The Possible Altitude of K2

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Editor's Note. The *Journal* is publishing the brief article which appears below because the Editor feels that it is most important for it to appear verbatim in this issue. It is important to note, however, that this does not mean in any sense that by so doing the AAC is announcing that, in essence, K2 is higher than Everest!

These figures are derived from extremely brief and cursory observations made by a mountaineering expedition—not a survey party. We hope they will create a challenge to others to return to the Karakoram soon and establish, once and for all, exactly where K2 is, and how high it is. However, in order to do this with the sort of validity that would be accepted by the world-wide surveying fraternity it would require:

1) An expedition whose prime purpose was to establish the position and altitude of K2.

2) A professional surveyor of high technical competence should either lead this party or be its deputy leader.

3) Assuming that the position is to be based on observations of GPS (Global Positioning System) Satellites, the equipment used should be recommended and approved by the FGCC (The Federal Geodetic Control Committee). Today there are four excellent producers of this equipment.

4) At least three base-stations should be occupied to do this, preferably four, if there appears to be any chance of K2 being higher than Everest.

5) The array of triangles relating these GPS stations to the summit of K2 should involve no angles smaller than 15° and the theodolite that observes these angles should be a Wild T-3, a Kern DKM3 or the equivalent. This is in part because the summit of K2 is not a sharp spire and a substantial "triangle of error" may result from these observations.

6) If laser prisms could be set up on the exact top of K2 (like the Chinese aluminum survey target on Everest) and sights could be made to them from one or more of the base stations, the results of this work would be much more conclusive.

7) The same sort of "final" determinations of the position and altitude of Mount Everest would be equally interesting, particularly if the observations were made from precise survey stations in both China and Nepal.

THE ALTITUDES usually quoted for most peaks of the Himalaya and Karakoram ranges were determined by triangulation measurements completed during the 19th century by the Grand Trigonometric Survey of India. Hence, it is worthwhile to improve the control of the altitudes of major peaks by entirely independent methods. The best such method is undoubtedly Doppler measurements of the Transit Navigational Satellites.

During the 1986 American K2 Expedition to the north ridge of the mountain, a JMR-1 satellite receiver was brought to Base Camp at Sughet Jangal near the

junctions of the Sarpo Laggo outwash stream and the K2 River, latitude = 36°4′ N, longitude = 70°23′ E. One satellite pass was recorded successfully to obtain the altitude of the site. The single pass was very favorable and yielded both the latitude and longitude to within 1′ of arc. The data were reduced at Edo Canada in Calgary. The fact that the latitude was recovered correctly shows that the local oscillator was stable and the high altitude of the pass—83°—greatly reduces any ambiguity between longitude and altitude. The derived altitude of the receiver was 4164 meters above mean sea level.

Since K2 was not visible from Base Camp, it was necessary to tie the station altitude to various altitudes determined by Spender[1] in 1938. All of the altitudes on Spender's map are tied to K2, hence the mean difference between our altitudes and those of Spender's map may be taken as indicative of a correction to the previously quoted altitude of K2 of 8611 meters.

Two base lines, roughly N–S and E–W, 374.4 m and 366.5 m, respectively, were set up and their lengths determined with a Topcon laser range finder. Sightings were made with a Zeiss theodolite on several peaks and other points of established altitude on the Spender map. The results are shown in the following table, in which corrections for refraction and earth curvature have been included.

TABLE 1

DERIVED ALTITUDES NEAR SUGHET JANGAL

Point	Map Altitude	Our Altitude	Difference	Notes
6050 m	6050 m	6312 m	264 m	(1)
6030 m	6030 m	6115 m	95 m	(2)
outcrop	3890 m	4205 m	328 m	(3)
river baseline	3857 m	4155 m	298 m	(4)

Notes:

(1) Peak 5.5 km SSE of Sughet Jangal, mean of observation from both baselines

(2) Peak 13.0 km SW of Sughet Jangal

(3) Bedrock outcropping at the junction of the Sarpo Laggo and Shaksgam Rivers

(4) Point 379.4 m N of base camp; map altitude interpolated between survey points at 3915 and 3730 m on the Sarpo Laggo River.

The mean correction is 247 ± 51 m, making the altitude of K2 8858 m, or 29,064 ft. If the sighting on peak 6030 is incorrect, *i.e.*, if I sighted a foreground and

[1] Spender, M. 1938, *The Himalayan Journal*, 10, 22.

hence lower point, which is quite likely, the mean correction from the other three points is 297 ± 16 m, yielding an altitude for K2 of 29,228 ± 52 ft. In that case, K2 is higher than the usually quoted altitude of Mount Everest. If our correction is confirmed it will apply to many peaks in the K2 area, and move several of them to heights above 8000 meters.

Our measurement must be considered to be indicative only, since it is based on a single satellite pass. In their determination of the altitude of Ulugh Muztagh, R. Bates reports (private communication) that of 21 passes at one station and 15 passes at a second station, the maximum deviation from the mean altitude of any single pass was 18 meters. This is a good estimate of the uncertainty in our altitude determination, though an error as large as 50 m is possible for a single satellite pass. In addition, we are uncertain as to the height reference system to which the canonical altitude of K2, 8611 m, refers. Our value refers to the Goddard Earth Model, GEM 10B (Lerch[2] *et al.* 1978), which is a global reference surface. It is essential that a full-fledged effort be made by experienced geodesists to redetermine the altitude of K2. There are rather few sites on the north side of the mountain that are favorable for satellite Doppler reception and have an unobstructed line-of-sight to K2. The most likely location is near the junction of the Sarpo Laggo and Shaksgam Rivers. On the Baltoro Glacier in Pakistan, Concordia is an obvious choice.

The JMR-1 was purchased by the Department of Civil Engineering of the University of Washington with partial support from the Putnam Research Fund of the AAC. The receiver is available for scientific use by AAC members for up to three months per year upon four months' notice to the C.E. Department. I am indebted to Dr. Delf Egge for showing me how to use the JMR-1 and Muhamed Hatem Eid for refreshing my memory on the use of the Zeiss theodolite. Assistance in the field was provided by Dan Bean and George Duffy. Mr. Henry Ayers reduced the satellite data at Edo Canada. The encouragement and support of the expedition leader, Lance S. Owens, is greatly appreciated. The American 1986 K2 Expedition was sponsored by the Coleman Corporation.

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[2] Lerch, F. J., Wagner, C. A., Klosko, S. M., Belott, R. P., Laubscher, R. E., Taylor, W. A. 1978, Spring Annual Meeting, Am. Geophys. Union, Miami, Florida.