

THE ALTITUDE AND LOCATION OF MINYA KONKA

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THIRTY miles south of Tatsienlu, in the Chinese-Tibetan borderland,¹ stands a group of magnificent snow mountains, whose highest peak is Minya Konka. This peak was ascended for the first time by the Sikong Expedition² in 1932. Previous to the ascent an altitude determination (24,900 feet) was made which we believe confirms its status as the highest measured mountain outside the central ranges of Asia and the second highest whose summit has been reached.

A résumé of our knowledge of Minya Konka (pronounced Gungka) and its surroundings was given in the *Geographical Journal* in 1930.³ The only instrumental measurement that had been published up to that time was by the Szechenyi Expedition of 1877-1880, which gave the altitude of Minya Konka, called Bo Kunka, as 7600 meters (24,936 feet). In 1920 some members of the staff of the West China Union University in Chengtu made a survey of Minya Konka, but the results were never published. Joseph H. Rock visited the mountain in 1929⁴ and gave its altitude as 25,600 feet but did not state how this result was obtained.

In 1931 an expedition from Sunyatsen University, Canton, led by Dr. Arnold Heim made a geological study of the region. An account of it is given in his interesting book "Minya Gongkar,"⁵ the proof of which Dr. Heim kindly furnished to the writer. It contains many sketches and photographs and a sketch map of "Tatsienlu and the Minya Kongkar Mountains" on the scale of 1:275,000. The surveying work was under the direction of Professor Imhoff. The expedition was seriously hampered by bad weather and the detailed map has not yet been published, but Heim gives the altitude of Minya Konka based upon this survey as 7700 meters (25,262 feet) and that of Jara (pronounced with French *j*, a peak 28 miles northwest of Tatsienlu) as 5930 meters (19,455 feet).

An additional measurement of Minya Konka seemed desirable, and, as the Chinese government kindly granted permission for the work, we made it the first objective of our expedition. We also

¹ See P. H. Stevenson: Notes on the Human Geography of the Chinese-Tibetan Borderland, *Geogr. Rev.*, Vol. 22, 1932, pp. 599-616.

² The members of the expedition were Arthur B. Emmons III, Terris Moore, Jack T. Young, and the writer.

³ The Mountains about Tatsienlu, *Geogr. Journ.*, Vol. 75, 1930, pp. 345-352; Herbert Stevens, Sketches of the Tatsienlu Peaks, *ibid.*, pp. 353-356.

⁴ The Glories of the Minya Konka, *Natl. Geogr. Mag.*, Vol. 58, 1930, pp. 385-437.

⁵ Bern-Berlin, 1933; see also *idem*: The Structure of Minya Gongkar, *Bull. Geol. Soc. of China*: Vol. 11, 1931, pp. 35-40.

