MAGDAS I and II Magnetometers in Peru

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Abstract The Department of Terrestrial Magnetism of the Carnegie Institution of Washington founded in 1919 the Huancayo Observatory, in Peru (Lat. -12.06°, Long -75.21°) and installed a classical magnetometer which has provided a long standing flow of data since March 1st, 1922. Today, there are 10 magnetometers in operation in Peru. On October 13th, 2006, Space Environment Research Center - SERC of Kyushu University installed a new Magnetic Data Acquisition System MAGDAS I (PI; Prof. K. Yumoto) at Ancon Observatory (Geographic Latitude: -11.79°, Longitude: -77.16° and Geomagnetic Latitude (2000): 3.10° and Longitude (2000): 354.66°). On July 13th, 2011, SERC installed a MAGDAS II at Ica Solar Station (Geographic Latitude: - 14° 04', Longitude: -75° 44'). Details of the magnetometer that we are hosting will be explained in this presentation.

Keywords: Geomagnetic observatories, MAGDAS, SERC, CPMN.

Introduction

The Geophysical Institute of Peru, has installed magnetometers in important observatories:

Huancayo Observatory.- Geomagnetic measurements in Peru started in 1919 with the construction of a building dedicated to magnetic observations and with absolute measurements in the place where today is Huancayo Observatory, all of these made possible by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington - DTM CIW. On March 1st, 1922, the continuous photographic recording of magnetograms started. Photographic recordings were done with a Magnetograph DTM CIW N° 2 of the Eschenhagen type, consisting of declination (D), horizontal-intensity (H), and Pushkov vertical-intensity (Z), variometers and one photographic recorder made by Otto Toepfer and Sohn, Potsdam. This equipment was used as the principal magnetograph.

Huancayo data enabled scientists to determine the Magnetic Equator, which helped them to estimate the real shape of the Earth's magnetic field. The determination of the Magnetic Equator is one of the main contributions of Huancayo Observatory. This fact made the data of this Observatory important.

Jicamarca Radio Observatory.- This observatory is about half an hour driving inland (to the east) from Lima, and 10 km from the central highway (latitude: 11.95° south, longitude: 76.87° west). Some magnetometers have been installed at different stations for the Low Latitude Ionospheric Sensor Magnetometer Network (**LISN**) project:

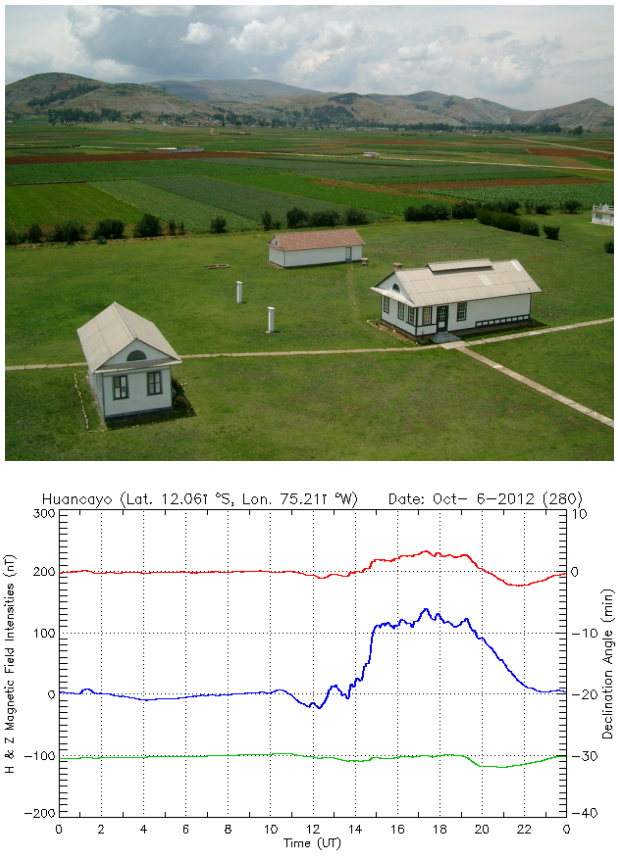

Figure1. Huancayo Observatory and magnetograms of 06th October 2012

Table 1. Magnetometers operated by Huancayo Observatory

Variations instrument	Time resolution	Starting data	Ending data
HDZ Fluxgate INTERMAGNET	1 sec.	July 1997	Operating and data is available in real time
XYZ Tokyo-ERI	1 sec.	July 1997	Operating , data is available in real time Earthquake Research Institute of Japan
Eschenhagen DTM CIW No. 2 Variometer	1 sec.	1922	Operating at present, data is available in real time

