THE UPGRADE OF BASE ORCADAS MAGNETIC OBSERVATORY

E. Cabrera [(1)], C. W. Turbitt [(2)], J. Rasson [(3)], J. Gianibelli [(4)], J. C. Riddick [(5)]

[(1)] Argentine National Weather Service, Observatorio Central Buenos Aires, Av. de los Constituyentes 3454 (CP 1427, Buenos Aires, Argentina.
[(2)] British Geological Survey, Murchison House, West Mains Road, Edinburgh, EH9 3LA, United Kingdom, c.turbitt@bgs.ac.uk
[(3)] Institut Royal Météorologique, Centre de Physique du Globe, B-5670 Dourbes, Belgium, jr@oma.be
[(4)] Head of the Geomagnetism and Aeronomy at the UNLP, Argentina, geofisicogianibelli@yahoo.com.ar
[(5)] john_riddick@hotmail.com

SUMMARY

In January 2012 new absolute magnetometers, fluxgate variometers and recording hardware to monitor and record changes in the Earth's magnetic field have been installed at Base Orcadas Observatory, in a collaborative project between the Argentine National Weather Service (SMN), the British Geological Survey (BGS) in Edinburgh and the Institut Royal Météorologique de Belgique, Dourbes as part of the INTERMAGNET Digital Geomagnetic Observatory (INDIGO) program. This observatory is located on the Argentine Antarctic Base on the South Orkney Islands (Orcadas del Sur), with the new equipment replacing existing photographic recording equipment which was damaged by an earthquake in 2003. The equipment is designed to meet INTERMAGNET standards for data quality providing a one-minute data set which will be corrected to absolute through a program of absolute observations. The original magnetic observatory at Base Orcadas (the oldest in Antarctica) was installed by the Scottish National Antarctic Expedition in (SNAE) 1902-04 and recordings of variations in the Earth's magnetic field have continued since that time at this remote location.

1. INTRODUCTION

Base Orcadas, operated by the Argentinean Navy, is located on Laurie Island on the South Orkney Islands (latitude 60° 44′ 17"S, longitude 44° 44′ 26" W, altitude 4 m, Figures 1a,b). The Antarctic base was originally set up in 1903 by the Scottish National Antarctic (Scotia) Expedition (SNAE), led by William Spiers Bruce (Mossman et.al. 1906, Schott and Rasson 2007, Moneta 1951). This expedition established an overwintering base on Laurie Island and built accommodation from which they carried out a program of meteorological and magnetic measurements. The house, which provided living accommodation for four staff was called Omond House (Figure 2) named after Robert Trail Omond who was the first Superintendent of Ben Nevis Observatory, in Scotland. Also, as a major part of the expeditions scientific program was the study and recording of the Earth's magnetic field. A second canvas covered wooden shelter was built by the *Scotia's* carpenter and named Copeland House after Professor Ralph Copeland the then Astronomer Royal for Scotland who had given one of the expedition members, Robert Mossman, training in making measurements of the Earth's magnetic field.

Using Omond House as a base and Copeland House as a magnetic observatory, in 1903 a program of meteorological observing and magnetic measurements were begun, with this program continuing to the present day. Details of the work carried out by the SNAE and details of the many problems, both political and practical, are fully described in the excellent papers by Keighren (2005) and Swinney (2007).

In 1904 Bruce and most of the SNAE members left Laurie Island to return home to Scotland leaving Mossman to train Argentinean scientists who would continue the scientific program. Since then this work has been supported by Argentina which makes Base Orcadas the longest continuously manned base in the whole of Antarctica. As the base is in a unique location the data and results generated by the

many scientific programs carried out there are of immense value to the scientific community worldwide and it is essential that this work continues. Unfortunately in August 2003 a magnitude 7.5 earthquake, in the sea, 190 km east of the base, damaged the instruments in the magnetic recording hut. Although no major structural damage was caused to the base infrastructure by the earthquake, unfortunately the violent ground movements damaged the suspension of the declinometer which resulted in a loss of record from this instrument.

Today, the scientific community demand that the data output from magnetic observatories is digital. Ideally in an internationally recognized format, conforming to either INTERMAGNET or IAGA standards. Currently, Base Orcadas is generating data from hand scaled photographic recordings which do not conform to these standards. Because of this and as it is essential that this long data set continues the observatory was regarded as an ideal site at which to install the INDIGO hardware. This hopefully will allow Argentina to continue to provide data from this important site in a form that is readily useable by the research community.

The upgraded hardware consists of a non-suspended DMI three component fluxgate magnetometer recording variations in three orthogonal components (horizontal (H), declination (D) and the vertical (Z) components) every 5 seconds and a GEM proton magnetometer measuring total field (F) every 10 seconds. The outputs of these instruments are digitized and logged using a low-powered (battery backed) digitizer and a USB memory stick with timing control from a GPS receiver giving an accuracy better than ±1 second/day.

2. SITE LAYOUT AND INSTRUMENTS

At Base Orcadas two wooden huts, Figure 3, have been built to replace the original 1903, Copeland House, the position of these huts within the base can be seen in Figures 1a,b. One hut is the Absolute House in which BMZ and QHM magnetometers were used to determine the absolute values of Z (BMZ) and H and D, (QHM). During the 2012 visit a D/I fluxgate theodolite was installed in the absolute building replacing the obsolete QHM and BMZ instruments.