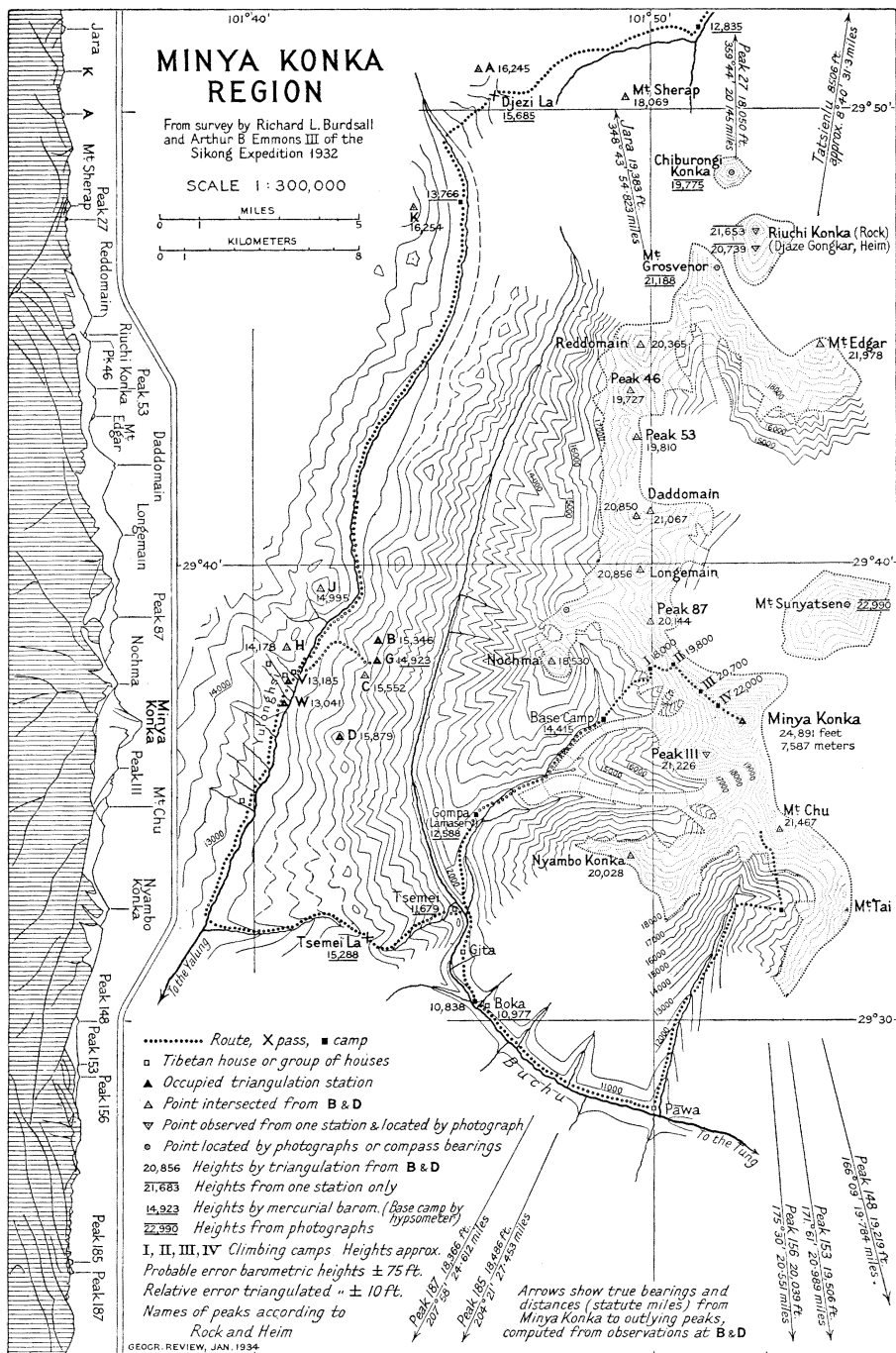


FIG. 1.—Map of Minya Konka. Above the snowline (heavier dotted line) contours are shown by dotted lines. The panoramic sketch is from station B: the area below the snowline is shaded.