Table 2. Magnetometers operated by Jicamarca Radio Observatory

Station	Variation instrument	Time resolution	Starting data	Operating status
Leticia (LET) Colombia (-4.19 -69.94)	HDZ LISN Magnetometer	1 sec.	April 2009	Operating at present
Puerto Maldonado (PMO) – Peru (-12.58 -69.18)	HDZ LISN Magnetometer	1 sec.	March 2008	Operating at present
El Leoncito (LEO) Argentina (-31.00 -69.29)	HDZ LISN Magnetometer	1 sec.	September 2008	Operating at present
Alta Floresta (ALF) – Brasil (-9.87 -56.10	HDZ LISN Magnetometer	1 sec.	November 2010	Operating at present
Cuiba (CBA) Brasil (-15.56 -56.07	HDZ LISN Magnetometer	1 sec.	November 2010	Operating at present

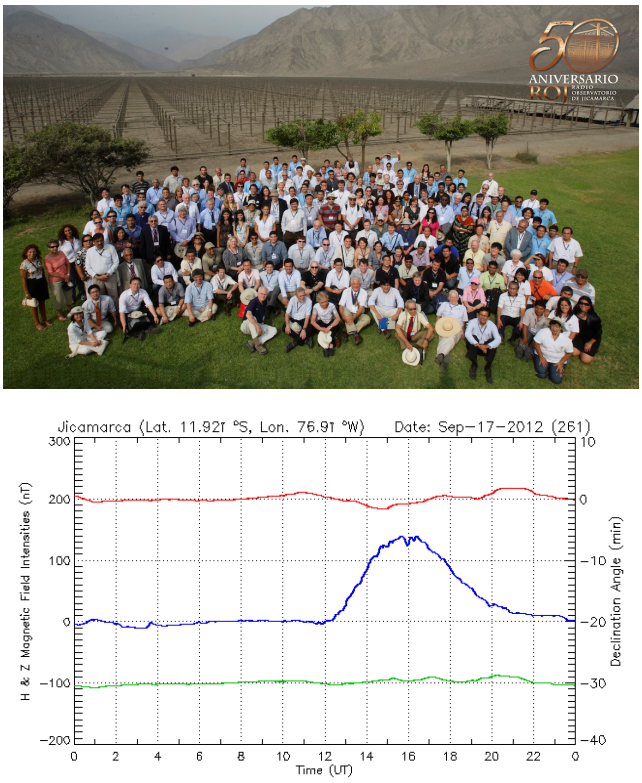

Figure 2. Jicamarca Radio Observatory and magnetograph of 17th September 2013

Ancon Observatory.- It was constructed in 1961 by NASA, for satellite tracking. Then, in 1966, a magnetometer was installed in Ancon, as part of the geomagnetic network deployed along the path of the total solar eclipse occurred on November 12th 1966 (PI. M. Casaverde et al., 1967).

In 1985, the first Kyushu University magnetometer was installed in Huancayo Observatory, but then it was moved to Ancon Observatory, which has almost the same latitude. During 1989, the project for the establishment of a new magnetic Observatory at Ancon was started with the installation of an H, D and Z Askania Variograph recording on 70 mm film. At the same time detailed ground magnetic survey was carried out finding an homogenous magnetic gradient less than 10 Nt. per 50 mt. A high sensitivity fluxgate magnetometer with 3 sec. sampling rate was installed. It was part of the Equatorial Magnetic Observation Network (PI: Prof. T. Kitamura). Then it was included in the Circum-pan Pacific Magnetometer Network (CPMN) (Yumoto et al., 1996; 2001). The PI of CPMN is Prof. K. Yumoto.

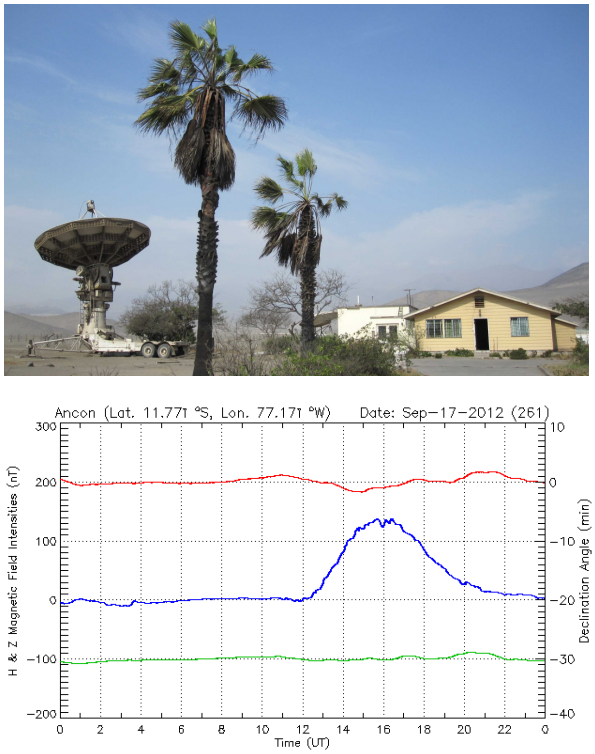

Figure 3. Ancon Observatory and data of 17th September 2013

The Geophysics Research Laboratory (GRL) of the Tokyo University of Japan has developed high sensitivity and very stable Fluxgate magnetometers using latest electronic technology. The first Fluxgate magnetometer was installed at Huancayo Observatory in 1984 by Dr. T. Araki. A data logger with 1 sec sampling rate was used, recording on commercial cassette tapes. Finally, this magnetometer was reinstalled at Ancon.

