Visualization and Acoustic Detection of Microcrack Development in Rock Salt

H. Alkan[1], Y. Cinar[2], G. Pusch
Technical University Clausthal, Clausthal-Zellerfeld, Germany

[1] Now with GRS ISTec, Cologne, Germany
[2] Now with Stanford University, Stanford, CA, USA.

Abstract

This study presents an experimental investigation of microcrack formation and development in rock salt due to deformation. An analog equipment was designed and built to visualize the microcrack behavior under biaxial stresses. Variable biaxial deviators were subjected to the rock salt plates. The formation/development mechanisms and geometrical properties of the cracks in rock salt were optically evaluated. When deviator was increased, a non-recoverable damage was observed along the crystal boundaries. The crack widths were correlated with applied stress, which shows a crack opening yield as well as a decreasing crack opening rate with increasing maximum principal stress. The optical visualization of the rock salt cores before and after triaxial compression experiments conducted at various radial stresses showed comparable crack width distributions. The dependence of the crack openings of 2-10 microns on the minimal principal stress was obvious. Microcrack observations under both biaxial and triaxial conditions showed that the dilatancy-induced conductivity is resulted from the opened and joined cracks rather than the formation of new cracks and branching.

Acoustic detection of cracking behavior during compression and dilatancy was performed by recording the passive seismic response to the sensors mounted on the outer wall of the cylindrical rock salt cores in triaxial apparatus. Various sensor-positioning schemes were applied to optimize the accuracy of crack locations. The continuous recording showed an obvious increase in the number of acoustic events and changes in P and S wave velocities after the dilatancy boundary. In some experiments, where a sufficient resolution could be obtained, a cluster forming structure of crack continuities was observed. A number of the acoustic events were used to formulate the critical percolation probability, which characterizes the sudden increase in the conductivity due to cluster-like network of the microcracks.