trying weather conditions as prevailed throughout. Mr. Abdul Hakk supplemented the triangulation up the Tangon and Edza valleys, but owing to bad weather failed to extend it to the main ranges. The total number of stations of observation is 25 and intersected points 180. Captain Morshead completed the computations of almost every triangulated point within a few hours of the observations having been made and sent the results to plane-tablers long before the latter required them. As most of the computations were carried out while camped in snow and under very trying conditions it can be realized what a fine record Captain Morshead has to show for his season's work.

20. When we found ourselves in the Luhit valley last year we thought that we had found the wildest and most precipitous country in India, but we

were yet to visit the Dibāng gorges. The

Nature of the country as affecting the work. precipices and mountain slopes up the Luhit, after having seen the gorges of the Dri, Tangon and Adzon rivers, pale to insignificance. The road up the Dibāng was one succession of dips down into deep gorges and ascents up over high spurs; for instance the march from Angolin to Imbolin entailed a climb of 2,000 feet, a descent of 1,500 feet, another climb of 2,000 feet, a descent of 2,700 feet, and a third climb of 3,100 feet, *i.e.*, a total climb of 7,100 feet, and descent of 4,200 feet; and again the road from the Emra to the Ahui was a continuous climb of 5,000 feet, during the first march over the watershed. The only piece of country approaching flatness in the whole 4,500 sq. miles is the "Downs" at the junction of the Dri and Matun, 3 miles long by $1\frac{1}{2}$ miles wide.

The greatest difficulty presented to the plane-tableer owing to the precipitous nature of the country was that of recognizing triangulated points; ranges consisted of innumerable snow peaks close together and much alike in profile; looking up at them from down below one could never be sure whether the peak visible was the triangulated point on the main range itself or merely the near end of a spur jutting out from the main range. Up the gorges of the Adzon and Dri fixings by resection were impossible and survey up both these rivers was carried on by means of a range-finder traverse with quite satisfactory results: in Annexure A I have written a few notes on the use of the Barr and Stroud range-finder which was used. Throughout the country as a whole plane-table fixings could not be obtained without a climb of 2,000 feet to 3,000 feet from the valley road, but in the neighbourhood of the villages the main spurs and the southern side of mountain slopes were usually found to be cleared of jungle, so that fixings were always possible after a climb. Higher up the rivers beyond the villages dense forest was met with on all hill sides and spurs from the river bed right up to elevations of 12,000 feet and sometimes 13,000 feet and here of course fixings were difficult to obtain. Without doubt an interesting feature of the country in the Dibāng basin is the unusual steepness of the river gradients. From Nizamghat up the main valley to the junction of the Ahui river the rise is 300 feet in 23 miles, a gradient of over 13 feet a mile.

Torrential nature of all the rivers.

From the Ahui junction to the Tangon junction the main river rises 800 feet in 13 miles or a grade of 61 feet a mile. From the junction of the Tangon to the junction of the Dri and Matun rivers the rise is 1,630 feet in 14 miles or a grade of 116 feet per mile.

The Tangon rises 2,850 feet from its junction with the Dri to the Edza junction, a distance of 24 miles, a grade of nearly 120 feet per mile.

The Alui rises 4,000 feet from its junction with the Tangon in 30 miles or a grade of 133 feet per mile.

The Adzon rises 3,000 feet in 17 miles or a grade of over 180 feet per mile.

The Dri from the Matun junction to the Ange junction rises 1,200 feet in 12 miles, a grade of 100 feet per mile while in its upper reaches the Dri drops 2,000 feet in $1\frac{1}{2}$ miles.

It is not surprising therefore that the Dibāng river rushes through the gorge at Nizamghat with such terrific force.

21. The weather, being a very important factor on the North-East Frontier in survey operations, should occupy a prominent place in every report. Up to January 15th it was very favourable and clear cloudless days were the rule; only periodical storms lasting two or three days were experienced but after this date the weather broke up and continuous rain, snow and mist predominated up to the very last day of the expedition. The record from 15th January to 15th May when all work was practically completed is as follows: Cloud and mist 38 days, continuous rain 62 days and clear fine days, when snow peaks were visible, only 21 days. To get only 21 days of fine weather in four months was rather a trying experience, especially to a triangulator. The patience, endurance and professional ingenuity of every member of the party were taxed to their utmost by the disgusting weather conditions and by the enclosed, precipitous and snow bound nature of the country. It would be difficult to imagine worse conditions for survey operations than prevailed throughout the season from January to May.

22. The health of the party was good throughout and the Hazāribāgh tindals and khalasis, with the exception of a few men in the triangulation squad, did very well. One khalasi suffered from frost bite in both feet, but he was recovering rapidly before he left and amputation will probably not be necessary. One of my khalasis fell down a precipice, but was fortunately caught up in a tree some 80 feet down and on being rescued informed every one that he was "dead."

23. A list of principal places of interest fixed during the season is shown in Annexure C.

ANNEXURE A.

Notes on the use of the Barr and Stroud Range-finder as a traversing instrument.

The instrument used by me was of the F. T. type with direct image, obtained by the Mathematical Instrument Office from the makers at very short notice last year; it unfortunately arrived too late to be used in the Mishmi survey of 1911-12. The ordinary stand supplied with the instrument was not used; the Mathematical Instrument Office constructed an adaptor by means of which the instrument was used on the stand supplied with my 3" theodolite; this proved a very satisfactory arrangement. The image being magnified 14 times it was very necessary for accurate work to have a firm stand. The great advantage of the range-finder for traversing is that one can use objects on the far side of an impassable river as a forward point; being on the far side of the river also makes the object easier to keep in sight while proceeding to the forward station. My usual procedure was to pick out an object with a straight vertical line, such as a tree trunk or edge of a white rock in a cliff, etc., about $1\frac{1}{2}$ miles ahead, taking care that the object would also be visible from the forward station. Having ranged this, two other objects were also ranged, and entered in the traverse book, in case the first object might not be visible from the forward station—ranges to hill tops, etc., should also be taken—the plane-table being set up rays are drawn to each of these ranged objects, distances plotted and carefully marked and the necessary vertical angles taken with the clinometer. While moving forward it is easy to keep the object in sight, but after it has been passed it is usually found that the object disappears in the most annoying way and for this reason it should be high up and well above the tops of trees in the foreground. Having settled on the new station from which the back object is visible and a good view forward can be obtained, the same procedure of ranging, etc., as at the first station is followed. Observed distances of $1\frac{1}{2}$ miles on the $\frac{1}{4}$ -inch scale having an elevation of 10 degrees or more require a correction to obtain the correct horizontal distance. On the back of my Wahab's Height Indicator were pasted:—

- (a) A scale of feet. (b) Height correction up to distances of 147,000 feet. (c) Correction per 1,000 feet for observed distances up to a slope of 35 degrees. In traversing up narrow gorges, such as are met with in the Mishmi country, many of the forward rays may be at a slope of 30 degrees so that the ordinary survey clinometer should be supplemented by the small military pocket clinometer which is quite accurate enough (reads $\frac{1}{4}$ degree) for short rays.

2. As regards instrumental adjustments, etc., I found that halving adjustment was necessary practically every time the instrument was taken out of its case, the jolting after being carried even for only a couple of miles upset this adjustment. For short ranges up to $1\frac{1}{2}$ miles the mean of three observations is quite sufficient, but for longer ranges such as 6 or 7 miles, five or seven observations are necessary. It is best to range with the right eye only and then read the scale with both eyes open. Coincidence adjustment was necessary only once during the season after the instrument had been tested and set on the roof of the Mathematical Instrument Office, Calcutta. The various

mirrors and lenses kept wonderfully clean throughout the season in spite of the intense damp and they were not touched by me once in the eight months.

Every survey party working on the North-East Frontier should have one of these instruments in case work has to be carried up long narrow gorges where the ordinary methods of plane-tabling and traversing are impossible. It is certainly the most rapid method of traversing that I have so far experienced;

ANNEXURE B.

Notes on coolie transport, etc., for the North-East Frontier.

Experience of the last two years shews that the best coolies for the North-East Frontier hills are "Nepalese", the next best are "Gurkhas" and "Gurkhalis" and for work on lines of communication in low ground "Nāgās" are useful. "Bhotiās" are bad as they cannot negotiate the hill climbing and are too slow and also cannot cut jungle. All coolies accompanying a survey party must be fully clothed on the "winter" scale with boots, putties and socks, etc. A supply of green gauze for issue to coolies and khalasis while working in the snow should be taken to prevent snow-blindness.

It is useful to note that whereas up the Luhit valley all Mishmis take opium in preference to money and for money they prefer four anna pieces to rupees, up the Dibāng valley opium is useless and all money should be in rupees and not small coin. Up the Dibāng Mishmis are fond of "rum" and village headmen become quite communicative and pleasant after a few "tots" of it; they also prize a good large briar pipe, the larger the better, and warm cloth.

ANNEXURE C.

The chief places of interest fixed by the Survey were :—

(a) The main watershed of the Dibāng basin separating it from the rivers to the west, north and east, about 280 miles in length, all of which was previously entirely unknown and consisting of snow ranges varying in height from 14,000 feet to 19,000 feet.

(b) The Tibetan village of Mipi in the Matun valley.

(c) The following passes :—

Baisha.—Leading from the Sesseri river to Damro on the Yamne
Height approximately 5,000 feet, river—1 march.
always open.

Abroka.—Leading from the Ahui river to Simong on the Dihāng
Height approximately 12,900 feet usually open except in
February and March. river—3 marches.

Andra.—Leading from Mipi village on the Matun river to
Height approximately 12,500 feet open from middle of April
but the rivers are not passable during the rains. Rinchengpung, Dihāng valley, and
Chimdru — 4 to 5 marches.

Yonggyap.—Leading from Mipi village on the Matun to Chimdru
Height approximately 13,000 feet open from end of May,
but road not passable during the rains. in Tibet. Mipi to Chimdru is about ten
marches. Captains Bailey and Mor-
shead went over this pass to Chimdru.

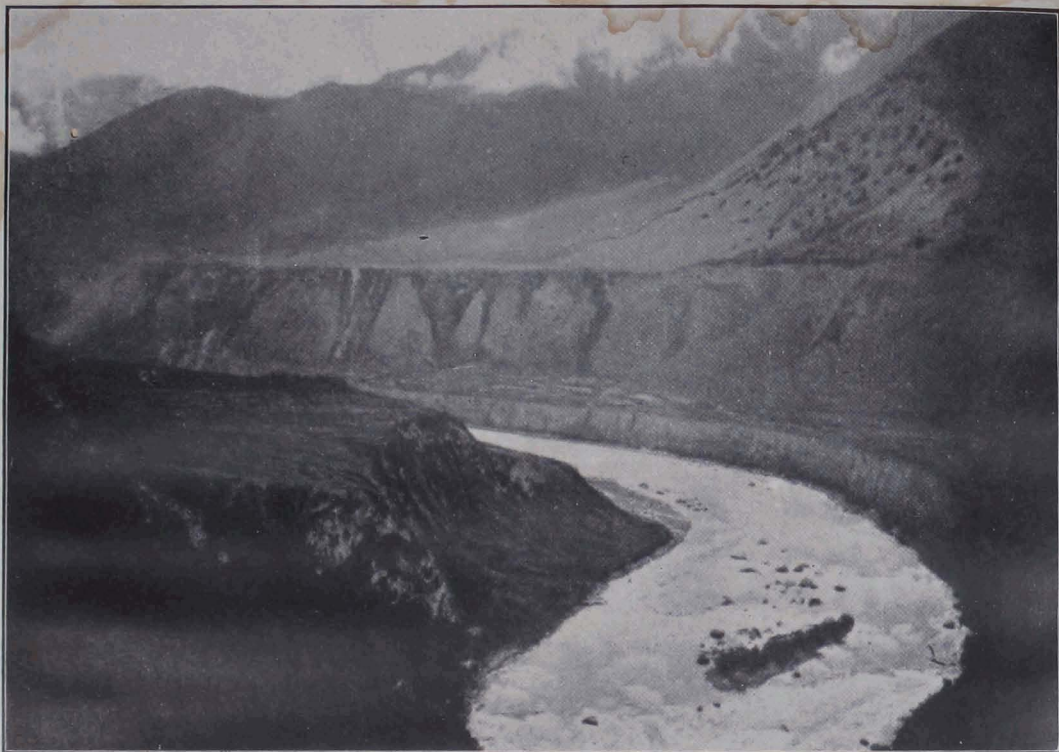
Aguia.—Leads from the Dri river to Ruipu on the Rong Thod
Height approximately 17,000 feet open during November
only. Chu, pass to Ruipu is four marches,
seldom used and is in permanent snow.

Kaya.—Leads from the Tangon river to Alupu on the Rong Thod
Height approximately 15,700 feet open in November only. Chu, reported one march. None of the
passes except the Baisha are passable
for troops or large bodies of men with-

out many days' road-making, and then only in fine weather.

(d) Many magnificent water-falls and cascades up the Adzon and Dri gorges and at Yuron village, varying in height from the Yuron fall, 1,500 feet to the Detza falls on the Dri over 3,500 feet.

VIEWS ON THE TSAN-PO FROM PHOTOGRAPHS BY
CAPTAIN F. M. BAILEY I.A.



View up stream from right bank of TSAN-PO near KYIKAR village. These are the first rapids below PE.
Taken on 15th July 1913.



View of rapids on the TSAN-PO looking up stream from NYUKSANG.
Altitude 8,730 feet.
Taken on 20th July 1913.

VIEWS ON THE TSAN-PO FROM PHOTOGRAPHS BY
CAPTAIN F. M. BAILEY, I.A.



Falls on TSAN-PO near PEMAKOI-CHEN from a point 100 feet above the water on the right bank.
Altitude of top of fall 8,380 feet. Height of fall about 30 feet.
Taken on 21st July 1913.



Falls on TSAN-PO near PEMAKOI-CHEN, from the water level on the right bank.
Altitude 8,380 feet. Height of fall about 30 feet.
Taken on 21st July 1913.

REPORT OF THE ABOR EXPEDITION SURVEY DETACHMENT, 1911-12, AND OF THE ABOR EXPLORATION SURVEY DE- TACHMENT, 1912-13.

BY CAPTAIN O. H. B. TRENCHARD, R.E.

1. Survey operations extending over two seasons, were carried out in the basin of the Dihāng river by a detachment with the Abor Expeditionary Force in 1911-12 and by a detachment with the Abor Exploration Party in 1912-13. This report deals with the operations of both detachments.

2. Dihāng is the commonly accepted name of that portion of the Tsan-po river on the Indian side of the main range of the Assam Himālayas, *i. e.*, from the Eastern end of the gorge through the range to its junction in the plains of Upper Assam with the Dibāng and Luhit rivers; these three rivers forming the Brahmaputra.

Strictly speaking the river is only known locally as the Dihāng by the Miris who inhabit small villages on its banks near the confluence of the three rivers; throughout the whole of its course in Abor country it is almost invariably known as the Siang; while in Pemakoi-chen the inhabitants use the Tibetan name of Tsan (Po or Chu = river).

It may be noted that all the local names by which this river is known are merely adjectival; translated into English they all mean 'The Big River'.

To avoid confusion the name Tsan-po will only be used in this report to denote the river in Tibet proper; the name Dihāng will be used to denote the whole of the remaining portion of the river on the Indian side of the main Himālayan range.

After the Tsan-po leaves Tibet, by cutting its way through the Himālayas from west to east, about longitude 95°, in a gorge by what must be from all accounts of considerable length and so utterly precipitous as to make it impossible for any man or animal to traverse it, it enters the country of Pemakoi-chen, through which it flows roughly speaking in a south-westerly direction. Pemakoi-chen may be described shortly as the portion of the valley of the Dihāng between latitude 29° (south of which it is bordered by the Abor country) and latitude 30° (north of which the country of Pomed is situated). The valley is a narrow one, of an average width of 30—40 miles, being bounded on the right bank of the river by the well defined main Himālayan range and on the left bank by the equally well defined and regular watershed between the Dihāng and Dibāng rivers.

The northern limits of Pemakoi-chen are at present somewhat vague; our knowledge of them is confined to the information collected by the Political Officer in charge of the Abor Exploration Party from the inhabitants of the Southern Pemakoiba villages which were visited by the party in 1912-13. The surveys now being executed in this area by Captain Morshead, R.E., should however define the boundary between Pemakoi-chen and Pomed.

The only important tributary received by the Dihāng in its course through Pemakoi-chen appears to be the Chimdru Chu, draining a considerable

side valley of the same name, which joins the left bank of the Dihāng just north of the village of Khapu in latitude $29^{\circ} 30'$. Several large mountain torrents drain the eastern slopes of the main range and join the right bank of the Dihāng during its course through Pemakoi-chen, but none of them are large enough to be termed tributary rivers. The largest of them is the Sirapateng (Sigong) river which forms the southern boundary of Pemakoi-chen (as claimed by the Pemakoibas, although there are three Abor villages north of this river) on the right bank. A slightly larger stream called the Yang Sang Chu forms the boundary between Pemakoi-chen and Abor country on the left bank of the Dihāng, which it joins about 10 miles north-east of the Sirapateng confluence.

