

# MEMOIR

## RELATIVE TO A SURVEY OF KEMAON,

*With some Account of the Principles, upon which it has been conducted.*

BY CAPTAIN WEBB,

COMMUNICATED BY THE MOST NOBLE THE PRESIDENT.

---

**T**HE progress made in the survey of KEMAON induces me to submit an abstract of the results before His Excellency the Commander in Chief, prefaced by a short memoir, not merely to exhibit, what has been done, but with a view to obtain instructions, as to the degree of minuteness, with which it may be deemed expedient, that the survey in question should be made up.

THE number of places, whose latitudes, longitudes, and elevations, are included in the annexed catalogue, is considerably greater, than that "of places on, and near the Ganges river, by Mr. R. BURROW," which latter forms the basis, on which the whole map of this side of India has been made to rest.

IF it is not required, that the map of KEMAON should be more detailed, than those of other districts under this Presidency, it may be sufficient to fill up the work by routes and information: the present list of elevations may alone, be sufficient to convey a general idea of the physical aspect of the country.

BUT as great attention has been attracted to surveys of this nature, since M. HUMBOLDT's account of *New Spain* has been published, and from other considerations, it is probable, that the work will be thought incomplete, if not accompanied by vertical sections. Hitherto the want of barometers, none having yet reached me in serviceable condition, has prevented my attempting a continued section, which could scarcely be effected by geometrical methods only, as no continued lines of stations could be selected, the distances of which can be determined with sufficient accuracy for this purpose.

It might also be desirable, that some approach to a physical map should be had, with a view to facilitate geological and mineralogical researches, which may by possibility, lead to important consequences. It cannot be doubted, that the mountain districts contain the precious metals, from the well known fact, that the lands of almost every mountain stream are assiduously washed for gold at the points, where their rapidity diminishes. The tribe of people, who follow this avocation, are denominated *Boksa*, and their employment is by general report attended with ample profit. The gold dust supplied by the rivers of *Africa*, has long made an opinion current in *Europe*, that some lofty central land exists, which may rival *South America* in its mines of the precious metals—and the same speculation seems no less applicable to the mountains of central *Asia*.

I HAVE it also in view to point out a service of great practical utility, which may be derived to geography from a knowledge of the true position and elevation, of several snowy peaks in the *Himáláya* chain, of which my survey already includes upwards of *thirty*, and most of them are visible from the plains.

WITH scarcely an exception, surveys in *Bengal* have been made by the compass and perambulator only, and those who have had much

experience in measurements of this description, are well aware, that five miles in an hundred is not an impossible error.

THE known positions of snowy peaks afford a ready mode for determining the true geographical place of any station, from whence they are visible, and may therefore be applied to the correction of maps compiled from route-surveys of the description just named. It may be well to detail the several cases, in which they may be so applied, and I have appended to this memoir examples of most of them, from which a tolerably correct idea may be formed, of the degree of accuracy, which may be expected to attend the results.

#### CASE 1st.

THREE snowy peaks, the geographical positions of which are known, being visible from any place or station—and the horizontal angles they subtend at that station being observed—the distance of the station from each peak, together with its latitude and longitude, become known also.

#### CASE 2d.

The latitude of a station being observed, and also the true azimuth of a single known peak—the distance between the peak and the station, and the longitude of the latter, become known also.

#### CASE 3d.

THE angle of elevation of any peak, the height and position of which are known, being observed, and the height of the station being also known—these data are competent to give the distance between the peak and the station; and if the azimuth of the peak be observed, the latitude and longitude of the place of observation become known also. This case comprises the method adverted to by M. HUMBOLDT in his "Geographical Essay," under the denomination of "Vertical Bases," and which he appears to have adopted very extensively. The survey of a mountain province may thus be accomplished by aid of ba

rometrical observations only, and with extreme accuracy, if the stations be not very remote from each other, and are so chosen, that their relative difference of elevation shall be considerable.

#### CASE 4TH.

THE distance and height of a known peak, together with its observed angle of elevation, give the absolute height of the station of observation—or, if this be known, the prevailing degree of refraction may be obtained: which latter it may sometimes be important to know; far to the westward for instance, where the surface of the country undulates considerably, or within the mountains.

#### CASE 5TH.

As, by some of the foregoing, the true distance, and relative position of two or more stations on the plains of *India*, may be correctly found, it follows, that the true positions of snowy peaks, not at present known, as well as their altitude, may be found, and that such peaks will again enable an observer to determine the position of any number of stations on the plain, or within the mountains, from whence they may be visible.

