Department of the Magnetism

About

The main research directions in the Department of Magnetism include studies of the lithosphere structures using electromagnetic methods, research in the field of magnetohydrodynamics with applications to the dynamics of the Earth's interior, paleomagnetism and research in the field of environmental magnetism.

Paleomagnetic team in 2018 took part in a wide range of activities. The environmental magnetism group working on the NM1 task, continued the application of combined magnetic and non-magnetic methods to study the anthropogenic pollution in various settings such as road and air dusts, water bank deposits and soil pollution. The collaborate efforts with other teams allowed for a multidisciplinary approach to resolve the questions concerning sources of pollution. These methods were also tested in polar areas at Svalbard. The group directed active efforts towards integration of the environmental studies community in Poland with organization of a workshop in Warsaw. The service of continued monitoring of the PM dust with magnetic methods was also expanded.

The research work conducted within the NM2 task focused mostly on the problems of paleographic reconstructions. The research concerned palaeogeographic positions of both large lithospheric plates as well as smaller units, such as terranes, individual tectonic blocks or nappes. The processes of collision of lithospheric plates and the associated formation of mountain belts together with rock deformations were also investigated. The works were carried out in the Carpathians (Slovakia and Poland), Africa (eastern Zimbabwe) and also in the Svalbard area. In addition, research was conducted on Silurian gas-bearing shales (northern Poland) where magnetic methods were applied for determination of the degree of their tectonic deformation and direction of sediment transport in the sedimentation basin.

The magnetic dynamo team within the NM3 has conducted research on the role of diffusive effects in stability of magnetohydrodynamic flows and large-scale field generation. The results involve determination of spatial scales of evolution for magnetically buoyant parcels and novel nonlinear mechanisms of generation of natural large-scale magnetic fields.

The research within the NM3 task involved development of a final 3D model of the conductivity distribution for the Fore-Sudetic Monocline and efforts were undertaken in order to identify the structure of the crust and the upper mantle in Poland. The data from several profiles crossing the TESZ zone in Poland was reinterpreted. Some methodological work was carried out on a 3D inversion algorithm, with particular emphasis on the influence of regularization parameters and the selection of the transition function on the inversion results. The relationship between the seismic activity in nearby areas and the observed changes of magnetotelluric transition functions was investigated. Seasonal changes in the transfer functions were analyzed and the way to obtain the correct estimation was determined. A combined quantitative interpretation of GCM and DC-R methods was also performed.

The research group for geomagnetic observations has conducted absolute measurements and continuous recording of the Earth's magnetic field in Belsk, Hel and Hornsund (Spitsbergen) observatories. All three observatories are members of the global INTERMAGNET network. A continuous recording of geomagnetic field changes with real-time data access has been carried out in the permanent stations Birzai (Northern Lithuania), Suwałki, Poleski Park Narodowy and Zagórzyce near Cracow. Moreover, Schumann Resonance observations have been continued in Polish Polar Station Hornsund and Suwalki in 2018. Also the group was strongly engaged in EPOS project.

In addition, the Department of Magnetism is responsible for the Task 3 and Task 4 of the EPOS-PL project. In 2018 the palaeomagnetic laboratory was refurbished and equipped with a new set of palaeomagnetic and rock magnetic devices (total of 1.5M PLN). The works on the paleomagnetic and magnetotelluric database were also continued.

The paleomagnetic team co-organized the international conference the 16th Castle Meeting "New Trends on Paleo, Rock and Environmental Magnetism" in Chęciny in June 2018 acting as LOC, and the short course for students preceding the meeting – sponsored by IAGA.

Personel

Head of the Department
Waldemar Jóźwiak
Associate Professor

Tomasz Werner
Head of Paleomagnetism Research Team

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Anna Wójcik
Technician

Research Project

- Diversity of technogenic magnetic particles in the soil environment depending on the emission sources and their role in transport of potentially toxic elements.
  B. Górka Kostrubiec | NCN | 2017 -2020

- Magnetic properties of sediments applied for assessment of pollution level of heavy metals of Vistula River water within Warsaw.
  I. Szczepaniak-Wnuk | NCN | 2018 -2020

- EPOS – PL European Plate Observing System; Task 4- CIBAL - Centre of Research Infrastructure of Analytical laboratories.
  T. Werner | POIR | 2017 -2021

- EPOS – PL European Plate Observing System; Task 4- CIBAL - Centre of Research Infrastructure of Analytical laboratories.
  B. Górka Kostrubiec | POIR | 2017 -2021

- Paleomagnetic studies of Lower Triassic sandstones from the autochthonous cover of Central West Carpathian targeted to further define the degree of rotation of this unit with respect to the European platform.
  R. Junosza Szaniawski | NCN | 2015 -2018

- Fire, and then the ice: calibrating southern Africa's position within the Neoproterozoic supercontinent Rodinia
  A. Gumsley | NCN | 2018 -2019

- On the edge of an Old continent: the search for the eastern margin of the European Variscan orogen.
  A. Gumsley | National Geographic Society, USA | 2018 -2019

- Changeability of the Earth's resistivity and its relation to seismicity around the Trans-European Suture Zone.
  V. Semenov | NCN | 2015 -2018

- Buoyancy driven magnetic dynamo.
  K. Mizerski | NCN | 2018 -2021

- The role of lithospheric memory in the spatial and temporal localization of the intraplate deformation - investigating a deep structure of the Grójec Fault Zone based on potential field anomalies and seismic data.
  W. Jóźwiak | NCN | 2018 -2021

- EPOS – PL European Plate Observing System; Task 3.
  W. Jóźwiak | POIR | 2017 -2021

PhD Students

Marek Grądzki | Poland
supervisor: Krzysztof Mizerski

Katarzyna Dudzisz | Poland
supervisor: Rafał Szaniawski

Magdalena Gwizdała | Poland
supervisor: Maria Teisseyre-Jeleńska

Mariusz Burzyński | Poland
supervisor: Marek Lewandowski

Iga Szczepaniak-Wnuk | Poland
supervisor: Beata Górka-Kostrubiec

Dominika Niezabitowska | Poland
supervisor: Rafał Szaniawski

Agata Bury | Poland
supervisor: Krzysztof Mizerski

Instruments and facilities

Equipment

Equipment for magnetic susceptibility measurements in the field:

- MS2 susceptibility meter (Bartington, UK) with sensors
- MS3 susceptibility meter (Bartington, UK) with sensors

Equipment for PM dust collection (environmental magnetism studies):

- PNS15C/ PM dust samplers (Atmoservice, Poland) - 3 units
- PNS18T/ PM dust samplers (Atmoservice, Poland and Comde Derenda) - 3 units

Equipment for Magnetotelluric Survey and Magnetic Observations:

- 2 Magnetotelluric broad-band stations Phoenix
- 7 Magnetotelluric low-frequency stations Geomag
- 7 Low-frequency magnetometers LEMI
- 6 PMP proton magnetometers
- 5 Low-frequency PSM magnetometers
- 5 DIFLUX magnetometers for absolute measurements
- 19 NDL digital recorders
- 18 LB-480 digital recorders

Laboratory

Paleomagnetic laboratory - list of the laboratory equipment:

Equipment for measurements of magnetic remanence with step-wise AF/TH demagnetization:

- 755–1.65 2G Enterprises cryogenic magnetometer DC SQUID with AF degausser, JR6a automated dual speed spinner magnetometer (Agico, Czech republic)
- MMTDSC - Nonmagnetic furnace for thermal demagnetization Magnetic Measurements, Great Britain
- MMTD-80 Nonmagnetic furnace for thermal demagnetization by Magnetic Measurements, Great Britain
- MMTD1 Nonmagnetic furnace for thermal demagnetization by Magnetic Measurements, Great Britain

Equipment for acquisition of magnetic remanence:

- LDA5/PAM1 Alternating Field Demagnetizer/ Anhysteretic and Pulse Magnetizer,
- Agico Czech Republic
- LDA3a/AMU1a, Alternating Field Demagnetizer/ Anhysteretic Magnetizer, Agico Czech Republic
- Two MMPM10 pulse magnetisers, Magnetic Measurements, Great Britain
- SI6 - Pulse magnetizer, Sapphire Instruments, Canada
- Two MMLFC low field cages, Magnetic Measurements, Great Britain

Equipment for magnetic susceptibility measurements

- KLY-5A/CS-4/CS-L Susceptibility bridge Agico, Czech Rep.
- MFK1-FA - Susceptibility bridge, Agico, Czech Rep.
- KLY-3/CS-3/CS-L - Susceptibility bridge, Agico, Czech Rep.
- KLY2 Susceptibility bridge, Geofyzika Brno, Czechoslovakia
- MS2 susceptibility meter (Bartington, UK),
- MS3 susceptibility meter (Bartington, UK)

Equipment for studies of magnetic hysteresis and Curie temperatures:

- Micromag AGFM 2900-02 Alternating gradient force magnetometer, Princeton Measurements Corp., USA
- AVFTB (Advanced Variable Field Translation Balance) Petersen Instruments, Magnetic Measurements, Great Britain)
- VSM Nuvo Vibrating Sample Magnetometer, Molspin Ltd, Gr. Britain

Research activity and results

Identification of metallic iron in an urban dust using magnetometry, microscopic observations and Mössbauer spectroscopy | **B. Górka-Kostrubiec, T.Werner, S. Dytłow, I. Szczepaniak-Wnuk, M. Teisseyre – Jeleńska**

The work presents a thermomagnetic study of fresh, unheated indoor dust, outdoor dust, street dust and dust from the cabin air filters of cars. Detailed analysis of thermomagnetic curves clearly indicated the presence of two magnetic transitions: the first identified at the Curie temperature TC□585□C for magnetite; the second TC detected at about ~765□C, indicating the presence of metallic iron and/or iron-based alloys. The 'tail,' i.e., the substantial decreasing of □ visible on the heating curves of □(T) between 600°C and 700°C, was attributed to the metallic iron or iron-based alloys. The presence of a high-temperature Fe-phase is not dependent on the types of urban dust or the sampling method, as variable amounts of metallic iron were detected in material collected from different environments: both indoor and outdoor dust, and dust gathered by sweeping indoor floor surfaces as well as dust collected with a vacuum cleaner.

The presence of metallic iron in different types of dust was confirmed by non-magnetic methods. Electron microscopic observations with energy-dispersive X-ray spectroscopy revealed elongated shaving-like particles comprised of metallic iron. A component with a magnetic hyperfine field of Bhf□33 T and an almost zero value for isomeric shift as well as zero quadrupole splitting typical of metallic α-Fe at micrometer size or Fe-based alloys was recognized in all the Mössbauer spectra.

Additional measurements of hysteresis properties at high temperatures (up to 750°C) and after step-wise annealing indicated the process of oxidation of iron to magnetite. This has a strong effect on the run of □(T) and M(T) curves during heating and cooling that M and □ are strongly dependent on the apparent concentration of both ferromagnetic phases (magnetite and metallic iron).

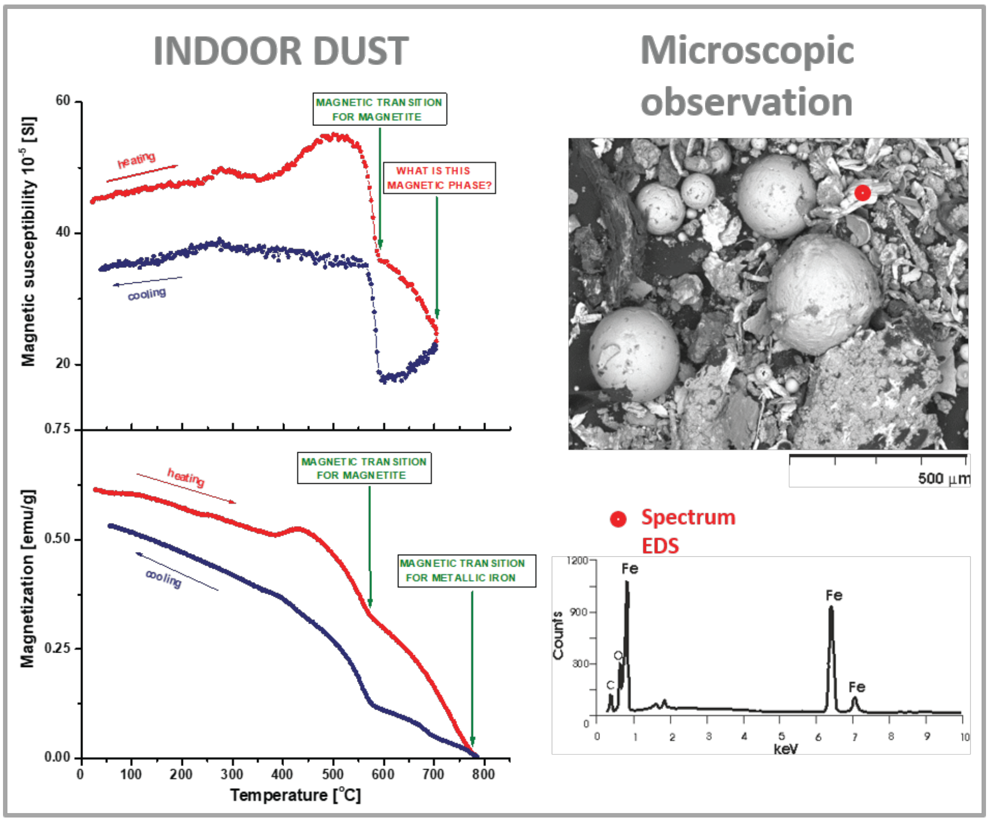

Figure 1: The curves of κ(T) and M(T) for the same sample of indoor dust. Images of SEM with the spectra of EDS for the magnetic extract of dust from cabin air filters of car.

Effective and universal tool for evaluating heavy metals-passive dust samplers | S. Dytłow, B. Górka-Kostrubiec

The study presents designating, accomplishing, optimizing, and validating a new tool - "passive sampler" (PS) that can be effectively used as a proxy to assess the level of traffic-related pollution. To construct the PS, a drainage pipe filled with a mixture of coarse sand and peat in a volume ratio of 1:1 was used; this was previously verified to exhibit high ability to accumulate pollutants. Magnetic methods supplemented with chemical method evaluating heavy metal content and electron microscopic observations were used to detect the effectiveness of the PS. The PS was validated in Warsaw, Poland, by observing the capacity and trends in the accumulation of traffic-related heavy metals as well as magnetic particles and by comparison of the properties of magnetic fraction of PS filling and street dust collected from the surface of road. A depth decreasing trend in distributions of magnetic susceptibility related to the concentration of magnetic particles and the content of heavy metals confirmed a very strong accumulation of pollution in the surface layer of samplers and their depth-migration. Magnetic fraction of PS filling and street dust revealed similarities in terms of magnetic mineralogy, grain size, domain state, morphology, and chemical composition. The good correlation of concentration of magnetic particles with traffic-related heavy metals indicates their similar transport pathway from road to sampler. Passive sampler is a compact, mobile, low-cost tool that does not require electricity for installation and can be effectively used for the identification of traffic-derived pollution. Moreover, the PS can overcome disadvantages of street dust arising from different geological backgrounds, cleaning of the road surface, runoff of deposited dust, etc., which cause the underestimation of pollution level.

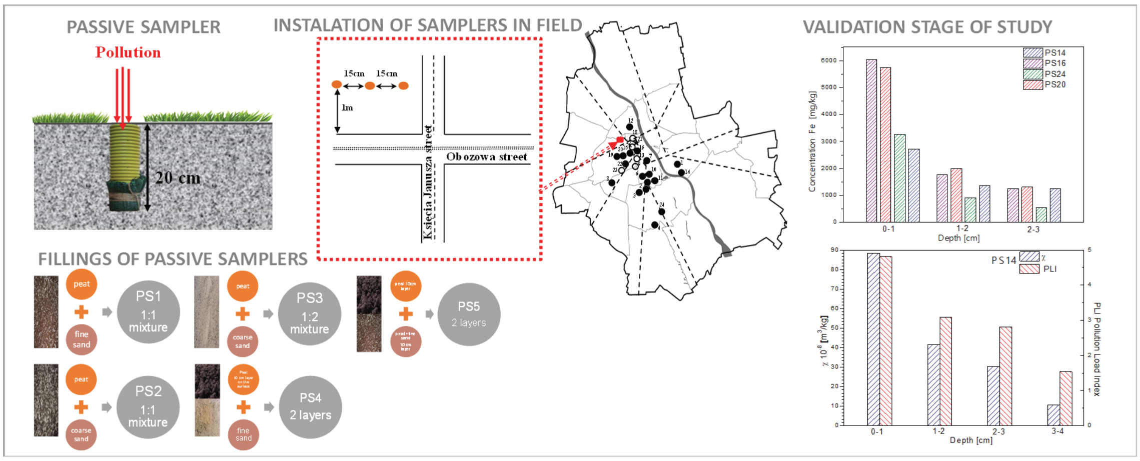

Figure 1: The figure shows the construction of passive sampler and its implementation in field, the types of fillings of sampler, the locations of installation of samplers in Warsaw and the results of depth distribution of iron in four samplers, Pollution Load Index and magnetic susceptibility in sampler PS14.

Magnetic properties of different granulometric fractions of street dust from Warsaw | S. Dytłow, B. Górka-Kostrubiec

The study presents variations in the magnetic properties and heavy metal concentrations of five granulometric fractions, i.e., 500 µm, 250 µm, 100 µm, 71 µm and less than 71 µm, for street dust collected at two locations in Warsaw. Combination of grain-size determination, magnetometry, electron microscope observation, mineral composition and chemical analyses was applied as an effective and multidisciplinary approach for the complete characterization of individual fractions of street dust. The magnetic properties of street dust were influenced by their grain size; concentration-dependent magnetic parameters, e.g., the magnetic susceptibility, saturation magnetization, saturation remanence and anhysteretic remament magnetization of the finest fraction (d < 0.071 mm) were about three times higher than that of the coarsest fraction (d > 0.5 mm). For all fractions the main magnetic mineral was near stoichiometric magnetite. The fractions with grain size less than 250 µm additionally contain a phase with a Curie point ~770°C, ascribable to metallic iron. The distribution of mass fractions showed that the smallest contribution to the total mass is from the finest size fractions, which simultaneously contain the highest concentrations of the traffic-related heavy metals. The differences in traffic intensity and type of vehicles movement (fluent driving, repeated braking and accelerating) between both studied sites were well reflected by the concentration of anthropogenic magnetic particles strongly associated with traffic-related heavy metals. Magnetic extract of finest fraction dust contains a mixture of spherical magnetic particles and irregular angular particles containing iron-oxides with Mg, Al, Na, Ca, K, and Si. The study of the granulometric fractions of street dust can significantly contribute to their complete characterization, with interesting implications on the definition of their impact on environment and human health.

