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MOUNT EVEREST—ITS NAME AND HEIGHT

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For nearly a century now, Mount Everest which is situated on the Nepāl-Tibet border in latitude $27^{\circ} 59' 16''$ and longitude $86^{\circ} 55' 40''$ has been regarded as the highest point on the earth. Ever since then, due to its unique position, it has been the centre of controversies both as regards its name and its height and there still exist misunderstandings regarding it in more than one respect. Its name has been objected to, as Sir George Everest was not immediately associated with its discovery. The exact significance of its adopted height of 29,002 feet is not even understood by most surveyors not to speak of the layman. Quite a number of other heights have been quoted for it and have even been put on the maps, which makes for confusion. For instance, the value adopted for the Survey of India maps is 29,002 feet but American Air maps and certain other maps use the figure 29,149 feet. Such a standard publication as the Times Survey Atlas of the World, prepared in 1920 under the direction of J. G. Bartholomew, Cartographer to the King, gives its name wrongly as Gaurisankar on Plates 55 and 57 and so do quite a number of German maps.

Mount Everest has featured during question time in the Indian Parliament. It has been asked whether the Government had any information that the original name of Mount Everest was Gauri Sankar. When was the height calculated and should not the name be changed, particularly when Sir George Everest was not its calculator? Should not a Committee be appointed to investigate whether its original name could be identified?

Various authorities have at different times pressed the Survey of India to adopt such Nepalese and Tibetan names as Devadhunga, Gauri Sankar, Chomo Kankar, Chomo Lungma, etc., in place of Mount Everest, but the Survey of India has not considered any of these as having been satisfactorily established.

Certain aspects of Mount Everest's discovery have received undue publicity and much has been written that will not bear examination. It is the object of this paper to set out some of the problems associated with high Himālayan peaks in their proper perspective and to indicate their complexity.

THE NAME OF MOUNT EVEREST

The Himālayan peaks in Nepāl were observed by surveyors in 1849-55 from distant low-lying stations in the plains of India about a hundred miles or so away from them. Nobody at that time, including the observers had even a suspicion, that one of these was the highest mountain in the world; as from this view-point, Mount Everest is not at all prominent and merely appears as one of the numerous array of peaks. In fact, at this distance it was hidden by lower peaks that lay between it

and the various stations of observation, and some of these gave the appearance of greater height. The peaks were observed as intersected points as a matter of routine, from the triangulation stations of the North East Longitudinal series of Primary Triangulation of the Survey of India. The general belief at that time was that Kānchenjunga was the highest mountain in the world.

The observers could not allot individual names to the innumerable peaks that they observed, as many of these were unknown to local people in the Indian plains and the normal method was to designate them by Roman numbers. Thus when Mount Everest and Gauri Sankar were first observed, they were entered in angle books as Peak XV and Peak XX respectively.

So much work is involved in sorting out observed data and checking field books that the computations at Headquarters invariably lag considerably behind observations. The observations to Mount Everest were taken in 1849 and 1850 but it was not till 1852 that the computations were sufficiently advanced to indicate that Peak XV possessed a height greater than that of any other known mountain. The question of atmospheric refraction was, however, still being investigated at that time and it was only in 1865 that the determination of the figure of 29,002 feet for the height was considered sufficiently reliable to be accepted.

Finding a name for this peak then became of paramount importance. From 1852 to 1865 much thought was given to the question of the name, but none of the suggested local names was found acceptable, and consequently Col. Waugh with the concurrence of Colonel Henry Thullier, Deputy Surveyor General and Mr. Radhanath Sikhdar, the Chief Computer and in consultation with the Royal Geographical Society finally decided to name it after Sir George Everest (who had actually retired in 1843) to commemorate his contribution to the Geodetic Survey of India.

