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Technical Conference Paper

Conventional and Innovative Methods of Surface Monitoring above Cavern Fields

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CONVENTIONAL AND INNOVATIVE METHODS OF SURFACE MONITORING ABOVE CAVERN FIELDS

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Abstract

Caverns formed in salt deposits converge over time and as a result cause subsidence troughs to be formed at the surface. In accordance with German mining law the subsidence behavior has to be controlled every year above cavern fields. Exceptions are possible for smaller cavern fields. As subsidence is usually very small, measuring must be executed with the greatest accuracy possible. Therefore subsidence is measured conventionally by means of precision levelling and digital leveling instruments. These levels have a resolution of 1/100 mm and are economical owing to the automatic data acquisition and recording. High accuracies have been achieved with these kinds of instruments with mean kilometer errors of between 0.6 and 0.9 mm. The height accuracies resulting from such measurements are around 1 mm. The high accuracy on the one hand has to be seen alongside with the high efforts for the field work on the other hand.
When designing a subsidence surveillance program, secure reference points must be marked and surveyed which are well outside of the influence area of the cavern field. The results of such levelling control surveys must be documented in official maps, which must comply with defined accuracy requirements. Up to now it has been possible to satisfy these requirements only by using geometric levelling. Having said that satellite-borne methods have been continuously further developed and improved with the result that it can now be advantageous and expedient under specific circumstances to use these new technologies for monitoring ground movements above cavern fields.
Satellite-borne methods of monitoring ground deformation are InSAR (satellite radarinterferometry) and GNSS (GPS+GLONASS). With GNSS methods it is possible to measure horizontal and vertical coordinates of specific points with both high accuracy and high resolution in time. Daily measurement results can record even high and discontinuous movement rates. By using highly sophisticated equipment and post-processing procedures, the accuracy of measurement can be enhanced up to a few millimeters in case of permanent observation in horizontal and vertical direction. In many cases, GNSS monitoring therefore already replaces leveling and subsidence monitoring with traditional techniques. However, due to a limited number of measurement points, the spatial resolution is often too low to fully describe ground subsidence. To avoid information gaps, satellite InSAR can be applied in combination with GPS measurements. Satellite InSAR enables to measure large areas with high temporal and spatial information density of thousands of points per sqrkm and helps to avoid misinterpretations of subsidence or uplift effects. InSAR measurements offer various measurement repeat cycle lengths, e.g. from 35-days by C-band Radarsat to 11 days by TerraSAR-X, and a spatial ground resolution up to 1 m. The accuracy of movement detection using advanced InSAR methods is on millimeter, under best conditions even on sub- millimeter resolution level. These parameters are ideal for monitoring the effects of short- and long-term ground movements. Following a short general introduction, the advantages and disadvantages of the methods for their use above cavern fields are discussed and demonstrated by practical examples. Also, some example cases introduce results of advanced InSAR products from Terrafirma, an ESA service for monitoring surface deformation. Trough the combination of InSAR deformation maps and additional information, e.g. geologic characteristics of investigated areas, further knowledge on deformation origin and prevention of damages can be achieved. The poster concludes by giving some recommendations for carrying out effective surface monitoring, both from a technical as well as an economic point of view.

Key words: Instrumentation and Monitoring, Radar, Subsidence