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IN 1855 Lieutenant Montgomerie of Engineers was given charge of a party of the Great Trigonometrical Survey for the survey of the territories of Maharaja Gulab Singh of Jammu.

Gulab Singh, a Dogra chief, had been Rajah of Jammu since 1820 in the days of the great Sikh ruler Ranjit Singh. He was ambitious and enterprising. After the British defeat of the Sikhs in 1846 he was granted possession of Kashmir which had been a province of the Sikhs since 1820.

There had been many attempts to put Kashmir on the map from travellers’ tales, but the first serious contribution had been Trebeck’s surveys between 1820 and 1823 when he accompanied William Moorcroft on his long journey to Bukhara. Moorcroft had been held for two years in Ladakh waiting for a chance of travelling through Yarkand, and when that eventually proved impossible, he made the journey down through Kashmir and on by Peshawar and Kabul.

Following the treaty of Lahore in 1846 a political mission was sent up to lay down a boundary between British territories and those of Gulab Singh, and rough sketches were made by Alexander Cunningham of southern Ladakh, Spiti, and Lahaul. The following year he led another mission to determine the outer frontiers of Gulab Singh’s possessions towards Tibet and Sinkiang, and a rough map of the Ladakh area was made by Henry Strachey.

At this time also the Great Trigonometrical Survey had started a major chain of triangles along the lower hills from Dehra to Attock, and had formed a special party for the topographical survey of the mountainous area between Garhwal and Chamba. Magnificent work had been done running chains of triangles through the deep gorges of the Sutlej, the Spiti, and the Chandra-Bhaga—or upper Chenab—across the great ranges into Kulu and Lahaul, and across the Bāra Lācha La. After six years of strenuous work in the mountains the party was well keyed up for the survey of Kashmir, with a grand team of seasoned signalmen and khalāsis. Led by William Johnson, who had established himself
as a bold mountain surveyor, the party marched up from Dehra
Dun to meet Montgomerie at Amritsar at the end of February,
1855. Gulab Singh had already given his cordial assent to the
survey and mapping of his territories.

Montgomerie had joined the Great Trigonometrical Survey in
1852 and had been on triangulation in the Punjab and on the
measurement of two base-lines. His immediate task was to set
out a chain of triangles starting from the main series about 20 miles
east of Jammu, and to work it across the Pir Panjāl range to the
Kashmir valley. The peaks of the Pir Panjāl rise to over 15,000
ft., and carry a heavy crown of snow well into June. Fresh falls
of snow were frequent, and the surveyors had to work in wintry
conditions right through March and April. They had to camp
several days at a time on each summit, building platforms and
masonry pillars, and huts for the signal parties, and waiting for
clear views.

After selecting the first stations himself, Montgomerie sent
Johnson ahead to lay out the advance triangles whilst he and
Douglas, who had only joined the survey within the past year,
went back to start theodolite observations. Montgomerie decided
to dump the large two-foot theodolite as being too cumbersome
for work on the mountains, and he worked with a reliable 14-inch.
Observations were taken to heliotropes worked by the signal
squads camped on the surrounding peaks, and Montgomerie writes
of the thrill of spotting 'the bright point of light shining from the
apex of a noble snowy cone'. When clouds prevented the use
of heliotropes by day, observations had to be made to lamps at night.
He made a point of keeping his observations and angle-books with
the most meticulous refinement, up to the highest geodetic
standards.

Johnson had a stiff task on peak Munt Mal, 14,536 ft. above
the sea, making his climb of over 7,000 ft. through heavy snow
in one day with all his men. Most of them suffered from head-
aches and snow-blindness from the glare, in spite of shading
their eyes with fir-tree twigs. They dug first through the highest
crest of the snow without touching ground, but had better luck
at a lower point where they found rock eleven feet down. Clouds
came over charged with electricity which made their hair and
clothes crackle and spark most unpleasantly. Snow had to be
melted for all their water, whether for drinking or for mixing the
lime mortar for the masonry pillar. Johnson had in all to spend
more than two weeks on the peak, building platform and signaler's
hut, and then taking theodolite bearings in the intervals between
clouds and snowstorms. He left a signal party of four men under Daffadar Moli, who did such noble work with heliotrope and lamp for the next two months that the peak was dubbed Moli hill station on all the charts. His heliotrope was always to be seen so long as there was the faintest gleam of sunshine on the peak, and at night his lamp was always well trimmed and bright.

