



**DEPARTMENT OF
GEOPHYSICAL IMAGING**

• ABOUT

The Department's activities in 2022 were traditionally focused on the two research topics. The first one deals with geophysical imaging of geological structures at various scales; the second one - with the mathematical analysis of complex systems in geophysics and the dynamics of porous media. We contribute to all four research areas of the Institute of Geophysics.

The year 2022 - like the previous one - was a period of changes. During the summer holidays there was a change of the head of the department – Michał Malinowski handed over his duties to Mariusz Białecki. The research team has been significantly strengthened - we have recruited one professor of the institute – Ali Gholami, and two assistant professors – Toktam Zand and Qamar Yasin. All doctoral students are finalizing their work on doctoral dissertations.

The Department's activities were mostly related to research projects. We continued five NCN projects and acquired two new projects: Mariusz Majdański's project within Horizon Europe program and Andrzej Górszczyk's project financed by NCBiR.

The most remarkable achievements made by the Department include:

- Multi-method geophysical mapping of ground properties and periglacial geomorphology in Hans Glacier forefield, SW Spitsbergen (Mariusz Majdański, Artur Marciniak)
- Imaging the effects of seamount subduction: evidence from the Tokai area, Nankai Trough, Japan (Andrzej Górszczyk)
- An evaluation of depth imaging methodologies for deep mineral targeting tested on complex Kylylahti deposit, Finland (Brij Singh, Michał Malinowski)
- Advancements in seismic depth imaging for mineral exploration using data from Ludvika, Sweden (Brij Singh, Michał Malinowski, Andrzej Górszczyk)
- Investigation of patterns in glacial microseismicity for Hansbreen terminus, Spitsbergen, Norway (Wojciech Gajek)
- Shallow gas expression of the petroleum system offshore western Poland — Pomeranian Bight (Quang Nguyen, Michał Malinowski)
- Fault and fracture network characterization using seismic data: a study based on neural network models assessment (Qamar Yasin, Mariusz Majdański)
- High resolution imaging of subduction zone using Ocean Bottom Nodes and Streamer Data (Toktam Zand, Andrzej Górszczyk, Ali Gholami)
- Improved Full Waveform Inversion by the Method of Multipliers (Ali Gholami)
- Methods for qualitative and quantitative assessment of the transformation of pore geometry of a rock as a result of karstification illustrated on Smerdyna's samples (Mariusz Białecki)

• PERSONNEL

Head of Department

Michał Malinowski | Professor (up to July 2022)

Mariusz Białecki | Associate Professor (from August 2022)

Professor

Michał Malinowski

Associate Professors

Mariusz Białecki

Ali Gholami

Mariusz Majdański

Assistant Professors

Wojciech Gajek

Andrzej Górszczyk

Qamar Yasin

Toktam Zand

PhD Students

Artur Marciniak | Poland | Supervisor: Mariusz Majdański

Brij Singh | India | Supervisor: Michał Malinowski

Quang Nguyen | Vietnam | Supervisor: Michał Malinowski

Rishabh Sharma (UW) | India | Co-supervisor: Mariusz Białecki

• MAIN RESEARCH PROJECTS

Three-dimensional imaging of subduction zones with full waveform inversion of two-dimensional seismic data | Górszczyk A. (PI), Zand T., Gajek W. | NCN OPUS | 2020 - 2023

Mechanistic explanation of a generation of (and deviations from) the universal curve of the Earthquake Recurrence Time Distribution by means of constructions of solvable stochastic cellular automata and their analytical description | Białecki M. (PI) | NCN OPUS | 2018 - 2023

Active and passive source multiscale subsurface imaging and monitoring based on the full seismic waveform | Malinowski M. (PI), Górszczyk A. | NCN SHENG | 2019 - 2022

Linking deep and shallow geological processes in the transition from Precambrian to Palaeozoic platform in the southern Baltic Sea using new geophysical data | Malinowski M. (PI), Nguyen Q. | NCN OPUS | 2018 - 2022

Anthropogenic triggering of landslides in the environment modified due to climate change - geophysical investigation | Marciniak A. (PI), Majdański M. | NCN PRELUDIUM | 2021 - 2023

Seismic and electromagnetic methods for deep mineral exploration | Górszczyk A. (PI), Singh B. | NCBiR 2022-2025

Geo-INQUIRE | Majdański M. | Horizon Europa | 2022-2026

Extension of seismic monitoring network in Hornsund | Majdański M. | SIOS | 2019-2022

• INSTRUMENTS and FACILITIES

Equipment

• Department equipment was not updated in 2022.

Laboratory

• Geophysical data analysis performed at the Department is supported by the local cluster composed of blade servers.

