

A photograph of the Aurora Borealis (Northern Lights) over a snowy mountain range at night. The aurora displays vibrant green and purple bands against a starry night sky. The mountains in the foreground are covered in snow and are dark against the bright sky.

Department of
Magnetism

• ABOUT

The activities of the Department of Magnetism include the studies of lithospheric structures and dynamic processes inside the Earth, environmental magnetism, and the study of magnetohydrodynamics with applications to the dynamics of the Earth's interior.

Problems of environmental pollution (outdoor and indoor air, soil and water sediments) and their wide range of impacts on human life are contained within the NM1 task. In 2021, the work was focused on the application of combined magnetic and non-magnetic methods to study quality of outdoor and indoor air, transformations of Fe-bearing magnetic minerals in technogenic soils, pollution around former and active mining areas and to identify which of Fe-bearing phases bind heavy metals in road dust. The multidisciplinary national and international level collaboration allowed to study sources of urban air pollution and to evaluate adverse health effects related to exposure pathway of heavy metals. The monitoring service of the concentration of particulate matter (PM10 and PM2.5) and its magnetic susceptibility to trace the trends in the ground-level air pollution variability was also continued.

The research group working on the NM2 task conducted research on paleogeographic and tectonic issues. In 2021, research work was carried out in the Carpathians (Slovakia and Poland) and Svalbard, as well as in the area of the East European Craton, the latter studied based on rock material from drilling cores. The main subject of these research works was the paleoposition of lithospheric plates and tectonic deformations related to the collision of lithospheric plates and the formation of mountain belts. The problem of stability of the magnetic field in the Proterozoic was also investigated. In addition, organic-rich shales were studied in the context of environmental changes, in particular the variable geochemical conditions on the seabed and related preservation of organic matter in marine sediments.

Within the NM3 task, the construction of regional models of the geoelectric structure as well as research on source effects in the magnetotelluric method was continued. A detailed, three-dimensional model of the resistivity distribution in the lithosphere in Poland has been developed using the magnetotelluric and the magnetovariation data from 593 points collected over the last 50 years. Other activities included the study of large-scale magnetic fields and their generation in the Earth's core and other astrophysical objects, such as the Sun and the Milky Way galaxy. It was shown that turbulent fluctuations of the Lorentz force in the fluid medium (liquid iron or plasma) can lead to creation of negative diffusivity effects and rapid enhancement of the magnetic energy. Throughout 2021, the monitoring tasks included the absolute measurements and continuous recording of the Earth's magnetic field in Bel'sk, Hel and Hornsund (Spitsbergen) observatories, a continuous recording of geomagnetic field changes with real-time data access at four permanent stations and Schumann Resonance observations in Hornsund and Suwałki. Our magnetic observatories and permanent stations participated in the INTERMAGNET, IAGA, IMAGE and EMMA networks. We are also continuously providing geomagnetic data for SWARM missions.

Furthermore, in 2021 the works on the paleomagnetic and magnetotelluric databases was completed under the EPOS-PL project.

• PERSONNEL

Head of Department

Waldemar Józwiak | Associate Professor

Professors

Magdalena Kądziałko-Hofmokl

Marek Lewandowski

Maria Teisseyre-Jeleńska

Associate Professors

Tomasz Ernst

Beata Górka-Kostrubiec

Rafał Junosza-Szaniawski

Krzysztof Michalski

Krzysztof Mizerski

Anne Neska

Krzysztof Nowożyński

Assistant Professors

Katarzyna Dudzisz

Sylwia Dytłow

Marek Grądzki

Dominika Niezabitowska

Szymon Oryński

Laboratory Technician

Grzegorz Karasiński

Technicians

Paweł Czubak

Krzysztof Kucharski

Mariusz Neska

Anna Wójcik

Stanisław Wójcik

Head of Laboratory for Paleomagnetism and Environmental Studies

Tomasz Werner

Head of Belsk Observatory

Jan Reda

PhD STUDENTS

Agata Bury | Poland | supervisor: Anne Neska

Paweł Jujeczko | Poland | supervisor: Krzysztof Mizerski

Sarasija Sanaka | India | supervisor: Anne Neska

Dorota Staneczek | Poland | supervisor: Rafał Szaniawski

Wojciech Szkółka | Poland | supervisor: Krzysztof Mizerski

• MAIN RESEARCH PROJECTS

EPOS – PL European Plate Observing System; Task 4- CIBAL - Centre of Research Infrastructure of Analytical laboratories | T. Werner, B. Górka-Kostrubiec | European Union, European Regional Development Fund, Operational Program Smart Growth 2014 - 2020 | 2017 - 2022

