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**POLISH GEODETIC ANTARCTIC STUDIES.
A SHORT HISTORICAL OUTLINE**

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Member of the First Polish Antarctic Expedition 1958/59**

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Active exploration of the Antarctic Continent by Polish scientists began in late fifties and was focused mainly on different scientific investigations (geophysics, geodetic, biologic, ecologic etc.) carried out in two Polish Antarctic stations: Station A.B.Dobrowolski located in Bunge Oasis and Station H. Arctowski, Admiralty Bay, King George Island. This short historical outline will remind the main milestone works of Polish geodesists carried out in these two Antarctic stations.

First Station in Bunge Oasis was taken over by Polish scientists from their Soviet colleagues on 23 January 1959 and was named Station A.B.Dobrowolski. The station is situated in a very specific Antarctic "oasis" where the nunatac stones appear above the ice, where there blow very strong winds, there is very high solar radiation and very high temperature gradient, big differences of the day and night temperature; in summer time the day temperature is usually above zero and the humidity is very low.



Fig.1 A. B. Dobrowolski Station



Fig.2 Author in front of the gravimetric pavilion.



Fig.3 Vicinity of the A. B. Dobrowolski Station (Bunger Oasis)

During Antarctic summer 1958/59 first magnetic observations were made by Dr. Wojciech Krzeminski (†) but probably the most valuable achievement of this first expedition to the A.B.Dobrowolski Station was the establishment of the gravimetric point in one of the pavilions of the Station and direct connection of this point to the main Polish gravimetric network. The gravimetric point was embedded in the stone ground and marked by special brass plate. For the measurement of the gravity difference the four-pendulum gravity-meter Askania Werke was used. It is to be reminded that this gravity-meter was commonly recognised at that time as very precise and sophisticated instrument. The gravity value determined by Z.Zabek and J.Sledzinski for the Antarctic Station ($f = 66^{\circ}16.3' S$, $\lambda = 100^{\circ}45.0' E$, $H = 35.4 m$) was

$$g_{Ant} = 982\,424.4 \text{ mGal} \pm 0.4 \text{ mGal.}$$

Coordinates of geodetic network points, gravity values and free-air and Bouguer anomalies

No.	X	Y	f	H	g	Free-air anomaly	Bouguer anomaly
	[m]	[m]	[$^{\circ}$ ‘ ‘’]	[m]	[mGal]	[mGal]	[mGal]
ASTRO	5000.00	5000.00	66 ⁰ 16'30.0"	35.26	982 438.41	76.94	73.98
CS	4704.62	5235.25	39.5	59.23	431.42	77.17	72.20
F1	4617.70	4084.38	42.3	52.16			
F2	4905.18	3988.64	33.1	24.91	439.46	74.74	72.65
F3	5382.02	4290.39	17.7	76.16	428.85	76.67	72.60
M	4886.99	4533.26	33.6	48.52	434.12	80.23	73.84
F4	5253.99	4604.34	16 21.8	76.03	428.74	80.00	73.63
F5	5988.78	4223.39	15 58.1	80.16	428.19	81.17	74.45
F6	5785.19	5032.66	16 04.7	63.49	432.14	78.46	74.23
F7	5864.13	5984.15	02.1	50.41	434.73	79.85	74.53
F8	5473.48	5994.72	14.7	80.46	427.66	80.43	73.60
F9	4947.06	5997.41	31.7	55.84	432.35	77.20	72.52
F10	4550.33	6040.11	44.5	29.62	437.95	74.47	72.00
PC	5038.59	5025.10	28.8	38.20	437.60	77.06	73.86
PG1	5461.48	4604.59	15.1	51.05	434.49	78.17	73.89
PG2	5373.71	4788.87	17.9	41.81	436.13	76.91	73.41
PG3	5425.25	4953.83	16.3	45.96	435.40	77.48	73.62
PG4	5594.60	4977.57	10.8	55.60	433.49	78.66	74.01
PG5	5364.95	5175.63	18.2	31.02	438.18	75.62	73.02
PG6	5686.30	5469.55	17.9	84.74	426.56	80.77	73.67
PG7	5592.20	5528.32	10.9	50.12	434.43	77.90	73.70
PG8	5247.25	5308.19	22.0	34.32	437.16	75.55	72.67
PG9	5387.80	5638.50	17.5	40.06	436.57	76.81	73.45
PG10	5225.66	5665.24	22.7	57.21	432.11	77.55	72.76
PG11	4895.34	5723.13	33.4	28.13	438.35	74.61	72.26
PG12	4792.26	5106.24	36.7	11.72	442.40	73.55	72.57

