SOLUTION MINING RESEARCH INSTITUTE
105 Apple Valley Circle
Clarks Summit, PA 18411, USA

Telephone: +1 570-585-8092
www.solutionmining.org

Research Report 2017-1

SMRI Research Report RR2017-1:

Very Slow Creep Tests As a Basis for Cavern Stability Analysis

Pierre Bérest and Hakim Gharbi, Ecole Polytechnique, Palaiseau, France
Benoit Brouard, Brouard Consulting, Paris, France
Gerd Hofer and Stefan Stimmisher Salinen Austria AG, Ebensee, Austria
Dieter Bruckner, Institut für Gebirgsmechanik, Leipzig, Germany
Kerry DeVries, RESPEC, Rapid City, South Dakota, USA
Grégoire Hévin, Storengy, Bois Colombes, France

With kind help from Christopher Spiers, Utrecht University, The Netherlands and Janos Uraï, Aachen University, Germany

SMRI Sponsor: Steve Bauer, Sandia National Laboratories, Albuquerque, NM

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EXECUTIVE SUMMARY

In July 2014, a contract was signed between the SMRI and a research group composed of Ecole Polytechnique, Brouard Consulting, IfG, RESPEC and Salinen Austria. The objective of this contract was to assess the creep law of natural salt in a small deviatoric stress range. It was suspected that in this range creep is much faster than what is predicted by most constitutive laws used in the cavern industry, with important consequences for the computation of cavern behavior.

Four 2-year-long multistep creep tests were to be performed on creep testing devices designed by Ecole Polytechnique and set in the Altaussee Mine to take advantage of the very stable temperature (and humidity) conditions in this salt mine. Each step was planned to last 8 months. Loading steps were planned to be 0.2, 0.4 and 0.6 MPa (The actual applied loads were slightly different) — much smaller than the loads usually applied during creep tests, which are in the range 5-15 MPa. Four salt samples were to be used: two samples cored from the Avery Island salt mine in Louisiana and two samples cored from the Gorleben salt mine in Germany.

Storengy, a gas cavern operator and a SMRI member, proposed to pay for a fifth testing device, set in the same mine, to assess the creep properties of a salt sample cored at Hauterives, France. It was agreed that the results of this additional test should be included in the general report prepared for the SMRI membership.

The tests began on August 1, 2014. Updates were presented to the SMRI Research Committee during the 2014, 2015 and 2016 SMRI Meetings.

An electric outage took place at the end of stage 1. Data were lost, however sample creep was not affected during this period. The second stage began on July 6, 2015. The third stage began on April 6, 2016 and the tests were completed by November 2016, as stipulated in the contract signed between the SMRI and the research group.

At the beginning of Stage 1, a 0.2 MPa load was applied to the five samples. At the end of Stage 1, it appeared that steady-state has not yet been reached in the case of the Avery Island and Gorleben samples (strain rates were still decreasing). It was decided to keep the 0.2 MPa load on Avery Island #2 and Gorleben # 1 and to increase the load applied to the other three samples to 0.4 MPa, as initially planned. An example of a strain-vs-time curve is represented on Figure A1.

The two Gorleben samples raised an unexpected problem. After September 2014 and November 2015, expansion was observed on samples #1 and # 2, respectively. It is suggested that swelling (of anhydrite?) took place in these two samples. At the beginning of Stage 3, a 0.6 MPa load was applied on the Avery Island, Hauterives and Gorleben #2 samples, as initially planned. A 0.107 MPa load was applied on the Gorleben #1 sample.