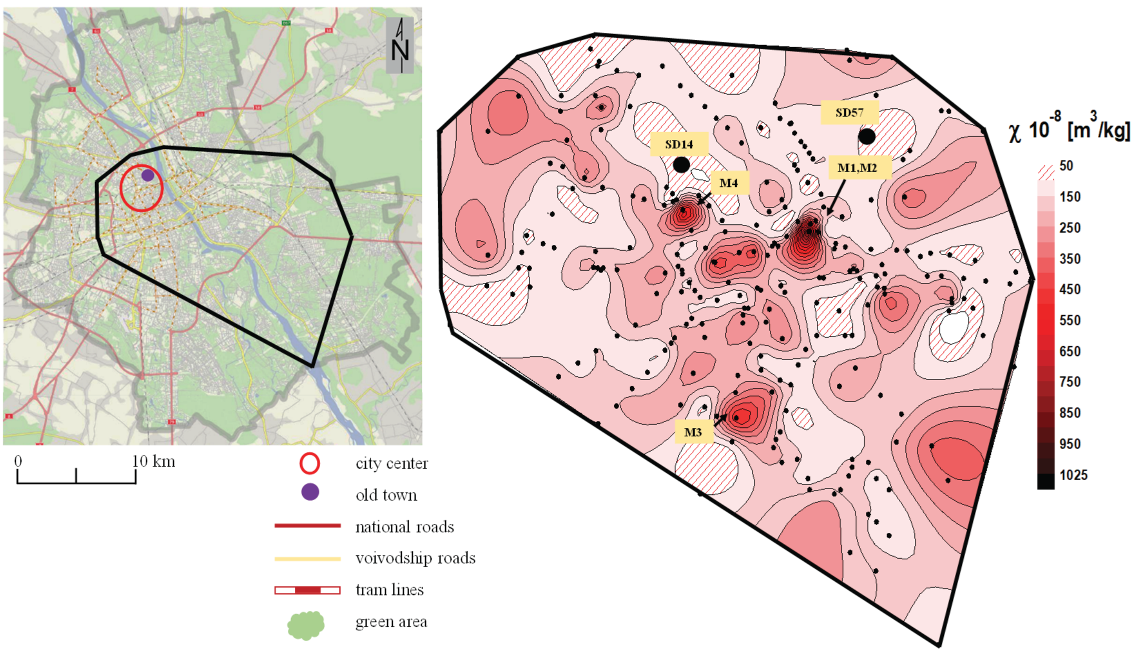

Figure 1: The figure shows the construction of passive sampler and its implementation in field, the types of fillings of sampler, the locations of installation of samplers in Warsaw and the results of depth distribution of iron in four samplers, Pollution Load Index and magnetic susceptibility in sampler PS14.

Comparison of traffic-related pollution level using street dust and passive dust sample | S. Dytłow, B. Górka-Kostrubiec

The magnetic susceptibility and concentrations of traffic-related heavy metals were used to compare the pollution level for 24 locations in Warsaw (Poland) estimated for street dust and passive dust samplers collected for the same sampling sites. The spatial distribution of magnetic susceptibility showed diversity ranging from ~36⌧10-8 m3/kg to ~406⌧10-8 m3/kg for passive samplers - ⌧PDS and ~49⌧10-8 m3/kg to ~520 ⌧10-8 m3/kg for street dust – ⌧SD. and Although the ⌧SD and ⌧PDS values of individual sampling sites significantly differ, they follow the same trend in case of traffic intensity. The values of ⌧SD and ⌧PDS were higher mainly at the crossroads of multilane roads with high-intensity traffic. For example, ⌧PDS2 ~400⌧10-8 m3/kg and ⌧SD2 ~520⌧10-8 m3/kg were obtained from one of the biggest and busiest crossroads in the city center with almost 70,000 cars and trams crossing through per day. In places of traffic restricted to privileged vehicles and public transport, relatively low values of ⌧PDS18 ~61⌧10-8 m3/kg and ⌧SD18 ~104⌧10-8 m3/kg were noted. The lowest values of ⌧PDS21 ~49⌧10-8 m3/kg and ⌧SD21 ~36⌧10-8 m3/kg were observed in one of the biggest park in the center of Warsaw. Although the park is surrounded by streets with heavy traffic, it is separated from the roads by tree lines. Thus, it proves that green walls and effectively reduce traffic-related pollution.

A general trend between traffic intensity and ⌧ values cannot be observed in all sampling sites because of several local factors, e.g., different concepts of space management (density, height of buildings, distance of buildings from road edge) and surface runoff (often rainfall, cleaning streets) that disturb the spread of street dust particles. For example, the high value of ⌧PDS5 ~366⌧10-8 m3/kg obtained from the sampler installed at a multilane crossroad (sampling site number 5) reflects the impact of high traffic intensity with ~73,000 cars crossing per day. However, the relatively low value of ⌧SD5 ~187⌧10-8 m3/kg obtained from another crossroad suggests the influence of several factors on the distribution and amount of street dust particles. The crossroad is characterized as unusual by the Warsaw land development due to the absence of buildings and the presence of ample open area providing good ventilation and, thus, facilitating the particles being blown away and lowering the ⌧ than that of passive sampler. However, this effect was not observed for PDS5, which is able to accumulate and preserve the pollution particles by transporting them inside the sampler. All these observations proved that the properties of street dust could rather be used for preliminary tests or as a supporting measurement than for detailed studies.

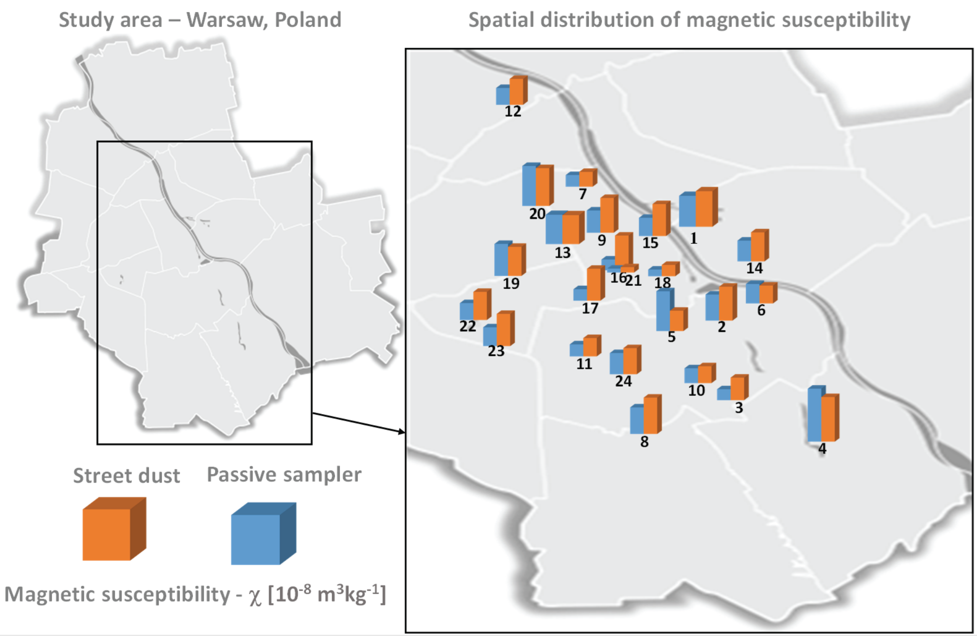

Figure 1: Spatial distribution of mass magnetic susceptibility (χ) of passive dust samplers and street dust in Warsaw (Poland).

Assessment of heavy metal pollution of Vistula River sediments using magnetic methods | I. Szczepaniak-Wnuk, B. Górka-Kostrubiec, S. Dytłow

The aim of the study was to evaluate the level of heavy metal pollution of Vistula River, within high urbanized area. The river surface sediments that accumulate pollutant particles and reflect the level of water contamination was investigated. The study was conducted in Warsaw agglomeration, which is the largest emitter of urban pollution in the central part of Poland. Measurements were performed for fine fractions (71 μm and less than 71 μm) of sediments taken from the surface layer of river bank. An interdisciplinary approach including magnetic methods (e.g. mass magnetic susceptibility χ, temperature dependence magnetic susceptibility and hysteresis loop parameters), microscopic and chemical analyses was undertaken to assess the level of heavy metal pollution.

The results showed local impact of Warsaw's activity on the level of heavy metals pollution. This was indicated by the maximum values of magnetic susceptibility and the maximum concentrations of heavy metals in the city center. The anthropogenic origin of pollution was confirmed by magnetic mineralogy of finest granulometric fraction (less than 0.071 μm), dominating by magnetite and large amount of spherical magnetic particles. The dominant sources of sediments pollution were discriminated by analysis the relationship between magnetic parameters dependent on the domain structure of magnetic particles and the concentrations of individual heavy metals. It was found that the source of cadmium, zinc and copper were mainly vehicle emissions and the motion process of vehicles such as abrasion of road surfaces, brake discs, brake pads etc. These chemical components are associated with irregularly-shaped particles. Nickel, aluminum, titanium and chromium were connected with spherical shaped particles originated from high temperature combustion processes. Results suggested that the source of large amount spherical particles in sediments observed in the city center was the storage of ashes from coal power plant, located at the south of Warsaw. This was demonstrated by the similarity in mineralogy and morphology of magnetic particles observed in sediments and street dust collected from the road at the vicinity of the waste disposal site.

The study demonstrated that magnetic method have a useful and practical application for detecting and mapping heavy metal pollution of river systems.

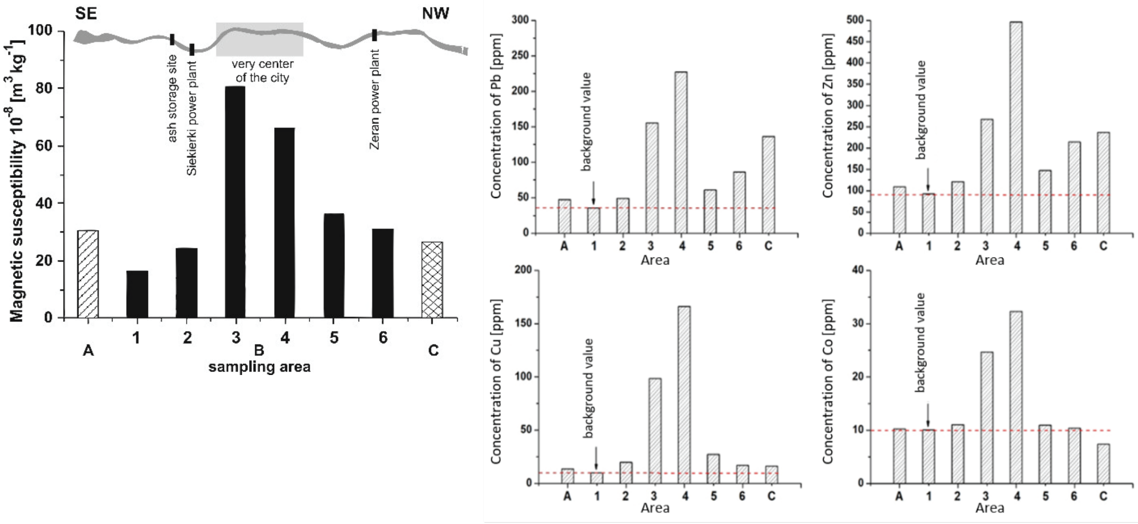

Figure 1. Distribution of average magnetic susceptibility (χav) of surface Vistula River sediments for area A (stripes pattern column), for area B with corresponding subareas 1-6 (black columns) and for area C (column with grid pattern). Concentrations of selected heavy metals for "<0.071" fraction of sediments from area A and subareas (1-6) of area B and area C.

The project is financed by the National Science Centre (NCN) Preludium 13 programme

The magnetic method as a tool to investigate the Werenskioldbreen environment (south-west Spitsbergen, Arctic Norway) | M. Gwizdała, M.Teisseyre – Jeleńska, L. Łęczyński

We used a novel approach of applying magnetic analyses to investigate the material released from the receding glacier Werenskioldbreen on Spitsbergen, Svalbard, Arctic Norway. Surface sediments were taken from the bay Nottinghambukta and the Werenskioldbreen foreland, along two main proglacial streams. Magnetic analyses, namely the low-field mass magnetic susceptibility, anhysteretic susceptibility mass normalized and hysteresis parameters, served to determine magnetic properties and identify the magnetic composition of the study material. We selected two distinct types of sediments. The first group, consisting of magnetite and pyrrhotite, has more single-domain grains in comparison to the second one, containing only magnetite. In the second group, multi-domain particles dominate. Deposits from the north stream, glacier river and an area close to the estuary of Nottinghambukta include magnetite and pyrrhotite. Magnetite was found in the south stream and in the outside part of the bay. Magnetic composition reflects different source rocks of sediments. This study demonstrates the utility of the magnetic method in analysing the current state of glacier environments.

Details at: Magdalena Gwizdała, Maria Jeleńska & Leszek Łęczyński (2018) The magnetic method as a tool to investigate the Werenskioldbreen environment (south-west Spitsbergen, Arctic Norway), Polar Research, 37:1, 1436846, DOI: 10.1080/17518369.2018.1436846

This work was partially financed by funds from the Leading National Research Centre, received by the Centre for Polar Studies for the period 2014-18

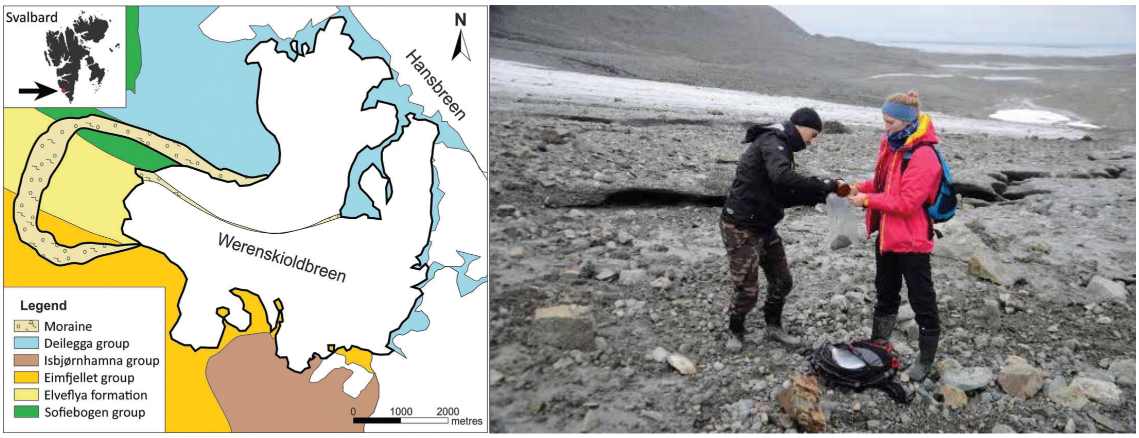

Figure 1. Lithostratigraphy of the Werenskioldbreen basin, modified after Stachnik et al. (2016).
All subdivided units belong to the Heckla Hoek Succession(left).

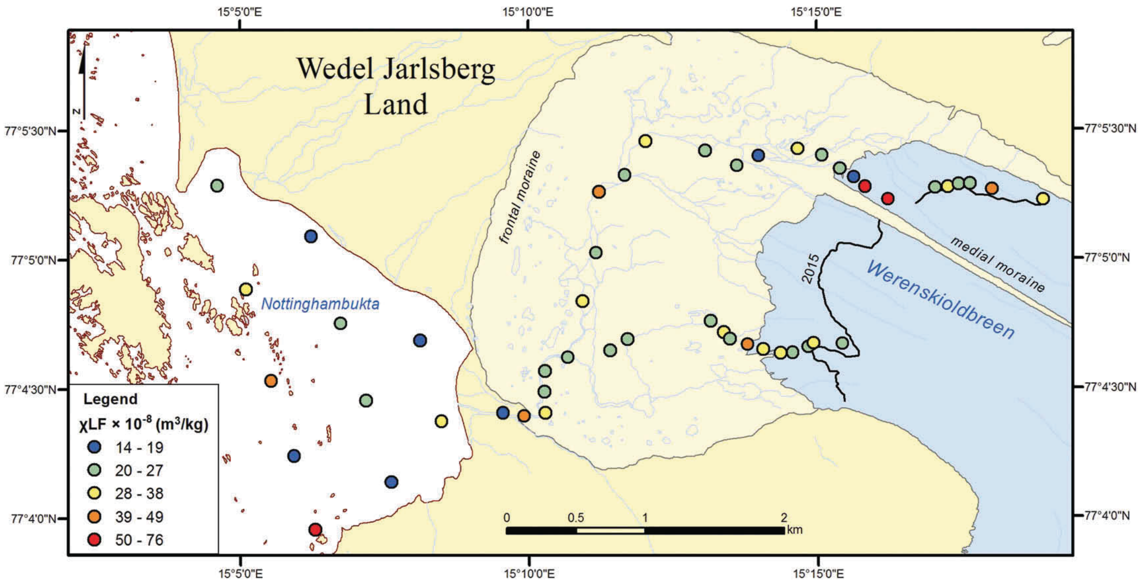

Figure 2. Distribution of magnetic susceptibility in the investigated area (based on Norwegian Polar Institute maps at http://toposvalbard.npolar.no/).(right)

Magnetic properties of chromite ores: Fe-Cr Mixed Binary Spinels as Accessory Magnetic Minerals in the Sudetic Ophiolitic Rocks | M.Kądziałko-Hofmokl, T.Werner

The project is carried out within statutory activities since 2010. In the project effects of substantial structure changes of the chromitites on the their magnetic properties were studied in the Sudetic ophiolite.

Sudetic ophiolite is formed of three serpentinite massives situated around the Sowie Góry Mts Block: Jordanów-Gogołów Massif (JGSM), Braszowice-Brzeźnica Massif (BBSM) and Szklary Massif (SZM). Chromite Fe-Cr spinels occur in chromium ore (chromitites) in JGSM and BBSM (ore fragments on waste heaps) and as scattered grains in ultramafic rocks.

The Fe-Cr chromite series have a general formula of (Fe2+1-x Fe 3+x)[Fe2+1-xFe3+2--2y-xCr3+2y]2O4 is built of mixed spinels with end members: primary chromite (Fe2+)[Cr3+2]O4 (y=1) with normal ordered spinel structure (x=0) and magnetite (Fe3+)[Fe2+Fe3+O4] (y=0) with inversed ordered spinel structure (x=1). The composition affects substantially Curie temperatures: Tc of primary chromite is -202°C, Tc above r.t. for ferrichromites up to Tc of 585°C for magnetite. The primary chromites crystallize from mafic melt in upper mantle-lower crust environments. They are very stable against metamorphism and retain primary composition of their cores long during later metamorphism. Under cooling below ca 600°C chromite begin to alter: magnetite starts to replace chromite, with subsolidus exsolutions and oxidations processes. The core of the grain retains its primary composition with typical Tc of –180° up – 120°C, around it ring 1 composed of Fe-Cr solution grains of ferrichromite and ring 2 of Cr-magnetite formed during metamorphism were observed.

Apart of changes in composition additional alterations, namely order – disorder transformation takes place (e.g. described by Harrison and Putnis, 1999). Such transformation is caused by electron hopping between tetrahedral and octahedral sublattices with help of oxygen ions (x in the above formula presents a fraction of 3+ cations in tetrahedral sublattice).

Chromites from Sudetic ophiolite and Lutynia chromite rich olivine were studied with magnetic methods as determinations of the magnetic susceptibility upon temperature curves (km-T) at the range -190°C up to 700°C for fresh and previously heated samples as well as with hysteresis properties studies. The Km-T experiments for fresh samples showed a wide spectrum of Km(T) curves depending on the composition Changes in composition influence changes in Tc observed on the heating branch of km-T curve, changes in ordering impart changes in Tc observed on the cooling branch. Therefore k-Tc curves are irreversible and Tc of samples observed in Cr-magnetites during heating is higher by 10 – 20°C than observed during cooling. During next heating – cooling cycles both branches become reversible. The observed thermal hysteresis during heating-cooling cycle is due to kinetic lag in cation ordering during cooling (Harrison and Putnis,1996). The coercivity usually increases due to heating suggesting subsolidus exsolutions.

In 2018 results were presented at the 16th Castle Meeting “New Trends on Paleo, Rock and Environmental Magnetism” in Chęciny, Poland.

