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Panagjurishte Observatory Upgrade for INTERMAGNET

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Abstract

Panagjurishte Geomagnetic Observatory was installed in 1937. From that time, this observatory runs continuously, the used instruments being a classical set made by Mating & Wiesenberg, Potsdam. A long collaboration exists then between Panagjurishte Observatory and Adolf Schmidt Geomagnetic Observatory Niemegk. In 2005 the GeoForschungsZentrum (GFZ) Potsdam and the Geophysical Institute Sofia of the Bulgarian Academy of Sciences (GIBAS) agreed in a cooperative programme, the aim being to upgrade the Panagjurishte Observatory with modern instruments in order to qualify it as an IMO. The GFZ provided a DI-flux theodolite, a vector and a scalar variometer and the data logger. The GIBAS purchased 2 computers, an uninterruptible power supply unit, network components and the internet connection. A Polish proton magnetometer is still in use. The arrangement of the instruments, comparisons of the classical and the modern system and the first results of absolute measurement reductions are presented.

1. Introduction

The Geophysical Institute Sofia of the Bulgarian Academy of Sciences (GIBAS) operates Panagjurishte Geomagnetic Observatory, which was opened on 7 November 1937 (Cholakov 1998). Its geographical location is at 42°30.9′ latitude, 24°10.6′ longitude and 556 m elevation. The observatory operates since the beginning continuously a classical set of magnetometers made by Mating & Wiesenberg, Potsdam. Beginning with Panagjurishte Observatory establishment, both observatories, Panagjurishte and Niemegk, cooperate closely. This collaboration is expressed in regular comparison measurements of both observatories. Table 1 shows the results of comparisons. Sixteen measurements were carried out during 40 years more or less regularly.

Table 1

Comparison measurement results of Panagjurishte and Niemegk observatories

			PAG – NGK			
Year of Meas.	Obs. host	Operators	ΔD '	ΔH nT	ΔZ nT	ΔF nT
1963	NGK	K. Kostov	+0,42	0,0	0,0	–
1964	PAG	A. Grafe, W. Zander	–1,30	+3,2	–1,0	–
1966	NGK	K. Kostov	–0,43	+2,2	–	–
1967	PAG	A. Grafe, W. Zander	–0,02	+0,3	–5,6	–
1969	NGK	K. Kostov	+0,7	–0,8	–1,5	–3,0
1971	PAG	K. Lengning, W. Zander	–0,80	+0,5	–2,0	–1,8
1974	NGK	K. Kostov	0,0	–0,4	+0,8	–0,3
1975	PAG	K. Lengning, W. Zander	–0,48	+1,3	+0,3	+0,4
1976	NGK	K. Kostov	–0,04	–1,2	–	–0,1
1978	NGK	K. Kostov	+0,06	–1,1	0,0	–0,3
1980	NGK	K. Kostov, I. Butchvarov	–0,02	+0,2	–	–0,4
1984	PAG	E. Ritter, W. Zander	+0,11	+1,2	–	+0,7
1986	NGK	I. Cholakov, Ch. Georgiev	+0,18	+0,1	–	+0,3
1987	PAG	E. Ritter	–0.86	–2,2	–	–
1992	CLF	I. Cholakov	+0,1	–3,3	+2,0	+0,7
2003	NGK	I. Cholakov, B. Srebrov	+0.23	–2.6	+1.0	+0.16

Panagjurishte observatory owns the following classical instruments:

- Magnetic theodolite Mating & Wiesenberg for D and H (Gauß/Lammont);
- Oscillation box Mating & Wiesenberg for H;

- Earth inductor Mating & Wiesenberg for I;
- Two quartz variometers sets type ”Bobrov” with photographic recording for H, D, Z and F.

Panagjurishte Observatory purchased the following proton magnetometers: an ELSEC 592/J in 1969, a PMP-2A in 1975, and a PMP-5A in 1989 from Central Geophysical Observatory Belsk of the Institute of Geophysics of the Polish Academy of Sciences, Warsaw. All observatory data were obtained on the base of this set of instruments until 2005. Figure 1 shows the ground plan of the observatory.

