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Prediction of sinkholes induced by solution mining through the inverse velocity method

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Abstract

The analysis of ground displacement when trying to anticipate the occurrence of an incoming failure in any geomaterial (e.g. natural slopes, man-made slopes, dams, sinkholes, etc.) is of paramount importance. In this regard, many authors have focused on monitoring in time the behavior of materials subject to deformations in order to predict their time of failure, and several empirically derived methods that make use of displacement, strain, velocity or acceleration have been consequently proposed in the scientific literature. Although a universal law which successfully accomplishes this goal for all the types of failure mechanisms and materials does not yet exist, a good number of empirically derived methods and equations have been produced in the last decades. Several examples of ground deformations associated with solution mining are available in the scientific and technical literature, showing the typical evolution of deformations with time prior to the occurrence of a sinkhole having many similarities with a generalized creep characterized by an exponential increase of deformations on the surface prior to failure. The inverse velocity method, the most common empirically derived approach for the prediction of the time of failure for natural and man-made slopes, works for cases which fail in accordance with the accelerating creep theory. The objective of this paper is to show the results of the implementation of the inverse velocity method by using ground deformations measured at different solution mining sites prior to the occurrence of sinkholes. The outcome of the analysis clearly shows how the inverse velocity method works for the analyzed cases, proving for the first time to the knowledge of the authors, how such a method can be effectively used to predict the occurrence of sinkholes associated with solution mining.

Key words: subsidence, salt caverns, deformation, sinkholes, monitoring, collapse prediction, inverse velocity