SEISMIC MONITORING FOR MINING, INDUSTRIAL AND GEOTHERMAL PLANTS

K-UTEC
SALT TECHNOLOGIES

WHY SEISMIC MONITORING:

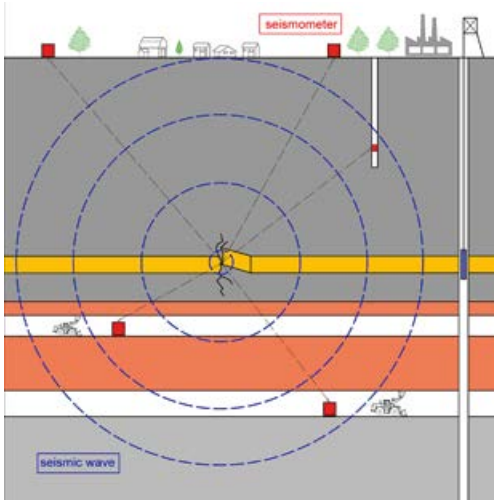
Seismic events, whether they are caused by local tectonics, fracturing of the overburden or induced by local mining or fracturing in the underground, are only sporadically occurring events, thus the assessment of the general seismicity within an area can only be realised over a longer period of time. These events can occur spontaneously or artificially induced (i.e. fracking of lithological layers for geothermal plants).

K-UTEC has a long lasting experience within this subject and offers extensive support both in planning and installing seismic monitoring systems. We also offer extensive assistance for the operation of monitoring systems. Furthermore, we also offer the interpretation of the single events as well as the general assessment of the seismicity in a target area. K-UTEC is able to design, build and monitor the best fitting, individual solution for each customer.

With the help of this information it is possible to react to seismic events. Geothermal companies can use seismic information for instance to detect areas with high permeability and/or fractures in the reservoir. It is also possible through seismic monitoring to react if the seismicity in a certain mining area increases by adapting the operational conditions.

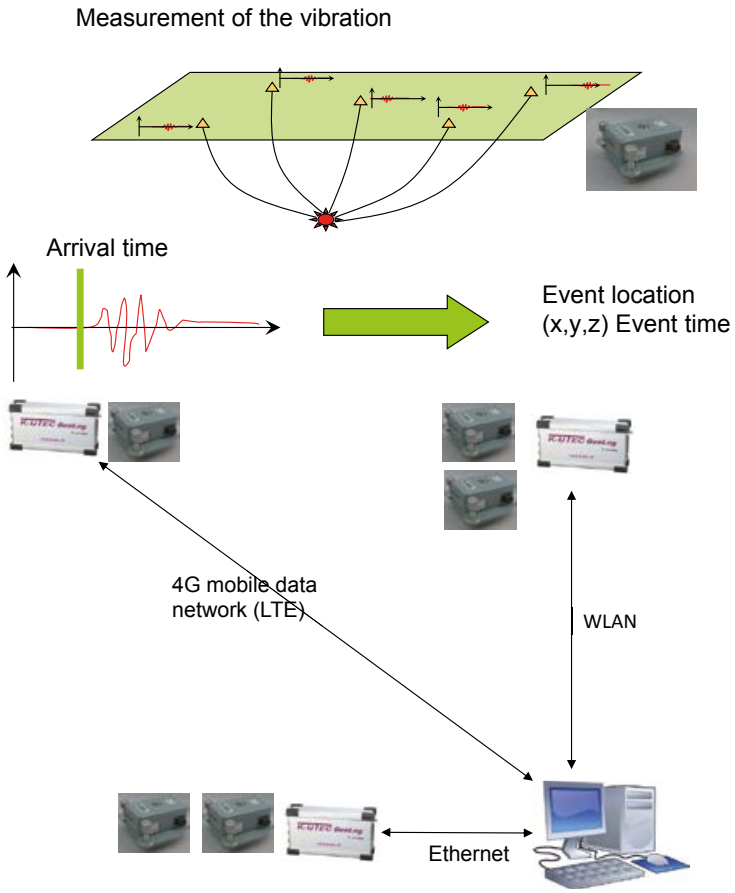
Furthermore, if seismic vibrations occur, the measurements can quantify these vibrations and allow comparison with conditions set by regulators.