EPOS – PL + European Plate Observing System; Task 4- CIBAL - Centre of Research Infrastructure of Analytical laboratories | T. Werner, S. Dytłow | European Union, European Regional Development Fund, Operational Program Smart Growth 2014 - 2020 | 2020 - 2023

Diagramy FORC jako narzędzie do kompleksowej charakterystyki faz ferromagnetycznych | K. Dudzisz | NCN MINIATURA | 2019 - 2021

Magnetic fatigue: effect of cyclic loading under elevated temperatures on the magnetic and structural behaviour | K. Dudzisz | Deutsche Forschungsgemeinschaft (DFG) | 2021

EPOS – PL European Plate Observing System; Task 3 - CIBOGM Geomagnetic and Magnetotelluric Observations Research Infrastructure Center | W. Józwiak | European Union, European Regional Development Fund, Operational Program Smart Growth 2014 - 2020 | 2017 - 2022

EPOS – PL + European Plate Observing System; Task 3 - CIBOGM Geomagnetic and Magnetotelluric Observations Research Infrastructure Center | W. Józwiak | European Union, European Regional Development Fund, Operational Program Smart Growth 2014 - 2020 | 2020 - 2023

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. Józwiak | National Science Centre Opus 13 | 2018 - 2021

Buoyancy driven magnetic dynamo | K. Mizerski | NCN SONATA BIS | 2018 – 2021

Svalbox 2.0 – FAIR geoscientific data from Svalbard | K. Michalski | Research council of Norway | 2021 - 2023

• INSTRUMENTS AND FACILITIES

Equipment

Equipment for field laboratory for paleomagnetism and environmental magnetism

- MS2 susceptibility meter (Bartington, Great Britain) with sensors
- MS3 susceptibility meter (Bartington, Great Britain) with sensors

financed by EPOS-PL+

- DJI MATRICE 600 PRO drone with AIR DRON/ AD – SH 24 unit for PM measurements
- PM meter/sampler (DustTrak 8533DRX, TSI, USA) – 2 pcs
- Black carbon meter – aethalometr (AE-51, Aeth-Labs, USA)
- MS3 susceptibility meter (Bartington, Great Britain) with new sensors
- Portable rock drills (RSD, Germany) – 2 pcs
- Nonmagnetic sample containers (Magnetic Measurements, Great Britain) – 4 pcs

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
- 8 Magnetotelluric low-frequency stations Geomag
- 6 Low-frequency magnetometers LEMI
- 4 PMP proton magnetometers
- 4 Proton Overhauser magnetometers
- 2 Torsion photoelectric magnetometers PSM
- 4 DIFLUX magnetometers for absolute measurements
- 4 Induction coil magnetometers
- 1 GEM GSM-19T Gradiometer
- 1 Electromagnetic conductivity meters CMD MiniExplorer 6L (2021)
- 13 NDL digital recorders
- 18 LB-480 digital recorders

Laboratory

Laboratory for paleomagnetism and environmental studies - 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, 2021 - the upgrade of cooling system (financed by EPOS-PL)
- 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/ Anhyseretic and Pulse Magnetizer, Agico, Czech Republic
- LDA3a/AMU1a, Alternating Field Demagnetizer/ Anhyseretic 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

Equipment for studies of magnetic hysteresis and Curie temperatures

- Micromag AGFM 2900-02 Alternating gradient force magnetometer, Princeton Measurements Corp.,USA
- VSM Nuvo Vibrating Sample Magnetometer, Molspin Ltd, Gr. Britain
- AVFTB (Advanced Variable Field Translation Balance) Petersen Instruments, Magnetic Measurements, Great Britain) upgrade of the cooler unit (EPOS-PL)
- STEPS III apparatus for SIRM (T) experiments (TUS Electronics, Poland) - upgrade of the new electronics (EPOS-PL)

Mass balances

- The microbalance MYA 5.4.Y F (RADWAG, Poland) for mass determination of PM collected on filters used in dust samplers (EPOS-PL)

