ABSTRACTS

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Effects of reduced number of repeat stations

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Last repeat (secular) station survey over the territory of Serbia was carried out in 2008. Usual interval between two surveys was 3 to 5 years. There is a network of 14 repeat stations and they were surveyed along with continuously recording local variometer. The 4-member field team was recording variometer data during 3 to 5 day period and also absolute measurements were carried out at the variometer location and at 1 or 2 additional stations. Due to the lack of financial support, survey planned in such a way has been postponed from one year till another and this paper presents the effects of reduced number of stations from 14 to 10.Grocka geomagnetic observatory is also a part of secular station network. We have compared the results of surveys carried out in the year 1994 and 2008. The differences in normal field values (obtained by the second degree polynomial analysis) applied on the data from 15 and 11 repeat stations is presented. The result suggested that, applying the same measuring procedure on smaller number of stations, the cost of survey can be reduced up to 25%. From this point of view, our results might be of interest to other countries facing similar financial problems in this field.

Type of presentation: Oral

Thickening of the repetition station network for determining secular variation of geomagnetic field in Romania

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The study of secular variation of the geomagnetic field and its distribution in Romania was one of the main concerns of specialists from Surlari Geomagnetic Observatory throughout its existence.

Unfortunately in recent years on the background of economic issues, this activity was divided into two components: one acquisition and data processing for repetition stations and the continuously monitoring of geomagnetic field in Geomagnetic Observatory Surlari, used as reference station for the national network of repetition stations . Existing network provides not enough coverage for the central and south-eastern Transylvania, central Dobrogea and central Moldova.

In order to improve coverage of these areas, but also to connect the network to infrastructure objectives that using information acquired by geomagnetic measurements made to determine the secular variation.

Setting up a point of national network of repetition stations for determining secular variation involves the following steps:

- selecting of areas of interest in terms of infrastructure and areas with low horizontal gradient of the geomagnetic field components, placed at a sufficient distance from any source of anthropogenic electromagnetic disturbances (industrial, power distribution networks, telecommunications networks, rail and road networks, airports, waterways). Were selected sites located at Mihail Kogalniceanu (Constanta), Tulcea, Bacau, Iasi, willow (Suceava), Targu Mures, Ghimbav (Brasov), Craiova.
- realization of measurements of total field in a regular grid of 5x5m close to the areas of interest set out to select the station point location in the area with the lowest horizontal gradient of the total geomagnetic field .
- selection and marking the point with a buried nonmagnetic concrete milestone, without reinforcement.
- performing several series of measurements with fluxgate Declinometer / inclinometer for determining the absolute value of declination and inclination of geomagnetic field, a proton magnetometer for determining the absolute value of the total magnetic field, and a variational fluxgate magnetometer which will record the variation of the geomagnetic field components in the directions north (X), east (Y) and vertical (Z).

D etermination of declination and inclination is performed using a Bartington declinometer / inclinometer mounted on a theodolite non-magnetic. To determine the declination is performed for each point a set of four measurements of magnetic field vector direction and one of 10 measurements of the position of the sun at meridian. Following these determinations can establish position of the geographic and magnetic meridian of the place based on a formula of the form:

G(i)=H(i)-arctg(sinTT(i) cosD(i))/(sinF cosTT(i)-cosF sinD(i))

Where H (i) is the angle read on the horizontal circle of the theodolite at the time Ti when the solar disk was perfectly framed in the theodolite collimator, F represents the latitude in degrees of arc, D (i) is momentary declination of the sun for every moment that a measurement of the position of the sun is made , TT (i) is the hour angle of the sun.

Determination of the geomagnetic inclination is performed the following procedures: for each point is made a set of four point measurements of the magnetic field vector direction. Following these determinations the inclination of geomagnetic total field vector is calculated according to the following formula:

I=180-((180-SU)+(360-ND)+(SD-180)+NU)/4

Having these absolute determined values of the declination, inclination and total field we can compute trigonometric the other components of the geomagnetic field.

Measuring the total geomagnetic field is achieved with a proton precession magnetometer brand GEOMETRIX G 856 with an accuracy of 0.1 nT. It aims to determine the total geomagnetic field variation during measurement of geomagnetic declination, required for calculating the corrections applied to the measured declination value and to compute the other components of the geomagnetic field.

To obtain the secular variation of the geomagnetic field components, from the measured values of the geomagnetic field, the effect of external components of geomagnetic field (quiet diurnal variation, disturbed diurnal variation) are extracted. In this way, considering the crustal component of the geomagnetic field stationary and eliminating the external component is considered that the difference in value of the components of the geomagnetic field recorded in the interval between two successive measurements in the same point is solely due to changes in the inner component (secular variation).

During 2010 we achieved absolute measurements of the geomagnetic field components in 19 locations randomly distributed in Romania. After processing and reducing them to epoch 2010.5 we obtained maps of the geomagnetic field components with a distribution pattern similar to that of IGRF10 geomagnetic model. Differences between the values obtained by us and the IGRF ranges (-35 to + 120) nT. These differences are the produced by crustal component of geomagnetic field recorded in stations where measurements were made.

In the case of processing performed to obtain the secular variation, as in the case of the calculation of the declination for airport installations the correction for the crustal effect is not required.

The distribution of these values is similar to that obtained for the same period based on data acquired in the national network of repetition. However, may notice slightly improved of details in the areas where we propose the creation of new stations for the national repetition stations network for determining secular variation.

Extension of the network with points mentioned above will lead to a more accurate picture of the distribution of the geomagnetic field components in Romania and to extend the use of such data by operators of air transport.

Type of presentation: Poster

Considerations on the deep geomagnetic soundings in the Vrancea zone

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Using the natural geomagnetic variations to determine the distribution of conductivity in basement, tens of kilometers, is based on the high penetration of currents induced by geomagnetic variations with periods longer.