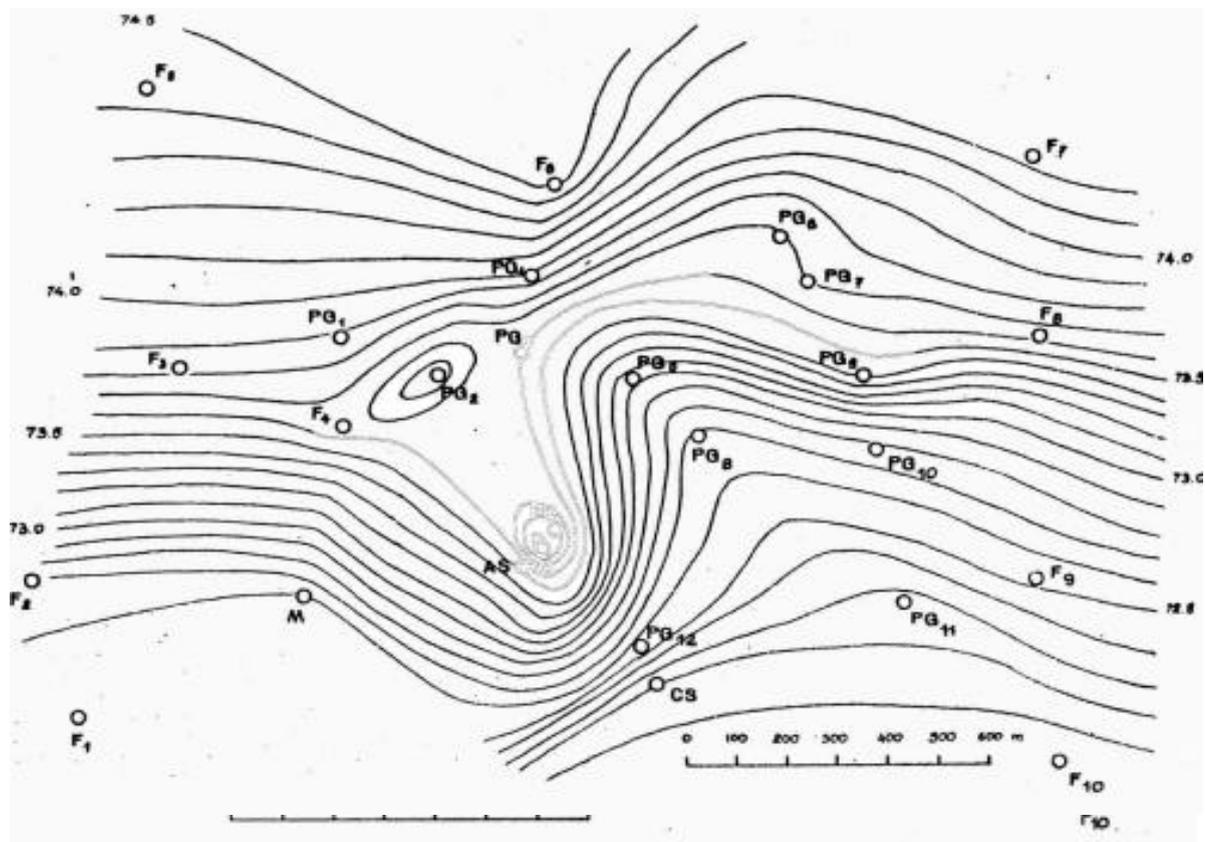


Fig.4 Bouguer anomalies

Next geodetic works in the A.B.Dobrowolski Station were carried out during the third Antarctic expedition organized by Polish Academy of Sciences in 1978/79. The broad scientific program included the following works: establishment of a geodetic network in the Bunger Oasis, establishment of an astronomical reference point, magnetic observations, photogrammetric surveys aiming at developing maps of the vicinity of the Station at the scales 1:500 and 1:5000 (Z. Battke – author of the maps). Also the gravimetric measurements were continued. Established geodetic network consisted of 26 points and was measured by Dr. A. Pachuta and Dr. J. Cisak using theodolites Wild T2 and distancemeters Zeiss EOK.