• SEMINARS and TEACHING

SEMINARS AND LECTURE

K. Dudzisz | Can titanomagnetites from pyroclastic rocks be used to explain the emplacement mechanism and determine the emplacement temperatures? | Institute of Technology | Karlsruhe, Germany | 07.05.2021 | Seminar

K. Dudzisz | How deep and how far can pollution migrate from abandoned mining areas? Insights from the application of magnetic and electromagnetic methods | Institute of Technology | Karlsruhe, Germany | 11.06.2021 | Seminar

K. Mizerski | Negative diffusion effects in magnetohydrodynamic turbulence induced by fluctuations of the Lorentz force | Physics Faculty, University of Warsaw | Warsaw, Poland | 05.11.2021, 13.12.2021 | Seminar

TEACHING

K. Dudzisz, A. Kontny | Microstructures course (co-conducting the practical part) | Karlsruhe Institute of Technology | Karlsruhe, Germany

K. Mizerski, M. Grądzki | Hydromagnetic dynamo theory in geo- and astrophysics | Physics Faculty, University of Warsaw | Lecture

THESIS

R. Szaniawski (supervisor) | **Dominika Niezabitowska** | Rock magnetic properties of lower Paleozoic gas-bearing shale rocks from northern Poland | IGF PAN | Warsaw, Poland

VISITING SCIENTISTS

Darko Matešić | Faculty of Mining, Geology and Petroleum | Engineering, University of Zagreb | Zagreb, Croatia | 06 - 23.12.2021

Yuri Sumaruk | Institute of Geophysics of the National Academy of Sciences of Ukraine | Kiev, Ukraine | 07 - 17.11.2021

Dorota Staneczek | University of Silesia | Katowice, Poland | 15 - 20.03.2021 | 21 - 24.06.2021, 05 - 16.07.2021, 22 - 26.11.2021, 06 - 17.12.2021

MEETINGS, WORKSHOP CONFERENCES and SYMPOSIA

J. Reda | INTERMAGNET Meeting | Report on definitive data timelines | On-line meeting | 27.09 - 01.10.2021 | Oral and Poster | Online meeting

J. Reda | INTERMAGNET Meeting | Progress on one-second data collection | On-line meeting | 27.09 - 01.10.2021 | Oral + Poster | Online meeting

J. Nawrocki, K. Standzikowski, T. Werner, M. Łanczont, J. Gancarski, Z. Gil | EGU General Assembly 2021 | Reuse of medieval bricks as important limitation for construction of geomagnetic secular variation curves based on archeomagnetic studies of brick buildings in Poland | Vienna, Austria | 19 - 30.04. 2021 | Oral | Conference

M. Lewandowski, M.A. Kusiak, A. Nawrot, T. Werner, B. Barzycka, M. Laska, B. Luks | The 5th High latitude Dust Workshop | Seeking the Sources of Dust: Geochemical and Magnetic Studies on “Cryodust” in Glacial Cores from Southern Spitsbergen (Svalbard, Norway) | Reykjavik, Iceland | 10 - 11.02.2021 | Oral | Workshop

K. Dudzisz, R. Harrison | Magnetic Interactions 2021 | Magnetic signature recorded on soils from mining areas – an indicator of soil transformation? | St. Andrews, UK | 07 - 08.01.2021 | Poster | Conference

K. Dudzisz, M. Walter, R. Krumholtz, B. Reznik, A. Kontny | GeoKarlsruhe 2021: Sustainable Earth - from processes to resources | Effect of cyclic loading at elevated temperatures on the magnetic susceptibility of a magnetite-bearing ore. Karlsruh, Germany | 19 - 24.09.2021 | Oral | Conference

G. Karasiński, B. Górka-Kostrubiec, T. Werner | Workshop on Changes of the Polar Ecosystem | Measurements of magnetic susceptibility of PM10 in Warsaw | České Skalici, Czechy | 13 - 15.10.2021 | Oral | Workshop

K. Mizerski | International Congress on | Theoretical and Applied Mechanics ICTAM2020+1 | Large-scale magnetic field generation by wave interactions in highly conducting plasma | Milano (online) | 22 - 27.08.2021 | Oral | Conference

K. Mizerski | Konferencja Zastosowań Matematyki 49 | Renormalizacja równań magnetohydrodynamiki | Zakopane | 20 - 25.09.2022 | Oral | Conference

• PUBLICATIONS

ARTICLES

Dytłow S., Górka-Kostrubiec B., 2021, Concentration of heavy metals in street dust: an implication of using different geochemical background data in estimating the level of heavy metal pollution, *Environmental Geochemistry and Health*, 43, pp. 521–535.