It appears, therefore, that the positions of snowy peaks, already obtained by my survey, are amply sufficient to correct the geography of a vast belt of country: the breadth of which, in a southerly direction from the *Himālaya* range, averages from one hundred to one hundred and thirty miles, and in length somewhat exceeds that of the range itself.

THE general direction of the snowy chain is from W. N. W. to E. S. E. nearly, to which of course the belt is parallel, and if from such a line even perambulator routes were surveyed in a southerly direction, so as to make but small angles with the meridian, the error in mea-

surement would not sensibly vitiate the longitude of the place come to, which is the element most difficult to obtain. That error would affect the latitude almost exclusively, and every tyro in practical astronomy can correct the latitude by celestial observation to within a few fathoms of the truth; and thus it appears, that the limits of geographical correction, for which a means is offered by a knowledge of the positions of peaks in the *Himálaya* chain, may be made to extend far beyond the points, at which the peaks themselves cease to be visible.



*Principles upon which the Survey of Kemaon has been conducted.*

THE base is a line, nearly in the direction of the meridian. The latitude of the station, at either extremity, having been carefully observed with a circular instrument, and the angle of an azimuth made by one of them with a meridian passing through the other, astronomically determined, the length of the base was calculated with those data. The value of the meridional degree is assumed to be 60,600 fathoms.

FROM the base so obtained, triangles were extended in the usual manner, the three angles being observed in all practicable cases. The sides of these were next computed in order, by plane trigonometry, the instrument made use of being divided only to 20 of a degree.

THE latitudes of the several stations were now calculated, the angle of azimuth being in all cases either referred to the original base, or astronomically computed. In every instance of trial, the latitude computed from the survey agreed with celestial observation, so nearly, as to leave it doubtful, which might be in error.

BUT it was desirable to have a station of verification, if I may so term it, as far south as possible, and I selected *Pilibhit* for this purpose. The geographical position of the great mosque at that place had been given by M<sup>r</sup> BURROW in this catalogue, and I purposed adopting it, as the first meridian of my survey; by which means, my map would be immediately connected with that of *Rohilkhand*, and I reserved the verifying of the absolute longitude of *Pilibhit*, till leisure and opportunity should permit me to make a series of observations, correspondent with others at the *Madras OBSERVATORY* for that purpose.

The snowy peaks, Nos. XIII, XIX, and XXV, are distinctly visible from a grove, near the town, which became my station, and I was enabled to connect it with a minaret of the great mosque by a single triangle, one side of which was measured. The true azimuth of the minaret, and the distance so obtained, gave its difference of latitude from my station  $0^{\circ} 51.4$  southerly. Also the latitudes of the snowy peaks, as fixed by my survey, were respectively,

XIII =	30	15	36.1	N.
XIX =	30	12	15.1	N.
XXV =	29	52	45.7	N.

THE horizontal angles, subtended by the abovementioned peaks, were observed, and their several azimuths astronomically computed.

ASSUMING the position of the snowy peaks to have been truly given by my survey, I computed, (as in Case 1st,) their respective distances from my station, which came out by the calculation as under;

XIII = 97291 fathoms.      XIX = 98340 fathoms.      XXV = 96030 fathoms.

THESE distances, computed with the true angles of azimuth, gave their differences of latitude, and consequently the latitude of my station, and that of the mosque as follows:

# A SURVEY OF KEMAON.

299

Latitude of snowy peaks	XIII = 30 14 36,1	XIX = 30 12 15,1	XXV = 29 52 45,7
Differences of latitude	.... 1 36 19,8	1 32 58,2	1 13 28,2
Latitude of station	.... 28 39 16,3	28 39 16,9	28 39 17,5
Mosque south	.... 0 0 51,4	0 0 51,4	0 0 51,4
Latitude of mosque	.... 28 38 24,9	28 38 25,5	28 38 26,1

The latitude of the mosque, by Mr. BURROW's observation, is 28° 38' 29" N.

THIS very exact result may be admitted, as a proof of the correctness of the base, the smallest error in which would have been sensibly felt, when its operation was extended to distances approaching to ten times its own length, or nearly one hundred thousand fathoms.

I NEXT computed the differences of longitude of all the stations from *Pilibhit*, using, what is generally termed, a table of meridional parts for that purpose. It was not till a month ago, that I was much gratified by finding, that M. HUMBOLDT had adopted the same method in his survey of *Mexico*, and that he had even used the same table, that given by MENDOZA DE RIOS.