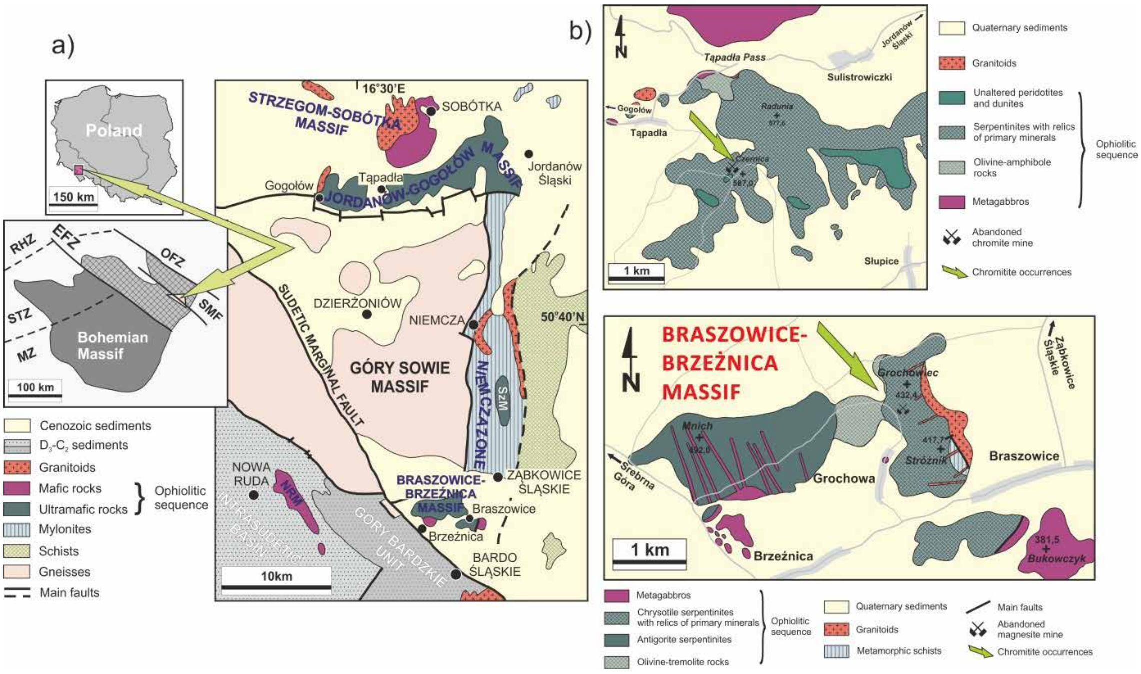

Figure 1. Chromite occurences: a) scattered within serpentinites, dunites, hazburgites, peridotites, eclogites of Sudetic ophiolite (Jordanów- Gogołów Massif (JGSM), Braszowice-Brzeźnica Massif (BBSM), Nowa Ruda gabbro (NR), Szklary massif(SzM)
b) chromite ore (chromitite) - at Tąpadła pass at JGSM and Grochowa at BBSM

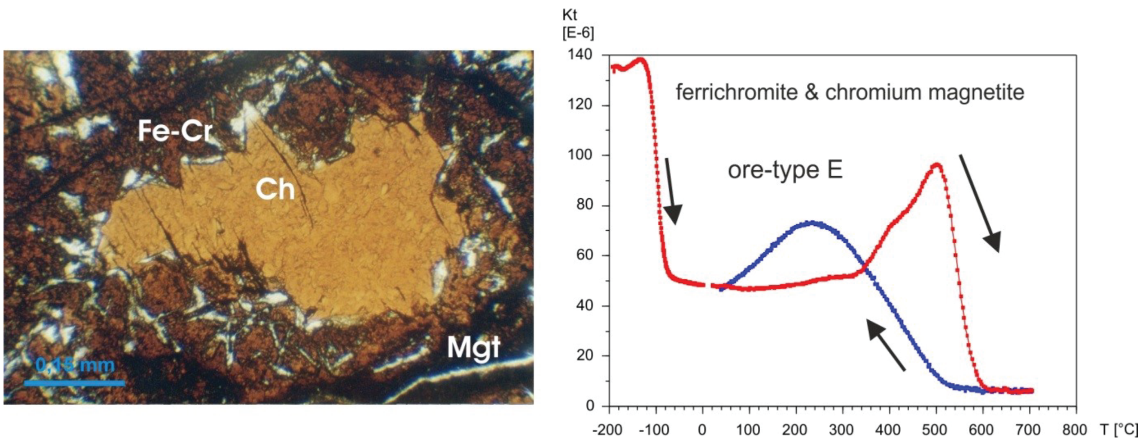

Figure 2. SEM maps for chromite grains from chromite ore (JGSM, Tąpadła), K(T) curves for chromite ore (chromitite) - at Tąpadła pass.

EPOS – PL European Plate Observing System ; Task 4: CIBAL - Centre of Research Infrastructure of Analytical laboratories | T. Werner, B. Górka Kostrubiec, G. Karasiński, S. Dytłow, R. Szaniawski, K. Michalski, M. Kądziałko-Hofmokl, M. Teisseyre –Jeleńska, K. Dudzisz

The Task 4 - CIBAL - Centre of Research Infrastructure of Analytical laboratories is a part of the Polish activities (EPOS-PL) within the European Plate Observing System (EPOS) Infrastructure project. In general European Plate Observing System (EPOS) Infrastructure is an interdisciplinary and interoperable research infrastructure which gathers data from measurement networks scattered all around the Europe. Processed, standardized and integrated data is stored in databases connected with web portals, where the data can be visualized and analyzed with the use of dedicated applications and visualizations.

CIBAL will belong to the first layer of Research Infrastructure in Poland built by so-called Research Infrastructure Centers (RICs). It will provide a complete dataset concerning palaeomagnetic and environmental magnetism data with basic data storage and basic computing resources. CIBAL resources will be connected to the EPOS Thematic core service (TCS) of the MultiScale Laboratories.

Within activites to build CIBAL the enhancement of the research potential of the IG P.A.Sc. palaeomagnetic laboratory was performed in 2018 supported by funds of EPOS-PL. The motion to establish ties with EPOS-EU MSL group was initiated to collaborate with other EPOS EU laboratories in following years. The third activity is connected to the task to shear the data and results in the building of the database system for data and metadata created and stored according to rules of EPOS WP16 Multiscale Laboratories.

Palaeomagnetic Laboratory hosts a set of the complementary equipment for palaeomagnetic and rockmagnetic studies, that was set up in years 1990-2013. The new set of equipment was added for measurements of magnetic properties and laboratory experiments (magnetometer, magnetic susceptibility bridge, amagnetic furnace, low field magnetic cage, equipment for magnetizing samples in the laboratory). The additional units for sampling and analyzing of magnetic properties of environmental pollution (dust samplers, magnetic susceptibility meters) were also acquired.

Planned Data bases:
- of palaeomagnetic results
- of rock-magnetic properties
- of results of environmental magnetism

Experimental data from years 1990 – 2016 stored locally outside the database system are being processed and prepared for access according to procedures of WP 16 EPOS including standardization of data and metadata. The software to access the CIBAL databases, to process measurement data: collect, store, standardize, support the generating of metadata is under development.

After the successful application to Transnational access to MSL Laboratory scheme implementation of rules to admit other researchers for short –term visits according to rules set in „Transnational access WP 16 EPOS" will be set. In 2018 the laboratory were undergoing some preparation these visits (procedures, training of the staff, laboratory space refitting).

Figure 1. Paleomagnetic team in a refitted lab space with some new acquired equipment financed by the EPOS-PL (low-field cage, JR6 spinner magnetometer, demagnetizer).

The EPOS-PL project is financed by the Operational Programme Smart Growth 20140-2020; Priority IV: Increasing The Research Potential, Action 4.2: Development Of Modern Research Infrastructure Of The Science Sector, Co-financing from European Regional Development Fund

European Funds
Smart Growth

Republic of Poland

European Union
European Regional Development Fund

New paleomagnetic and magnetic fabric results from hematite-bearing Lower Triassic redbeds of the Central Western Carpathians

| R. Szaniawski

The progressive collision of the Alcapa and Tisza-Dacia microplates with the European Platform resulted in the formation of the Carpathian orogen. With the objective of better constraining the regional paloegeographic evolution,we carried out paleomagnetic studies within the Central Western Carpathians, representing a fragment of the Alcapa microplate. Our investigations were focused on Lower Triassic red sandstones from the autochthonous cover overlying the crystalline basement. This study is a continuation of our earlier works performed in the Tatra.

Mts. Here we present results from the nearby mountain massifs of Low Tatra, Velka Fatra and Strazovske Vrchy. Petromagnetic studies reveal that the dominant ferromagnetic carrier in the studied red sandstones is hematite, whereas magnetic susceptibility and magnetic fabric are mostly governed by paramagnetic minerals (phyllosilicates). AMS studies document the occurrence of a distinct magnetic foliation compatible with the bedding plane, and of a magnetic lineation of tectonic origin. Such a lineation lies in the bedding plane, but it is not exactly parallel to the strike of the bedding. The orientation of the lineation most probably reflects the multi-stage character of the deformation – folding and thrusting were followed by uplift and/or block faulting which affected the present day bedding attitude.

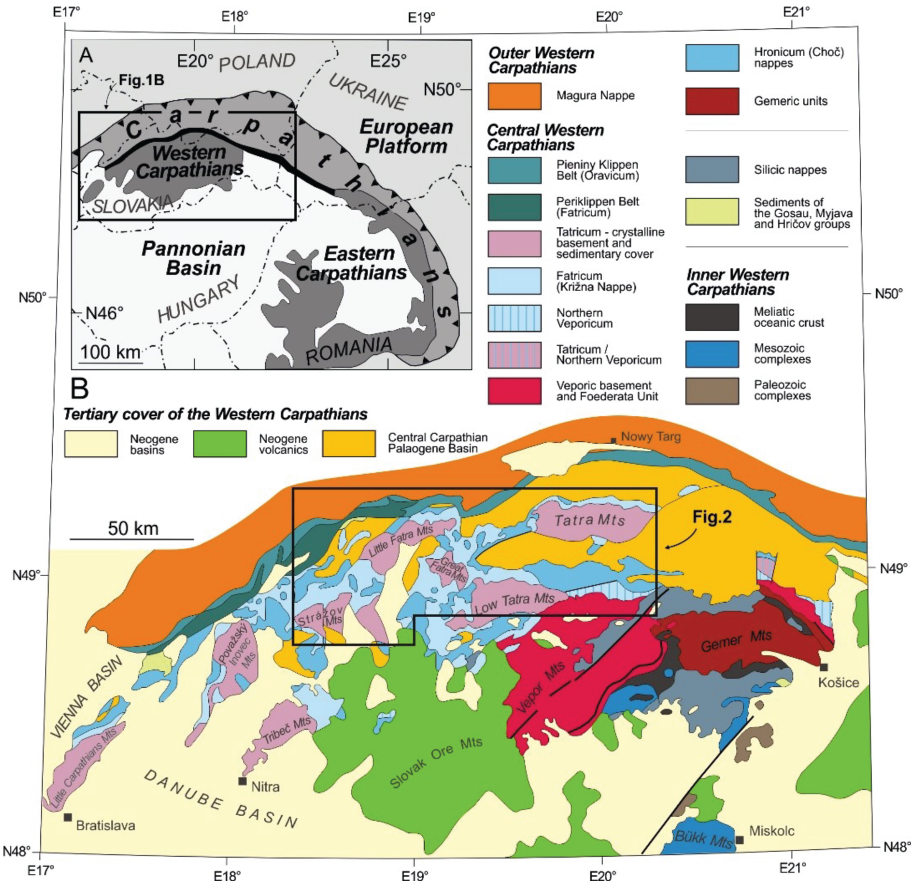

Figure 1. Schematic tectonic map of the Western Carpathians with marked location of study area (compiled after Bezák et al., 2004; Lexa et al., 2000; Plašienka 2003).

The hematite carrier records a characteristic component characterized by maximum unblocking temperatures of 680 C. This component displays both normal (dominant) and reversed polarity, as well as shallow to moderate inclinations, i.e. similar to those expected from reference paleomagnetic data from the European Platform. Declination values are rather uniform for all four studied mountain massifs and indicate moderate counterclockwise rotations of the Central Western Carpathians.

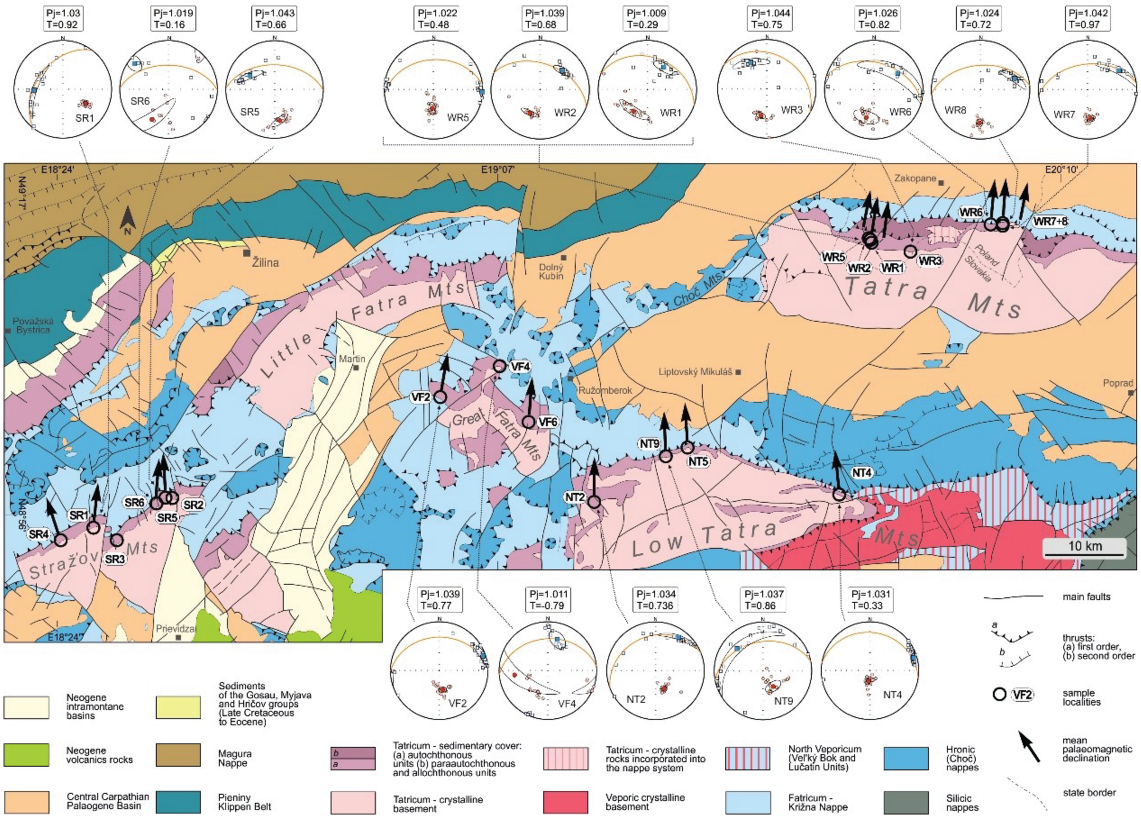

Figure 2. Simplified geological map of the study area with marked location of sampling sites (compiled after Biely et al., 1992; Mahel' et al., 1982; Polák et al., 1997; Nemčok et al., 1994). Stereographic diagrams show AMS results (only for samples in which the susceptibility is higher than 30 × 10–6 SI volume), AMS principal axes are marked as red circles (Kmin) and blue squares (Kmax). Larger symbols representing site mean principal axes shown with their 95% confidence ellipses. Orange circle is mean bedding. T: shape parameter; Pj: corrected anisotropy degree (both parameters after Jelínek, 1981).

Magnetic Anisotropy in Silurian Gas-Bearing Shale Rocks From the Pomerania Region (Northern Poland) | D. Niezabitowska, R.Szaniawski

Analysis of anisotropy of magnetic susceptibility (AMS) and anhysteretic remanent magnetization (AARM) was conducted on unconventional gas-bearing Silurian shales from northern Poland. Samples of these rocks were collected from depths greater than 3,500 m from two exploration drill cores (Fig. 1). The main aim was to investigate magnetic fabrics to verify current models of depositional conditions, current direction, and/or tectonic evolution. To obtain an in-depth interpretation, rock magnetic studies, microscopic analyses, and graptolite orientation measurements were performed.

The results of AMS and AARM indicate that the magnetic susceptibility is mainly governed by paramagnetic minerals (phyllosilicates) with a small contribution of ferromagnetic minerals, mostly magnetite. Typically, the studied mudstones and carbonate concretions are characterized by bedding-parallel foliation, resulting mostly from compaction. The foliation is much weaker in the associated early-diagenetic concretions, indicating that cementation occurred during the early stage of diagenesis. This phenomenon resulted in preservation of the early diagenetic fabric from the initial stages of the compaction process. In other words, in the concretions, the orientations of the phyllosilicates (AMS results) and other rock-forming minerals (SEM-BSE results) show some small/weak incipient arrangement in the horizontal plane and have been frozen in time by the early calcite crystallization and formation of rigid concretions. The mudstone rocks surrounding the concretions were subjected to further compaction, which resulted in a much better horizontal alignment of minerals and thus a much stronger magnetic foliation.

A weak magnetic lineation with an orientation of NNW-SSE is preserved in the early-diagenetic, rigid concretions, and the same trend also prevails in the preferred orientation of graptolites. This observation suggests that the observed alignment was produced by bottom currents. We interpret these bottom currents along the Baltica margin as longshore currents. The observed directions show that during the Wenlock (Silurian) in the studied part of the Baltic Basin, the dominant currents had an orientation of circa NNW-SSE along the margin of Baltica. The results suggest that there is no clear evidence for significant CDF accretionary prism activity, such as turbidity currents, influencing the sediment transport process in this part of basin during the early Wenlock (Silurian) epoch. Moreover, our results confirm that even in such fine-grained sediments, in which there are no other unequivocal directional sedimentary indicators, paleocurrent directions can be determined by applying AMS and AARM methodology.

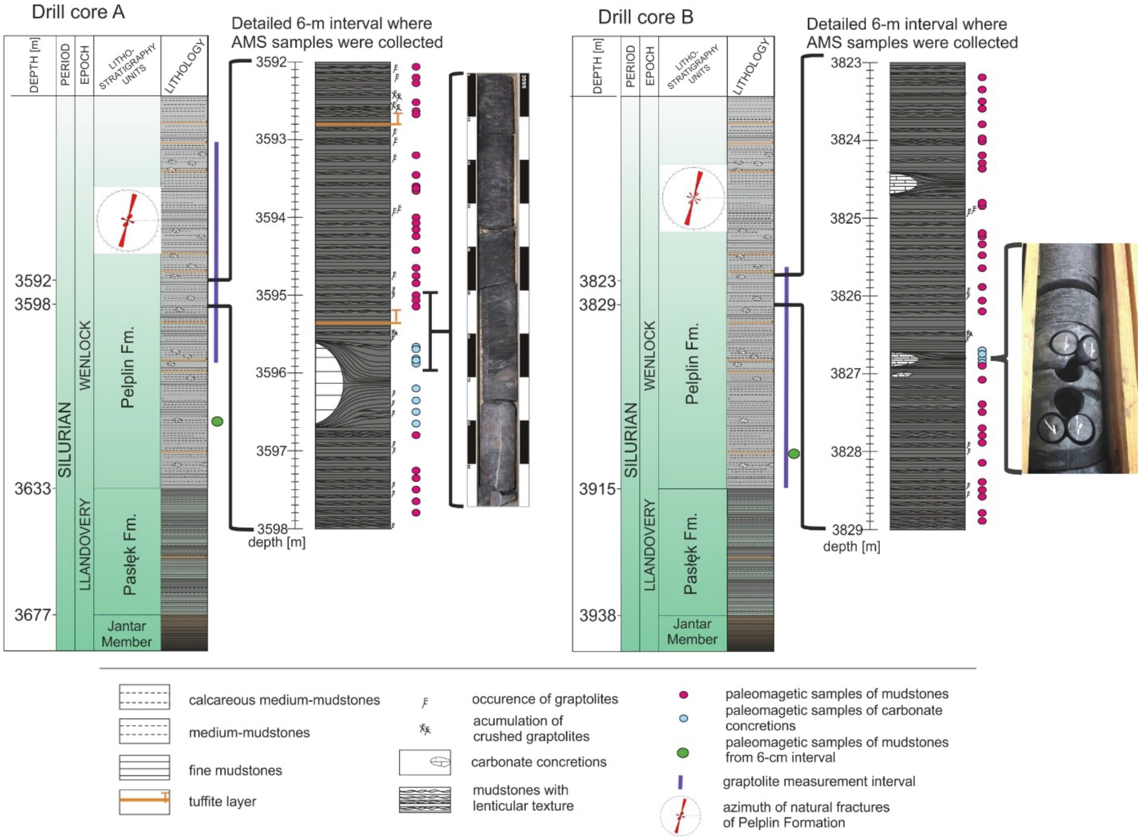

Figure 1 Lithostratigraphic profiles of Wenlockian rocks from the Pomerania region with marked locations of the drilled samples, intervals of graptolite measurements and orientations of natural fractures in the Pelplin Formation (after Kinga Bobek – unpublished materials of the ShaleMech project).