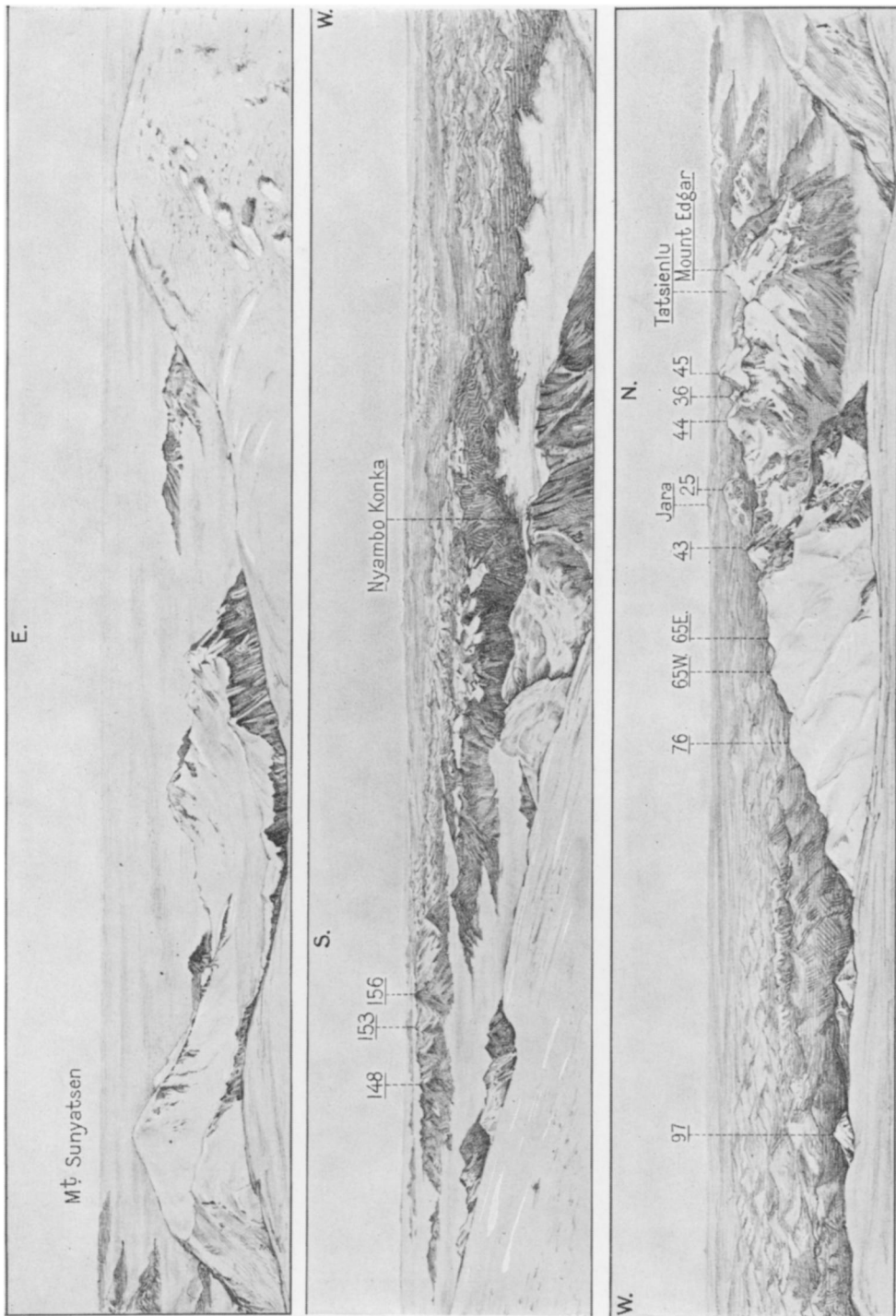


FIG. 2.—Drawing made from a complete panorama of photographs taken on the summit of Minya Konka (Oct. 28, 1932). Of the numbered peaks 97 is Nochima; 65, Daddoma; 43, Reddomain; 25, Mt. Sherap; 44, Mt. Grosvenor; 36, Chiburongi Konka; 45, Riuchi Konka. Tatsienlu is below the clouds.