Localization of events and estimation of the event parameters



The seismic monitoring system or vibration measurement system can be installed to monitor the ground surface, mines, reservoirs and/or caverns. The required seismometers can be installed near the surface, underground and/or in boreholes.

Design of the monitoring system:



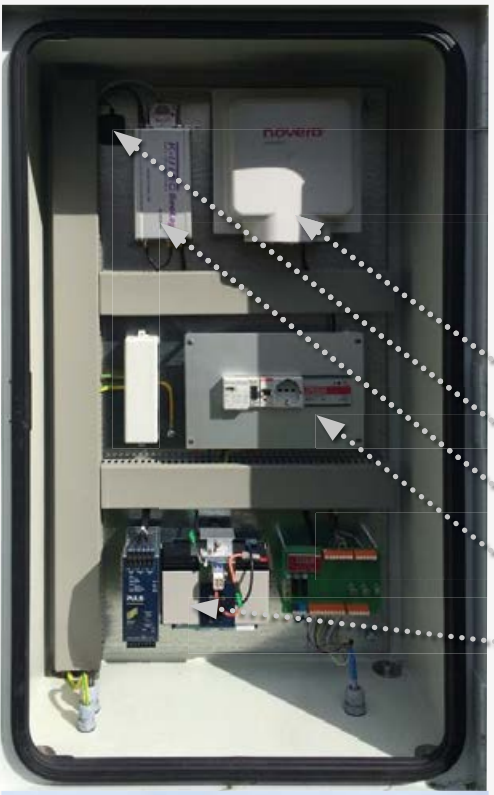
Seismic Monitoring Geophysics

establish seismic monitoring systems	operate seismic monitoring systems	locate seismic events and evaluate the seismic data
• design the best solution for the costumer • compute the accuracy of the system in the observed area • install the system in the field	• 24/7 monitoring of the system • maintenance of the system • updating of the system, in case of changing local conditions	• automatic localization and alerts • manual control of the localization • calculation of the event and seismological parameters • status report in time intervals as desired by the client

DESIGN OF A SINGLE STATION

indoor

- Transient recorder
- Power supply
- GPS – Antenna-cable



outdoor

with 230 V power supply

- LTE – Antenna
- GPS – Antenna
- Transient recorder
- Power supply
- uninterrupted power supply unit

with Solar power supply

- LTE – Antenna
- GPS – Antenna
- Power supply – Solar panel
- Transient recorder
- power supply – buffer battery

