

Keetmanshoop – A New Observatory in Namibia

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Abstract

One of the most fascinating geophysical studies in southern Africa is to track the evolutionary behaviour of the geomagnetic field. The Keetmanshoop Observatory was installed in 2005 on the premises of the Keetmanshoop Airport as part of a collaboration project between Hermanus Magnetic Observatory (HMO) and GeoForschungsZentrum Potsdam (GFZ). This location was specifically chosen about halfway between Hermanus in the South and Tsumeb in the North in order to correct for disturbance effects from external sources and to refer the repeat station data to a common epoch during field surveys. This newly-established INTERMAGNET-grade observatory will play a key role in the region, as a reference magnetic observatory for field stations within a radius of 600 km located in the large area between the Northern Cape and southern Namibia, a region which has not been adequately covered in the past. In addition it will also serve as an accurate monitor of spatial changes in secular variation across southern Africa.

1. Introduction

In addition to a rapid decrease in the total field intensity over southern Africa, as recorded by the Hermanus Magnetic Observatory since 1941, the orientation of the geomagnetic field in this region is also changing substantially. In the northwest part of

southern Africa the declination of the magnetic field is propagating eastward (Tsumeb) and in the south-east part westward (Hermanus and Hartebeesthoek), causing a spatial gradient over the subcontinent which is presently increasing with time. The spatial structure of the geomagnetic field can therefore not be resolved with only these 3 magnetic observatories. Figure 1 shows the declination and total intensity secular variation of the observatories Hermanus, Hartebeesthoek and Tsumeb.

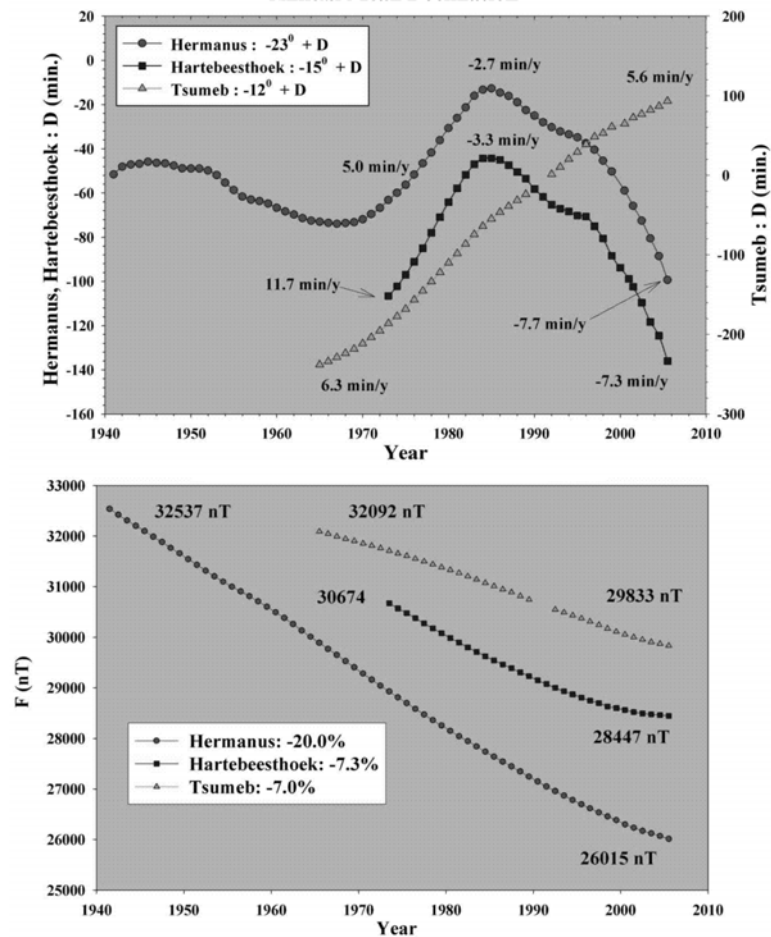


Fig. 1. Declination and total intensity secular variation of the observatories Hermanus, Hartebeesthoek and Tsumeb.