In principle, the two sides must be separated from the disruptive fields, namely:

- external side, ionospheric currents generated by hydrodynamic nature of plasma oscillations of the magnetosphere.
- internal part, generated by induced currents in conductive layers of the crust by external electromagnetic oscillations.

So each external current system corresponds to a system of currents inside and variations recorded on the Earth's surface are overlapping magnetic fields of both systems.

According to the laws of induction, the internal currents are in opposition to the external currents and same adverse effect occurring in the corresponding magnetic fields. Accordingly, within the system induced currents will be cancel out at greater or lesser depth. It follows that the higher spectrum of periods used in the research include longer periods, the information received will refer to layers of depths.

In a first approximation is assumed Earth as a sphere whose conductivity is a function of radius, variable in time.

For terrestrial areas small obvious that these inhomogeneities of internal field can be neglected so that the total field is the sum of the normal external side and normal internal side. Only a small part of magnetic variations satisfy the conditions imposed by homogeneity in the first approximation. So for example, the vast majority of short variations, including the case of disturbances in the form of golf, variations which are based in ionospheric layer at an altitude of approx. 100 km, are far from being homogeneous in relation to areas exceeding a continental area.

Relations between the internal and external field changes categorically whether within the region in which observations are made is a conductivity anomaly.

In this case, in areas with higher conductivity higher current densities occur, so additional current spreads, which are characterized by well localized inhomogeneities.

The problem geomagnetic depth survey consists of separating the internal anomalous of magnetic field. To this end we started from the difference between the total field and normal field. There are many separation ways (numerical and analytical) of these fields. The methods of numerical processing of observation data give a good enough approximation for the separation.

In the absence of anomalies, aren't changes in vertical component from one point to another, while, in their presence, the vertical component changes are most important.

So another way of highlighting the internal anomalous part of the analysis may be given the spatial distribution of the vertical component variations.

In quantitative research issues geomagnetic flux variations in a heterogeneous substrate, arise considerable mathematical difficulties. Because of this, some models of practical importance, it is necessary to seek a qualitative solution.

Geomagnetic data processing and interpretation with long recording is made, in practice, following the procedure described by the following formulas:

$H_Z(f)=A(f)H_X(f)+B(f)H_Y(f)+\varepsilon(f)$, after performing Fourier transform on the three orthogonal components of the geomagnetic field.
Geomagnetic induction vector is given by:

$T(f)=[A(f)^2+B(f)^2]^{1/2}$ and phase: $\theta(f)=\arctan[-B(f)/A(f)]$.

For different frequencies can obtain information about basement conductivity at different depths.
In Vrancea area we made geomagnetic survey in 10 locations on the profile Valea Sarii-Tg.Secuiesc. In the locality Lepsa we made geomagnetic surveys simultaneously with two Bartington magnetometers (MAG 03 MC + MAG 03 DAM) with a recording time of 4 days.
For all these surveys geomagnetic surveys we calculated the geomagnetic Tipper and finally we realized the section 2D for the full profile.

Type of presentation: Poster

Geopotential data filtering through moving averages, trend surfaces and analytical continuations from the curvature of the Eastern Carpathians

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Today tectonic activity in the Vrancea region is best characterized by a small area with an intermediate to depth seismic causes, reflecting the advanced stage of continental collisions similar to those in Bucaramanga (Colombia-Bolivia) and Hindu Kush- (Afghanistan) . Although few in number, these specific regions may hold important clues to the development of ocean-continent late active stage or continent-continent regions spatial dimensions interactions relatively small compared to the scale of global tectonic plates. Interaction of this kind may have occurred several times in the geological past and elsewhere on Earth, but are not recognized as such in the geological record. These complicated tectonic zones are not well understood. To highlight the active geodynamic processes in south-eastern Carpathians, Vrancea seismogenic region is subject to many ranges of complementary studies. These geological and geophysical studies, following investigations by both classical field of potential methods (gravity and magnetism), magnetotelluric surveys and by deep seismic studies reflection / refraction, the crustal and upper lithosphere on the structure images, seismic tomography experiments the lithosphere and the imaging of deep shell anisotropy and attenuation of seismic measurements studied with the aim of identifying the flow type of the mantle, and the lithosphere in vranceana earthquakes are generated, a number of geological surveys integrated (Cloetingh et al. [2003]), however, none of these studies could lead to consistent estimates of tectonic surfaces that may or may not be related to the earthquakes from Vrancea zone. An important role in deciphering the deep geological structure, they have gravimetric and magnetic data filtering of type "low pass filter". In this paper we realized this filtering, based on programs that have drawn the methodology in the potential field.In this way, we processed the parameters: vertical geomagnetic field anomaly, Bouguer anomaly, Free Air anomaly, isostatic anomaly, gravity disturbation and elevation of land. Filters "pass down" that we have done in this paper are moving average with various sizes of windows, upward continuation and trend polynomial surfaces with varying degrees. If the moving average, used as the window is larger (include more values) the information obtained is relevant to greater depths. If surfaces polynomial trend, with the degree of the polynomial surface is higher, the information is relevant to shallower depths. Because the purpose of this paper is deep structure, we use only surfaces of degree 6 and 3. Residual anomalies calculated, both for moving average and trend surfaces reflecting surface structure and local effects. These anomalies waste is filtered with filters data "pass up". We calculated the data filtered with filters "band pass" represented by the difference between the moving averages with different windows. These data reflect the average depth without depth could be quantified reflected. However, their interpretation correlated with the depth and surface allows proper introduction as input parameters in modeling program. For geomagnetic field we developed the databases on the data contained in the archive Geological Institute of Romania. This database contains the geographic coordinates of the measuring points, the values recorded in the vertical component of the network base stations in which measurements were performed, the vertical component values recorded at each point of the network and the corrected values of reduced vertical component at epoch 1967.5. The anomaly of vertical geomagnetic field was calculated by applying corrections with the value of normal field to the vertical component of the geomagnetic field. It should be noted that