South and west of these two boundary rivers the whole basin of the Dihāng is inhabited by the various tribes commonly called Abor.

From the Sirapateng confluence the Dihāng flows nearly south-east to latitude $28^{\circ} 30'$; thence in a more southerly direction to the Siom confluence about latitude $28^{\circ} 15'$, whence it again trends east and south-east until it debouches at Pasihat (latitude $28^{\circ} 4'$) from the Abor hills into the plains on the north bank of the Brahmaputra river.

Dihāng basin.

After leaving Pemakoi-chen the basin of the Dihāng widens out considerably, two large valleys of the Siom and Yamne being situated on either side of the main valley. Both these important tributaries join the Dihāng before it debouches into the plains. The Siom is by far the larger of the two; rising in the main range of the Himālayas in latitude 29° it flows to the west of and roughly parallel to the Dihāng as far south as latitude $25^{\circ} 12'$ whence it turns east for about 20 miles before joining the Dihāng near the village of Yekshing.

The Yamne is a considerable river which rises in the small range (jutting out west about latitude $28^{\circ} 45'$ from the main Dihāng-Dibāng watershed) that forms the divide between the valley of the Yang Sang Chu and the valley of the Yamne.

Yamne river.

It flows to the east of the Dihāng, to which it is for the most part roughly parallel, and joins it below the trade post of Rotung in about latitude $28^{\circ} 10'$.

The Dihāng basin is thus bounded on the west by the well defined watershed between the valley of the Siom and that of the Subansiri river to the west; on the east it is bounded by the range which divides Pemakoi-chen and the Yamne valley from the basin of the Dibāng river to its east.

The range which forms the Dihāng-Subansiri watershed takes off from the main Himālayan range in latitude $28^{\circ} 50'$ and longitude $94^{\circ} 0'$, the junction being marked by a clump of three snow peaks all over 16,500 feet in height, and runs in a south-easterly direction down to about latitude $28^{\circ} 0'$ where it merges into the outer range.

The range which forms the Dihāng-Dibāng watershed has not been surveyed yet north of latitude $29^{\circ} 30'$; it is not certain therefore whether it actually joins the main Himālayan range. Between latitudes 29° and $29^{\circ} 30'$ the direction of this range is from south-west to north-east; south of latitude 29° it runs almost due south down to latitude $28^{\circ} 15'$ where it also merges into the outer range.

This outer range is a remarkable feature which runs for many miles parallel to the north bank of the Brahmaputra and at a distance of 20—40 miles from it. It averages between 3,000 to 6,000 feet in height, and slopes very steeply to the plains of the Brahmaputra. Forming the southern boundary of the Dihāng river basin proper it completely shuts off all view

of this basin from the Brahmaputra
valley. The Dihāng has cut its way
through this range at Pasighat before issuing into the plains of the
Brahmaputra.

The Outer range.

The main range of the Assam Himālayas forms the northern boundary of the Dihāng basin from longitude 94° on the west to the big gorge in longitude 95°. North and east of the gorge the direction of the range has not yet been defined, and very little is known about the valley of the Po Tsang Chu which drains Potodh, Pomed and Poyul and which constitutes the extreme north-eastern portion of the Dihāng basin.

3. Pemakoi-chen is inhabited by a race of people very similar to their neighbours in Tibet proper on the other side of the main range.

They are undoubtedly emigrants from Tibet, but appear to have been settled in the Dihāng valley for a considerable time, as I understand their language is a very distinct variation of Tibetan spoken in the Kongbu district of Tibet.

Inhabitants of the Dihāng basin.

Pemakoi-chen appears to be a separate district of the Po country, to the headman of which, called the Po Khanem living at Shawa in Pomed, taxes are remitted by officials who are appointed by him and reside in Pemakoi-chen for the purpose. It is doubtful whether the Po Khanem is a Tibetan official or not; I understand that all the latest evidence points to the fact of the Po country being entirely independent of Tibet.

Pemakoi-chen is certainly not connected officially with the neighbouring Kongbu district of Tibet in any way, although a good deal of trade passes between the two districts over the Himālayas and the Pemakoibas seem to understand and talk the Kongbu dialect well.

The Pemakoibas are sturdy well-built people and much cleaner than either the Tibetans or the Abors between whom they act as middlemen in the matter of trade. They have attained (or perhaps not yet lost) a fair degree of civilization, and utterly despise the Abors whom they call Lobas. The Abors call them Menbas (the Abor name for a pure Tibetan being Mimat).

Pemakoibas.

The Pemakoibas dress in Tibetan fashion modified for the heat of the Dihāng valley, and their religion is the same as that of Tibet. As a rule the Gom-pa (place of worship) is the only masonry building in each village; the houses being built of boards with well made shingle roofs and raised off the ground on timber posts or masonry pillars. All the carpentering shows a considerable degree of skill.

The Dihāng valley does not lend itself to easy cultivation, but the Pemakoibas terrace and irrigate their rice fields wherever possible, and even their jhūmed fields on steep hill sides are properly ploughed and all the paddy transplanted dry. They are open, cheerful and friendly people; but could probably put up as good a fight as the Tibetans if necessary, being armed with bows and arrows, the long straight sword, and a certain number of matchlocks and ancient pistols.

Tibetan coinage is current in Pemakoi-chen and seems a fairly well understood medium of exchange. No difficulty was therefore experienced in persuading the Pemakoibas to accept Indian rupees, at the rate of three of their own *tankas* to a rupee. Eight and four anna pieces did not seem as popular as the rupee, but were accepted. Assamese silk cloths are the most popular articles of gift.

The Abors are very dissimilar from their northern neighbours, although presumably of the same Mongoloid extraction. The irruption of their ancestors from the highlands of Tibet into the Dihāng valley must have taken place several centuries before that of the Pemakoibas, and in the meantime they have certainly lost all traces of any slight civilization they may have possessed originally.

The chief reason for their present state of savagery appears, to be the peculiar political (if such a term can be used) organization which prevails all over the Abor country. The only political unit is the village; there is no real tribal organization, although the country is divided into several more or less defined sections which, for lack of a better definition, might be termed tribal areas.

In some of these tribal areas there is one dominating village which by its wealth or numbers of fighting men can impose its orders on the other villages of the same tribal area, but in other areas there are two or more big villages of equal importance which seem far more disposed to quarrel with each other than to combine against the villages of another tribal area. In fact the only features which appear to distinguish the various tribal areas as such, are the separate dialects of each and the intermarriage in the different sects of all the villages in each area.

The more important tribal areas may be roughly defined as follows:—

- (1) The Simongs, so called by the name of the most important village of the group, occupy the left bank of the Dihāng from the Yang Sang Chu (Pemakoi-chen boundary) in the north down to about latitude $28^{\circ} 30'$ and stretch over into the north-west corner of the Yamne valley. This is perhaps the most important group, though not the largest numerically, in the whole Abor country.
- (2) South of the Simongs, on the left bank of the Dihāng and stretching across the Dihāng-Yamne divide into the Yamne valley, are the Pangis, a small tribe which seems closely allied to the Simongs and undoubtedly has to take orders from the head village of Simong.
- (3) On the right bank of the Dihāng, immediately south of Pemakoi-chen, is a group of seven villages, the two most important of which are Janbo and Bomo, the most southerly. This group does not appear to have a tribal name.
- (4) South of Bomo on the right bank of the Dihāng are the Karkos, a small group of four villages, of which Karko is the most important.
- (5) South of the Karkos are the Minyongs, who inhabit a small portion of the Siom valley, a few villages on the left bank of the Dihāng south and west of the Pangis, all the right bank of the Dihāng

(including the Shimang valley) south of latitude $28^{\circ} 30'$ right over the outer range into the foot hills just above the north bank of the Brahmaputra.

This Minyong tribe is the largest numerically, but there are a number of large and powerful villages in it which do not pull together. Of these *Riga* is the largest village and *Dosing* (at the mouth of the Shimang valley) the most powerful.

- (6) The Yamne valley is mainly inhabited by Padams, who also thrust a wedge into the Dihāng valley between the Simongs and Paṅgis and stretch across the outer range into the foot hills between the Dihāng and Sesseri rivers. This is a large tribe and the head village of Damro is the largest in the whole Abor country.
- (7) The Boris occupy the head-waters of the Siom valley down to about latitude $28^{\circ} 36'$. As all the Bori villages have not yet been visited it is impossible to say which is the most important.
- (8) The remainder of the Siom valley and the valley of the Simen river, the only river of any size on the south of the outer range between the Dihāng and Subansiri rivers, are occupied by a number of cognate sub-divisions which in the bulk are known as Galongs. The largest village in this area is Kombokong, in the south-east corner of the Siom valley.

In all these areas each village is entirely self-contained and independent except in so far as it has to take orders from some neighbouring and more powerful village. As the only method of

Agriculture.

cultivation known to the Abors is by *jhūming*, it follows that each village requires a large area of land to enable it to exist; hence the villages are all at a considerable distance from one another, and there seems to be little communication between the villages. A *jhām* (not an Abor word, but one commonly used all over Assam) is a clearing in the forest used for cultivation. As the only iron instrument the Abor possesses is a dao, this forest clearing is a matter of infinite labour.

The crops raised are rice, maize, and millet; the last principally for brewing apong, a mild and unpleasant intoxicant of which the Abors drink inordinate quantities.

Not more than two or three crops can be raised in successive years from the same soil, as the principle of manuring is unknown; so patches of forest have to be cleared in rotation, trees and jungle being allowed to grow on each clearing again after it passes out of cultivation until its turn comes round again.

Industry in all matters agricultural seems to be the Abor's one redeeming feature. In other respects he possesses all the usual traits and vices of the savage. His fighting qualities are not very conspicuous, but his intense hatred and suspiciousness of strangers combined with a full measure of treachery will make it unsafe to neglect military precautions when travelling through the Abor country until it has been brought under proper political control.

The village has already been mentioned as the sole political unit of the Abor country. A village may have one or more Gams (headmen), but these dignitaries do not seem to have any real power other than that they may acquire by wealth, force of character, or a large following of fighting men in the village. An Abor village is one of the most democratic institutions in the world,

The Abor village.

and exhibits all the effects of unrestrained democracy. Every matter, however trifling, is referred to the *Kebang* (village council) which all men and most boys seem at liberty to attend and at which they all talk at length. If the *Gam* or *Gams* be strong enough they can sway the *Kebang*; otherwise they are merely the mouthpieces of the temporary majority in the *Kebang*.

This system of self-government does not tend to simplify the dealings of outsiders with the Abors.

These are further complicated by an extraordinary system of octroi which prevails, under which every village takes its toll of all the merchandise which passes through its territory. Trade does not prosper under these conditions, and is limited to the bare necessities such as iron, cloth and salt.

The natural hatred of a foreigner imbued in every Abor is not lessened by the feeling that he can only be coming into the country to deprive the Abor of his middleman's profits.

The Abor does not possess nor does he understand a coinage; all trade is by barter. Now that a British trade post has been opened in the lower part of the country the value of money may gradually come to be understood; for many years however its acceptance can only be guaranteed by a sufficient backing of military force.

Salt, red blankets, cloths (ordinary and silk), buttons, needles, cheap ornaments, knives, pipes, etc., are all useful and appreciated by the Abor as gifts or in payment for labour and the few commodities he is able or willing to dispose of. It may be noted however that the Abor dislikes nothing so intensely as cooly work even for liberal payment. It is very difficult to persuade an Abor village to provide transport; even if one can get it at all only the women and children will turn out as a rule.

Opium is at present practically unknown, but the habit will soon be introduced no doubt when inter-communication between the hills and plains is an established fact. Rum is useful for entering into relations with an Abor village.

Abors wear little clothing, the male dress sometimes consists of a loin cloth and a loose cloth or woollen coat is worn in the cold weather. The women all wear a curious girdle of metal discs, called a *boyop*, from babyhood until the first child is born; their clothing consists of a short petticoat and a shoulder wrap. The women do most of the field work and are excellent carriers.

In assuming his war dress the Abor adds a rain coat (made of sago palm) to his scanty attire; and his equipment consists of bow and arrows, long Tibetan sword, dao, cane helmet and a large rucksack woven out of bamboo shavings.

4. The *Dihang* basin is for the most part extremely mountainous; the *Dihang* itself and all its tributaries running in deep, narrow and most tortuous gorges which the rivers have cut in the course of ages. Wherever by some change in the geological formation the valleys widen out bold precipitous spurs run down steeply from the crest of the ranges bordering each valley to river level. The only comparatively flat and level spot in the whole basin is contained in about 20 square miles of plateau in the south-east corner of the *Siom* valley on which *Kombong* village is situated.

An excessive rainfall causes the whole of this precipitous mountain region

to be covered with dense forest and semi-tropical vegetation right up to permanent snow level, which is estimated to be about 14,000 feet. Large trees of many varieties, but all excessively difficult to cut, flourish on steep slopes (which only the Serow can traverse) right up to 10,000 feet, interlaced with all kinds of impenetrable undergrowth, among which the rhododendron, small bamboo and ringalls growing in thick clumps, and prickly cane seem to preponderate.

A kind of cypress covers the hill sides and tops in the Abor country above 10,000 feet; in the higher latitudes of Pemakoi-chen this tree is to be found as low as 6,000 feet.

The pine is only met with in the Tsañ-po valley where it flourishes exceedingly.

A feature of the country is the width and roundness of most of the actual hill tops. Seeing that they are all as heavily timbered and covered with as dense an undergrowth as the valley bottoms the labour of clearing them for triangulation is immense. It is not always possible to select only the hill tops above permanent snow level as stations of observation; a triangulator must therefore be accompanied by a strong detachment of men provided with and skilled in the use of cutting instruments, if his work is not to be seriously delayed. The plane-table can fortunately make shift as a rule with the innumerable *jhūm* clearings on the hill sides; but it is imperative to provide him with good English axes, both of the felling and hand variety, and a number of flexible chain saws which are easy to carry, to enable him to undertake a limited amount of clearing whenever it is unavoidable. Abors very seldom *jhūm* the actual hill tops of even the lowest hills, as they seem to reserve them for game sanctuaries.

Apart from other considerations it is evident that, in a country like this only good hill climbers used to forest work and skilled in the use of a cutting instrument should be recruited as *khalasis*. The pure Nepalese is undoubtedly the best man for this sort of work, but any Gurkhali is more useful than men of other races. If possible young ex-sepoys should be recruited through the agency of some Gurkha Regiment or Police Battalion, as they are naturally more reliable in an emergency and understand the necessity and reason of discipline better than a Gurkha who has not been in the ranks.

Communications in the Abor country invariably and in Pemakoi-chen generally are extremely bad.

Even if the Abor habit of exclusiveness, mentioned in the preceding paragraph, did not exist to militate against an expansion of trade and the consequent necessity for better communications, the extraordinary natural difficulties of the country would make it nearly impossible for him to improve the tracks much with the materials at his disposal.

As it is both Abors and Pemakoibas are uncommonly good bridge builders; not only are all the smaller streams provided with good stout log bridges, but very ingenious tubular cane bridges (and in Pemakoi-chen wooden cantilever ones as well) are built over all the larger streams. In the early part of 1913 the Dihāng was found to be bridged in this way at four places in the Abor country and in no less than seven places in that portion of Pemakoi-chen visited.

These tubular cane bridges do not of course permit the passage of animals nor will they stand constant heavy traffic such as a daily convoy of coolies.

For this purpose however they can easily be strengthened by the insertion of two 1 or 1½ inch wire ropes to carry an additional footway of bamboo slats.

No rope bridges of the Mishmi pattern were actually seen, though one is reported to exist over the Tsan-po near Gyala.

In all other respects the tracks are excessively difficult and present many obstacles to a laden cooly. With the exception of 32 miles of mule road built from Pasighat to the Yembung river near Kebang during the Abor Expedition in 1911-12, a road which one monsoon season sufficed to obliterate in most places, the only tracks in the Dihāng basin are foot-paths. From the nature of the country and climate the building and maintenance of the mule roads, which are so urgently required to open the country out, will be a very difficult and expensive undertaking.

The present foot-paths invariably go straight up and down hill, the art of grading a road is not understood, or at any rate is despised.

To enable the villages to collect their octroi, all tracks must lead through the different villages; alternative tracks by an easier route are not permitted. The bad places on these switch back paths are often improved as far as possible by galleries and ladders of notched logs; but it may be taken as a general rule that survey parties and their escorts cannot be maintained in the Abor country for any length of time unless they are accompanied by strong detachments of Sappers and Miners to improve the lines of communication by which the convoys of coolies must travel.

Until the country is taken over and properly administered large escorts will be necessary, the rationing of which entails the employment of immense numbers of imported coolies. There are no supplies in the Abor country available for sale or export; under the present system of cultivation the produce barely suffices to support the local population and has to be eked out at certain periods of the year with food stuff prepared from the fruit of the jack tree and even from the fibrous core of a kind of palm tree pounded into pulp. There are no sheep or goats in most parts of the Dihāng basin; village pigs can sometimes be bought to feed certain classes of Gurkhas and other pig-eating races, but the Englishman and Musalmān have to go without meat as a rule seeing that poultry is scarce and the tame Mithan practically unobtainable.