Therefore, the GeoForschungsZentrum (GFZ) and the Hermanus Magnetic Observatory (HMO) have decided to establish a new magnetic observatory at Keetmanshoop in the southern region of Namibia as part of a joint collaborative research project. It will approximately be located halfway between HMO and Tsumeb in a North-South direction, while it will also be approximately on the same latitude as Hartebeesthoek.

The GFZ provided the 3-component fluxgate variometer FGE (Danish Meteorological Institute), 2 Overhauser effect proton magnetometers (model GSM19) and a

DI-flux theodolite (model 3T2KP), equipped with a fluxgate magnetometer model G (DMI). The site was selected on the premises of the Keetmanshoop airport, sufficiently away from man-made magnetic noise, with suitable logistic conditions for the observatory. The instruments are located in a security environment, while airport staff is able to monitor the continuous functioning and perform absolute measurements on a regular basis.

2. Establishment of the New Observatory

In 2005 the GeoForschungsZentrum (GFZ) Potsdam and the Hermanus Magnetic Observatory (HMO), as part of a collaboration project, decided to establish the new geomagnetic observatory in Keetmanshoop, Namibia. At first the Hermanus Magnetic Observatory negotiated with the responsible Namibian governmental agencies and the administration of Keetmanshoop Airport and obtained permission for the establishment and operation of an observatory on its premises.

In order to minimize expenses it was decided not to construct buildings for the measurements and recordings. It was planned to construct a stable pillar for the absolute measurements with a roof for protection against direct sun radiation and wind, while the recording instruments are to be located in a glass-fibre container, buried partially underground, also with a protection roof. Transmission of data to HMO will be done using cellular phone technology. The airport provided a room of the terminal building to place the computer and to store the absolute instruments. Electric power is also supplied by the airport.

First of all, suitable places were searched for the absolute measurement pillar and the variometer container. The airport staff recommended an area of the airport, which will be long-term free of magnetic perturbations, produced by the airport service. A first raw survey was done by means of one of the Overhauser proton magnetometers to find a place free of big total intensity gradients. This proved to be somewhat difficult due to the rather high concentration of magnetic minerals in the soil. Furthermore, the area was covered with a number of big rocks, which showed a very strong magnetic perturbation (the proton magnetometer signal was even saturated close to some of these rocks). Suitable locations were however found for both the absolute measurement pillar and variometer container.

Around the centre of the variometer container more gradient surveys were carried out at 1 m intervals, covering a size of 10×10 m, while those around the absolute measurement pillar was actually 5×5 m. Figure 2 shows the resulting maps of the total intensity gradient sounding.

A contractor carried out the following constructions:

- Absolute measurement pillar construction consisting of an asbestos cement pipe, filled with concrete, on a stable concrete basement;
- Embedding of the variometer container about 1 m deep into the ground with a pillar for the FGE sensor of the same construction as the absolute measurement pillar;

- Construction of wooden protection roofs above the absolute measurement pillar and the variometer container;
- Removal of a number of big rocks to eliminate their influence on the instruments;
- Installation of a sleeve pipe of 550 m length including 7 inspection man-holes for the cables between the variometer container and the computer room; installing of the power supply cable in the pipe;
- Installation of burglar bars and solar shield at windows of the computer room;
- Electrical installation in the computer room;
- Installation of an air conditioner in the computer room.

