

Title of the presentation:

Technical possibilities and developments for seismological long-term monitoring in underground and surface mining

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Abstract

Geophysical and geotechnical methods for long-term monitoring in all kinds of mines, underground and on the surface, have become increasingly important in recent years. During the phases of mining as well as during backfilling, closing and post-mining the combination of geophysical methods and classical geotechnical measurements allows the long-term assessment of mine and public safety. Also in related branches like geothermic, tunneling and drilling their relevance ascends.

The K-UTEC AG Salt Technologies is a private company and the successor of the former central German potash industry's "Kaliforschungsinstitut" (potash research institute). The department of geophysics started in the 1970s with the concept, development, execution and support of monitoring systems to estimate states of destabilization as well as the hence resulting effects of stress and demands at the surface or the mine caverns. This experiences and activities are nowadays much more widespread than potash mining. Our present projects include log-term monitoring of salt and potash mines, a lignite mine as well as former opencast brown coal mines. But also the monitoring of caverns, remediation works (esp. monitoring of blasts for consolidation of dumps) and classical vibration measurements are part of our daily work.

Seismic engineering monitoring networks are fitted with spatially small but sensitive equipment with a wide range of connected sensors like velocity-proportional seismometers with different specifications, accelerometers, inclinometers, pressure-, ultrasonic-, temperature-, gas detector- and pore water pressure sensors (and more). In addition, a lot of other sensor types can be implemented. The systems consist of the measuring sites and a central registration unit on a PC or server. Data transfer is possible via cable (copper, light-wave cable), mobile (3G, 4G) or DSL (per line or satel-lite).

For analogue data transfer the former potash institute developed pulse-frequency modulation units (PFM). The technique is very robust and utter practical for use under hard conditions in salt and potash mining. This transfer method was developed during the last years to overcome long distances (up to 30 km), to minimize interferences, to transfer 2 signals via one cable or to carry out measurements in potentially explosive atmospheres. That is why the meanwhile relatively old method is still applied successfully in mines. In 2015 and 2016 K-UTEC developed a 4,5 Hz velocityproportional sensor and a PFM-modulation which obtained the EC-type examination certificate (ATEX) for use in explosive atmospheres. For the installation under special conditions (e. g. horizontal/vertical boreholes) special casings and probes were constructed.

In collaboration with a manufacturer K-UTEC also designed a new data logger (K-UTECGeoLog) that was launched for production. These new-generation data loggers are installed and operated since 2013. They allow the simultaneous digital recording of data from numerous analogue or digital input channels (from 4 to modular extendable). The integrated signal processor and the control software enable the definition of complex trigger functions and online data processing. Various digital and analogue output channels allow communication with and even control of peripheral systems. The device provides high resolution data (24 Bit), high sampling rates (5 kHz per channel), time synchronisation (GPS module), and the ability to use modern media for data transfer (internal, downwardly compatible 4G modem, LAN port, WLAN hotspot, etc.). Due to a power consumption of less than 6 W it can be supplied by solar power. The development of a new data logger was accompanied by the development of an enhanced visualization and evaluation software package (SeismoSuite). This ingenious, tailor-made seismological solution also enables the automatic interpretation of seismic events or other specific values (liquid level, etc.) and a downstream alert vie email, SMS or switching of facilities or equipment.

Technical examples and practical implementation of measuring concepts and their development over the last years will be demonstrated in the presentation.





figure 1: seismological measuring site in the mine with PFM-modulation unit and velocity-proportional seismometer



figure 2: seismological measuring site in the mine with mounting and isolation against explosive atmosphere





figure 3: seismological measuring site on the surface supplied by solar power (GTS, Salzmuende/Teutschenthal)



figure 4: seismological measuring site on the surface supplied by solar power (open switchgear cabinet)





figure 5: seismological measuring site on the surface supplied by 230 V (open switchgear cabinet) (GTS, Salzmuen-de/Teutschenthal)