Montgomerie and Douglas had similar trouble with electric discharges, and rigged up a portable lightning conductor from crowbars and other tools. When Douglas put up his umbrella to keep off some extra large hailstones there was an alarming cracking which changed to a terrific humming when he closed the umbrella again. The daffadar had his hair set alight and a lamp box was torn open. But there were fine spells when gorgeous views of the mountain ranges opened up, and the surveyors had the joy of recording the bearings of the great peaks, such as Haramukh, Nanga Parbat, and Nun Kun, or Ser Mer. From these first observations and preliminary computations Montgomerie made Nanga Parbat about 25,700 and Nun Kun 23,400 ft. and he was amazed to find them so very much higher than any of the earlier geographers and travellers had suggested. Both had till now been put down as about 19,000.

When they moved forward to Moli, they came in at once for a terrific hailstorm, with lightning and thunder on the very peak as it were. The small iron stove crackled in the most unpleasant manner, and the little dog's hair crackled and sparkled. But the heavy snow blocked up the slits of the tent and kept them warm at night. The next morning cleared with brilliant sunshine and a grand view of the Kashmir valley and even a sight of the houses of Srinagar through the telescope. For more than a week they had to stay on the peak going backwards and forwards between their living tent and the observatory platform and observatory tent, having to cross a narrow neck of snow with just enough room for the feet, and a precipice on either side, especially tricky at night by the light of a lantern, with the trodden snow all frozen and slippery.

By the middle of July they brought the triangulation up to Srinagar where they took three weeks' rest before starting out once more. This time Johnson ran a minor series of triangles up the Lidar through Pahlgām into the land of glaciers and high peaks, and back to Srinagar down the Sind River. After several weeks' delay from the rain Montgomerie finished off his observations near Srinagar, and then took Douglas to explore the route down the Jhelum to Murree and back. During October and November the whole party marched back to Dehra, some travelling by the Pir
Panjal Pass and others by the Banihal, and there they spent the
cold weather months on computations and sketch maps, and in
preparation for the coming season.

For 1856 three more assistants were posted to start secondary
triangulation to provide points for half-inch detail survey.
Shelverton, the only one with previous experience, worked north-
wards through Kishtwar on the eastern borders; Brownlow spent
two months with Montgomerie before starting independent triangu-
lation down the Jhelum valley, whilst Beverley took over as recorder
on the main triangulation, relieving Douglas who started a branch
series over the Zoji La towards Drâs.

Three young military officers were posted for plane-table survey
and after instruction by Montgomerie took up detail survey—half-
inch scale—at the east end of the valley, Lumsden sketching part
of the glacier area at the head of the Lidar.

In addition to some secondary triangulation Johnson laid out
the forward stations of the main triangles northward towards the
Deosai Plains, and after starting off all the various detachments
Montgomerie himself completed observation of the main triangles
at the west end of the valley across the Wular Lake. Observing
from Haramukh in September he got rays to several peaks on the
Karakoram Range, dubbing the two most conspicuous as K1 and
K2. He did not get another view of the range that year, and it was
not until July and August the following year, 1857, that Brownlow
got intersections from three stations further north and found K2
to be about 28,000 ft. above the sea, with K1, or Masherbrum,
some 3,000 ft. lower, though far more prominent from the south.

For season 1857 the topographical section was strengthened
by four young survey assistants, and three new military officers
posted in place of those of the previous season who had been
recalled to military duty. Several weeks had to be spent at the
beginning of the season on the instruction of all the new-comers,
and before October they had all done useful areas of plane-table
in and around the valley.

Johnson spent season 1857 laying out and preparing the stations
of the main series across the desolate Deosai Plains to the north,
fixing his forward stations astride the Indus River near Skârdu.
Brownlow took over the main observations and carried them
forward to just short of the Indus, getting successful bearings to
the Karakoram peaks. On his work being stopped by winter con-
tions, he was released to military duty and hurried off to join the
army at the siege of Delhi. His accidental death at Lucknow in the
following March was a great loss to the survey. Another sad
accident occurred towards the end of the season when Douglas, a most promising young surveyor, was killed in a shooting accident at Srinagar.

