

THE STEREO-PHOTOGRAMMETRIC MAP OF GOLDBERGKEES, 1909, HOHE TAUERN, AUSTRIA (1:10,000)

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Reprint of the original map published by the Sonnblickverein in 1911: Die stereophotogrammetrische Aufnahme des Goldberggletschers im August des Jahres 1909. In: Neunzehnter Jahresbericht des Sonnblickvereins für das Jahr 1910, Vol. 19. Wien: Selbstverlag des Sonnblickvereins.

Goldbergkees (also known as Vogelmaier-Ochsenkar-Kees or Goldberggletscher), adjacent to the meteorological observatory (built in 1886) on top of Hoher Sonnblick (3,105 m a.s.l.), has been the focus of scientific research since the late 19th century.

This particular map of Goldbergkees, drawn in August 1909, can be seen as a milestone in the development of cartography and alpine glaciology. It was the first time that a brand new method – the terrestrial stereo-photogrammetry – was implemented to map a glacier with a yet unknown speed and accuracy (Böhm et al. 2011).

In 1904 the *Imperial Academy of Science* in Vienna, Austria decided to fund the mapping of Goldbergkees at a scale of 1:10,000 to establish “*a fundament to explore the impact of climatic conditions on changes in the Goldberggletscher*”. The *Sonnblickverein*, owner and sustainer of the Sonnblick Observatory, commissioned Artur Freiherr von Hübl, *Generalmajor* of the Austro-Hungarian Empire who already had gained some reputation for his 1899/1900 photogrammetric surveying of the Karls-Eisfeld, a glacier of the Dachstein massive, with the task of making this map. The stereo-photogrammetric map of the Goldbergkees subsequently became the most accurate basis for various glaciological studies in the Sonnblick area for many decades. The fieldwork was carried out during the summer of 1909 by Karl Wollen under the guidance of Artur Freiherr von Hübl. In the following winter this beautiful little piece of art was completed.

Photogrammetric surveying as the method for mapping the Goldbergkees was chosen in the first place because it was understood that a direct surveying using plane table and tachymeter was unfeasible due to “*mostly bad weather*” and the poor accessibility of the glacier, as well as the lack of natural objects to use as measurement markers for the positioning on the plane.

Only few years earlier, Dr. Carl Pulfrich, a German physicist, had developed the first stereo comparator for the Carl Zeiss Company in Jena, Germany. Artur Freiherr von Hübl soon realized its compatibility for photogrammetric glacier surveying, adapted the procedure and the first terrestrial stereo-photogrammetric surveying of a glacier ever was carried out – the 1909 map of Goldbergkees.

The trigonometric ground control points were defined by the 1st and 2nd order triangulation of the Austrian Military Institute in the year 1906. In doing so the surveying network was consolidated around the glacier in order to facilitate the forthcoming photogrammetric surveying.

For map construction Karl Wollen and his associates used, besides the control points, another 1200 detail points. The differences generated by the determination of terrain points from different survey points lead to a mean horizontal accuracy of ± 3 m. The mean elevation error was specified as ± 0.3 m. The equidistance on rocky areas is 100 m, on the glacier 20 m and on more gentle slopes 10 m.

Goldbergkees was predestined for stereo-photogrammetric surveying because of a 2,800 m high ridge between the summits of Neuner Kogel and Herzog Ernst that afforded an overview of the entire glacier. On that ridge the most important camera station for the surveying was established. Today it still serves as a photo-point to observe the glacier retreat in its full areal dimension. To catch all the topographic details another 9 photo-points around Goldbergkees were established. The summit of Hoher Sonnblick (3,105 m a.s.l.) served as a control point, from which 3 photos were taken consecutively at an angle of 45° to each other, to check the correct position of terrain points. The camera used had a focal length of 245 mm. To measure the angles, a small theodolite was placed on the camera tripod.

The final product – originally published by the Sonnblickverein in 1911 – is that stunning historic map of Goldbergkees, the first stereo-photogrammetric map of a glacier ever made and a small work of art in itself.