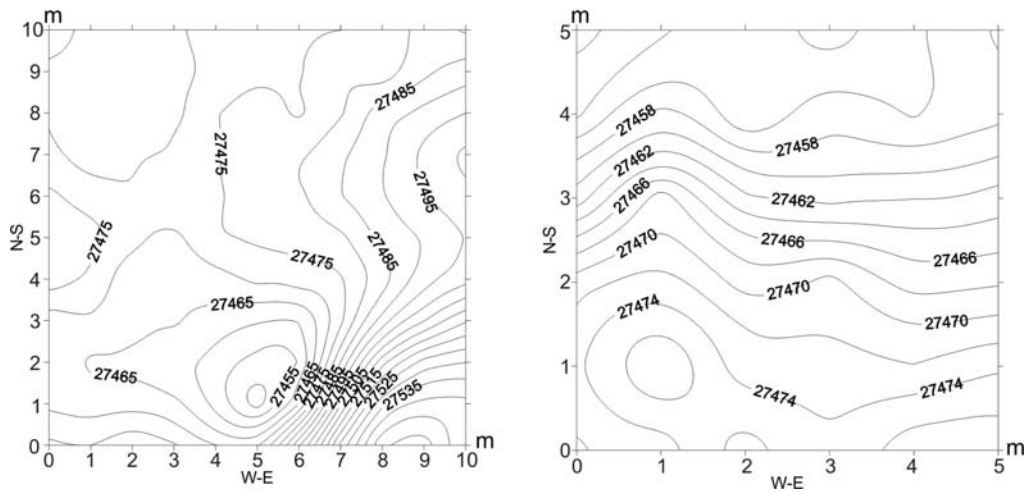


Fig. 2. Total intensity gradient map around the variometer container (left) and the absolute measurement pillar (right), at 2 m elevation both. Isolines in nT.

The constructions were finished by the end of January 2006. Figure 3 shows a sketch of the location.

For the absolute measurements, an azimuth mark was painted on the visible wall of the airport main building. To determine the azimuth value some Sun observations were carried out. HMO did the calculations and determined the azimuth value as $353^{\circ} 38' 30''$. The geographic coordinates of the absolute measurement pillar were determined by means of a GPS receiver as: Latitude = $26^{\circ} 32' 26.1''$ S, Longitude = $18^{\circ} 06' 37.3''$ E, Elevation = 1065 m.

The instruments, the data logger and the optical cable were installed in May 2006 by HMO staff. At the same time 3 airport staff members were trained to carry out absolute measurements. Since that time the recording runs continuously and the absolute measurements are carried out regularly.

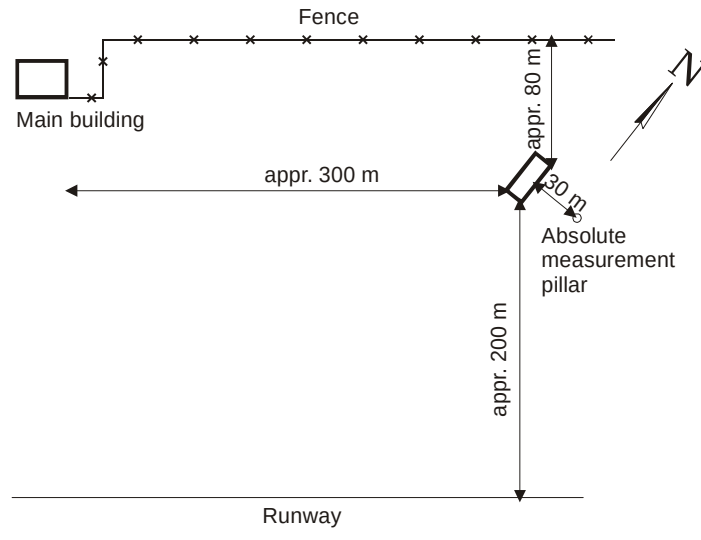


Fig. 3. Sketch of the location.

3. Description of the Data Logger

The data-logging system at the Keetmanshoop Magnetic Observatory is used to control the data-acquisition operations to capture data from the different geomagnetic instruments. This data is stored on Compact Flash media, but is also remotely accessed for further processing. Figure 4 shows the block diagram of the logger system. The system consists of the following:

- Industrial embedded computer;
- Data acquisition modules;
- Cellphone remote communications.