Montgomerie himself was kept at headquarters at Srinagar right through the summer looking to the needs of his numerous detachments. The Maharāja was dangerously ill, and died on 2nd August, and Montgomerie was greatly relieved to find that his son Ranbir Singh was just as friendly towards the survey. The situation was particularly uncomfortable because of the mutiny that had broken out at Meerut in May, but it all seemed very far away, and the Kashmir survey went forward without any interference. It was during this summer that Montgomerie sketched the magnificent coloured panorama of the Pir Panjāl viewed from the Takht-i-Sulaiman at Srinagar. The party reassembled at Dehra Dūn in December for the short recess that was fully occupied by computations and mapping.

The three military officers were the first to start out again, and in February, 1858, they took up detail survey in the lower country round Jammu, moving to higher ground for the summer months. Good progress was made in the eastern areas adjoining Chamba that Shelverton had triangulated.

Away in the north the main triangulation was extended up the Indus from Skāhīn, Johnson taking the approximate series forward to Leh, and Shelverton following up with the final observations. Further shots were taken to K2, and Montgomerie reported its height to be 28,287, overtopping Kāñchenjunga and second only to Mount Everest. The main series was brought to a close just beyond Leh by Johnson in 1859.

By the end of 1858 the half-inch survey of the whole of the Kashmir valley had been completed, and the fair map, largely the work of W. H. Scott and the draughtsmen at Dehra, was despatched to Calcutta at the end of May, 1859, and won enthusiastic praise in Calcutta and also in London where it was sent for publication.

Early in 1859 the few remaining gaps in the Jammu area and on the upper Kishanganga to the west were cleared up, and then the whole party was diverted to the triangulation and quarter-inch survey of Baltīstān and Ladākh to the north. Whilst Johnson carried observation of the main series up to Leh, Beverley, Scott, and Neuville extended minor triangulation up the Indus and its tributaries to the south to provide points for the plane-tables. Melville and Ryall, the only assistants available for plane-tableing this season, were sick for several months, but spent some of their
time at headquarters making a large-scale survey of Srinagar town. Montgomerie himself made a long tour through southern Ladakh to inspect the triangulators at work. During July and August he reconnoitred the highlands of Rupshu as far as the Cho Morari Lake, ‘a splendid sheet of water, perhaps twenty miles long. . . Rupshu consists of a series of lakes or the beds of what have . . . been lakes. From these, which are generally at or over 15,000 ft., mountains with tolerably easy slopes rise. . . to some . . . 19,000 ft. The lakes have become more or less salt. Fuel gets scarcer and scarcer towards the Chinese frontier. . . Near the Chinese frontier nothing except cow-dung was to be had, and the greatest care was necessary to select a place for encampment where Tartars had formerly been’.

For season 1860 there were fourteen assistants, six for triangulation, the rest for plane-tabling. One of the latter was Godwin Austen, who had been employed on plane-tabling in the lower country from 1857 till he had left in April, 1859, to rejoin his regiment in England. He now returned at his own request and spent 1860 and 1861 on plane-table survey of the western Karakoram, sketching the precipices and glaciers northwards from Skardu up to K2 itself, and then westwards down the Indus and up the Baltoro and Biafo Glaciers. He was a great mountaineer, and a beautiful draughtsman with an eye for ground. One of the large glaciers now carries his name on modern maps, but suggestions to give his name to peak K2 have always been officially rejected though it is shown on many unofficial maps. Godwin Austen took no part in the fixing of the peak or the discovery of its great height. At the same time Ryall sketched the Shyok and Nubra gorges of the eastern Karakoram, and Bolst, the plains of Deosai.