geomagnetic data are not uniformly distributed and the number of values varies, there are areas with a high density of measuring points (in areas of interest at the time of prospecting, the valleys and in areas accessible relief) but also areas very little coverage (low interest areas and inaccessible areas with relief). On this map it can notice a number of bipolar anomalies, located in the Eastern Carpathians and a maximum number of anomalies concentrated in the area north of Panciu, to Răcăciuni. Except these two areas, is highlighted the anomalous strong upward trend in the direction SW-NE sometimes disturbed by small anomalies as the local maximum above the massive Leaota. Much clearer is highlighted the anomaly of the vertical geomagnetic field because was eliminates the normal field value, namely the increasing trend towards NE. In addition was noted that ΔZ between Panciu and Răcăciuni anomaly has extends to the NE to Iasi and S to Tg. Frumos and close to Braila.
Acknowledgements: Data source for this paper was Gravimetric Bureau International (BGI, http://bgi.omp.obs-mip.fr/), which gave us access to all data for Romania and whom we thank very much.

Type of presentation: Oral

Geomagnetic Field Observatories run by Italian INGV

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Istituto Nazionale di Geofisica e Vulcanologia (INGV) is responsible for systematic magnetic observations in Italy made by means of observatories and repeat stations. At present three geomagnetic observatories provide a full coverage of the whole Italian latitudinal extension. L'Aquila (AQU, central Italy) was the main Italian observatory since 1958; in 2003 AQU joined the INTERMAGNET consortium but in 2009 the city of L'Aquila was struck by a M=6.3 earthquake and also the observatory was affected. It was replaced in 2010 by a new observatory, in Duronia (DUR, 120 km apart in SE direction).
In northern Italy the INGV operates since 1964 the Castello Tesino (CTS) observatory; absolute measurements were made twice a month till the end of 2014. Starting from the end of 2014 absolute measurements are made three times a month in order to improve and reach the quality required by INTERMAGNET consortium.
Recently a new observatory was installed in the southern part of Italy, in the middle of the Mediterranean (near Sicily) at Lampedusa Island; the IAGA code of the new observatory is LMP. We are working to reach also at Lampedusa the INTERMAGNET standard, since LPM data are particularly valuable as the southernmost observatory in Europe.
In addition, INGV has been involved since the eighties in geomagnetic field observations in Antarctica. In particular, during the 1986-87 austral summer a geomagnetic observatory was installed at the Italian Antarctic Base Mario Zucchelli Station (TNB) and since 1991 the recording was implemented with an automatic acquisition systems operating through the year. Lastly, in 2004 a geomagnetic observatory was installed on the Antarctic plateau, at Dome C (DMC), very close to the geomagnetic pole; it is jointly operated by INGV (Italy) and EOST (France).
Acknowledgements The work on Antarctic observatories was supported by Italian PNRA (Programma Nazionale Ricerche in Antartide).

Type of presentation: Poster

Land and ocean magnetic networks at the time of Swarm satellites

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Swarm is an European Space Agency satellite mission composed of 3 satellites that, launched on 22 November 2013, are presently monitoring the geomagnetic field from space. As said in ESA web site: “The three Swarm satellites will measure precisely the magnetic signals that stem from Earth’s core, mantle, crust and oceans, as well as its ionosphere and magnetosphere.” However, this great effort will be almost useless without the continuous operation of Earth’s surface (land and ocean) observation monitoring by means of land Geomagnetic Observatories and Repeat Stations, and seafloor observatories. This important ground segment represents the best reference for the satellite observations, and the European Network of the Magnetic Repeat Stations is an important backbone of this Infrastructure. In this presentation we will show how important the Earth’s surface magnetic measurements are for satellite missions.

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Type of presentation: Oral

Preliminary results from an interferometric array to detect low frequency electromagnetic signals in the area near L'Aquila, Italy

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A large frequency band network of three electromagnetic stations has been installed near L'Aquila (Italy) in the framework of the Firb Abruzzo project, a national research program on the seismic risks in the area beaten by the 2009, April 6th earthquake. The study of low frequencies (<100 Hz) electromagnetic signals generated within the Earth interior, due to the dynamics of terrestrial crust, is conducted for one of the aim of the project. Each interferometric station is composed by a three axial flux-gate and a three axial search coils magnetometers to measure magnetic field and its rapid variations. Also they are equipped with two electric sensors for telluric electrical field measurements. Preliminary results of background environmental noise measurements and the detection of electromagnetic signals are presented.

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Type of presentation: Poster

On external signals in long time-span geomagnetic models

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The annual means at geomagnetic observatories are supposed to be free of most of the variations with periods smaller than one year. It has long been recognized, however, that sunspot-cycle-related variations are present in the annual means at geomagnetic observatories and in data from repeat stations. They are the effect of external processes controlled by the solar activity, such as geomagnetic storms, incompletely averaged out in the annual means. It is well known that observatory data are essential to constrain global field model and that they offer a particularly good representation of the magnetic field over Europe, thanks to the relatively dense network. However, not accounted for in modelling, the external contribution to observatory annual means maps into the main field Gauss coefficients, leaking as noise into the main field values given by models. We show this external noise in long time-span geomagnetic models, such as gufm1 (1590-1990) and COV-OBS (1865-2010), by means of simple filtering procedure, for the European observatory locations. The importance of eliminating, from observatory and main field model data, prior to any discussion on secular variation, the signal related to external variations is demonstrated and its consequences are shown.

