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Surface deformation in areas of abandoned mining: a case study of InSAR applied in the Northumberland region of the UK

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The United Kingdom has a rich history of coal mining probably dating back to Roman times, and this was a driving force behind the industrial revolution. Although the amount of mining has decreased significantly in recent years, the effects of mining on ground stability are widespread, complex and under-monitored.

The Coal Authority is responsible for protecting the public and environment in coal mining areas. Particularly they are responsible for administering coal mining subsidence damage claims and preventing problems due to rising groundwater in old mining areas.

Drawing on the expertise of Fugro NPA (FNPA) and the British Geological Survey (BGS), the aim of this project was to show how a wide-area ground stability dataset with associated geological interpretation could help the Coal Authority better administer their subsidence claims and groundwater management. This work was performed within the Terrafirma project.

The study area chosen was the Northumberland and Durham coalfield where the last active mine closed in 2005. More than 20 seams have been mined and as depths increased this led to the need to pump water to prevent the mines from flooding. As the mines shut down the pumping stopped, causing the water level to rise and recover.

Using interferometric synthetic aperture radar (InSAR) techniques FNPA produced a surface deformation dataset which was interpreted by BGS to add value in the form of geological interpretation. The dataset covers two epochs; 1995-2000 and 2002-2008.

During the earlier epoch eight to nine 'hotspots' of subsidence were identified, mainly in the south of the study area. All but one of the subsidence areas shows a strong spatial correlation with areas of past mining. However there is a discrepancy in the timing of InSAR deformations and the timing of subsidence that would be expected given the type of workings. It is suspected that the spatial and temporal pattern of deformation relates not only to material extraction but also to water extraction and the accommodation of resulting deformation along pre-existing faults.

Surface deformation during the later epoch is dominated by a low magnitude, wide area uplift that correlates well to rising groundwater levels. The area is divided into mine water blocks that fill up sequentially as groundwater levels rise, and this effect can be clearly seen in the InSAR dataset. The correlation between surface deformation and rising groundwater has allowed The Coal Authority to optimise their management of groundwater in a cost-effective manner across wide areas.