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Anelastic modeling of surface subsidence induced by the Crandall Mine (Utah) collapse

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The Crandall Mine collapsed in August 2007 and resulted in the death of 6 miners. The collapse induced surface subsidence visible by satellite geodesy. We processed data from ALOS satellite acquired before and after the collapse to quantify the subsidence and infer the deformation at depth. Our InSAR results show a localized oval shaped (1000 x 500 m2) pattern of subsidence with a maximum vertical displacement of 29 cm. Profiles across the subsided area show a steep V-shaped pattern.

We first model the collapse using an elastic halfspace model. However, we find poor agreement between the elastic model solution and the InSAR observations, mainly because the elastic solution is characterized by a broad subsidence pattern. To improve this fit, we apply a model predicting surface settlement from tunneling (Loganathan and Poulos, 1998), where the internal friction angle is considered in the solution. To account for the flat shape of the collapse strata, we modify the model by changing its geometry from circular shape to elliptical (500 x 2.4 m). Our results show a very good fit in terms of the subsidence pattern, in particular the localization of the subsidence. We found that the surface subsidence was caused by a 7.7% collapse of the mine elliptical shaped mine. Although our simple model does not explain all the observed features, we find it more suitable than elastic halfspace models to explain the localized deformation pattern.