

Astronomical observations for determining the latitude and longitude of an age point on Arctowski Station on King George Island*)

Determination of the movements of the Antarctic Continent in relation to the Earth's axis is a very important geophysical problem. This movement can be discovered by periodical determination of the latitude and longitude of a specific point providing that the surface area on which this point is fixed can not belong to formations having their own local movement in relationship to the whole island. Such place has been found on the Polish Station at the margin of vast swampy surface area overgrown with mosses (Fig. 1). At the foot of the rocks, belonging to the reserve, rocks closely connected with the substrate (in situ) protrude above the swampy area.

The column for astronomical observations was made from reinforced concrete. Into sufficiently deep drilled holes in the rock reinforcement bars were inserted and after making the timbering cement mixed with gravel was poured. Thus the column together with the rock formed a monolith. A special metal box on the top of the column was installed in order not to remove the instrument after finishing the observations (Fig. 2).

On a high rock on the shore with a lighthouse on top (Fig. 3) the vertical ridge which is visible (Fig. 4) was chosen as an azimuth mark. The distance between the azimuth mark and the column was 500 m. Important here was the choice of observation method used under difficult polar conditions, considerably differing from conditions under mean altitudes. Because of very low temperatures in winter precise measurements in an open area can not be conducted. Also, judging by my experience on Spitsbergen, winter is not a suitable period for astronomical measurements of high accuracy because of great anomalies in atmospheric refraction. The direct cause of these anomalies is a great difference of temperatures on land and sea, because the land surface area cools down greatly due to radiation on a nice day and its temperature drops below zero. At the time the sea surface is covered by ice floats and is a reservoir of warmth. The temperature of water, depending on its salinity fluctuates around -2°C .

Spring and autumn have better conditions, but even then the temperatures above the land and sea are not sufficiently balanced. The best period is

*) The work was done during the Second Polish Antarctic Expedition at the Arctowski Station as part of Project MR-II-16 granted by the Polish Academy of Sciences.

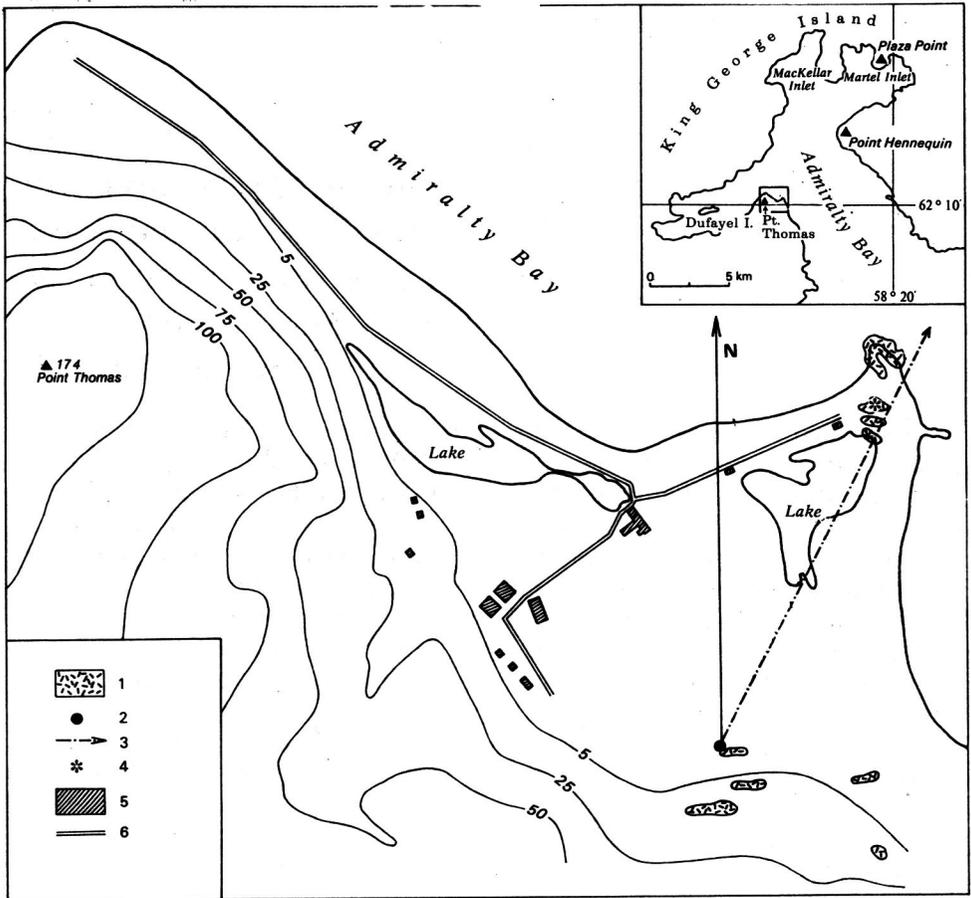


Fig. 1. Schem of the Polish Antarctic Arctowski Station
Marked are rocks used as an age point.