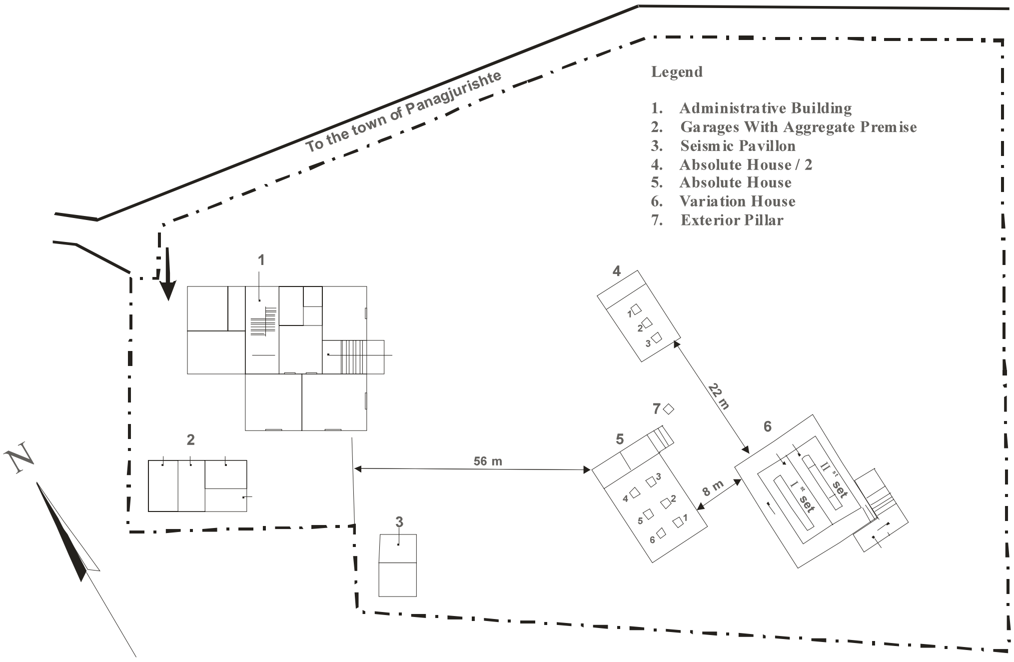

Fig. 1. Ground plan of Panagjurishte Observatory.

2. Instruments Upgrade

In 2005 the GeoForschungsZentrum Potsdam and the Geophysical Institute Sofia of the Bulgarian Academy of Sciences agreed in a contract on the upgrade of Panagjurishte Observatory to join the observatory to INTERMAGNET. The contributions of both partners are listed in Table 2.

The DI-flux, consisting of a Zeiss THEO 020B and a Bartington fluxgate MAG 01H was placed on pillar No. 5 in the absolute house. The azimuth value exists for this pillar. The observatory staff was trained to carry out the D and I absolute measurements by means of the instrument. They were also instructed to reduce the measurements by means of EXCEL tables, which were also provided by GFZ Potsdam.

The three-axial variometer MAGSON and the sensor of the Overhauser proton magnetometer GSM-90 were placed in the variometer house in the West room. The data logger MAGDALOG (Linthe, 2004) was installed in the electronic box of the MAGSON (primary part) and in the main building (secondary part). The connecting glass fiber cable (RS232 connection) and the power supply cable were placed into a pipe, which connects in the underground both the buildings. A switching board, which carries the electronic box of the Overhauser proton magnetometer GSM-90, transformers, optical transmitters and further components, has been mounted in the entrance room of the variometer house.

Table 2

Contributions of the partners to the observatory upgrade

GeoForschungsZentrum Potsdam	Panagjurishte Observatory of the IGP BAS
THEO 020B (Zeiss), MAG 01H (Bartington)	Computers and components
Three-axial fluxgate variometer MAGSON	Internet connection
Overhauser proton magnetometer GSM-90	Network components
Data logger MAGDALOG	Operation system and network administration
Glass fibre cable and components	Installation
Staff training	

Two computers were placed in the main building of the observatory: a DOS PC for running the secondary software of the data logger MAGDALOG and a Linux PC as central file server. Both PCs are connected by means of a LAN. A Windows PC is also connected to the LAN for any manual routine data processing. The LAN has connection to Internet for data transmission. The DOS PC, the Linux PC, the MAGDALG data logger, the MAGSON variometer and the GSM90 proton magnetometer are powered by an uninterruptible power supply unit (UPS) with a capacity of about 30 minutes.

The time base of the logger is a special GPS unit, which receives the satellite signal and sends the time information in DCF77 code (German radio clock signal) to the logger. Because of that, the normal logger software can be used to synchronize the primary PC clock. The GPS unit has been mounted on the roof of the main building. The time code is sent by one core of the glass fiber cable to the primary data logger in the variometer house. Lightning protection components were mounted at both ends of the power supply cable and into the cable of the GPS unit.