BEING now assured, that the distances given by my survey were trustworthy, it became necessary to determine the height of the several stations above *Rohilkhand*, and approximately above the sea; but the weather became hazy at *Pilibhit*, and it was not till my arrival at *Cáśipur*, that a favorable opportunity for this purpose presented itself.

THE snowy peaks, Nos. XI, XII, XIII, XIV, are distinctly visible from *Cáśipur*; and their respective heights above that place; and also above *Cáli Ma'h*, a high mountain near *Almora*, were calculated from their observed angles of elevation at each. The refraction being allowed at  $\frac{1}{4}$  of the intercepted arch, though it is not probable, that exactly the same degree prevailed at the mountain station, and that on the plain, gave results as under:

		XI.	XII.	XIII.	XIV.
Above Cásipur	Feet	20019.6	22724.4	21684.0	24904.2
Above Calí Mat'h	Ditto	14269.2	16845.6	15895.8	19252.2
Calí Mat'h above Cásipur	Ditto	5750.4	5878.8	5788.2	5652.0
The mean of the four, give the height of Calí Mat'h above Cásipur	....				5767 Feet
Assumed height of Cásipur above the sea	....			....	650 Ditto
Approximate height of Calí Mat'h above the sea	....			....	6417

THE preceding differences, should, of course, be exactly equal to each other, but the uncertainty with respect to the refraction due, together with the possible errors of observation, at both stations, are more than sufficient to account for the existing discrepancy. The mean of the whole is taken as the height of *Calí Mat'h* above the plains of *Rohilkhand*, and *Cásipur* is estimated to be 650 feet above the sea, which cannot be very wide of the truth.

ALL the heights of places within the hills, have been referred to this altitude of *Calí Mat'h*, either directly, or with intermediate stations; also  $\frac{1}{8}$  of the intercepted arch, has been uniformly allowed for the effect of refraction, in computing the altitude of snowy peaks, and  $\frac{1}{4}$  of the same arch, for all points below the inferior limit of congelation.

It is at present my opinion, that both these quantities exceed the medium effect of refraction; under the circumstances, in which the observations are made, and though it is not necessary to exaggerate heights, already enormous, I am inclined to believe, that all the elevations err a little in defect, in consequence of having used them.

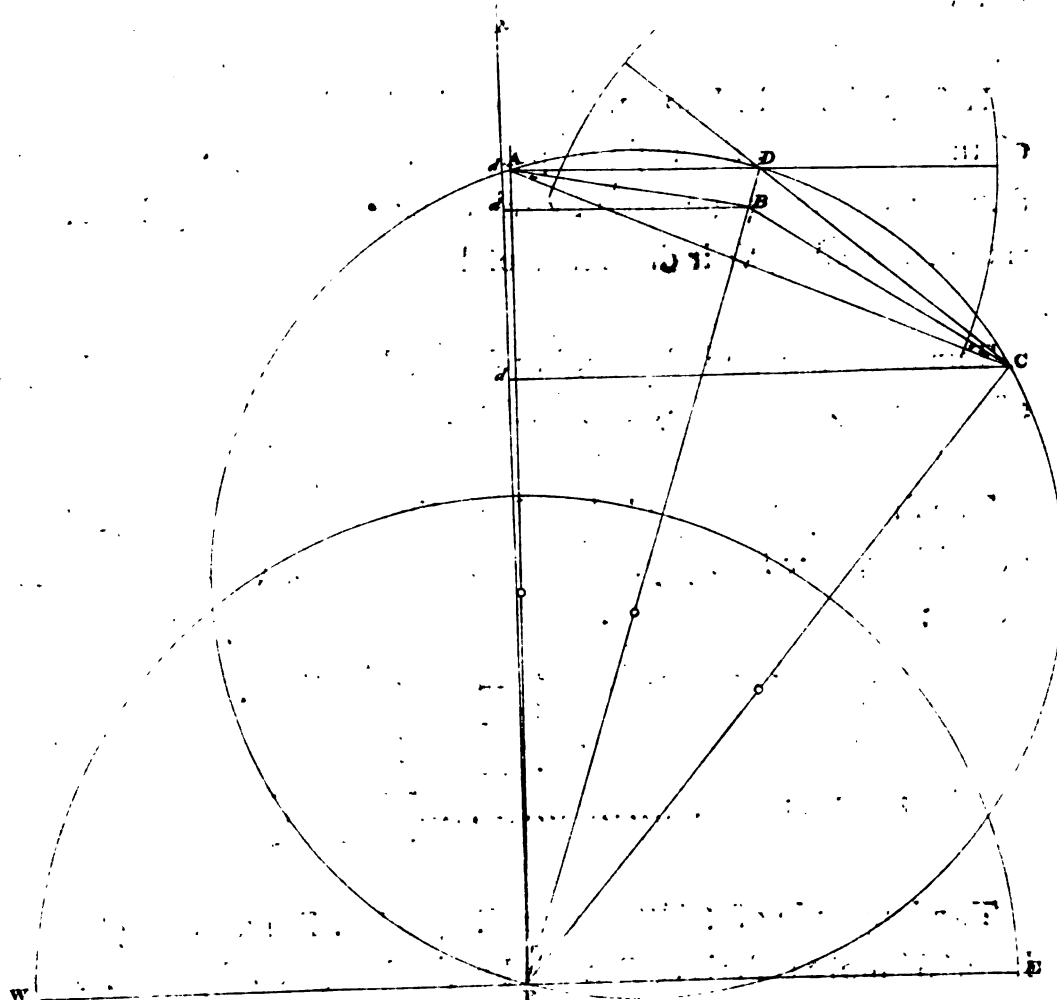
It remains to shew examples of the cases I have suggested, in which the known positions of snowy peaks may be usefully applied to the connection of geographical maps, constructed from perambulator measurements.