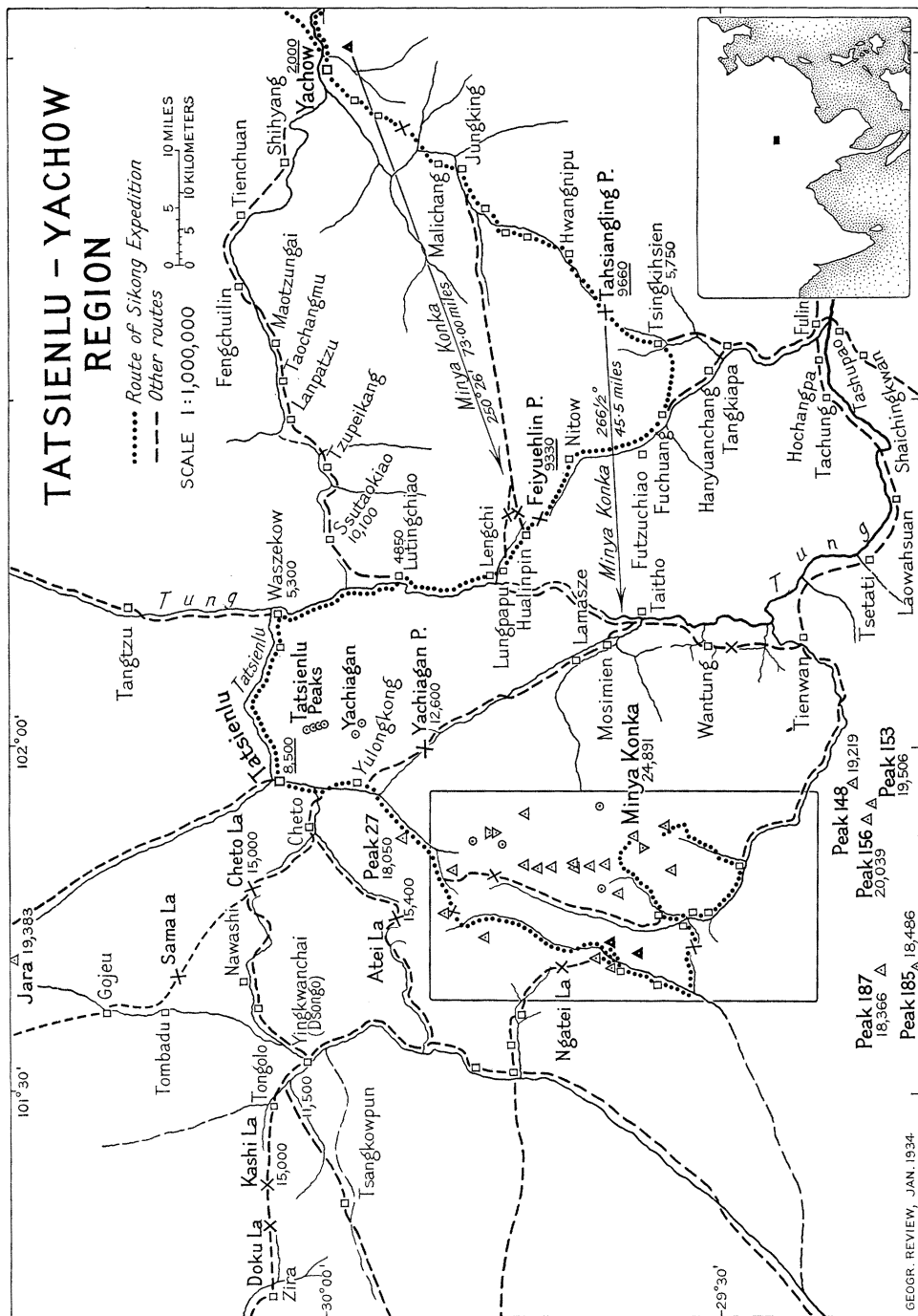


FIG. 3—This map was compiled from Survey of India 1:1,000,000 sheet 100 and "Kartenskizze von Tatsienlu und Minya Gongkar-Gebirge, 1:275,000," by Heim and Imhof, with a corrected grid and a few other changes and additions by the Sikong Expedition. Symbols are the same as Figure 1. Peaks were given numbers corresponding to their magnetic bearings from station B. The position of Peak 156 agrees roughly with that shown for Tzumci Mt. on the Survey of India sheet.

measured a number of other peaks in the vicinity, including Jara, and determined their geographical positions. While this was all we had expected to accomplish, we found that with complete panoramas from Station B and from the summit of Minya Konka, together with numerous other photographs, we had sufficient material for the accompanying map, Figure 1.

APPROACH TO THE MOUNTAIN

Leaving Moore and Young to complete arrangements and equipment for an ascent of the mountain, Emmons and the writer, who were to do the surveying, left Shanghai on June 16, 1932.⁶ Tatsienlu was reached on July 23, and four days later we started southward with a pack train of horses and yaks. Our route led up a narrow valley. On the second morning following our departure we crossed the Djezi La (15,700 feet), whose summit, like that of all Tibetan passes, is marked by a cairn of stones supporting sticks with prayer flags. Mist and hail prevented a view of the mountains, so, after Emmons had climbed a hill to erect a stone beacon (Station A on map), we descended into the Yulong Valley. We were now in the Tibetan grasslands, the valley being carpeted with short grass and the hillsides covered with grass and low bushes. The elevation (13,700 feet) is too high for crops, but in summer the Tibetans pasture their yaks here: we passed many herds containing several hundred animals. At Yulonghsi we found three widely separated stone houses; and over the crest of a ridge to the northeast, beside a tiny lake, we located our camp, from which we hoped to see Minya Konka.

As rainy weather was expected soon, we lost no time and by the next afternoon had selected two stations on the ridge (B and D). That evening we had our first glimpse of the mountain and found that the stations were satisfactorily located. When we looked out of our tent the next morning, it was clear, and we beheld a sight unsurpassable in its rugged grandeur. Across the deep Buchu Valley stood the range of snow-clad mountains, while beyond a second little valley rose Minya Konka, towering far above its enormous neighbors.

It is interesting to note in passing that all the drainage from this mass of mountains passes into the Tung River, while the ridge on which we stood, though a mile lower in altitude, forms the divide between the Tung and the Yalung.

DETERMINATIONS OF ALTITUDE

Stations B and D, on which 7-foot stone beacons had been erected, were about 2.6 miles apart. As the terrain was such that this dis-

⁶ For details of the journey and for an account of the ascent see Arthur B. Emmons, III: *The Conquest of Minya Konka*, *China Journ.*, Vol. 19, 1933, pp. 14-21; and Terris Moore: *The Minya Konka Climb*, *Amer. Alpine Journ.*, Vol. 2, 1933, pp. 1-17.

tance could not be measured directly, a base line V-W was selected in the Yulong Valley. The mountains cannot be seen from this valley, and a traveler from Tatsienlu, crossing the Djezi La in bad weather, as we did, might continue down the valley on his way south without a hint of their existence.