The installation of the instruments, data loggers and computers was carried out on 20-28 June 2005. Two people from Niemegk Observatory, several employees from the Geophysical Institute Sofia and the whole Panagjurishte staff were included. Also during this time interval, Panagjurishte staff was instructed to use the DI-flux, to reduce the absolute measurements and to handle the recording system.

The absolute measurements by means of the DI-flux theodolite are carried out weekly. The corresponding total intensity readings are taken from the GSM90 Overhauser proton magnetometer recordings taking into account the difference between the location of the GSM90 sensor and the measurement pillar No. 5. The pillar difference is checked regularly by means of measurements taken by the proton magnetometer PMP-5A at pillar No. 5, which are compared with the GSM90 recordings.

During the summers 2005 and 2006 very heavy thunderstorms happened in Bulgaria. Though lightning protection measures, the UPS was destroyed by very heavy lightnings and so the recording was out of work during the time intervals July-October 2005 and June-October 2006. Finally a suitable lightning protection system was installed to avoid such problems in future. Absolute measurements by means of the DI-flux were carried out even during summer time. The readings were reduced with the classical recordings.

In November 2006 a second recording system was installed again on the base of the cooperation contract. The GIBAS was able to purchase a suspended three-axial fluxgate variometer FGE manufactured by the Danish Meteorological Institute Copenhagen. The GIBAS further provided a DOS PC and the GFZ Potsdam installed a second data logger MAGDALOG. It is intended to complete the recording system by an Overhauser proton magnetometer GSM90.

3. First Measurement Results

At present, 18 months of absolute measurements by means of the DI-flux theodolite and nearly one year of continuous MAGSON recordings are available. The obtained base lines are very satisfying. Figure 2 shows the reduced absolute measurements and the adopted base lines for the recorded elements H, D and Z. The reduced measurements by means of the classical instrument set are drawn as rectangles. Those of the DI-flux in combination with the Overhauser proton magnetometer GSM90 (taking into consideration the pillar difference) are depicted as triangles. The classical measurements were reduced using the Bobrov type photographic recording variometers. The DI-flux measurements were reduced by means of the MAGSON recordings. The dashed lines represent the adopted base lines obtained from the reduced absolute measurements by means of the Mating & Wiesenberg and PMP-5A instrument set. The solid lines are the base lines adopted from the reduced absolute measurements by means of the DI-flux theodolite on pillar No. 5 and the GSM90 Overhauser proton magnetometer. The total intensity difference between pillar No. 5 and the GSM90 was determined to:

$$\Delta F_{GSM90\text{-}P5} = F_{GSM90} - F_{P5} = -38.6\ \mathrm{nT}\,. \tag{1}$$

The proton magnetometer PMP-5A has an instrumental offset against an Overhauser proton magnetometer GSM19 (owned by GFZ Potsdam) of:

$$\Delta F_{PMP5A\text{-}GSM90} = F_{PMP5A} - F_{GSM90} = 1.0\ \mathrm{nT}\,. \tag{2}$$

The other proton magnetometer PMP-2A was also tested. It does not have any offset against the Overhauser proton magnetometer GSM19. The instrumental offset is taken into consideration, when the difference between pillar No. 5 and the GSM90 is checked by measurements taken by means of the proton magnetometer PMP-5A.