## CASE 1st.

THE computations at *Pilibhit*, an abstract of which I have already given, furnish an example of this kind; and it has been shown, that the latitudes of the place of observation as obtained severally, from three very distant snowy peaks, do not differ from each other more than a single second. It may therefore be presumed, that the distances are equally correct, or that the error upon any one of them does not exceed twenty fathoms.

On account of its great simplicity, I subjoin a graphical solution of the problem in that particular instance.



In the preceding diagram the station near *Pilibhit* is represented by P. A, B, C, are the snowy peaks, Nos. XIII, XIX, XXV, respectively; PA, PB, PC, their distances from the station; Pd, Pd', Pd'' their differences of latitude. PN is a meridian passing through the station. The things known are marked with a line (') the things required with a cypher (o).

## CASE 2d.

Is that most likely to occur in practice, as it affords a means of computing the longitude of the station from observations of a single known peak.

It supposes to be known, the co-latitude of the peak, the co-latitude of the station, and the angle of position at the latter; to find the arch of distance, and the angle made by their meridians at the pole, or which is the same thing, their difference of longitude.

The following are instances, in which I have computed the longitude of places in *Rohilcund* by this method.

The first station is a walled garden a little to the eastward of the town of *Cásipur*, four snowy peaks were visible and gave the longitude as below:

Longitude of <i>Cásipur</i> by No. XII	≡	78° 48' 54,8 E.
XIII	≡	78 48 52,3
XIV	≡	78 48 55,5
XI	≡	78 48 53 8
Mean Longitude .....		<u>78 48 54,1</u>

The longitude of *Cásipur* according to Mr. BURROW is 78° 51' being 2' 6" more easterly. But the longitudes given by Mr. BURROW are deduced from astronomical observation entirely, and he himself suggests that some of them may be as much as five minutes in error.

THE next station is the village *Chemrowa*, in the *Rampur* jaghir.

Longitude of Chemrowa, deduced from No. XII,	=	78 58 13,4
No. XV,	=	78 58 8,3
Mean Longitude,	...	<u>78 58 10,8</u>

THE third and last example was obtained at the fort of *Afzelgerh*.

Longitude of Afzelgerh by No. VI,	=	78 31 55,8
VIII,	=	78 32 17,7
XI,	=	78 32 2,7
XIII,	=	78 32 5,7
XV,	=	78 32 25,8
Mean Longitude,	....	<u>78 32 9,5</u>

THE snowy peaks, Nos. VI and VIII, are comprised in the cluster supposed to be *Badarináth*, and by a reference to the conditions of the triangle, which assigns their position, they will be found so unfavorable as not to promise a result of *great exactness*.

IT will also be observed, that the angles made by the azimuths of the eastern peaks with the meridian are very considerable, and that the smallest error in the assumed latitude or azimuth, will produce a very sensible effect, under these circumstances.

THE longitude of *Afzelgerh* by Mr. BURROW is  $78^{\circ} 33' 40''$ , or easterly of mine  $1' 33''$ .

THE difference of longitude between *Pilibhit* and *Cásipur*, is by Mr. BURROW  $2' 6''$  less than by my survey. And the difference of longitude between *Cásipur* and *Afzelgerh* is  $0' 35''$  greater, than by me; although his station at the former place, was to the westward of mine.