Fire, and then the ice: calibrating southern Africa's position within the Neoproterozoic supercontinent Rodinia | A. Gumsley, M. Lewandowski, B. Luks

In this year, we conducted a field trip to eastern Zimbabwe to obtain geochronological and paleomagnetic samples from the supposed 0.72 Ga NNE-trending Mutare Dyke Swarm. This dyke swarm has some unpublished ages on it, which indicated an age of approximately ca. 0.72 Ga. During the field trip, we took samples from a total of 9 sites for paleomagnetic analysis, and 31 samples in total for U-Pb geochronological and geochemical investigations, which are complimentary to the paleomagnetic results. In the meantime, we also procured samples from 7 dykes which are linked to the same dyke swarm in eastern Antarctica (Dronning Maud Land), the Fingeren Dyke Swarm. These were sampled on a South African National Antarctic Programme (SANAP) expedition during the southern hemisphere summer of 2017/2018. These samples were collected for geochronological and paleomagnetic investigations. In the paleomagnetic investigations, a portable hand drill was used in Zimbabwe for sampling oriented cores, whereas oriented samples were taken in Antarctica.

Figure 1. Sampling in the eastern highlands of Zimbabwe, with the Nyanga mountains visible on the horizon.

The samples from Antarctica have been prepared for geochemistry, geochronology and paleomagnetic investigations. Petrographic and geochemical studies have also been completed using light and scanning microscopy (to identify alteration and the presence of baddeleyite for geochronology), together with electron microprobe analysis, to determine the minerals present, and the degree of alteration. The results reveal a similar geochemistry of the dykes, indicative of it being from same swarm, and age determinations indicate that the swarm is ca. 0.72 Ga. Further age dating, using both U-Pb on baddeleyite and apatite will help to reveal better crystallisation ages of the swarm, as well as its metamorphic history, which appears to be lower greenschist facies, according to the petrography. Some samples from Zimbabwe have been processed in a similar manner, although many more samples are expected to arrive in January 2019. Preliminary data from Zimbabwe indicates lower to upper greenschist facies in many of the dykes, depending on the region. However, U-Pb crystallisation ages appear identical to those in Antarctica at ca. 0.72 Ga. Further U-Pb crystalisation and cooling ages by baddeleyite and apatite will be sought in 2019, combined with further petrographic and geochemical studies. Paleomagnetic sample analysis of the dykes from Antarctica will begin in January 2019, and samples from Zimbabwe in February 2019.

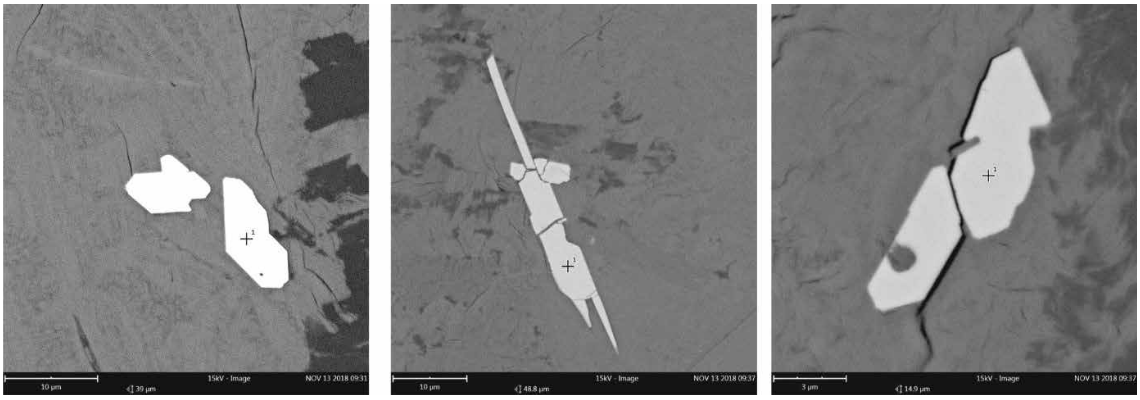

Figure 2. Baddeleyite (ZrO_2) present in dykes from Antarctica, found using scanning electron microscopy. Each grain is approximately 10 µm in size.

Identification of stages of remagnetization within Mesozoic cover of western Spitsbergen. Origin of the West Spitsbergen Fold and Thrust Belt based on Anisotropy of Magnetic Susceptibility results. | **K. Michalski, K. Dudzisz, R. Szaniawski**

A. Palaeomagnetic, rock-magnetic and mineralogical investigations of the Lower Triassic Vardebukta Formation from the southern part of the West Spitsbergen Fold and Thrust Belt.

Magnetic, petrological and mineralogical data from 13 sites (99 independently oriented samples) of the Lower Triassic rocks located in the SW segment of the West Spitsbergen Fold and Thrust Belt (WSFTB) are presented in order to identify the ferrimagnetic carriers and establish the origin of the natural remanent magnetization (NRM). Volcanic lithoclasts and other detrital resistive grains in which the primary magnetization might endure are present in some samples. On the other hand, petrological studies indicate that sulphide remineralization could have had an important influence on the remagnetization of these rocks. The dominant ferrimagnetic carriers are titanomagnetite and magnetite. While the titanomagnetite may preserve the primary magnetization, the magnetite is a more likely potential carrier of secondary overprints. The complex NRM patterns found in most of the samples may be explained by the coexistence and partial overlapping of components representing different stages of magnetization. Components of both polarities were identified in the investigated material. The reversal test performed on the most stable components that demagnetized above 300 °C proved to be negative at the 95% confidence level at any stage of unfolding. They are better grouped, however, after 100% tectonic corrections and the most stable components are clustered in high inclinations (c. 70–80°). This suggests that at least part of the measured palaeomagnetic vectors represent a secondary prefolding magnetic overprint that originated in post-Jurassic time before the WSFTB event. Vitrinite reflectance studies show these rocks have not been subjected to any strong heating (<200 °C).

B. Rock magnetism and magnetic fabric of the Triassic rocks from the West Spitsbergen Fold-and-Thrust Belt and its foreland

Magnetic fabric and magnetomineralogy of the Early Triassic sedimentary rocks, collected along the length of the West Spitsbergen Fold-and-Thrust Belt and from subhorizontal beds on its foreland, is presented with the aim to compare magnetic mineralogy of these areas, determine the carriers of magnetic fabric and identify tectonic deformation reflected in the magnetic fabric. Magnetic mineralogy varies and only in part depends on the lithology. The magnetic fabric at all sampling sites is controlled by paramagnetic minerals (phyllosilicates and Fe-carbonates). In the fold belt, it reflects the low degree of deformation in a compressional setting with magnetic lineation parallel to fold axis NW-SE (Fig.1). This is consistent with pure orthogonal compression model of the WSFTB formation, but it also agrees with decoupling model. Inverse fabric, observed in few sites, is carried by Fe-rich carbonates. In the WSFTB foreland, magnetic lineation reflects the Triassic paleocurrent direction (NE-SW). The alternation between normal and inverse magnetic fabric within the stratigraphic profile could be related to sedimentary cycles.

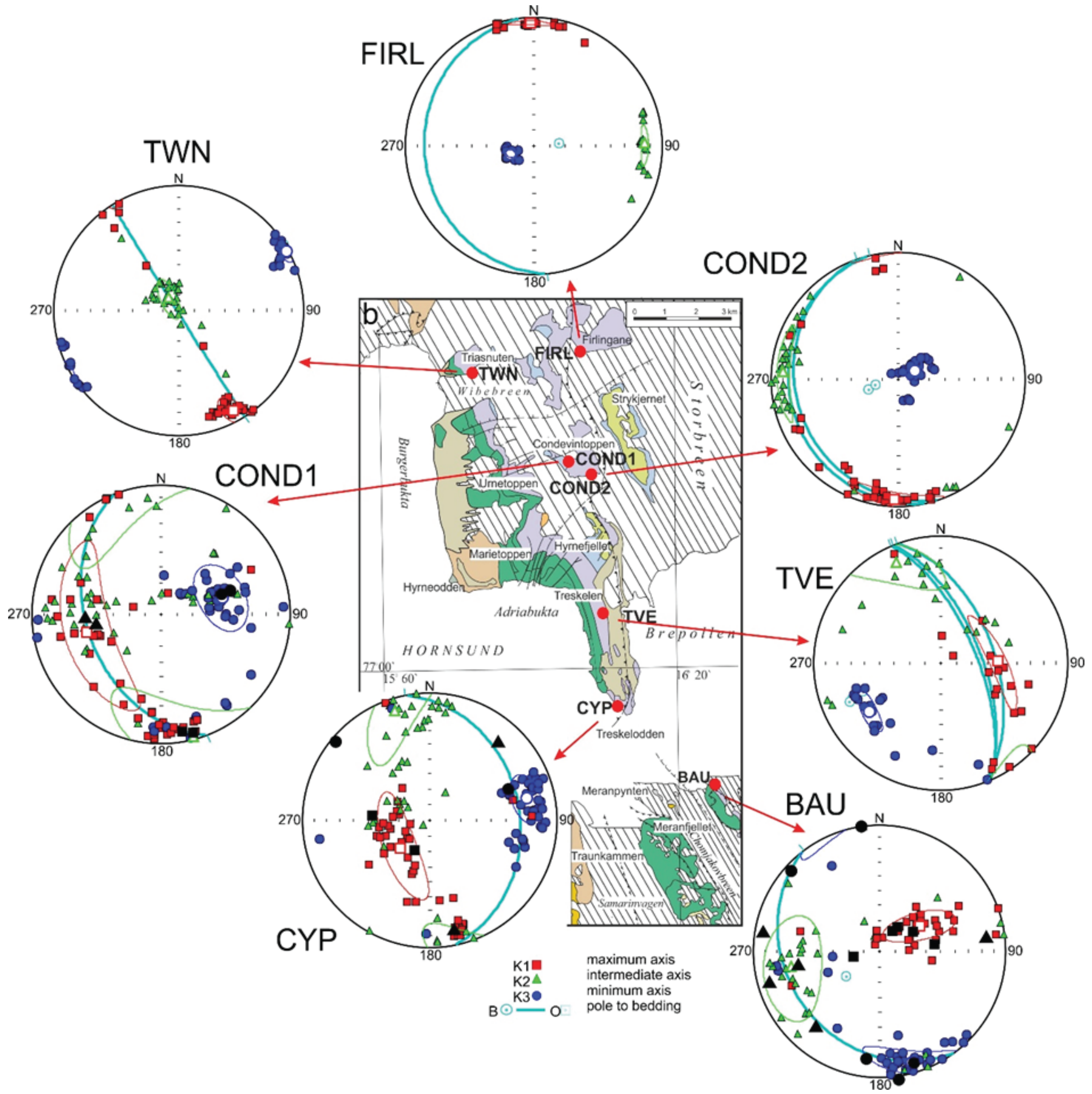

Figure 1. The low-field and high-field AMS (black symbols) results of sites located along the WSFTB at Hornsund. Equal-area lower-hemisphere projections show results in the geographic coordinate system.

Identification of late, post – Caledonian tectonic rotations within metamorphic basement of central western Spitsbergen | K. Michalski, M. Burzyński

A. Mineralogical, rock-magnetic and palaeomagnetic properties of metadolerites from central western Svalbard.

A combination of mineralogical, rock-magnetic and palaeomagnetic methods were employed in an attempt to shed a new light on the tectonism and paleogeography of Central Western Svalbard. The focus is on six metadolerite sites from the metamorphic Proterozoic–Lower Palaeozoic complex of south-western Oscar II Land (Western Spitsbergen). The primary mineral compositions of the metadolerites were strongly remineralized during Caledonian (sensu lato) greenschist-facies metamorphism although some younger tectonothermal modification is also apparent from the rock-magnetic studies. Rock-magnetic experiments supported by thin-section mineral identification and separation of Fe-containing fractions indicate that the main ferromagnetic carriers of the Natural Remanent Magnetization are represented by low-coercivity pyrrhotite and magnetite/maghemite. The investigated metadolerites are characterized by complex pattern of magnetization. The low-temperature palaeomagnetic components which demagnetized up to 250°C, are characterized by high inclinations (~70–80°) potentially representing Mesozoic–Cenozoic remagnetization. The most stable middle-high temperature directions which demagnetized from 250°C, were obtained from only two of six sites. Two Virtual Geomagnetic Poles calculated from two of the middle-high temperature site means do not correlate with the Laurussia reference path for syn to post-Caledonian time. Two possible explanations of observed inconsistency are discussed. These are a modification of the Oscar II Land Caledonian basement geometry by listric faulting and/or tectonic rotations related to Daudmannsdalen–Protectorbreen high-strain (shear) zone. The results presented here suggest that post-Caledonian tectonic modification of the palaeomagnetic directions may be more a widespread feature of Western Svalbard.

B. Palaeomagnetism of metacarbonates and fracture fills of Kongsfjorden islands (western Spitsbergen).

A total number of 156 palaeomagnetic specimens of metacarbonates from 9 sites in Blomstrandhalvøya and Lovénøyane (Kongsfjorden, western Spitsbergen) and an additional 77 specimens of unmetamorphosed sediments infilling fractures (4 sites) within the Caledonian metamorphic basement of Blomstrandhalvøya were demagnetized. No relicts of pre-metamorphic magnetization were identified. The Natural Remanent Magnetization (NRM) pattern of metacarbonates is dominated by Caledonian (sensu lato) – Svalbardian and Late Mesozoic/Cenozoic secondary magnetic overprints carried by the pyrrhotite and magnetite/maghemite phases, respectively. The NRM of unmetamorphosed sediments infilling the karstic/tectonic fractures is dominated by hematite carrier. It revealed three stages of magnetization: Caledonian sensu lato, Carboniferous and Late Mesozoic/Cenozoic, which can be related to their initial fracturing, karstification and sedimentation or reactivation. As the majority of the palaeopoles calculated for the Kongsfjorden sites fit the 430 – 0 Ma sector of Laurussia reference path in an in situ orientation these results support the hypothesis that Blomstrandhalvøya and Lovénøyane escaped main Eurekan deformations. The potential rotation of the Kongsfjorden basement by any west dipping listric fault activity rotating the succession accompanying the opening of North Atlantic Ocean was not documented by obtained the palaeomagnetic data.

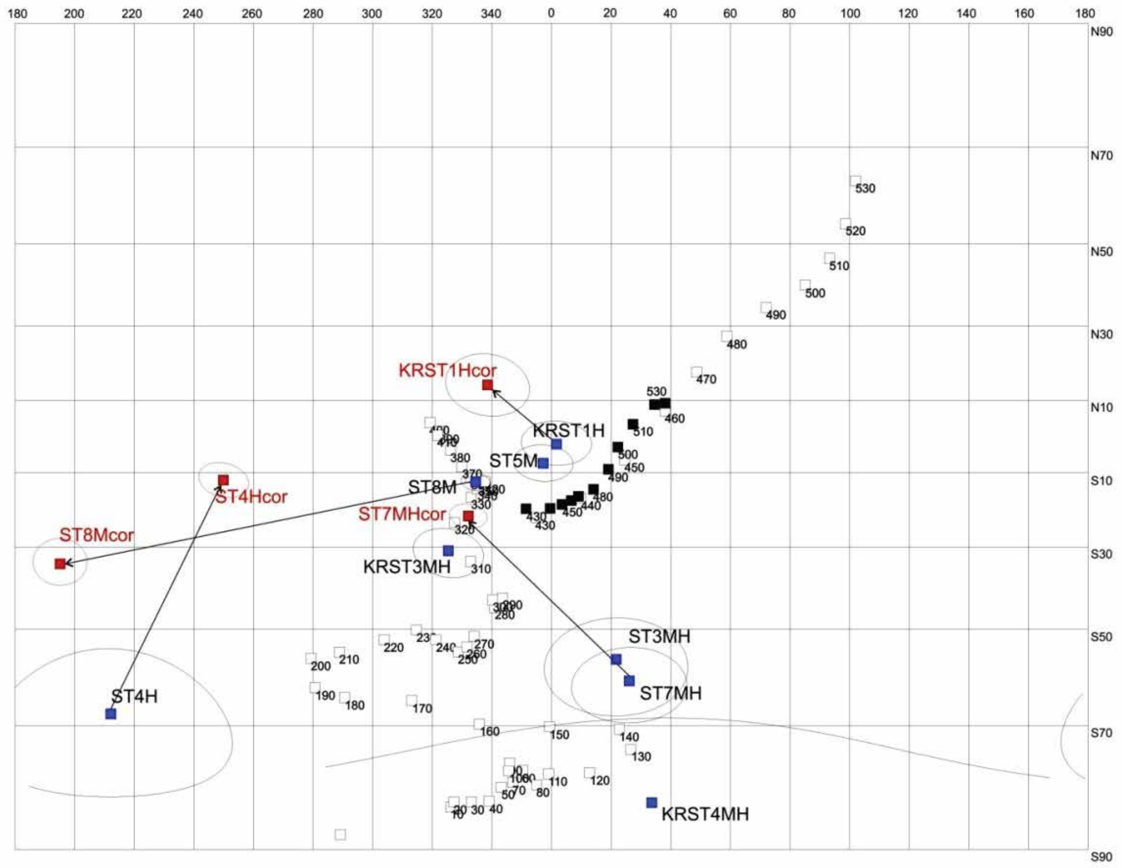

Figure 1. Palaeopoles calculated for middle- to high-temperature components (M, H, MH) identified in Kongsfjord (this study) with their ellipses of the confidence limit α95 against reference path of Laurussia (open squares, palaeopoles 0 – 430 Ma), Baltica (open squares, palaeopoles 440 – 530 Ma) and Laurentia (filled squares, palaeopoles 440 – 530 Ma); reference palaeopoles were taken from Torsvik et al. (2012). Ages of particular palaeopoles are given; blue filled squares represent position of in situ palaeopoles before tectonic; in the case of metacarbonates red filled squares represent positions of VGP's after tectonic corrections according to F2 deformations; as ST5 was characterized by horizontal schistosity in that site tectonic correction was not applied; in the case of KRST1 site red filled square indicates position of VGP after correction according to identified weakly developed AMS foliation; Galls projection.

Deep lithospheric structure beneath Dolsk and Odra fault zones as a result of integrated Magnetotelluric 1-D, 2-D and 3-D data interpretation |

S. Oryński, W. Jóźwiak, K. Nowożyński

The scientific aim of the project is detailed identification of the crust and upper mantle structure around a part of the Fore-Sudetic Monocline. The data obtained from the measurements and the data from the Pomerania studies and also from our previous research from eastern part of Fore-Sudetic Monocline, will be used to a better establishment of the boundaries of lithospheric blocks (terranes) as well as to recognise their origin. The magnetotelluric (MT) soundings were carried out to achieve this goal. The collected data allow to construct 3-D models of the conductivity distribution. The area where the investigation is going to be done involves the region of the Dolsk fault and the Odra fault. These zones are important geologic borders of a regional nature and they pull apart the crust blocks which have different origins. The character of this geological structure is currently almost unknown. We hope that our investigation could shed additional light on the problems connected with the geology and geotectonic of this area. The Variscan basement between these two faults is not well-known as well, that is why it attracts interest a strong group of researchers. The previous geophysical results, mainly seismic, show that it is highly likely that the Dolsk fault zone mark out the polish, northern border of the Variscan crust. It is worth to admit that the Odra fault is a natural continuation of the Elbe fault in the eastern Germany.

