

PSP04

## Mine Induced Seismicity: From a Passive Microseismic Monitoring in Complex Near-Field Underground Conditions to an Open & Accessible Database

M Marot\* (INERIS), J. Kinscher (INERIS), S. Coccia (INERIS), I. Contrucci (INERIS), E. Klein (INERIS) & P. Bigarré (INERIS)

### SUMMARY

---

In the scope of cavity surveillance and instability forecasting, the underground salt mine cavity of Cerville-Buissoncourt, NE France, was monitored during 5 years and represents a large collection of microseismic data, encompassing the cavity's stability phase until its provoked collapse. The growing instability of the cavity is witnessed by several microseismic crises recorded at 1D and 3D geophone stations deployed at the surface and in boreholes. Event localizations indicate that they lie near the cavity roof and are interpreted as block falls and growing of the cavity.

Our objectives are (1) to follow the cavity's growth over time until its collapse, in order to improve prognostics of underground cavity collapses in a general sense, and (2) to make accessible our catalog data and methods via open source web platforms, e.g. e.cenaris (INERIS) and EPOS.

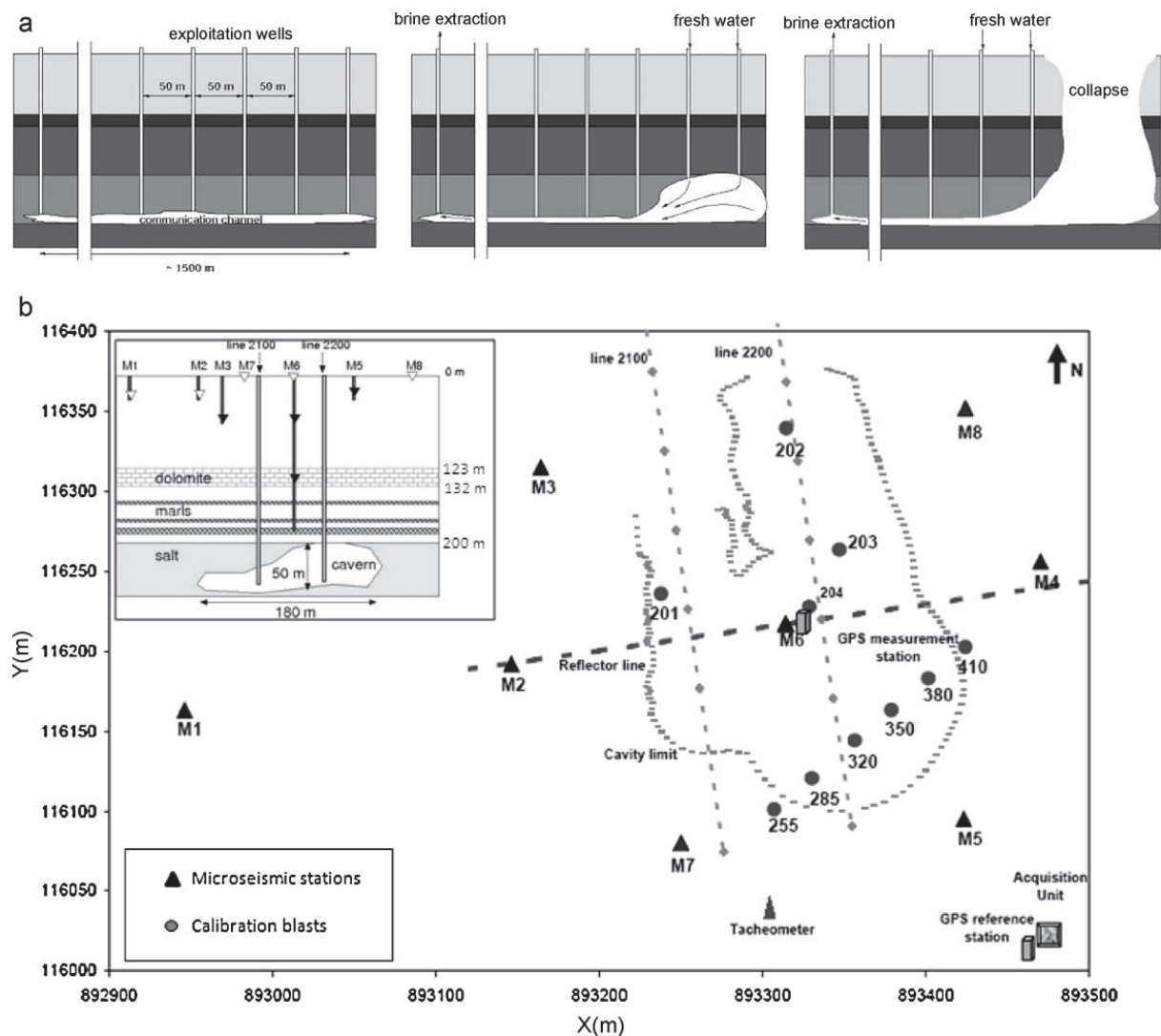
In order to achieve this, a comparison is made between event localizations and characteristics along the different evolution stages of the cavity: stable, unstable and collapse. Once data processing is automated and a calibration magnitude law is found for each time period, we apply them to a much larger dataset within each time period and obtain a complete catalog describing the evolution of the salt mine cavity.