A second fluxgate magnetometer was built at GRL in 1987, improving the first design. The analogue output was between ± 10 volts, equivalent to ± 500 nT. After recording tests were made at Kakioka Magnetic Observatory, this Magnetometer was installed at Huancayo Observatory in March 1988. Data acquisition system used a PC equipped with a 12 bits ADC and GRL software developed for this purpose. The fluxgate magnetometer is still working at Ancon.

Recently, electronics were renewed thanks to WDC-Kyoto support. Since that happened, barometric pressure data is also available (PI: Dr. T. Iyemori).

The Huancayo Magnetic Observatory is situated at latitude 12.04° south and longitude 75.82° west, at an elevation of 3350 meters above sea level. Ancon Observatory is situated at latitude 11.79° south and longitude 77.16° west, at an elevation of 40 meters above sea level, 40 kilometers to the north of Lima.

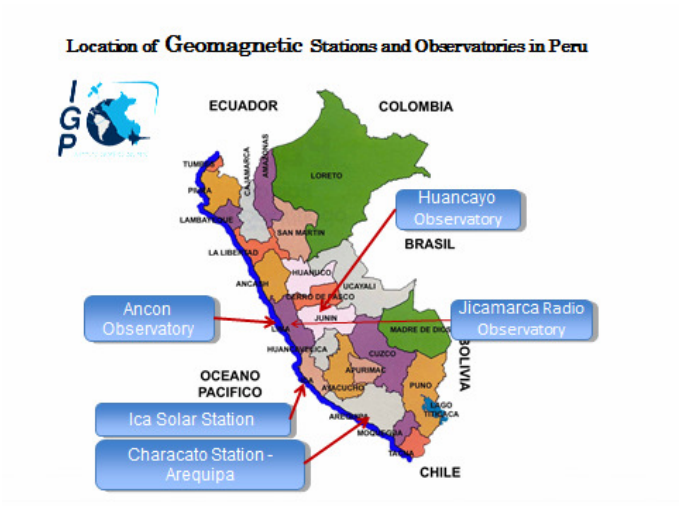

Figure 4. Location of Geomagnetic Station and Observatories in Peru

Magnetic Data Acquisition System MAGDAS

Magnetic Data Acquisition System MAGDAS I

For space weather studies and applications, the Space Environment Research Center, Kyushu University, deployed a new real-time MAGDAS (MAGnetic Data Acquisition System) in the CPMN region (Yumoto and MAGDAS Group, 2006, 2007). On October 13th, 2006, the SERC of Kyushu University installed a new MAGDAS in Ancon. The new magnetometer system consists of 3-axial ring-core (amorphous metallic alloys) sensors, fluxgate-type magnetometer, data logger/transfer units, and power unit. Magnetic field digital data (H+δH, D+δD, Z+Zδ, F+δF) is obtained with the sampling rate of 1/16 seconds, and then the averaged data is transferred from Ancon to the SERC, Japan, in real time.

Magnetic Data Acquisition System MAGDAS II

On July 14th, 2011, SERC of Kyushu University installed MAGDAS II at ICA Solar Station at San Luis Gonzaga National University, located 300 km south of Lima: Lat. 14.04° S Long. 75.44° W.

This magnetometer was a CPMN, then it was refurbished and became MAGDAS II. Characteristics: magnetometer: FR 601, data transfer: Armadillo, highest data resolution: 1Hz, time correction: GPS.

MAGDAS is one of the largest ground magnetometer array in the world. Ancon and Ica stations send geomagnetic data to the Space Environment Research Center (SERC) at Kyushu University of Japan.

Ancon station sends data in real time and Ica Solar Station in near real time.