Magnetotelluric deep soundings, respectively, differ significantly from most other methods in the way, they use natural sources. The methods have a great practical importance, especially in environmental research. Variations of the external magnetic field induce electric currents in the Earth, direction and intensity of which depend on the electrical conductivity distribution in geological structures. In the case of local horizontal heterogeneities presence, the induced currents generate also a vertical component of the Earth's magnetic field. The relationships between corresponding components of the electric and magnetic fields define so-called transfer functions. These functions depend on the location and on frequency and base on them we are able to derive numerical models of distribution of electrical conductivity in the Earth. Collected data is a subject to the numerical processing.

There were conducted 51 soundings on five parallel profiles. That allow to construct a regular mesh in the area of the Fore-Sudetic Monocline. Processing and preliminary data interpretation were conducted according to the progress of field work. There were created 1-D and 2-D models by using the inverse algorithms. The models were prepared for each profile separately. There were apply a parallel (ModEM) 3-D inversion codes. ModEM is an inversion code which employs MPI and which, besides impedances, includes tippers and magnetic tensor.

The research area is characterized by remarkably complex geological structure and unclear history of tectonic evolution. Geotectonic processes that occurred in this region are currently unknown. The area was covered with a relatively dense network of deep seismic profiles but the doubts about the fault zones are not settled. Taking into account the previous local logging and geological studies, the need for a thorough and large-scale magnetotelluric basic research, seems to be natural. The study allows a relevant supplement of foregoing knowledge, thereby to obtain more delighted recognition of the Dolsk and Odra fault zones. Sub-vertical orientation of the Dolsk fault that is suggested by the seismic and geological data, implicate a strike-slip character of this dislocation. Even though the direction of them is still unidentified. The other problem is the origin of the basement block between these two faults. This research project substantially permits for better reconstruction of the tectonic evolution of Baltika foredeep.

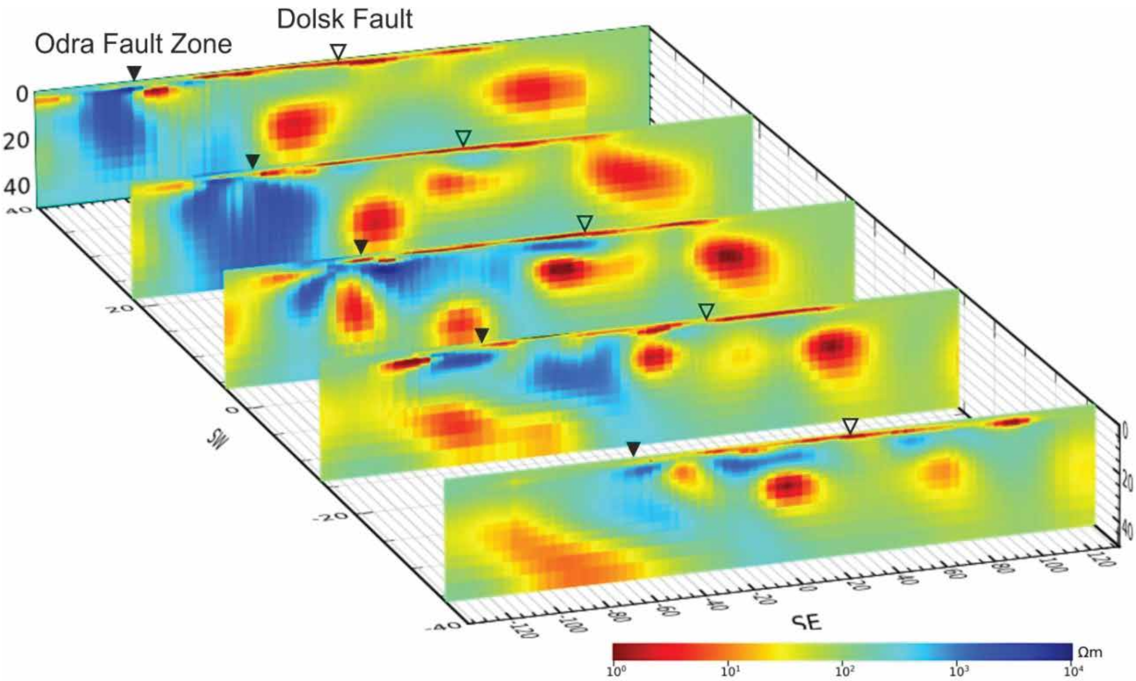

Figure 1. The results of 3D NLCG in ModEM, presented as a section on every profile (from 0 to IV).

The complexity of the geological structure of the Fore-Sudetic Monocline, is manifested by occurrence numerous dislocations and tectonic zones. The boundaries between the particular basement units are most probably near-vertical sutures representing trans current zones, mostly accompanied by Permo-Carboniferous well-conducting deposits. The zone equivalent to the central-German crystalline zone (MGCR), which separates the Saxo-Thuringian Zone and Rheno-Herzynian Zone, is probably not located below the middle Odra fault zone as was postulated. The results of the study indicate that it is located more to the north (about 40 km), in the Lower Silesian Basin between the Bielawa-Trzebnica High and Wolsztyn-Leszno High. 3-D approach is a major advance and give a more reliable image of geoelectrical structure than was possible with a 2-D approach. Moreover the 3-D structures are better specified on 3-D inversion results.

Deep lithospheric structure beneath the Polish part of the East European Craton as a result of magnetotelluric surveys. | S. Oryński, A. Neska

The scientific aim of this project is the investigation of deep crust and upper mantle structure in north-eastern Poland. For this purpose, all profiles which were carried out in this region were collected. The majority of them is crossing Poland from the South-West to the North-East. Two of these profiles were made in the last three years, by Institute of Geo-physics, Polish Academy of Sciences, using Geomag Apparatus. For the common interpretation the magnetotelluric profile II (it is a part of a big-ger profile named Zgorzelec-Wizajny), which was made by PBG Geo-physical Exploration Company Ltd in 2006 was also used. The data was processed and then a database in the WinGLink Software was construct-ed. The one-dimensional Occams inversion and the two-dimensional NLCG inversion, using this software, were carried out. The results of these two types of inversion were presented as sections of the apparent resistivity distribution, and then compared and contrasted. The analysis of polar diagrams revealed that for the most of research area, two-dimensional structures were observed. The fitting to the known geological model was much better for 2D inversion than for 1D. The final results were presented as a 3D cube, which was made from the interpolation be-tween sections.

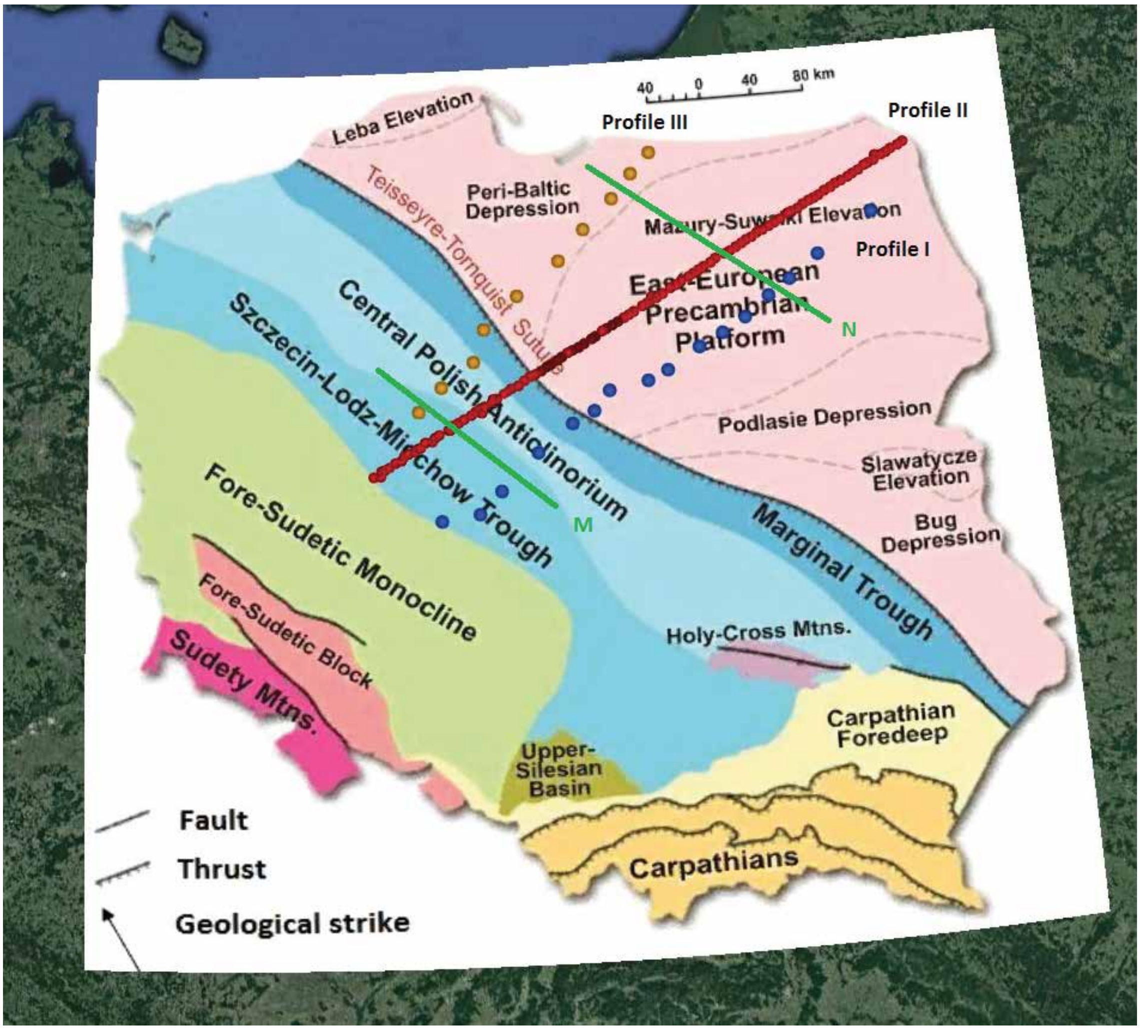

Figure 1.Tectonic map of the survey area with profiles. Source: Google Earth. Red dots mark Profile II (Zgorzelec-Wiżajny), orange ones Profile III, and blue ones Profile I.

In the present work, we jointly interpreted 1D and 2D resistivity models obtained by the inversion of 420 magnetotelluric sites. Structural dimensionality of the dataset was analysed by polar diagrams and this analysis showed clearly that underlying resistivity structure is not one dimensional. Only for several higher frequencies it is possible to accept a layered model. Good results are obtained only for depths up to 20 kilometers, what has been confirmed by a skew analysis and polar diagrams. Two-dimensional inversions give satisfactory results. There are clearly visible the Trans European Suture Zone in form of a good conductor in mid-crustal depth on every profile and especially in the 3-D visualization. The shape of this structure agrees very well to the previous research from the Polish Pomerania region (Ernst et al., 2008; Slezak et al., 2016). The most interesting result seems to be deep regions of lower resistivity within the East European Craton. These structures occur consistently on each profile and it is highly probable that there are two of them. This is visible at the most densely sampled Profile II. This effect is very pronounced in the case of a three-dimensional visualization. A possible interpretation of these structures is that the platform hosts numerous ancient rifts or aulacogens. Some of them were possibly caused by a cluster of mantle plumes.

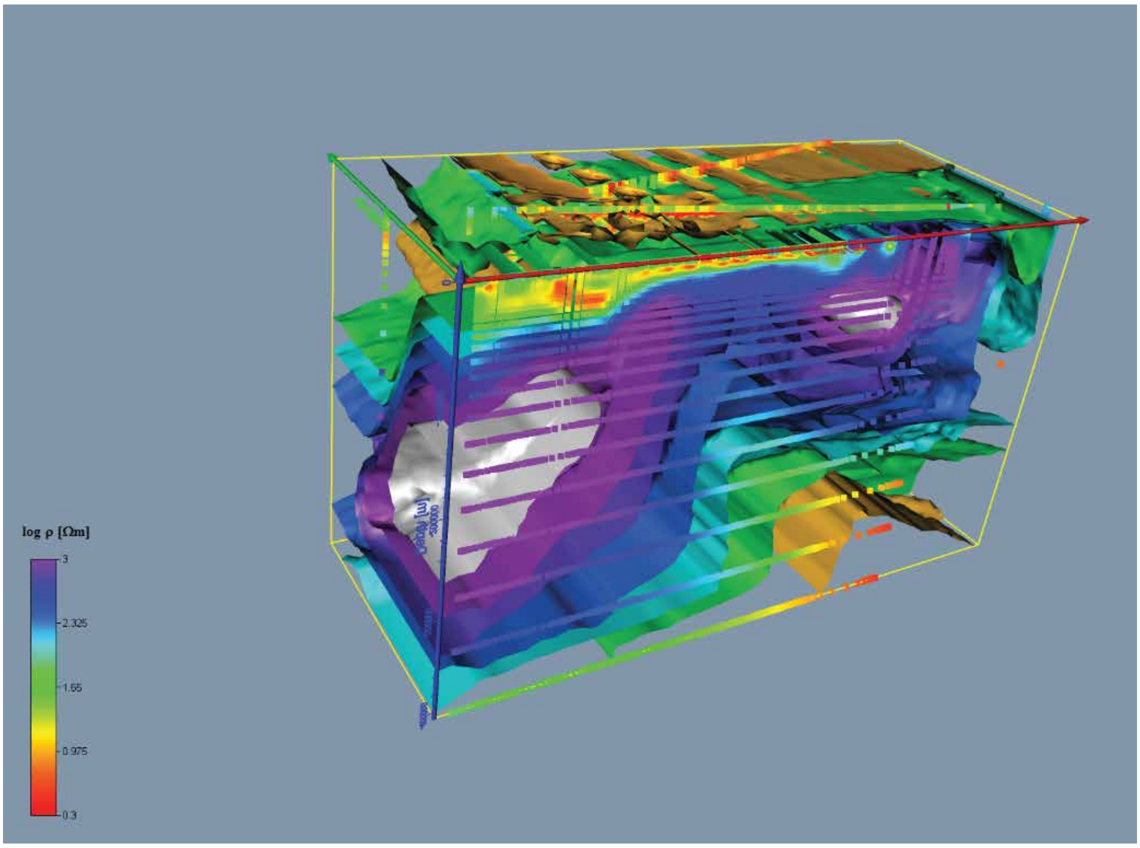

Figure 2. 3-D visualization of the results of 2D inversion of all the profiles presented in GS Voxler as a scatter plot combined with isosurfaces.

Some structures do not continue consistently from profile to profile. This indicates a certain three-dimensionality of the deep structure, which is not unexpected, e.g., in context of intrusions. Hence there is a need to carry out a three-dimensional inversion using all available data from this region. It would help to come to a final geologic interpretation of the da-ta which have been analysed in this work.

Combined quantitative interpretation of GCM and DC sounding data from selected area in Cracow, Poland. | S. Oryński

Apparent conductivity is a value that is measured with the use of Ground Conductivity Meters (GCM). The apparent conductivity, σ_a [mS/m], is a geoelectric parameter, which characterizes heterogeneous medium that is in the field of view of the measurement array. The apparent conductivity can be treated as some resultant conductivity of a heterogeneous medium, in which the spatial distribution of 'true' conductivity is imposed by the geological built-up. Apparent conductivity is measured using the horizontal (HD) and vertical (VD) magnetic dipole at a several levels of depth (using different spacing). The area around the transmitting coil in which (for given frequency and conductivity) measurement is done is called near zone or induction zone.

Ground conductivity meters: CMD-MiniExplorer and CMD-Explorer, produced by the GF Instruments, s.r.o., are designed for induction profiling. The equipment employs the HD and VD configurations and measures apparent conductivity, and owing a six different options for spacing (s= 0.32, 0.71, 1.18 for MiniExplorer and 1.48, 2.82, 4.49 for Explorer). There are two types of configuration available. It allows to regulate the depth of penetration.

The GCM measurements were made along two profiles with a one meter measurement step in two different areas of Cracow (Poland). For the purposes of the geoelectrical identification of the medium, there were carried out a benchmark DC-resistivity soundings, with a measuring step of 5 meters along the same profiles. Measurement were carried out with the Schlumberger 4-electrode system.

The results of quantitative interpretation of DC-resistivity and GCM soundings were linked to the lithology of the studied medium. There were used two different interpretation algorithms for both methods: Occam and Levenberg-Marquardt (LMA). In the LMA method there is obtained a model with a clear contrast between the successive layers as a result of the interpretation. The result of the Occam interpretation is a model with smoothed resistivity distribution and diffuse boundaries between layers.

The research was carried out in two different areas in Cracow, first one in the Błonia area (right side of the Vistula river) and second one in the Ruczaj district (left side of the Vistula river). The distribution of the interpreted resistivity was compared with the literature data about lithology and resistivity occurring in this area. In the second case, the first interpreted layer is soil with a subsoil (conductivity approx. 20 mS/m) and a volume of several dozen centimetres. Below them, there are clays, (conductivity approx. 55-60 mS/m) and a thickness of about 3 meters. Below the layer of clays there is a gypsum complex with conductivity about 14 mS/m and a thickness of about 12 meters. The conductivity of this complex determined as a result of the interpretation of GCM data is greater - it is about 30 mS/m. This is due to much greater sensitivity of the GCM method to the occurrence of small, dispersed conductive zones in the gypsum (e.g., loams, wet karst voids). These gypsums are part of the evaporative works that have been created as a result of Tortonian sea regression. The Miocene aquifer is associated with the layer of skeletal gypsum. The last recognized layer is the low-resistive loam of the Wieliczka layers. This layer is too deep to be recognized by the GCM method. The resistivity of clays obtained as a result of the interpretation of DC-R soundings is about 3 Ωm (conductivity approx. 300 mS/m).

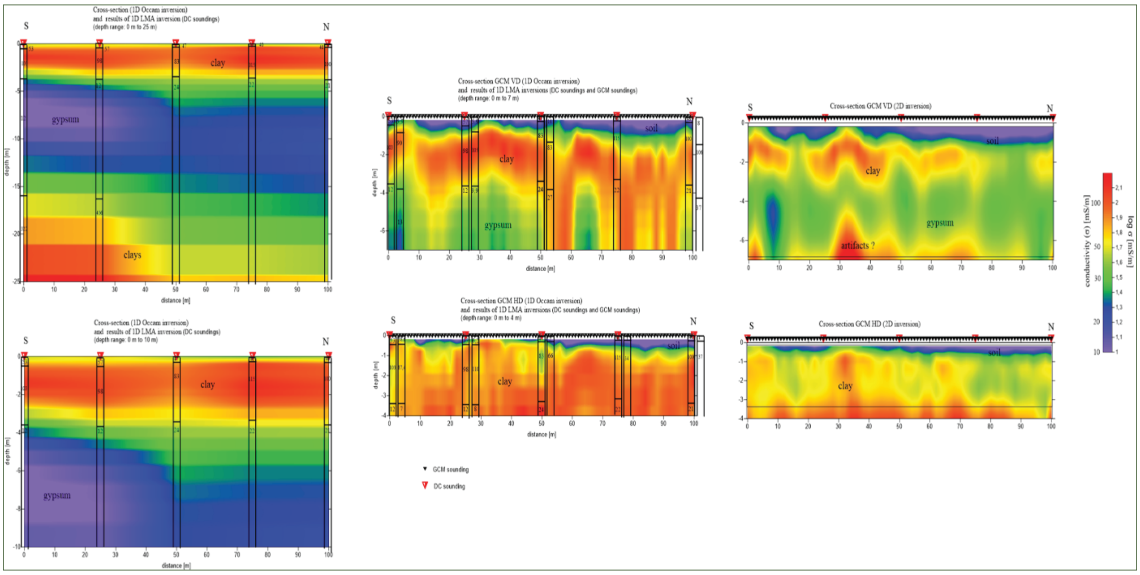

Figure 1. Comparison of cross-sections: DC – 1D Occam, GCM – 1D Occam, GCM -2D, for two different depth ranges.