During this same season, 1860, Johnson first closed the main series near Leh, and then ran a minor series along the Zaskar range which he connected the following season with the work of the Himalayan party at the Bara Lacha La. The junction showed remarkable agreement, with discrepancies of 0.63 inch (about 64 ft.) in latitude—0.28 inch in longitude—and 1 ft. in height. It was on this triangulation that Johnson fixed points along the 21,000 ft. crest running north of the Spiti valley. Two or three of his single unproved intersections were wrongly passed by the computers a few years later, and one of them giving height 23,050 ft. from a single ray was actually shown on the maps. The best of triangulators may have a number of such single intersections but does not accept them till ‘proved’ by a third ray or by two heights in agreement. The so-called ‘Shilla Peak’ was no fault of Johnson’s.
Montgomerie records that in working east along the ranges south of the Indus ‘Johnson twice observed at 19,979 ft., and Beverley at 19,958. A trigonometrical mark was erected on a point 21,484 ft., but unfortunately there was not sufficient space to put a theodolite on it’.

In 1861 the plane-tablers followed into these highlands of Rupshu and Hanle, and Todd now proved the Tso Morari Lake to be 16 miles in length and from two to three miles in breadth. The many lakes teemed with duck and geese, and the slopes surrounding them were scattered with herds of Tibetan antelopes and the kyang, or wild horse. Melville sketched the great snow range from the Zoji La to the twin peaks of Nun and Kun, and their glaciers.

In 1862 numbers dropped to three triangulators and six plane-tablers. Johnson and Clarke worked east from Leh, to the north of the Indus, into Changchenmo, with orders to ‘cover all the Mahārāja’s territories east of longitude 78° and north of latitude 33° 45’, and to fix as many points as possible in Chinese Tartary towards Ilchi, the capital of Khotan . . . You must be careful to prevent all collision with the Chinese Tartars on the common boundary’. The average height of Johnson’s stations was over 19,800 ft., and he fixed several peaks on the Kunlun, the recognized limit with Khotan, one of them rising to 23,890 ft. They returned to complete this series in 1864, and on the return journey worked westward across the Shyok to reach the Yārkand road and the Karakoram Pass. Meanwhile during 1862 and 1863 Beverley extended triangulation westward to Astor, cutting in the peaks of the Haramosh range towards Hunza and Nagar. The surveyors were not allowed to visit Gilgit which had been occupied by the Mahārāja’s troops from Kashmir during 1859.

This western area was surveyed by plane-table during 1862 and 1863 by James Low at the same time that Godwin Austen and other plane-tablers worked east and completed the detail survey of Ladākh. Austen pushed to the furthest east, sketching the Pangong Tso and its string of lakes. In November, 1864, Montgomerie was able to report the completion of all survey ‘of the dominions of His Highness the Mahārāja of Jammu and Kashmir’. At the same time he asked that Johnson might be given one more opportunity to visit the north-east borders, to fix points and sketch detail ‘in that vast terra incognita east of the Pangong Lake’.

Permission was given, and Johnson travelled up by Simla and Rāmpur to reach Leh on 17th July, 1865. There he received an invitation from the Khan of Khotan to cross the frontier and visit Ilchi. This meant crossing the British frontier, a breach of standing
orders, but he decided to accept the invitation without asking for permission which could not have reached him in time. An escort was sent to meet him, and on the way he climbed three of the peaks of the Kunlun, and sketched a wide area beyond. Unfortunately his board was wrongly plotted, and all his work was thrown out of position and had to be rectified on his return to Dehra. He stayed at Ilchi more than two weeks, making several excursions to the east, and then returned westward through wholly unknown country to cross the Karakoram Pass from the north, and reached Leh on 12th December. This remarkable journey brought an official rebuke, but was enthusiastically acclaimed by the Royal Geographical Society. Johnson was much disappointed at receiving no official reward and resigned from the survey the following year to take service with the Mahārāja of Kashmir, who had offered him a salary of Rs.1,500 a month, or three times his survey salary.

The quarter-inch map of *Jammu, Kashmir and Adjacent Countries* was completed at Dehra Dūn early in 1861. One copy was sent to London and lithographed in 1863 with the Srinagar town map reduced to the one-inch scale as an inset. The Ladākh survey was published on the eight-mile scale at Dehra Dūn in 1868, and later included in the quarter-inch Atlas sheets.