Geophysical Research Abstracts
Vol. 16, EGU2014-7706, 2014
EGU General Assembly 2014

Insights to caving processes from localization of microseismic swarms induced by salt solution mining

Jannes Lennart Kinscher (1), Pascal Bernard (2), Isabelle Contrucci (1), Anne Mangeney (2), Jack Pierre Piguet (3), and Pascal Bigarre (1)

(1) L'Institut National de l'Environnement Industriel et des Risques INERIS, Nancy, France (j.l.kinscher@gmail.com), (2) Institut de Physique du Globe de Paris IPGP, Paris, France, (3) Ecole des Mines de Nancy - Université de Lorraine, Nancy, France

In order to improve our understanding of hazardous ground failures, caving processes, and collapses of large natural or man-made underground cavities, we studied microseismicity induced by the development and collapse of a salt solution mining cavity with a diameter of $\sim$ 200 m at Cerville-Buissoncourt in Lorraine, France. Microseismicity was recorded as part of a large geophysical, multi-parameter monitoring research project (GISOS) by a local, high resolution, triggered 40 Hz geophone monitoring system consisting of five one-component and four three-component borehole stations located around and in the center of the cavity. The recorded microseismic events are very numerous ($\sim$ 50.000 recorded event files) where the major portion ($\sim$ 80 %) appear in unusual swarming sequences constituted by complex clusters of superimposed microseismic events. Body wave phase based routine tools for microseismic event detection and localization face strong limitations in the treatment of these signals. To overcome these shortcomings, we developed two probabilistic methods being able to assess the spatio-temporal characteristics in a semi-automatic manner. The first localization approach uses simple signal amplitude estimates on different frequency bands, and an attenuation model to constrain hypocenter source location. The second approach was designed to identify significantly polarized P wave energies and the associated polarization angles. Both approaches and its probabilistic conjunction were applied to the data of a two months lasting microseismic crisis occurring one year before the final collapse that was related to caving processes leading to a maximal growth of $\sim$ 50 m of the cavity roof.

The obtained epicenter locations show systematic spatio-temporal migration trends observed for different time scales. During three phases of major swarming activity, epicenter migration trends appear in the order of several seconds to minutes, are spatially constrained, and show partially a reversal and cyclic spatio-temporal behavior. Similar epicenter migration trends are observed in the order of hours, and days from the spatio-temporal distribution of epicenter clusters in the cavity zone. From these observations and other geophysical parameters we conclude that microseismicity mainly represents detachment cracking at the cavity roof which is in a critical state of stress. Furthermore, we assume that the systematic epicenter migration trends represent chain reaction failures initiated by partial fracturing and subsequent stress redistribution processes. These preliminary results give first evidence that local microseismic monitoring can be a very powerful tool in order to survey and study hazardous caving processes. In future work, these hypotheses will be further tested and specified by detailed analysis of the spectro-energetic mircoseismic signal characteristics and comparison to local geodetic deformation data.