Fruit does not abound in this country; there are immense quantities of wild plantain trees (the leaves of which are very useful for hutting purposes) but only small patches of the edible variety are to be found in the vicinity of villages. Oranges seem to thrive in the lower parts of the Abor country into which they have probably been introduced from the plains. A few peaches are grown in Pemakoi-chen. Kinds of wild crab apple, wild plum, and lemons grow in certain localities, but only the Abor could eat the two former.

A peculiar feature about the Dihāng river worth noting is the comparatively easy gradient at which it flows throughout its entire course in Pemakoi-chen and the Abor country.

The river has been surveyed accurately up to the Chimdru Chu confluence in latitude 29° 30', that is to within a distance from the probable position of the big gorge through the Himālayas of not more than 30 to 40 miles (estimated along the bends of the river).

At this point the height of the river is only 2,750 feet above mean sea level.

At the Sirapateng confluence in latitude $28^{\circ} 53'$, about 85 miles further down, the height is 1,270 feet.

In this section therefore the gradient is 1 in 300.

At the Shimang confluence in latitude $28^{\circ} 19'$, about 80 miles below the Sirapateng confluence, the height is 700 feet, giving a gradient in this section of 1 in 750.

At Pasighat, where the river debouches into the plains about 45 miles below the Shimang confluence, the height is 494 feet, the gradient being 1 in 1,200; while 30 miles lower down at the junction of the Dihāng and Dibāng rivers the height is 400 feet, the gradient being 1 in 1,760.

This gives an average gradient in a total length of some 240 miles of 1 in 530.

Seeing that the height of the Tsan-po at Gyala cannot be less than 9,000 feet above mean sea level, it is interesting to speculate on the nature of its course in the intervening and still unsurveyed portion of 40-50 miles between Gyala and the Chimdru Chu confluence, in which it drops 6,250 feet. This drop may be fairly regular, but it seems more probable that it must occur mainly within the limits of the gorge itself.

Unfortunately the Dihāng river is not navigable for any considerable distance above Pasighat owing to innumerable rapids throughout its entire course. The Abors utilize rafts made of bamboos to cross this and other rivers; we have found Wheatley and Polyansky bag rafts more satisfactory for the same purpose. Berthon boats are very useful in the preliminaries of getting the cable and traveller for the raft across big rivers, but are difficult to parry about over the bad tracks on account of their weight and bulk.

Crossing the Dihāng and its large tributaries on rafts is only practicable between the end of October and the beginning of April. During the other months of the year the river is in high flood from melting snows and sudden storms. In the narrow gorge below the trade post at Rotung for instance the measured difference between low water and high flood level is 78 feet. At the same place the width of the water channel at low water is 160 yards; during high floods it is nearly 300 yards.

No really satisfactory methods could be devised for measuring the volume of water in the Dihāng river. Lieutenant Huddleston, R.E., executed a series of measurements, as accurately as possible under the circumstances, at Pasighat in December 1912, and has computed the volume at 80,000 cubic feet per second. The volume determined by the late Captain Harman, R.E., at mean low level of the year in 1878 at a spot a few miles below Pasighat was 55,500 cubic feet per second (*vide* Report on the Explorations of A.K. dated 1884.) As however Captain Harman omitted to measure the volume of water in one of the channels into which the Dibāng divides on entering the plains, Lieutenant Huddleston's figure of 80,000 cubic feet per second at mean low level of the year is undoubtedly the more correct.

5. A marked and unpleasant characteristic of the Dihāng basin is the extremely heavy rainfall it receives. The main valley appears to act like a funnel up which pours every moisture laden wind from the Bay of Bengal during most of the year to precipitate all over the valley on striking the Himālayas at its top.

Even when it is not actually raining the higher hills are nearly always en-veioped in heavy clouds; in fact during every single month of the year it is never possible to observe to the higher Himālayan peaks after 9 A.M.

Not having been in the country during the month of September I am not in a position to give a definite opinion as to the wettest portion of the year, but I am inclined to think the months of March, April and May are the worst in this respect.

Curiously enough the three monsoon months of June, July and August in 1913 were infinitely finer and drier than the three preceding months, but I believe the summer of 1913 was an abnormal one all over Upper Assam.

It is now a well-established fact that there are only three months, *i. e.*, from 15th October to 15th January during which any operations, particularly survey work, can be carried out with any certainty of comparatively fine weather. It has been proved that it is not impossible to carry on survey work in this country throughout the year, but people who have to work or even merely live in the country from the middle of January to the middle of October must be prepared to undergo considerable hardships and suffer a good deal of sickness.

The following table shows the number of days on which plane-tabling either could or could not be carried out during the whole of the season 1912-13.

MONTH.	Fine days.	Wet days.	Total.
November 1912	7	...	7
December „	28	3	31
January 1913	25	6	31
February „	18	10	28
March „	12	19	31
April „	18	12	30
May „	8	23	31
June „	16	14	30
July „	21	10	31
August „	12	2	14
TOTAL	165	99	264

A similar meteorological record was kept by all Survey Officers during the season 1911-12 and submitted to the Director-General of Observatories. No copy is however available for this report. Very similar conditions prevailed during the season of 1911-12 as in that of 1912-13. Torrential rain was experienced during the latter end of September and the first week of October 1911. A period of comparatively fine weather then followed from 9th October 1911 until about 20th January 1912. From that date until the detachment left Kobo on 9th April 1912 very bad weather was experienced, few days being fine or clear enough to permit theodolite observations.

The first consideration therefore in a climate like this is to devise some efficient protection against the rain for all the members and equipment of a

Equipment.

detachment, with due regard to the limitations of weight and bulk imposed by cooly transport. Tents (except for the base) are out of the question, efficient huts locally known as *bāshas* can only be made in standing camps; for temporary bivouacs however it is always possible to run up rough frame works of timber or bamboo and to roof them with waterproof sheets and tarpaulins. These should invariably be of stout Willesden canvas or some other rot-proof material and even the best rot-proof material will not stand the effect of the Dihāng valley climate for a longer period than six months if used continuously.

It has been found that an officer's or surveyor's squad of khalasis requires one big (12' × 8') paulin for the roof of its *bāsha*. The best patterns are those supplied by the Ordnance Department or Supply and Transport Corps.

If each khalasi is supplied in addition with one rot-proof sheet (7' × 4 $\frac{3}{4}$ '), as issued by the Supply and Transport Corps to all troops and followers, in which to roll up his bedding by day and which serves as a ground sheet by night; and also with one light Mackintosh sheet (5' × 5') which he carries on his person by day for use as a Mackintosh, it has been found possible to keep the men comparatively dry and comfortable at night while bivouacking on the march.

The light Mackintosh sheets mentioned above which the khalasis carry on the person are also useful in sheltering the plane-table when working in light drizzles of rain or in dripping jungles.

For officers and surveyors the light (10 lb.) *tente d'abri* made by the Elgin Mills Company of green rot-proof canvas, size 8' × 7', forms an excellent shelter tied on the underside of a rough frame work, on top of which plantain leaves, small branches of trees with the leaves on, etc., can be quickly piled to break the force of the rain.

Theodolite boxes must be provided with stout waterproof covers; the plane-table in its ordinary cover must also be wrapped in an extra sheet (6' × 6') of Willesden canvas to protect it from the rain.

Intense cold is never experienced on the lower hills and in the valleys of the Dihāng basin; in fact all members of the A bor Expeditionary force carried on with remarkably little sickness during the cold weather months of 1911-12 on practically a summer scale of clothing, although several parties had to bivouac above or near the snow line for considerable periods on many occasions.

As a rule however the khalasis should be provided with the winter scale of clothing from the start, seeing that survey detachments must work above snow level as far as possible in order to be above tree level.

Arrangements should be made if possible to ensure the escorts and coolies who accompany Survey detachments above snow level being also provided with winter clothing and good boots. Boots have to be renewed every two months in this region.

If all details of equipment, etc., are carefully worked out on the above lines before the detachment is actually mobilized, it has been found possible to keep officers and men fit for weeks on end in the wettest weather on a very limited scale of transport. The following is the minimum scale of baggage for any period over and above a week :—

	Coolies.
One officer's and his servants' personal baggage and cooking pots (mess extra according to time).	2
One khalasi	$\frac{1}{2}$
Tarpaulin, cooking pots, etc., for one squad of khalasis	1

The coolie's ordinary net load is 60 lbs. This minimum scale only provides the minimum amount of comfort of course; but it is given to show what has been and can be done to limit the baggage of a detachment without unduly imperilling its health.

Owing to the excessive humidity of the Dihāng basin it is impossible for men to reach and work at the same heights as in the drier climate of the Western Himālayas. 16,000 feet is probably the extreme limit of height to which plane-table or theodolite can be carried, but, as men who are quite capable of working at this height on the Western frontier feel great distress at lower altitudes in this region, it is essential for every member of a Survey detachment to undergo a careful medical examination before the start of operations.

From the latter end of February survey work in this basin is much impeded during any long spell of dry weather by the haze of jhūm fires.

The obnoxious *dam dim* fly puts in an appearance about the same time. Leeches of course abound at most periods of the year. On account of both these pests a large supply of permanganate of potash should be carried and the men should be made to bathe their feet and legs therein nightly whenever leeches are very prevalent. Unattended bites, sores, and cuts usually put far more men on the sick list than fever and other diseases.

Great heat is usually experienced in all the valleys from July to September and at this period the sandflies are unbearable. They seem to cause a peculiar kind of malarial fever, which medical science has not yet been able, I believe, to define exactly.

Quinine must of course be issued in prophylactic doses to every one from start to close of operations in this region.

6. Our geographical knowledge of the Dihāng river basin and of the eastern reaches of the Tsan-po in Tibet, prior to the surveys now under report, was very scanty.

Previous knowledge of the country.

From time to time between 1858 and 1911 several small military expeditions had been despatched up the Dihāng from Assam to punish the Abors living just behind the outer range for incursions into British territory. None of these expeditions were accompanied by trained surveyors and none of them managed to penetrate very far into the Dihāng basin, so their contributions to the geography of the country were practically *nil*.

The last and most successful of these expeditions advanced up the Yamne valley in 1894 to operate against the Padams and managed to reach the vicinity of the most important village, Damro, before retiring back to Assam. There was no trained surveyor with the expedition and the survey work accomplished was practically *nil*.

In 1909 the Assistant Political Officer of Sadiyā (the late Mr. Noel Williamson) made a journey up the right bank of the Dihāng from Pasighat to Kebang village. He was accompanied by Surveyor Partab Singh, who executed a very accurate survey on the $\frac{1}{4}$ -inch scale of the country traversed, about 300 square miles in extent, although only 11 days in all were spent on both the outward and return journeys.

No surveyor accompanied Mr. Williamson on his last journey up the Dihāng in the spring of 1911, when he was massacred by Abors in Komsing village.

Much valuable and, as it turns out, extremely reliable information about

the Dihāng basin was however collected by the Explorer Kinthup during the course of his travel between 1880 and 1881.

In order to determine, if possible, the unknown course of the Tsan-po in Eastern Tibet and beyond, the late Explorations of G. M. N. and Kinthup. Captain Harman, R.E., then in charge of the Assam Survey Party, sent a man known as G. M. N. up to Tibet (*via* Darjeeling and Lhāsa) in 1878 to follow down the course of the Tsan-po.

G. M. N. was a Lāma of the Pemiongchi monastery in Sikkim whom Captain Harman had engaged as a Munshi to teach him Tibetan. Finding him very intelligent Captain Harman offered him service as an explorer, which G. M. N. eagerly accepted, and instructed him in the methods of route surveying before despatching him on this journey.

Kinthup, a native of Sikkim, accompanied G. M. N. as an Assistant, and they managed to reach the village of Gyala at the western end of the big gorge through the Himālayas before returning to India by the same route they had gone out.

On G. M. N.'s return to India in 1879 his work was plotted and adjusted by Captain Harman; the course of the Tsan-po between Chetang and Gyala, as depicted ever since on the maps of the department, depends therefore mainly on this compilation of the surveys and report of G. M. N.

Full details are given in the "General Report on the operations of the Survey of India" of 1878-79.

G. M. N. had been told at Gyala that the Tsan-po, after passing through the gorge of the Himālayas east of that village, flowed eventually into British territory.

As this report fitted in with the theory (first advanced in 1788 by James Rennell in his 'Memoir to the Map of Hindoostan') that the Tsan-po and Dihāng were one and the same river, Captain Harman engaged a Chinese Lāma in 1880 to continue G. M. N.'s explorations of the Tsan-po.

Kinthup was again employed to accompany this Chinese Lāma as an Assistant.

They reached Tibet by way of Darjeeling, visited Lhāsa, and then proceeded down the Tsan-po to Gyala where they crossed to the left bank and continued their journey to Pomed, crossing the mountains by the Dhemu La from Tibet. On reaching a place called Tong-juk Dzong in May 1881 the Chinese Lāma sold Kinthup as a slave to the Jongpen and decamped with the proceeds. All his instruments, note books, etc., were taken away from Kinthup, who had to work for the Jongpen until March 1882, when he managed to make his escape into Pemakoi-chen.

He eventually reached the monastery of Marpung on the right bank of the Dihāng, and was kindly received by the head Lāma whom he served (in repayment of the ransom to his pursuers from Tong-juk Dzong) for practically the whole of the time he remained in this region. During this period he managed on several occasions to obtain leave of absence from Marpung on pretence of visiting holy places in different parts of the country, and made several extended journeys of exploration.

The last of these journeys he made was down the Dihāng into Abor country, in the hope of being able to return to India that way.

He managed to reach the vicinity of Damro, but was not allowed to proceed further and had to retrace his footsteps to Pemakoi-chen, from where he

returned to Lhāsa and finally to India, which he reached in November 1884 after four years' absence.

Owing probably to the death of Captain Harman, which had taken place in the meanwhile, Kinthup's story was not taken down and translated until two years after his return, when Colonel Tanner compiled a sketch map of the Dihāng basin from Kinthup's narrative.

This map has constituted the sole geographical record of the Dihāng basin from that day to now.

Kinthup was not a trained explorer, all his instruments, note books, etc., were stolen from him early in his journey, and he had therefore to rely entirely on his memory in giving his account of travels extending over four years and a large area of country. The sketch map prepared by Colonel Tanner was not compiled from information based on any kind of route survey, but from a narrative account only.

These facts are presumably unknown to or else ignored by people who criticize either the map or Kinthup's narrative.

Kinthup's story was corroborated in many particulars by a previous narrative (given to Explorer U. G. of the Survey of India) of a Mongolian Lāma called Serap Gyatsho who had lived and travelled in Pomed and Pemakoi-chen between 1856-68.

Furthermore the important fact, established by Kinthup, of the identity of the Tsan-po and Dihāng was indirectly proved by the explorations made by Surveyor A. K. in Eastern Tibet between 1879 and 1882, who found that the Tsan-po did not continue to flow north or east beyond Gyala and did not join the systems of the Irrawaddy, Salween, Mekong or Yangtse-Kiang rivers.

In face of all this evidence few geographers have since doubted the fact of the Tsan-po and Dihāng being one river; it has only remained for scientific survey to furnish the final proof.

The complete reports, narrative accounts, etc., of the above-mentioned explorers are given in the following publications:—

- (1) Report on the Explorations of Lāma Serap Gyatsho, Explorer K. P., Lāma U. G., Explorers R. N. and P. A. in Sikkim, Bhutān and Tibet (Trigonometrical Branch Office, 1889).
- (2) Report on the Explorations in Great Tibet and Mongolia made by A. K. in 1879-82 (Trigonometrical Branch Office, 1884).

Further references to these explorations will also be found in the "General Reports on the operations of the Survey of India" for 1881-82, 1882-83, 1886-87, 1887-88, 1888-89.

7. After the murder of Mr. Williamson and his party by Minyong Abors

Employment of the Survey detachment during the Abor Expedition, 1911-12.

in March 1911, the Government of India decided, with the sanction of the Secretary of State, to despatch a military expedition up the Dihāng in the cold weather of 1911-12 with the primary object of punishing the Minyongs and of finally establishing our military superiority in the estimation of the Abors. An important but secondary object of the expedition was the survey of as much of the country as possible. The Surveyor General was accordingly requested to detail a survey detachment to accompany the Abor Expeditionary Force. He was also asked to detail two other detachments to accompany friendly Missions which it was also decided to send at the same time to co-operate in the general programme

of survey operations on the North-East Frontier (of Assam); one to visit the tribes living in the Subansiri valley; and the other to visit the Mishmis of the Dibāng and Lubit valleys.

In addition to the main requirements of survey, as stated above, the Government of India also wished an exploring party from the Abor Expeditionary Force to visit the falls (mentioned by Kinthup) of the Tsan-po river in the vicinity of Gyala and incidentally to settle the question of the identity of the Tsan-po and Brahmaputra rivers.

Orders were issued by the Surveyor General early in September 1911 for

PERSONNEL.

Abor Expedition Survey Detachment, 1911-12.

Imperial Officers.

Captain O. H. B. Trenchard, R.E., in charge.
 Lieutenant G. F. T. Oakes, R.E.
 „ J. A. Field, R.E. (from 4th February 1912).

Upper Subordinate Service.