AND it is evident, that though the errors of astronomical observations may be plus or minus, *indiscriminately*, such cannot be the case with

trigonometrical deductions from fixed points. I have used the same peak No. XII and XIII both at *Cásipur* and *Afzelgerh*.

### CASES 3 and 4.

I HAVE already noticed that to attain *great* accuracy by these methods, the difference of height of the stations should be considerable, and the distance not very great; especially when the angle of elevation or depression, can be observed at one station only. Not being provided with barometers, I have no such example to offer, as I could wish, or as the methods themselves are fully sufficient to afford.

WHEN the arch of distance is very great, and the angle of elevation extremely small, the varieties to which the refractive state of the atmosphere is subject, will alone occasion discrepancies of vast amount. That this is the case, will be clearly seen by the following approximations, in which I have supposed the stations to be precisely on the same level with *Cásipur*, which is not of course, strictly true.

### STATION AFZELGERH, EXAMPLE I.

Refraction.	°	$\frac{1}{12}$	$\frac{1}{18}$	$\frac{1}{24}$
Distance No. XII. by case 3d. ....	77820	80266	79424	79018
True Distance of No. XII. ....	78843	78843	78843	78843
Errors. ....	-1023	+1423	+581	+175

Refraction	°	$\frac{1}{12}$	$\frac{1}{18}$	$\frac{1}{24}$
Distance No. XIII. by case 3d. ....	79779	82316	81403	80926
True Distance No. XIII. ....	80895	80895	80895	80895
Errors. ....	-1116	+1423	+508	+31

Refraction.	°	$\frac{1}{12}$	$\frac{1}{18}$	$\frac{1}{24}$
Distance No. XV. by case 3d. ....	87107	90558	89371	88812
True Distance No. XV. ....	89018	89018	89018	89018
Errors. ....	-1911	+1540	+363	-206

## STATION CHAMROWA, EXAMPLE II.

Refraction.	.	$\frac{1}{11}$	$\frac{1}{15}$	$\frac{1}{17}$	$\frac{1}{17}$	$\frac{1}{17}$
Distance No. XII. by Case 3d. ....	94679	97397	97979	98252	98485	98831
True Distance of No. XII. ....	98578	98578	98578	98578	98578	98578
Errors. ....	-3899	-1181	-599	-326	-93	+253

THE true distances of the snowy peaks, which have been used as a standard of comparison in the preceding examples, were derived by Case 2d..

It seems reasonable to infer, that the refractive state of the atmosphere demanded an allowance, in the first example, equal to about  $\frac{1}{11}$  of the intercepted arch, and in the second to  $\frac{1}{17}$  nearly.

HAD the mean state of refraction, which I assume to be  $\frac{1}{17}$  for snowy peaks, been used in these instances by a traveller, desirous to know his place in the map, his conclusion would have been erroneous by about  $\frac{1}{2}$  a mile, at *Afzelgerh*; and by something less than  $1\frac{1}{2}$  mile at *Chamrowa*. He might still, however, console himself with reflecting, that, even were it possible to find a level road to the *Himālaya*, a derambulator surveyor could not measure the distance, after many day's labor, with any chance of obtaining it so correctly, as it had been thus acquired by an observation, which was made and computed in twenty minutes.

I CANNOT at present offer an example of the 5th Case, as no snowy peak is visible from any part of *Rohilcund*, where I have been, the position of which is not already established by my survey of *Kamaon*.

*Catalogue of Places, with their respective Latitudes, Longitudes, and  
Elevation above the Sea, as derived from a survey of Kemaon.*

By CAPTAIN W. S. WEBB, Surveyor.