The Survey of India has often been blamed for this choice on the ground that local names did exist for the peak and were deliberately ignored. Thus, when in 1855 Sir Andrew Waugh first suggested that the newly discovered peak should be named Mount Everest, Mr. Brian Hodgson who had been Political Officer in Nepāl for many years and was an able linguist and scientist gave out that the peak had a local name, Devadhunga. Enquiries regarding this assertion went on for well over the next half a century whenever opportunity offered but the claim has not been substantiated. In 1904, Captain H. Wood visited Nepāl for observations to the principal peaks and consulted the Nepalese authorities on the subject, but did not hear the name Devadhunga mentioned. Neither did it come to the knowledge of Surveyor Natha Singh, who surveyed the Nepalese slopes of Mount Everest in 1907, nor of General Bruce who had been in Nepāl for some time and published an account of it in 1910. It was also not heard by the Mount Everest Expedition under Colonel Howard Bury in 1921 and the Nepāl Survey Detachment of the Survey of India when they visited Nepāl in 1924-25. It can thus be taken as fairly certain that Hodgson was mistaken in his belief, and that he had possibly learnt the name Devadhunga from Nepalese literature and regarded it as a mystic name suitable for Mount Everest. It is possible, however, that some scholar may be able to offer a better explanation of how such an eminent authority went astray over such an important matter.

Yet another name for Mount Everest over which a keen controversy has raged for years is "Gauri Sankar". In 1855, soon after the discovery

of Mount Everest had been made by the Survey of India, three German brothers by the names of Schlagintweit came on a scientific mission to India and one of them resolved to carry out some observations to the new mountain. He observed it from Phallut in Sikkim and from Kaulia in Nepāl (see Chart at end).

On his return, he gave out that his enquiries had revealed that Mount Everest was locally named as Gauri Sankar in Nepāl and that its Tibetan name was Chingopamari. Schlagintweit's results were published in Berlin in 1862 and caused a great sensation. The Royal Geographical Society, London, supported his views and disagreed with the Survey of India. The name Gauri Sankar came to be adopted in European maps for the highest mountain instead of Mount Everest and even as late as 1903, Mr. Douglas W. Freshfield the then Secretary of the Royal Geographical Society who later became the President wrote in an article in the journal: "The reason for which the surveyors argued so strenuously forty-five years ago that the 29,002-foot peak cannot be the Gaurisankar of Nepal was, of course, that their chief's proceeding in giving the mountain an English name was excused, or justified, at the time by the assertion that it had no local or native name. We have now got two native names, the Indian name Gaurisankar and the Tibetan name Chomo Kankar, long ago brought forward by Chandra Das, and, though never, so far as I know, seriously disputed, generally ignored, until Colonel Waddell brought it into prominence. Personally I should like to see Gaurisankar win the day".

Schlagintweit was a good artist and a fine mountaineer but he was apparently not familiar with the technique of identifying peaks from different points of view. Even a professional surveyor needs careful instrumental observations and computations for this purpose. This is especially so when as in the case of the Himālayas, the area involved is immense and covered with countless ranges of innumerable peaks which obscure one another.

Schlagintweit's sketches and observations were subjected to close scrutiny by the Survey of India and it was discovered that at both his stations of observation, he had failed to see the peak Mount Everest. From Phallut he had observed to Makālu a mountain about eleven miles east of Mount Everest and from Kaulia to Gauri Sankar about thirty-six miles west of Mount Everest and in his "Panoramic Profile of the Snowy Ranges of High Asia", published by F. A. Brockhaus, Leipzig in 1861, the three distinct peaks Makālu, Mount Everest and Gauri Sankar are wrongly shown as being one and the same.

The Survey of India's arguments were, however, not then considered convincing and the controversy was only finally settled in 1904, when Captain Wood was specially deputed by order of Lord Curzon to sketch and identify all peaks that could be seen from Kaulia and other stations in Nepāl. By accurate observations he established that Gauri Sankar was a distinct peak about 36 miles distant from Mount Everest and 5,500 feet lower than it (see Chart at end). From this locality it so happens that Gauri Sankar (23,440 feet) is very conspicuous while Mount Everest is hardly visible above intervening ranges; and this is how Schlagintweit was misled.

But traditions die hard. The imagination of the European world had been excited by the local name Gauri Sankar; and as stated above Mount Everest was wrongly named in the Times Atlas prepared as late as in 1920 by Bartholomew at the Edinburgh Geographical Institute. Some German maps still persist with the name Gauri Sankar and questions

have only lately been asked in the Indian Parliament as to why the name of Mount Everest is still perpetuated when its original and proper name was Gauri Sankar.

