DEPARTMENT OF SEISMOTECTONICS

INSTITUTE OF ROCK STRUCTURE AND MECHANICS
of the Czech Academy of Sciences

THEMATIC RESEARCH FOCUS

- NEAR SURFACE AND CRUSTAL EXPLORATION VIA SEISMIC, GRAVIMETRIC AND RESISTIVITY DATA
- MONITORING AND ANALYSIS OF NATURAL AND INDUCED MICROSEISMICITY
- IMPLEMENTAION OF NOVEL TECHINQUES AND DEVICES FOR GEOPHYSICAL DATA ANALYSIS AND ACQUISITION WITH SPECIAL EMPHASIS ON SEISMICS
- ACTIVE TECTONICS

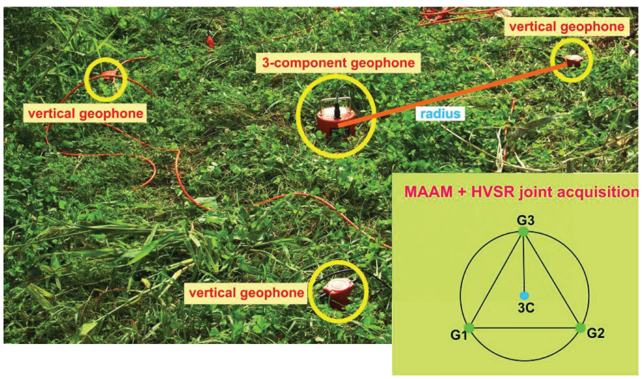
Acquiring geoelectrical data in the vicinity of the Temelín nuclear power plant

MAIN RESEARCH SUBJECTS

- Monitoring of fluid-induced microseismicity and its risk assessment
- Application and interpretation of seismic (surface and body) waves in a broad range of frequencies and scales (from near surface applications up to crustal studies)
- Analysis of earthquake, moment tensor inversion
- Prototyping novel sensors and devices for the acquisition of seismic data
- Seismic, resistivity and gravimetric data acquisition and analysis for near-surface studies (geotechnical applications, environmental monitoring, archaeological studies, geological mapping, seismic-hazard evaluation etc.)
- Evaluation of possible Earthquake precursors in the light of Global tectonics theories
- Paleoseismological evaluation of fault structures
- Joint analysis of surface waves according to advanced procedures (acquisition and inversion of multicomponent data)
- Brittle tectonics and paleostress analyses
- Probabilistic seismic hazard analysis
- Analysis of microseismicity caused by hydraulic fracturing for unconventional resources and geothermal energy

KEY RESEARCH EQUIPMENTS

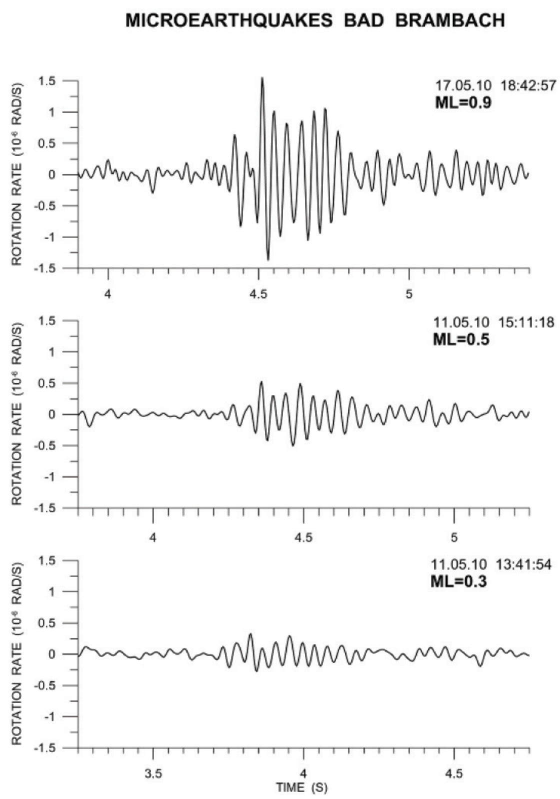
- Geode 24-channel Seismograph (Geometrics)
- Seismic equipment for continuous monitoring - RUP2012/SeisComP
- 4 Permanent Seismic Stations for Czech Regional Seismic Network (CzechGeo/EPOS)
- 5 Permanent Small Aperture Seismic Arrays
- CG-5 Gravity Meter
- ARES geoelectric apparatus
- Geophone SM6-3D (ION Geophysical Corporation)
- Seismometer CMG-40T (Guralp Systems)
- Seismometer STS-2 (Streckeisen)
- Rotaphones



Optimized acquisition of data for the joint analysis of the Horizontal-to-Vertical Spectral Ratio (HVSR) and the Miniature Array Analysis of Microtremors (MAAM), aimed at defining the Rayleigh-wave phase-velocity dispersion curve.

