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Longwall mining and surface deformation – lessons learned from dInSAR measurements

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Differential radar interferometry (dInSAR) techniques are well known for their ability to provide mm- to cm-scale measurements of surface deformation. Very accurate measurements of deformation have been achieved in several areas of research including 1) subsidence related to mining and groundwater abstraction, 2) deformation following earthquake events, 3) monitoring of landslides and slope stability, 4) monitoring the stability of infrastructure and large engineering works, and 5) monitoring volcanic activity. The maturity of the technology has advanced to a stage where operational monitoring of surface deformation in different environments is possible. In shallow underground mining environments, the risk of surface deformation is significant and dInSAR for monitoring of surface deformation is frequently used. The advantage of using dInSAR measurements is that large areas can be monitored. Additionally, regular image acquisitions by earth orbiting sensors imply that the evolution of deformation basins over time can be monitored. In contrast, field-based measurements using GPS or spirit-levelling provide only point-based measurements. Therefore, the full extent of deformation basins and their evolution over time is frequently not well understood.

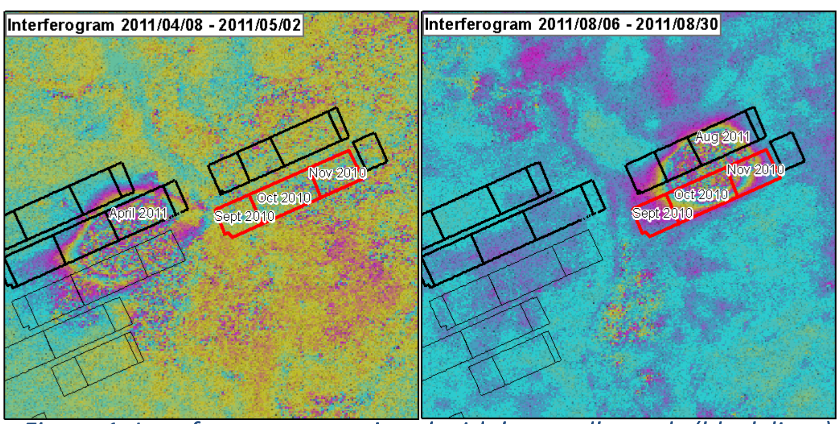

Figure 1: Interferogram associated with longwall panels (black lines) illustrating the area of active mining and the reactivation of subsidence for previously mined panels (red lines)

To better understand the surface deformation caused by underground mining, dInSAR monitoring in several environments were performed. In particular, an area undergoing longwall mining was considered. In longwall mining, coal is mined in a single slice and the roof is allowed to collapse into the void [1]. This leads to subsidence of the surface. The surface subsidence is largely immediate, allowing for better planning. To understand the deformation due to longwall mining and its evolution over time, a time-series of SAR data was commissioned to be captured between 2008 and 2011. In general, surface deformation could be detected with high accuracy and the evolution of the subsidence basins over time could be monitored. The results indicated that subsidence progressed for a period of up to 3 months after mining. However, the commencement of mining of a panel adjacent to the previously mined panel leads to the reactivation of subsidence. In fact, it was determined that the angle of draw, defined as the angle between the side of the longwall panel and the line of zero deformation at the surface, was almost double adjacent to previously mined panels compared to the angle of draw adjacent to unmined areas. This result was unanticipated by rock engineers working in the area. The results suggest that the measurements provided by dInSAR techniques can complement current monitoring approaches and used to refine current subsidence prediction models.

References:

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