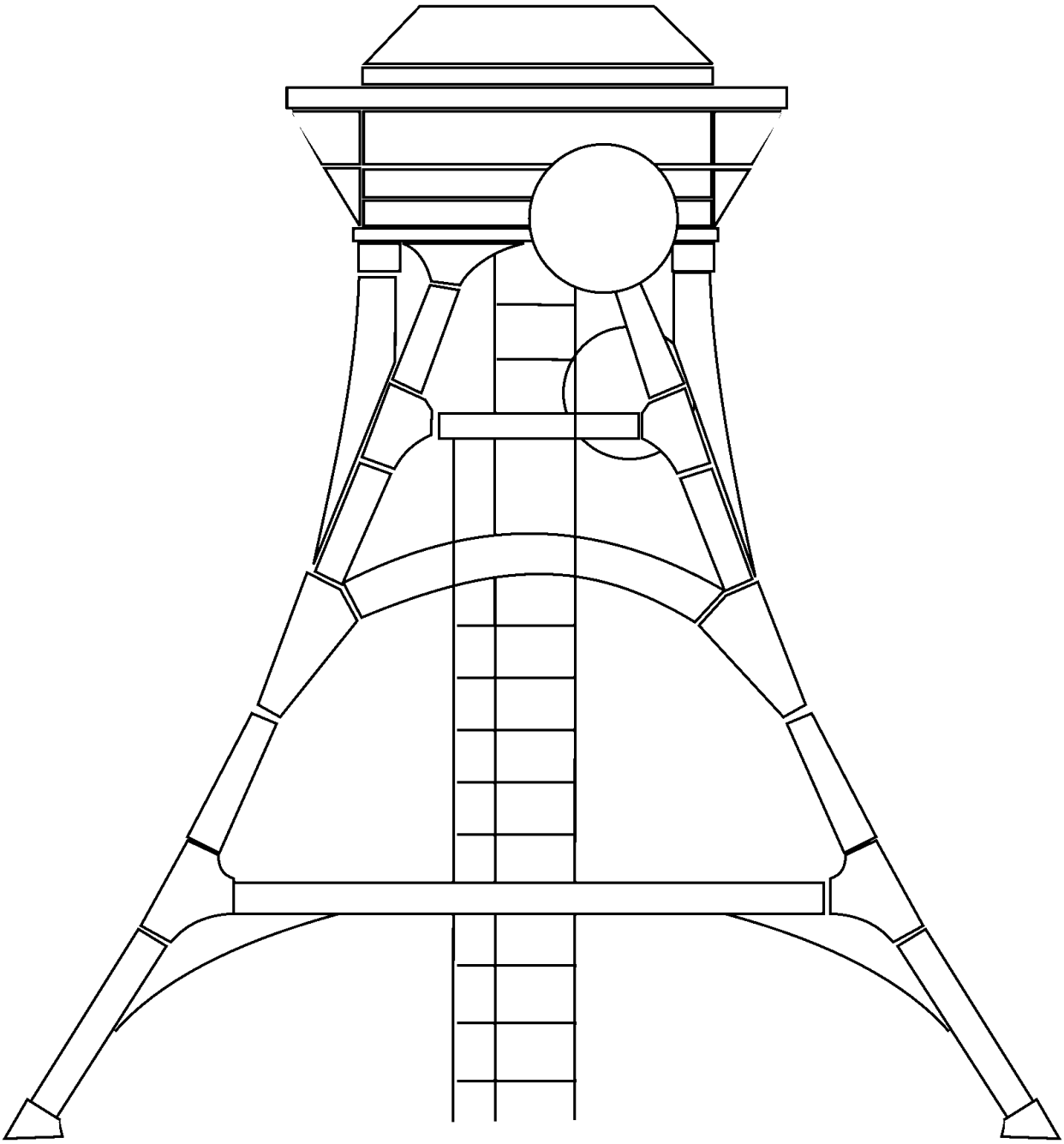
K-UTEC
SALT TECHNOLOGIES



Seismic Monitoring for Industrial Mining

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Why seismic monitoring:

Seismic events, whether they are caused by local tectonics, fracturing of the overburden or induced by local mining, 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.

K-UTEC has a long time experience within this subject and offers extensive support both in planning and installing seismic monitoring systems but we also offer extensive assistance for the operation of the monitoring system, the interpretation of the single events as well as the general assessment of the seismicity in the target area.

With help of this information it is possible to react to the seismic events. It is also possible to react if the local seismicity increases in a certain area (i.e. refilling of cavities). Mining companies can use these information for enhancing an prove of safety for the public and infrastructure.

The K-UTEC AG Salt Technologies offers

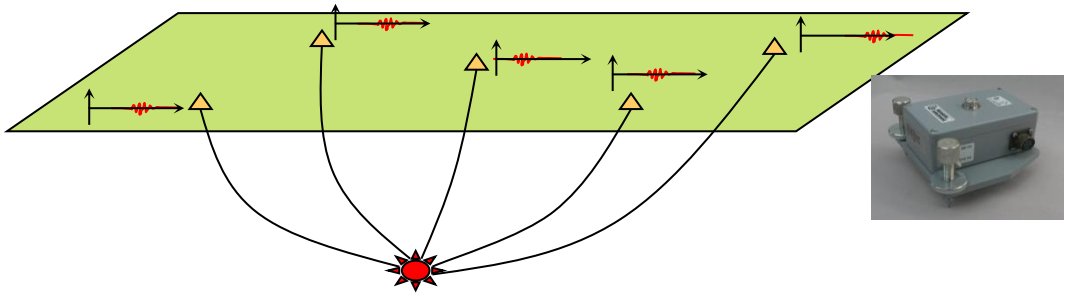
Seismic Monitoring		
➢ establish seismic monitoring systems • design the best solution for the costumer • compute the accuracy of the system in the observed area • build up the system in the field	➢ operate seismic monitoring systems • daily control of the monitoring system • servicing of the system • updating of the system, in case of change of the local conditions	➢ locate seismic events and evaluate the seismic data • automatic location and alerting • manual control of the localization • calculation of the event and seismological parameters • status report in time intervals as desired by the client

The seismic monitoring systems can be built up on the surface or in mines. The seismometers can be installed on the surface, in boreholes or in the mine.