Mr. Sher Jang, K.B.

Lower Subordinate Service, etc.

Surveyor Hamid Gul.
 „ Abdul Majid (served as computer).
 Computer Narayan Singh.
 Surveyor Abdur Rahim (from 4th February 1912).
 Surveyor Shankar Singh (from 4th February 1912).
 34 khalasis.
 23 khalasis (from 4th February 1912).

the formation of the Abor Expedition Survey detachment. Mobilization was completed in Calcutta by 23rd September 1911; on which date the detachment embarked on the S. S. *Sherani* for the river journey to Kobo, the base of operations, a small clearing on the north bank of the Brahmaputra, a few miles west of the Dihāng confluence.

The detachment arrived at Kobo, where the troops composing the force were then assembling, on the 8th October 1911.

Active military operations against the Minyong Abors were in progress from about the 20th October 1911 until the end of December 1911. During this period very little survey work was accomplished owing to the exigencies of the military situation. While the main body of the army was advancing up the right bank of the Dihāng river, a small column on the west flank operated against the Minyongs established on the south side of the outer range.

Captain Trenchard and Mr. Sher Jang followed the main body up the Dihāng; Lieutenant Oakes and Surveyor Hamid Gul accompanied the flank column until the end of November 1911 when the operations of this column came to an end, the troops and Survey detachment returning to the valley of the Dihāng.

The total outturn of detailed survey on the $\frac{1}{4}$ -inch scale up to the end of December 1911 amounted to about 200 square miles. Plane-tabling was rendered possible by the number of Great Trigonometrical intersected points of the Assam valley series of triangulation, completed in 1877-78, which cover the whole area traversed up to about latitude $28^{\circ} 15'$.

As the outer range completely shuts out all view from the south of the mountain ranges of the Dihāng basin behind it, no points in the area, north of latitude $28^{\circ} 15'$, had been fixed by triangulation from the old series, which follows the course of the Brahmaputra river. Lieutenant Oakes managed to clear Torne hill on the outer range and observe therefrom in November 1911; other than this no triangulation could be carried out up to end of December 1911.

The exploration parties working in the northern portions of the Dihāng basin from about the beginning of January 1912 until the end of March 1912, when all operations closed, had therefore to enter an area devoid of triangulated points and one in which the dense vegetation, covering all the hills up to permanent snow level, precluded all idea of a hasty reconnaissance triangulation on the march.

On the 27th December 1911, a small exploration party, commanded by Mr. A. Bentinck, I.C.S., Assistant Political Officer to the General Officer Commanding, left the head-quarter camp near the Yembung river and the village of Kebang to penetrate as far up the Dihāng river as possible and to cultivate friendly political relations with all the villages on the line of march.

First Exploration party. Captain Trenchard and Mr. Sher Jang accompanied this party. Singing, a small village of the Simong group on the left bank of the Dihāng nearly opposite the Sirapateng (Sigong) river confluence, was reached on the 31st January 1912. The party was unable to proceed any further up the Dihāng river and retired slowly down the valley, reaching the head-quarter camp near Kebang again on 28th March 1912.

During the advance of this party the detailed survey carried out by Mr. Sher Jang had to depend entirely on a plane-table triangulation made from fixings on or near the path along the bottom of the valley. Although the most northerly point intersected by Mr. Sher Jang is more than 60 miles distant from the two triangulated points (of the old Great Trigonometrical Series) from which this plane-table triangulation was started, there is no plottable error between the positions of any points intersected on the plane-table and afterwards computed from the later triangulation.

Two hill tops, near the villages of Simong and Geku on the right bank of the Dihāng, were cleared by working parties of the 1st Battalion, 8th Gurkha Rifles, and transport coolies on the line of communication of the party during its advance.

As no skilled labour or felling tools were available this proved a task of great magnitude.

During the retirement of the party down the valley Captain Trenchard was able to make theodolite observations from both these cleared hills. At the beginning of March 1912 Captain Trenchard crossed the Dihāng and spent 20 days on the top of Arte Hill, the highest point of the Dihāng-Shimang river divide, clearing the hill top and waiting for fine weather before the necessary theodolite observations could be made.

At the same time Mr. Sher Jang crossed the Shimang valley and the hills which divide it from the Siom valley to the west, and managed to make a reconnaissance survey of a small area in the latter valley before returning to the rest of the party at Riga in the Dihāng valley. Apart from this and a small area in the vicinity of its confluence with the Dihāng reconnoitred by two other parties, the Siom valley was neither visited nor mapped during the expedition.

Captain Trenchard and Mr. Sher Jang finally reached the head-quarter camp near Kebang on 28th March 1912.

Another small party, under the command of Colonel D. C. Macintyre and accompanied by Lieutenant Oakes and Surveyor Hamid Gul left Rotung on the 26th December 1911 to explore the Yamne valley. Having crossed to the left bank of the Dihāng the party marched down it to Porging village near the Yamne confluence, from there advanced up the right bank of the Yamne as far as Sibbum village, and then crossed the divide into the Dihāng valley, reaching Geku village on 1st January 1912. After halting in this village for

two days the party returned by the same route to Rotung where it arrived on the 7th January 1912.

On the 20th January 1912 the same party again left the main line of communications on the right bank of the Dihāng, which it crossed a few miles above Pasighat. From here the party followed the route taken by the expedition of 1894 up the left bank of the Yamne and reached Damro village, where a halt of five days was made to give Lieutenant Oakes an opportunity of making theodolite observations from Kallang, a hill in the vicinity. It rained continuously throughout the three days Lieutenant Oakes spent in bivouac on top of Kallang, and no triangulation could be carried out. The party then retired down the Yamne and returned to Rotung on the 10th February 1912.

On the 4th February 1912, the detachment was reinforced unexpectedly by the arrival at Kobo of Lieutenant Field, R.E., and three surveyors. Owing to lack of transport, escorts and other reasons it was found impossible to utilize

The detachment reinforced.

the services of the three surveyors as fully as could have been wished during the remaining two months; one of them extended by a small amount the surveys (during November 1911) of Lieutenant Oakes and Hamid Gul on the southern slopes of the outer range, another carried out a 1-inch plane-table traverse survey of the mule road from Kobo to the Yembung river, while the third was practically unemployed.

Lieutenant Field was usefully employed in carrying out a good minor series of triangulation from two base stations of the Assam Valley (G. T.) series over the outer range and terminating near the latitude of Kebang. He

Triangulation.

observed at five out of the six stations of this series, Lieutenant Oakes completing the observations at the sixth station. Bad weather unfortunately prevented a satisfactory junction of Captain Trenchard's triangulation with this series.

During February 1912 a small party accompanied by Surveyor Abdul Majid made a hasty reconnaissance of the lower reaches of the Siom and Shimang rivers. Practically the whole of this area was re-covered by Lieutenant Oakes and Surveyor Hamid Gul in March 1912, who left the head-quarter camp near Kebang on 4th March with a small party to explore the Shimang valley and to extend the triangulation from a station at its head.

The survey of the Shimang valley was completed, but bad weather and lack of time and transport made it impossible either for Lieutenant Oakes to make any theodolite observations or for the party to cross over into the Siom valley and return down it to the head-quarter camp as had been arranged. The party therefore retired down the Shimang valley and reached the head-quarter camp on 23rd March 1912.

On the 28th March Mr. Bentinck's Dihāng party also reached this camp, and the next day the united detachment accompanied the Head-quarter staff on the final stage of the retirement to Kobo which was reached at the beginning of April 1912.

The week which elapsed before demobilization orders were received was spent at Kobo in drawing the originals from which the provisional map of the surveys executed was published later.

The whole detachment left Kobo on the 9th April 1912 by river steamer. On arrival in Calcutta the khalasis were immediately paid off and sent to their

homes, the surveyors returned to their original parties or proceeded on leave, and the detachment was completely demobilized by the end of April 1912.

The geographical results achieved by the expedition were disappointingly small.

Owing to the inability of the exploring party to penetrate further up the Dihāng valley than latitude $28^{\circ} 55'$, neither of the geographical objects of the ex-

Results.

pedition—the survey of a suitable frontier line and the establishment of the identity of the Tsan-po and Dihāng as one and the same river—was accomplished.

As it was found impossible to survey the Siom valley no connection was made with the work of the Miri Mission to the west; similarly, the inability of the Mishmi Mission to the east to survey the Sesserri and Dibāng valleys resulted in no connection being made with their work.

A good minor series of triangulation based on the old Assam Valley (G. T.) series was however carried over the outer range into the Dihāng basin, as a result of which (and the subsidiary triangulation carried out by Captain Trenchard) 45 new points were intersected in a previously untriangulated area, 11 of them being situated in a continuous range of high snowy mountains bounding the valley to the north and west which we now know is a portion of the main Himālayan range. An interesting fact disclosed by this triangulation was the existence of a peak (Namcha Barwa) in this range well over 25,000 feet in height. Further details of the work completed by the Abor Expedition Survey Detachment are given in paragraphs 9 and 10 of this report.

The detachment suffered very little sickness throughout the expedition. One officer spent the first week at Kobo in hospital with fever, and one of the computers had an attack of jaundice in November 1911 which necessitated his removal to the base hospital at Dibrugarh for a short period. Only one of the khalasis suffered severely from fever.

Early in the autumn of 1912 the Government of India decided, with the sanction of the Secretary of State, to renew

The Abor Exploration Party, 1912-13.

during the ensuing cold weather the exploration of the Dihāng river basin in continuation of the work of the previous winter.

The programme laid down for the season was as follows:—

- (1) *The Dihāng Party*.—To explore and fix the Doshung La, and discover as much as possible of the geography north of the main ranges of the Himālayas; ascertain the point where the Tsan-po breaks through the main range; fix this range west of the Dihāng in conjunction with the Siom-Sigong party; fix the main range as far as possible east of the Dihāng; discover whether the course of the Nagong* Chu is north or south of the main range and whether it flows into the Tsan-po, the Dihāng or the Dibāng.
- (2) *The Siom-Sigong Party*.—To fix the main range of the Himālayas in conjunction with the Dihāng party; fix the courses of the Siom and Sigong rivers and explore the passes said to be at the heads of these valleys; endeavour to discover the course of the Nia Chu, whether it becomes the Subansiri, the Siom, or the Sigong, whether it flows north of the main range into the Tsan-po, or whether it breaks through the main range.

* The headwaters of which were discovered in about Longitude $97^{\circ} 0'$, Latitude $29^{\circ} 30'$ by A. K. in 1882.

Under the orders of the Surveyor General preparations had been proceeding in Calcutta throughout September 1912 to enable the survey detachment to mobilize quickly should the proposals of the Government of India be sanctioned by the Secretary of State.

Sanction was received early in October 1912 and communicated by the Surveyor General on the 7th October with orders to collect the personnel of the detachment, who had been warned previously, and to proceed to Assam as soon as possible.

PERSONNEL.

Abor Exploration Survey Detachment, 1912-13.

Imperial Officers.

Captain O. H. B. Trenchard, R.E., in charge.

Lieutenant G. F. T. Oakes, R.E.

Lieutenant P. G. Huddleston, R.E.

Lower Subordinate Service, etc.

Surveyor Hamid Gul.

" Bhamba Ram,

" Anwar Ali.

38 khalasis.

After making all final preparations and despatching the instruments, equipment, tents, etc., of the detachment by river steamer to Gauhāti, Captain Trenchard left Calcutta on the 16th October 1912 for Shillong in order to recruit Gurkhali khalasis for the detachment and ascertain what arrangements had been made by the Assam Government for the forthcoming exploration.

As soon as orders from Government were received, the Chief Secretary to the Chief Commissioner of Assam held a conference on 22nd October of all officers connected with the frontier explorations who were then in Shillong.

Details affecting the composition of the Abor Exploration Party were discussed and a rough scheme of operations formulated for the approval of the Chief Commissioner.

All the proposals made by the conference were accepted next day by the Chief Commissioner who appointed Mr. W. C. M. Dundas, C.I.E., Political Officer in charge of the Central and Eastern Sections of the North-East Frontier at Sadiyā, as Political Officer in charge of the Abor Exploration Party: Escorts consisting of the whole Lakhimpur Battalion Military Police were detailed. Orders were given to recruit 1,800 transport coolies, and the Army Department was asked to supply a mule corps, half a company of Sappers and Miners, and a cadre of British officers and Non-Commissioned officers of the Supply and Transport Corps for supply services.

With the assistance of Lieutenant M. A. C. Kennedy, D.S.O., Adjutant, 1/8th Gurkha Rifles, all the khalasis of the detachment were carefully selected and medically examined before the end of October. Lieutenant Oakes, Lieutenant Huddleston and the three surveyors also joined the detachment in Shillong before the end of the month.

Owing to the prevalence of cholera in Gauhāti and on the Shillong-Gauhāti road arrangements were made to transport the entire personnel of the detachment to Gauhāti by motor car service and to embark it on the river steamer immediately on arrival in Gauhāti.

The detachment left Shillong early on the 4th November 1912, picked up the equipment, etc., on arrival at Gauhāti and loaded it on to the steamer which sailed the same evening for Dibrugarh, where it arrived on the 7th November 1912.

It was unfortunately only too obvious that the start of the main operations up the Dihāng would be considerably delayed, as the first necessity was to render the mule road, constructed from Pasighat to the Yembung river during the Abor Expedition, fit for traffic. This proved an arduous and lengthy under-

taking as large portions of the track had been obliterated during the preceding monsoon season. The half-company of Sappers supplied by the Army Department did not reach Kobo until the middle of December 1912, and the whole road was not reopened for mule traffic up to the Yembung river until the end of February 1913.

The Supply cadre and the mule corps lent to the local administration by the Army Department reached Kobo about the beginning and middle of December 1912 respectively. Preliminary operations. The transport coolies also began to arrive in Kobo about the middle of December 1912 and were employed on the carriage of rations up the mule road as succeeding sections were opened out by the Sappers (as a preliminary measure) for coolie traffic. The section of road between Kobo and Pasighat had been rendered passable for cart traffic by the Public Works Department during the preceding summer.

The first phase of the operations in establishing an advanced base in the Dihang valley at the head of the reopened mule road on the Yembung river may therefore be held to have been completed about the end of February 1913.

It had been clear from the very beginning that little new survey work could be done during this period, as there is only one line of advance into the Dihang basin and this had been completely surveyed the previous winter.

A considerable quantity of useful work was however accomplished, with the assistance of the Political Officer in charge, between the middle of November 1912 and the middle of January 1913 while the other units of the party were collecting at Kobo, though it had perforce to be confined to the area south of the outer range.

In November and December 1912 Lieutenant Huddleston and two surveyors were able to extend the survey of the southern slopes of the outer range on the right bank of the Dihang as far west as the Simen river, besides contouring the whole area in this direction surveyed during the previous winter. This section of the detachment and its escort were provided with transport by the Political Officer from local Abor villages, as none of the regular transport coolies had reached Kobo by then. No attempt was made to survey the belt of lowlying and densely forested country between the southern foothills of the outer range and the north bank of the Brahmaputra; partly owing to the difficulties of obtaining a sufficiency of local transport and partly owing to the probability of incapacitating the personnel of the section in this malarious tract before the start of the real operations in the Dihang valley.

In the meantime Lieutenant Oakes was employed in carrying out theodolite observations to complete the triangulation of the previous season.

Having collected some Abor coolies from the villages near Pasighat he was able to proceed to Bapu hill (one of the stations which Lieutenant Field incorporated in the new series of triangulation in the spring of 1912), completed his observations and returned to Pasighat on 11th December 1912.

The first batch of regular transport coolies had reached this place a few days previously from Kobo, but could not be employed fully on regular daily convoy work as the road above Pasighat was not yet open for traffic.

The Political Officer in charge readily agreed therefore to spare some of these coolies from the main line of advance for a short period, so Lieutenant Oakes was able to cross the river from Pasighat on 14th December 1912 with the purpose of observing from a new station on the outer range on the east side of the

Dihāng and also of completing the survey of the southern slopes of the outer range between the Dihāng and Sessleri rivers up to a marginal line previously arranged with the Dihāng Survey Detachment.

Bhamba Ram, the third and hitherto unemployed surveyor of the detachment, accompanied Lieutenant Oakes. A satisfactory connection was made with the work of Captain Gunter's surveyor along the low divide between the Dihāng and Sessleri rivers by the 22nd December 1912. The party then crossed the outer range (by a very difficult track) into the Yamne valley, Captain Oakes reaching the summit of Kine hill (10,010 feet), practically the highest peak in this section of the outer range, on 27th December 1912. The next three days were spent in carrying out theodolite observations; Captain Oakes rejoined the party at Sibbuk village, and the party then returned down the left banks of the Yamne and the Dihāng and recrossed to Pasighat on the 4th January 1913.

The computations of these observations were worked out by Captains Trenchard and Oakes in Rotung by the end of January 1913; the co-ordinates and heights were thus obtained of 24 entirely new points and of 13 other points which had only been fixed provisionally by the triangulation carried out during the expedition. Most of these points were snow peaks situated on the main range, the general outline and direction of which began therefore to be more clearly defined.

The main outlines of the plan of operations for carrying out the survey programme had been settled by the Political Officer in charge before the close of December 1912.