The second larger building, where temperature is controlled throughout the year, housed the photographic La Cour variometers and also a small photographic darkroom where the photographic records were processed. These instruments have been removed and replaced by the three component fluxgate and the GEM proton magnetometer. The power supplies, digitizer and data logger have been installed in the now unused photographic darkroom with a cable data transmission link installed to connect the Variometer House to the main office building. In the main office the data are decoded, displayed and logged on a PC running the INDIGO Watch software package.

3. INSTALLATION

In January 2012 a team of engineers from SNM travelled to Base Orcadas to install the new INDIGO hardware and organize an absolute observing program. Their first task was to remove the existing photographic variometers and organize the installation of the INDIGO DMI fluxgate, GEM GSM 90 proton, GPS time receiver along with the control and recording hardware in the Variometer House. In order that the operation of this equipment could be monitored remotely a trench was excavated and a multicore cable was installed between the Variometer House and the Main Office, 100m distant (Figure 4). This link is used to transmit the data from the INDIGO hardware to a PC in the office running INDIGO Watch software which allows staff to continuously monitor the operation of the variometers and also provide a backup recording facility if problems are experienced with the data logger in the Variometer House or bad weather makes it difficult to visit and check that the equipment is operating correctly.

The above work took 10 days to complete and continuous recordings started in early February 2012. The next task was to set up the absolute observing program and to measure the site differences between the GEM proton in the Variometer House and the D/I absolute observing pillar in the Absolute House.

The site difference measurements were made on 2 separate days with continuous recordings being made over a 16 hour period by Geometrics 856 proton mounted on the D/I observing pillar. The results of these measurements were subtracted from the simultaneous measurements made by the INDIGO proton in the Variometer House. These tests established a site difference of 4 nT between the proton in the Variometer House and the D/I observing position. Unfortunately it will not be possible to leave this second proton magnetometer on the Base to check this site difference every few months but this site difference will be remeasured on the next service visit.

Prior to this installation a QHM and BMZ were used to make absolute observations of the magnetic field. In February 2012 these instruments were removed and a Rukca D/I theodolite with Institut Royal Météorologique, Belgium electronics is now used to measure the absolute values of declination (D) and inclination (I). The calculation of the horizontal (H) and vertical (Z) intensities and baselines are calculated using the total field (F) measured in the Variometer House, corrected for site difference as described above.

All this work was successfully completed by 7 February 2012 when continuous recordings of the fluxgate and proton began and a regular absolute observing program was also started. From this date analog recording stopped and Base Orcadas became a fully digital magnetic observatory.

4. FUTURE PROGRAM OF WORK

Following on from this successful installation to ensure continued reliable operation of the new digital system at Base Orcadas the staff will carry out the following work program:

Regular visual checks on the operation of the INDIGO equipment.

Data files of variometer data will be transmitted daily to SMN in Argentina and to the INTERMAGNET GIN in Edinburgh.

A regular program of absolute observing will start. This program specifies that overwintering base staff make 3 absolute observations every day throughout the year.

A bulletin containing plots of the daily magnetograms and fluxgate baselines derived from the absolute observing program will be generated every month.

Annually the staff from SMN will carry out a service, calibration and maintenance visit, typically this will include:

Checks on the scale values of the fluxgate variometers.

Using astronomical observations, remeasure the declination fixed mark bearing.

Remeasure the total field site difference between the D/I observing position and the proton magnetometer in the Variometer House.

5. CONCLUSIONS

The installation of this new hardware is a significant event in the long history of Base Orcadas. The original base was set up by a Scottish expedition in 1903 with the observing program carried out by a joint Scottish/ Argentinean team of scientists making this the longest continually operational base in Antarctica. In 2012 the base was again re-equipped as part of a joint INTERMAGNET program and it is hoped that this co-operation will continue to ensure the successful operation of Base Orcadas long into the 21st century.

6. ACKNOWLEDGEMENTS

We would like to acknowledge and thank the following people, Ted Harris (BGS) and Lic. Mateo Virgilio Hernandez (Trade and Imports Office SMN) for all their help in shipping and organizing the export and import of the INDIGO hardware. Roberto Orlando Guzman, Principal Warrant Officer of the Air Force, Argentina for his help in installing the equipment in Base Orcadas and his excellent work in carrying out the absolute observing program. The staff at Base Orcadas and Esteban Hernandez, Gerardo Cifuentes Nava and the staff of UNAM Mexico for their assistance in providing the D/I theodolite. CWT contributes by permission of the Executive Director, British Geological Survey (NERC).

7. REFERENCES

Keighren, I.M. (2005) Of poles, pressmen, and the newspaper public: reporting the Scottish National Antarctic Expedition, 1902-1904. *Scottish Geographical Journal*, **121(2),** pp 203-218.

Moneta J.M., (1951). Cuatro Años en las Orcadas del Sur. *Peuser : Buenos Aires.*

Mossman, R.C., Harvey Pirie, J.H, Rudmose Brown, R.N., "The Voyage of the Scotia" 1902, reprinted 2002, *Mercat Press, Edinburgh, 2002,* **ISBN I 84183 044 5.**

Schott, J.J., Rasson, J.L., (2007). Magnetic Observatories in Antarctica, Encyclopedia of Geomagnetism and Paleomagnetism, *Encyclopedia of Earth Sciences Series, David Gubbins & Emilio Herrero-Bervera (Eds.)*, **ISBN: 978-1-4020-3992-8,** 1020p.

Swinney, G.N. (2007) The Scottish National Antarctic Expedition (1902-04) and the Founding of Base Orcadas, *Scottish Geographical Journal,* **Vol 123,** No 1 pp 48-67, March 2007.