Budzinski, Spies,, Alheid, Weber, Eisenblätter (2004):

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Detailed characterization of fractures in the rock mass using ultrasonic measurements, permeability measurements and engineering geology methods

Deformation of large rock salt formations occurs for the most part without the formation of fractures. Fracturing, however, can occur near cavities and at geological boundaries. A typical problem in salt mining is the succession of layers with very different mechanical properties like ductile rock salt and rigid anhydrite. The redistribution of stresses around the cavities mined in rock or potash salt includes nearby anhydrite beds, leading to stress concentrations in the anhydrite and at the boundary.

In the repository for radioactive waste in Morsleben, Germany, long-term acoustic emission measurements are performed providing the locations of current microfracturing which could affect the hydraulic integrity of the rock (permeability increase) and the stability of cavities. One network of acoustic emission sensors was installed around large cavities mined beneath anhydrite beds. Clustering of acoustic emission events was found in the rock but could not be attributed to certain geological features as the locations of geological boundaries were not known precisely. So two boreholes were drilled into a region of the rock in which a very prominent cluster of events was observed. By careful inspection of the rock cores in the laboratory and of the borehole walls using a video camera, geological boundaries as well as evidence of fracturing could be detected. The results of the active ultrasonic measurements confirmed the existence of fractures in the single boreholes and helped to identify the persistence of fractures between boreholes. Permeability measurements were carried out also to identify persistence of fractures and to determine the volume of the fracture network.

Combining the results of the methods of engineering geology and geotechnics, it was concluded that the appearance of the investigated cluster of acoustic emission marked the shape of a roughly elliptical macroscopic fracture plane of 10 m diameter at the boundary of rock salt and anhydrite. It had an opening width in the order of 1 mm. These results can be transferred to other clusters observed with the network in Morsleben in similar geological conditions so that it can be stated that the clusters mark the very slow growth of single fractures along the boundary of rock salt und anhydrite.

The integrative approach of this study is suggested for the detailed characterization of fractures in the rock, especially at prominent geological boundaries. The use of the ultrasonic measurements is very effective. Acoustic emission measurements, which are passive ultrasonics, provide the identification of zones of current fracturing in the rock and one can monitor the evolution of fracturing. Active ultrasonic measurements provide fracture locations with high spatial resolution. In comparison with permeability measurements, active ultrasonics are quicker and cheaper to perform so that the extent of permeability measurements can be clearly reduced and the overall efficiency enhanced.