It was decided that the main advance up the Dihāng valley from the head of the mule road at the Yembung river should be along the right bank, both to avoid the dangers of an inevitable Dihāng river crossing on the line of communications attendant on the alternative route along the left bank and also to simplify the maintenance of a detached party working in the Siom valley.

Plan of operations.

In order that the operations of this Siom party should not unduly delay the main advance up the Dihāng valley, the Political Officer in charge decided to restrict the number of regular transport coolies employed by it to the minimum required for carriage of baggage and a small reserve of rations; thus making the party dependent on obtaining local Abor labour for the carriage of its surplus rations, to be sent out to it monthly from the main line of communications in the Dihāng valley.

This bold policy proved on the whole eminently successful, thanks largely to the ability, tact and knowledge of the Abors and their language displayed in the conduct of the operations of this party by Captain Hore, in political charge. Seeing that the Siom valley had to all intents and purposes not been visited during the Abor expedition and it became very clear as the advance of the Exploration Party progressed that the only section among the Abors really impressed by our military superiority as a result of that expedition was the actual Kebang group against which military operations had been directed the success achieved by the Siom party may be considered remarkable.

Lieutenant Huddleston and Surveyor Hamid Gul accompanied this party, which left Rotung on the 21st January 1913 and started work in a hitherto unsurveyed area at Kombong village in the south-eastern corner of the Siom valley on 28th January 1913.

By the middle of January 1913 mule convoys were running daily up to Rotung. The final stage of this road to the Yembung river had still to be re-made and seven stages (about 100 miles) for coolie transport of the main line of communications beyond it had to be established before the surveyors could start work in the unsurveyed area of the Dihāng valley north of latitude $28^{\circ} 55'$. The only immediate survey operation therefore for the remainder of the detachment was the extension of the series of triangulation up to the snow covered (and treeless) spur which juts out west into the Dihāng valley about latitude $28^{\circ} 45'$ from the Dihāng-Dibāng watershed.

From stations on this spur theodolite observations would not only provide intersected points for the surveyors working in the untriangulated area of Pemakoi-chen but would also determine the general position and direction of the main range east of the big Namcha Barwa peak in longitude 95° .

The easiest route to this spur lay up the Yamne valley which rises in its southern slopes.

The Political Officer in charge agreed to the despatch of a party with this purpose and decided to accompany it himself, both to make the political acquaintance of the Padam Abors and to supervise the recruitment of the local Abor coolies required for the transport of the party.

Captains Trenchard and Oakes accompanied the party to carry out the triangulation and surveyors Bhamba Ram and Anwar Ali to contour the Yamne valley.

The party crossed from Rotung to the left bank of the Dihāng and reached Porging village near the mouth of the Yamne on the 3rd February 1913. It marched up the right bank of the Yamne to Sibbum village, then crossed the river and proceeded through Sibbuk village to Damro which was reached on the 11th February 1913.

On this date the weather, which had been extraordinarily good ever since the detachment reached Dibrugarh early in November 1912, broke up and a period of constant rain and mist set in for the next three months.

It was realized that the somewhat hazardous mountaineering feat of reaching the top of the peaks of this spur in bad weather and the waiting thereon for a fine interval would consume too much time and entail the withdrawal of numbers of coolies from the main line of advance up the Dihāng valley. It was therefore decided to abandon the attempt and to make other arrangements for extending the series in the main valley itself, and in the vicinity of the line of communications.

After completing the resurvey and contouring of the Yamne valley the party crossed the divide into the Dihāng valley on 25th February 1913 and reached Geku village next day. From here Captain Oakes and Surveyor Bhamba Ram crossed to the right bank of the Dihāng and marched to Dosing village, near the confluence of the Shimang river, with a view to proceeding up that valley and working beyond it in the Sike valley to assist the Siom Party.

Captain Trenchard and Surveyor Anwar Ali accompanied the remainder of the party on the return journey down the left bank of the Dihāng river to the ferry below Rotung, which was reached on the 9th March 1913, and then proceeded up the right bank of the Dihāng with the Political Officer in charge to Dosing.

On reaching that place on 14th March it was found that the arrangements

for extending the main line of communications up the valley had been disorganized somewhat by rumours of coming warfare with the Abors further north.

It was therefore found necessary to curtail the scope of Captain Oakes' work beyond the limits of the Shimang valley. He returned to Dosing with Surveyor Bhamba Ram on the 26th March 1913 after meeting the Siom Party at Bogu village in the Siom valley, and having completed the resurvey and the contouring of the Shimang valley.

Final arrangements to ensure a methodical advance up the Dihang valley were then made; the Assam Government having agreed to supply a reinforcement of 1,200 transport coolies for which the Political Officer in charge had asked early in March. These extra coolies reached Kobo in April and were at once sent up to the head of the line.

By the 24th April 1913 the line of communications had been extended to the Angong river confluence where the main party was rejoined by the Siom party, on completion of its work in the Siom valley. Henceforth it ceased to exist as a separate party, exactly three months after it was constituted as such in Rotung.

As mentioned above the Siom party reached Kombong on the 24th January 1913. Surveyor Hamid Gul first accompanied Captain Hore into the south-west corner of the Siom valley and completed the survey of that portion of the lower Siom valley up to the Subansiri watershed before he rejoined the rest of the party at Along village on the Siom river on the 11th February 1913.

In the meantime Lieutenant Huddleston crossed to the left bank of the Siom river from Along and completed the survey of the valley of the Sirit, a small tributary of the Siom, before rejoining the party at Along.

The small area between the Sirit confluence and the mouth of the Siom was surveyed towards the latter part of April 1913 by Surveyor Anwar Ali.

The whole party proceeded up the right bank of the Siom river from Along and reached the confluence of the Sike river, the big northern tributary of the Siom, on the 14th March 1913.

Despite the almost continuous rain experienced during this period the valley was surveyed right up to the Subansiri watershed, and Surveyor Hamid Gul also managed to sketch in the head-waters of the Siu river, a big tributary of the Subansiri not completely surveyed by the Miri Mission during the previous season.

On the 17th March 1913, the whole party crossed the Siom river to Bogu village on the left bank, and picked up its third and last month's supply of rations which had been sent out by convoy up the Shimang valley from Dosing, on the main line of communications in the Dihang valley. It then crossed the Sike and reached Yiyu village on the left bank of the Siom on the 25th March 1913. A depôt of rations to feed the party on its return journey (by way of the Sike valley) to the main line of communications in the Dihang valley was formed at Yiyu, and the rest of the party continued along the left bank of the Siom to complete the survey of the top portion of that valley. Ro village was reached on the 27th March 1913. Between Ro and the next village Pa-um the Siom breaks through a snowy range of mountains in a very narrow gorge. This range, known north of the Siom as the Pari and south of it as the Yorjing mountains, is a very large spur of the main Himalayan range and approximately follows the 94° 30' meridian from north to south.

The Pari mountains form the watershed between the Sike valley and the top portion of the Siom valley, while the Yorjing mountains divide the valleys of the Siom and the Subansiri.

The trade path to the upper portion of the Siom valley is very difficult throughout the whole length of the gorge, crossing several sheer rock faces (on which the path degenerates into a series of precarious footholes) at an altitude of about 3,000 feet above the river bed.

The first of these cliffs, Pu-U, was encountered between Ro and Pa-um villages. It proved so serious an obstacle that it was impossible to get any of the loads or most of the coolies across it, and the party possessed no means of improving the track by the only possible method of blasting it out of the rock face.

Moreover the attitude of the Boris, which had been distinctly unfriendly since the party entered their territory a short distance below the Sike confluence, became openly hostile at this juncture and Ro village had to be punished on the 29th March 1913. Captain Hore then decided in consultation with Lieutenant Huddleston that, in view of the necessity of getting the whole party back to the main line of communications in the Dihāng valley before its rations were exhausted, no further attempt should be made to proceed further up the Siom valley but that the party should spend the remaining time at its disposal before returning to the Dihāng valley in completing the survey of the Sike valley and any other northern tributaries of the Siom.

In pursuance of this decision—the only possible one under all the circumstances with regard to the main objective of the Exploration Party in the Dihāng valley, even though it entailed the non-fulfilment of one of the items of the survey programme laid down by the Government of India—the party returned to Yiyu, picked up the depôt there and marched up the right bank of the Sike river to Gasheng village which was reached on the 11th April 1913. From here Lieutenant Huddleston and Surveyor Hamid Gul managed to reach the top of a peak on the watershed between the Sike and Sirapateng (Sigong) valleys from which the survey of the head-waters of the former valley was completed and a useful start in the survey of the latter valley was made.

They rejoined the rest of the party, which had meanwhile been progressing slowly up the Sike valley from Gasheng village, on the 17th April and then crossed that river into the valley of the Sirang, a small tributary stream, up which the party proceeded to a pass over the top of Luyor hill—a peculiarity common to many Abor paths—situated at the head of the Sirang and on the watershed between the Sike and Dihāng rivers.

After halting on this hill top for four days, the fourth day fortunately being fine and clear, the party marched down the Nidgong river, a Dihāng tributary which like the adjoining and parallel stream the Angong flows from south to north, to Mosing village which is built on top of a commanding bluff between the two tributaries and immediately above a deep and narrow gorge through which the Dihāng flows below this village.

From Mosing the party marched down to the Angong river confluence on the 24th April, and rejoined the main party.

With the exception of Surveyor Anwar Ali, whom it was found impossible to employ after the end of April 1913 owing to lack of transport and who therefore remained in reserve at the advanced base on the Yembung river for

the remainder of the season, the whole detachment were collected at or near the head of the line of communications at the Angong river confluence by the beginning of May 1913. Captain Oakes, who had been incapacitated for the whole of April by an attack of mumps, reached the Angong river from Dosing on the 3rd May ; and surveyor Bhamba Ram completed the contouring of the whole area in the Dihāng valley surveyed during the previous season up to latitude $28^{\circ} 55'$ by the 9th May 1913.

Owing to the failure experienced in February 1913 to extend the series of triangulation to the range at the top of the Yamne valley, the northern portion of the Dihāng valley, known as Pemakoi-chen, which the Exploration Party was now about to enter, had to remain untriangulated up to this.

Lieutenant Huddleston had, however, fortunately discovered on crossing the watershed between the Sike and the Dihāng that Luyor hill on that divide would make a suitable station and that another high hill (Dino) in the vicinity of Pango village on the line of advance could probably be utilized as a second station from which the necessary points in Pemakoi-chen might be fixed.

A third hill (Loyung) in the vicinity of Bomo village further down the Dihāng valley and, like the other two, close to the line of communications, was selected as an intermediate station to connect the two forward stations with the series.

The Political Officer in charge having made all arrangements for escorts, supplies and transport immediately the suggestions for this triangulation had been put before him, the three survey officers were able to leave the Angong river to execute it before the middle of May 1913.

Captain Oakes reached the top of Luyor hill on the 9th May 1913, but owing to bad weather was not able to complete his observations until the 20th May 1913.

Lieutenant Huddleston reached the top of Loyung hill on the 10th May 1913 and had a very heavy job cutting down the trees on it. He managed however to complete all his observations by the 20th May 1913.

Captain Trenchard accompanied by surveyor Hamid Gul left the Angong river on 10th May 1913 to clear the top of Dino hill and erect a signal for the other two triangulators to observe to. This was completed on the 15th May 1913.

Captain Oakes after completing his observations from Luyor hill proceeded at once to Dino hill which he reached on the 22nd May 1913.

Another spell of bad weather delayed the completion of his observations there until the 3rd June 1913.

By this time the head of the line of communications had been advanced across the Sirapateng river and had reached Tuting, the most northerly Abor village on the right bank of the Dihāng. Computations of all the recent triangulation were completed by the 13th June 1913, as a result of which 40 new points were provided for the plane-tablers. Although Captain Oakes was able to observe from one more hill (Nishing) north of Tuting village before the end of June and obtain six more new points it was not found possible to extend the series north of latitude $29^{\circ} 0'$ before the close of the season.

Compared with the lower portion of the Dihāng basin Pemakoi-chen proved an easy country to survey. It is not only more populous and therefore less densely forested than the Abor country ; the bold lofty spurs which run down from the main range to the river enable the plane-tableter to climb above

the tree level and therefore to work far more rapidly than he can in the Abor hills of lesser altitude.

During the first week of June 1913 Surveyor Hamid Gul spent some days in bivouac at altitudes between 11,000 and 14,000 feet on the Dipung ridge, which divides the two right bank tributaries Ringang and Nugong; from which he was able to complete the survey of the Yang Sang Chu valley on the opposite side of the Dihāng.

Working at the same altitudes Surveyor Bhamba Ram practically completed the survey of Ringang valley between the 3rd and 13th June 1913. He was not able to reach the pass (Lushe La) at the head of this valley by which the Abors state a track crosses the main range into the Tsan-po valley, as this path ceased to be practicable for loaded coolies half way up the Ringang valley.

The head of the line of communications was established at Kopu, the most southerly Pemakoiba village on the right bank of the Dihāng, on the 14th June 1913. The hot weather had set in by this time, the original transport coolies had been working continuously for six months, and it was obvious that operations in the Dihāng basin could not be continued for much longer.

The Political Officer in charge decided therefore not to extend the line of communications beyond Kopu, but to continue the advance up the Dihāng with a small self-contained party (carrying rations for 20 days) before returning to Kopu. It was also arranged that another small party should make a similar journey up the Sirapateng (Sigong) valley to complete the unsurveyed portion at its head and reconnoitre the pass over the main range by which a track was said to lead into the Tsan-po valley.

The Dihāng Party left Kopu on the 23rd June, Captain Trenchard accompanying it, and picked up Captain Oakes and Surveyor Hamid Gul, who had spent the previous week observing from the Nishing ridge and completing the survey of the Nugong valley, on the evening of the same day.

The party reached Janyor village on 26th June, where Surveyor Hamid Gul was detached to ascend the Jijung ridge between the Nugong and Pemasiri valleys. The remainder of the party reached the Pemasiri river (near Yortang village) on the following day.

On the 28th June 1913, Captain Trenchard left the main party and with a small escort commanded by Captain Pemberton, R.E., marched up the left bank of the Pemasiri river, reaching Ani Basam, one of the halting places on this important trade route just beyond the junction of the Pemasiri and the Doshung Chu that evening. On the following day he crossed the divide into the Doshung valley and marched up the left bank of that river to the pass (the Doshung La, about 13,500 feet) over the main range at the head of the valley. The pass, an easy one, was crossed on the 2nd July 1913. Next day the party reached Phea Doshung, a small village on the right bank of the Tsan-po about half-way between the villages of Chilagong and Gyala, and was received in a friendly and hospitable manner by the villagers. Chilagong is an important, if not the principal, village of the Kongbu district of Tibet and is three days' ride west of Phea Doshung. Gyala is two days' ride north-east of Phea Doshung.

The 4th July was spent on a neighbouring hill, but unfortunately bad weather prevented any trigonometrical observations being carried out. A plane-table sketch however was made of the portion of the Tsan-po valley

visible from this hill and of the neighbouring areas compiled on the spot from the topographical information freely given by the local inhabitants. Lack of time and rations and the necessity of rejoining the main party in the Dihāng valley on the arranged date rendered it impossible to continue the march from Phea Doshung to Gyala.

The headman of Gyala reached Phea Doshung however on the evening of the 4th July to visit the party and absolutely confirmed Kinthup's account of the Tsan-po breaking through the Himālayas just below his village and flowing into Pemakoi-chen on the other side of the mountains in a very deep and impassable gorge. About the falls this headman was reticent and contradictory; the general impression he gave both officers of the party was that falls undoubtedly do exist even if they are not as big as described by Kinthup.

With the knowledge that Captains Bailey and Morshead were on their way to settle this question definitely as a partial consolation for the disappointment of not being able to forestall them, the party left Phea Doshung on the 5th July 1913, recrossed the Doshung La the following day, and rejoined the main party on the Pemasiri river on the 9th July 1913.

Owing to continuous bad weather both on the outward and return journey it was not found possible to survey the Doshung valley in detail nor even to make any astronomical observations. A prismatic compass traverse of the whole route was executed, which will be adjusted eventually with Captain Morshead's survey in the Tsan-po valley.

The reconnaissance survey, based on this traverse, of the whole area covered during this exploration is however fairly complete.

On the 29th June 1913 the Political Officer in charge, Captain Oakes and the main party continued the advance from the Pemasiri river up the right bank of the Dihāng river. On the 4th July they reached the Chhanjuk La, a pass of low elevation on the south-eastern extremity of the watershed between the valleys of the Pemasiri and the Nyalam Chu.

Captain Oakes completed the survey of the Dihāng valley in detail up to this watershed on the right bank; on the left bank he completed the survey up to the confluence, near Khapu village in about latitude $29^{\circ} 30'$, of the big left bank tributary the Chimdru Chu, thus effecting a very satisfactory connection with the survey Captain Morshead will have made in that valley and also in the Dihāng valley north of latitude $29^{\circ} 30'$.

The party found on reaching the vicinity of Khapu that Captain Morshead had left that village a short time previously and was proceeding up the left bank of the Dihāng towards Pomed. He had been informed previously of the extreme northern limits to which the surveys of the Abor Exploration party could be carried.

