MAGNETIC VALLEY: A KNOWLEDGE TRANSFER PROJECT

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ABSTRACT

The knowledge transfer project called "Magnetic Valley" that was launched in 2009 is presented below. This project is funded by the Belgian government to investigate and develop products and services that will improve the socio-economic development in the area around the "Centre de Physique du Globe de l'IRM".

Keywords: Applied research, Knowledge transfer, Technology transfer, Education

1 INTRODUCTION

The Royal Meteorological Institute of Belgium manages a geophysical centre, which is situated in Dourbes (Viroinval) about 100 km south of Brussels, in a rural area far away from electromagnetic disturbances. Inaugurated in 1954, the centre has long-standing experience with real time monitoring of the geomagnetic field, ionospheric activity, and cosmic ray intensity as well as rockmagnetic analysis and archaeomagnetic dating and in the development of scientific measurement instrumentation. In order to provide the impetus for socio-economic development in the region, the Belgian government decided to support this knowledge transfer project based on products and services identified in the frame of our research activities.

In each of the three sections of the "Centre de Physique du Globe", based on our "know-how", we have identified products and services we propose to further develop. Those are described below.

In addition, Magnetic Valley also promotes education and outreach activities in order to attract and inspire young people in engineering and scientific research.

2 GEOMAGNETIC INSTRUMENTATION

2.1 AutoDIF

The Geomagnetic Observations and Instruments Section decided to finalize the development of the automatic Diflux instrument, called AutoDIF, which is able to perform automatic, unattended absolute geomagnetic declination and inclination measurements to make these instruments rapidly available to other magnetic observatories. By the end of 2009, the first AutoDIF had been successfully running for a few weeks.

The experience we acquired during the construction and operation of this first automatic DIflux has been very useful for validating implemented engineering concepts and hardware and software solutions (laser pointing to a cornercube target, non-magnetic optical angle encoders, user interface, etc). We are currently working on a second automatic Diflux, with the main challenge to increase its lifetime. New ultrasonic nonmagnetic motors have been selected; the mechanical design of the theodolite has been completely renewed; and ceramic bearings were adopted. We expect this second AutoDIF to be running in an observatory in 2011. For further information, we refer the reader to a dedicated article about this instrument elsewhere in these proceedings.

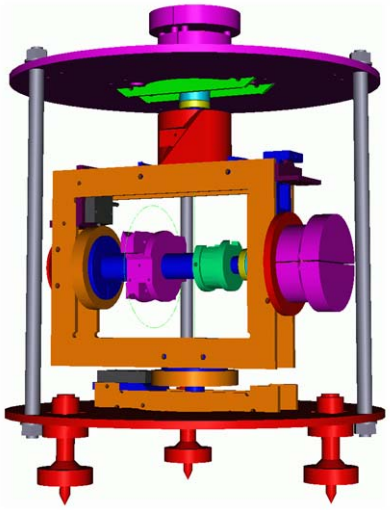

Figure 1. AutoDIF MKII new design

2.2 Production facilities

In order to be prepared for the expected demand for new instruments, such as the AutoDIF, and to improve the production of our already existing instruments (Lama and FLM2), we are further developing our production facilities (electronics lab, manufacturing shop, computer sciences) and providing suitable training to our co-workers.

3 AIRPORT GEOMAGNETIC SERVICES

For more than 20 years, the Geomagnetic Observations and Instruments Section has provided magnetic declination data and services, such as compass rose certification, aircraft runway azimuth determination, and delivery of isogonal information or maps, to airports. Up to now, we have provided those services and data in addition to our research activities. In the scope of Magnetic Valley, we are investigating current and potential interest for our experienced services. If we see a growing interest, we would consider creating a dedicated operational unit.

Figure 2. Providing geomagnetic services to airports

4 HEAVY METAL SOIL POLLUTION MAPPING

Soil is a complex biogeochemical system playing a critical role across many natural cycles that are of vital importance to humans. For example, the water and the carbon dioxide cycle is of primary importance to agriculture. High population density and industrial development have made arable land a very precious and scarce geomaterial. Anthropogenic soil contamination is an increasing problem in densely populated areas, such as Belgium and eastern Asia, requiring political decisions to be based on scientific reports and certified analytic methods. Recently, the European Environment Agency estimated the number of potentially polluted sites to be approximately 3 million (http://www.eea.europa.eu/soer/synthesis/synthesis).