No.	Names of Places.	Latitudes.	Longitudes.	Elevations.
				Fet.
1	Pilibhit, (the Great Mosque.)....	28 38 20 N.	79 41 45 E	—
	Station (A) (in Grove near ditto.)..	28 39 16.9	79 42 19.8	—
	Cái Math, (Gorkha Stockade.) ...	29 38 11.5	79 30 19.6	6417
	Snowy Peak I. (Great Himalaya.)..	30 49 47.2	78 51 19.6	22345
5	.... N. ....	30 49 4.3	78 52 11.3	22058
	.... III. ....	30 46 22.3	78 55 16.9	22840
	.... IV. ....	30 45 46.9	78 58 46.1	21611
	.... V. ....	30 38 28.9	79 4 49.5	19106
	.... VI. ....	30 42 22.9	79 6 10.9	22498
10	.... VII. ....	30 41 57.7	79 7 28.9	22578
	.... VIII. ....	30 43 40.9	79 8 17	23164
	.... IX. ....	30 42 4.3	79 15 16.2	21311
	.... X. ....	30 40 16.9	79 28 0.7	15733
	.... XI. ....	30 20 6.1	79 33 40.8	20686
15	.... XII. ....	30 17 59.6	79 37 7.6	23263
	.... XIII. ....	30 15 36.1	79 42 49.8	22313
	.... XIV. ....	30 21 51.7	79 48 39.6	25669
	.... XV. ....	30 16 13.3	79 54 25.7	22419
	.... XVI. ....	30 12 3.7	80 5 26.6	17994
20	.... XVII. ....	30 11 14.6	80 7 9.7	19153
	.... XVIII. ....	30 14 33.1	80 12 40.5	21439
	.... XIX. ....	30 12 15.1	80 15 42.6	22635
	.... XX. ....	30 9 28.3	80 16 44.3	20407
	.... XXI. ....	30 6 41.5	80 28 51.1	19099
25	.... XXII. ....	30 6 18.7	80 30 22.8	19497
	.... XXIII. ....	29 59 33.7	80 44 3.6	22727
	.... XXIV. ....	29 57 13.3	80 50 23.8	22338
	.... XXV. ....	29 52 45.7	80 51 36.5	22277
	Snowy Peak XXVI. (Himalaya.)..	29 50 44.5	80 51 31.1	24045
30	.... XXVII. ....	29 49 42.8	80 54 19.3	20923
	Reoni Temple. ....	29 39 33.7	79 22 4.2	6526.7
	Nyathana Fort. ....	29 47 56.5	79 9 32.8	5785
	Siabi Oak Tree. ....	29 34 14.6	79 24 4.7	7193.2
	Badhun Dhua Peak. ....	29 28 33.7	79 13 1.1	8433
35	Dona Gisi Temple. ....	29 47 21.7	79 17 50.1	7272.2
	Bhatcot Peak. ....	29 49 34.9	79 20 50.4	9060.6
	Abri Deo Peak. ....	29 44 42.7	79 25 8.2	7030.9
	Gana Nath Stockade. ....	29 45 56.5	79 30 29.6	6828.5
	Binsar Peak. ....	29 42 1.9	79 35 42.4	7896.6
40	Shem Deo Temple. ....	29 36 34.9	79 40 33.9	6964.9
	Fort Moira. ....	29 35 7.9	79 29 49.4	5520.8
	Mote'hsar Peak. ....	29 28 12.1	79 29 20.7	7710.9
	Bandani Peak. ....	29 33 16.3	79 32 24	6725.9
	Shem Deo. (Station.) ....	29 36 13.1	79 41 15.9	6923.3
45	Pin Nath Temple. ....	29 49 57.1	79 23 19.2	7627.6
	Bagha Ling Temple. ....	29 47 30.1	80 2 27.5	7646.5
	Rai Peak. ....	29 42 21.1	79 51 49.7	7796.7
	Rai (Station.) ....	29 43 14.5	79 51 29.3	6594.3
	Dhaj Peak. ....	29 38 34.9	80 7 45.1	8168.3
50	Thasil Peak. ....	29 30 17.9	80 2 27.2	8148.6