Owing to the time limit imposed by the arrangements for the retirement of the whole exploration party made before the Dihāng party left Kopu, the Political Officer in charge and Captain Oakes were unable to continue their journey across the valley of the Nyalam Chu, the last of the big mountain torrents on the right bank of the Dihāng, and reach the eastern end of the big gorge through the Himālayas.

The return journey down the Dihāng valley was started on the 5th July 1913, the Pemasiri river being reached on the 9th July 1913.

Surveyor Hamid Gul, having reached the top of the Jijung ridge from Janyor village on the 28th June 1913, spent a week in completing the survey

of the southern and western portions of the Doshung valley up to the crest of the main range. Continuous bad weather prevented him from completing the detailed survey of the whole of the Doshung and Pemasiri valleys; he was however able to do a certain amount of reconnaissance work which, combined with that of Captains Trenchard and Oakes in this area, provides a complete and fairly accurate survey of the main range at the head of the Doshung and Pemasiri valleys up to the big Namcha Barwa peak, and also of the two valleys up to the Pemasiri-Nyalam Chu watershed which takes off from the main range in the vicinity of that peak.

Surveyor Hamid Gul rejoined the main party at the Pemasiri river on the 9th July 1913.

Next day the reunited party started its long march down the Dihāng valley, acting as the rear-guard of the whole exploration party during the retirement to Kobo, which was reached on the 9th August 1913.

While the main Dihāng Party was making its final advance up that valley Lieutenant Huddleston and Surveyor Bhamba Ram accompanied a small party under the command of Captain Hore up the Sirapateng valley. Leaving Miging village on the main line of communications in the Dihāng valley on the 19th June 1913, the party crossed to the left bank of the Sirapateng (Sigong) river at Kerak on the 21st June and continued its advance up the valley. The junction of the Simu with the Sirapateng river was reached on the 27th June and from here the party proceeded up the left bank of the Simu river to the top of the valley, reaching the Lungma (Lulung) La, the 13,500 pass on the main range by which the track crosses into the Tsan-po valley, on the 30th June.

Orang Gacha, a village on the right bank of the Tsan-po, is said to be only two days' march by a good *Yak* road from the Lungma La. The party had been delayed considerably in its advance up the Sirapateng valley by the extremely bad condition of the alleged trade route. Much time was spent in repairing and rebuilding the cane bridges over the numerous side streams, all of which were in flood from the continuous rain experienced throughout the whole journey.

The party was unable therefore to continue its advance over the Lungma La into the Tsan-po valley in the time allotted for this exploration, nor could Lieutenant Huddleston carry out any survey of the western slopes of the main range from the pass. The continuous bad weather made it impossible even to survey the Sirapateng valley in detail; a prismatic compass traverse of the route was made and the reconnaissance survey of the whole valley based on this traverse is complete and very fairly accurate.

The party returned to Miging village on the 7th July 1913, where Lieutenant Huddleston was employed for the next week in determining an accurate height by theodolite observations for the Sirapateng confluence. Thence he and Surveyor Bhamba Ram marched down the Dihāng valley, reaching Pasi-ghat on the 26th July and Kobo on the 9th August 1913.

The whole detachment embarked on a river steamer at Kobo on the 14th August and reached Gauhāti on the 17th August, where the khalasis were paid off and discharged.

The officers and surveyors of the detachment, who had been transferred to the head-quarters of the Eastern Circle on demobilization of the Abor Exploration party, reached Shillong on the 18th August 1913.

Despite the length of the season, which lasted from the 7th November 1912 until the 14th August 1913, the detachment did not experience much sickness. One officer had an attack of mumps in April 1913 and the other two officers suffered from malaria during the return journey to Kobo in July and August 1913. The surveyors and khalasis escaped serious sickness in a remarkable manner; only one khalasi had a mild attack of pneumonia during March 1913.

8. A short recapitulation of the survey work accomplished in the basin of the Dihāng river partly during 1911-12-13 in the Dihāng river basin. 1911-12 but mostly in the season 1912-13 will show to what extent the requirements of the Government of India have been fulfilled.

With exception of the head-waters of the Siom river the whole area of the Dihāng river basin, from the Brahmaputra river in the south to the confines of Tibet and Pomed in the north, has been surveyed in detail—for the most part rigorously—on the scale of 4 miles to 1 inch, the hill features being delineated by approximate contours at 250 feet vertical interval.

Satisfactory connections along the entire lengths of the common margins have been made with the surveys of the Dibāng Exploration party to the east along the Dihāng-Dibāng watershed, and with the surveys of the Miri Mission of 1911-12 to the west along the Dihāng-Subansiri watershed.

The southern slopes of the outer range of the north bank of the Brahmaputra river from the Simen river in the west to the Sesseri river in the east, an area which, strictly speaking, is not contained in the actual basin of the Dihāng river, have also been surveyed in detail.

The detail surveys are based on a good minor series of triangulation which emanating from the Assam valley (G. T.) series in the Brahmaputra valley, has been carried over the outer range and extended into the Dihāng valley up to latitude $28^{\circ} 55'$. From this series of triangulation 30 peaks have been intersected on the main range of the Assam Himālayas bounding the basin to the north and north-west which determine the position and direction of the range from longitude 94° in the south-west to longitude 95° in the north-east.

The greater portion of the entire length of this section of the main range has also been surveyed in detail (on the Dihāng side) up to the crest of the range; only the small portion at the head of the Siom valley between longitude 94° and $94^{\circ} 15'$ has not been surveyed in addition to being fixed by triangulation.

Two passes on the main range by which the two main trade routes from the Dihāng valley cross into the Tsan-po valley—the Doshung La at the head of the river of that name, and the Lungma (Lulung) La at the head of the Simu branch of the Sirapateng (Sigong) river—have been accurately fixed and the routes leading to them surveyed. In addition four passes of minor importance, the Deyan La and Demya La at the top of the Nugong valley, the Lushe La at the top of the Ringang valley, and an unnamed pass at the head of the Sirapateng river, have been fixed approximately; the paths leading to them were not completely surveyed only because they were found impossible for loaded coolies.

Finally the approximate positions of the Nam La, by which the route from the northern part of Pemakoi-chen up the Nyalam Chu crosses the main range

to Gyala, and that of the Tunga La at the head of the Siom valley have been obtained from local information.

The course of the Dihāng river itself and those of all its tributaries south of latitude $29^{\circ} 30'$ (except the head-waters of the Siom) have been accurately surveyed up to that parallel.

The correct position of the Tsan-po river in the neighbourhood of Gyala has also been determined, which enables us to correct the course of that river as shown on existing maps from Chetang to Gyala; and a certain amount of new geographical knowledge about the country to the north of the main range has been obtained.

The identity of the Tsan-po and the Dihāng as one and the same river has been established to all intents and purposes. Kinthup's statement that the Tsan-po broke through the Himālayas from Tibet to Pemakoi-chen in a deep gorge has been confirmed, the position of this gorge has been fixed with a fair degree of exactitude, and only a short length of the Dihāng river (probably not more than 30 miles measured along the bends of the river) between latitude $29^{\circ} 30'$ and the eastern end of the gorge in about latitude $29^{\circ} 45'$ has not been surveyed, though actually we are able to show this small portion on the map with tolerable certitude from local information pending the final confirmation of Captain Morshead's surveys.

These will also confirm and of course correct the sketch map, which has been compiled from local information, of the areas known as Potodh, Pomed and Poyul which lie to the north of Pemakoi-chen and which are drained by the big river Po Tsang Chu and its tributaries.

The headwaters of this river (known as Nagong Chu) were discovered by Surveyor A. K. in the autumn of 1882 flowing west after rising in the mountains in which Shuiden Gom-pa is situated in about latitude $29^{\circ} 30'$, longitude $97^{\circ} 0'$.

It is now clearly established (though actual surveys in confirmation are still wanting) that this Nagong Chu or Po Tsang Chu does not flow into the Dihāng river or into the Rong Thod Chu, but that it joins the Dihāng river in the vicinity of Gompone monastery at or near the eastern end of the big gorge through the Himālayas. Whether this river pierces the main range at any point higher up in its course must remain a moot point until the question is settled on Captain Morshead's return to India; all the evidence we have obtained up to the present points to the fact that the big range of mountains discovered by A. K. in 1882 on his return journey to Lhāsa from Shuiden Gom-pa, which bounds Potodh, Pomed, and Poyul on the north, and divides that country from the valley of the Giama-Nu Chu (or Upper Salween river) is probably a section of the main range of Himālayas; in which case the Po Tsang Chu would not break through it at any point.

Unfortunately it was impossible to carry out that particular requirement of the Government of India to fix the main range east (or probably north) of the Tsan-po Gorge.

If, as has been suggested above, the range trends nearly due north from the gorge—and visual evidence was obtained at Phea Doshung to support this theory—and joins the mountains which divide Potodh, Pomed, and Poyul on the south from the valley of the Giama-Nu Chu on the north, it would not be possible to survey or even fix the direction of such a range approximately without entering Pomed.

This the Abor Exploration party was unable to do, even had time permitted, owing to an insufficiency of transport and escort.

As a net result of the surveys executed during 1912-13 it may fairly be claimed that the whole programme of survey for the Abor Exploration party as laid down by the Government of India has been practically accomplished.

9. During the Abor Expedition in 1911-12 a short series of triangulation,

Triangulation.

based on the side Nāri H. S. and Dutia P. S. of the Assam valley (G. T.)

series (Synoptical Volume XXII), was carried northwards over the outer range into the Dihāng valley. Two stations of this series, Bapu h. s. and Torne h. s., are situated on the outer range; the other two terminal stations, Sadap h. s. and Namkam h. s., are situated in the lower portion of the Dihāng valley in about the latitude of Kebang village. Namkam h. s. is on the left bank of the Dihāng, on the southern end of the watershed between that river and the Yamne; the other three stations are on the right bank of the Dihāng river. When this series was computed during the summer of 1912 the figures were "ground down" roughly; the mean triangular error is 4.0 seconds and the mean linear error for four common sides is 1.8 inches per mile.

It may therefore be classed as good "minor" triangulation or even better. A fifth station Pangi h. s. was observed at in connection with the series, but the triangle Torne-Sadap-Pangi is a supplementary one and not part of the series.

North of the series five independent stations in the Dihāng valley were observed from—Arte, Simong, Geku, Shumsing and Peram. They could not be connected with the series in the ordinary way and were computed by interpolation from some of the intersected points fixed from stations of the series.

Altogether 45 new intersected points were fixed during 1911-12.

In 1912-13 the series was considerably extended by the Abor Exploration party. Bapu h. s. was re-observed at and a new station, Kine h. s. situated on the outer range east of the Dihāng, was also established before the close of 1912. Kine was fixed by two triangles, one angle of each being unobserved. The observations were however made to opaque signals and the two values obtained for the side Kine-Bapu show a discrepancy of only 1.3 feet, or 0.9 inches per mile, so that Kine may be considered well fixed.

A plain's station was also fixed in December 1912 at Pasighat, included in the series chiefly to provide an accurate point for the closing of traverses across the plains between the Brahmaputra and the outer range in future.

After the failure of an attempt, made in February 1913, to extend the series northwards by establishing stations on the big spur at the head of the Yamne valley, the series was eventually completed about the beginning of June 1913 by observations made from three new stations west of the Dihāng river, Loyung h. s., Luyor h. s., and Dino h. s.:

The first is situated on the right bank of the Dihāng near Bomo village, the second on the Sike-Dihāng watershed, and the third on the right bank of the Dihāng near Pango village.

Though all the angles of this triangle Loyung-Luyor-Dino were observed to signals, the triangular error being 3 seconds only, it was not possible to connect it with the two forward stations in the series of the previous season. The connection with the series had to be made as follows. The side Kine-Loyung was obtained from triangles (with one angle of each unobserved) off five well fixed intersected points. A mean of the values was taken giving a probable error

of 12 feet, or 0·3 inches per mile. Off the *corrected* sides of the same five triangles the side Loyung-Dino was obtained, the mean of the five values giving a probable error of 5 feet, or 3·4 inches per mile. From this mean value of the side Loyung-Dino, the triangle Dino-Loyung-Luyor was computed, giving one value for the side Loyung-Luyor. Another value for this side was obtained, the mean giving a probable error of 10 feet or 9·7 inches per mile.

These two values for the side Loyung-Luyor differed by 4 feet only, or 3·8 inches per mile. The mean of these two values was accepted as the final base from which the triangle Loyung-Luyor-Dino was recomputed.

North of these three stations, but unconnected with them, an interpolation was made from several well fixed intersected points at Nishing h. s., on the ridge of the same name near Geling village, towards the end of June 1913 to provide a few more intersected points for the plane-tablers. In addition one station with an auxiliary station near it was made at Miging village in July 1913 for the purpose of obtaining an accurate value of the height of the Dihāng river at its junction with the Sirapateng river (1,270 feet).

As a result of the triangulation carried out in 1912-13 it has been decided to treat the five independent stations, Arte, Simong, Geku, Shumsing and Peram of 1911-12 merely as intersected points, and all work dependent on them has therefore been rejected. Many of the intersected points fixed in 1911-12, having been fixed more accurately in 1912-13, have also been recomputed.

The total number of intersected points which have been finally obtained from the triangulation of both seasons is 125.

No useful purpose would be served in working out a mean linear error for all these intersected points, as so many special factors which cause the errors to vary abnormally in any trans-frontier triangulation would have to be taken into consideration.

Errors in rays to sharply defined snow peaks for instance are naturally less in proportion than in rays to rounded jungle clad hills. The quality also of the northern portion of the series as triangulation is not, by nature of its connection, as good as the southern portion.

The most accurately fixed intersected points, *viz.*, nine sharply defined snow peaks were computed in more detail than the rest because they were required for use in extending the triangulation.

These nine peaks should serve as well fixed points from which an extension of the triangulation to the north and north-east could in future be made if necessary.

No connection has been made with the triangulation executed by the Miri Mission Survey detachment in 1911-12, or by the Dibāng Exploration party in 1912-13. Some of the peaks on a part of the Dihāng-Subansiri watershed (the common margin) intersected from the Dihāng series appear to be identical with those fixed by the Miri Mission triangulation, but there is sufficient discrepancy between the coordinates in nearly every case to affect the work of the plane-tablet considerably (even on the $\frac{1}{4}$ -inch scale) if both sets of points are used indiscriminately.

A partial explanation of this discrepancy lies in the fact that, although both the Subansiri and Dihāng triangulation emanate from the same Assam valley series, these identical peaks were observed from opposite sides of the watershed, different features on the same peak being observed to from either

side. Another reason is the inferiority of the Subansiri series as compared with that in the Dihāng. The Subansiri series of 1911-12 was extended from Colonel Woodthorpe's stations of 1877-78, which are connected somewhat precariously with the Assam valley series.

If therefore the Subansiri series is ever extended northwards without revision it is doubtful whether the intersected points of the Dihāng series on this watershed can be utilized for accurate theodolite interpolations in the Subansiri valley unless some means can be devised to connect the two series and adjust the present discrepancies.

No identical points on the common margin the Dihāng-Dibāng watershed have been fixed by the Dihāng and Dibāng triangulation. Even had the same peak been fixed in any case from either side the discrepancy between the coordinates would be considerable, as the two series are not in the same terms and the basis of the Dibāng triangulation is unreliable.

During both seasons it proved a difficult and troublesome matter to arrive at a satisfactory coefficient of refraction. Seeing that even in the finest spells of weather in the Dihāng basin all snow peaks and most of the lower hill tops are invariably hidden in cloud after 8 or 9 A.M., for the rest of the day, most vertical angle observations have to be taken in the early morning instead of at the time of minimum refraction. This may possibly account for the large discrepancies which have been experienced in working out this coefficient.

Eleven reciprocal values for heights were obtained in 1911-12; five of these were from the hills to the plains, but the mean coefficient for the remaining six values in the hills worked out to $\cdot 041$.

Though this figure seemed too low it was adopted in the absence of any other more reliable data to work out the heights of all the intersected points fixed in 1911-12. However, as the triangulation of 1912-13 was extended northwards, disagreements in values for heights of the more distant intersected points indicated that this coefficient was too low and that the correct coefficient would probably be about $\cdot 060$ or $\cdot 065$.

As a result of all the triangulation of 1912-13 seven more reciprocal height values were obtained, six of which were in the hills. The mean coefficient for these six values worked out to $\cdot 079$; and the mean of the twelve values of both seasons therefore gives a coefficient of $\cdot 060$.

As however the Dibāng triangulation of 1912-13 had resulted in a mean coefficient of $\cdot 069$ from 21 reciprocal height values, the matter was referred to the Superintendent of the Trigonometrical Survey who decided that the usual coefficient $\cdot 070$ should be adopted. The heights of all the intersected points fixed in both seasons have been recomputed with this coefficient.

5" micrometer theodolites (by Troughton & Sims) were used both seasons. Though three khalasis are required to carry one of these instruments and its stand, this disadvantage is greatly outweighed by its superiority over a lighter vernier instrument, both in accuracy and the ease and quickness with which observations can be made.

Usually it was found quite sufficient to read only one horizontal and one vertical microscope, a great consideration on the North-East Frontier where speed in observing is all essential owing to the limitations imposed by an extremely adverse climate.