The established astronomical point (measured by Dr. J. Cisak) was determined by Kawrajski method from pairs of stars at equal heights using a theodolite Wild T2. The result of the determination was:

$$f = 66^{\circ} 16' 34.4''S \pm 1.6''$$

$$? = 100^{\circ} 45' 00.7'' \text{E} \pm 0.3''$$

During the third expedition the Station has visited Dr. Vincent Morgan, a scientist from Australia, who determined the coordinates of the astronomical point by satellite Doppler technique. His result gained from only three satellite passes was:

$$\begin{aligned} f &= 66^{\circ} 16' 30'' \text{E} \\ ? &= 100^{\circ} 45' 03'' \text{E} \end{aligned}$$

Magnetic works performed in 1979 by S. Mroczek focused on measurement of the magnetic deviation of navigation devices of two helicopters Mi-2 available at the Station and determination of the magnetic declination in the vicinity of the Station. The value of the declination was determined as

$$D_{\text{Dobrow.}} = - 89^{\circ} 36.4' .$$

The time variation of the declination with respect to the measurements from 1958 were also determined.

The programme of gravimetric works included the gravity surveys in the region of the Station Dobrowolski and the gravimetric connection Station Dobrowolski – Mirnyj (Soviet Antarctic station). The gravimetric surveys in the vicinity of the Station was made by using the Canadian gravimeter Sharpe CG-2. For gravimetric connection of the Mirnyj station there were carried out 4 flights by either Soviet helicopter Mi-8 or Polish helicopters Mi-2. As a result the new value of gravity for the point in Mirnyj was established; the gravity difference was determined as

$$? g_{\text{Mirnyj-Dobrow.}} = 34.37 \text{ mGal} \pm 0.05 \text{ mGal.}$$

Hence, for the gravimetric point at Mirnyj:

$$\begin{aligned} f &= 66^{\circ} 33.1' \text{S} \\ ? &= 93^{\circ} 09.5'' \text{E} \\ H &= 35.058 \text{ m} \end{aligned}$$

the following gravity value referenced to the pendulum point of Station Dobrowolski was achieved:

$$g_{\text{Mirnyj.}} = 982\,390.0 \text{ mGal} \pm 0.4 \text{ mGal.}$$

This value is in a good agreement with other determinations performed for Mirnyj by German, American and Soviet scientists. The gravimetric works were done by Dr. A. Pachuta from the Institute of Geodesy and Geodetic Astronomy of the Warsaw University of Technology.

It is to be outlined that Polish geodesists have introduced some Polish names on maps developed

during the expedition 1978/79. We mention only the following: Zatoka Polskich Geodetów (Bay of Polish Geodesists), Beskid, Giewont (peaks of the mountains south Poland), Skala fok (Rock of Seals), Gniazdo Skuy (Nest of Skuy Birds), Czarna Skala (Black Rock), Wzgórze Kaminskiego (Kaminski Hill), Dolina Manczarskiego (Manczarski Valley), Góra Rózyckiego (Rózycki Peak) etc.

Another Polish Antarctic station established in the Admiralty Bay King George Island, South Shetland Islands began its operation on 26 February 1977 and since that time it has been working permanently.

Fig.5 Localization of Arctowski Station



Fig.6 The main building of Arctowski Station



Fig.7 Arctowski Station in winter



One of the first geodetic works was the establishment of the reference astronomic point. located near the lighthouse. However, the unfavourable weather conditions and very short nights during the summer expedition 1977/78 allow Dr J. Jasnorzewski (†) to determine the astronomic coordinates with very low accuracy:

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

This accuracy was well improved about ten years later by J.Cisak, M.Dobrzycka. They obtained:

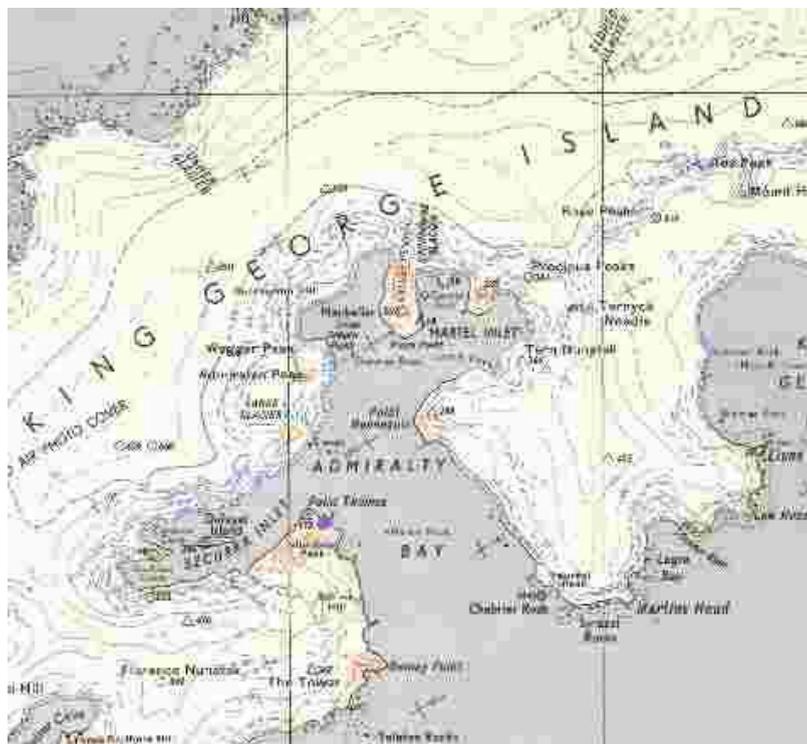
$$\begin{aligned} f &= - 62^{\circ} 09' 39'' \pm 2'' \\ ? &= 301^{\circ} 31' 32'' \pm 2^{\text{s}} \end{aligned}$$