Recently several Tibetan names are claimed to have been found for the peak such as Chomo Kankar, Chholungbu, Chomo Lungma, Chomo Uri and Mi-ti Gu-ti Cha-pu Long-ga. The last one is intriguing and when freely translated is said to mean "You cannot see the summit from near it, but you can see it from nine directions and a bird that flies as high as the summit goes blind". In addition to the above, General Bruce in his book "Twenty Years in the Himalayas" published in 1910, writes that he had heard the name Chomo Lungmo applied to Mount Everest by Bhotias in Nepāl and Sarat Chandra Das gives in his dictionary (page 450) Jomo-Gans-Dkar as the Tibetan name for the peak. Burrard in his 1933 edition of "A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet" (pages 21-25) has fully discussed these names and gives reasons to doubt that these names are really applicable to the actual peak.

The question has often been asked, "Who was the discoverer of Mount Everest?" The story which has unfortunately gained considerable currency and has a special appeal to the popular press is that one day the Bengali Chief Computer Radhanath Sikhdar rushed into the room of the Surveyor General breathlessly exclaiming, "Sir, I have discovered the highest mountain in the world". Burrard in his book (page 194) has effectively contradicted this version and proves that the above words could not have been uttered. Even if they had been, a computer at the computing office cannot be properly regarded as the discoverer of a peak, as the observations play a more important part than computations. That considerable skill is required in observations should be apparent from the failure of such a reputed explorer as Schlagintweit to identify Mount Everest even when he went with the express purpose of observing to it. He actually confused it with a peak about one mile lower in height and about 36 miles distant. The discovery of Mount Everest must therefore be regarded as the result of a combined effort of the observers and computers, and the credit should go to the Survey of India Department as a whole.

It will be manifest from the above how keen controversies can arise over a name and how different are the views that have to be reconciled. The policy of the Survey of India has always been to adopt the local names of all geographical features rather than give them any personal names. Mount Everest is the only exception as no local name was known at the time of its discovery and none has been since put forward that stands out as indubitable.

In a similar way, no local name has ever been found for the peak of the Karakoram Range that is the second highest in the world. It has been allowed to retain its symbolic name K², which was given to it by its discoverer Captain Montgomerie during his triangulation of the Kashmir series in 1856-59, although several personal names such as Mount Godwin-Austen, Mount Waugh, Mount Babar and the like have been suggested for it.

HEIGHT OF MOUNT EVEREST

Determination of heights in the area of his work is one of the most important tasks of every surveyor. There are a number of methods at his disposal, the one usually resorted to being the observations of vertical angles. The most accurate method is of course spirit-levelling which

apart from the disadvantage of being very slow is quite inapplicable to high peaks. So long as the surveyor's work is confined to short rays to hills of moderate height, all is plain sailing but with lofty peaks observed from great distances numerous complications set in and the problem comes within the domain of higher geodesy, involving a knowledge of advanced theory of refraction, plumb-line deflections, gravity, geoids, datums of reference and so on. Indeed many of the technical considerations cannot be elucidated in simple language and even geographers find them difficult.

Before going into the value adopted for the height of Mount Everest, it will be well to set forth some elementary facts about the various factors that play an important part in the determination of the heights of very high mountains.

Datums.—The heights of points on the earth to be comparable with one another have to be reckoned above a level surface. Mean level of the open sea if imagined to be prolonged under the continents by means of narrow channels provides such a level surface. This is called the geoid. This surface along with the other level surfaces of the earth above or below it is approximately spheroidal in shape. The surveyor for computing his latitudes and longitudes adopts a true spheroid (approximating very closely to the geoid) as his figure of the earth on which he can carry out his mathematical computations. In India, this figure is called the Everest Spheroid. It should be realized that on account of the irregular distribution of land and sea, the geoid is necessarily an irregular figure but it has an actual physical existence and the surveyor's or engineer's level at each setting sets itself parallel to it.