The adjustment of the micrometers of these instruments is not affected by rough usage nearly as much as might be expected. It was only possible to use

heliotropes at the one plain's station Dutia in 1911-12. Otherwise opaque signals of various types were used for all the remaining stations in both seasons; the best and most usual type of signal being a single tree left standing on all the jungle covered hill tops, the other trees all round it being cut down.

Attempts were made on several occasions to build machans in big trees in order to save the heavy labour of clearing, but none of these attempts proved satisfactory. At two or three stations the top of a tree was cut off several feet above ground level, the stump being used as a stand for the theodolite with a rough machan built round it as a platform for the observers. This is the most satisfactory kind of machan, but skilled labour is required to remove the tree top at a sufficient height from the ground and to build a reasonably secure platform of that height.

The station marks have been cut on rocks *in situ* wherever possible; at some of the stations however the mark had to be cut on tree stumps and cannot therefore be relied on as permanent.

Mention has already been made of the extraordinarily dense vegetation which covers all the hills in the Dihāng river basin right up to permanent snow level, and of the execrable climate, both of which offer the greatest impediments to triangulation and render hasty reconnaissance work impossible.

The heavy clearing which had to be undertaken in the preparation of every hill station, especially as the tops of the lower hills are usually flat rather than pointed, rendered it essential to select as few stations as possible, and a very large number of observations therefore had to be made at each station. The only weather suitable for triangulation is experienced between the middle of October and the middle of January. At any other time of year the triangulator must be prepared to wait several days on each hill station before one of the infrequent spells of fine weather occurs to make any work possible.

As also snow peaks and all the higher hills are only visible between dawn and 8 or 9 A.M. at all seasons of the year the triangulator must be encamped in the immediate vicinity of the station so that he can start work at dawn. Water is seldom found near the tops of hills below snow level so arrangements must be made for carrying it up to the camp on the hill top. Canvas chagals are useful but wear out very quickly. Choongas made out of bamboos are excellent but not always obtainable. The best arrangement of all for survey detachments working on the North-East Frontier would be a light metal pakhal covered with rope netting to protect it from damage, of similar pattern to the regulation mule pakhal but designed to weigh not more than 60 lbs. when full, so that it could be carried by a coolie.

10. During the Abor Expedition of 1911-12 the total area plane-tabled on the scale of 4 miles to 1 inch amounted to about 2,300 square miles; of this total area however only about 1,730 square miles were more or less rigorously surveyed, the remaining 570 square miles consisting of approximate reconnaissance surveys by members of the detachment. Compilations of the sketches, reports, etc., submitted by the Intelligence and other officers of the Force have not been included in the above totals.

Owing principally to the impossibility of executing any triangulation until towards the close of the expedition, plane-tableing was carried out under great difficulties in an area devoid for the most part of triangulated points.

For this reason no contouring could be done, all hill features were shown by (horizontal) hill shading.

The following table shows the total outturns of the individual members of the Abor Expedition Survey detachment in 1911-12 :—

Name.	Outturn, square miles.	Approximate number of working days.
Mr. Sher Jang, Khan Bahadur	1,431	50
Surveyor Hamid Gul	1,512	60
„ Abdul Majid	230	15
„ Abdur Rahim	345	25
„ Shah Muhammad	92	4

The large difference between the aggregate of these individual outturns and the total area (2,300 square miles) surveyed is due to the unavoidable duplication of work caused, as on most military expeditions, by the inevitable subordination of survey considerations to military and political requirements.

The numbers of working days shown in the above table are only approximate; it is impossible to work out accurate totals expressed in complete working days put in by surveyors employed with military expeditions and exploration parties. As has been mentioned in a preceding paragraph practically the whole of the plane-tabling was accomplished in the last three months—January to March 1912—before the Expedition returned to India.

Before the Abor Exploration party started work in 1912-13, the outline fair sheet of the previous season's work had been drawn and all the triangulation data had been computed. As the same area had to be covered again during the advance up the Dihāng valley it was decided to contour the work of the previous season.

Blue prints on mounted drawing paper of the fair outline sheet were accordingly obtained and given to the surveyors of the Abor Exploration Survey detachment to facilitate this work. These blue prints were attached to the plane-tables by a few strips of adhesive plaster, a small overlap of the print being first turned down all round the edge of the plane-table. This arrangement proved very satisfactory and resulted in very little distortion.

Except for the fringe of flat densely forested country between the Brahmaputra and the outer range the whole area (about 2,000 sq. miles) surveyed in the previous season was thus contoured during 1912-13.

This entailed practically the resurvey of the whole of this area and incidentally disclosed the excellence of the work of Mr. Sher Jang and Surveyor Hamid Gul in 1911-12.

This work of contouring the lower portion of the Dihāng basin was completed in the first half of the season 1912-13, while the extension northwards of the main line of communications was in progress. As the extension of the series of triangulation was also completed before the Exploration party reached the unsurveyed area in the northern part of the Dihāng basin, the plane-tables were supplied with triangulated points before starting work in this area, and so were able to continue the work of contouring throughout the season.

The upper portions of two valleys only, the Sirapateng and the Doshung-Pemasiri, could not be accurately surveyed and contoured owing to the bad weather experienced while the surveyors were working in them. Reconnaissance surveys (based on prismatic compass traverses) could only be accomplished in these two cases, comprising a total area of 722 sq. miles. The area surveyed in detail and contoured in the remainder of the Dihāng valley basin during 1912-13, including the 2,000 sq. miles resurvey of the previous season's work, amounted to 5,478 sq. miles.

The total area surveyed in the Dihāng basin during 1912-13 is therefore 6,200 sq. miles.

In addition a reconnaissance survey of about 140 sq. miles was executed by Surveyor Hamid Gul of the head-waters of the Siu valley, a tributary of the Subansiri river.

Thus the total outturn of the plane-tabling in 1912-13 amounts to 6,340 sq. miles.

The following table shows the total outturns of the individual members of the Abor Exploration Survey detachment:—

Name.	Outturn, sq. miles.	Approximate number of working days.
Captain Trenchard, R.E.	239	10
„ Oakes, R.E.	328	10
Lieutenant Huddleston, R.E.	400	15
Surveyor Hamid Gul	3,790	120
„ Bhamba Ram	1,333	50
„ Anwar Ali	250	20

11. At the close of the Abor Expedition rough outline and hill originals were prepared in Kobo while the detachment was awaiting demobilization orders at the beginning of April 1912.

Mapping.

From these a provisional map of the surveys of 1911-12 was published in colours by the Map Publication Office towards the end of the same month.

By the end of September 1912 all the computations had been finished and the outline sheet of the fair map was practically completed. (Blue prints of this outline sheet were used in 1912-13 for the resurvey and contouring of that area). The fair map of the Abor Expedition Surveys was not completed nor published however, as the Surveyor General decided, when sanction for the operations of 1912-13 had been received, that publication should await the completion of surveys in that season. This mapping is now in hand.

12. Mention has already been made in paragraph 6 of this report of the explorations of Kinthup in the Dihāng basin between 1881 and 1884.

The Explorer Kinthup.

As prominence has been given of late to the opinion of certain geographers that the geographical information which Kinthup supplied about the Dihāng basin was merely collected by him in Tibet without visiting the Dihāng valley and is therefore unreliable, this report seems a fit place to examine his work

briefly in the light of the recent surveys carried out by the Abor Exploration party.

Firstly the accuracy of his names is very striking. In Pemakoi-chen and the Abor country he gives 57 names of which 34 fall within the area recently surveyed. Of these 34 names only 6 were not found : two being names of camps or caves, one a village since deserted, while the other three might well be known now under different names. Of the remaining 23 names which Kintthup gives beyond the area recently surveyed all except three were confirmed by information obtained locally by the Political Officer in charge of the Abor Exploration party ; two of the unverified names being those of caves and the third that of a pass.

Secondly, his description of the physical features of the different parts in which he travelled is remarkably correct. In the more intricate parts of this tangle of hills and winding rivers it was sometimes difficult to picture the topography from his account before actually visiting it, but, as a rule, it would be impossible to give a more accurate description in as few words.

Seeing that he was unable to keep a written record of his travels extending over a period of four years the accuracy of his account is remarkable. In the area recently surveyed he only appears to have made two geographical mistakes worth considering :—

(i) Between Mobuk (or Gobuk) and Onlet (now known as Olon or Milang) villages he mistook the Yamne valley for that of the Dihāng.

(ii) He stated that the river issuing from Sanga Chu Dzong joins the Tsan-po about three miles from Miri Padam.

As regards the first mistake anyone who has experienced days of continuous rain and mist among the intricate and often very deceptive hill features of the Abor country will realize how easy it is even for trained topographers to make such mistakes. Further it must be remembered that at this the most southerly point in his journey he was attempting to reach Assam and was following the direct trade route from Simong in the Dihāng valley to Sadiyā when he was turned back by Padam Abors at Onlet (Olon or Milang) village in the Yamne valley. It is easy to understand how, after crossing the low saddle from Simong into the Yamne valley he must have concluded that the river below him flowing south must be the same as the one he had just left. The second mistake appears to be the result of one of the few attempts he made to compile a topographical description from local information without actually visiting the ground. As this particular bit of information was obtained from Abors whose language he did not understand it is not surprising that he made this mistake. With these exceptions Kintthup made no serious mistakes.

Some of his critics, with the very insufficient knowledge of the Dihāng basin obtained only in the Abor Expedition of 1911-12, have fastened on trifling details in his report in their attempts to prove that his whole account is purely imaginary.

One critic, for instance, maintained that there are no pine trees or apples in the Abor country as stated by Kintthup, and expressed his surprise that Kintthup should have omitted to mention Jido, a large Abor village near the junction of the Yang Sang Chu with the Dihāng.

Kintthup may not have known the different varieties of conifers, or may have been wrongly translated. One variety, the cypress, flourishes in many

parts of the Abor hills, and with the crab apple (eaten by Abors) has been found in most of the localities described by Kinthup. Jido village was not built until three years after Kinthup had returned to India.

In short the theory that he must have ascended some high mountain in Tibet overlooking the Dihāng basin from which all the villages on the Dihāng were pointed out and described to him, and that he merely committed all these names, details of routes, etc., to memory without leaving Tibet is utterly ludicrous, specially when advanced by those who have themselves visited even a small portion of this Dihāng basin.

His account has been confirmed in the most remarkable manner and we are now able to establish Kinthup's claim to honourable record in the annals of the Survey of India, which he served with such zeal and devotion to duty.

REPORT ON THE MĪRI MISSION SURVEY DETACHMENT, 1911-12.

BY LIEUTENANT C. G. LEWIS, R.E.

1. Orders were issued in September by the Surveyor General for the formation of a detachment to accompany the Political Mission into the Miri hills.

Introductory.

The Mission was a part of the general operations along the North-East Frontier, its locale being the western-most of the four sections of the Frontier to which the various expeditions were allotted.

2. The area allotted to the Miri Mission extended from Bhutān on the west to the Dihāng watershed on the east, and included an area of some 10,000

Area allotted.

square miles. This would have required two separate expeditions starting from Gaubāti and North Lakhimpur respectively, and was altogether beyond the scope of the small mission sanctioned.

3. The Mission left North Lakhimpur on the 10th November 1911. It was at first proposed to reach Chemir on

Brief account of the operations of the mission.

the right bank of the Kamla river by a direct route entering the hills from Seājuli tea garden, and to form advanced base at that place. The path, selected without reconnaissance, proved to be impracticable and had to be abandoned in favour of the ordinary route through the Subansiri gorge, thus involving a change of base from Seājuli to Dulangmukh. Much valuable time was lost by this unfortunate and unnecessary check at the start, and it was not until the beginning of December that the first convoys of coolies began to move forward from Siphumukh. The section from Dulangmukh to Siphumukh was traversed by river in dug-outs. A depôt was formed at Gocham on the Kamla ; this was afterwards abandoned, as it was off the direct route from Siphumukh to Peinmukh (Chemir). From Gocham a small party accompanied by 8 rifles made a reconnaissance into the Subansiri valley leaving on the 27th December and returning on the 9th January 1912 to Peinmukh.

On the 15th January the main body moved forward from Peinmukh reaching Tāli, the most advanced post, on the 9th February.

Considerable opposition from the Miris was encountered during the last four marches, and on the 14th February an attack was made on the Tāli post by a large body of tribesmen, who were, however, repulsed with a loss of some 20 men. This episode prevented further advance.

Owing to bad weather, survey work had been at a stand-still since the beginning of February, and a considerable area remained unsurveyed which could have been completed but for the continuous rain and mist. The whole Mission reassembled at Peinmukh on the 2nd March and the return to the plains was made through the Apa Tanang country and down the Rangānadi, thus enabling the survey to be joined up with previous work in the Dikrang valley to the south-west.

North Lakhimpur was reached on the 17th March. The detachment remained ten days there for the completion of plane-table sections, settlement

of accounts, etc., and left for Calcutta by river steamer on the 28th March, arriving on the 5th April.

The detachment broke up on the 20th April.

Strength. 4. The detachment consisted of 2 British Officers, 2 Surveyors, a Sub-Assistant Surgeon and 22 khalasis.

Lieutenant A. A. Chase, R.E., was originally deputed in charge, but falling sick early in October, was unable to proceed. Lieutenant C. G. Lewis, R.E., was then detailed.

Lieutenant R. S. Wahab, I.A., was the second Imperial officer.

Surveyors.—Jumna Prasad and Muhammad Nabi.

Sub-Assistant Surgeon.—Badri Prasad, I.S.M.D.

5. Lieutenants Lewis and Wahab arrived in Calcutta from Bangalore and Mussoorie respectively, on the 15th October. Lieutenant Lewis proceeded at once

Preliminary arrangements. to Dibrugarh to meet the Political Officer and ascertain the proposed route and arrange for transport and rations; he returned to Calcutta on the 26th. Lieutenant Wahab, in the meantime, had taken over the equipment and instruments. Surveyor Jumna Prasad from No. 2 Party arrived on the 26th October, while surveyor Muhammad Nabi from No. 1 Party did not join till the 10th November in North Lakhimpur. The detachment left Calcutta on the 29th October and proceeded by rail to Gauhati, thence by river steamer to Ghagarmukh on the Subansiri, 12 miles by road from North Lakhimpur reaching the latter place on the 3rd November.

There had been no time to prepare the plane-tables in Calcutta, consequently there was good deal of work to be done during the week available, before the Mission started. Plane-tables were projected and plotted, and instruments tested, sun and star observations for latitude, time and azimuth were taken daily by both officers, although, subsequently, owing to the sufficiency of triangulated points astronomical observations were not found necessary.

6. Twenty khalasis were sanctioned, 6 for each officer and 4 for each surveyor, and two extra men were entered Khalasis. retained to look after the spare equipment at North Lakhimpur. With the exception of seven men (5 Muhammadans and 2 Hindus) from the Northern Circle, all were Hazaribagh khalasis. A sufficient number of men had been recruited by the Eastern Circle recruiting officer, for the requirements of the four expeditions, and the Miri detachment being the last to start, had to be content with all the inferior men, who had not been selected for the other detachments. Several of these men were afterwards dismissed, and their places filled by Nepalese coolies, who are far superior to the Hazaribagh men, in this sort of country. For future expeditions in these hills it is recommended that only a small proportion of the best Hazaribagh tindals be taken, and the squads made up with Nepalese. For an officer with both plane-table and theodolite, 8 men are required, for a surveyor with plane-table only, 4 men are sufficient.*

7. The clothing for each khalasi amounted to over 20 lbs. in weight and

* These numbers are in excess of those laid down, but may be taken as the minimum consistent with efficiency, which are required in country of such a difficult nature as these hills.

with the addition of cooking pots, etc., it was found that one coolie was required for two khalasis.

Small American hand-axes carried slung on the belt, were most useful, the Hazāribāgh men being able to use them with better effect than the kukris.

Nails for the khalasis' boots are essential, as boots are nearly useless on the slippery paths, without them. Swiss climbing nails, turning up over the welt are recommended.

8. Light single fly tents weighing 14 to 18 lbs. were carried by officers and surveyors, but as a rule they were only used when camping near hill tops, where the foliage was unsuitable for the construction of rain-proof shelters.

At ordinary elevations (the average camp was at about 3,000 feet altitude) bamboo and wild plantain were generally to be found, the latter makes an excellent roof and is quite rain-proof for several days. Large water-proof paulins of light canvas were found extremely useful. When pressed for time one or more of these stretched over a framework roof, made an excellent shelter.

9. The theodolites used were Cooke's 5" micrometer in two boxes; these were fitted together, in stiff canvas cases with slings, but this formed a load much too heavy for a khalasi to carry, and they were always carried separately. Separate covers should be prepared for each box.

Perambulators and pedometers are quite useless in these hills.

Folding sight rules, if they are strongly constructed, are more useful than those with rigid vanes, as the former can be carried in the plane-table cover whereas the latter require a box.

Aneroids were found fairly accurate if checked soon, both before and after the observations.

Chronometers should be 'hunters' or 'half-hunters,' or else spare glasses should be taken; several of the glasses were broken and the watches thus rendered useless.