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Type of presentation: Oral

The Italian magnetic repeat station network: situation at 2015 and results from the 2012.5 ‘reduced network’ completion

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In Italy INGV (Istituto Nazionale di Geofisica e Vulcanologia) has systematically undertaken the task of periodically making measurements of the Earth's magnetic field on a network of more than 110 points, called the first order repeat stations, with an average spacing around 55-60 km.
Measurements are repeated regularly every 5 years and the last published data report and magnetic maps, refer to 2010.0 and are available in Dominici et al, 2012. At that time the report referred to a survey of 131 repeat stations (including 2 observatories, 11 stations in Albania, 3 stations in Corsica and 1 in Malta) carried out between 2009 and 2010, also with the purpose of updating the national magnetic cartography.
At the epoch 2012.5 a selection of stations, from the first order Italian Magnetic Network, chosen on the basis of the lowest values of anomaly, with respect to a 'normal' field, was repeated. The number of the selected stations amounts to 25, distributed also according to a uniform national geographical coverage, with an average spacing around 100 km. Secular variation and analytical expressions, such as second order polynomials, in latitude and longitude for all field elements, were determined and coefficients were obtained for the field spatial variation and secular variation.
We describe here the characteristics of the 2012.5 reduced network with the data reduction procedure and compare the results with other magnetic field models.
Dominici G, A. Meloni, A. Di Ponzio, M. Miconi: Italian Magnetic Network and magnetic reference fields at 2010.0, Annals of Geophysics, 55, 6, doi: 10.4401/ag-5411, 2012.

Type of presentation: Poster

How to determine the exact attitude and position of an unmanned vehicle?

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In the near future unmanned vehicles (drone, wave glider) will be utilized often for geophysical prospecting. Probably different type of measuring instruments will be attached to them, for example LiDAR, thermometer, magnetometer etc. To correct and interpret data measured by the instruments it is essential to know the true location and orientation of the device during the surveys in reference to the geographic north.

This paper is intended to give the audience a solution example of this problem. Nowadays the most commonly used navigation system are the inertial navigation system (INS) and the GPS technology, respectively.

The INS includes a hardware and a software block. The hardware is an inertial measurement unit (IMU), which contains triads of accelerometer and gyroscope sensors. The software processes the IMU measurements using navigation equations/algorithms to yield the inertial solution. The INS is a self-contained system, which provides high-bandwidth outputs exceeding even 200 Hz. However, INS accuracy decreases with time as the inertial instrument errors are accumulated during the processing.

In contrast to INS, GPS provides a long term accuracy with a few meter errors. But, it is prone to high frequency noise and it updates only maximum with 10 Hz rate. A typical GPS receiver does not give a precise attitude information and it is necessary to note that the GPS has to receive at least four satellite’s signals to provide navigation solution.

The benefits and drawbacks of the INS and GPS are complementary, so by integrating their advantages an improved and more accurate frequent navigation solution can be achieved. In the integrated INS/GPS navigation system, GPS surveys prevent the inertial solution drift, while INS can interpolate between the GPS data. In the presentation of this paper an implementation of a loosely-coupled, closed-loop INS/GPS integration will be exhibited.

Type of presentation: Oral

Spanish repeat station network results in 2013-2014

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The paper shows the results of the geomagnetic measurements of the new Spanish repeat station network in 2013 and 2014. The network, currently consits of 42 stations distributed among Iberic Peninsula and Balearic Islands. The measurements are made with a Di-flux Bartington mounted in a theodolite Zeiss 020B and a G-856 proton precesion magnetometer. Also are used a FGE variometer and a Gem Gsm19 Overhouser magnetometer for the variometer stations. The measurements are reduced using the following observatories: San Pablo-Toledo (SPT), Ebro (EBR) and San Fernando (SFE). The data analysed for the last 5 years have been used to update the Spanish regional model in the components D, H, Z and F with their secular variation to 2015.0. Also we present in the poster the computations and graphs used to analyse the data.

Type of presentation: Poster

Romanian secular variation network. Geomagnetic measurements 2013-2014

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The study reports the results of geomagnetic measurements carried out in the last two years (2013-2014) at the 26 repeat stations of the Romanian secular variation network. The absolute values of declination, D, and inclination, I, have been taken by means of a LEMI-204 DIFlux instrument, of total intensity, F, by a G-856 Geometrics proton magnetometer. The horizontal component, H, was also controlled by two QHMs, in order to continue the measurement series started in 1964. The variation of geomagnetic field at each repeat station, by using a LEMI-018 magnetic variometer, has been recorded as well. The values obtained for the geomagnetic elements have been reduced to the middle of the year (geomagnetic epoch year.5) using Surlari observatory (SUA) data. Maps with geographical distribution on the Romanian territory are presented.

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Type of presentation: Poster

Fluxset magnetometer in geophysical applications

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In many geophysical applications size weight or power consumption of the magnetometer create problems or prohibit the task. With a small size, low power vector magnetometer these difficulties can be resolved or several new applications can be realized.
The fluxset magnetometer wich is a low power, full-field vector magnetometer with it's small sensor size originally was designed for nondestructive material test. In the last few years significant development was carried out to reduce the noise and temperature dependence of this device and for now it's technical specifictons are competitive with classical vector magnetometers but requires less power and room.
The paper presents operating principle and main technical parameters of the fluxset magnetometer and shows examples of realised and planned future applications.