Starting with mean sea-level at a given coastal observatory, precise levelling would trace the geoid in great detail within the limits of observational and instrumental errors. The reference spheroid on the other hand has a mythical existence and can only be located by means of the geoid with the help of geodetic observations.

Our predecessors in the last century knew levelling and so were able to obtain geoidal heights, but if they had wanted to obtain levelled heights above the Everest Spheroid, they would not have been able to do so as they lacked the information regarding the separation of the geoid from the spheroid. The geodetic programme of gravity and plumb-line deflections in India in late years has enabled us to determine the undulations of the geoid with respect to the spheroid in detail in the plains of India but not in the mountainous regions, on account of difficulties of observation. There are grounds for inferring that sea-level under Mount Everest would be raised by 150 feet on account of the attraction of the mighty mass above it, but the exact amount can only be determined by further observations.

In India, for our precise purposes, we use mean sea-level as the datum of reference for heights, and not the spheroid which is assumed as the normal figure of the earth. In the plains, there is no alternative but to use this height because of the following difficulty. Everest's spheroid is so placed that its height differs from that of the geoid by the following amounts at some ports :—

Karāchi	..	+ 50 ft.
Bombay	..	— 25 ft.
Cochin	..	— 35 ft.
Madras	..	— 40 ft.
False Point	..	— 45 ft.

If then this spheroid were to be used as the datum of heights, a point near Karāchi at mean sea-level on the coast would have to be shown as 50 feet above sea-level and a corresponding point near Madras as 40 feet below mean sea-level. This would violate the usual conception of height and would not only cause endless embarrassment to engineers, but would be quite intolerable on maps. The engineer accordingly has to be given heights above mean sea-level.

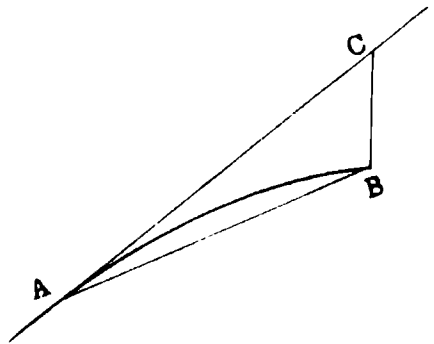
It can be argued that engineers are never going to work up to Mount Everest and that for mountainous peaks, we can reasonably take the spheroid as a height datum, particularly as the Himālayan peaks are so far from the sea and position of the geoid under them is still unknown.

This system would lead to non-uniformity as different countries use very different spheroids as their figures of the earth while the geoid (the mean sea-level) is a universal surface. It is accordingly desirable to obtain heights of Himālayan peaks above the geoid in conformity with heights in the plains. These heights would in fact be the heights of perpendiculars from the peaks to the surface of water at mean sea-level, were this brought up from the open sea by channels to points below the peaks.

Plumb-Line Deflections.—The normal to the geoid represents the true vertical and the bubble of any optical instrument when levelled sets itself perpendicular to it. This line may not be normal to the spheroid at this particular point, and the angle between the two verticals is called the deflection of the plumb-line. The method of its determination is a technical problem of geodesy involving a combination of astronomical and triangulation observations.

Angles observed with survey instruments are with respect to the geoid. The liquid in levels of instruments is generally tilted upwards towards high hills and consequently the observed angles of elevation are too small. Approximate corrections for this tilt or what are technically named as plumb-line deflections have to be applied to such observations. These do not normally worry the surveyor in his ordinary work. It is only in mountainous areas that they assume large proportions and have to be taken into account.

Refraction.—The main difficulty in obtaining great precision in trigonometrical heights is on account of the refraction with which observed vertical angles are burdened. An observer viewing a peak B from a point A does not see it along the straight line AB but along a curved line. The point B appears to him elevated to the position C along the tangent to this curve. A correction has, therefore, to be applied for this, but its exact evaluation presents great difficulties. To obtain accurately the curvature of the ray AB, a knowledge of the air density is required all along the ray at the time of observation. This is never achievable in practice and certain assumptions have to be made.



