# MAPPING BY AERIAL PHOTOGRAPHY IN ANTARCTICA

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The german antarctic expedition of 1938/39 produced in seven flights about 12.000 aerial photographs, tilted photograms, of the surveyed ground. It was first of all intended to compile therefrom a general geographic map to the scale of 1 : 500.000 and possibly later a topographic map of a few prominent masses of mountains to the scale of 1 : 50.000. In order to carry out this work and to determine the orientation, it was necessary to obtain geodetic points in addition to tilted photograms.

Before describing this cartographic work, it is therefore necessary to consider the foundation underlying the cartographic plotting of the aerial photographs. Seven flight polygons were flown over in order to cover the intended area by aerial photography. The total distance of flights was 7.700 Km. and the total number of hours of flight 57 h. 14 m.

With the exception of a few interruptions of minor importance, the strips of photographs were continuous for all polygons. Such a large number of pictures of an unnkown country for which no general map was available, necessitated from the outset a good flight and photographic record. For each flight polygon was required, according to its length, about six film bands with a total length of 360 meters and about 1800 18 cm. × 18 cm. photographs. The operator had to attend to two serial film cameras. He had to mark the exposed films "port side" or starboard and to enter at definite time intervals of say 5 or 10 minutes, into an observation form the working registration number together with the exact time of the corresponding shutter release. This entry had also to be made at each change of course and position determination. By means of these notations it was possible after developing the film bands in Berlin, to obtain the orientation of all photographs. The operator had also to enter the time intervals of successive exposures into the observation form.

Specimen page :

Taken on January 22nd 1939 Film N° 16.
» starboard
» from Sauter-Bu

| *Greenwich mean time* | *Exposure time interval* | *Working registration number* |
|---|---|---|
| 06 39 | 22 s | 805 |
| 06 41 | 42 | 811 |
| 06 54 | 68 | 829 |
| 07 02 | 68 | 837 |
| 07 48 | 90 | 879 |
| 08 13 | 90 | 901 |
| 08 46 | 90 | 929 |
| 09 23 | 90 | 965 |
| 09 47 | 90 | 980 |
| 10 03 | 42 | 993 |
| 10 13 | 19 | 008 |
| 10 17 | 19 | 019 |
| 10 22 | 19 | 037 |

The relative flight altitude diminished as the ground was rising towards the pole. In order however to always obtain a stereoscopic over lap on the foreground of photographs, the camera operator had to modify the succession of exposures accordingly. Hereby were partly required the shorted possible general time intervals. But in spite of this severe tax on the photographer no interruption worth mentioning occured, so that, practically, the work was carried out according to plan. The seaplane crew determined the air position from time to time especially when there was a change of course, viz. at each angle of the flight polygon. These positions were transmitted by wireless to the "Schwabenland" who on the basis of this information entered the seaplane course in a working sheet. At the same time some observations were notified by wireless with regard to the country flown over, the relative and absolute altitudes of flight, the ground forms and conspicuous points sighted during the flight.

Meteorologic observations made aboard the "Schwabenland" supplied inter alia information on wind conditions and thereby a basis for an approximate estimation of the drift. The following data were also available for the cartographic plotting of aerial photographs.

1. The shooting off positions (vessel position at the time of shooting off).
2. 11.600 pictures of 18 × 18 cm. size, which were set as tilted photographs.
3. Wireless notifications of position, altitude of flight and observations.
4. Indications given by the camera operators on times and succession of exposures and
5. Weather reports.

To this was added the astronomic determination of a point on the edge of the insular shelf ice.

The completion of the general map was required by June 15th 1939. As the order was only issued at the end of April, there remained but about six or seven weeks for the plotting of photographs and cartographic work. In consideration of the legitime motives for this short time limit working arrangements were made accordingly and the map was delivered in due time.

For the choice of projection, only a conformal representation could be considered. As no eventual extension of the region could possibly be known at the outset of the expedition, the choice of the projection was rendered more difficult. It was assumed that eventually an extension towards the pole would be taken in hand. On the strength of this and of the short time available, a conformal cylindrical projection in transverse position was selected. Calculation for the projection were made by certificated engineer Rudolf FÖRSTNER, of the Hansa-Luftbild.