Type of presentation: Oral

European magnetic observations at the end of the 18th century

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Societas Meteorologica Palatina, also known as *Mannheimer Meteorologische Gesellschaft* was founded by Karl Theodor, the Electoral Prince of Mannheim (Germany) in 1780 to coordinate meteorological observations in Europe (and later worldwide). Each observer was supplied by the Society with uniform instruments, instructions and forms to record the observations. Letters were transported by the diplomatic post of the Electoral Prince of Mannheim.
Geomagnetic declination observations were carried out three times a day with a magnetic needle. Magnetic measurements with all other observations were published regularly by the Society in the volumes of the *Ephemerides Societatis Meteorologicae Palatinae*, Obsevationes Anni 1781-1792. Observations started in Mannheim, Würzburg, Berlin, Hochpeissenberg, Prague and Buda in 1781, however, in the following years the network rapidly.
At MFGI, the full geomagnetic database of Ephemerides volumes has been digitized. We present details on the observations, the observational results and the results of our analysis on the reliability and accuracy of these unique dataset. We also present some ideas how these data can be used to study 18th century space weather.

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Type of presentation: Oral

EPOS Implementation Phase: The concept of Geomagnetic Core Services

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The European Plate Observing System (EPOS) is the integrated solid Earth Sciences research infrastructure approved by the European Strategy Forum on Research Infrastructures (ESFRI) and included in the ESFRI Roadmap in December 2008. The EPOS Preparatory Phase Project (November 2010 – October 2014) was supported by the FP7 Grant. Conclusions on the implementation of the roadmap for the ESFRI adopted by EC Council in May 2014 ranked the EPOS among three priority projects for implementation. Base on this evaluation, Implementation Phase (IP) project was submitted in January 2015 and Horizon2020 Grant approved in April 2015. The four years project will start on 1st October 2015.

The IP Project is aimed at building Thematic Core Services in individual disciplines and their integration under the Integrated Core services. One of the thematic Working Packages is TCS Geomagnetic Observations. Goals of this WP are to consolidate the community; modernize data archival and distribution formats for existing services, such as INTERMAGNET; and create new services for magnetotelluric data and geomagnetic models.

Specific objectives are:

- enhance existing services providing geomagnetic data (INTERMAGNET; World Data Centre for Geomagnetism; IMAGE - International Monitor for Auroral Geomagnetic Effects) and existing services providing geomagnetic indices (ISGI - International Service of Geomagnetic Indices)
- develop and build access to magnetotelluric (MT) data including transfer functions (TFs) and time series (TSs) data from temporary, portable MT-arrays in Europe, and lithospheric conductivity models derived from TM-data.
- develop common web and database access points to global and regional geomagnetic field and conductivity models and establish links from the WP data services, products and models to the Integrated Core Services.

Whereas seven institutions are directly involved in the implementation of services, the entire European geomagnetism (including MT) community is asked to give response to the TCS architecture, contribute with their data and also test the developed components. Communication with the community represents thus an important task of the Project.

Type of presentation: Oral

Antropogenic disturbances on geomangetic observatories: A comparison between Vienna Cobenzl and the new Conrad Observatory

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The geomagnetic observatory at Vienna Cobenzl was established in 1954, and since then it was subjected to increasing disturbances from the nearby city. For this reason, the location of the newly constructed Conrad Observatory, 50 km SW of Vienna, has been carefully chosen to be as remote as possible with respect to urban areas, power grids, and ground transportation. Here we present a first comparison between the two observatories over magnetically quite days selected over a total period of 7 months. Hourly power spectra of the geomagnetic field recorded at with 10 Hz sampling rate by two identical LEMI variometers (Lviv Institute for Space Research, Ukraine) show clear anthropogenic noise signatures at Vienna Cobenzl, whose intensity correlates with daily variations of electric power consumption. This signatures includes a broad continuous spectrum of frequencies, as well as a single, broad peak with a period of ~77

Type of presentation: Poster

Comparison of regional field models compiled by different methods for the area of Croatia and Hungary

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We take aim at the compilation of a regional geomagnetic field model for the Middle-European area bordered by latitude and longitude coordinates of 42°<Λ<49.5° and 13°<Φ<23.5°, respectively. We use the three component repeat station data and observatory annual means of the area contained by the Edinburgh World Data Center for Geomagnetism. In the adjustment, the traditional polynomial and constrained polynomial fit methods as well as the adjusted spherical harmonic analysis (ASHA) are applied. The residuals between the model values and the observations are used for the ranking of the different models. For testing the optimal station density in the representation of the core field of the area, a Monte Carlo test is carried out with the use of the Enhanced Magnetic Model (EMM) data (Maus, 2010) belonging to the spherical harmonic degree of 15 (representing the core field) and 720 (representing the core and crustal field, i.e. surrogating the real measurements). In area of low station density, virtual stations are inserted with magnetic field values derived from the EMM model. The EMM model data are also used for determining the optimal degree and polar cap half angle parameter of the ASHA method applied for the determination of the ideal core field model of the area.

Type of presentation: Oral

JavaFx rich client covering absolute measurement process

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The contribution introduces a java-based rich software client which can be used for producing protocols about absolute measurements. An employee puts measured data into the client during absolute measurements. The output of our client is a valid xml protocol about an absolute measurement which describes measured values. The xml file provides measured data but it can also be used for computing of geomagnetic vector elements or baselines of variation instruments. The client can be used off-line but it can use online web services as well.

