Solution Mining Research Institute Spring 2013 Technical Conference

Lafayette, Louisiana, USA, 22 – 23 April 2013

Use of satellite InSAR for measurement of ground subsidence over Salt Caverns

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Abstract

InSAR (Interferometric Synthetic Aperture Radar) uses satellite radar imagery to precisely measure ground deformation. The technology can provide high densities of measurement points, up to thousands per square kilometer, with millimeter accuracy over large areas. It has been used since the late 1990's in a growing range of fields including oil and gas, mining, geothermal energy, carbon capture and sequestration, transportation, and the monitoring of natural hazards.

In the oil and gas sector InSAR is used to monitor subsidence above producing fields as well as heave associated with improved recovery techniques such as water flooding and CO2 or steam injection. An application where the technique has encountered success, is in the monitoring of displacement produced by underground gas storage where the injection/extraction cycles have been closely matched with corresponding surface deformation patterns.

In solution salt mining InSAR can play a role in both the monitoring of any long term movement occurring over mine sites as well as an early warning system for the potential abrupt formation of sinkholes and mining-related collapses. Similar occurrences, although not related to salt mining, have been documented for the Wink Sinks, two large sinkholes that formed in Texas in the 1980's and 1990's. InSAR data processed over this area illustrates the potential of the technology for forecasting precursor ground movement prior to the catastrophic collapse of the ground surface as well as the possibility of continued monitoring during and after the formation of the sinkholes.

Compared to traditional surveying techniques InSAR presents the advantages of producing a much higher density of measurement points with comparable millimeter-scale precision, over large areas and at a reduced cost. The technology involves the processing of large stacks of radar imagery in which advanced algorithms analyze the data to automatically identify radar targets, which can be man-made or natural objects, such as buildings, lampposts, rock outcrops, areas of exposed ground, etc., from which it is possible to measure ground deformation.

Key words: Subsidence, Instrumentation and Monitoring, Radar, Caverns for Gas Storage, Caverns for Liquid Storage, Cavern Operation, Gas storage, Geophysics, Sinkholes,