Geophysics is carried out anywhere and at any time. Seismic monitoring in the Třeboň Basin.

The Rotaphone: prototype of the seismic rotational sensor system and generator of rotational movements.



Testing of Rotapfone in USGS laboratory in Albuquerque, New Mexico, USA. Special rotary shock table facilitates a detailed determination of the Rotaphone parameters.

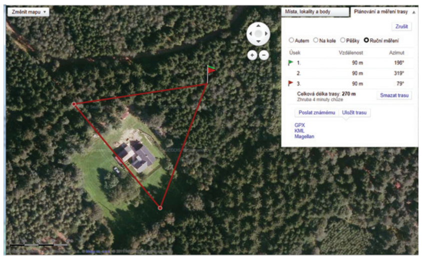
ACHIEVEMENTS

• Microseismic monitoring, Induced Seismicity

Anikiev D., Valenta J., Staněk, F. Eisner L., 2014. *Joint location and source mechanism inversion of microseismic events: benchmarking on seismicity induced by hydraulic fracturing.* Geophys. J. Int, 198, 249-258.

Benetatos Ch., Málek J., Verga F., 2013: *Moment tensor inversion for two micro-earthquakes occurring inside the Haje gas storage facilities, Czech Republic.* Journal of Seismology, 17, 557-577.

Clarke H., Eisner L., Styles P., Turner P., 2014. *Felt seismicity associated with shale gas hydraulic fracturing: The first documented example in Europe.* Geophys. Res. Lett., 41.



Nový Kostel Small Aperture Array

Eisner L., Gei D., Hallo M., Opršal I., Ali M., 2013. *The peak frequency of direct waves for microseismic events.* Geophysics, 78, A45–A49.

Opršal I, Eisner L., 2014. *Cross-correlation - an objective tool to indicate induced seismicity. Geophysical.* Journal International, 196, 1536-1543.

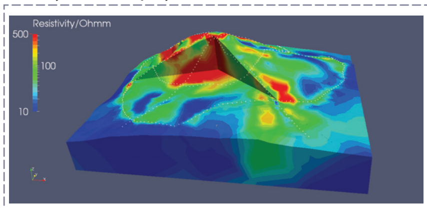
Staněk F., Eisner L., Moser T. J., 2014. *Stability of source mechanisms inverted from P-wave amplitude microseismic monitoring data acquired at surface.* Geophysical Prospecting, 62, 475–490.

• Seismicity, tectonics and paleostress analysis

Brokešová J., Málek J., 2013. *Rotaphone, a Self-Calibrated Six-Degree-of-Freedom Seismic Sensor and Its Strong-Motion Records.* Seismological Research Letters, 84, 737-744.

Fojtíková L., Zahradník J., 2014. *A new strategy for weak events in sparse networks: the first-motion polarity solutions constrained by single-station waveform inversion.* Seismological Research Letters, 85, 1265-1274.

Hartvich F., Valenta J., 2013. *Tracing an intramontane fault: an interdisciplinary approach.* Surveys in Geophysics, 34, 317–347.



3D reconstruction of the Zebín volcano by means of DC resistivity tomography.

Kolínský P., Valenta J., Gaždová R., 2012. *Seismicity, groundwater level variations and Earth tides in the Hronov-Poříčí Fault Zone, Czech Republic.* Acta Geodynamica et Geomaterialia, 9, 191-209.

Nováková L., 2010. *Detailed brittle tectonic analysis of the limestones in the quarries near Vápenná village.* Acta Geodynamica et Geomaterialia, 7, 167-174.

Nováková L., Sosna K., Brož M., Najser J., Novák P., 2011. *Geomechanical parametres of the podlesí granites and its relationship to seismic velocities.* Acta Geodynamica et Geomaterialia, 8, 353–369

Nováková L., 2014. *Evolution of paleostress fields and brittle deformation in Hronov-Poříčí Fault Zone, Bohemian Massif.* Studia Geophysica et Geodeatica. 58, 269-288.

Štrunc J., Brož M., 2011. *The detection of weak earthquakes in the western bohemian swarm area through the deployment of seismic arrays.* Acta Geodynamica et Geomaterialia, 8, 469–477.