Having laid out the base line, we postponed its measurement and again turned our attention to the high stations B and D, the latter nearly 100 feet higher than Mt. Blanc. Fortunately we were able to get our sights before the bad weather began. Horizontal and vertical angles were measured to 25 peaks, including Jara 50 miles away to the north. We used a Keuffel and Esser transit reading to minutes. All readings were taken face right and face left, bubble corrections being applied to the vertical angles. Sixteen altitudes were taken of Minya Konka and six of Jara, and the horizontal angles to these peaks were measured by repetition. Our sights were completed on August 9. The mountains were never clear for long after that: from August 18 to September 17 we had some rain or snow every day but three. Conditions then began to improve, and while we were on the mountain in October the weather was fairly good.

The base line of 3185.15 feet was measured twice with a steel tape, the discrepancy being 0.56 feet.⁷ It was then extended to B-D, all the angles being measured by repetition at each corner of the quadrilateral. A small triangulation was required to connect our camp (Station G), where the barometer readings were taken, with Station B. The altitude of Minya Konka above our camp was found to be 9963 feet, the calculations through B and D showing a discrepancy of 11.5 feet. Judging from the angles involved and from photographs taken on the summit, 5 feet seems the right amount to add to this figure for the height of the true crest above the point of tangency of our sights. The value .60 was used as the index of refraction.

A series of 70 barometric readings was taken at camp from July 31 to August 25. We used a Fortin-type barometer loaned by the American Geographical Society—the first mercurial barometer to reach Tatsienlu without breaking. Its index error and that of the attached thermometer were determined by the Zikawei Observatory in Shanghai before our departure. The observatory publishes a daily weather map for China showing isobars at 6 a. m. Upon my return to Shanghai I was kindly supplied with these for each day of our observations. Their nearest station was at Chungking⁸ about 275 miles east of our

⁷ Correction was made for temperature of the tape, which has since been checked by the U. S. Bureau of Standards.

⁸ Leveling has been carried up the Yangtze only as far as Hankow, but from a long series of barometric observations the zero mark on the river gauge at Chungking is considered to be 546.5 feet above sea level. The mercurial barometer of the Customs Office, which reports to Zikawei, is 165.9 feet above this, or 712.4 feet above mean sea level.

camp, so the isobars for our location can be only approximate. However, they seem to offer the best values obtainable, and I used them to get the sea-level pressure, interpolating for the time of our observation and making a correction for diurnal variation. For the mean temperature of the hypothetical air column I used the temperature at time of observation for the upper station and assumed a gradient of 0.30° F. per 100 feet to get the sea-level and mean temperatures.⁹ The temperatures were taken with a small sling psychrometer, which has since been checked by the U. S. Bureau of Standards.

The altitude was worked out independently from each of the 70 observations according to the Smithsonian Meteorological Tables. The unsatisfactory status of the temperature correction is shown by the fact that, while the uncorrected altitudes show a range of 351 feet, the altitudes corrected for temperature and average degree of humidity show a range of 744 feet. Observations taken at midday, when the temperature was high, gave higher altitudes than those taken in the morning or evening. The temperature correction, however, must be made, and there does not appear to be any better method of making it. Though the range in altitude is considerable, there were few observations near its limits, and the mean of the 70 observations gives a value whose probable error is considered to be ± 0.5 per cent or ± 75 feet. This figure, 14,923 feet, was accepted as the altitude of our camp (Station G), and all the altitudes obtained by triangulation were based upon it. This, added to the height of Minya Konka above our camp, gives 24,891 feet (7587 meters) as its altitude above sea level. We believe the probable error of this result is about ± 85 feet, and as a round figure call the altitude 24,900 feet or 7590 meters.

On November 28 I measured the altitude of Minya Konka from the side of Tsokungshan overlooking Yachow. The result was 24,629 feet or 262 feet lower than the figure given above. Another peak, Mt. Edgar, came out 177 feet lower than the altitude obtained for it at our survey camp. These results are based on our figure of 2000 feet as the elevation of Yachow. Because of the distance (73 miles) and the uncertainty in the elevation of the instrument the only value attached to these observations is that of a rough check.

It may here be worth while to comment on the Szechenyi Expedition's figures for Minya Konka and Jara, as the figure for the former is nearly correct and for the latter (7800 meters or 25,592 feet) very much in error. The account of the determination, which was made by Lieutenant Kreitner, is contained in "Die Wissenschaftlichen Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien 1877-1880"

⁹ The suitability of this figure was confirmed by correspondence with the U. S. Bureau of Standards and the Weather Bureau, and sea-level temperatures computed by it are fairly consistent with records at Chungking. A change of 0.014 in the value of this gradient will give a change of 1° F. in the mean temperature of the air column and a change of 30 feet in the resulting altitude.

