MAGNETIC MEASUREMENTS AND DATA PROCESSING

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Magnetic houses

Geomagnetic elements are measured in 3 separate places. Absolute measurements are made in the quite large absolute house which is constructed of non-magnetic limestone and covered with reeds. This house comprises of two rooms, the bigger one has four stable pillars, two of them serves for calibration. There are two external pillars, too. One azimuth mark for the determination of declination is fixed on the pillar of entrance at a distance of 50 m, the other is on the top of the church about 5km from the observatory. The underground variometer chamber is constructed also of non-magnetic limestone. It comprises four separate rooms. Variometers are placed in separate well insulated rooms 1m below the level of the ground. The temperature variation can be maintained by this way within 0.5°C between the weekly absolute observations. Standby batteries and digital recorder of the torsion photoelectric magnetometer are in the entrance hall, fluxgate data are recorded in the computer centre. The small proton magnetometer (DI/DD) hut next to the variometer chamber is made of non-magnetic concrete. Proton magnetometer is controlled also from the computer centre.

Recording of geomagnetic variations

Geomagnetic variations prior to 1991 were recorded by two sets of normal run (15 mm/h) La Cour systems. In 1991 the Geodetic and Geophysical Institute installed electronic variometers and a digital recording equipment (ARGOS) at the observatory, which allowed to participate in INTERMAGNET. ARGOS (developed by the Geomagnetism Group of British Geological Survey) is a PC based automatic observatory equipped with triaxial fluxgate and a proton magnetometer in a DD/DI configuration.

The fluxgate variometer sensors are aligned in X, Y, Z directions. 10 second samples are used to provide minute values centred on the minute by means of a 7-point cosine filter. Reported elements are: H (horizontal), Z (vertical), D (declination) and F (total force). From the year 1993 on the minute values

Table I. Main specifications of ARGOS used in Nagycenk Observatory

Device	Resolution	Dynamic range	Temperature coeff.
Triaxial Fluxgate Magnetometer	0.1 nT	±500 nT/±400 nT	~ 1 nT/°C
Proton Magnetometer (ELSEC 820)	0.1 nT	10000–90000 nT	–

are transmitted through the METEOSAT satellite to the Edinburgh Geomagnetic Information Node.

DI/DD coil system consists of two orthogonal sets of Helmholtz coils (proton head is mounted at the centre). Coils orientated so that one provides bias fields approximately perpendicular to F vector in the magnetic meridian and the other provides bias fields approximately perpendicular to F in the horizontal plane. DD and DI relative to the initial values (D0, I0) are calculated. DD/DI proton magnetometer is used in every tenth minutes from which F and almost absolute values of D an I are obtained.

Satellite transmitter, 6800 Series of Data Collection Platform, was supplied by Space Technology Systems. Power output to antenna (two linearly-polarised Yagi arranged to give circular polarisation) is 4 watts at 402 MHz. Data storage capacity is 2×40 kbytes.

Timing is produced by the IBM clock corrected by the high stability crystal built in the Proton Magnetometer.

To ensure continuous recording a high stability torsion photoelectric magnetometer (type PSM-8711) has been run from 1 January 1998. Data along with telluric data are logged by a DR-02 type digital recording system. The PSM magnetometer records the H, D and Z component with an exceptionally high parameter stability. The baseline variation has never exceeded 1.5 nT/year. Maximum resolution is 3 pT, sampling rate applied is 10 s. Frequency response: 0.3 Hz to DC. Sensitivity to tilting: less than 10 nT/′.

Data are stored in the internal memory of the digital data logger DR-02. Both the PSM and the DR-02 was developed and provided by the Institute of Geophysics Polish Academy of Sciences.