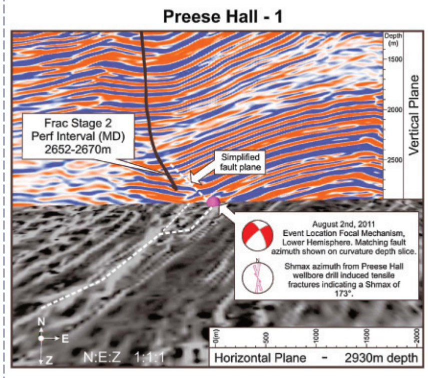
• Meteories and Earthquake prediction

Borovička J., Spurný P., Brown P., Wiegert P., Kalenda P., Clark D., Shrbený L., 2013: *The trajectory, structure and origin of the Chelyabinsk asteroidal impactor.* Nature, 503, 235–237.

Borovička J., Tóth, J., Igaz, A., Spurný, P., Kalenda, P., Haloda, J., Svoreň, J., Kornoš L., Silber, E.,

Pavel Kalenda while installing a pendulum in the Magdalena cave (part of Postojna cave system – Slovenia).

Leo Eisner in the Savuka mine (South Africa), 3.7 km underground.

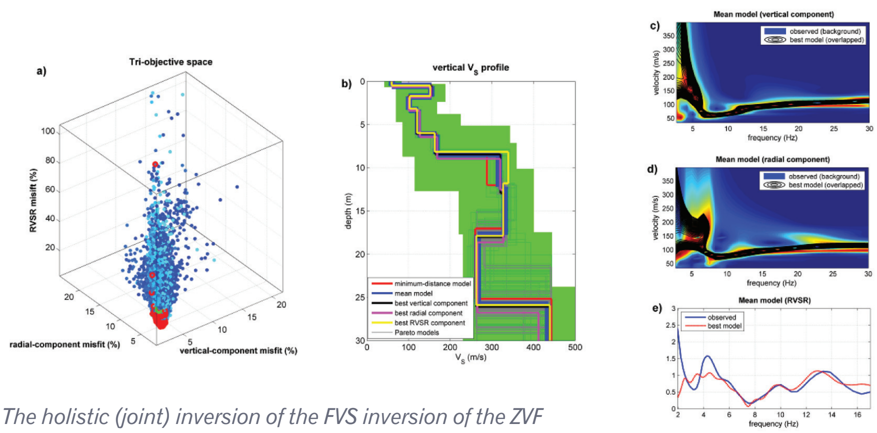


Location of microseismic event (ML-0.2 and its mechanisms agrees with the subsequently identified fault plane, both in special placement as well as in orientation of the fault.

Brown, P., Husárik, M., 2013. *The Košice meteorite fall: Atmospheric trajectory, fragmentation, and orbit.* Meteoritics and Planetary Science 1–23.

Kalenda P., Holub K., Rušajová J., Nuemann L., 2013. *Microseisms and spreading of deformation waves around the globe.* NCGT, 1, 38-57.

Kalenda P., Neumann L., Málek J., Skalský L., Procházka V., Ostřihanský L., Kopf T., Wandrol I., 2012. *Tilts, global tectonics and earthquake prediction.* SWB, London, 247pp.



The holistic (joint) inversion of the FVS inversion of the ZVF and RVF group-velocity spectra jointly with the RVSR (Radial-to-Vertical Spectral Ratio): a) model distribution in the three-objective space (reported as misfits for the three considered objective functions); b) VS profiles for the „best models“ (green area represents the adopted search space); c) and d) the group-velocity spectra for the vertical and radial components (background colours the field data, overlaying contour lines the synthetic); e) observed and synthetic RVSR.

Building of local seismic network REYKJANES in Iceland

MAIN COLLABORATING PARTNERS

- Academy of Sciences of the Czech Republic - Geophysical Institute; Geological Institute (Prague, CZ)
- AGH (Krakow, Poland)
- Arcadis Geotechnika a.s. (Prague, CZ)
- Czech Geological Survey (Prague, CZ)
- Cuadrilla Resources, (Birmingham, UK)
- Charles University in Prague, Faculty of Science (CZ)
- Charles University in Prague, Faculty of Mathematics and Physics (Prague, CZ)
- Czech Technical University in Prague, Faculty of Electrical Engineering (Prague, CZ)
- Eötvös University in Budapest (Hungary)
- Isatech, Ltd. (Prague, CZ)
- MicroSeismic, Inc. (Texas, USA)
- New Mexico Highlands University (Las Vegas, USA)
- Petroleum Institute, (Abu Dhabi, United Arab Emirates)
- National Academy of Sciences of Ukraine, (Lvov, Ukraine)
- NORSAR (Norway)
- Karst Research Institute, Scientific Research Centre of the Slovenian Academy of Science and Art (Postojna, Ljubljana, Slovenia)
- OGS Trieste (Italy)
- Palivový Kombinát Ústí, Státní Podnik, (Ústí Nad Labem, CZ)
- Polish Academy of Sciences (Poland)
- Seismik s.r.o. (Prague, CZ)
- Stanford University (USA)
- Slovak Academy of Sciences - Geophysical Institute (Slovakia)
- Slovmag Lubeník a.s., (Slovakia)
- United States Geological Survey (USA)
- University of Stuttgart, Institute of Geophysics (Germany)