Type of presentation: Oral

Historical magnetic records and the past geomagnetic field evolution

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Records of historical measurements of the geomagnetic field are invaluable sources to reconstruct temporal variations of the Earth's magnetic field. For this study we investigated new sources and new records with focus on Austria and some neighboring countries. These include 19th century land survey and observatory records of the Imperial and Royal „Centralanstalt f. Meteorologie und Erdmagnetismus" and daily measurements at the Imperial and Royal Observatory in Prague. The Imperial and Royal Navy carried out observations in the Adriatic Sea during several surveys. Declination values have been collected from famous mining areas in the former Austro-Hungarian Empire. In this connection, a time series for Banska Stiavnica has been compiled. In the meteorological yearbooks of the monastery Kremsmünster regular declination measurements for the first half of the 19th century were registered. Marsigli's observations during military mapping works in 1696 are also included in our collection. Moreover, compass roses on historical maps or declination values marked on compasses, sundials or globes also provide information about ancient field declination. The gathered records are integrated into a database together with corresponding metadata, such as the used measurement instruments and methods. This information allows an assessment of quality and reliability of the historical observations. The combination of compilations of historical measurements with high quality archeo- and paleomagnetic data in a single database enables a reliable joint evaluation of all types of magnetic field records from different origins. This connection is of particular importance to extend the basic directional information into the past and to obtain estimates of the geomagnetic field strength prior to the inventions of Gauß and Weber in the early 19th century. The validity of this evaluation is verified by a detailed comparison regarding for spatial and temporal differences between data. This collection forms the basis for a combined inverse modeling of the geomagnetic field evolution. A fundamental task of modern geomagnetic field reconstruction is to use the sparse and inaccurate data sources about the ancient geomagnetic surface field to infer the spatio-temporal variations of the Earth's geodynamo over an as large as possible time interval. The main problems for a reliable inversion of the available data into a global model of geomagnetic field variation are inhomogeneous data distribution, highly variable data quality, and inconsistent quality parameters. As a consequence, the verification of any proposed model is a necessary request. Here we will present an overview of data collection and the principles of the resulting database. We will show examples on validity tests and comparison of archeomagnetic data to direct measurements. Finally, we will briefly discuss the modeling and its verification approach.

Type of presentation: Oral

Italian Geomagnetic observatories in Antarctica: analysis of low frequency variations

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Variations of the Earth's magnetic field with period ranging from several seconds to several days derive most of their energy from the interaction between the Earth’s magnetic field and the solar wind; most of the present knowledge about the conditions and dynamics of the magnetosphere comes from the study of these variations. Antarctica is an optimal site for the study of external variations because the local field lines are connected to the extreme magnetospheric regions in which the interaction with the solar wind takes place. Italian research activity in Antarctica now covers a period of about a quarter of a century and provides an important and useful dataset. This presentation shows some of the experimental results obtained during these years; the analysis is based on the comparison between data coming from different Antarctic stations integrated with solar wind and interplanetary magnetic field data, and the results are principally related to the diurnal variation and low frequency geomagnetic field pulsations.

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Type of presentation: Poster

Repeat stations measurements in Ukraine 2014 – 2015

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Nowadays Ukrainian Repeat Stations network includes 78 stations. Herewith, some higher density of RS points in the Western part – approximately 1 RS point per 4000 km^2, with mean average for all Ukraine – 1 RS per 8 000 km^2. Additionally three magnetic observatories Lviv, Kyiv and Odesa are available in the region.
In year 2014 next step of geomagnetic observations for epoch 2014-2015 was started. RS network densification in the Western Ukraine and measurements of magnetic field components on 39 RS points were done by means of flux-magnetometer (D1) and proton magnetometer (F). All components were reduced to epoch 2013.5 using the data from magnetic observatories Belsk (Poland) and Kiev (Ukraine). Corresponding SV maps of X, Y, Z, D, I and F components were plotted for Western Ukraine region for period 2010 – 2013.
In 2015 geomagnetic observations in Central, Southern and Eastern parts of Ukraine (except Crimea and Donbas) are planned.

Type of presentation: Poster

Comparison of the spatial structure of secular variations of the Earth magnetic field based on Ukrainian Repeat stations measurements and IGRF global Earth magnetic field model

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Based on the results of the geomagnetic field measurements on the Ukrainian RS network during the years 2005-2006 and 2010-2011, new catalogue of the magnetic field components X, Y, Z, H, D, I, F was established for the corresponding epochs 2005.5 and 2010.5. In general, during these two campaigns, 52 national repeat stations were observed. Appropriate maps of the secular variations (SV) of the geomagnetic field were prepared as well as analyzed for the entire period of years 2005-2010. The comparison of SV maps with respect to global IGRF geomagnetic field model shows high consistency of experimental and modeled secular variations values mainly in all Ukrainian region. However, some differences can be found as well. Secular variations anomalies with local character available in all seven components. Such δF and δZ fields can be characterized by significant negative anomalies in the Carpathians and Crimea peninsula (2-3 nT per year) and positive anomalies in Volyno-Podillya and Donbas regions. Differences between IGRF and measured D-component values in mentioned above anomalous zones do not exceed ± 0.5 – 1.0 min/year. In general, spatial structure of SV correlates with the crust tectonic structure peculiarities and regional magnetic field anomalies.

Type of presentation: Poster

Current status of the Lonjsko Polje geomagnetic observatory

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In 2012, the observatory was established at Lonjsko Polje Nature Park in mid-northern Croatia. The technical aspects, software solutions and data processing techniques of this remotely operated observatory are presented. The geomagnetic filed changes, recorded and calibrated to the absolute level during the last three years are also given and the observatory representativeness is evaluated. Like in many remote, unmanned observatories (without active temperature control), it is difficult to achieve high baseline stability and collect continuous recordings without any breakups. However, the obtained results accentuate the potential of the new observatory to provide high-quality data and thus to contribute in the real-time monitoring of the Earth's magnetic field. The start of regular observatory measurements concludes a decade-long effort of the Geophysical Institute toward establishing the observatory as a prerequisite for scientific and professional development of geomagnetism in Croatia.