1—rocks, 2—place and direction of azimuth mark, 4—age point, 5—buildings,
6—routes

the summer providing the meteorological conditions are satisfactory. But then, there are other obstacles. Short nights or no nights at all leave out these methods which require observations of not very bright stars. Because of a usually small number of days and nights having good weather conditions all possibilities have to be used, including observations of stars in sunlight. Under these circumstances it seems to be most useful to apply the method of Kavraiski elaborated for the northern polar areas (Kavraiski 1936) where φ and λ are simultaneously determined from pairs of stars at equal altitudes. I have used this method successfully when determining the latitude and longitude of an age point in the Polish Station at the Isbjörnhamna Bay in Hornsund fiord on Spitsbergen in the summer of 1958 (Jasnorzewski 1964) obtaining values $\varphi = +77^{\circ}00'03.57'' \pm 0.19$ and $\lambda = -1^{\text{h}}02^{\text{m}}14.421^{\text{s}} \pm 0.005^{\text{s}}$. Because of such accuracy it is possible,

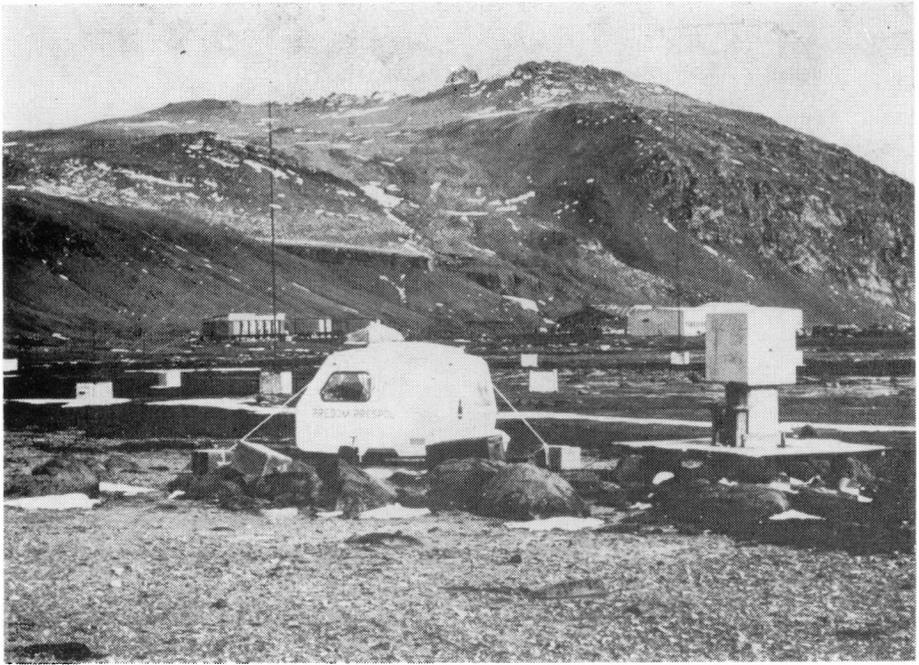


Fig. 2. Astronomical pole. Photo J. Jasnorzewski



Fig. 3. Rock with lighthouse chosen as an azimuth mark. Photo J. Jasnorzewski



Fig. 4. Rock contour used as an azimuth.
Azimuth — astronomical pole — is $25^{\circ}10'40''$.

when repeating the measurements after years, to obtain information about land movements. The use of this method requires good weather conditions and clear sky on both sides of the meridian. Unfortunately the summer of 1977—78 on King George Island was cloudy, and probably due to high humidity even at clear sky I have not observed stars during the day. Thus the night remained, which under these latitudes is relatively short. I have not had an opportunity to observe stars at equal altitudes in short time intervals and in precisely determined places. If the western part of the sky is relatively clear then the eastern part is clouded and vice versa, most probably due to the wind direction.

Thus only classical methods remain which from the nature of things have high refraction errors. But even these methods have not been always easy to use, because frequently brighter stars showed for a short while among clouds and without seeing the whole constellation it is difficult to find out which star is being observed. Then by means of approximate calculations probable equatorial co-ordinates have been determined and on their basis, after the star catalogue, their real co-ordinates for the moment of observation.

Because of so unfavourable atmospheric conditions I have managed to determine co-ordinates of age point on King George Island on Polish Arctowski Station with relatively low accuracy:

$$\begin{aligned}\varphi &= -62^{\circ}09'51'' \pm 12'' \\ \lambda &= +3^{\text{h}}53^{\text{m}}51^{\text{s}} \pm 0.8^{\text{s}}\end{aligned}$$

I would like to add that determination of these co-ordinates with a higher accuracy which allows to judge in the future about land movements, is not hopeless. Such bad weather does not happen each year and therefore it would be useful to send a geodesist and astronomer in Polish expeditions.

On behalf of what has been said I should like to mention that although the summer of 1957 in Spitsbergen was all the time cloudy and rainy the summer of the following year had long periods of nice weather and brighter stars could be observed in full sunlight.

References

1. Jasnorzewski J. 1964 — Astronomic age point measured at the Isbjörnhamna Bay in Hornsund fiord on Spitsbergen.
2. Kawraisky W. W. 1936 — Simultaneous determination of time and latitude by corresponding altitudes of stars. The General Editorial Office of the Technical Literature — Leningrad.

Paper received 17 September 1980

Jerzy Jasnorzewski