Refraction depends on temperature, pressure and temperature gradient of the atmospheric layers through which a ray passes and is consequently changing all the time. A rigorous theoretical formula for it involves an infinite series. In the olden days when reciprocal vertical

observations were taken it was thought that refraction was the same at both ends of the ray and cancelled out in the mean. This assumption has been shown by experience to be very untrue both in flat terrain where the rays graze the ground and also for long steep rays. By far the major portion of the variation of refraction is caused by the temperature gradient which is subject to large fluctuations in the course of a day and in particular near the vicinity of the ground. Modern tables of refraction tabulate it according to temperature and pressure on the hypothesis of a fixed temperature gradient (called the Adiabatic Lapse rate) of $-5^{\circ} \cdot 42$ F. per 1,000 feet, the reason being that while temperature and pressure can easily be measured at the time of observation, the determination of lapse rate involves much more laborious work which is generally not possible at a field station. Now, the Adiabatic lapse rate is the greatest temperature gradient that can occur in the atmosphere and generally obtains at a time when the temperature is the maximum ; and at this time the amount of refraction is a minimum. The modern practice, accordingly, is to overcome irregular effects of refraction by selecting a particular time of observation called the time of minimum refraction which happens to be near midday, because it is only at this time that variations in the temperature gradient from day to day are least. Observations of vertical angles are, accordingly confined to the hours between 12 noon and 3 p.m.

Now, the law of propagation of error of trigonometrical heights is such that the error due to refraction is proportional to the square of the length of the ray. Hence within limits, the shorter the shots the greater the accuracy. As a corollary it follows that the greatest possible accuracy for heights would be given by spirit-levelling with rays of seven chains or less ; and where topographical and geodetic triangulations exist in the same area, the former because of its much shorter sides, provided the work is of good quality, should be used to control altitudes of geodetic triangulation—a fact not generally recognized.

The modern technique of taking reciprocal angles at times of minimum refraction works on the whole quite well for rays of moderate length. The snow peaks of the Himālayas, however, present one great difficulty in that reciprocal observations are not possible. When fixed by observations from the plains at long distances, the refraction effect can amount to several hundreds of feet and the conditions at the elevated end of the ray being entirely unknown, the estimation of the refraction can be in error by as much as 25%. It might be of interest to record here that the observations to Mount Everest necessitated a refraction correction of as much as 1,375 feet. In such cases, a variation in the angle of refraction of as much as 200 seconds of arc can occur in a 100-mile ray between the morning and afternoon observations.

Variations of Snow.—The amount of snow on very high peaks varies considerably with the seasons and this source of uncertainty cannot be precisely evaluated. Indubitably on a peak like Mount Everest, the fluctuation of snow will be considerable during the course of a year.

Adopted Value 29,002 feet of height of Mount Everest.—Observations to Mount Everest were made from the following six stations of the N.E. Longitudinal Series in 1849-50 :—

Jarol, Mirzapur, Janjipati, Ladnia, Harpur and Minai (see Chart at end).

These are stations in the plains at an average height of about 230 feet above mean sea-level and towers had to be built on them to make them intervisible for triangulation. The stations were about 110 miles away from the mountain. The heights of Mount Everest as computed from

these stations were 28991·6, 29005·3, 29001·8, 28998·6, 29026·1 and 28990·4 feet respectively. The mean of these is 29,002 feet and this is the figure adopted up to the present time.

Regarded in the light of modern knowledge this value suffers from several serious sources of error. While it is sound principle to determine the height of a peak from observations at several stations, it is well to realize that at such long distances all measurements blur in a common uncertainty, due to refraction. It has been described how meteorological observations of temperature and pressure are necessary for first class geodetic work to delineate properly the curvature of the observed ray. These were not made, neither were the observations taken at the time of minimum refraction. The observations are thus quite heterogeneous, being taken under very different conditions and should not be lumped together. Again in the actual computations refraction was allowed for by assuming coefficients of refraction varying from 0·07 to 0·08. These seem too high for a ray whose other extremity goes up to 29,000 feet and the error in resulting height may be as much as 200 feet due to this wrong supposition.

Furthermore the distances are far too great for any accurate value of height to be obtained by vertical angles.