## Introduction

It has long been known that several industrial processes are capable of inducing earthquakes, including reservoir impoundments, surface and underground mining, subsurface fluid and gas withdrawals, and fluid injections into underground formations. For this reason, human-induced earthquakes have become an important issue of political and scientific life and discussion, owing to the concern that these events may be responsible for significant environmental, social and economic consequences and may endanger surface communities.

In the scope of cavity surveillance and instability forecasting, the underground salt mine cavity of Cerville-Buissoncourt in the Lorraine basin, NE France, was monitored with a high-resolution passive microseismic monitoring network during 5 years (from 2004 to 2009). It represents a large collection of microseismic data, encompassing the cavity's stability phase until its provoked collapse.

The growing instability of the cavity is witnessed by repeated microseismic crises of several thousand events over only a few days, in the form of isolated and tremor events, and recorded at 1D and 3D geophone stations deployed at the surface and in boreholes. Localization of these events indicates that they lie near the cavity roof and are interpreted as block falls and the growth of the cavity.



**Figure 1:** (a) Layout diagram illustrating operations using channels and drill holes from the creation of a communication channel at the base of the deposit (left), the extension of the cavern (center), to its collapse (right). (b) Aerial map view of the high-resolution microseismic monitoring network. The

insert illustrates a vertical cross-section of the instrumentation, the cavity extension, and the lithostratigraphy. From Contrucci *et al.* [2011]

## Objectives

- (1) Our primary aim is to characterize the microseismicity in terms of the hypocentral locations, local magnitudes, source energies, and focal mechanisms, in order to recognize and predict a pattern tending towards the cavity's instability.
- (2) Our final aim is to publish our complete database and methods of calculations onto open access web platforms, such as the European environmental large-scale infrastructure EPOS (<http://www.epos-eu.org/>), to share with the worldwide scientific community.

## Methods

Most of our efforts are focused on the determination of an accurate hypocenter location, since all subsequent seismological processing depends on its accuracy. Furthermore, in order to observe event migration patterns throughout time, improving the hypocenter location accuracy is fundamental.

From a selection of 200 reliable isolated events describing four different evolution stages of the cavity's stability (pre-, syn- and collapse of its roof), we tested and validated different methods of source localization, based on various data parameters (S-P, amplitude, polarization, and combinations) [Kinscher *et al.*, submitted] and evolving velocity models (1D and 3D). Spectral amplitude ratios are then analyzed to provide information on the types of focal mechanisms (tensile versus double-couple) and source seismic energies (seismic moment and magnitude) from overlying 3D sensors.

Once data processing is automated and a calibration magnitude law is found for each time period, we may apply this procedure for a much larger dataset representing each time period (i.e. thousands), in order to obtain a complete catalog describing the evolution of a salt mine cavity towards instability and eventually its collapse.

## References

- Contrucci, I., Klein, E., Cao, N.-T., Daupley, D., & Bigarré, P., [2011]. Multi-parameter monitoring of a solution mining cavern collapse: First insight of precursors, *C. R. Geoscience*, **343**, 1-10
- Kinscher, J., Bernard, P., Contrucci, I., Mangeney, A., Pigué, J.-P., & Bigarré, P., submitted. Localization of local microseismic swarming sequences induced by salt solution mining, *J. Geophys. Int.*