Carrying out GCM measurements for six different depth ranges (levels) allowed to perform a two-dimensional GCM data inversion using the Res2Dinv software. The inversion results in the form of cross-cut conductivities are smoothed (i.e. the conductivity at the boundaries between different mediums changes gradually) and are a certain averaging of the conductivity distribution in the studied medium.

The GCM method proved to be effective in recognizing shallow geological layers in the Cracow area. Due to the specific geological structure, the range of conductivity of geological layers (from a dozen to several dozen mS / m) allowed to qualify the condition of the near-field zone for the GCM method and the clear geoelectric contrasts allowed to separate the most important layers.

Changeability of the Earth's geoelectric parameters and its relation to seismicity around the Trans-European Suture Zone

| V. Semenov, W. Jóźwiak, K.Nowożyński, M. Neska

Investigation of the Earth's geoelectric structure and of possible temporal changes in its parameters requires both reliable observation data and an appropriate data processing method. the Earth's interior based on measurements of electromagnetic field variations. An advantage of this method is that it is non-invasive for the environment, whereas a drawback is the complexity of the measured signals which come from different sources.

A new methodology of performing induction soundings have been finished as a part of ongoing work and a software package for analysis and interpretation of long-term magnetotelluric and magnetovariational data has been created.

Geomagnetic observatories at mid-latitudes of Eurasia (50° ± 10° of the northern hemisphere) operating at least in the years 1957-2010 have been chosen for deep induction soundings along a profile going from Europe through Asia up to the Pacific Ocean.

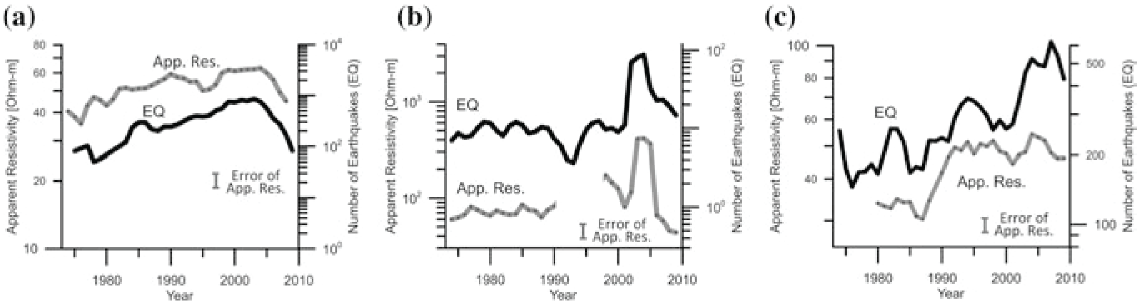

Figure 1. Locations of geomagnetic observatories marked by international codes 1 and profile with centers of soundings. 2 Boundaries of main tectonic structures. 3 TESZ Trans European Suture Zone; EEC East European Craton, SC Siberian Craton; and CAOB Central Asian Organic Belt.

Good correlations between apparent resistivity and change in the number of earthquakes taken from NEIC PDE catalog within a 700 km radius around the center of sounding were established in the first zone (Fig. 1a, Europe). Sample earthquakes with magnitudes over 3 were taken from the catalog NEIC PDE. The second zone has been fixed in Siberia (Fig. 2b) where deep soundings have been made for group of stations AAA, IRT and NVS, because exactly there a good earthquake statistics (ten and more events per year) was observed in the years 1973–2010. Such a statistics of earthquakes is absent in Western Siberia. The third zone includes part of the Pacific Ocean shore (Fig. 2c), that stands in the way of correct deep soundings.

The application of the new methodology enabled a documentation of temporal changes in the Earth's resistivity for both long- and short-period geomagnetic field variations. In Poland it is most visible in the region of the TT Zone. These changes are clearly correlated with the level of seismic activity in the Mediterranean Region. Also it has been shown that earthquakes in this region are preceded by anomalous electromagnetic signals that are clearly visible in both magnetic and telluric spectra. Similar analyses for data of Asian observatories have shown that there exist analogous zones to the TESZ in which clear resistivity changes are observed that are correlated to seismic activity as well. Furthermore there has been shown that the length and direction of induction arrows change with time. They are very probably connected with conductivity changes in the lower mantle. Possibly this is the reason for the magnetic jerks that are observed at the Earth's surface.

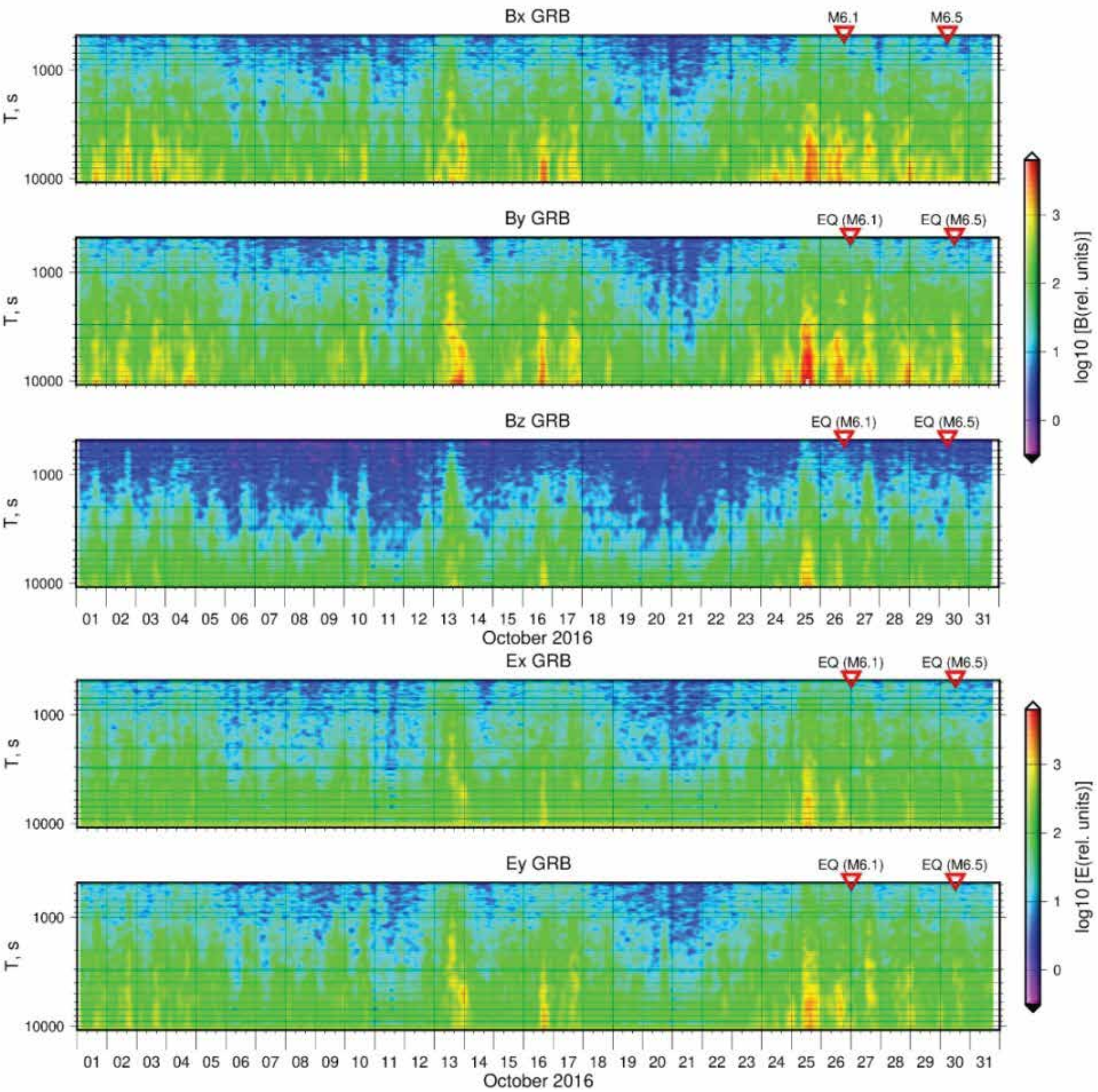

Figure 2. Variability of EM spectra with time at point GRB in October 2016. Red triangles mark the earthquakes in Italy mentioned in text.

The changes in the electromagnetic field of the Earth and consequently, the changes of geoelectric parameters are extremely interesting. The nature of the phenomena taking place in the Earth's interior that are the source of the observed signals has not been finally understood and hence further research is necessary.

3-D studies of MT data in the Central Polish Basin: Influence of inversion parameters, model space and transfer function selection. | W. Jóźwiak, K. Nowożyński, S. Oryński

3-D inversion of geophysical data has become a practical, commonly used tool in the interpretation of magnetotelluric (MT) data. However, 3-D inversion is a nonlinear and ambiguous task and requires adopting additional assumptions. The influence of the selection of parameters on the solution can be investigated on the basis of synthetic models for which it is easy to verify the correctness of the results and therefore the adopted assumptions. In contrast, we analyze the influence of selection of inversion parameters in the case of previously published, real model for Pomerania region (Poland). This area is a fragment of the Trans European Suture Zone. This zone is a regional scale 2-D structure, which locally becomes 3-D. The analyzed model was accomplished by inversion of full impedance and tippers from 31 long-period MT stations with the period range from 10 s to 10,000 s. A number of tests were performed employing an implementation of the freely available ModEM code. These included the choice of an appropriate initial model and an evaluation of model covariances as a means to control smoothness between adjoining model areas. Additionally, we compared the models calculated from all transfer functions (impedances and tippers) and from subsets (only tippers and off-diagonal components of the impedance tensor and tippers). Moreover, the tests with the rotation of the model's coordinate system were performed.

Inverse algorithms base on minimizing the misfit between data and model response (the RMS parameter). It happens, however, that we get relatively small and/or similar RMS values for models with a significantly different structure of conductivity distribution. Moreover, the model with the lowest RMS value does not always fit to the well-known geophysical or geological data, if available. Therefore, including such independent data allows to better select the inversion parameters. The RMS is defined using measurement data errors. These data are often a subject of a preliminary modification (by adopting an error floor or fixed error values for tippers). This affects the obtained RMS values and therefore we should not treat these values as an objective benchmark of choosing the best model.

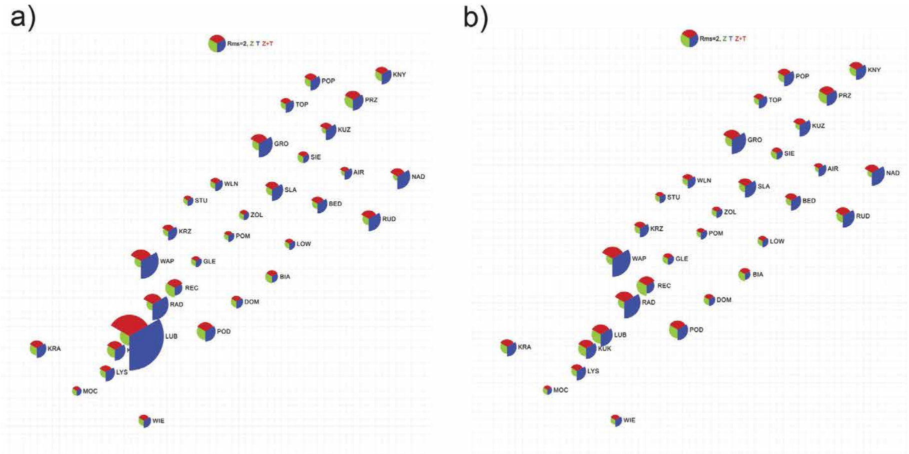

Figure 1.On the left (a): the RMS values for individual points in case of inversion of all input data; on the right (b): the same values after removing one unrealistic vector for a period of 10 s for site Lub (the global RMS decreased from 1.9 to 1.7).

Our analysis has shown that initial model and the selection of the transfer function for inversion can significantly change the model. The coefficient values of the covariance matrix also have a significant impact on the results. The selection of a too small value allows large contrasts between neighboring cells and then the model trends to set conductive areas shallower, only in a few first layers. On the other hand, the selection of a too big value leads to the “blurring” of conductive zones in the model while the conductivity values for these structures decrease (preserving their conductance). The optimal selection of covariance values requires preliminary test calculations, and of course, in this case, any independent geological and geophysical information is very useful. The selection of the coordinate system does not have a crucial influence on the inversion result; however, for a 3-D modeling of local-scale structures, it is advisable to orient the model (the model grid) obliquely to the global strike direction of the structure. Such an approach will not allow strengthening the dominant global 2-D character and it can make local 3-D areas more visible. Our tests have also confirmed that models based on tippers are less detailed and not sensitive to layered structures than the models based on telluric data (only impedances) and they provide complementary information on structure. Models based only on impedances may illustrate well smaller, local structures but they are potentially more sensitive to static shift. The addition of magnetic data that are not sensitive to static shift weakens these effects and leads to a more realistic model. Our tests indicate that 3-D algorithms are a great tool for modeling the conductivity distribution. However, their use requires a careful and appropriate selection of inversion parameters, in particular while modeling deep structures. Only then, we can expect that the inversion provides a reasonable model, which is close to the true geological structure. The criterion based only on the minimization of RMS does not guarantee this.

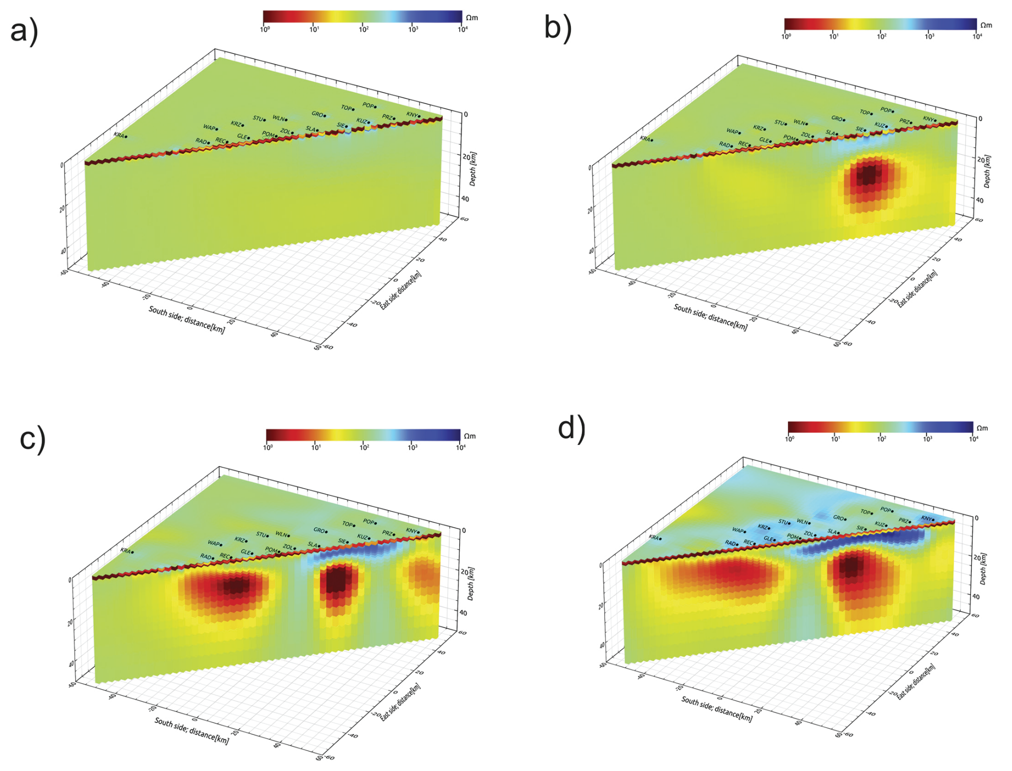

Figure 2. 3-Dmodels along the LT-7 profile for different covariances. 0.3 model covariance (a), 0.4 model covariance (b), 0.5 model covariance (c), 0.7 model covariance (d). A homogeneous half-space of the initial model (background resistivity) of 100 Ωm was used for each model and the RMS values were 2.017, 1.982, 1.824, and 2.005, respectively.

Temporal changes of geomagnetic induction arrows in non-seismic regions – reality or estimation errors? | T.Ernst, K. Nowożyński, W. Jóźwiak

Various scientific articles report that induction arrows estimated in the same place are changing over the time, which should not happen in seismically non-active regions. The induction arrows in geomagnetic sounding are strictly related to local deep conductivity distribution (geological structure). In general, the geological structure is stable in non-seismic areas. So, in our opinion, the temporal changes of induction arrows signaled in the literature are related to the estimation errors produced in calculation process by the presence of the external part of vertical field, appearing as noise in the data set. And additionally, what is very important, this noise is correlated with input signals.

To confirm our thesis, we estimated induction arrows at different time periods (seasons), analyzing carefully their variability. For calculations we used one-minute recordings of geomagnetic variations from some magnetic observatories and selected permanent sites in Poland and Lithuania registered between 2002 and 2015. The periods longer than three hours was filtered out . We used symmetric optimal filterers calculated by the algorithm of Parks&McClellan (1972) (see Fiq.1). In data processing we used our original algorithm based on the method of least squares in the time domain and Egbert's EMTF package (1986). Our task is a typical problem of studying a linear system (black box) of two input signals (horizontal components of geomagnetic field) and one output signal (induction part of the vertical field). Unfortunately, the assumption that external sources are spatially uniform is often not satisfying, and the external part of the vertical field usually exists, and sometimes is much bigger than the internal part.

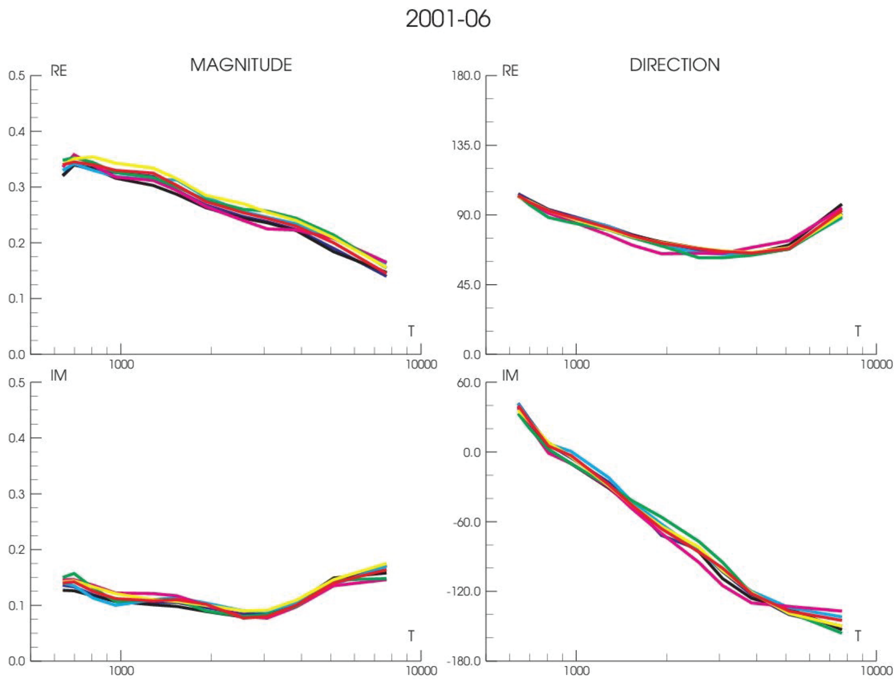

Figure 1. The results of induction arrows estimation for Belsk (our original code working in time domain was used) . The input data contained 50 selected 8 -hour time series (Ze/Z < 0.2). Colour curves shows the results for the data recorded between 2001 and 2006. Black curve for 2015. All curves are practically identical.