For the construction of the map contents, the data described above were available. Considerable land elevations were also to be found out. The choice of the mode of representation was left with the Hansa Luftbild G.m.b.H. Here again, the technique was governed by the short period of time available. In order to appreciate the work done, it is necessary to draw a comparison with the known area of our own country. The surveyed region which was to be mapped, with its 600,000 square kilometers is practically of the same size as greater Germany. The edge of the insular shelf ice would correspond to our North and Baltic sea coasts. Here a few points were known through position determinations, viz the vessel position as the planes were shot off and a point of the ice edge. Photographic survey flights were made inland from 200 to 400 kilometers from the coast. This would correspond to the distance from the Baltic sea coast to the Mittelgebirge and partly to the Main. That region, which like in Germany kept rising from the coast towards the south, presented therefore no sort of basis for a conclusion a posteriori permitting to infer the determination of the heights above land from the heights above the sea. Work previously carried out, for instance in Arctica (North East Greenland) revealed a region with fjords cutting deeply into the coast mountain, which facilitated considerably the determination of heights. Here, this facility was completely lacking. Plotting had to rely exclusively on the data supplied by wireless from the navigation and observation reports. From the observed and transmitted absolute and relative heights of flights, it was possible, for various land points to ascertain the heights above the sea. There were also a few isolated observations of mountain heights. So that, apart from the positions of the flight polygon only these few height observations were available as control heights.

The observation of the height of flight, made by means of a barometer, is naturally subject to the variations of air pressure conditions and on this score, unreliable to a

certain extent. Assuming that great pressure oscillations actually occur in the over flown region and considering that the planes flew occasionally as far as 400 km. away from the vessel position, these variations will surely not exceed ± 10 mm. Still, it is very rarely that such great uncheckable pressure oscillations are to be reckoned with, as for instance, falls of — 10 mm. were accompanied by such bad weather conditions that an interruption of the flight became necessary. An increase in the air pressure, however, provided the flight is made in good weather can never amount to 10 cm. Therefore under unfavorables condition the measured heights would be erroneous to the extent of the calculated amount of difference in pressure. This also means that the heights given on the map may be ± 100 meters wrong. The heights are therefore only given in rounded off hundred meters on the 1 : 500 000 map.

The first flight polygon to be plotted was that of photographic flight N° VI as covering the longest stretch in an East-West direction and involving the least breakings over the mountain area. This proved to be necessary, as somewhat considerable deviations occured when flight polygons had to be set together and adjusted. It was found that the method of course coupling employed for these flights did not always succeed in determining positions with sufficient accuracy. A change of method will therefore have to be made in the next expedition. All camera positions which had been used for plotting were then inserted in the adjusted polygon net, according to the data of the observation book, in which the photographers had already entered the successions of exposures, times and registration numbers. Taking account of the drift, the direction of the photograph axis was then obtained for each exposure, in relation to the direction of flight and the side of the polygon. The plotting of the contents of the photograph was made by intersection. The heights above land were partly calculated on the basis of the annotations entered in the observations book (in accordance with a method evolved by the Hansa-Luftbild G.m.b.H.). It was thus possible to calculate the relative height of flight on the basis of the succession of exposures recorded in seconds and overlap of the fore-ground. As the absolute height of flight was read off from time to time, the approximate height above ground was inferred therefrom in the air position. This possibility was rendered difficult by the sometime very hilly nature of the ground. Still, this method was applicable in the case of a few ice areas. By plotting photographs, the main salient points of the region were intersected graphically and the ground plan then inserted in the net of points. The determination of the photograph axis direction with due regard to the drift could only be effected after the delivery of a weather bulletin before each flight. This bulletin which was issued by the weather station of the "Swabenland" supplied also some information on wind conditions, which permitted the forecasting of the probable drift. Unfortunately, this did not result in a running determination of the drift that is also of the difference between the steered course and the flight direction. The unavoidable resulting variations in the determination of the frame work of points had to be adjusted by means of averages.

The cartographic elaboration of the map was made in four colours: green for ice, blue for water, brown for mountains and black for letters. The names were alloted by the directing staff of the expedition. The map was reduced to a scale of 1 : 1.500.000 for publication.

The production of the 1 : 50.000 map contemplated for particular mountain parts had to be provisionally postponed on account of other urgent work.

For this sort of work, the plotting of air photographs will no longer be made graphically as for the 1 : 500.000 map, but the pictures will be admeasured in stereoplanigraphs, wherby the bases ought to be obtained by aerotriangulation.

In spite of a few breaks in the plan of flight, which came out later in the plotting, the 1 : 500.000 projected map was compiled within the very short total period of six weeks. Including all accessory work which did not belong to photogrammetry, it was possible to send the map to the printers, as early 2 months and a half after receipt of order. Photogrammetry has thus given proof of its great efficiency. At the same time, it is to be noted that no other process is capable of achieving such exceptional results, even if more time were actually available.

Thus the extensive work carried out during the antarctic expedition of 1938/39 has provided a great deal of new practical knowledge, which can be made use of by future expeditions.