

CORDILLERA REAL NORTH, BOLIVIA, 1:550,000

(Aerial photogrammetric map)

R. Finsterwalder, Institute of Cartography and Reproduction Technology,  
Technical University of Munich

This map sheet covers the most intensely glacierized part of the Cordillera Oriental (Cordillera Real) in Bolivia around the two mountain peaks Illampu (6368 m a.s.l.) and Jankhouma (6427 m a.s.l.). C. Troll and E. Hein had already surveyed this area in 1928 by means of terrestrial photogrammetry during a climbing expedition of the German and Austrian Alpine Club. Aerial photography has now been used to repeat the exercise and the area's glacial features have been comprehensively mapped. On this basis, the extent of glacial retreat in the region since 1928 can be quantified. In addition to furnishing such glaciological information, this map can also be used by mountain climbers and was thus included in the so-called "Alpine Club Map" series.

The geodetic basis for the mapping was produced by means of aerial triangulation which was based on the trigonometric points used for the triangulation of Bolivia as a whole. In order to achieve a standard level of elevation, trigonometrically and photogrammetrically determined points from the 1928 project were also included. Photogrammetric interpretation was performed primarily by using aerial photographs taken in 1963 (photo scale 1:35,000) at the Institute of Cartography and Reproduction Technology of the Technical University of Munich. Cartographic editing was done at the same institute. The map was produced in the Alpine Club map style which entailed the retention of contour lines in rocky areas.

Glaciological analysis:

A comparison of the map compiled in 1928 with the new map showing the situation in 1963 makes it possible to determine changes in the elevation of glacier tongues as well as in glacier length and surface area. In addition, the elevations of the snow lines for five large glaciers in

the region have also been identified (Finsterwalder 1987). The same parameters can be compared for the period 1963 to 1975 from additional cartography of these glaciers using photographs taken during a flight in 1975 (Jordan 1991). The interpretation of aerial photographs taken in 1983 gave the same parameters for a further five glaciers in the Cordillera Real near Illimani (6438 m a.s.l., Finsterwalder 1990), so that glacier retreat in the Cordillera Real is well documented for the years 1928 to 1983. Average values are as follows:

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Time period	1928-1963	1963-1975	1975-1983
Change in length	- 197m	- 39m	- 32m
Change in tongue elevation	+ 60m	+ 12m	+ 15m
Change in area (percentage)	- 7.5%	- 0.6%	- 0.4%
Change in snow line elevation	+ 72m	+ 6m	+ 3m

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In comparison with glaciers of the Eastern Alps in Europe, these figures reveal that

- changes of glaciers in the Bolivian Andes may have been less pronounced, and
- the general glacier advance observed in the European Alps during the 1970s did not occur in the Bolivian Andes where there has only been a deceleration in the rate of retreat.

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