No.	Names of Places.	Latitudes.	Longitudes.	Elevations.
		N.	E.	Fet.
	Heights above Ascot. (Station.)....	29 45 46.3	80 2 50.8	5502.9
	Si acot Temple. ....	29 48 28.9	80 5 3	6862.1
	Bárah Bishí Peak. ....	29 42 49.9	80 4 40.1	7805.4
	Rán Peak. ....	29 58 35.5	80 6 28.9	9847.4
55	Cutlgérh Fort. ....	29 24 13.9	79 53 38.4	6321.7
	Bancu Peak. ....	29 20 36.1	80 3 7.3	6061.2
	Bynthari Fo t. (Dotee.) ....	29 33 9.7	80 15 58.3	5543.2
	Calí Nágh Peak. ....	29 51 36.1	79 57 13.4	7298.
	Chará'ék'h P. (in Dotee.) ....	29 34 55.9	80 19 6.4	6544.4
60	Roulacot. (Ditto.)....	29 33 15.7	80 24 6.3	8291.2
	Go'al Lékh P. (Ditto.)... ..	29 29 1.9	80 14 57	8194.8
	Chaumunh Temple. ....	29 35 41.8	79 11 35.9	6355.7
	Gupat Gangá Peak. ....	29 37 31.9	79 52 57.6	7192.2
	Asú Chula Temple. ....	29 37 31.9	80 1 11.4	7934.9
65	Cumbhpúr Temple. ....	29 38 17.5	79 15 34.4	6306.9
	Cát'h cí Na'o Fort. ....	29 35 45.7	79 0 32.4	4978.1
	Lobahger'h Fort. ....	29 58 4.3	79 10 53.3	6357.7
	Ascot Village. ....	29 45 17.5	80 10 35.9	5916.7
	Chipata Peak. (Bútan.) ...	29 54 42.1	80 16 52.5	13455.1
70	Rán Shica P. (Dotí) ....	29 46 41.5	80 24 1.2	10132.3
	Shica P. (Ditto.) ....	29 44 34.9	80 21 10.5	976.3
	Chand Nágh P. ....	29 37 37.3	80 3 56.9	7078.7
	Mount Lébug (Summit of the Pass. (a))	30 19 43.3	80 27 24.9	18870.6
	Goh Village. (Bútan.) ....	30 14 40.5	80 22 45.5	11488.3
75	Edge of the Calí R. below Ascot...			3273.2
	Deo Dhúá Temple. ....	29 24 33	79 43 17	6669.6
	Khilpatí Stockade. ....	29 21 30	80 0 44	6324.8
	Chamáwat Cantonment. ....	29 19 45	79 56 17	5467.5
	Súí Peak. ....	29 25 27	79 55 10	5837.8
80	Hawal Bág'h. ....	29 38 20	79 28 3	3889.
	Sitolí Stockade. ....	29 36 13	79 29 2	5187.
	Mount Browne. ....	29 36 44	79 30 46	5705
	St. Mark's Tower. ....	29 35 40	79 30 28	5104
	Fort Almora. ....	29 35 30	79 30 0	5337
85	Cutár Mall. ....	29 37 22	79 27 9	5144
	Simtouca Peak. (Bútan) ....	29 18 46	80 28 49.9	10662.2
	Jé'úí Village. (Ditto.) ....	29 57 40.1	80 26 24.7	6310
	Snowy Peak ab. Golaghi (Himalaya.)	29 8 19	80 32 38	21150.
	Taugling Gharí. (Bútan.) ....	30 1 12	80 27 15	11651.6
90	Runju Village. (Ditto.) ....	30 57 48	80 25 25	6779
	Safusura Village. (Ditto.)....	29 55 32	80 28 45	6211.8
	Cála, or Seeslpunt. (Ditto.) ....	29 56 20	80 25 36.3	5218.6
	Cála Bridge over the Dhúí R. (Do.)			3811.2
	Confluence of Réla Gher & Calí R. (Ditto.)	29 53 56	80 24 0	3721.8
95	Camp below Lúma. (Ditto) ....	29 54 18	80 23 45.8	3924.8
	Júma Village. (Bootan.) ....	29 52 57	80 23 27	5664.3
	Rat'hí (Ditto.) ....	29 55 27	80 24 15	5937.2
	Shacúrí (Ditto.) ....	29 48 31	80 0 16	4443.2
	Dingat'har, Village ..	29 47 23	79 56 55	4224.8
00	Thal Debís Temple. ....	29 48 11	79 52 52	5128.1
	Khené Village. ....	29 50 43	79 51 52	5717.4
	Hanú'cí Thán. (Temple.) ....	29 48 10	79 51 45	5703.5
	Odíarí Village. ....	29 46 12	79 53 53	5375.3
	Dhandulú. Ditto, ....	29 46 43	79 54 32	4341.5
05	Bádéra. Ditto, ....	29 50 31	79 51 52	5730.6
	Loha Thal Ditto, ....	29 50 31	79 53 33	5734.8
	Desaulí Ditto, ....	29 51 30	79 52 0	5618.4
	Saulí Ditto, ....	29 50 50		