(Vienna, 1893-1899). Describing his method Kreitner says:¹⁰

. . . I determined the position of conspicuous peaks and summits of mountains and other prominent objects by compass bearings, and, as far as practicable, from several, or one other, similar bearings, plotted the angles graphically. I thus obtained a distance, within the possible limits of accuracy, for the fixed object from my position, in order to ascertain the relative difference of height by measuring the vertical angle. On a rapid journey on public roads, it is possible only occasionally to set up the theodolite, so a few only of the determined heights were measured with that instrument. I generally used for sighting the corners of my rectangular survey-box, on the reverse side of which I had constructed a quadrant with a 5° scale, or else the compass of the expedition's geologist, fitted with a contrivance for reading vertical angles.

In his table of altitudes Kreitner does not state whether the theodolite or the rougher instruments were used. Bo Kunka (Minya Konka) was measured from Dsongo, which is the Tibetan name for Yingkwanchai. Its elevation is given as 3482 meters, the distance to the mountain 16,000 meters, the vertical angle 14° 30', and the resulting altitude 7655 meters, which is rounded off to 7600 meters. According to Heim's map the true distance is 55,500 meters. Kreitner's angle would therefore indicate an altitude of 18,100 meters! Using our altitude for Minya Konka and Heim's altitude (3500 meters) and distance for Yingkwanchai, the vertical angle there should be 4° instead of 14° 30'. As Kreitner's figures are consistent, there does not appear to be a typographical error, and the position on his map is in agreement with them. Misidentification suggests itself, but his sketch from Dsongo (p. 703) is obviously the same as Stevens' sketch from the same place. Stevens gives another sketch of Minya Konka in nearly the same aspect from Haja La. Here he had his back toward Kreitner's position of the mountain, which, according to Edgar, is occupied by "rolling downs with excellent pastures."¹¹ Kreitner's measurement of Jara was made from Kashi La. Its elevation is given as 4474 meters, the distance to the mountain 33,000 meters, vertical angle 5° 35', and resulting altitude 7774 meters, which is rounded off to 7800 meters. According to Heim, the true distance is 47,600 meters, and Kreitner's angle would indicate an altitude of 9400 meters. Using our altitude for Jara and Heim's altitude (4600 meters) and distance for the Kashi La, the vertical angle there should be 1° 23'.

DETERMINATION OF POSITION

While in camp we were unable to ascertain our position, because our wireless set had not arrived, the sun at noon was too high for observation with our transit, and at night we were always enveloped in cloud. We did, however, take time and azimuth observations from

¹⁰ From translation in the *Geographical Journal* (Vol. 75, 1930, pp. 347-348).

¹¹ J. H. Edgar: Notes on the Mountains about Tatsienlu, *Geogr. Journ.*, Vol. 82, 1933, pp. 264-267.

the sun, using an assumed position. As the position is now known, these sights have been reworked, and the four azimuth observations show a range of only 4' 34". A single compass bearing taken with the transit showed a magnetic variation of 0° 36' W. Thirty-three bearings taken with a pocket compass at B showed variations of 38' E. to 1° 57' W., the mean of all being 53' W.

On our return journey we obtained the position of Yachow, using the John Ball adaptation of the Marc St. Hilaire method—observing six stars and taking six altitudes of each. We consider that the location obtained is correct within one-quarter of a mile. Moore obtained time signals on a wave length of 33.8 meters from Station NPO, Cavite, P. I. A good watch was used, and the rate was determined by a series of receptions before and after the observation.

From the side of Tsokungshan the angle was measured between Minya Konka, Mt. Edgar, and a line to a point in Yachow. Later the direction of this line was obtained by two sun azimuths, which agreed within one minute. The distance from the station on Tsokungshan to the point in Yachow was 12,300 feet measured roughly by stadia. Our work at camp gave the distance from Minya Konka to Mt. Edgar and the direction of the line joining them. This, with the angle at Tsokungshan and the directions from there, allowing for convergence of meridians, gave sufficient data to solve the triangle. We consider the resulting location of Minya Konka to be correct within one mile (see Table III).