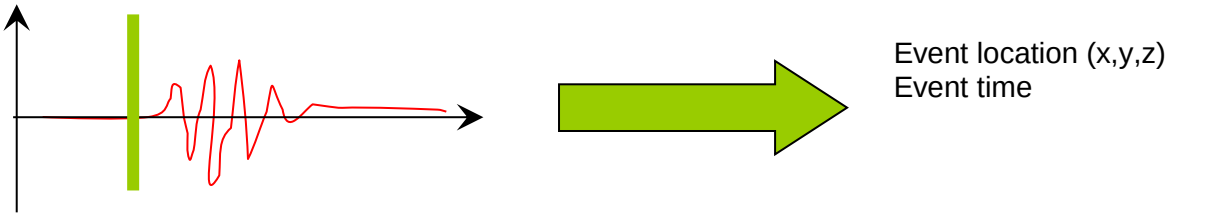
Seismic monitoring system

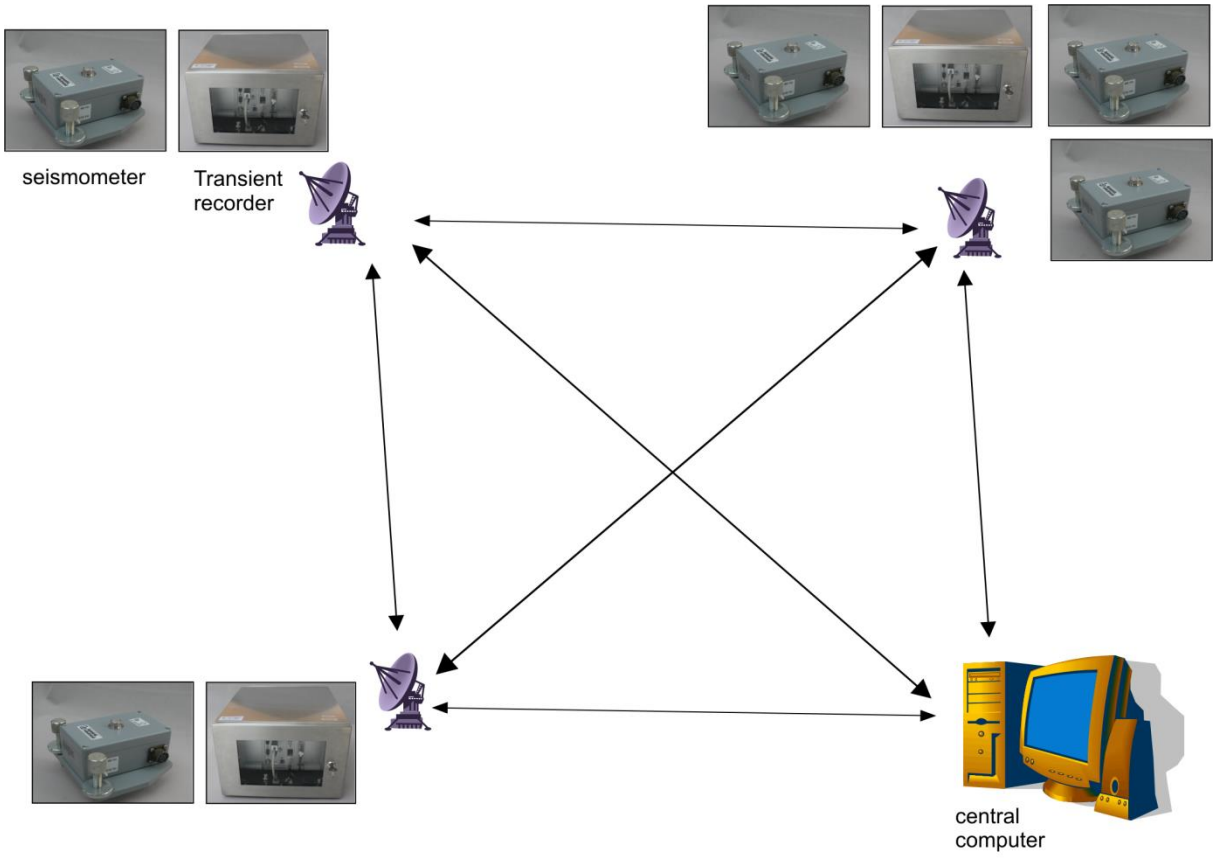
Design of the monitoring system:

Measurement of the vibration



Arrival time





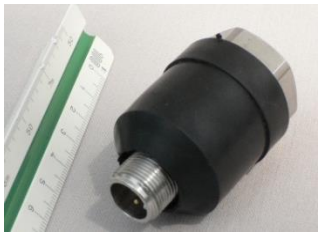
Design of a single station (example)

Installation of seismometers and data loggers at the surface and in underground mines