No	Names of Places.	Latitudes.	Longitudes.	Elevations.
		° ' "	° ' "	Feet.
	Garbia village. (Bútan.)	30 6 55 N.	80 41 32.6 E	10200.2
110	Mt. Namjang. (Himalaya.)	30 2 18.4	80 39 44.6	18398
	Trig. Station near Garbia.	30 6 1	80 39 46	10983.2
	Spar Bridge over Calapaní R. (Bútan.)	30 9 7	80 42 23	12670.4
	Byás Rik'hi P. (Himalaya.)	30 9 28	80 46 2	19857.2
	Mandarin's Camp. (Bútan.)	30 11 19	80 44 18	14433.8
115	Ghatí, or Pass to Factory.	30 11 45	80 48 10	17697.8
	No. 1 of Cántas. (Himalaya.)	30 13 17	80 45 0	22441.4
	No. 2, (Ditto.)	30 12 47	80 46 8	20991.8
	Kuwa Lekh P. (Bútan.)	30 8 0	80 42 52	15245.4
	Station near confluence of the Calí and Calapaní Rs. (Bootan.)	30 8 16	80 41 31	11341.4
120	Sithi Lekh P. (Himalaya.)	30 7 28	80 40 16	15811.4
	Bouling village. (Bútan.)	30 5 12	80 26 49	—
	Phakul ditto. (Ditto.)	30 3 21	80 27 17	—
	Calapaní Fountain.	30 10 30	80 43.28	—
	Deodar Ghat. (b)	29 28 2	79 26 40	6273.7
125	Ghagar Ghat. (c)	29 24 25	79 23 3	7696.1
	Loharcot Stockade.	29 27 45	79 26 7	6732.4
	Surface of the Lake, Bheem Tal. (d)	29 19 18	79 23 53	4271.5
	Kissenpúr (Rohilcund.)	29 12 18	78 48 54.1	—
	Chamrowa. (Ditto.)	28 46 26.9	78 58 10.8	—
130	Afzel Khan's Palace. (Ditto.)	29 23 52	78 32 9.5	—
	APPROXIMATIONS. (e)			
	Taclasot. (Chinese Factory.)	30 12 43	81 2 10	14500
	Lake Mansarovar. (Ditto ditto.)	30 23 7	81 2 10	

(d) *A ch'habútra*, or Sat'hi at the southern extremity of the lake.

### REFERENCES.

No. 73, (a.) With extreme difficulty, and I may add, with extreme peril, I was fortunate enough to accomplish the passage of *Lébúg Ghátí*, without accident on the 6th of June 1816.

Nos. 124, 125, (b.) (c.) The new road from *Bamauri* to *Almora*, recently constructed at the expence of the British Government, crosses both these points.

No. 126, (d.) The shape of the lake *Bhim Tal* approaches more nearly to a triangle, than to any other regular figure, the length of the longest side is about a mile, and that of the shortest five furlongs. Its extent appears to have been much greater at some former period; and the diminution it has experienced, is evidently to be attributed to deposition by the streams flowing into it. There is still depth of water



sufficient for a first rate line of battle ship to ride at anchor. Lieut. STEPHEN, who had a small canoe on the lake, struck soundings in 64 feet or nearly 11 fathoms, about the central parts, and the banks shelve very rapidly.

APPROXIMATION E; the position of the pass leading to *Taclacot* is already given by my survey; the direction of *Taclacot* was pointed to the north  $82^{\circ}$  east from thence, and its distance from the eastern descent is one day's journey for laden goats; the above bearing, with a horizontal distance of eight miles from the summit of the pass, cannot give a very erroneous position to *Taclacot*.

THE direction of *Manjarovar* was also described to me by many persons, who had visited it to be about north  $30^{\circ}$  east from *Taclacot* and the distance two day's journey, for laden goats, which as the road is level may perhaps be 14 miles.

By this information I have assigned, what I imagine to be the geographical position nearly of the monastery, mentioned by Mr. MOORCROFT, and which I conclude to be situated on the western bank of the lake, but as *Manjarovar* is stated to be of an elliptical shape, and to have its diameters equal to eleven and seven miles respectively, it seems at least probable that the latitude and longitude, I have given will fall somewhere within the limits of the lake itself especially if it be remembered, that the place at which my information was obtained, is not so much as twenty miles distant from *Manjarovar*.

ALL the *Tartars* and *Bhútias* who were with me were of opinion, that the eastern descent of *Taclacot Gháti* was not greater than the western, and hence we may conclude that the elevation of the lofty table

land of central *Afia* is nearly the same, as that of the *Deba's* camp. (No. 114,) or 14,500 feet above the level of the sea.

ALTHOUGH several of the preceeding latitudes, and longitudes, are inferted to the tenth part of a second, as given by the calculations, it is by no means intended to convey an idea, that the principles, on which this survey is conducted, can attain to that great degree of exactness.

EVERY figure of even the most trivial computation will be found in the field books, which I have transmitted to the Surveyor General's Office : in so much work, when the survey in the field and all its dependant computations rest with an individual, a few errors may be excused ; some I have discovered and corrected, though none have been pointed out to me, some may still remain.

UPON the whole, I flatter myself, that in the more essential parts, this survey will bear comparison with any, that have been performed in Bengal, and I can only lament that I have not been able to collect the materials into a map of suitable external appearance.

---