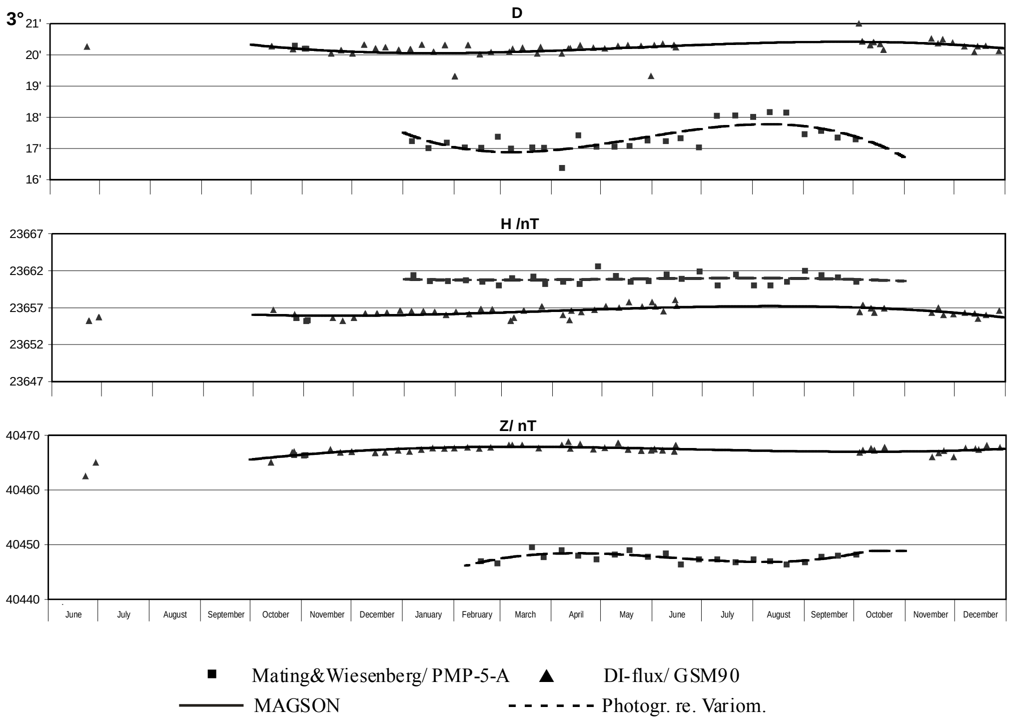

Fig. 2. Absolute measurement results and adopted base lines for the classical and the new instrument set.

The final observatory data, obtained by means of the new instrument set, show clearly offsets in the magnetic elements against the data from the classical instrument set. First estimations determined the offsets to:

$$\Delta H = H_{MW} - H_{DIflux} \approx -6.3\ \mathrm{nT}, \tag{3}$$

$$\Delta D = D_{MW} - D_{DIflux} \approx -0.1', \tag{4}$$

$$\Delta Z = Z_{MW} - Z_{DIflux} \approx +4.2\ \mathrm{nT}, \tag{5}$$

with MW: Element level of the classical instrument set;
DIflux: Element level of the “new” instrument set.

They are caused by several influences. The first reason is that there are pillar differences in the absolute house. The pillar differences are well determined. They are listed in Table 3. The differences of the special magnetic elements can be found in the single lines. The columns are ordered after the pillars.

The pillar differences alone do not explain the offset levels. The classical measurements are taken at 3 different pillars (declination and horizontal intensity by means of the Mating & Wiesenberg theodolite at pillar No. 1, horizontal intensity by means of the oscillation box at pillar No. 2, inclination by means of the earth inductor at pillar No. 6, and total intensity by means of the proton magnetometer PMP-5A as well at pillar No. 6). The DI-flux measurements are taken at pillar No. 5. The second reason is obviously a systematic error in the absolute determination of the horizontal intensity by means of the classical magnetic theodolite and the oscillation box. This fact was also found when Niemegk Observatory changed from the classical instrument set to the DI-flux and proton magnetometer (Best *et al*. 1997).

Table 3

Pillar differences in Panagjurishte absolute house

Element	P_1-P_5	P_6-P_5	P_1-P_6
ΔD	−0.4 ’	–	–
ΔH	−0.3 nT	–	–
ΔZ	−0.4 nT	−2.1 nT	+1.7 nT
ΔF	–	−0.3 nT	+0.4 nT

After the final data processing the Panagjurishte level offset between the classical and the new system will be stated with the annual mean values as a jump in the level of the observatory with the beginning of the year 2007.

4. Summary

With the instrumental upgrade of Panagjurishte Observatory, a long tradition of international cooperation has been continued. So one long-term geomagnetic observatory more obtained INTERMAGNET standard. On the base of the cooperation contract both the partners contributed to this success. GFZ will continue the support for Panagjurishte Observatory by further upgrades of the software and in the preparation of the final observatory data. The status of an IMO (INTERMAGNET observatory) has been applied.

References

Best, A., and H.-J. Linthe, 1997, Ergebnisse der Beobachtungen am Adolf-Schmidt-Observatorium für Geomagnetismus in Niemegk im Jahre 1996, Jahrbuch 1996 des Adolf-Schmidt-Observatoriums Niemegk, Potsdam.

Cholakov, I., 1998, *60 Years Geomagnetic Observatory Panagyurishte*. VIIth IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, September 8-15, 1996, Adolf Schmidt – Observatory for Geomagnetism Niemegk, STR 98/21, Potsdam, pp. 17-24.

Linthe, H.-J., 2004, *MAGDALOG – Data logger for magnetic observatories*. Proceedings of the XIth IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, November 9-17, 2004, Kakioka and Tsukuba, Japan, pp. 90-94.

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