Various types of seismometers

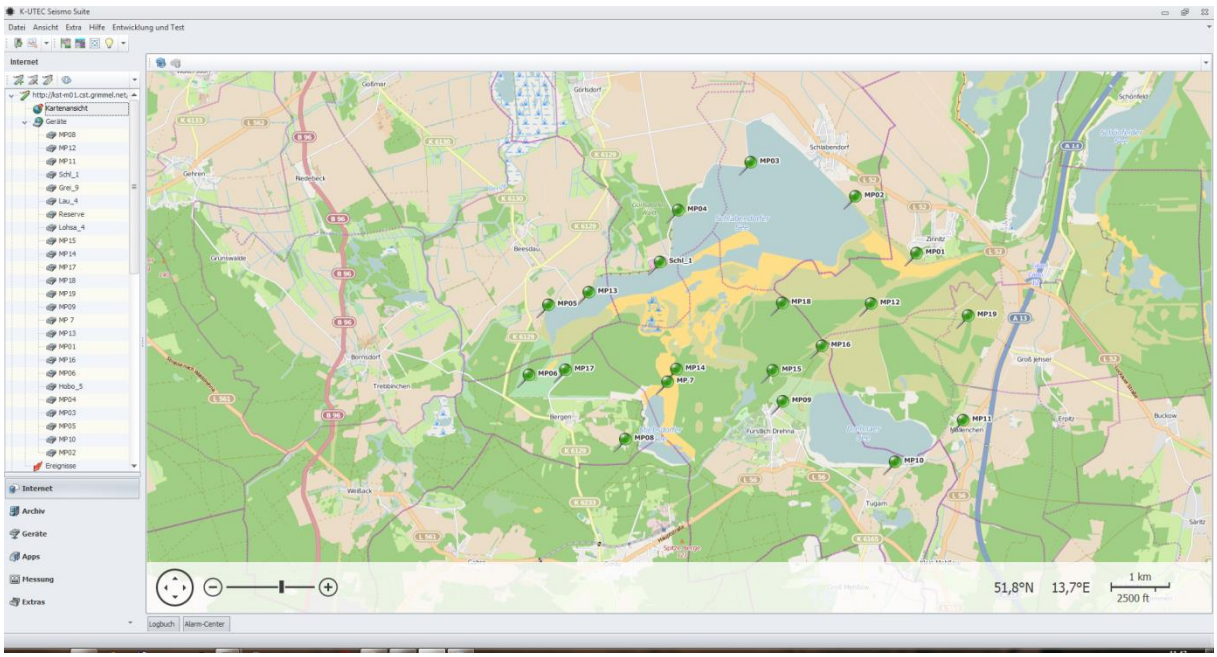
- 3D/1D Seismometers / accelerometers



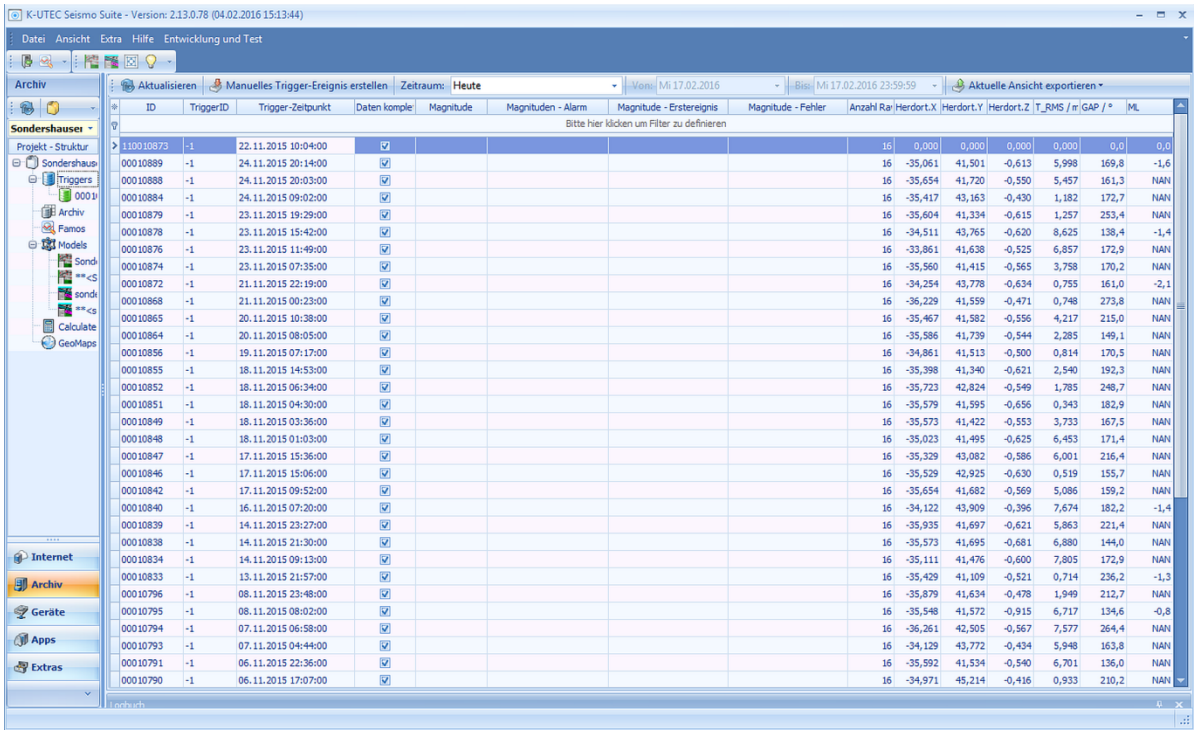



- Accelerators
- Borehole seismometers
- Hydrophones

Signal-processing software:

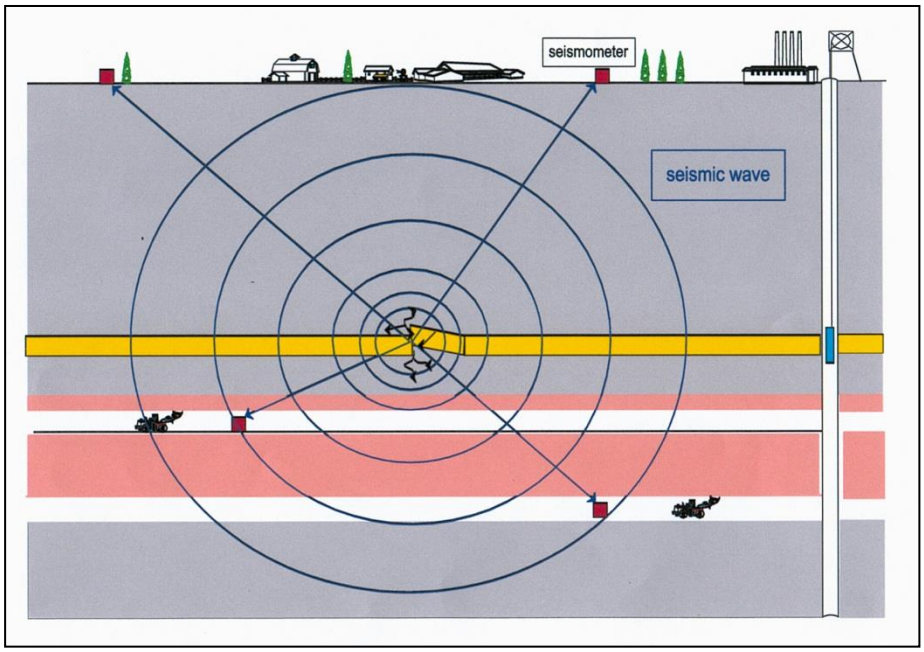


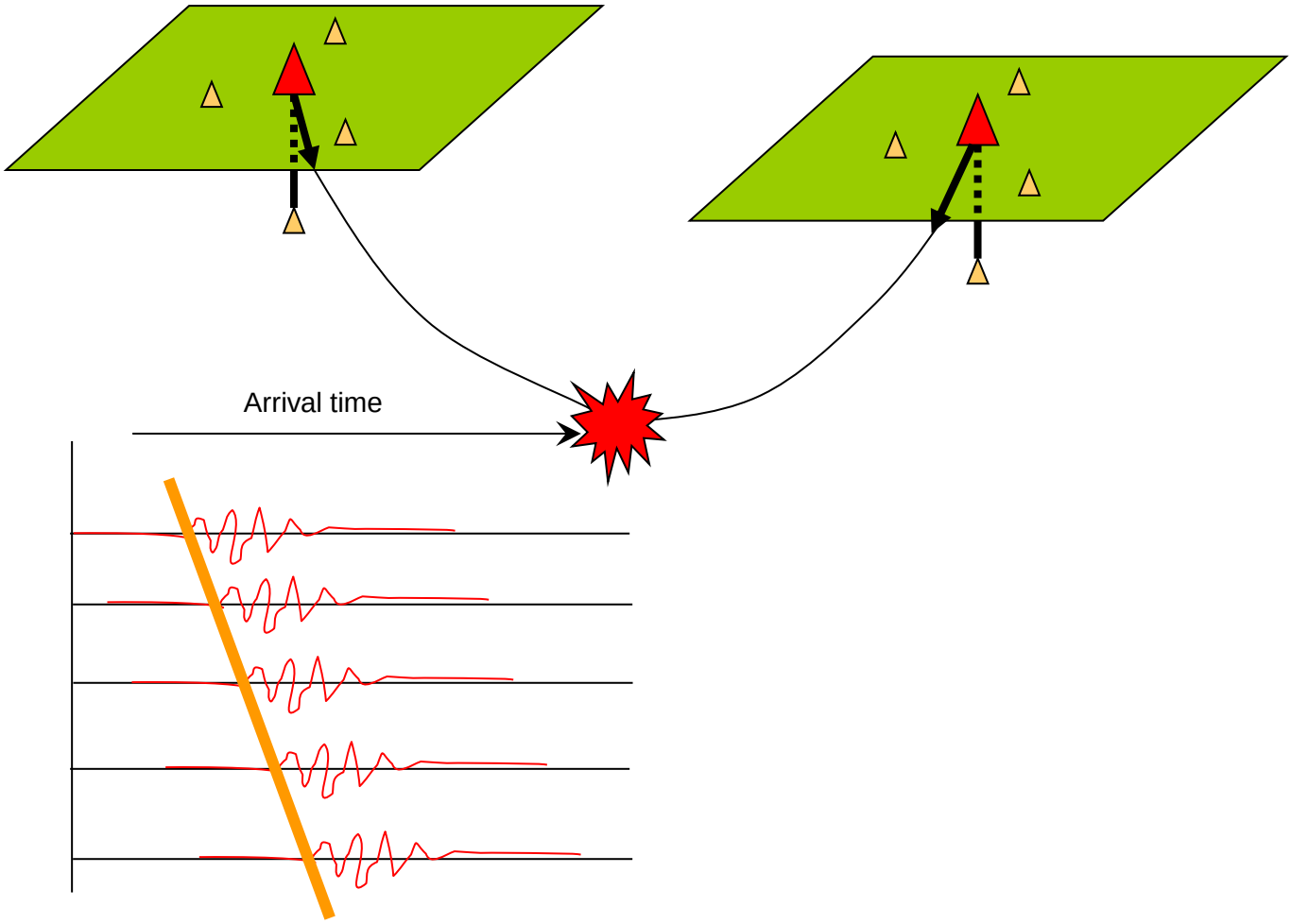
View of the seismometer stations for monitoring active and not active stations



