Controlled Solution Salt Mine Collapse in Romania

A microseismic system was installed at the salt deposit at Ocnele Mari in southern Romania to monitor a controlled collapse of the cavern roof. Advanced analysis of microseismic events linked the site seismicity to fragmentation and falling of the main cavern collapse as well as to roof fracturing of smaller nearby caverns.

The Ocnele Mari salt deposit located in the sub-Carpathian hills of southern Romania actively extracted salt through dissolution in four fields beginning in 1954. Following the removal of 13.5 million tones of salt from Field II, operations were permanently halted after a major collapse in 1991. These events highlighted the risks associated with the presence of a dissolution chamber near to a densely populated area and provided an opportunity to safely monitor corrective actions to reduce risks using a microseismic system.

Background

Exploitation of salt deposits through solution mining at Ocnele Mari, Romania created the world’s largest
artificial underground cavern containing several million cubic meters of brine. A large collapse in 1991 led to the shut-down of the field; however the hazards associated with the presence of this volume of brine near to a densely inhabited region remained real. In 2001, the collapse of roof material from the surface formed a crater almost 200m in diameter and caused 1.7 million m$^3$ of brine to spill. A second collapse in 2004 enlarged the sinkhole and highlighted the need to find a solution to stabilize the current situation.

The decision was made to perform a controlled collapse of the cavern roof. A component of the cavern roof was cut open and sterile water was pumped into the cavern while brine was simultaneously removed to maintain hydraulic pressure.

**ESG Solution**

A staggered microseismic array consisting of 36 sensors were installed in 12 boreholes between 160-360 meters deep and covering an area of over 1km$^2$. The array provided information about microseismic activity related to stress re-distribution during the controlled collapse.

A total of 2392 events with a moment magnitude Mw between -2.8 and 0.2 were measured with an average location accuracy of 18m between July 2005 and March 2006. The majority of these events were found to be related to the fragmentation and falling of the cavern roof during the controlled collapse. Specifically, the most active clusters were related to the main cavern collapse while the lesser active clusters correspond to the roof fracturing of nearby, smaller caverns.

As part of some advanced analysis of the seismic data, seismic moment tensor inversion solutions were calculated to evaluate the failure mechanisms of the seismic events. The analysis provided strong evidence that event mechanism evaluation reflected the expected trends for controlled salt mine collapse.

**Fig 2:** Distribution of seismicity in a vertical cross-section striking north.

**Fig 3:** Event mechanism solutions of a portion of the seismicity showing predominant normal and reverse shear fractures.