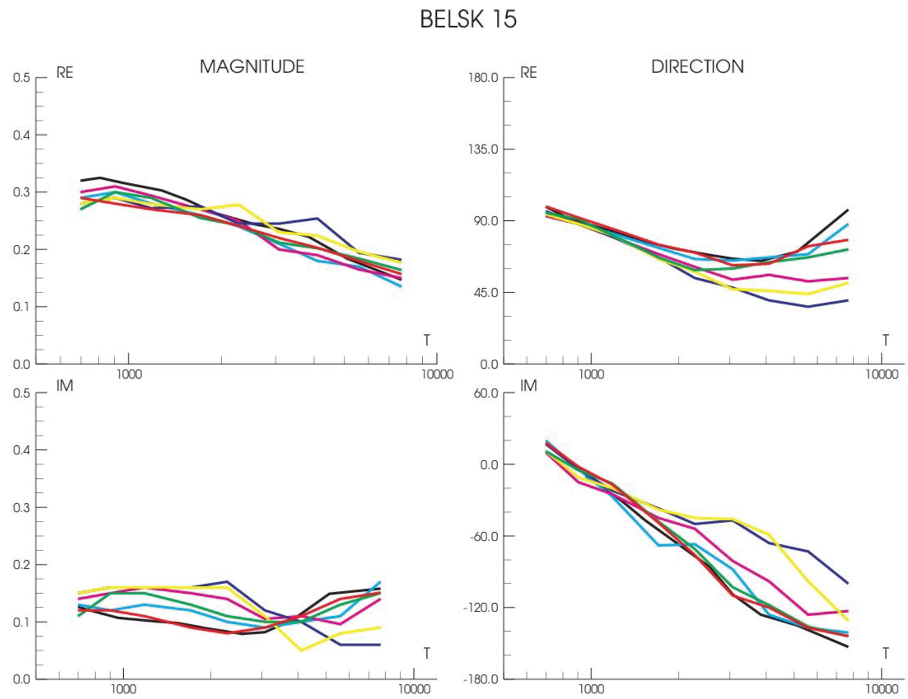

Figure 2. The results of induction arrows estimation for site Belsk(BEL) in Poland. One-year data registered in 2015 were used. The annual data has been divided into six parts containing two consecutives months. The color curves show the results obtained for the six different input data sets containing different pairs of months. Initial data selection has not been made. The Edberg EMTF package was used for the calculated. One can see the large dispersion of estimated values for long periods. The obtained results using our own code for pre-selected data shows the black curve.

In our opinion, the observed seasonal changes in the transfer function values are the result of incorrect estimation. The only way to receive a reliable estimation of induction vectors is the initial and subtle selection of the data. The data selection in our calculation process is based on an analysis of the external part of vertical geomagnetic field variation. The results we obtained show that induction arrows calculated in such way are stable over time.

Investigations of diffusive effects in hydromagnetic dynamo theory |

K. Mizerski, M. Grądzki

The dynamo team has concentrated efforts on two important topics from the hydro-magnetic dynamo theory about generation of large-scale magnetic fields by perfectly conducting (or more realistically extremely highly conducting) fluids and about buoyancy driven magnetohydrodynamic instabilities. In general terms the question which are at stake here can be formulated shortly:

Can the large-scale fast hydro-magnetic dynamos operate in real low-resistivity systems? How effective are the buoyancy effects in generating of natural magnetic fields?

The typical situation for dynamo action to occur, is when the flow field exhibits chirality (lack of reflexional symmetry), and this requires some mechanism (e.g. gravity g in conjunction with mean rotation ⌧ as in Moffatt 2008, or boundary forcing) that breaks the `up-down' symmetry of the field. An electromotive force E(⌧B⌧) (EMF) is then generated, which depends nonlinearly on the mean magnetic field ⌧B⌧, and this leads to amplification of magnetic energy until the growing Lorentz force reacts back upon the flow field, leading to a saturated state.

It is frequently found that in the weak seed field limit the mean EMF is linear in the seed field E_i=⌧_ij ⌧B⌧_j, and that the trace ⌧=⌧_ii⌧0 as the magnetic diffusivity η⌧0, thus excluding dynamo action at very high conductivities; the dynamo is then termed `slow'. If, on the other hand, ⌧⌧ const.≠0 as η⌧0, (leading also to a non-zero growth rate in this limit), then the dynamo is described as `fast'; this possibility has been intensively studied with a vast majority of investigations done in the simplest kinematic regime, with the fluid flow given beforehand, uninfluenced by the effect of the Lorentz force. In this case, it is generally found that fast-dynamo eigenmodes have a pathological structure, non-differentiable wherever they are non-zero; the applicability of fast-dynamo theory to real physical systems is then questionable.

New fast-dynamo mechanisms have been obtained and described by the team members at IGS PAS, for which the growing magnetic field remains smooth during the whole dynamo process. This results from a random superposition of waves, perturbed by the magnetic field through the action of the Lorentz force and nonlinear interactions between kinetic and magnetic components of distinct waves.

It is well known that a field of random inertial waves in a fluid of non-zero resistivity η is capable of exciting a large-scale magnetic field through the ⌧-effect mechanism, pronounced in the induction equation

$$\partial_t\langle \boldsymbol{B}\rangle = \boldsymbol{\nabla}\times\boldsymbol{\mathcal{E}} + \boldsymbol{\nabla}\times[\langle \boldsymbol{u}\rangle\times\langle\boldsymbol{B}\rangle] + \eta\nabla^2\langle\boldsymbol{B}\rangle,$$

(1)

where E=〈u'×B'〉=⌧·〈B〉 is the large-scale electromotive force induced by the kinetic and magnetic components of small-scale wave field. In the fully dynamical situation, when the effect of the Lorentz force is taken into account, the α tensor is nonlinear in the mean field $\langle B \rangle$, which is of great significance, since even if the mean EMF lacks ability to induce an exponential growth of the weak seed magnetic field in the linear regime, there still remains a possibility for nonlinear amplification, even faster than exponential. Such an effect has been obtained numerically in the recent paper published in the SIAM J. Appl. Math. Indeed it was shown, that in an idealized setting (half-space and no boundary conditions at infinite depth) initial period of mean field decay was followed by strong nonlinear amplification, faster than exponential. This was achieved by consideration of interactions of linear waves generated by a vertically oscillating top boundary (vertical direction was associated with the direction of background rotation). These were the well-known Lehnert waves and in the absence of fluid's resistivity the large-scale EMF was generated by interactions of two waves with distinct frequencies. Such an EMF has an oscillatory time structure, however, due to nonlinear dependence on the mean magnetic field its time average is non-zero and it is turns out to be capable of fast mean field amplification.

A similar study involved the effect of beats (named by analogy with the acoustic effect of "beat"), published in J. Plasma Phys. – that is interactions between distinct forced MHD waves with close frequencies, which led to a more standard dynamo picture with exponential amplification of a weak seed field, in perfectly conducting fluids, in the limit of weak wave amplitudes, that is weak MHD turbulence. No geometric constraints resulting from presence of boundaries were included in the study and a weak forcing of very general structure, in the form of two Fourier modes was applied. Furthermore, two other mechanisms of large-scale EMF generation were proposed; the first one in the recent joint study with Professor Keith Moffatt, published in Geophys. Astrophys. Fluid Dyn. on large-scale dynamos by decaying Lehnert waves, were the mean EMF which was due to viscous decay was induced only temporarily, but lead to large-scale field amplification in a perfectly conducting medium. The last mechanism is based on dynamo driving by instabilities.

The second topic involved determination of the influence of weak thermal and magnetic diffusion on the so-called magnetic buoyancy instability. It is often conjectured in the literature, that the magnetic buoyancy instability has a profound influence on the dynamics of the Solar magnetic field. The Ph.D. thesis of Marek Grądzki, published in the form of a scientific article in the Astrophys. J. Suppl. Series, has been concerned with the issue of establishing a scaling law for the spatial length scales of variation of perturbations in the Solar tachocline and determination of the dynamical regime in that region. It has been shown, that the joint effect of the ohmic resistivity and thermal diffusion is very non-trivial, involving situation unallowed when only one of the effects is considered.

Finally some analysis of the geomagnetic data has also been performed with the aim to identify perturbations in the Earth's core via the time-series analysis. Based on the data from the World Data Centre maps of the magnetic field evolution during the last 70 years at the Core-Mantle Boundary have been prepared.

Conducting continuous observations of geomagnetic fields in Belsk, Hel, and Polish Polar Station Hornsund. Modernization of apparatus and development of measurement methods | **J. Reda, M. Neska, P. Czubak, S. Wójcik, A. Wójcik**

The main purpose of the research was a continuation of observations of geomagnetic field in three observatories of the Institute of Geophysics Polish Academy of Sciences: Central Geophysical Observatory at Belsk, Polish Polar Station at Hornsund, Geophysical Observatory at Hel (Fig. 1). All three observatories are members of IAGA (International Association of Geomagnetism and Aeronomy).

The network of geomagnetic observatories/permanent stations IG PAS in 2018

Belsk
- RIDE (EPOS) since 2011
- INTERMAGNET since 1992
- EMMA network since 2011

Hornsund
- RIDE (EPOS) since 2011
- INTERMAGNET since 2002
- IMAGE network since 1993
- Schumann Resonance observation

Hel
- RIDE (EPOS) since 2011
- INTERMAGNET since 1999
- EMMA network since 2013
- IMAGE network since 2018

Suwałki
- RIDE (EPOS) since 2011
- IMAGE network since 2018
- EMMA network since 2011
- Schumann Resonance observation

Birzai
- IMAGE network since 2015
- EMMA networks since 2011

Polesie
- EMMA network since 2014
- IMAGE network since 2018

Zagórzyce
- EMMA network since 2014

RIDE	Research Infrastructure Database for EPOS
INTERMAGNET	International Real-time Magnetic Observatory Network
EMMA	European quasi-Meridional Magnetometer Array
IMAGE	International Monitor for Auroral Geomagnetic Effects

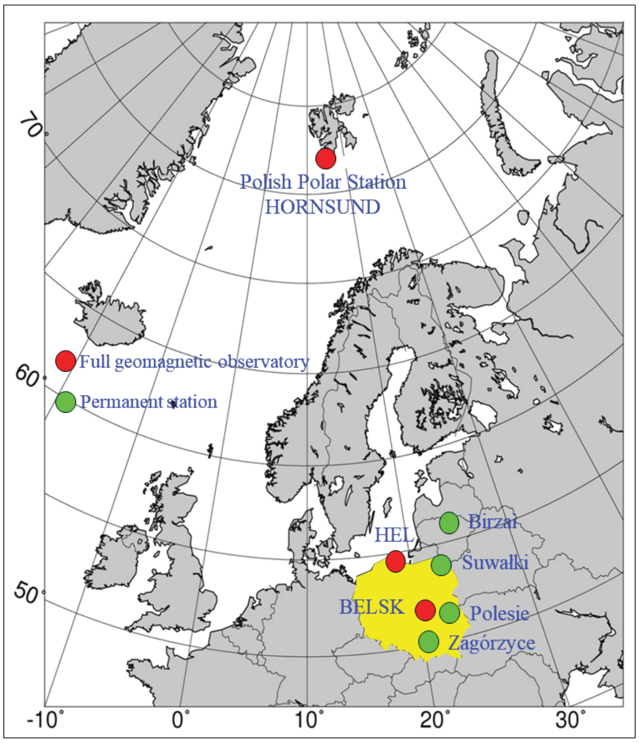

Figure 1. Map of IG PAS observatories and permanent stations performing continuous observations of the Earth's magnetic field in 2018.

The main activity of geomagnetic observatories comprehends recording changes of the geomagnetic field with full absolute control and publishing the observation results.

All three Polish geomagnetic observatories continued their work in INTERMAGNET (International Real-time Magnetic Observatory Network) in 2018. Data of geomagnetic field elements XYZF have been sent to the INTERMAGNET centre in real time so they are publicly available on the internet. At the beginning of 2018 we carried out the final data processing of the whole year observations of 2017. The final data (status Definitive) were provided for INTERMAGNET. Definitive Data are published on INTERMAGNET websites and also on a DVD containing data from all participating observatories for the given year. The final compilation of such DVDs is carried out in Belsk, what is an additional contribution of IG PAS to the INTERMAGNET program. The final geomagnetic data of IG PAS are provided to WDC Centers for Geomagnetism as well.

In 2018 there were prepared and provided for INTERMAGNET Quasi-Definitive Data every month. A quality of Quasi-Definitive is similar to Definitive-Data, but provided much earlier. These data are very important for the scientific world particularly in the context of the current SWARM satellite mission.

The Polish Polar Station Hornsund, Hel Observatory and the permanent stations in Birzai, Suwalki and Polesie (Fig. 1) have worked for the IMAGE program during the whole year (2018). The station Polesie and observatory Hel joined to IMAGE in 2018. The primary objectives of IMAGE is to study auroral electrojets and moving two-dimensional current systems. All five stations sent their real-time data to the IMAGE centre in Helsinki.

The recording and providing of real-time data series to EMMA network (European quasi-Meridional Magnetometer Array) has been continued. These data are exploited for investigation of the plasmasphere. From our side it involves Birzai, Suwałki, Hel, Belsk, Polesie, and Zagórzyce stations.

Furthermore in the permanent station Suwalki and in Polish Polar Station Hornsund the Schumann Resonance monitoring has been continued in 2018. It consists of measuring two horizontal magnetic components with a sampling frequency of 100 Hz. This recording was initiated by IG PAS in 2004.

An important element of our work in 2018 was training the members of the 41st Polar Expedition in the field of geomagnetic observations. Moreover, Belsk and Hel observatories provided assistance to institutions interested in geomagnetic observations such as the Institute of Geodesy and Cartography (IGiK) and the Space Research Centre of PAS (CBK PAN). In case of IGiK the cooperation concerned the Polish repeat station network conducted by IGiK. Belsk and Hel observatories are references for this network. CBK PAN was the recipient of real-time data from Belsk observatory, also there were provided K indices of geomagnetic activity every day except non-working days.

EPOS – PL European Plate Observing System; Task 3: CIBOGM - Centre of Research Infrastructure of Geomagnetic and Magnetotelluric Observations | W. Jóźwiak, A. Neska, J. Reda, K. Nowożyński, M. Neska, S. Oryński, P. Czubak

The aim of the European Plate Observing System (EPOS) project is creating an infrastructure for access to as well as exchange and integration of European geophysical data and metadata. The main task of EPOS-PL in the field of earth magnetism is an integration and dissemination of results obtained in geomagnetic observatories. First of all, time-series data measured in Polish observatories (Belsk, Hel, and Hornsund/Spitsbergen) and permanent variometer stations (Birżai/Lithuania, Suwałki, Polesie, Zagórzyce) will be provided to EPOS along with their meta-data in an xml format that facilitates integration with magnetotelluric time-series data. The appropriate software, e.g. for format conversion, is developed. Moreover, archival analog geomagnetic recordings from the mentioned and historical (i.e., Świder and Arctowski/Antarctica) observatories are scanned and arranged in proper order.

Thanks to EPOS, also the infrastucture for both magnetotelluric and observatory measurements (instrument pool) is modernized. A DI-flux theodolite, four Overhauser and two fluxgate magnetometers, 17 data loggers, two sets of induction coils for Schumann resonance monitoring, and two broadband magnetotelluric instruments have been or are planned to be purchased in this framework.

Its MT part or rather Tematic Core Service (TCS) is called EMTDAMO (European Magnetotelluric Data and Models). The project is on the first stage of its implementation and it will last for another few years. Whereas the focus on electric resistivity models is still a task for the future, some work on MT time series and transfer functions has been done already.

Metadata play a decisive role in both documentation and checking availability of certain types of data in an automated way. For these reasons EPOS attaches special importance to them. Metadata of MT time series in EPOS comprehend (but are not limited to) precise information on site location, measurement time and sampling interval, measured channels/ EM field components, instrumentation including system responses, underlying projects, and the institutions behind the data. Currently, we have an xml time series metadata format for internal purposes, and discussions with the international European community have led to an agreement on a json format for exchange of both time series and transfer function data along with their metadata. A format standard for exchanging resistivity models shall follow.

Currently the archival data sets prepared for EPOS comprehends 254 long period MT and GDS sites, some of which were occupied by an instrument not only once. The oldest data have been measured 20 years ago. The sites were situated in six countries (mainly in Poland and Germany) and on the Baltic Sea. The measurements were conducted by the Institute of Geophysics PAS in Warsaw, the Free University of Berlin, and the GEOMAR Helmholtz Centre for Ocean Research in Kiel. The distribution of sites over space and time MT and GDS sites prepared for EPOS. Those referred to later on the poster are marked is displayed on the map.

The main aim of EMTDAMO is making results of magnetotellurics, i.e., models of electric resistivity distribution in the solid earth, easier accessible to practitioners of other branches of earth sciences and comparable with their results. However, transfer functions and time series are included not only for reasons of model reproducibility but they can have their own scientific value. The latter are, e.g., potentially compatible with observatory and satellite data or they can be newly combined for sounding purposes when provided and documented in the way intended by EPOS.

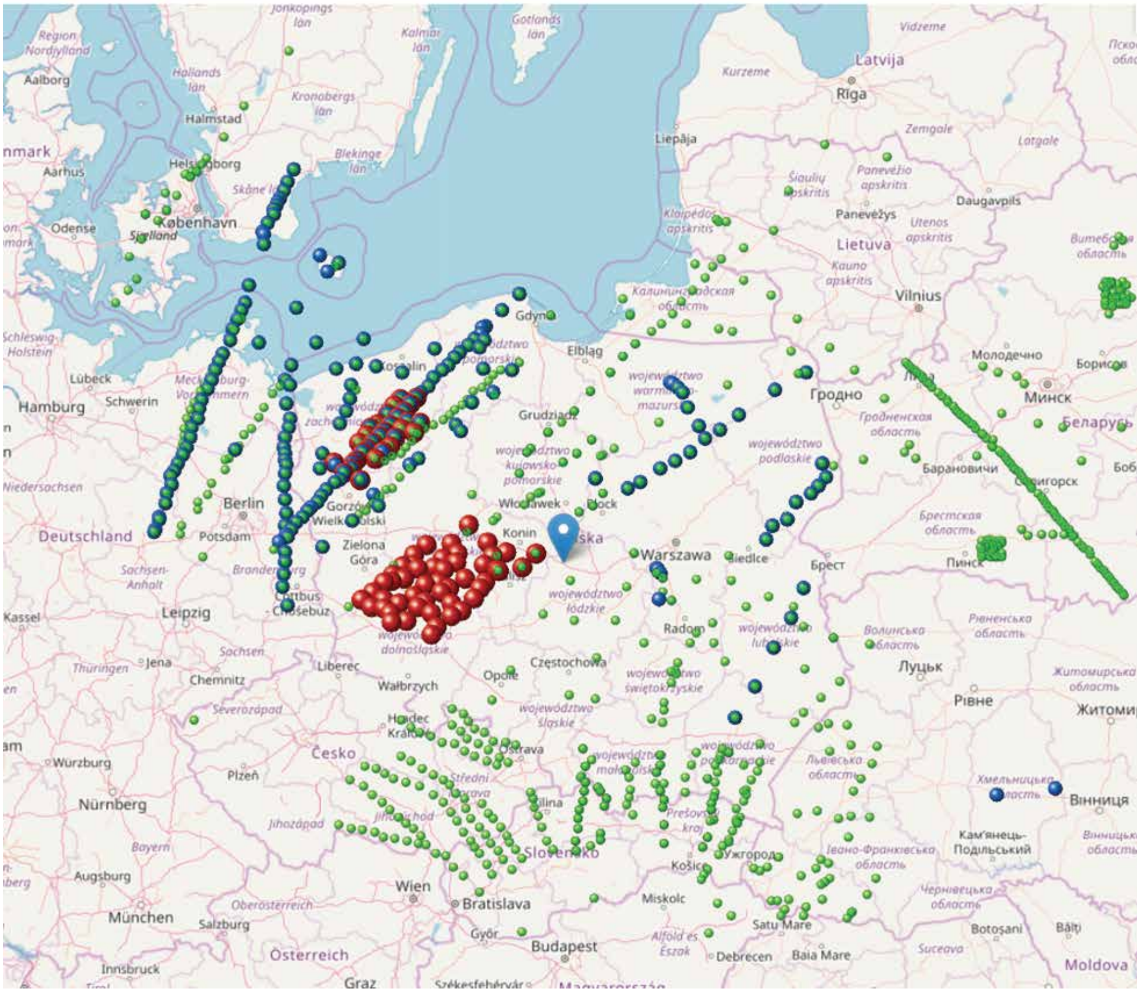

Figure 1. MT and GDS sites prepared for EPOS.