10. Lieutenant Lewis was employed on triangulation and plane-tabling, Lieutenant Wahab and the two surveyors on plane-tabling.

Owing to the country beyond the first few Miri villages being quite unknown and the attitude of the tribes doubtful it was impossible to let small parties move out to any distance from the main line, for survey purposes. On three occasions independent parties were sent out for a rapid reconnaissance with rations for ten to fourteen days. The first left Gocham on the 27th December and proceeded over Podu hill into the Subansiri valley. Lieutenant Wahab accompanied this party and succeeded in completing a large area in spite of very unfavourable weather conditions and considerable opposition from the Miris. Up to this time there had been no opportunities for employing the surveyors, but on the 9th January Surveyor Jumna Prasad with an escort of 4 rifles proceeded up the Pein valley from Peinmukh and returned after ten days, having completed the survey of the Pein basin and caught a glimpse of the Apa Tanang country with its wide stretches of wet cultivation and large villages. On the 21st another party proceeded up the Khru valley returning by the Pisi valley to Sartam where they rejoined the main body. The weather conditions were getting rapidly worse and during the latter half of this trip rain fell

almost continuously. In the meantime, the main valley of the Kamla above Peinmukh was surveyed by Surveyor Muhammad Nabi whose work joined up with that of Lieutenant Lewis. The latter, by fixing trigonometrically a number of near points from the two stations on Rōmta hill, was able to put in the valleys to the north and east from this one point.

11. The following approximate areas were surveyed by the members of the

Area surveyed.	detachment :—	
Lieutenant C. G. Lewis	600	square miles.
Lieutenant R. S. Wahab	400	" "
Surveyor Jumna Prasad	700	" "
Surveyor Muhammad Nabi	300	" "
	TOTAL	2,000 " "

The total area surveyed was very disappointing. Three months were taken to cover the fifteen marches between the base Dulangmukh and Tāli the furthest point reached. Under favourable conditions Tāli should have been reached by the middle of December, but the Mission was delayed throughout by transport difficulties.

12. The survey was on the scale of 1 inch to 4 miles. Plane-tabling by interpolation was as a rule possible, except in the southern-most hills adjoining the plains, where the jungle growth is so dense that fixings are not obtainable without laborious clearing operations. Plane-table traversing was rarely necessary. A prismatic compass and pacing traverse was resorted to for the survey of paths which passed through several miles of unbroken jungle.

13. The points supplied by previous triangulation were quite insufficient for the plane-tablers and many of them were found to be wrong.

Three new stations Podu h. s., Rōmta N.E. h. s., and Rōmta S.W. h. s., and one old G. T. secondary station Dichu H.S., were observed from. The connection with the previous triangulation of Lieutenant Woodthorpe in 1877-78 was of a precarious nature, but the results proved very satisfactory under the circumstances. From Podu h. s., Yelu, Dichu and S. Potu H.S. were observed to; as the latter station could not be visited in order to clear it of jungle and show a helio or signal, the triangulator was obliged to estimate the position of the markstone at the centre of the hill top (which was fortunately a pointed one).

From these stations Podu h. s. was computed as an interpolated station, the angles being afterwards corrected when Dichu H.S. was visited. A large number of snow peaks were observed to from Podu h. s., most of which were identified from Rōmta. The total number of points computed was 116, of which 41 were distant snow peaks.

An azimuth was observed at Podu h. s., but the conditions were not such as to justify its value being accepted.

The average linear error of intersected points is 5.2 feet per mile, determined from 49 common sides.

Four G. T. intersected peaks on extreme west were observed to at an average distance of 100 miles, the mean differences between the G. T. values and those now obtained were 2".2 in latitude and 2".4 in longitude and 54 feet in height. Differences scarcely plottable on the $\frac{1}{4}$ -inch scale.

A coefficient of refraction of 0·06 was adopted ; this was the value obtained by reciprocal observations from Podu and Dichu.

14. The chief characteristic of these hills is the extraordinary density of the jungle growth at all elevations, rendering survey work very tedious and difficult and necessitating much loss of time in the clearing of hill tops. It was only at 12,000 feet that the jungle began to thin out. The country as far north as the snow ranges showed no signs of alteration in this respect.

In the main valleys of the Kamla, Khru and Subansiri a typical cross section is as follows :—

From the watershed at an average height of 8,000 feet, the ground drops steeply for 2,000 or 3,000 feet, the slope then gradually decreases to a minimum at about 3,500 feet, below which it falls abruptly to the river; the steepest part, immediately above the river bed, is often precipitous.

On the shoulder thus formed between 3,000 and 4,000 feet most of the Miri villages are situated. A village of average size consists of 8 to 12 houses with a population of 150 to 200.

The ever-green jungle gives way in many places at this altitude to more open grass lands, whence a good view is obtained. The *jhūms*, or hill-side clearings for the cultivation of rice and millet, often facilitate a fixing in places where it would otherwise be impossible.

The paths never follow the river banks, the precipitous nature of which would render this difficult or impossible ; they rise and fall over each succeeding spur at an average elevation of between 2,000 and 3,000 feet. In passing from one valley to another the path almost invariably passes over the highest hill on the intervening ridge. There is a reason for this. In order to avoid the dense undergrowth, obstructions from fallen trees, and the excessive weathering which occur on the steeper slopes of a valley, the path is taken up a main spur with a less steep gradient ; such a spur always leads up to a hill top ; the path is thus obliged to pass over the hill instead of over a saddle which may be considerably lower, but to which access will be more difficult ; for the Miris are an indolent folk, who prefer circuitous communications to the labour of road maintenance.

The Kamla and Khru rivers consist of a series of rapids and broken water throughout their whole course; the average bed fall is, however, comparatively small: only about 10 to 12 feet per mile as far up as surveyed. The Subansiri, on the other hand, though it contains many rapids below the Kamla confluence, has long stretches of level water above this point, and would be navigable for dug-outs for many miles upstream.

The most interesting and remarkable feature of these hills is the Apa Tanang country. At an altitude of 5,000 feet the Kāl river (a tributary of the Rangānadi) forms a broad flat valley some 6 miles in length and 2 to 3 miles broad. This plain is cultivated throughout by a clever and intricate system of irrigated rice fields in the midst of which are situated the villages of the Apa Tanang tribe. The villages are systematically laid out with main and side streets, lined by neatly constructed houses, and form compact towns for the accommodation of the large population, estimated at 20,000. Elaborate arrangements are made for the collection and storage of fire-wood, which is brought down by well graded paths from the surrounding jungle clad hills.

The valley is dotted with small hillocks on which plantations of bamboo and pine are maintained. Those portions of the valley which are not given up to rice cultivation, form grazing land for herds of cattle, and are covered with a thick carpet of turf and flowers, of which the most common is the primula.

The tribe is in a far more advanced state of civilisation than the neighbouring Daffās and Miris, and is in strong contrast to them in most respects. They are more peaceably inclined and trust to their great superiority in numbers to act as a deterrent against hostile incursions.

This fertile valley is unique in the whole area of the Daffā Miri hills and forms a veritable oasis in a wilderness of unbroken ever-green jungle.

15. The most suitable time for survey work is during November and December, when the hills are comparatively free from rain. After the middle of January, rainy and misty weather again prevails.

Best season for survey.

During the fine weather, the valley mists, lying between 2,000 and 4,000 feet, from early morning until midday when they are finally dispersed by the heat of the sun, form a great hindrance to plane-tableing.

16. (a) *Geographical*.—The Mission did not penetrate far enough into the higher ranges to settle all doubts concerning head-waters of the Subansirī and Kamla rivers. At the same time, from the general position of the snow ranges fixed by triangulated peaks and by careful observation from the higher hills visited, it would appear improbable that either of these rivers rise to the north of the main range. The whole courses of the Kamla and Khru rivers were seen from Rōmta and from hill tops in the Khru valley; both rivers appear to take their rise in the high snowy range (20,000 to 23,000 feet) and no evidence of a break in this range could be detected through which either of these rivers might pass. At their junction the Kamla is only slightly larger in volume than the Khru and both are quite clear water, which would indicate that there is not much difference in area between their respective catchments, and that the proportion of glacier water from the higher ranges is small, otherwise the water would be more turbid.

Information obtained by the Mission.

The same argument is applicable to the Subansirī river, the volume of this river is about equal to that of the Kamla, at its junction with the latter, as far as it is possible to judge without actual measurement. Its water is perfectly clear (though it is no doubt quite possible for the glacier worn particles in suspension to have settled out before the river reaches the lower portion of its course)*.

(b) *Civil*.—The relations between the various clans, the extent of their trade with Tibet and with the plains, were investigated, and information was obtained as to the number of houses and names of headmen of 112 villages.

17. The only previous work in the Miri hills was that done by Lieutenant Woodthorpe, R.E., during the season 1877-78. The area surveyed included the outer ranges from the Rangānadi to the Subansirī and the valley of the Sidan river east of the Subansirī. Considering the short time at his disposal and the absence of fixed points the work was fairly accurate, though consider-

Previous surveys.

* From Captain Moorhead's explorations in 1913 it is now almost certain that the Subansirī does rise north of the main range and is identical with the Char Chu.

able revision was required in the N.W. portion where the detail was much out of position.

On the return journey of the Mission through the Rangānādī valley, the work was joined up with the previous survey in the Dikrang valley on the west by Captain Godwin-Austin, R.E.

The survey of the outer hills is now virtually complete as far east as the Dhal river.

18. The range of hills forming the watershed between the Subansirī and

Connection with Abor survey. Dihāng rivers was fixed by both parties.

The main streams on either side were inserted approximately. Rigorous survey, however, was not connected at any point.

19. On the whole, the health of the detachment was very good throughout. Both officers and surveyors kept

Health of the party.

quite fit; and there was comparatively little sickness amongst the khalasis. Mosquitoes were seldom met with, and there were very few cases of malaria.

20. During recess, a fair map of the work done, including previous surveys, was prepared by Lieutenant

Recess work.

Lewis in Bangalore and submitted for

publication during September 1912.

APPENDIX.

LIST OF SURVEY OF INDIA PUBLICATIONS.

Unless otherwise stated the publications can be obtained from the Superintendent, Map Publications, 13 Wood Street, Calcutta.

ACCOUNT OF THE OPERATIONS OF THE GREAT TRIGONOMETRICAL SURVEY OF INDIA.

Obtainable from the Superintendent of the Trigonometrical Survey, Dehra Dūn, U. P.

Price Rupees 10-8 per volume, except where otherwise stated.

- Volume I. The Standards of Measure and the Base-Lines, also an Introductory Account of the early Operations of the Survey, during the period of 1800-1830. *By Colonel J. T. Walker, R.E., F.R.S., etc., etc., Superintendent of the Survey.* Dehra Dūn, 1870 (out of print).
- Do. II. History and General Description of the Principal Triangulation, and of its Reduction. *By Colonel J. T. Walker, C.B., R.E., F.R.S., etc., etc., Surveyor General of India and Superintendent of the Survey, and his Assistants.* Dehra Dūn, 1879 (out of print).
- Do. III. The Principal Triangulation, the Base-Line Figures, the Karāchi Longitudinal, N. W. Himalāya, and the Great Indus Series of the North-West Quadrilateral. *By Colonel J. T. Walker, R.E., F.R.S., etc., etc., Superintendent of the Trigonometrical Survey, and his Assistants.* Dehra Dūn, 1873 (out of print).
- Do. IV. The Principal Triangulation, the Great Arc—Section 24°—30°, Rabūn, Gurlāgarh and Jogi-Tila Meridional Series and the Sutlej Series of the North-West Quadrilateral. *By Colonel J. T. Walker, R.E., F.R.S., etc., etc., Superintendent of the Trigonometrical Survey, and his Assistants.* Dehra Dūn, 1876.
- Do. IVA. General Description of the Principal Triangulation of the Jodhpore and the Eastern Sind Meridional Series of the North-West Quadrilateral, with the Details of their Reduction and the Final Results. *Prepared in the Office of the Trigonometrical Branch, Survey of India, Colonel C. T. Haig, R.E., Officiating Deputy Surveyor General in charge, and published under the orders of Colonel G. C. DePrée, S.C., Surveyor General of India.* Dehra Dūn, 1886.
- Do. V. Details of the Pendulum Operations by Captains J. P. Basevi, R.E., and W. J. Heaviside, R.E., and of their Reduction. *Prepared under the directions of Major-General J. T. Walker, C.B., R.E., F.R.S., etc., etc., Surveyor General of India and Superintendent of the Trigonometrical Survey.* Dehra Dūn and Calcutta, 1879.
- Do. VI. The Principal Triangulation of the South-East Quadrilateral, including the Great Arc—Section 18° to 24°, the East Coast Series, the Calcutta and the Bider Longitudinal Series, the Jabalpur and the Bilāspur Meridional Series, and the details of their Simultaneous Reduction. *Prepared under the directions of Major-General J. T. Walker, C.B., R.E., F.R.S., etc., etc., Surveyor General of India and Superintendent of the Trigonometrical Survey.* Dehra Dūn, 1880 (out of print).
- Do. VII. General Description of the Principal Triangulation of the North-East Quadrilateral, including the Simultaneous Reduction and the Details of five of the component Series, the North-East Longitudinal, the Budhon Meridional, the Rungir Meridional, the Amua Meridional, and the Karāra Meridional. *Prepared under the directions of Lieutenant-General J. T. Walker, C.B., R.E., F.R.S., etc., etc., Surveyor General of India and Superintendent of the Trigonometrical Survey.* Dehra Dūn, 1882.
- Do. VIII. Details of the Principal Triangulation of eleven of the component Series of the North-East Quadrilateral, including the following Series; the Gurwāni Meridional, the Gora Meridional, the Hurilāong Meridional, the Chendwār Meridional, North Parasnāth Meridional, the North Malūncha Meridional, the Calcutta Meridional, the East Calcutta Longitudinal, the Brahmāpūtra Meridional, the Eastern Frontier—Section 23° to 26°, and the Assam Longitudinal. *Prepared under the directions of Lieutenant-General J. T. Walker, C.B., R.E., F.R.S., etc., etc., Surveyor General of India and Superintendent of the Trigonometrical Survey.* Dehra Dūn, 1882.
- Do. IX. Electro-Telegraphic Longitude Operations executed during the years 1875-77 and 1880-81, by Lieutenant-Colonel W. M. Campbell, R.E., and Major W. J. Heaviside, R.E. *Prepared under the directions of Lieutenant-General J. T. Walker, C.B., R.E., F.R.S., etc., etc., Surveyor General of India and Superintendent of the Trigonometrical Survey.* Dehra Dūn, 1883.
- Do. X. Electro-Telegraphic Longitude Operations executed during the years 1881-82, 1882-83, and 1883-84, by Major G. Strahan, R.E., and Major W. J. Heaviside, R.E. *Prepared under the directions of Colonel C. T. Haig, R.E., Deputy Surveyor General, Trigonometrical Branch, and published under the orders of Colonel H. R. Thuillier, R.E., Surveyor General of India.* Dehra Dūn, 1887.
- Do. XI. Astronomical Observations for Latitude made during the period 1805 to 1885, with a General Description of the Operations and Final Results. *Prepared under the directions of Lieutenant-Colonel G. Strahan, R.E., Deputy Surveyor General, Trigonometrical Branch, and published under the orders of Colonel H. R. Thuillier, R.E., Surveyor General of India.* Dehra Dūn, 1890.
- Do. XII. General Description of the Principal Triangulation of the Southern Trigon, including the Simultaneous Reduction and the Details of two of the component Series, the Great Arc Meridional—Section 8° to 18°, and the Bombay Longitudinal. *Prepared under the directions of Lieutenant-Colonel G. Strahan, R.E., Deputy Surveyor General, Trigonometrical Branch, and published under the orders of Colonel H. R. Thuillier, R.E., Surveyor General of India.* Dehra Dūn, 1890.
- Do. XIII. Details of the Principal Triangulation of five of the component Series of the Southern Trigon, including the following series; the South Konkan Coast, the Mangalore Meridional, the Madras Meridional and Coast, the South-East Coast, and the Madras Longitudinal. *Prepared under the directions of Lieutenant-Colonel G. Strahan, R.E., Deputy Surveyor General, Trigonometrical Branch, and published under the orders of Colonel H. R. Thuillier, R.E., Surveyor General of India.* Dehra Dūn, 1890.
- Do. XIV. General Description of the Principal Triangulation of the South-West Quadrilateral, including the Simultaneous Reduction and the Details of its component Series. *Prepared under the directions of W. H. Cole, Esq., M.A., Officiating Deputy Surveyor General, Trigonometrical Branch, and published under the orders of Colonel H. R. Thuillier, R.E., Surveyor General of India.*

- Volume XV. Electro-Telegraphic Longitude Operations executed during the years 1885-86, 1887-88, 1889-90 and 1891-92, and the Revised Results of Aros contained in Volumes IX and X; also the Simultaneous Reduction and the Final Results of the whole of the Operations. Prepared under the directions of Colonel G. Strahan, R.E., Deputy Surveyor General, Trigonometrical Branch, and published under the orders of Colonel H. R. Thuillier, R.E., Surveyor General of India. Dehra Dün, 1893.
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