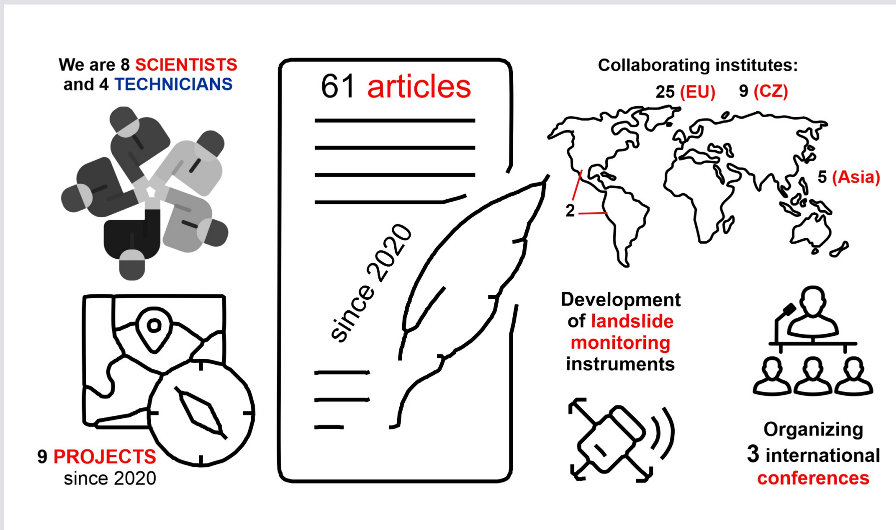
INSTITUTE OF ROCK STRUCTURE AND MECHANICS
The Czech Academy of Sciences

DEPARTMENT OF ENGINEERING GEOLOGY

THEMATIC RESEARCH FOCUS

- **NATURAL HAZARDS AND RISKS**
- **LANDSLIDES AND OTHER SLOPE DEFORMATIONS**
- **PRESENT-DAY DYNAMICS AND KINEMATICS OF FAULTS**
- **DEVELOPMENT OF SENSORS FOR FIELD MONITORING**



MAIN RESEARCH INTERESTS

- Sensors development and cooperation with the commercial sector
- Long-term fault displacements and kinematics
- Accompanying phenomena of fault movements
- Landslide susceptibility, hazard and risk assessment in societal context
- Landslide dynamics for hazard assessment
- Landslides in seismically active regions
- Application of advanced technologies in geosciences
- Landslide susceptibility, hazard and risk assessment in societal contexts

RESEARCH FOR COMMUNITY

- Assessing landslide susceptibility and hazard for critical infrastructure
- Monitoring of cultural heritage sites
- Safety monitoring in underground spaces
- Forensic expert opinions
- Monitoring and assessments for citizens and companies

Pressure on land development resulted in lifting the construction ban in 1980´ which resulted almost 30 years later in serious damage and monetary loss – recreational houses, NW Bohemia, Czechia.

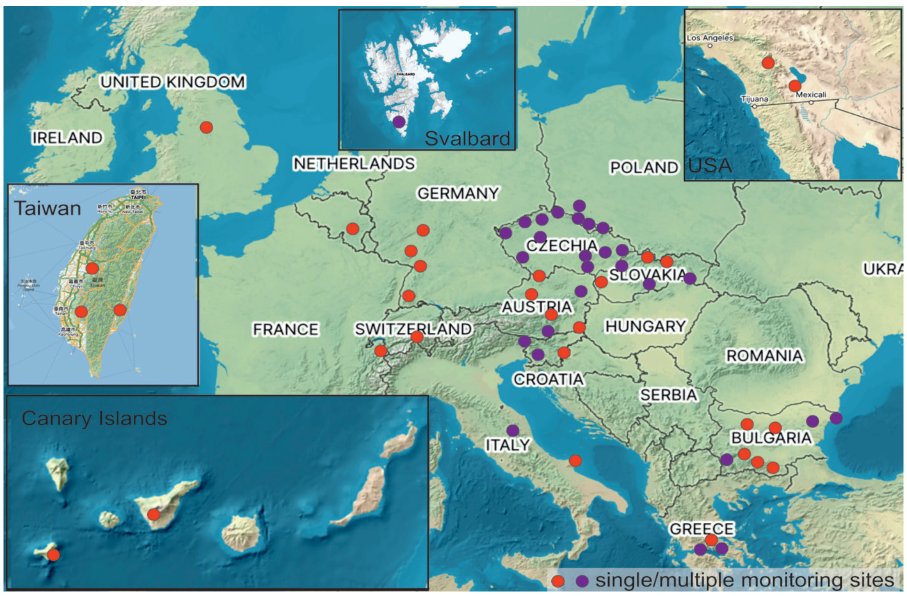
MONITORING NETWORKS

- TecNet – world-wide monitoring network using in-house crack gauge on tectonic faults
- SlopeNet – long-term monitoring of slow-moving landslides
- GNSS networks - long-term displacement monitoring (North Bohemia, Peru and Svalbard)
- Permanent radon RN^{222} monitoring network (Czechia, Slovakia and Slovenia)