TABLE I—BAROMETRIC HEIGHTS RECORDED JULY TO DECEMBER, 1932

| STATION | DATE AND TIME | NO. OBSERVATIONS | FEET ABOVE STA. | | AIR TEMP. °F. | | PRESSURE (REDUCED TO STD.) | | PRESSURE AT SEA LEVEL ² | | ALTITUDE OF STATION ³ FEET | | ALTI-TUDE METERS |
|----------------------------|---------------------|------------------|-----------------|-------|---------------|--------|----------------------------|--------|------------------------------------|--------|---------------------------------------|------|------------------|
| | | | MEAN | RANGE | MEAN | RANGE | MEAN | RANGE | MEAN | RANGE | | | |
| | | | | | | | | | | | | | |
| Chengt'u . . . | July 12 22:40 | 1 | 17 | 87 | .... | 27.901 | .... | 29.602 | .... | 1756 | .... | 535 | |
| Yachow . . . | July 15 18:30 | 1 | 15 | 85 | .... | 27.699 | .... | 29.687 | .... | 2044 | .... | 623 | |
| Yachow ¹ . . . | Nov. 28 11:45 | 2 | 8 | 54 | 2 | 28.177 | .079 | 30.243 | .108 | 1957 | 30 | 596 | |
| | Dec. 1 11:15 | | | | | | | | | | | | |
| Tahstangling . | July 18 15:30 15:40 | 2 | 2 | 74 | 2 | 21.334 | .002 | 29.520 | .004 | 9665 | 46 | 2946 | |
| Feiyuehlin . . | July 20 16:05 16:35 | 2 | 2 | 60 | 0 | 21.386 | .006 | 29.540 | .003 | 9332 | 4 | 2844 | |
| Tatsienlu . . . | July 24 to July 27 | 11 | 15 | 69.6 | 16 | 22.139 | .198 | 29.602 | .186 | 8533 | 545 | 2601 | |
| Tatsienlu ¹ . . | July 25 to Sept. 6 | 28 | 3 | 62.2 | 21 | 22.205 | .315 | 29.786 | .599 | 8480 | 363 | 2585 | |
| N. E. Diezi La | July 29 18:35 | 1 | 1 | 46 | .... | 18.758 | .... | 29.494 | .... | 12,835 | .... | 3912 | |
| Diezi La . . . | July 29 10:45-13:40 | 4 | 2 | 47.7 | 7 | 17.111 | .022 | 29.532 | .032 | 15,685 | 232 | 4781 | |
| Upper Yulong | July 29 18:20 | 1 | 2 | 47 | .... | 18.184 | .... | 29.481 | .... | 13,766 | .... | 4196 | |
| Station G . . . | July 31 to Aug. 25 | 70 | 3 | 43.8 | 28 | 17.571 | .150 | 29.705 | .449 | 14,923 | 744 | 4549 | |
| Tsimei La . . . | Aug. 26 9:30 9:45 | 2 | 2 | 41.7 | 1.5 | 17.420 | .016 | 29.880 | .000 | 15,288 | 23 | 4660 | |
| Tsimei . . . | Aug. 26 13:05 | 1 | 50 | 55.5 | .... | 19.865 | .... | 29.829 | .... | 11,679 | .... | 3560 | |
| Konka Gompa | Aug. 26 18:20 | 2 | 2 | 49 | 8 | 19.174 | .012 | 29.807 | .076 | 12,588 | 304 | 3837 | |
| | Aug. 27 11:00 | | | | | | | | | | | | |
| Boka House . . | Aug. 27 18:45 | 1 | 15 | 53 | .... | 20.281 | .... | 29.773 | .... | 10,977 | .... | 3346 | |
| Boka Camp . . | Aug. 28 to Sept. 19 | 5 | 2 | 53.2 | 15 | 20.451 | .064 | 29.861 | .128 | 10,838 | 179 | 3303 | |
| Base Camp . . . | Oct. 5 19:00 | 1 | 0 | 31 | .... | 17.745 | .... | 29.957 | .... | 14,415 | .... | 4394 | |
| Camp I ¹ . . . | Oct. 7 19:00 | 1 | 0 | 28 | .... | 15.615 | .... | 30.008 | .... | 18,078 | .... | 5510 | |

¹ By hypsometer; other readings by mercurial barometer. The hypsometer was compared with the barometer by 10 simultaneous observations at Station G and 2 at Tatsienlu. The hypsometer read low, the mean of the differences being .028". All hypsometer readings in the table have been corrected by adding this amount. The station at Tatsienlu was the China Inland Mission building. The series of hypsometer observations was made by the Rev. R. L. Cunningham using our spare thermometer in his hypsometer. This was checked by comparison with our hypsometer and gave the same reading.

² From weather maps of the Zikawei Observatory corrected for time of observation and diurnal variation.

³ By Smithsonian Meteorological Tables using temperature gradient of 0.30° F. per 100 feet.