Absolute control, baselines

Baselines of the variometer systems are derived from absolute observations. Prior to 1989 the baseline was controlled by two QHM, one declinometer and one BMZ. From 1989 till the end of 1994 the standard instrument for absolute measurements was the vector proton magnetometer (NVP) constructed in Niemegk Observatory. In 1994 an Overhauser proton magnetometer (type: GSM 19 of GEM Systems) and a fluxgate theodolite (developed by the Danish Meteorological Institute) was purchased. Since then the standard instruments are the fluxgate theodolite for I and D and the Overhauser effect proton magnetometer for F.

To determine the momentary angle of declination four observations (four null positions in the horizontal plane) are taken and it is repeated at least two times. Generally the closer azimuth mark is used but it is checked regularly with the far azimuth mark. Inclination angle is determined in the plain of the momentary magnetic meridian in the same way as D. Total intensity is measured simultaneously with I-measurements on the next (F) pillar with the Overhauser magnetometer. Absolute values of all geomagnetic elements are referred to the same pillar of the absolute hut. Observation is made weekly, occasionally more often.

Absolute measurements are supplemented by quasi absolute baseline reference measurements. Declination, inclination and total intensity are determined by means of a proton vector magnetometer in every ten minutes.

Operational problems of magnetic measurements and data transmission

Three types of operational problems were experienced since the installation of ARGOS system.

I. Operational problems derived from power outages in the observatory

Although standby power is provided by an uninterruptable power supply (giving 10–20 min continuous operation), the system stopped due to power failure several times. Longer breaks had occurred quite often until the power transmission line was changed in 1995 to a more secure cable of 1.5 km between the observatory and the transformer. Regarding the limited capacity of the uninterruptable power supply the default reading of DD/DI magnetometer was changed to 10 minutes because of its rather high current consumption. In summer 1994 an especially great number

of long power outages occurred. Following a series of power outages one of the 3 batteries which provide constant power to fluxgate and proton magnetometers did not recover. This led to power failure in fluxgate electronics and short term drifts, mysterious spikes appeared in fluxgate data. Its baseline had been out of control for several weeks until the 6 Volt battery in question was changed.

II. Lightning strokes

Lightning strokes have not caused serious operational problems only the analogue to digital converter IC of the fluxgate magnetometer had to be changed twice to spare ones.

III. Unexplained interference and gaps in transmission

Data Collection Platform 6800 series of the Space Technology Systems has been connected to ARGOS since 1993. Gaps of several hours appeared in transmission since the beginning. First assumption was interference because the failure occurred almost regularly at the same time at 9.54 GMT and 16.54 GMT. After nearly 2 years of experiments in Nagycenk, Tihany and Edinburgh it could be concluded that the problem was caused by the antenna. (It consists of two linearly polarised Yagi arranged to give circular polarisation by means of a combining and phasing units.) The manufacturer repaired it free of charge. In the meantime power connector of the DCP was hurted during its journey (Nagycenk – Tihany – Edinburgh and back) and polarity was changed. This caused a total break down. Reparation took nearly one year. On top of everything a strange signal of 300 kHz of varying amplitude appeared in the system. This induced radio frequency noise led to frequent malfunction and partial loss of house keeping data. Transmission have not failed since this problem was sorted out in June, 1996.

Data processing and availability

Sampling rate of magnetic variation data is 10s both for ARGOS and PSM. Minute mean values are produced with digital filter from the raw sampled data. According to the IAGA recommendation minute mean values are stored. Hourly means are calculated from minute means, yearly means are derived from hourly means. Final absolute values of H, D and Z field component are obtained from smoothed baselines.

ARGOS data are compared continuously to PSM data and gaps are filled.

Data are logged on floppy disk too. In addition to logging data to disk INTERMAGNET V2.8 format satellite transmission packets are sent to DCP.

Presentation of the results

- plot of hourly mean values of H, D, Z
- plot of daily mean values of H, D, Z
- tables of geomagnetic activity indices, K
- table of annual mean values of geomagnetic elements
- special phenomena: SSC, sfe

See CD (program Seenck.exe, menu item Magnetics).