KEY RESEARCH EQUIPMENT

In house developed monitoring devices

- 3D optic-mechanical crack gauge (TM-71/72) with remote connection, automatic reading and data processing
- 3D contactless magnetoresistive positioning system with remote connection, automatic reading and data processing
- Permanent electric resistivity profiling (ERT) with remote connection, automatic reading and data processing



Monitoring networks of the Department of Engineering Geology include fault and landslide monitoring, GNSS observations and radon RN^{222} measurements.

The 3D crack gauge TM72 monitors deformation in the Grimsel Test Site, 450 metres beneath the surface of the granite Aar Massif. Since 2012, the monitoring has been performed in collaboration with NAGRA (CH) and RAWRA (CZ).

Controlling unit and the measuring device of the permanent electric resistivity profiling are hidden underground in water-proof boxes.

ACHIEVEMENTS

- **Sensors development and cooperation with the commercial sector**

Balek, J., Klokočník, P. (2021): Development of low-cost inclination sensor based on MEMS accelerometers. IOP Conference Series: Earth and Environmental Science, Volume 906, 7th World Multidisciplinary Earth Sciences Symposium (WMESS 2021) 6th-10th September 2021, Prague, Czech Republic. DOI 10.1088/1755-1315/906/1/012057.

Rowberry, M., Frontera, C., Baroň, I., Kučera, J., Křivánek, L., Martí, X., 2020. A novel positioning system for three dimensional fracture displacement monitoring in the British Cave Science Centre, Poole's Cavern, Buxton, Derbyshire. Cave & Karst Science, v. 47, p. 146-152.

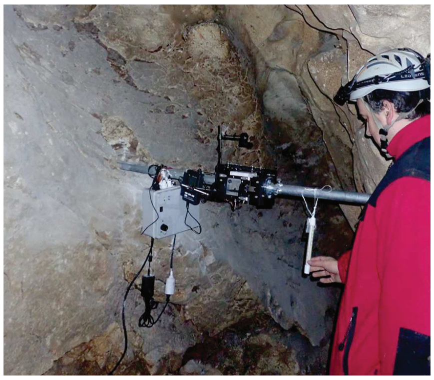
Installation of a novel contactless 3D positioning system on the Chihshang plate-boundary fault in Eastern Taiwan (photo by J. J. Dong).

Rowberry, M., Trčka, T., Mikluš, V., 2023. Portable muon detectors tested at the British Cave Science Centre. Cave & Karst Science, v. 50, p. 113-118.

Racek, O., Balek, J., Loche, M., Vích, D., Blahůt, J. (2023): Rock surface strain in situ monitoring affected by temperature changes at the Pozary Field Lab (Czechia). Sensors. 23. https://doi.org/10.3390/s23042237.

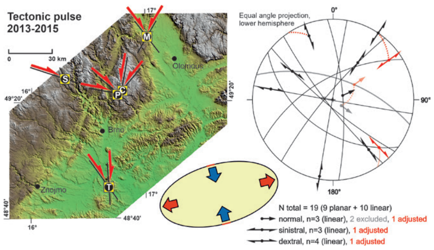
- **Long-term fault displacements and kinematics**

Šebela, S., Stemberk, J., Briestenský M. (2021): Micro displacement monitoring in caves at the Southern Alps–Dinarides–Southwestern Pannonian Basin junction. Bulletin of Engineering Geology and the Environment, Doi: 10.1007/s10064-021-02382-4.



Caves are the preferred places for monitoring tectonic movements. A photo from the Postojna Cave, Slovenia, shows the prototype of an automatic version of the 3D optic-mechanical crack gauge.

Briestenský, M., Stemberk, J., Littva, J., Vojtko, R. (2021): Tectonic pulse registered between 2013 and 2015 on the eastern margin of the Bohemian Massif, Geological Quarterly, 65: 14. Doi: 10.7306/gq.1582.



Deformations measured with the 3D crack gauge provide a record of regional stress fields. Example from the eastern edge of the Bohemian Massif.

Vavra, E.J., Fialko, Y., Rockwell, T., Bilham, R., Štěpančíková, P., Stemberk, J. Jr., Tábořík, P., Stemberk, J. (2024): Characteristic slow-slip events on the uperstition Hills Fault, Southern California. Geophysical Research Letters, 51, 12, e2023GL107244.