VARIOUS TYPES OF SEISMOMETERS

3D Seismometers

1D Seismometers

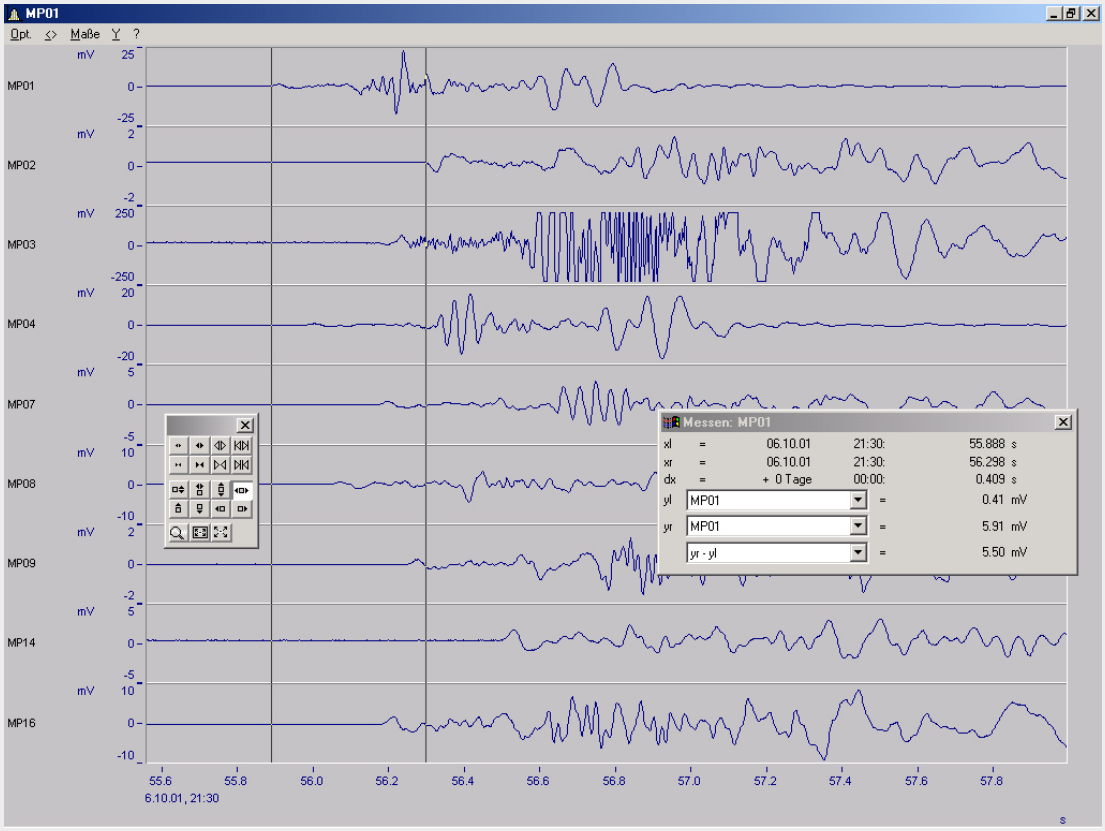
Different types of seismometers

ATEX certificated seismometer

Geprüfte Qualitätsfirma BDG 2387K/03/08/19/2024

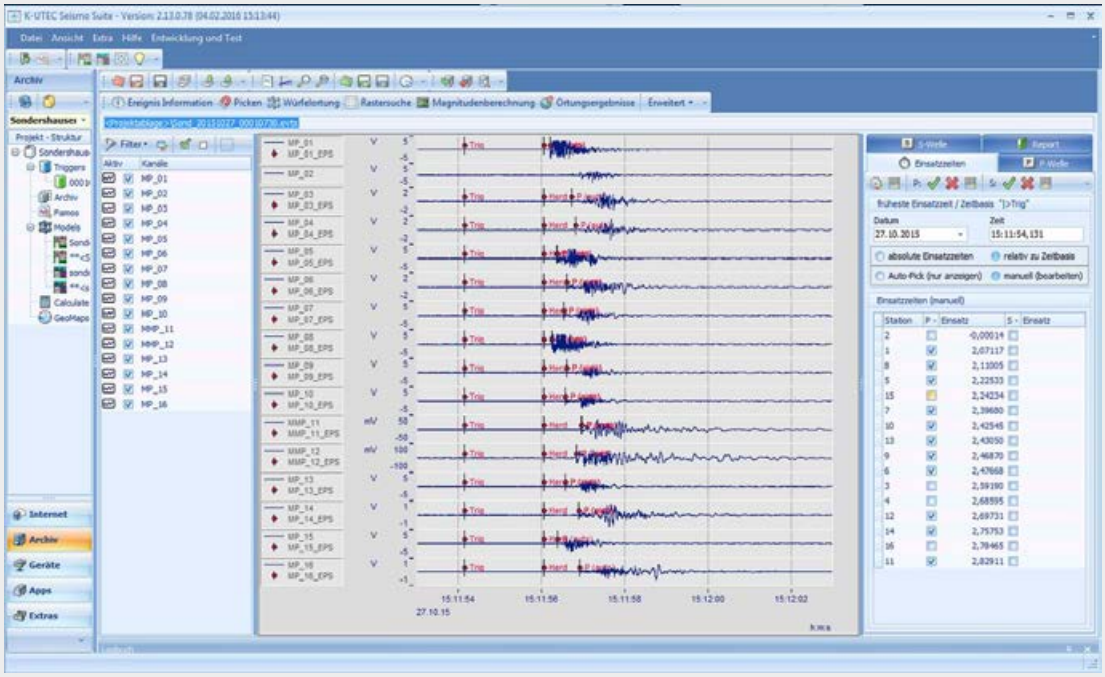
TÜV PROFI CERT ISO 9001 73 100 1022

Event example



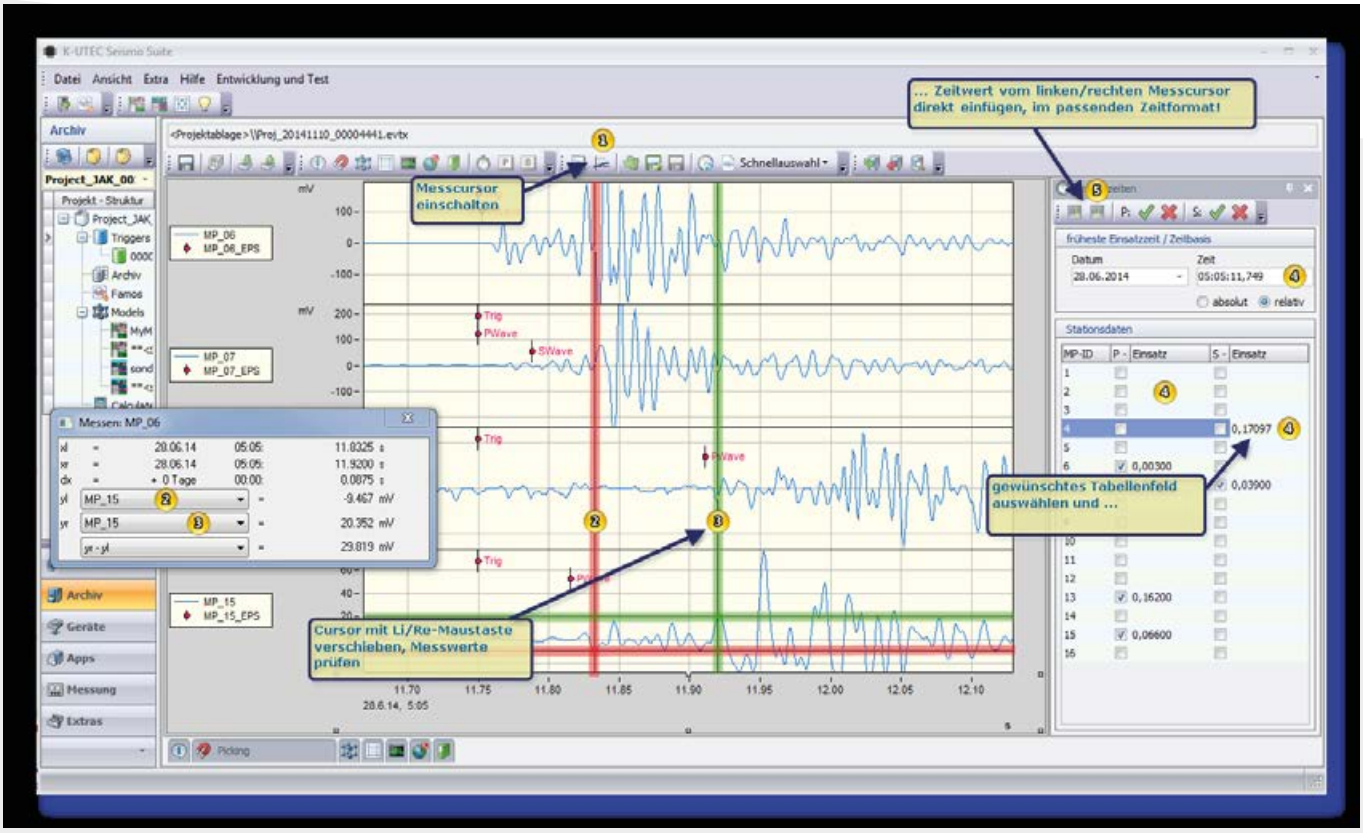
Raw data of a seismic event

Automatic localization



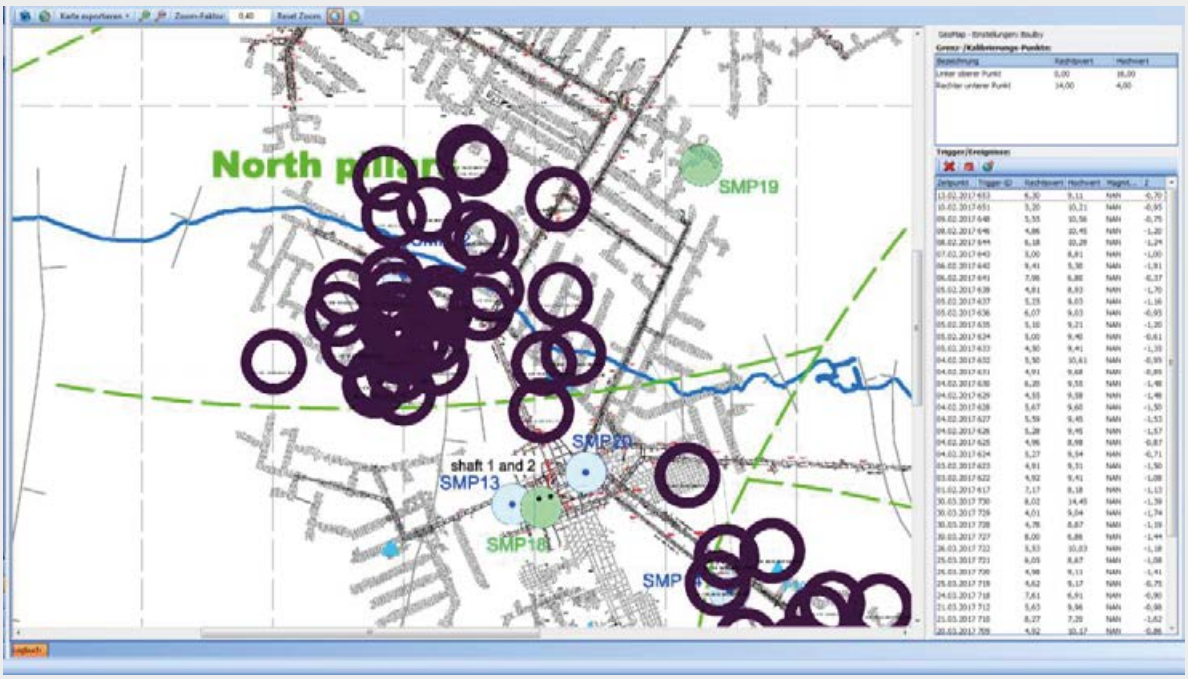
Automatically marked arrival times

Manual localization



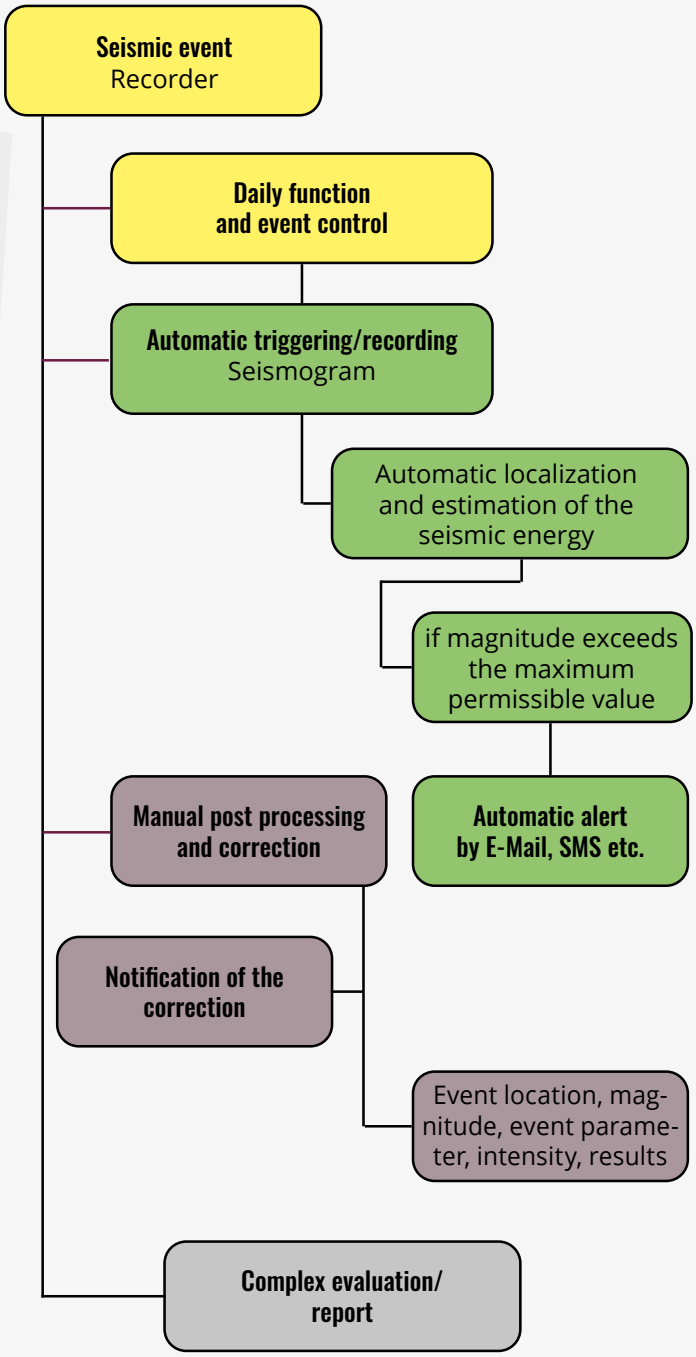
Marked arrival times