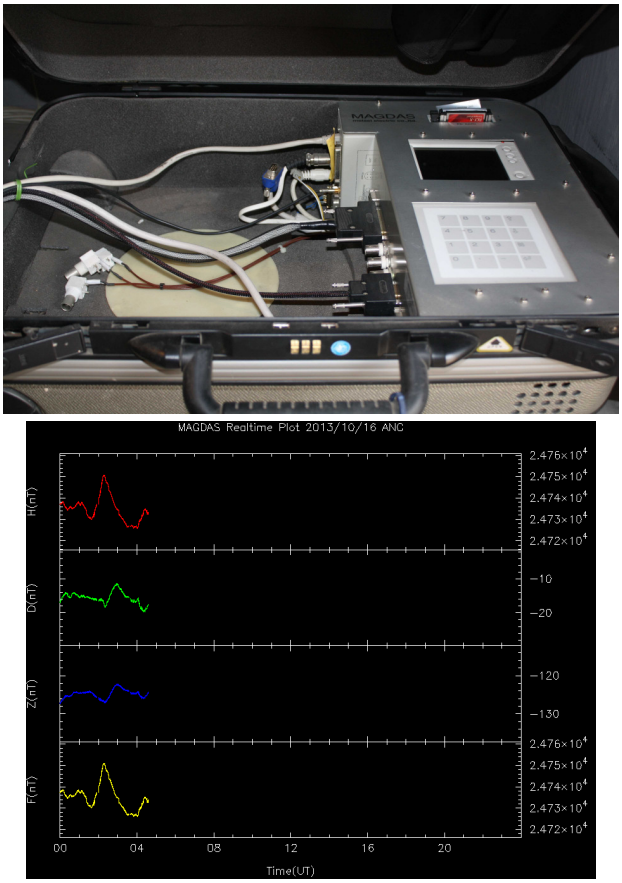

Figure 5. MAGDAS I of Ancon Observatory and real time magnetograms 17th October 2013

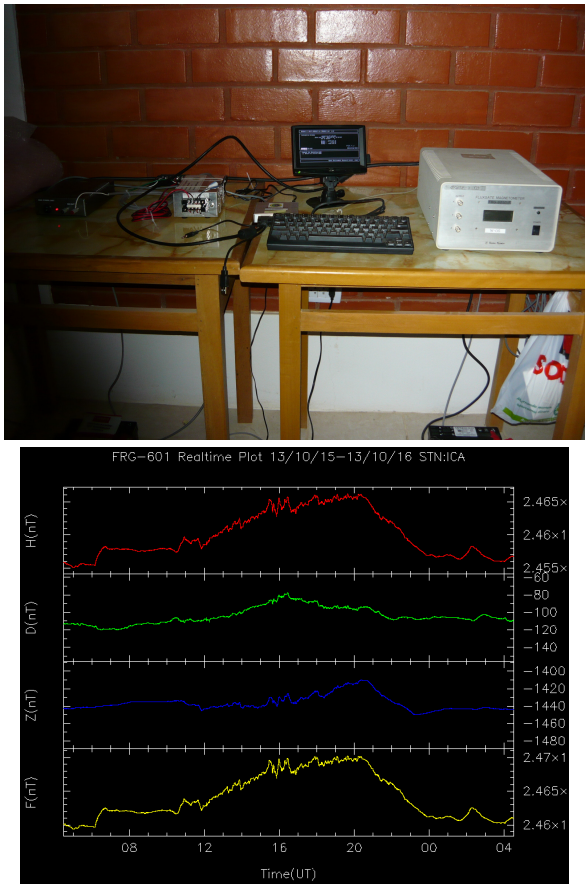

Figure 6. MAGDAS II, acquisition system installed at Ica Solar Station and real time magnetogram 15th October 2013

Conclusions

MAGDAS I and MAGDAS II actually working very well. The operatively of magnetometers in Peru is very important because of Magnetic Equator.

Acknowledgements

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References

Veliz, O., Ishitsuka, M., Palza, H., Rodriguez, R., Paraguay, F. : 1992, The International Equatorial Electrojet Year Geomagnetic Program.

Giesecke, A. and Casaverde, M.: Historia del Observatorio Magnético de Huancayo.

Rosales, D., Vidal, E., Orihuela,S.: Huancayo Geomagnetic Observatory absolute measurements on geomagnetic equatorial zone.

H. F. Johnston, A. G. McNish, S. E. Forbush, W. E. Scott, Ella Balsam, P. G. Ledig: Magnetic Results from Huancayo Observatory, Peru, 1936 – 1944.

Yumoto, K., and the 210MM Magnetic Observation Group, The STEP 210 magnetic meridian network project, J. Geomag. Geoelectr., 48, 1297-1310., 1996.

Yumoto, K., and CPMN Group, Characteristics of Pi 2 magnetic pulsations observed at the CPMN stations: A review of the STEP results, Earth Planets Space, 53, 981-992, 2001.

Yumoto, K., and the MAGDAS Group, MAGDAS project and its Application for space weather, Solar Influence on the Heliosphere and Earth's Environment: Recent Progress and Prospects, Edited by N. Gopalswamy and A. Bhattacharyya, ISBN-81-87099-40-2, pp. 309-405, 2006.

Yumoto, K. and the MAGDAS Group, Space weather activities at SERC for IHY: MAGDAS, Bull. Astr. Soc. India, 35, pp. 511-522, 2007.