• SEMINARS and TEACHING

SEMINARS AND LECTURES

Majdański M. | Seismology and active seismic | UW (Physics) | Warsaw | Oct 2021 – Feb 2022 | Lecture (30h)



Majdański M. | Seismology and structure of the Earth | UW (Physics) | Warsaw | Oct 2021 – Feb 2022 | Lecture (30h)

Singh B. | Seismic Imaging in the hardrock environment | EAGE Local Chapter Czech Republic | Prague, Czech Republic | 23.05.2022 | Invited Lecture (online)

Gajek W. | Sejsmologia lodowców | AGH | Cracov | 4.4.2022 | Invited Lecture

TEACHING

Gajek W. | 4 weeks bachelor student internship supervision (AGH) | Ongoing supervision of bachelor thesis

THESIS

Majdański M. | **Julia Chachulska** (ongoing) | Sejsmika przypowierzchniowa w badaniach środowiskowych na przykładzie aktywnego osuwiska | UW (Physics) | Warsaw

VISITING SCIENTISTS

Luciano Telesca | Institute of Methodologies for Environmental Analysis, National Research Council | Tito, Potenza, Italy | 31.10-5.11.2022

MEETINGS, WORKSHOP CONFERENCES and SYMPOSIA

Bialecki M., Sharma R.P., Cooper M.P., Szymczak P. | EGU 2022 | Comparative study of undissolved and karstified limestone based on microtomography | Vienna, Austria | 23-27.05.2022 | Oral | Conference

Bialecki M. | Summer Solstice Conference on Discrete Models of Complex Systems | On a certain model of earthquake statistics in the form of probabilistic cellular automaton and its connections with various domains of mathematics | Gdańsk, Poland | 28.05.2022 | Oral (Invited) | Conference

Bialecki M., Sharma R.P., Cooper M.P., Szymczak P. | Computational Methods in Water Resources | Comparative study of undissolved and karstified limestone based on microtomography | Gdańsk, Poland | 19-23.06.2022 | Oral | Conference

Bialecki M. | International Conference on Difference Equations and Applications | Discrete probabilistic aggregative dynamics related to integer sequences | Paris, France | 18-22.07.2022 | Oral | Conference

Górszczyk A. | AGU 2022 | On the Reliability of 2D Regional-Scale Velocity Model Building in Complex Geological Setting | Chicago/USA | 12.12.2022 | Poster | Conference

Górszczyk A. | IMAGE/SEG 2022 | Structure of the Tokai segment from the integrated high-resolution seismic imaging: A case study from the eastern Nankai Trough | Houston/USA | 29.08.2022 | Oral | Conference

Górszczyk A. | EAGE 2022 | Mitigating the cycle-skipping problem with Graph Space Optimal Transport misfit function - practical considerations for regional-scale FWI from sparse OBN data | Madrid/Spain | 05.06.2022 | Oral | Conference

Górszczyk A. | SEISCOPE Annual Meeting | On the reliability of regional-scale velocity model building from 2D OBS data | Grenoble/France | 12.04.2022 | Oral | Workshop

Majdański M. | Jubileusz 50-lat Wrocławskiej Stacji Polarnej | Zmienność permafrostu w warunkach zamarzania i tajania w zlewni przybrzeżnej Fuglebekken, Hornsund | Wrocław, Poland | Apr 2022 | Oral | Conference

Majdański M., Dobiński W., **Marciniak A.**, Osuch M., Wawrzyniak T., Owoc B., and Glazer M. | EGU 2022 | The effect of subsurface freezing-thawing in the SW Svalbard on the newly deglaciated areas | Vienna, Austria | 23-27.05.2022 | Oral | Conference

Marciniak A., Stan-Kłeczek I., Wróbel M., **Majdański M.**, Kowalczyk S. | EAGE NSG 2022 | Integrated geophysical imaging in the landslide studies - a case study from Outer Carpathians, Poland | Belgrade, Serbia | Sep 2022 | Oral | Conference

Nguyen Q., Malinowski M., Kramarska R., Kaulbarsz D., Huebscher C. | EGU 22 | Linking shallow gas occurrences and deeper structure offshore western Poland (Pomeranian Bight) | Vienna, Austria | 23–27 May 2022 | Oral | Conference

Nguyen Q. | Cretaceous Symposium 2022 | The Late Cretaceous inversion of the Polish Basin and surrounding area – a current perspective based on seismic data. In book: Cretaceous of Poland and of adjacent areas. | Warsaw, Poland | 21-26 Aug 2022 | Symposium

Nguyen Q. | IMAGE 2022 | Shallow gas expression of the petroleum system offshore western Poland - Pomeranian Bight | Houston, USA | 28-1 Sept 2022 | Poster | Conference

Singh B. | Seems Deep Kick-off Meeting| Oulu, Finland |15-18.08.2022 | Meeting

Singh B., Malinowski M. | EAGE NSG Conference 2022 | Depth Imaging of Crooked Seismic Profiles in Hardrock Environment: Is 2D Enough? | Belgrade, Serbia | 18-22.09.2022 | Oral | Conference