Manual localization and visualization



Marked events on the map

SCHEME OF THE EVENT PROCESSING



Technical characteristics of the transient recorder (basic system):

In 2013, a new concept for a seismologic registration unit was carried out by the K-UTEC AG Salt Technologies. In 2019, the instrument hardware was internally updated. Furthermore, an ongoing update process of the Firmware is carried out, depending on the tasks ahead. The background of the concept was to develop a device for high resolution data (24 Bit) high sampling rates (5 kHz each channel), time synchronisation (GPS module) and the ability to use modern media for data transfer (internal 4G modem downward compatible, internal LAN port, WLAN hotspot, and more). The power energy use is very low with less than 6 W. For this reason it is possible to supply the data recorder by solar power in the field.

The K-UTEC GeoLog is useable for:

- Qualifying of seismic events
- Alerting by specified parameters
- Long-time monitoring of geoscientific parameters
- Mobile and permanent data logging, monitoring and documentation

Characteristics

- Flexible external sensors with different parameters: accelerations, vibration velocities, pressure and more
- Internal mobile LTE modem
- Individual data cloud and Server application
- Up to 64 GByte internal storage, with 24 Bit resolution and 5 kHz sampling rate
- 4 to 8 channels with time synchronized sampling – modular extendable
- Internal mathematical calculation options
- Remote maintenance and remote-software-update with watchdog

Miscellaneous

- Temperature range -40° to +70° C
- Compact ALU-Housing 45 mm x 85 mm x 164 mm
- Integrated self-sufficient system monitoring (watchdog)
- Low power input (2,5 W without LTE modem, 6 W with LTE modem)