Acknowledgements
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Type of presentation: Poster

Method to calculate the Earth's magnetic field power and angular components

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A method to calculate power and angular components of the Earth's magnetic field induction vector is proposed. This method is grounded on the development of 3D model of the Earth's crust and following calculation by it of northern (ΔB_{ax}), eastern (ΔB_{ay}) and vertical (ΔB_{az}) components of anomalous magnetic field that together with corresponding components (B_{0x}, B_{0y} B_{0z}) of normal field enable to define full values of B_x -, B_y -, B_z - components of the Earth's magnetic field. Using them the value of horizontal component (B_H) as well as the angles of declination D and inclination I of geomagnetic field vector are calculated. Method allows calculate the components of the field to sources with remanent and induced magnetization. As an example, the values of magnetic declination D on the territory of Ukraine for the epoch of year 2010 (is changing from -6° to +20°) and secular variation for the period of years 2010-2015 (6,0÷7,5 min/year) are calculated. The contribution into magnetic declination D of its normal (D_0) and anomalous (ΔD) components is estimated. The accuracy of calculated values D is appraised by means of comparison with the values of magnetic declinations measured at magnetic observatories and secular variation stations. For majority of stations the difference is within 3-6 minutes. At the present time the calculation results of magnetic declination D for the period of years 2010-2015 are used by state services of the Ukraine (*"UkSATSE", "Topographic service of MoD"*) to ensure flight security and to compile topographic maps.

Type of presentation: Poster

Geomagnetic survey, Quiet-Time Level determination and reduction on Palagruža repeat station

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The first geomagnetic survey using the onsite variometer in Croatia was realized within the bilateral project '*Joint Croatian-Hungarian Geomagentic Repeat Station survey and Joint Geomagnetic Field model*' on the repeat stations Krbavsko polje (KRBP), Sinjsko polje (SINP) and Palagruža (PALA) in the period 19-31 July 2010. The results presented in this paper rely on the survey on PALA repeat station performed in the period 27-31 July 2010. In addition to usual equipment used for declination *D* and inclination *I* determination i.e. nonmagnetic fluxgate theodolite Zeiss 020A with DMI D&I electronic unit, the magnetic field during the survey was observed and monitored with onsite dIdD variometer. The time variability of the geomagnetic field elements differences between the variometer station (VAR) and repeat station (RS) (i.e. baselines) noticed on KRBP location were more pronounced on SINP and PALA repeat station locations. One of possible explanations of such a temporal changes can be the significant conductivity contrast between the Adriatic sea and the mainland that can result in spatial field variation in small spatial and temporal scales, even in large distances. Moreover, the temporal change of total intensity (*F)* gradient was detected by two PPM sensors observing on the same vertical (one above the other). Despite of noticed temporal change, the dIdD calibration parameters have been determined enabling the determination of the baselines and subsequent spatial reduction from VAR station to the repeat station. In such conditions, the repeat station was operating as a temporary geomagnetic observatory. The quiet-time difference between the geomagnetic elements on each repeat station and THY reference observatory was determined from 60 minutes long sliding windows provided the STDEV of the difference was < 0.3 nT in *X, Y, Z* components and *F* as well. In such a way determined quiet-time level differences have shown significant fluctuations, so they were determined considering several geomagnetic observatories surrounding Croatian territory (CTS, FUR, GCK, PAG, THY). Consequently, the quiet-time differences from 60 minutes sliding windows simultaneously determined with data from all surrounding observatories have provided more reliable results. Absolute set observations collected at the repeat station were reduced to reference observatories using reduction methods based on the assumption that transient (including diurnal) variations of the magnetic field are identical at both repeat station and chosen reference observatory (without and with consideration of the secular variation difference between the repeat station and reference observatory). Definitive geomagnetic element reduced values were given as weighted average (based on STDEV and SCATTER) taking into consideration all surrounding reference observatories. The comparison of different data reduction method results has shown that reduction to a quiet-time level provides better accuracy estimations. In order to provide reliable quiet-time level determinations, it is desirable that the repeat station is surrounded by several reference observatories at acceptable distances and that the survey is carried out during quiet external field conditions. Further investigations should be taken in order to clarify the impact of the high conductivity contrast to the temporal change of the geomagnetic field spatial gradients.

Type of presentation: Oral

UK repeat station summary for 2013-2014

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The British Geological Survey is responsible for conducting the UK geomagnetic repeat station programme. Measurements made at the UK repeat station sites are used in conjunction with data from the three UK magnetic observatories: Hartland, Eskdalemuir and Lerwick, to produce a UK regional model of the field each year. The UK network of repeat stations comprises 41 stations which are occupied at 3-4 year intervals. Procedures for conducting repeat station measurements evolve as advances are made in survey instrumentation. Here, a summary of the 2013 and 2014 UK repeat station surveys is presented, highlighting the measurement process and techniques, density of network, reduction process and recent results, including the introduction of an easterly grid magnetic angle into the UK regional model. Planned updates to measurement hardware and processing software are also presented along with a discussion on the importance of adequate knowledge transfer to ensure the long term viability of the UK repeat station programme. A brief update of the Edinburgh World Data Centre magnetic survey holdings will also be presented.

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Type of presentation: Oral

Temporal reduction of repeat-station measurements to quiet magnetic level by using different methods

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Between October 2014 and December 2014, a repeat station survey has been carried out in Hungary on 12 stations. The total field, declination and inclination were observed. In the practice of the Hungarian RS campaigns, the data are reduced with the use of the permanent geomagnetic record of the Tihany Geophysical Observatory. The reduction with the observatory record is completed for the observatory annual mean and to quiet night-time value showing minimal external influence in 5 days long period before and after the occupation of the RS. In 2014, an additional dIdD type of variometer was also installed in the Baradla cave, close to the Aggtelek station, for the reduction of the measurements carried out in the easternmost stations. In the presentation, the final result of the data reductions obtained with the use of observatory and on-site variometer records are compared.