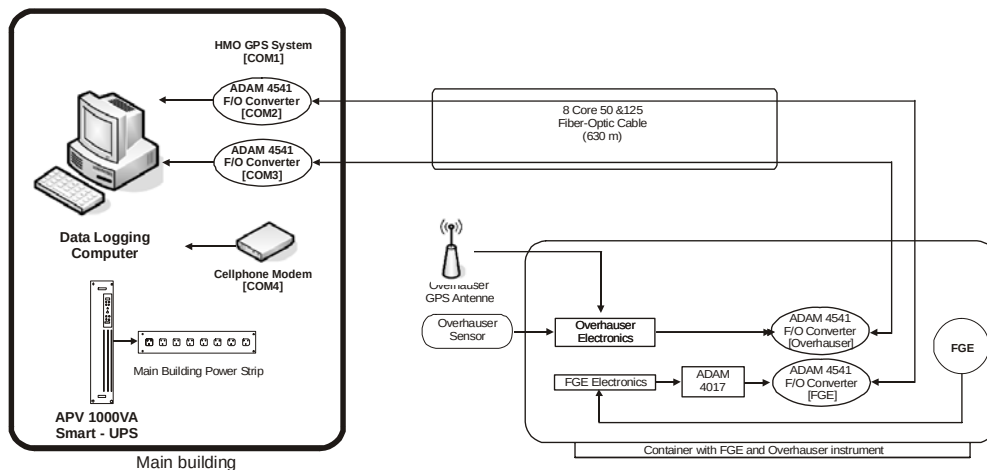


Fig. 4. Block diagram of the data logger.

3.1 Industrial embedded computer

A small industrial embedded computer, iEi Juki Eden 400R, is used as the master controller of all data operations. The operating system is a custom build Linux distribution developed at the HMO, and designed to operate on a Compact Flash card. Additional kernel patches (<http://www.rtai.org>) allow the system to operate as a real-time operating system, while allowing Linux to continue as normal. Specialized software controls the data collection from all the instruments. The HMO-developed GPS system allows accurate sampling of data. Instrument data are stored as well on the Compact Flash card. All data are transmitted daily from Keetmanshoop to the main data server at the Hermanus Magnetic Observatory. A web interface provides the user with the following services:

- Status information on all instruments as well as the HMO GPS system;
- Graphical view of the data from the instruments (24-hour period);
- Data capture screen to input observation data.

3.2 Data acquisition modules

Industry-standard ADAM modules are used for all data conversion. The ADAM 4017 module is used to convert the analogue signal from the fluxgate magnetometer into a digital representation. Due to certain limitations, the digital signals need to be transmitted over a distance of 630 meters. An 8-core fibre optic cable was installed with ADAM 4521 modules to provide reliable communications between the computer and instruments.

3.3 Cellphone remote communications

From past experience it is well known that in Namibian rural areas the local telephone infrastructure is unreliable. As an alternative, cellphone communication was chosen to provide remote connectivity. A previous installation at Tsumeb has proven to be a reliable method for data transfer.

A Wavecom Fastrack cellphone modem is used to interface to the cellphone network. This modem provides a standard modem interface to the computer. A PPP connection is established on a daily basis to transfer data using the FTP protocol.

4. First Measurement Results

To demonstrate the satisfying operation of the variometer and the data logger Fig. 5 shows the recording of 21 May 2006 in comparison to Tsumeb Observatory recording. At the upper part of Fig. 5 the H, D and Z recordings of both observatories are displayed, where an artificial offset was added to Tsumeb data. The lower part shows the differences of both recordings, where Keetmanshoop data were subtracted from Tsumeb values.

Up to now base lines were not determined. The reductions of the absolute measurements are still in preparation.