REFERENCES IN SEISMIC MONITORING BY K-UTEC

Project	Location / Client	Size	Year	Remarks
Seismic monitoring of abounded salt and potash mines	Staßfurt, Bernburg, Schierstedt/ Germany	diff.	Up 1959 to 2000	Seismic monitoring of controlled flood and abounded mines
installation of a seismic monitoring system	Unterbreizbach/Merkers / K+S, Germany	49 measuring points	Since 1975, renewed 2017-18	installation of a seismic monitoring system, technical support, consulting; vibration monitoring
Seismic monitoring of mining induced and natural seismicity	Bleicherode / NDH-E mbH, Germany	16 measuring points	Since 1981, several technical update phases	Seismic monitoring of the mine deposit, control of induced and natural seismicity, control and guidance of deposit work
Seismic monitoring of a cavern field	Bleicherode-Kehmstedt/ Deusa GmbH	7 measuring points (5 sensors in pipes)	1984, several technical update phases	Seismic monitoring of the cavern field Kehmstedt
Seismic monitoring of mining induced and natural seismicity	Sondershausen / GSES mbH, Germany	16 measuring points	Since 1985, several technical update phases	Seismic monitoring of the mine deposit, control of natural and induced seismicity, control and guidance of deposit work
Seismic monitoring of mining induced and natural seismicity	Teutschenthal, Angersdorf and Salzmünde / GTS mbH, Germany	16 measuring points	Since 1985 , several technical update phases	Seismic monitoring of the mine deposit, control of natural and induced seismicity, control and guidance of deposit work
Seismic monitoring of mining induced and natural seismicity	Bischofferode / LMBV KSE (former GVV mbH), Germany	27 measuring points	Since 1995, several technical update phases	Seismic monitoring of induced and natural seismicity, monitoring of non-controlled flood
Seismic monitoring of mining induced and natural seismicity	Sollstedt / NDH-E mbH, Germany	11 measuring points	Since 1995, several technical update phases	Seismic monitoring of the mine deposit, control of mining induced seismicity, control and guidance of deposit work
Seismic monitoring of induced and natural seismicity	Zielitz / K+S, Germany	11 measuring points	Since 1997	monitoring of natural seismicity, technical support
Seismic monitoring of natural and induced seismicity during brine process	Staßfurt / LAGB, Germany	16 measuring points	1997 (and before) – 2010	Seismic monitoring of natural and induced seismicity during brine process
installation of a seismic monitoring system	Velenje / Premogovnik Velenje, Slovenia	8 measuring points	Since 1998, renewed 2017	installation of a seismic monitoring system for a lignite mine
Seismic monitoring of seismic activity	Kirchheilingen / VNG, Germany	1 measuring point	Since 2001, renewed 2019	Vibration measurement (monitoring of seismic activity in the area of gas storage field)
Seismic monitoring of the former lignite opencast pit Nachterstedt	Nachterstedt / LMBV, Germany	Up to 8 measuring points	Since 2009	Seismic monitoring of the former lignite opencast pit Nachterstedt
Seismic monitoring of mining induced and natural seismicity	Bernburg / esco, Germany	10 measuring points	Since 2000	Seismic monitoring of the mine deposit, control of natural and induced seismicity,
Seismic monitoring of induced and natural seismicity	Volkenroda / LMBV KSE (former GVV mbH), Germany	11 measuring points	Since 2002	Seismic monitoring of induced and natural seismicity, monitoring of non-controlled flood
Seismic monitoring of induced and natural seismicity	Salzbergwerk Stetten / Wacker Chemie GmbH, Germany	9 measuring points	Since 2002	Seismic monitoring of the mine deposit, control of natural seismicity
Seismic monitoring of mining induced and natural seismicity	Morsleben/ DBE/BGE	24 measuring points	Since 2005, renewed 2016	Seismic monitoring of mining induced and natural seismicity
Seismic monitoring of induced and natural seismicity	Boulby Mine / ICL, UK	19 measuring points	Since 2015	Seismic monitoring, control of induced and natural seismicity
Seismic monitoring after landslide event and for reconstruction works	Nachterstedt / LMBV, Germany	Up to 9 measuring points	Since 2015	Seismic monitoring of an landslide area and of the vibroflotation soil compaction activities in a former lignite opencast pit area
Seismic monitoring of the explosive compaction activities	Lausitz / LMBV, Germany	4 to 15 measuring points	Since 2012	Seismic monitoring of the explosive compaction activities in several areas in the former lignite opencast pit area
Seismic monitoring of the former lignite opencast pits areas	Lausitz / LMBV, Germany	9 measuring points	Since 2013	Seismic monitoring of the former lignite opencast pits area, 50 km x 50 km
Seismic monitoring of a former lignite opencast pit area	Schlabendorf / LMBV, Germany	20 measuring points	Since 2014	Seismic monitoring of the former lignite opencast pit Schlabendorf-Süd
Seismic monitoring of a cavern field	Hengelo / Nouryon, The Netherlands	10 measuring points	Since 2015	Seismic monitoring of a cavern field, control of induced and natural seismicity
Seismic monitoring of a geothermal plant	Poing /Bayernwerke, Germany	5 measuring sensor stations	Since 2016	Seismic monitoring of a geothermal plant
Seismic monitoring of an underground limestone mine	Saarbrücken/ Saarstahl, Germany	15 measuring sensor stations	Since 2020	Seismic monitoring of a limestone underground mine, control of induced and natural seismicity
Seismic monitoring of the seismic activities of the Bavarian Geothermal plants	Bavaria / Stadtwerke München, Germany	About 21 stations	Starting 2020	Seismic monitoring of the Bavarian Geothermal industrial Plants

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