Baroň, I., Melichar, R., Sokol, L., Rowberry, M., Plan, L., Stemberk, J. (2024) 3D active fault kinematic behaviour reveals rapidly alternating near-surface stress states in the Eastern Alps. Geological Society Special Publication, 546 (1), pp. 119-133. Doi: 10.1144/SP546-2023-32.

● Accompanying phenomena of fault movements

Baroň, I., Koktavý, P., Trčka, T., Rowberry, M., Stemberk, J., Balek, J., Plan, L., Melichar, R., Diendorfer, G., Macků, R., Škarvada, P., 2022. Differentiating between artificial and natural sources of electromagnetic radiation at a seismogenic fault. Engineering Geology, v. 311, art. no. 106912.

Briestenský, M., Ambrosino, F., Smetanová, I., Thinová, L., Šebela, S., Stemberk, J., Pristašová, L., Pla, C., Benavente, D. (2022): Radon in dead-end caves (European studies). Journal of Cave and Karst Studies. 84, 2, 41-50. Doi: 10.4311/2021ES0101.

● Landslide susceptibility, hazard and risk assessment in societal context

Klimeš J, Müllerová H, Woitsch J, Bíl M, Křížová B (2020) Century-long history of rural community landslide risk reduction. International Journal of Disaster Risk Reduction, 51: 101756. https://doi.org/10.1016/j.ijdrr.2020.101756.

Scarp of a landslide which partly destroyed a village and caused relocation of its inhabitants and a decadal decline of the local economy and services (1967, Photo Archive of Quido Záruba).

Klimeš, J., Novotný, J., Balek, J., Rosario, A.M., Torres, J.C., Vargas, R., López, D., Obispo, Y., Roldán-Minaya, E., Caballero, A., Jara, H., Villafane, H., Melgarejo, E. (2024) Landslide hazard assessment and risk reduction in the rural community of Rampac Grande, Cordillera Negra, Peru. Environmental Earth Sciences, 83. https://doi.org/10.1007/s12665-023-11307-1.

● Landslide dynamics for hazard assessment

Klimeš, J., Hartvich, F., Šilhán, K. (2024) Long-term movement activity and internal structure of deep-seated landslide by using dendrochronology analysis and electric resistivity tomography in flysch rocks, Carpathians, Czech Republic. Landslides.

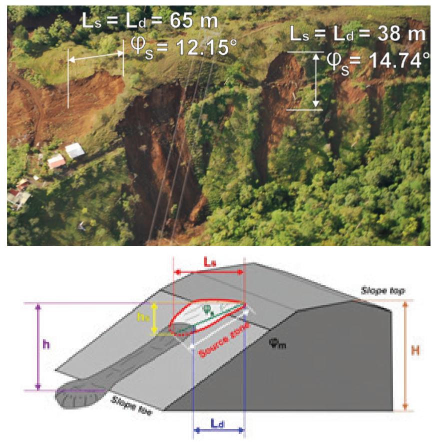
Blahůt, J., Balek, J., Eliaš, M., Meletlidis, S. (2020): 3D Dilatometer time-series analysis for a better understanding of the dynamics of a giant slow-moving landslide. Applied Sciences, 10, 5469.

Klimeš J, Novotný J, Rapre AC, Balek J, Zahradníček P, Strozzi Z, Sana H, Frey H, René M, Štěpánek P, Meitner J (2021) Paraglacial rock slope stability under changing environmental conditions, Safuna Lakes, Cordillera Blanca Peru. Front. Earth Sci. Doi: 10.3389/feart.2021.607277

Hartvich, F., Tábořík, P., Šobr, M., Janský, B., Kliment, Z., and Langhammer, J. (2020) Landslide-dammed lake sediment volume calculation using waterborne ERT and SONAR profiling. Earth Surf. Process. Landforms, Doi: 10.1002/esp.4977.

● Landslides in seismically active regions

Baroň, I., et al. (2024) Source area morphometry and high depletion rate of landslides may indicate their coseismic origin. Engineering Geology, 330: 107424. https://doi.org/10.1016/j.enggeo.2024.107424.



Main morphometric parameters for calculating the Index of potential trigger illustrated on coseismic landslides at Poás Volcano in Costa Rica in 2009.

Klimeš, J., Kilnar, K., Kopačková-Strnadová, V., Pánek, T., McColl, S. (2024) Landslides in the glaciated mountains of the Cordillera Blanca, Peru – types, spatial distribution and conditioning factors. Landslides 22, 803–819. Doi:10.1007/s10346-024-02387-6.

Landslides identified as active using the P-SBAS InSAR method, Cordillera Blanca Peru.

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