They also determined the coordinates of the reference point in the Station H. Arctowski by carrying out the Doppler observations in the frame of the Intercosmos Doppler Observation Campaign ICDOC. The coordinates of this point determined from 311 satellite passes related to the WGS72 system are:

$$\begin{aligned} f &= - 62^{\circ} 09' 41'' \\ ? &= 301^{\circ} 31' 49'' \\ H &= 30.60 \text{ m} \end{aligned}$$

The broad geodetic programme of the expedition 1978/1979 and the next expeditions included also the photogrammetric works aimed at preparation of maps of various parts of the vicinity of the Station H. Arctowski. We mention the following maps: the map of the Admiralty Bay Station H. Arctowski area at the scale 1:25000 (Dr. K. Furmanczyk, Dr. A. Marsz), maps at scales 1:5000 and 1:50000 of the vicinity of the Station of H. Arctowski (Dr. Z. Battke). map of a special protected area "Lions Rump" (Dr. J. Cisak and Dr. Z. Battke), map of the vicinity of the Spanish station at the Livingstone Island at the scale 1:5000 (Dr. P. Madejski). All the maps worked out by the geodesists were also used for the aims of biological studies (determination of the location of flora and fauna) as well as for geomorphologic and ecologic studies.

Fig. 8 1:50 000 map of the vicinity of the H. Arctowski Station



More than 1000 scientists have worked at the Station H. Arctowski since 1978. The scientists from other countries visited and worked at the station; they came from Argentina, Brazil, Belgium, Canada, former Czechoslovakia, Germany, Monaco, New Zealand, Peru, former Soviet Union, Spain, United Kingdom and USA. Long-term projects were commonly realised in 1990/1991 by Polish and Dutch scientists. Almost 20 000 tourists have visited the Station since 1976.

It is to stress that permanent activity of the Antarctic Station H. Arctowski was led successfully by the Institute of Ecology of the Polish Academy of Sciences, now is organized by the Department of Antarctic Biology of the PAS and personally by the Director of this Department Prof. S. Rakusa-Suszczewski. His personal engagement is gratefully acknowledged.

When speaking on Polish exploration of polar Antarctic regional we must not forget the activities of two Polish geodesists who died ten and eighteen years ago.

Dr. Wojciech Krzeminski as the young boy scout took part in the Warsaw Upraise during the last world war. Wounded he was then taken prisoner in Nazi Stalag IXB in Zeltchen near Dresden. In 1945-1946 he was a soldier of the Polish Army in Italy and in England. He returned to Poland in 1947. In 1947-1952 he was student of the Faculty of Geodesy and Cartography of the Warsaw University of Technology. He began to work in 1951 and the whole his activities were focused on magnetic surveys as well on selected problems of the geodetic metrology. He was a head of the First Polish Antarctic Expedition 1958/1959 and the Polish Antarctic Expedition 1978/1979. His international activity and cooperation was very active in the frame of the scientific organizations of International Association of Geodesy of the International Union of Geodesy and Geophysics, SCAR, KAAPG and others. He died on 9 April 1981

Dr. Jerzy Jasnorzewski graduated from Warsaw University of Technology, Faculty of Geodesy in 1932 began work at the Astronomical Observatory in Cracow and then at the Warsaw University of Technology. His specialisation were geodetic astronomy, geodetic instruments and geodetic metrology. He took part in two polar expeditions to Spitsbergen and to Station H. Arctowski in Antarctica where he established reference astronomic stations. From 1959 he worked for 10 years as a Deputy Director of the International Bureau des Poids et Mesures in Sèvres. He died on 14 May 1989.

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