Type of presentation: Oral

Report on the magnetic survey in Slovakia for the 2014.5 epoch

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The knowledge of the distribution of the geomagnetic field elements over a country is important for many practical as well as scientific reasons. Such distributions result from magnetic surveys. The surveys need to be repeated periodically: two-year period has been agreed for repeat stations by the MagNetE Group. This periodicity enables to find out information about the magnetic secular variations. Our report presents the results of the joint repeat and ground station survey which was carried out in Slovakia in the year 2014. The measurements were performed at 12 observation points; 3 stabilized repeat stations were supplemented by 8 temporary ground survey points. First degree polynomial models of the distributions of the geomagnetic field elements were derived. The differences between the current and the previous repeat station surveys are shown too. In addition, a note about the method of calculating azimuths of reference marks is appended. The note concerns a typing error in the listing of a computer code that has been printed in a manual that is widely used within the geomagnetic community. Fixing this inconspicuous error is recommended in order to obtain correct values of magnetic declination.

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Type of presentation: Poster

New method for fast identification of geomagnetic pulsations

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It is known, that one-day photoregistered magnetograms include more information than one-minute digital data at least for the magnitude of geomagnetic pulsations. Recent digital archives of photoregistered magnetograms use a zoomable picture-based graphical interface which is simillar to Geographic Information Systems to make this information visible.
We use additional columns in IAGA2002 format for keeping one-minute peak-to-peak values of residual second data obtained as the difference between one-second data and undecimated one-second data filtered by the "one-minute" 91-taps Intermagnet-approved gaussian filter.
This information is used for a variation of the line width in our minute vector data-plotting program. These plots can be useful for a fast data preview to find the positions of the geomagnetic pulsations.

Type of presentation: Oral

Models and forecasts of geomagnetic secular variation

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BA recently developed method of constructing core field models that satisfies a frozen-flux constraint is used to built a field model covering 1957 to 2013. Like the previous model C3FM2 we invert secular variation data derived observatory monthly means and repeat station data and adopt satellite-based field models to constrain the field morphology in 2010. In order to derive a frozen-flux field model we start from a field model that has been derived using ``classical" techniques, which is spatially and temporally smooth. This is achieved by using order 6 B-splines as basis functions for the temporal evolution of the Gauss coefficients and requiring that the model minimizes the integral of the third time derivative of the field taken over the core surface. That guarantees a robust estimate of the secular acceleration. Particular interest will be paid to assess the quality of repeat surveys. Comparisons between the ``classical" and the frozen-flux field models are given, and we describe to what extend the frozen-flux constraint is adhered. Our models allow the interpretation that magnetic diffusion does not contribute to the observed secular variation. Additionally, the resulting frozen-flux field model shows a more or less constant spatial complexity, so that the spatial complexity of the magnetic field imposed by the 2004 satellite field model is maintained backward in time to the beginning of the model period, 1957. Therefore, we understand the frozen-flux constraint as an instrument that aids the backward projection of high spatial resolution in core field models to earlier times.

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Type of presentation: Oral

A new perspective marine magnetic measurements on the Baltic Sea

Welker Elzbieta
Naval Academy, Institute of Geodesy and Cartography

The development of the observing techniques and navigation systems and the improvement of equipment for magnetic measurements require the knowledge of the Earth's magnetic field distribution not only on the land but also on the waters. For live updates of the marine magnetic measurements results requires the knowledge about secular magnetic changes on a selected region. This involves the assumption of a marine network of the secular points (repeat stations) and regular magnetic measurements of the three independent components of the Earth's magnetic field. The project of the marine network can be realized on the basis of the charts from the Atlas of the Magnetic Map of the Baltic Sea. On these charts are shown the anomalies detected by geomagnetic measurements.

Type of presentation: Poster

The results of the magnetic measurements in 2012-2014 in Poland

Welker Elzbieta
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The network of secular points (repeat stations) in Poland was established in the 1950. From 1998 it was completed by the additional complementary points. Presently, the network consists of 19 double monumented stations.
The measurements of the 3 elements of the Earth magnetic field *D*, *I* and *F* on the polish magnetic stations are made every one or two years. All data are reduced to Central Geophysical Observatory of the Polish Academy of Sciences in Belsk.
This poster shows the results of magnetic measurements from the last 3 years.

Type of presentation: Poster

Polish magnetic observatories and permanent stations – their use to repeat station surveys

Elżbieta Welker[1], Mariusz Nesca[2], Jan Reda[2],
[1)] *Institute of Geodesy and Cartography*
[2)] *Institute of Geophysics, Polish Academy of Sciences*

We present the Polish geomagnetic observatories and permanent stations in relation to Basic Geomagnetic Control (with the repeat stations) leaded by Institute of Geodesy and Cartography (Warsaw). These are as follows: Belsk and Hel – the INTERMAGNET observatories, Borowa Góra – the station where are both the continuous recording and the absolute control, Suwalki, Zagorzyce, Polesie and Birzai – the stations where is only continuously recording without the absolute measurements. The observatories Belsk and Hel, the Suwalki, Zagorzyce, Polesie and Birzai statations are operated by Institute of Geophysics PAS, the station Borowa Góra is operated by Institute of Geodesy and Cartography. The station in Birzai, which is located in northern Lithuania, has been installed with help of colleagues from Vilnius Gediminas Technical University. Operation of all mentioned observatories and stations helps to improve quality of the repeat station measurements. These points (Polish stations) are mostly located in the east and north of the center of Poland and can be useful for the repeat station surveys in Lithuania, Latvia or Belarus.

Type of presentation: Poster