The Environmental Magnetism Section investigates the relevance and limitations of magnetic methods (in particular magnetic low-field susceptibility measurements) as proxy methods for mapping heavy metal pollution in soils (Figure 3). Heavy metals are the most frequent soil contaminants in urban and industrial areas.

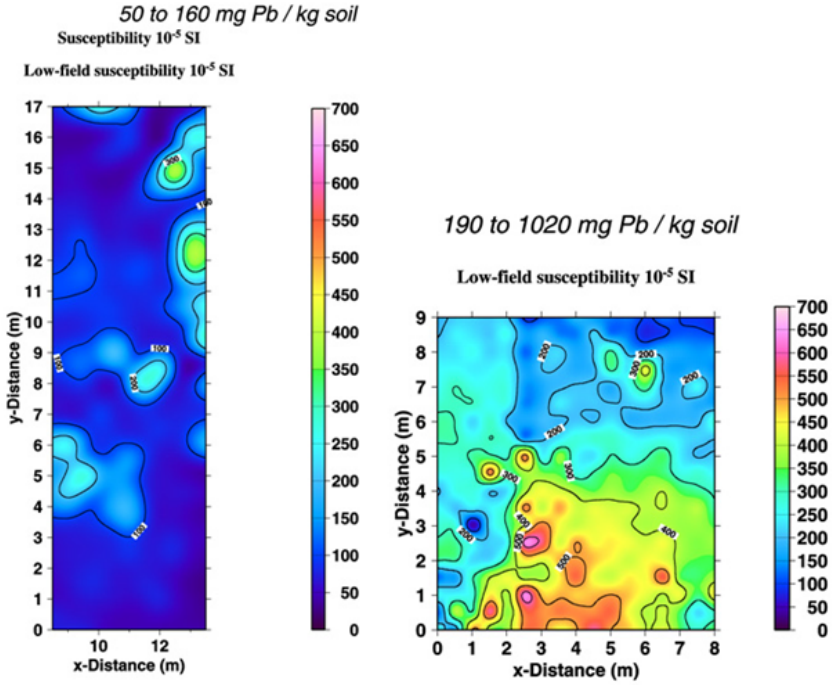

Figure 3. Examples of magnetic surface soil susceptibility mapping of an unpolluted (left) and a polluted (right) area (after Spassov *et al.* 2004a).

Industrial activities and organic fuel burning cause particulate matter (PM), known as fly ash, which is released into the atmosphere and then deposited on vegetation and soil. Its formation process often favors the formation of magnetic iron oxides or sulfides. Besides magnetic minerals, fly-ashes emitted from fossil fuel burning power plants, smelters (ferro and non-ferro metal producing factories), and cement factories are very rich in heavy metals (such as As, Be, Co, Hg, Ni, Se, and V for the first and Cd, Cr, Cu, Hg, Ni, and Zn for the second). Therefore, magnetic methods have been proposed for pollution monitoring of particulates carrying heavy metals resulting from combustion processes. Magnetic particulates are produced along with heavy metals, and both will follow the same sedimentation pathways (Versteeg et al., 1995). Heavy metals can also be incorporated into the magnetic crystal structure or be adsorbed at the magnetic particle surface (Dekkers & Pietersen, 1992; Georgeaud et al., 1997).

Chemical investigations of heavy metal pollution are time consuming and expensive; thus their application is limited when the pollution degree of large areas has to be estimated. In contrast, magnetic methods offer the great advantage that low concentrations (in the order of ppm) of ferromagnetic phases can be detected, identified, and quantified, without costly sample preparation and within a short measurement time. Measurements of magnetic susceptibility have now become an accepted method for soil pollution mapping (e.g., Evans & Heller, 2003) while more sophisticated magnetic methods have the ability to quantify natural and traffic related PM contributions to the total PM concentration (Spassov et al., 2004b).

We are currently developing instrumentation and methodologies dedicated to characterizing the magnetic properties of soils and other materials. We are aiming to validate our methods through comparison with geochemical and sedimentological data. In order to perform this validation in Wallonia (Belgium), and also to assess advantages and limitations of our methods, we joined the POLLUSOL project in 2010. Its purpose is to map the concentration of metals and micro organic pollutants in soils and ground water by chemical analysis throughout the Walloon region. Through POLLUSOL, we have a scientific collaboration with other research institutes, and we expect to be able to assess the economic potential of our methods as the project leader, the public SPAQuE S.A., is in charge of rehabilitation of former industrial sites in the Walloon region.