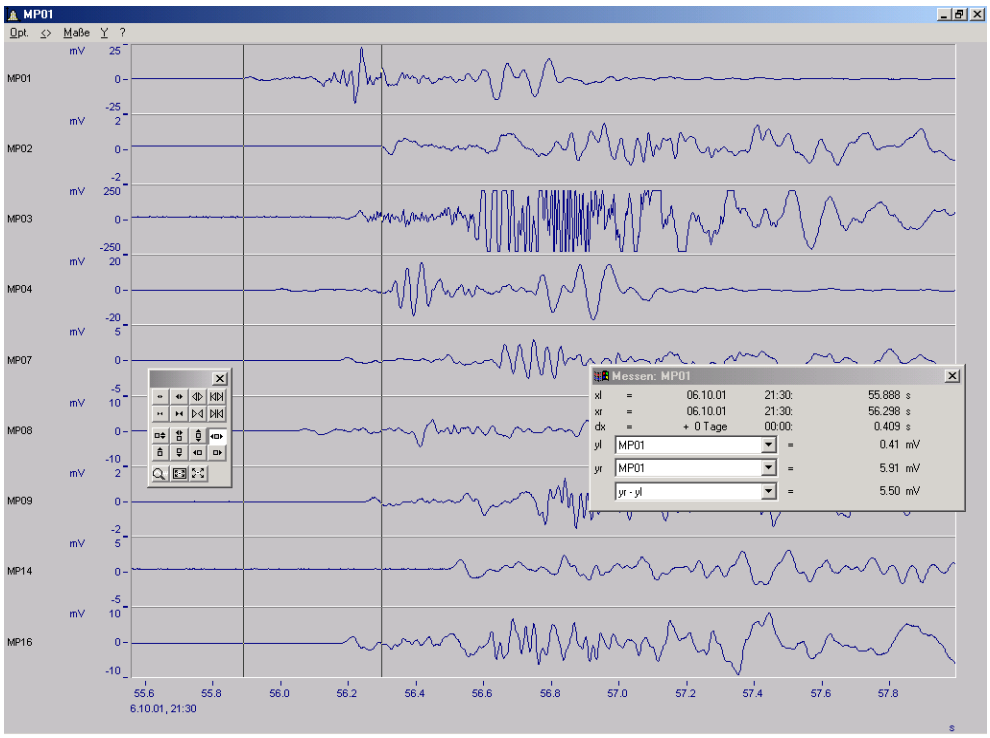
List of triggered seismic events

Localization of the events and estimation of the event parameter