N50°32'14", E016°02'31": this locality is unique for its clear establishment and apparent view of the fault. The outcrop exposes one of the main faults of the active Hronov-Poříčí Fault Zone, Czech Republic.

A quarry near Vapenna village, Rychleby Mts., Czech Republic (Devonian crystalline limestones of the Branna group): Mineral accretion calcite steps (mineral fibres displayed on the fault plane in the figure) as commonly used slickenside indicators. In this figure they are identifying right lateral movement along the fault plane. This outcrop is located at GPS coordinates: N50°16'41", E017°05'32".

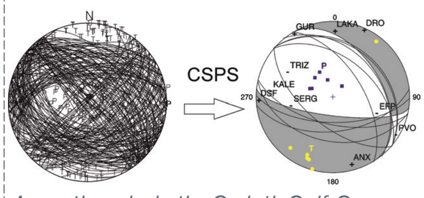
Crustal studies

Knapmeyer-Endrun B., Krüger F., Legendre C. P., Geissler W.H., Plomerová J., Babuška V., Gaždová R., Jedlička P., Kolínský P., Málek J., Novotný O., Růžek B., 2013. *Tracing the influence of the Trans-European Suture Zone into the mantle transition zone.* Earth and Planetary Science Letters, 363, 73-87.

Kolínský P., Málek J., Brokešová J., 2011. *Shear wave crustal velocity model of the Western Bohemian Massif from Love wave phase velocity dispersion.* Journal of Seismology,15, 81-104.

Kolínský P., Valenta J., Málek J., 2014. *Velocity model of the Hronov-Poříčí Fault Zone from Rayleigh wave dispersion.* Journal of Seismology, 18, 617-635.

Skácelová Z., Rapprich V., Valenta J., Hartvich F., Šrámek J., Radoň M., Gaždová R., Nováková L., Pécskay Z., 2010. *Geophysical research on structure of partly eroded maar volcanoes: Miocene aHnojnice and Oligocene Rychnov volcanoes (northern Czech Republic).* Journal of Geosciences, 55, 4, 299–310.

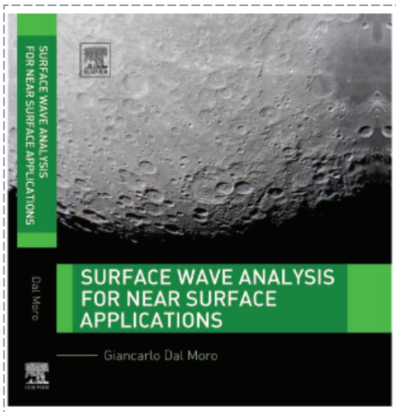


An earthquake in the Corinth Gulf, Greece. Comparison of the performance of two methods for the determination of the focal mechanism: on the left the classical first-motion polarity (the uncertainty of the focal mechanism is quite large); on the right panel: our six CSPS solutions (Fojtikova and Zahradnik, 2014) obtained by using polarities and waveform inversion of individual stations.

Near surface geophysics

Brokešová J., Málek J., Kolínský, P., 2012. *Rotaphone, a mechanical seismic sensor system for field rotation rate measurements and its in situ calibration.* Journal of Seismology 16, 603-621.

Brokešová J., Málek J., Evans J. R., 2012. *Rotaphone, a new self-calibrated six-degree-of-freedom seismic sensor.* Review of Scientific Instruments, 83, 8.



Dal Moro G., 2014. *Surface Wave Analysis for Near Surface Applications*, Elsevier, ISBN 978-0-12-800770-9, 252pp.

Gaždová R., Kolínský P., Vilhelm J., Valenta J., 2014. *Combining surface waves and common methods for shallow geophysical survey.* Near Surface Geophysics, doi: 10.3997/1873-0604.2014039.

Gaždová R., Vilhelm J., 2011. DISECA – *A Matlab code for dispersive waveform calculations.* Computers and Geotechnics, 38, 526–531.

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