The EPOS-PL project is financed by the Operational Programme Smart Growth 20140-2020; Priority IV: Increasing The Research Potential, Action 4.2: Development Of Modern Research Infrastructure Of The Science Sector, Co-financing from European Regional Development Fund

European Funds
Smart Growth

Republic of Poland

European Union
European Regional Development Fund

Seminars and teaching

Seminars and lecture outside of the IG PAS

- A.Gumsley | *The hunt for Earth's first supercontinent* | Invited lecture
  University of Johannesburg | Johannesburg, South Africa

- A.Gumsley | *Supercontinents, large igneous provinces and environmental change: applying U-Pb geochronology to stratigraphy at the beginning of the Proterozoic* | Invited lecture
  University of Silesia | Sosnowiec, Poland

- K.Mizerski | *Równania hydrodynamiki a turbulencja* | Lecture
  University of Warsaw | Warsaw, Poland

- K.Mizerski | *Podstawy teorii ziemskiego dynama magnetycznego* | Seminar
  Institute of Fundamental Technological Research Polish Academy of Sciences | Warsaw, Poland

- M.Grądzki | *Influence of diffusion on magnetic buoyancy instability* | Seminar
  Institute of Fundamental Technological Research Polish Academy of Sciences | Warsaw, Poland

- M.Grądzki | *Wpływ dyfuzji na niestabilność wyporności magnetycznej* | Seminar
  University of Warsaw | Warsaw, Poland

- A.Bury | *Analiza zaburzeń pola magnetycznego Ziemi widocznych w danych pomiarowych* | Seminar
  University of Warsaw | Warsaw, Poland

Teaching thesis

- D. Staneczek | *In preparation* | Supervisor: R. Szaniawski

- E. Gaitán | *U-Pb geochronological and chemical constraints on the ca. 2170 Ma magmatic event of the Kaapvaal Craton: implications for continental reconstructions* | Primary: Söderlund, Co-supervisor: A. Gumsley

- K. Rzepka | *Przestrzenna analiza wyników interpretacji 1Di 2D krzywych sondowań magnetotllurycznych dla wybranych danych z rejonu polskiej części platformy wschodnioeuropejskiej* | Supervisor: W. Jóźwiak

Completed PhD thesis defense

- M. Grądzki | *Wpływ oporności elektrycznej i przewodnictwa cieplnego na krótkofalową niestabilność wyporności magnetycznej* | Supervisor: K. Mizerski

- M. Gwizdała | *Zastosowanie własności magnetycznych osadów glacjalno- morskich do jakościowej analizy egzaracji lodowca Werenskiolda (SW część Ziem Wedela Jarlsberga, Spitsbergen)* | Supervisor: M. Teisseyre-Jeleńska

- K. Dudzisz | *Paleomagnetic and rock magnetic investigations of the Triassic rocks from Svalbard Archipelago* | Supervisor: R. Szaniawski

- M. Burzyński | *Paleomagnetyzm, własności magnetyczne oraz petrografia skał meta-magmowych Zachodniego Spitsbergenu* | Supervisor: M. Lewandowski

Visiting scientists

- Mark Dekkers | Utrecht University, Earth Sciences Department | Utrecht, the Netherlands
- Bernard Henry | Institut de Physique du Globe | Paris, France
- Ann Hirt | Institute of Geophysics, ETH Zurich | Zurich, Switzerland
- Aldo Winkler | Istituto Nazionale di Geofisica e Vulcanologia, Roma 2 Section | Rome, Italy
- Hana Grison | Institute of Geophysics of the CAS, Academy of Sciences of the Czech Republic | Prague, Czech Republic
- Frantisek Hrouda | AGICO Ltd., Brno, Czech Republic, Charles University, Faculty of Sciences | Prague, Czech Republic
- David W. Hughes | Department of Applied Mathematics, University of Leeds | Leeds, United Kingdom
- Grace Cox | Dublin Institute for Advanced Studies | Dublin, Ireland

Meeting, workshop conferences and symposia

16th Castle Meeting. "New Trends on Paleo, Rock and Environmental Magnetism" | Chęciny, Poland

Dytłow, Górka-Kostrubiec | Passive Dust Samplers as More Effective Study Material than Street Dust for Characteristic of Traffic Derived Pollution | oral

Gonet, Górka-Kostrubiec, Łuczak-Wilamowska | Assessment of Topsoil Contamination Near the Stanisław Siedlecki Polish Polar Station in Hornsund, Svalbard, Using Magnetic Methods | poster

Górka-Kostrubiec, Werner, Dytłow, Szczepaniak-Wnuk, Jeleńska, Hanc-Kuczkowska | Identification of Metallic Iron in an Urban Dust Using Magnetometry, Microscopic Observations and Mössbauer Spectroscopy | poster

Gwizdała, Jeleńska, Łęczyński | Environmental Conditions in the Werenskiold Glacier Basin (Spitsbergen, Arctic): Magnetic Study | poster

Jeleńska | Magnetometry Used for Comparison of Heavy Metals Air Pollution Inside and Outside Home; Case Study from Warsaw | poster

Kądziałko-Hofmokl, Werner | Fe-Cr Mixed Binary Spinels as Accessory Magnetic Minerals in the Sudetic Ophiolitic Rocks | poster

Muraszko, Ziółkowski, Blukis, Werner | Cosmic Dust as a Carrier of Natural Remanent Magnetisation? A Case Study from the Jurassic Stromatolites from the Zalas Quarry, Krakow Upland, Poland | poster

Szczepaniak-Wnuk, Górka-Kostrubiec | Assessment of Heavy Metal Pollution of Vistula River Sediments using Magnetic Method | poster

Dudzisz, Hanc – Kuczkowska | A detailed study on the magnetic mineralogy of the Lower Triassic sedimentary rocks from Spitsbergen | oral

Niezabitowska, Szaniawski, Jackson | Magnetic Mineral Composition as a Potential Indicator of Depositional Conditions in Gas-Bearing Silurian Shale Rocks from Northern Poland | poster

Burzyński, Michalski, Nejbert, Manby, Domańska-Siuda | Meta-igneous Rocks from South-Western Oscar II Land (Western Spitsbergen) and their Usefulness in Palaeomagnetic Investigations | oral

Michalski | Palaeomagnetism in the High Arctic. Palaeomagnetic Investigations of Svalbard Archipelago Conducted by the Institute of Geophysics, Polish Academy of Sciences from 1999 to 2018 | invited oral

Lewandowski, Werner, Karasiński, Matesič, Paszkowski | Palaeomagnetic Inclination Error in the Red-beds Deposits: A Contribution from the Ediacaran Sedimentary Rocks of the Western Part of the East European Platform | oral

Gumsley, Evans, Bleeker, Chamberlain, de Kock, Söderlund | The geological and paleomagnetic evidence for a late Neoarchean to early Paleoproterozoic supercontinent | poster

3rd International Conference on Atmospheric Dust – DUST 2018 | Bari, Italy

Dytłow, Górka-Kostrubiec | Passive dust samplers – effective tool to assess traffic related pollution level | oral

Górka-Kostrubiec, Gonet, Łuczak-Wilamowska | Topsoil pollution level near the Stanisław Siedlecki Polish polar station in Hornsund, Svalbard, evaluated by distribution of magnetic susceptibility and microscopic observation | poster

Górka-Kostrubiec, Werner, Dytłow, Szczepaniak-Wnuk, Jeleńska, Hanc-Kuczkowska | Presence of metallic iron in an urban dust detected by magnetic methods, microscopic observations and Mössbauer spectra | poster

II Scientific Meeting in the Environmental Magnetism | Warsaw, Poland
Szczepaniak-Wnuk, Górka-Kostrubiec, Dytłow | Badania zanieczyszczenia metalami ciężkimi osadów rzeki Wisły na wybranych jej odcinkach z zastosowaniem metod magnetycznych (Polish) | oral

Górka-Kostrubiec, Olszewska | Integracja infrastruktury badawczej w ramach projektu EPOS-PL | oral

Werner | Udostępnianie infrastruktury badawczej laboratorium paleomagnetycznego dla polskiego środowiska naukowego w ramach projektu EPOS-PL (Polish) | oral

EGU General Assembly 2018 | Vienna, Austria
Dudzisz, Szaniawski, Michalski, Chadima | Rock magnetism of the Lower Triassic sedimentary rocks from Spitsbergen | poster

Szaniawski, Jankowski, Ludwiniak, Mazzoli, Szczygieł | New paleomagnetic and magnetic fabric results from hematite-bearing Lower Triassic redbeds from the Central Western Carpathians | poster

Bury, Mizerski | Investigation of the fundamental types of the Earth's core perturbations in the oscillations of the geomagnetic field | oral

AAPG ICE 2018 | Capetown, South Africa
Niezabitowska Szaniawski, Jackson | Magnetic Mineral Composition as a Potential Indicator of Depositional Conditions in Gas-Bearing Silurian Shale Rocks from Northern Poland | poster

Geocongress | Johannesburg, South Africa
Gumsley | Direct Mesoproterozoic connection of Congo and Kalahari cratons in proto-Africa | oral

Gumsley | The 2789-2782 Ma Klipriviersberg large igneous province: implications for the chrono-stratigraphy of the Ventersdorp Supergroup and the timing of Witwatersrand gold deposition | oral

Gumsley | A controversy resolved: a precise U-Pb baddeleyite age for the Ongeluk Large Igneous Province | oral

Gumsley | The Molopo Farms Complex's age and country rock provenance: implications for Transvaal Supergroup correlations in southern Africa | oral

33rd Nordic Geological Winter Meeting | Copenhagen, Denmark
Michalski, Manby, Nejbert, Domańska-Siuda, Burzyński | Integration of palaeomagnetic, isotopic and structural data to understand Svalbard Caledonian Terranes assemblage | oral

11th Geosymposium of Young Researchers | Istebna, Poland
Gumsley | The late Neoproterozoic: the crossroad between the modern and ancient Earth | oral

Gumsley | Kenorland: Earth's first supercontinent? | oral

Ny-Ålesund Atmosphere Flagship open workshop | Potsdam, Germany
Karasiński | Preliminary results of the analysis of the inflow of air masses to the area of Hornsund fjord for the years 2005-2017 | oral

Workshop on Changes of the Polar Ecosystem | Czechy, Mala Skala

Karasiński | First view on air masses inflow in the surroundings of Polish Polar Station at Hornsund by analysis of backward trajectories | oral

The 24th EM Induction Workshop | Helsingoer, Dania

Ernst, Jóźwiak | Temporal changes of geomagnetic induction arrows in non-seismic regions: fiction or reality ? | poster

Oryński, Jóźwiak, Nowożyński | Deep lithospheric structure beneath Dolsk and Odra fault zones as a result of integrated Magnetotelluric 1-D, 2-D and 3-D data interpretation | poster

Klityński, Oryński | Combined quantitative interpretation of GCM and DC sounding data from selected area in Cracow, Poland | poster

Neska, Brasse | Magnetotelluric data and models within the EPOS project the Polish contribution to EMTDAMO | poster

World Congress on Plasma Science & Technology | Stockholm, Sweden

Mizerski, Moffatt | Magnetic field relaxation in the configuration of a sheet pinch in a low-β plasma | oral

MHD Days and GdRI Dynamo Meeting | Dresden, Germany

Mizerski | Mean field dynamo mechanisms in highly conducting fluids | oral

Grądzki, Mizerski | The effect of weak magnetic and thermal diffusion on magnetic buoyancy instability | oral

The XVIIIth IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing | Conrad Observatory, Austria

Neska | How the K index of geomagnetic activity helps to assess the data amount for magnetotelluric soundings | oral

Reda, Kozlakiewicz, Neska, Czubak | Scanning historical magnetograms kept in the archives of Institute of Geophysics Polish Ac. of Sc. | oral

ICAE 2018, 16th International Conference on Atmospheric Electricity | Nara, Japan

Williams, Guha, Liu, Boldi, Pracser, Said, Satori, Bozoki, Bor, Atkinson, Beggan, Cummer, Lyu, Fain, Hobara, Koloskov, Kulak, McCraty, Mlynarczyk, Montanya, Moore, Neska, Ortega, Price, Rawat, Sato, Sinha Yampolski | The Ranking of Africa in Daily Global Lightning Activity | poster

INTERMAGNET Meeting 2018 | Vienna, Austria

Reda | The collection of one-minute 2015 definitive data | oral

Publications

Beata Górka-Kostrubiec, 2018, Assessment of topsoil contamination near the Stnisław Siedlecki Polish Polar Station in Hornsund, Svalbard, using magnetic methods; Polar Science

Rafał Junosza-Szaniawski, 2018, Burial and exhumation of the western border of the Ukrainian Shield (Podolia): a multi-disciplinary approach; BASIN RESEARCH

Sylwia Dytłow, Beata Górka-Kostrubiec, 2018, Comparison of traffic-related pollution level using street dust and passive dust samplers; ProScience

Beata Górka-Kostrubiec, Tomasz Werner, Sylwia Dytłow, Iga Szczepaniak-Wnuk, Maria Teisseyre-Jeleńska, 2018, Detection of metallic iron in urban dust by magnetic methods and microscopic observations; ProScience

Ashley Gumsley, 2018, Direct Mesoproterozoic connection of the Congo and Kalahari cratons in proto-Africa: Strange attractors across supercontinental cycles; GEOLOGY

Krzysztof Mizerski, 2018, Dynamo generation of a magnetic field by decaying Lehnert waves in a highly conducting plasma; GEOPHYSICAL AND ASTROPHYSICAL FLUID DYNAMICS

Krzysztof Mizerski, 2018, Large-scale dynamo action driven by forced beating waves in a highly conducting plasma; JOURNAL OF PLASMA PHYSICS

Krzysztof Mizerski, 2018, Large-Scale HydroMagnetic Dynamo by Lehnert Waves in Nonresistive Plasma; SIAM JOURNAL ON APPLIED MATHEMATICS

Dominika Niezabitowska, Rafał Junosza-Szaniawski, 2018, Magnetic Anisotropy in Silurian Gas-Bearing Shale Rocks from the Pomerania Region (Northern Poland); Journal of Geophysical Research: Soilid Earth

Iga Szczepaniak - Wnuk, Beata Górka - Kostrubiec, 2018, Magnetic Study of Sediments from the Vistula River in Warsaw - Preliminary Results; GeoPlanet: Earth and Planetary Sciences

Maria Teisseyre-Jeleńska, Beata Górka-Kostrubiec, Sylwia Dytłow, 2018, Magnetic Vertical Structure of Soil as a Result of Transformation of Iron Oxides During Pedogenesis. The Case Study of Soil Profiles from Slovakia and Ukraine; GeoPlanet: Earth and Planetary Sciences

Mariusz Tadeusz Burzyński, Krzysztof Michalski, 2018, Mineralogical, rock-magnetic and palaeomagnetic properties of metadolerites from central Western Svalbard; Minerals

Rafał Szaniawski, 2018, New paleomagnetic and magnetic fabric results from hematite-bearing Lower Triassic redbeds of the Central Western Carpathians; GEOPHYSICAL RESEARCH ABSTRACTS

Jan Reda, 2018, Observing the cold plasma in the Earth's magnetosphere with the EMMA network; ANNALS OF GEOPHYSICS

Michał Malinowski, Marek Lewandowski, 2018, On the nature of the Teisseyre-Tornquist Zone; Geology, Geophysics & Environment

Jan Reda, Mariusz Neska, Anne Neska, 2018, On the relevance of source effects in geomagnetic pulsations for induction soundings; ANNALES GEOPHYSICAE

Katarzyna Dudzisz, Rafał Junosza-Szaniawski, Krzysztof Michalski, 2018, Palaeomagnetic, rock-magnetic and mineralogical investigations of the Lower Triassic Vardebukta Formation from the southern part of the West Spitsbergen Fold and Thrust Belt; GEOLOGICAL MAGAZINE

Krzysztof Michalski, 2018, Palaeomagnetism of metacarbonates and fracture fills of Kongsfjorden islands (western Spitsbergen): Towards a better understanding of late- to post-Caledonian tectonic rotations; POLISH POLAR RESEARCH

Tomasz Ernst, Waldemar Jóźwiak, 2018, Pre-seismic geomagnetic and ionosphere signatures related to the Mw5.7 earthquake occurred in Vrancea zone on September 24, 2016; Acta Geophysica

Katarzyna Dudzisz, Rafał Junosza-Szaniawski, Krzysztof Michalski, 2018, Rock magnetism and magnetic fabric of the Triassic rocks from the West Spitsbergen Fold-and-Thrust Belt and its foreland; TECTONOPHYSICS

Krzysztof Andrzej Mizerski, 2018, Subtle structure of streamers under conditions resembling those of Transient Luminous Events; ARCHIVES OF MECHANICS

Marek Grądzki, Krzysztof Mizerski, 2018, The Effect of Weak Resistivity and Weak Thermal Diffusion on Short-wavelength Magnetic Buoyancy Instability; ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES

Tomasz Werner, 2018, The Hilina Pali palaeomagnetic excursion and possible self-reversal in the loess from western Ukraine; BOREAS

Magdalena Gwizdała, Maria Jeleńska, 2018, The magnetic method as a tool to investigate the Werenskioldbreen environment (south-west Spitsbergen, Arctic Norway); POLAR RESEARCH

Tomasz Werner, 2018, 'Is the Hilina Pali "palaeomagnetic excursion" becoming another example of the reinforcement syndrome? A comment inspired by Nawrocki et al. (2018)': Reply to comments; BOREAS

Chapters

Vladimir Semenov, Maxim Petrishchev, 2018, Electromagnetic Monitoring; INDUCTION SOUNDINGS OF THE EARTH'S MANTLE

Vladimir Semenov, Maxim Petrishchev, 2018, Impedances, Sources and Environments; INDUCTION SOUNDINGS OF THE EARTH'S MANTLE

Vladimir Semenov, Maxim Petrishchev, 2018, Magnetic Susceptibility of Sediments as an Indicator of the Dynamics of Geomorphological Processes; Magnetometry in Environmental Sciences

Vladimir Semenov, Maxim Petrishchev, 2018, Modeling of Deep Soundings; INDUCTION SOUNDINGS OF THE EARTH'S MANTLE

Vladimir Semenov, Maxim Petrishchev, 2018, Results of Deep Soundings in Europe; INDUCTION SOUNDINGS OF THE EARTH'S MANTLE

Vladimir Semenov, Maxim Petrishchev, 2018, Several Impedances from One Equation; INDUCTION SOUNDINGS OF THE EARTH'S MANTLE

Books

Vladimir Semenov, Maxim Petrishchev, 2018, INDUCTION SOUNDINGS OF THE EARTH'S MANTLE; SPRINGER-VERLAG BERLIN, HEIDELBERGER PLATZ 3, D-14197 BERLIN

Maria Teisseyre - Jeleńska, Tadeusz Ossowski, Leszek Łęczyński, 2018, Magnetometry in Environmental Sciences; Springer