5 IONOSPHERIC PROFILES

Modern society relies more and more on electromagnetic wave propagation, whatever the application: ground to ground, ground to space, or Global Navigation Satellite Systems (GNSS), such as GPS or Galileo. The Ionosphere, which is the atmospheric layer where the free electron concentration is sufficient to affect radio wave propagation, consequently plays a major role in wave propagation and can strongly affect GNSS performances.

In the Ionospheric Profiles Section, a large part of the scientific activity is directed towards monitoring and predicting ionospheric disturbances and their effects on GNSS. Currently, scientific tools to characterize ionospheric and geomagnetic activity are being developed and tested; they are made available on a dedicated website: http://swans.meteo.be.

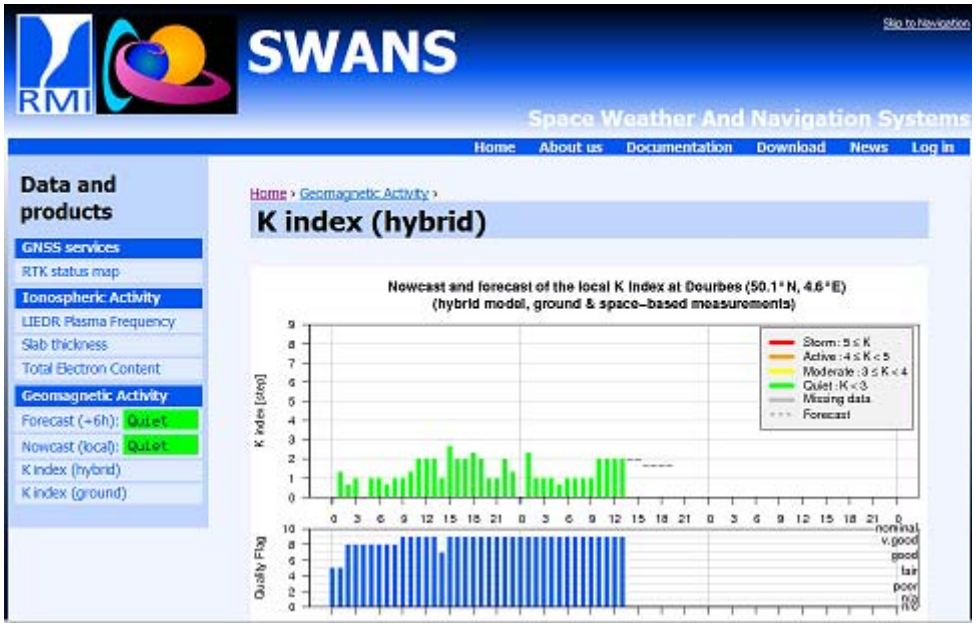

Figure 4. Ionospheric and geomagnetic activity characterization tools being tested are available at http://swans.meteo.be

In the scope of Magnetic Valley, we intend to provide specific services tailored to meet the needs of future Galileo users.

6 OUTREACH

In addition to the development of new products and services, we also wish to promote interest in science and engineering among the young public through our educational activities; for instance, we broadcast a film presenting Earth Magnetism in schools, and we support the organization of “Eurobot Junior”, a European

competition of robotics in the neighborhood close to our centre. As education and outreach is of interest to many scientific institutes, we invite this community to share experience and/or educational materials in the near future.

7 CONCLUSION

Magnetic Valley is a young project aiming to transfer know-how gained throughout research activities at the Centre de Physique du Globe of the Royal Meteorological Institute of Belgium into products and services. These products and services will benefit regional socio-economic development (job creation and outreach activities), our applied research activities (the expected added value will be reinvested into research activities), and of course, other organizations, e.g., scientific institutes, which will find interest in our products and services.

The different projects under development have been described in this paper. They are at different levels of finalization, and work is proceeding on all of them.

In order to communicate our progress, we have created a dedicated web site: http://www.magneticvalley.be. In addition, more specifically for the progress performed on geomagnetic instrumentation, we will send a newsletter to communicate major achievements.

8 ACKNOWLEDGEMENTS

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