Narloch W., **Werner T.**, et al., 2021, Deformation mechanisms and kinematics of a soft sedimentary bed beneath the Scandinavian Ice Sheet, north-central Poland, revealed by magnetic fabrics, *Sedimentary Geology*, 416, 105862.

Dudzisz K., Lewandowski M., Werner T., Karasiński G., et al., 2021, Paleolatitude estimation and premises for geomagnetic field instability from the Proterozoic drilling core material of the south-western part of the East European Craton, *Precambrian Research*, 357, 106135.

Magiera T., **Górka-Kostrubiec B.**, et al., 2021, Technogenic magnetic particles from steel metallurgy and iron mining in topsoil: Indicative characteristic by magnetic parameters and Mössbauer spectra, *Science of The Total Environment*, 775, 145605.

Williams E., **Neska M.**, et al., 2021, Evolution of Global Lightning in the Transition From Cold to Warm Phase Preceding Two Super El Niño Events, *Journal Of Geophysical Research-Atmospheres*, 126, 3, e2020JD033526.

Bury A., Lewandowski M., Mizerski K., 2021, Possible risk resulting from the recent decay of the dipolar component of the terrestrial magnetic field, *Acta Geophysica*, 69, pp. 47 – 52.

Niezabitowska D.K., et al., **Szaniawski R.**, 2021, Magnetic susceptibility variations in lower Paleozoic shales of the western Baltic Basin (northern Poland): A tool for regional stratigraphic correlations and the decoding of paleoenvironmental changes, *AAPG Bulletin*, 105, 5, pp. 987 – 1007.

Mizerski K.A., 2021, Renormalization group analysis of the turbulent hydromagnetic dynamo: Effect of anisotropy, *Applied Mathematics and Computation*, 126252.

Uzarowicz Ł., **Górka-Kostrubiec B.**, **Dudzisz K.**, et al., 2021, Magnetic characterization and iron oxide transformations in Technosols developed from thermal power station ash, *CATENA*, 202, 105292.

Nawrocki J, et al., **Werner T.**, 2021, Secular Variations of Inclination of the Geomagnetic Field in SE Poland Between 1200 and 1800 AD, *Geochronometria*, 48, 1.

Mizerski K. A., 2021, Possible Role of Non-Stationarity of Magnetohydrodynamic Turbulence in Understanding of Geomagnetic Excursions, *Symmetry*, 13, 10, 1881.

Mizerski K. A., 2021, Renormalization group analysis of the magnetohydrodynamic turbulence and dynamo, *Journal of Fluid Mechanics*, 926.

Oryński Sz., **Jóźwiak W.**, **Nowożyński K.**, 2021, An integrative 3-D model of the deep lithospheric structure beneath Dolsk and Odra fault zones as a result of magnetotelluric data interpretation, *Geophysical Journal International*, 227, 3, pp. 1917 – 1936.

Jones Ch. A., **Mizerski K. A.**, et al., 2021, Fully developed anelastic convection with no-slip boundaries, *Journal of Fluid Mechanics*, 930.

Mizerski K. A., 2021, Nonlinear turbulent dynamo induced by fluctuations of the Lorentz force, *Physical Review E*, 104, L053102.

Dudzisz K., et al., 2021, Effect of cyclic loading at elevated temperatures on the magnetic susceptibility of a magnetite-bearing ore, *Geophysical Journal International*, 228, 2, pp. 1346 – 1360.

Vellante M., et al., **Reda J.**, 2021, Multi-Instrument Characterization of Magnetospheric Cold Plasma Dynamics in the June 22, 2015 Geomagnetic Storm, *Journal Of Geophysical Research - Space Physics*, 126, 6, e2021JA029292.

MONOGRAPHS

Mizerski K.A., 2021, *Foundations of Convection with Density Stratification*, GeoPlanet Book Series, Springer.

Reda J., **Neska M.**, **Wójcik S.**, **Czubak P.**, 2021, *Results of Geomagnetic Observations: Belsk, Hel, Hornsund*, 2019, Publications of the Institute of Geophysics Polish Academy of Sciences, *Geophysical Data Bases, Processing and Instrumentation* 433 (C-114).