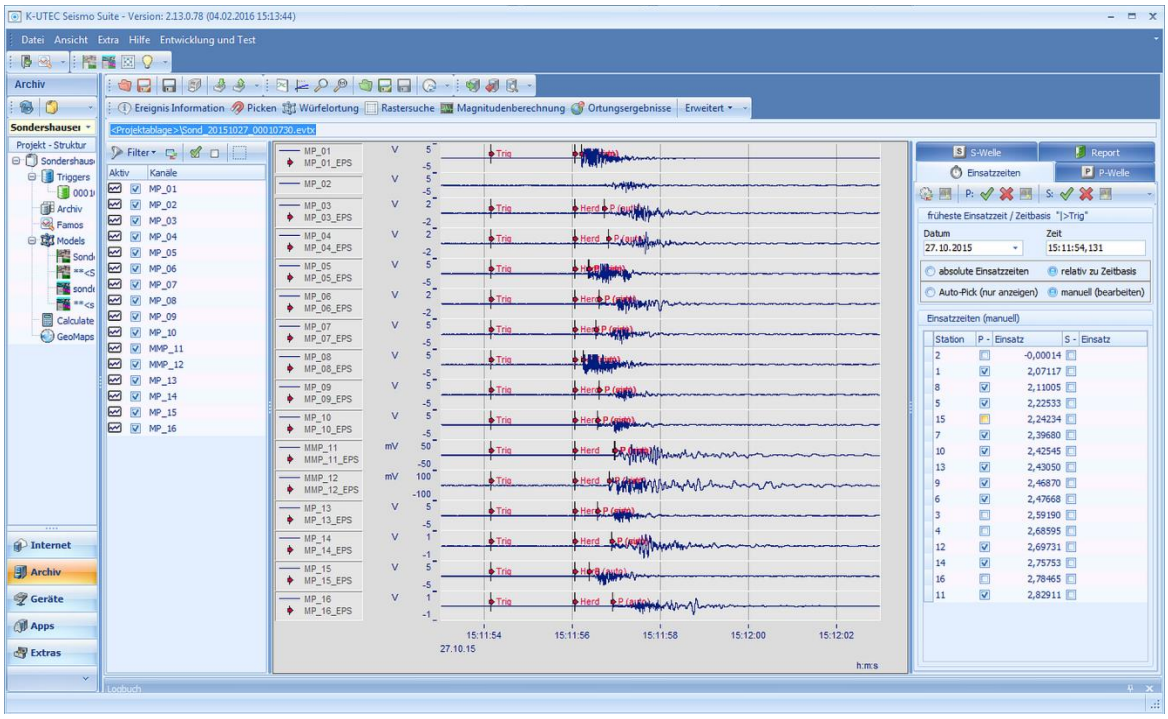




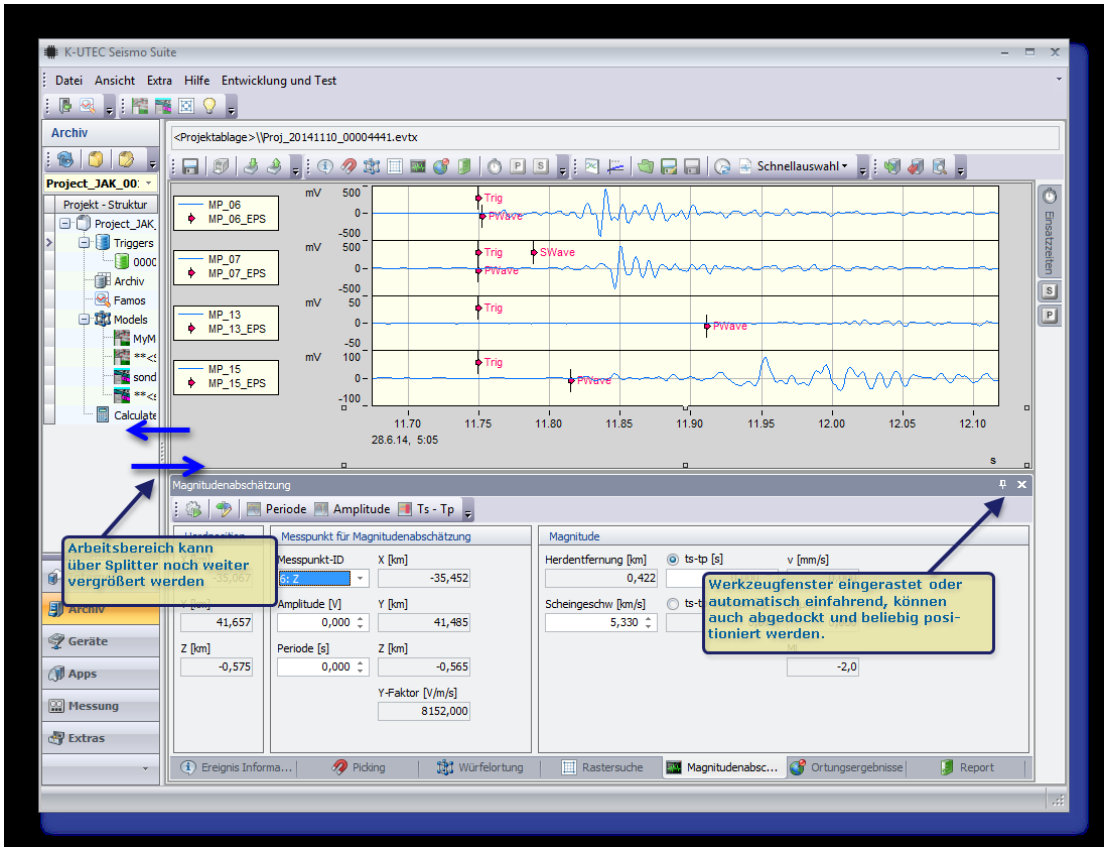
Event example



automatic localization:

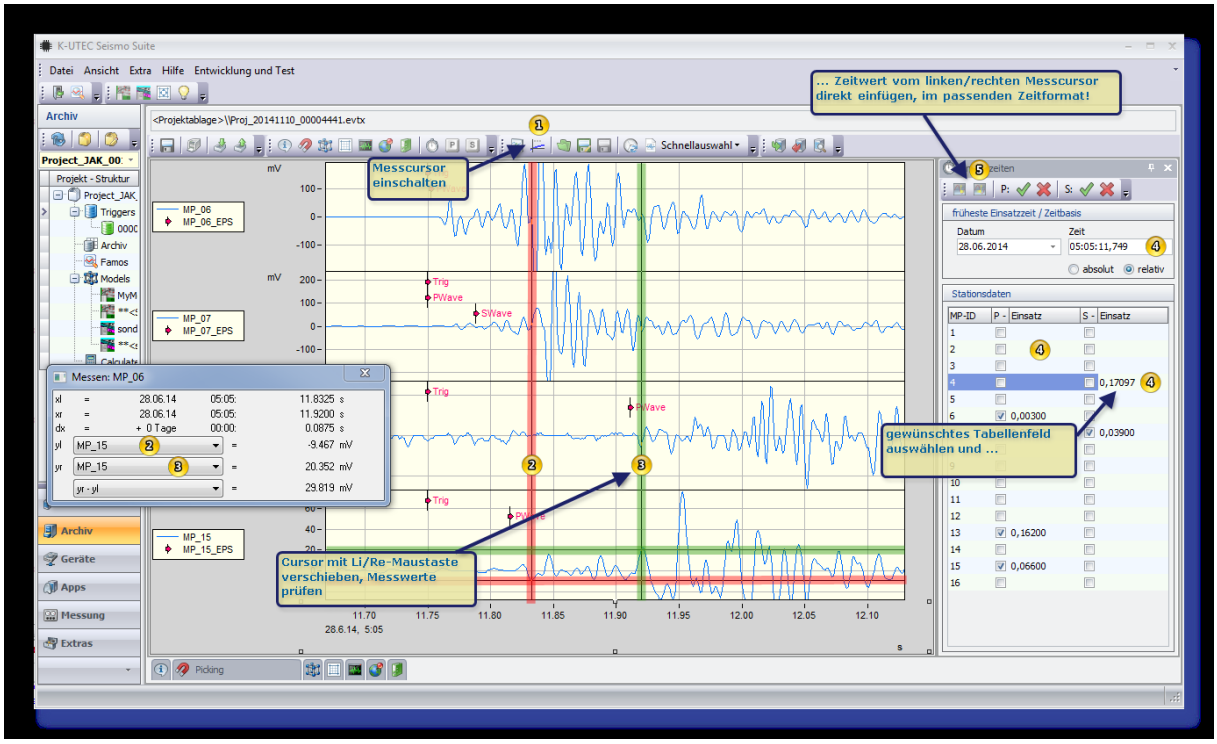


Automatically marked arrival times

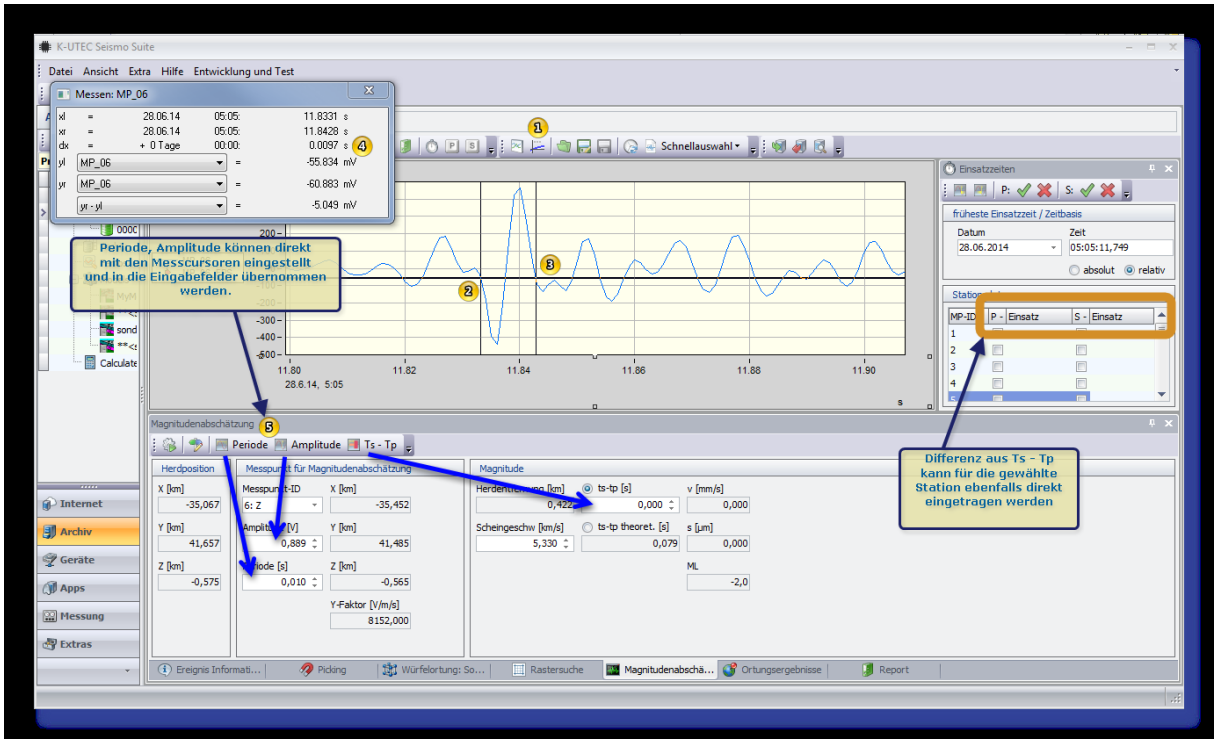


Automatically marked arrival times

manual localization:

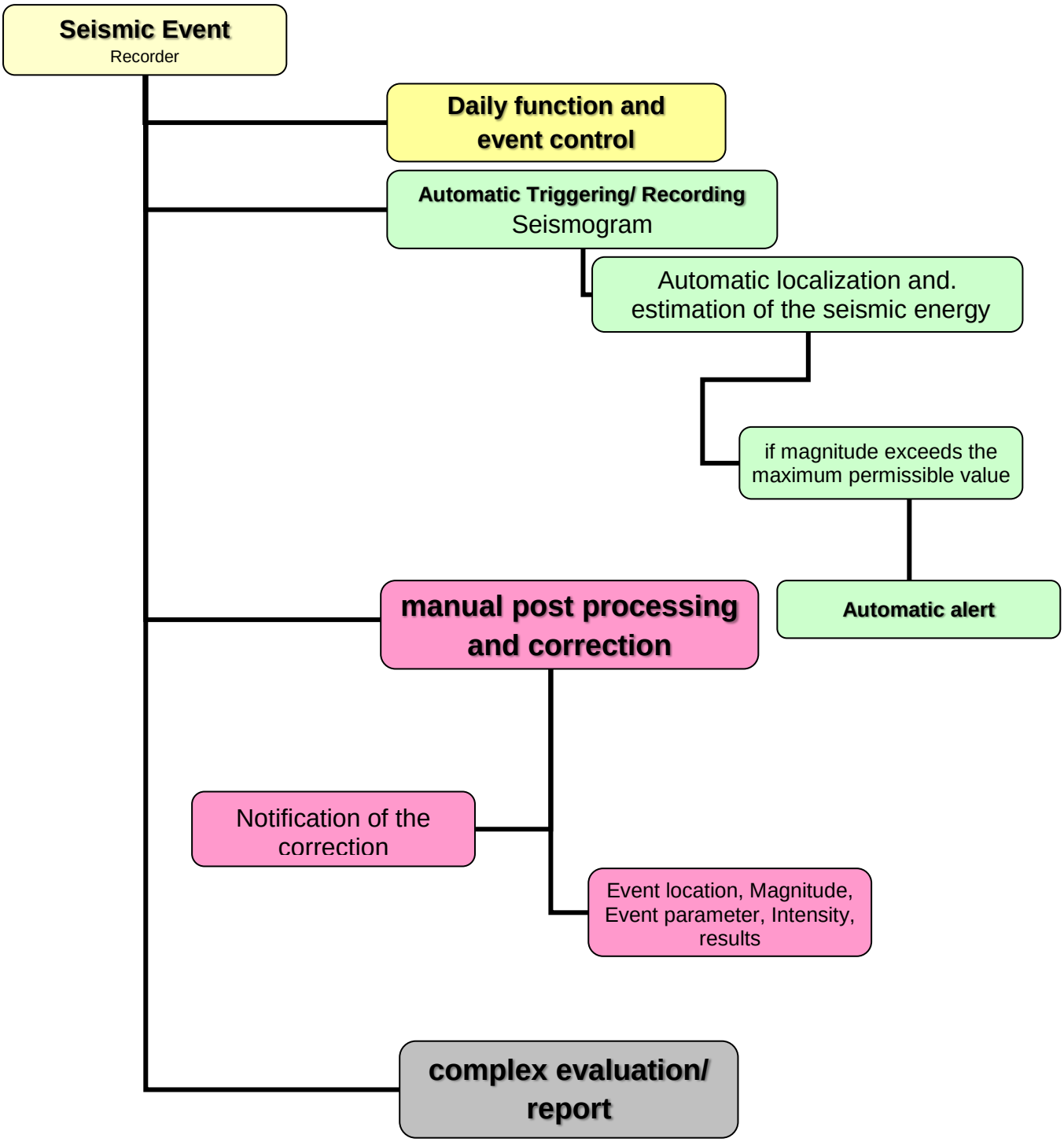


marked arrival times



Localization of the seismic event and calculation/ estimation of magnitude

Scheme of the event processing



Example for event localization over a certain time period in a potash mine (up to 1000 m under the surface)

Technical characteristics of the transient recorder (basic system):

2013 a new concept for seismologic registration unit were carried out by the K-UTEC AG Salt Technologies. This concept was realized until the end of 2013 to the new KutecGeolog. Since December 2013 the first registration units were installed in the field and work since this time in an uninterrupted service mode.

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 median for data transfer (internal 4G modem downward compatible, internal LAN port, WLAN hotspot, and more). The power supply 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 KutecGeolog is able to work together with different sensors like velocity proportional seismometers, accelerators, piezoelectrical pressure transducer and more.

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

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

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 of the last years in seismic monitoring by K-UTEC

Project	Location / Client	Size	Year	Remarks
Seismic monitoring of natural and induced seismicity	Teutschenthal, Angersdorf and Salzmünde / GTS mbH, Germany	16 measuring points	Since 1985	Seismic monitoring of the mine deposit, control of natural and induced seismicity, control and guidance of deposit work
installation of a seismic monitoring system	Unterbreizbach/Merkers / K+S, Germany	49 measuring points	Since 1970s	installation of a seismic monitoring system, technical support, consulting
Seismic monitoring of induced and natural seismicity	Bleicherode / NDH-E mbH, Germany	16 measuring points	Since 1994	Seismic monitoring of the mine deposit, control of induced and natural seismicity, control and guidance of deposit work
Seismic monitoring of natural and induced seismicity	Sondershausen / GSES mbH, Germany	12 measuring points	Since 1994	Seismic monitoring of the mine deposit, control of natural and induced seismicity, control and guidance of deposit work
Seismic monitoring of induced and natural seismicity	Bischofferode / LMBV KSE (former GVV mbH), Germany	27 measuring points	Since 1995	Seismic monitoring of induced and natural seismicity, monitoring of non-controlled flood
Seismic monitoring of induced and natural seismicity	Sollstedt / NDH-E mbH, Germany	11 measuring points	Since 1995	Seismic monitoring of the mine deposit, control of mining induced seismicity, control and guidance of deposit work
monitoring of 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	installation of a seismic monitoring system for a lignite mine
Seismic monitoring of seismic activity	Kirchheilingen / VNG, Germany	1 measuring point	Since 2001	Vibration measurement (monitoring of seismic activity in the area of gas storage caverns)
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 controlled flood	Friedenshall, Germany			Seismic monitoring of controlled flood
seismic monitoring of natural and	Kehmstedt / Deusa, Germany			Seismic monitoring of natural and induced

Project	Location / Client	Size	Year	Remarks
induced seismicity during brine process				seismicity during brine process of a cavern field
Seismic monitoring of natural seismicity	Bernburg / esco, Germany	9 measuring points	Since 2000	Seismic monitoring of natural 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 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 natural seismicity	Boulby Mine / ICL, UK	19 measuring points	Since 2009	Seismic monitoring, control of induced and natural seismicity
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
Seismic monitoring of a former lignite opencast pit	Schlabendorf / LMBV, Germany	20 measuring points	Since 2014	Seismic monitoring of the former lignite opencast pit Schlabendorf
Seismic monitoring of the vibroflotation soil compaction activities	Nachterstedt / LMBV, Germany	6 measuring points	Since 2015	Seismic monitoring of the vibroflotation soil compaction activities in a former lignite opencast pit area
Seismic monitoring of a cavern field	Hengelo / Akzo Nobel, The Netherlands	10 measuring points	Since 2015	Seismic monitoring of a cavern field
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	Auersmacher/Saarstahl, Germany	15 measuring sensor station	Since 2020	Seismic monitoring of an underground limestone mine to monitore sinkhole danger about the mine surface
Seismic monitoring of the geothermal plants in the Munich area	Greater Munich area/Bavaria Germany	prob. 21 sensor stations	Starting 2020	Seismic monitoring of all Bavarian geothermal plants in the greater Munich area/Bavaria