Zand T., Górszczyk A., Gholami A., Ghasemzadeh H., Malcolm A. | IMAGE22 | Least-squares RTM with shifted total variation regularization for depth imaging of sparse short-offset seismic data | Houston, US | 30/8/2022 | Oral | Conference

Malinowski M. | EGU22 | Multicomponent seismic acquisition for the characterization of the groundwater system at Kurikka, western Finland | Vienna, Austria | 23-27.05.2022 | Oral | Conference

Malinowski M. | EAGE NSG Conference 2022 | Multicomponent Seismic Acquisition for the Characterization of the Complex Multiaquifer System at Kurikka, Western Finland | Belgrade | 18-22.09.22 | Oral | Conference

Malinowski M. | Lithosphere 2022 Symposium | Exploring East European Craton crust in Poland using state-of-the-art deep reflection seismic profiling | Turku | 15-17.11.22 | Oral (invited) | Conference

Malinowski M. | Lithosphere 2022 Symposium | Distributed acoustic sensing walkaway vertical seismic profiling in Koillismaa deep drillhole | Turku | 15-17.11.22 | Poster | Conference

Gajek W. | EGU | Hansbreen's calving-driven ice loss derived from seismic data supported by millimetre-wave radar scans and neural networks | Vienna, Austria | 23–27 April 2023 | Oral | Conference

Harcourt (coauthored by Gajek W.) | EGU | Millimetre-wave radar observations of glacier calving at Hansbreen (Svalbard) correlated with TLS, time-lapse camera images and seismic records | Vienna, Austria | 23–27 April 2023 | Oral | Conference

Marciniak A. (coauthored by Gajek W.) | EGU | Integrated time-lapse geophysical imaging and remote-sensing study of the antropoghenic triggering of the landslides | Vienna, Austria | 23–27 April 2023 | Oral | Conference

• PUBLICATIONS

ARTICLES

Janik T., Wójcik D., et al., **Malinowski M.**, 2022, Crustal structure across the Teisseyre-Tornquist Zone offshore Poland based on a new refraction/wide-angle reflection profile and potential field modelling, *Tectonophysics*, 828, 229271.

Chamarczuk M., **Malinowski M.**, et al., 2022, Reflection imaging of complex geology in a crystalline environment using virtual-source seismology: case study from the Kylylahti polymetallic mine, Finland, *Solid Earth*, 13, pp. 705–723.

Singh B., Malinowski M., Górszczyk A., et al., 2022, 3D high-resolution seismic imaging of the iron oxide deposits in Ludvika (Sweden) using full-waveform inversion and reverse time migration, *Solid Earth*, 13, pp. 1065–1085.

Cao J., et al., **Górszczyk A.**, 2022, 3-D multiparameter full-waveform inversion for ocean-bottom seismic data using an efficient fluid–solid coupled spectral-element solver, *Geophysical Journal International*, 229, 1, pp. 671–703.

Yasin Q., Majdański M., et al., 2022, An Analytical Hierarchy-Based Method for Quantifying Hydraulic Fracturing Stimulation to Improve Geothermal Well Productivity, *Energies*, 15 (19), 7368.

Yasin Q., et al., 2022, Evaluation of Neoproterozoic source rock potential in SE Pakistan and adjacent Bikaner–Nagaur Basin India, *Scientific Reports*, 12, 11102.

Yasin Q., Majdański M., et al., 2022, Fault and fracture network characterization using seismic data: a study based on neural network models assessment, *Geomechanics and Geophysics for Geo-Energy and Geo-Resources*, 8, 41.

Majdański M., et al., **Marciniak A.**, Owoc B., Osuch M., Wawrzyniak T., 2022, Variations of permafrost under freezing and thawing conditions in the coastal catchment Fuglebekken (Hornsund, Spitsbergen, Svalbard), *Permafrost and Periglacial Processes*, 33, 3, pp. 264–276.

Marciniak A., Osuch M., Wawrzyniak T., Owoc B., et al., **Majdański M.**, 2022, Multi-method geophysical mapping of ground properties and periglacial geomorphology in Hans Glacier forefield, SW Spitsbergen, *Polish Polar Research*, 43, 2, pp. 101–123.

Hloušek F., **Malinowski M.**, et al., 2022, Three-dimensional reflection seismic imaging of the iron oxide deposits in the Ludvika mining area, Sweden, using Fresnel volume migration, *Solid Earth*, 13, pp. 917–934.

Qian J., et al., **Malinowski M.**, 2022, First observation of paired microseismic signals during solution salt mining, *Frontiers in Earth Science*, 10 – 2022.

Chamarczuk M., et al., **Malinowski M.**, 2022, Towards adapting reverse vertical seismic profiling for ambient-noise imaging with transient sources: Automatic estimation of stationary-phase receivers for improved retrieval of the interferometric Green's function, 87, 6, pp. 1ND-V570.

Gholami A., et al., 2022, Automatic balancing parameter selection for Tikhonov-TV regularization, *Bit Numerical Mathematics*, 62, pp.1873–1898.