



Overview on deformation at Cundinamarca and Boyacá (Colombia) mines

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Subsidence in active and abandoned underground coal mines continues to pose a potential threat to safety and infrastructure in many parts of the world, and in Colombia, surface deformation in mining regions is not routinely monitored. Here, we present results from our study in which Interferometric Synthetic Aperture Radar (InSAR) from Sentinel-1 was used to measure deformation associated with underground coal mining activities in the departments of Boyacá and Cundinamarca, Colombia, between 2014 and 2017. We processed 257 interferograms using 114 SAR images including both descending and ascending orbits, and produced tropospheric delay maps from local atmospheric data to model and remove atmospheric delays from the interferograms. We calculated deformation time series using three different techniques: Small Baseline Subset (SBAS), Multiple Small Baseline Subset (NSBAS) and a variation of Multiscale InSAR Time-Series (MinTS). After resolving the horizontal and vertical components of deformation using the two lines of sight, our results show regions of both uplift (of up to cm) and subsidence (up to 5 cm) over the 3-year period of study.

We validated our results using the vertical component of the only publicly-available continuous GPS station in the region, obtained from the Nevada Geodetic Laboratory catalog. Compared to the GPS data over the period of study, we found a total difference of 10mm for the SBAS method, 6.4mm for NSBAS and 13.3mm for MinTS. These results represent an encouraging first step in the implementation of deformation monitoring and impact assessment for underground coal mines in Colombia.