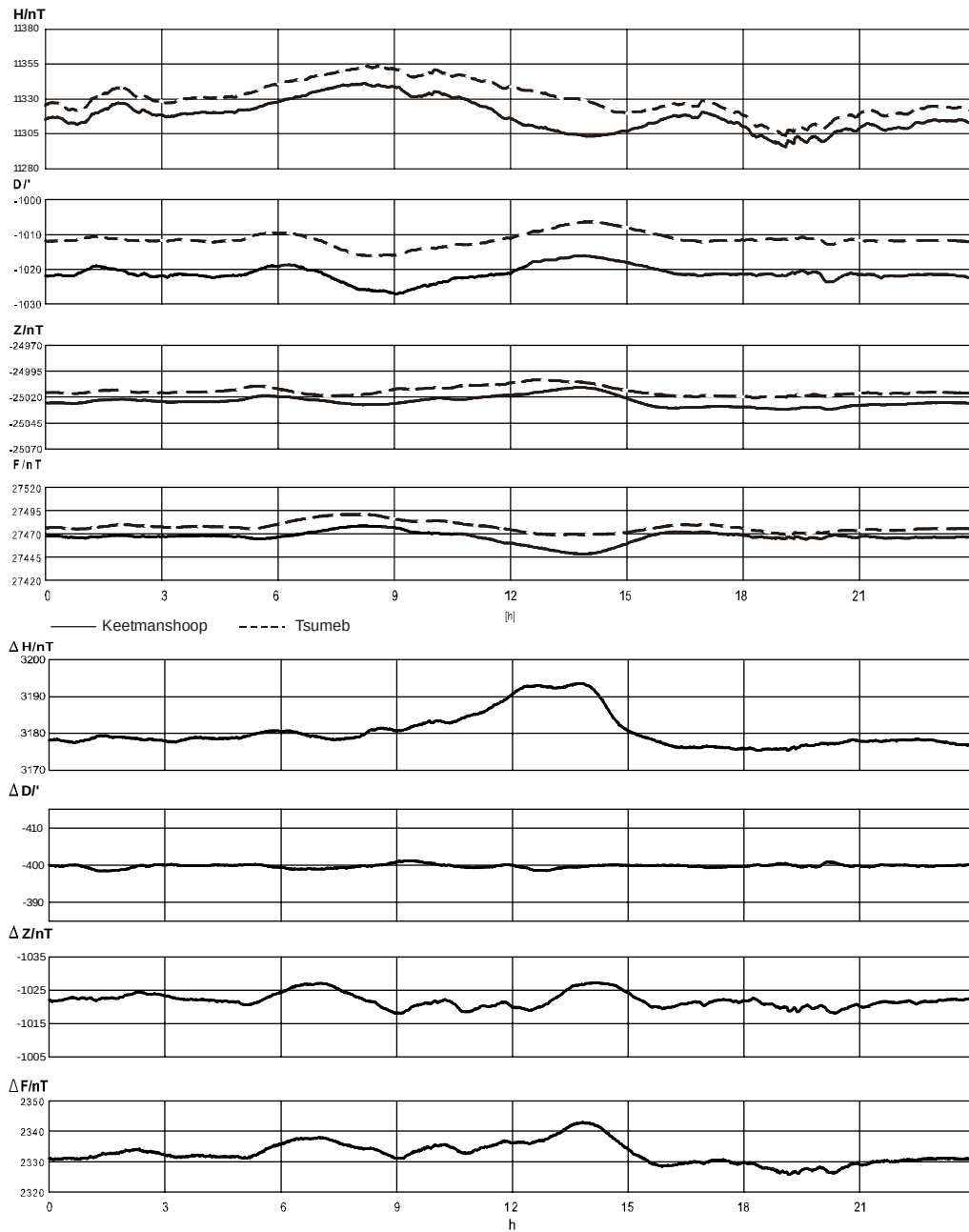


Fig. 5. Recording example in comparison with Tsumeb recording of 21 May 2006.

During several time intervals perturbations of high frequency in the recordings were observed. The origin of this effect could not be explained free of doubt. Eventually mining activities may be the reason. Further soundings are necessary in future.

5. Summary

On the base of a cooperation contract between GeoForschungsZentrum Potsdam and Hermanus Magnetic Observatory a new observatory was established at the Keetmanshoop (Namibia) Airport premises. The instrumentation of this new observatory meets the INTERMAGNET standard. The observatory data are intended to be used for more detailed studies of the magnetic field origin in Southern Africa.

The variometer recordings are working continuously and absolute measurements are carried out regularly. The HMO is mainly responsible for preparation of the observatory data. After resolving of starting problems, for example with strange disturbances, it is planned to apply to get IMO (INTERMAGNET observatory) status.

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