TABLE II—TEMPERATURES RECORDED (1932)*

| PLACE | ALTITUDE | DATE | TIME | TEMPERATURE °F. |
|--------------------|----------|---------|-----------|-----------------|
| Station G | 14,923 | Aug. 23 | Minimum | 29.5 |
| Base Camp | 14,415 | Oct. 6 | " | 31 |
| " " | " | Oct. 14 | " | 20.5 |
| " " | " | Oct. 15 | " | 21 |
| Camp I | 18,000 | Oct. 8 | 8:00 a.m. | 15 |
| " " | " | Oct. 16 | Minimum | 14 |
| Camp III | 20,700 | Oct. 25 | 9:00 a.m. | 5 |

*These were the only temperatures recorded in addition to those of the barometric observations. Using a gradient of 0.30° F. per 100 feet, the corresponding temperatures at the summit of Minya Konka would range from 0° to -11° F.

TABLE III—POSITIONS DETERMINED

| PLACE | LATITUDE (N.) | LONGITUDE (E.) |
|--|---------------|----------------|
| 1. Yachow | 29° 59' 38" | 102° 58' 55" |
| 2. Minya Konka | 29° 36' 32" | 101° 52' 12" |
| 3. Station B | 29° 38' 20" | 101° 43' 05" |
| 4. Station G | 29° 37' 53" | 101° 43' 05" |
| 5. Jara | 30° 23' 22" | 101° 41' 26" |
| 6. Tatsienlu (Approx.) | 30° 03' 30" | 101° 58' 50" |
| 7. Tahsiangling Pass (Approx.) | 29° 38' 44" | 102° 37' 40" |

The first position (tennis court of Dr. R. L. Crook, American Baptist Mission, Yachow) was obtained from six stars and is considered correct within one quarter mile. The next four were derived from it by azimuths and triangulation and are probably correct within one mile. The last two may be two miles in error; that of Tatsienlu is based on topography shown on photograph from summit of Minya Konka and upon our route to the mountain; that of Tahsiangling Pass is based on pocket compass bearings to Minya Konka and neighboring peaks and photographs of them taken from the pass.

THE NAME MINYA KONKA

Regarding the name Minya Konka, Rock says:¹²

In June of 1928, while exploring the Konkaling snow peaks to the northwest of Muli, I beheld from a ridge, at 16,300 feet elevation, a series of snowy ranges, one of special interest far to the northeast. My Tibetan guides said this was Minya Konka. . .

Stevens makes this observation:¹³

. . . when between Yatsu and Baurong before the descent to the gorge of the Yalung, I had an impressive view to the east of snow mountains, which the lama and carriers spoke of as the Minya Gonka. . .

However, in the *Geographical Journal* for September, 1933, Edgar says:

"Bang Gangs t'Kar" (pronounced "Bo Gang Kar") is now as it was in Kreitner's day the local designation. When at the Gang Kar Monastery in 1931 its scholarly abbot gave me, in the Tibetan script, the words "Bang Gangs t'Kar," asserting that they represented the official name. The same applies to the head monastery about 35 miles in a southerly direction on the Yalung side of the mountains.

When we visited the monastery the head lama was away on a visit to Lhasa. However, Edgar gave me the script referred to, transliterated and translated as follows: a'Bang Yul Gangs dkar, revered region ice white. The word "Gangs" is the same as the first syllable in Kanchenjunga, the great mountain north of Darjeeling, India. In his book Heim gives a cut showing the name as written for him by the head of this same monastery: this may be transliterated as:

¹² *Op. cit.*, p. 385.

¹³ *Op. cit.*, p. 355.

Men-as Kun-gar. The lama evidently spelled incorrectly, as the dictionaries of Jaeschke and Sarat Chandra Das both give Mi-nyag as the name of the province.

The natives called the mountain simply Konka (pronounced somewhere between Gongka and Gungka). In considering the two names Bo Konka and Minya Konka, it seems to the writer that there are likely to be other "revered" konkas in Tibet; if so, the first name would not be distinctive. There is only one Minyag, and, while there are other lesser konkas in it, this is the outstanding one, and therefore Minya Konka seems to be a suitable name. We could not substantiate from natives the names that Rock used for the other peaks as we were somewhat handicapped by lack of a good Tibetan interpreter. On the accompanying map the names are as used by Rock and by Heim, with the German spelling anglicized.

The results of our work are given by the accompanying tables and by the map. In closing, I wish to express our appreciation to the missionaries in China who helped us in many ways, to Father Gherzi of the Zikawei Observatory, and to O. M. Miller and John Kay of the American Geographical Society for assistance given both before our departure and since our return.