Finally, no account was taken of plumb-line deflections and no corrections to the observed angles were applied on this account. The resulting height is accordingly vague and above no recognized datum. It can be described either as a preliminary geoidal height or a rough height above the Everest spheroid so placed as to touch the geoid under the North Bihār plains. This is not our present definition of the Everest spheroid.

In the seasons 1880-83 and 1902, observations were taken from the Darjeeling hills in the course of the normal survey programme. These stations were also too far, being at an average distance of 90 miles from Mount Everest but had the advantage of being at a higher level. It was not possible to observe always at the time of minimum refraction and in certain cases, early morning observations had to be taken. The average height of Mount Everest was derived from these observations by Sir Sydney Burrard in 1905 by assuming a coefficient of refraction of 0·05 and worked out to be 29,141 feet; but he never claimed any finality for it. Here again, plumb-line deflections were not utilized for want of data and this value is still above an undefined datum. Actually for each station of observation there was a different datum and the various heights are above different Everest spheroids so placed as to touch the geoid under the hill stations.

This value seems to have attracted more attention than others in recent years. The Americans have published it on their maps and such an eminent mountaineer as F. S. Smythe in his book "Mountains in Colour" published in 1949 makes a definite statement that the true height of Mount Everest is 29,141 feet. He attributes the difference from 29,002 feet to be due to the fact that "the mass of the Himālayas puts the bubble of a theodolite very slightly out of plumb to the centre of the earth", which of course is not the true explanation.

Dr. Hunter in 1922 (Survey of India, Geodetic Report Vol. I) tried to put the existing data on a rational basis and selected some observations from both the earlier and the later sets of data but had to subject them to different treatments. Deflections were known only for a few of the hill stations and he utilized them, and for the others the geoidal angles had to be used. He also tried to reduce some of the earlier observations

which were not made at the time of minimum refraction to midday by conjectural extrapolations. His final value of height, viz., 29,149 feet is a confused height obtained from incomplete data. It is neither above the Everest spheroid nor above the geoid. He assumed the geoid under Everest to be 70 feet above the spheroid and allowing for this, the height of Mount Everest above sea-level works out to be 29,079 feet.

It should be made clear that although these later values may be slight improvements on the adopted value of 29,002 feet due to modifying the original faulty computations, they are by no means precise enough as judged by modern standards. It may also be that in spite of the height 29,002 feet having been computed in a most incomplete manner, e.g., with a definitely wrong refraction coefficient, omitting the plumb-line deflections, and with no idea of the datum surface, the various errors may have conspired in the direction of cancellation. In any case, the existing observational data is far too incomplete and so many doubtful factors enter into it, that no matter how it is manipulated, it cannot produce a result final enough to justify supersession of the traditional value. Further observations carried out on systematic lines are needed for this purpose and these would entail observations from mountains in Nepāl not far from Mount Everest. The recently executed topographical triangulation in Nepāl can be utilized for establishing suitable stations to the north of it. Refraction at these high altitudes being neither so large nor so erratic as in the low-lying plains can be tackled better. In addition it can be shown that this method does away with the necessity of finding the geoidal form under Mount Everest, which is quite a difficult proposition.

Conclusion.—Mount Everest being the highest point on the Earth's surface has rightly commanded a lot of attention and a vast literature exists about it in the form of books by eminent authors and explorers and a number of articles in such important journals as the "Royal Geographical Journal", the "Alpine Journal", the "Himālayan Journal" and so on. Just as it has so far successfully defied experienced mountaineers to reach its summit, it has also defied any attempt at finality both as regards its height and the establishment of a local name. There are still some widespread beliefs about it which are not well founded and contradictory reports about its discovery, height and name continue to be published in the popular press, scientific journals and on maps. This is not to be wondered at, since a study of the various problems associated with the Himālayan peaks provides a common meeting ground for linguists, historians, geographers, surveyors and geodesists whose views are not always reconcilable.

We can, however, deny certain fallacies that keep recurring at frequent intervals :—

- (i) Gauri Sankar is not the old and correct name of Mount Everest.
- (ii) Chief Computer Radhanath Sikhdar cannot be regarded as the discoverer of Mount Everest.
- (iii) 29,002 feet must be adhered to as the height of Mount Everest, until further observations are taken.