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Geophysical monitoring of injection tests to investigate transport mechanisms for brine prior construction of fluid barriers in especially sensitive salt formations

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Introduction

Fluid barrier and dam buildings in mines within good soluble salt formations are currently object of various research projects in Germany. The construction of dams in good soluble host salt rock like e.g. Carnallitite with in parts considerable contents of Tachhydrite and Kieserite as fluid barriers with long term stability raises a number of technical problems. Basic problems which have to be solved are for example to have brine with definite compounds in front of the dam, which is in equilibrium with the host formation in order to prevent a bypass of the barrier as a result of dissolution of the host rock.

In situ tests are in any case necessary to investigate the transport mechanisms of the brine solutions within the particular rock formation. A mechanically non-invasive method is needed to monitor these injection tests in order to prevent negative effects of the monitoring installation. The geophysical method such as DC-geoelectric is ideal for this task and can be applied at relatively low costs. Results from the monitoring of an in situ injection test using 3D-geolectic measurements are presented as a case example.

Case example – 3D- geoelectric monitoring of an injection test

The test site is an old roadway in an abandoned Carnallitite mining field. The host rock formation for the planned fluid barrier has relatively high contents of Tachhydrite and Kieserite. A 3D-geoelectric measurement consisting of several parallel profiles along the roadway was applied. Figure 1 illustrates the test site during a geoelectric measurement. The 3D-approach of the measurement was taken to reduce the side effects normally observed in 2D-geoelectric profiles at very inhomogeneous investigation areas. In the first step a measurement was carried out to map the initial state of the test site. Changes in the formation after the injection are monitored by repeated measurements.

The results of the electric measurements (figure 2 and 3) provided information of the spreading of the influenced zone into the host rock formation and the movement of the contact face over time (only if measured at adequate intervals). Figure 2 shows the results of the 3D-inversion after the injection, which provides a look into the side wall of the road way. The brine influenced zone is marked by a surface with resistivity of 350 Ωm. The top surface in figure 2 corresponds to the contact boundary between the unaltered formation and the zone which is affected by air humidity within the roadway. This invaded zone is characterised by a higher porosity and a water content of up to 1.5 %. The boundary to the unaltered formation was also verified by GPR-measurements. After more then 30 years of existents of the road way, this invaded zone reaches approximately 40 into the formation and has to be removed before erecting the barrier.

These information were obtained without mechanically interfering with the investigation area. After the completion of the test, rock samples can be taken directly from the test site for investigation with respect to water content, mineralogy and so on to verify and improve the results from the geoelectric measurements.

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Figure 1: Injection test site during the geoelectrical measurement.

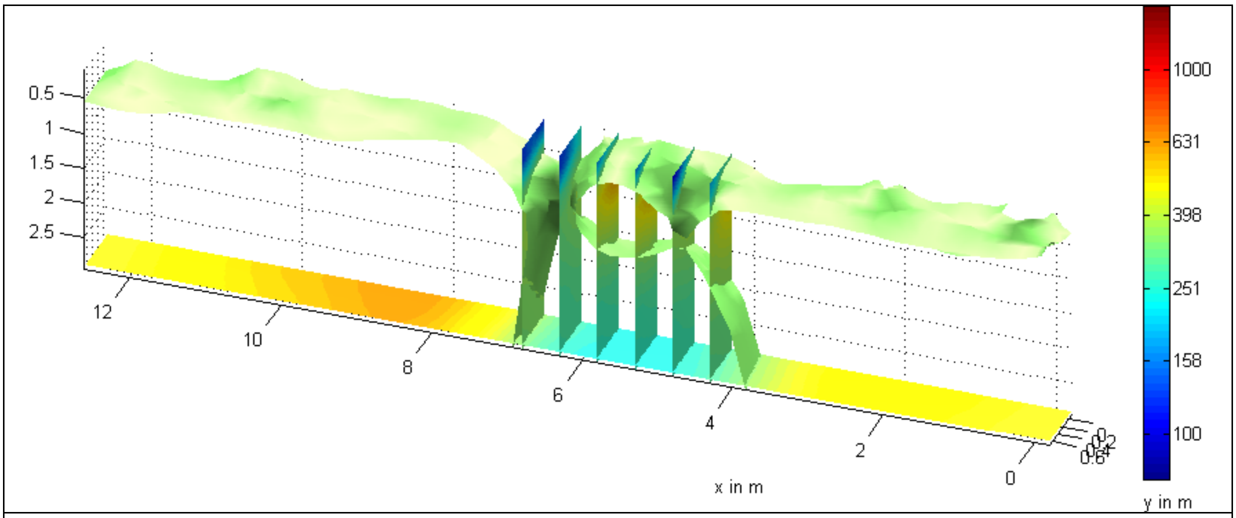

Figure 2: Results from 3D-inversion of the geoelectrical data. The top surface corresponds to the boundary of the invaded zone (surface of equal resistivity with 350 Ωm.).

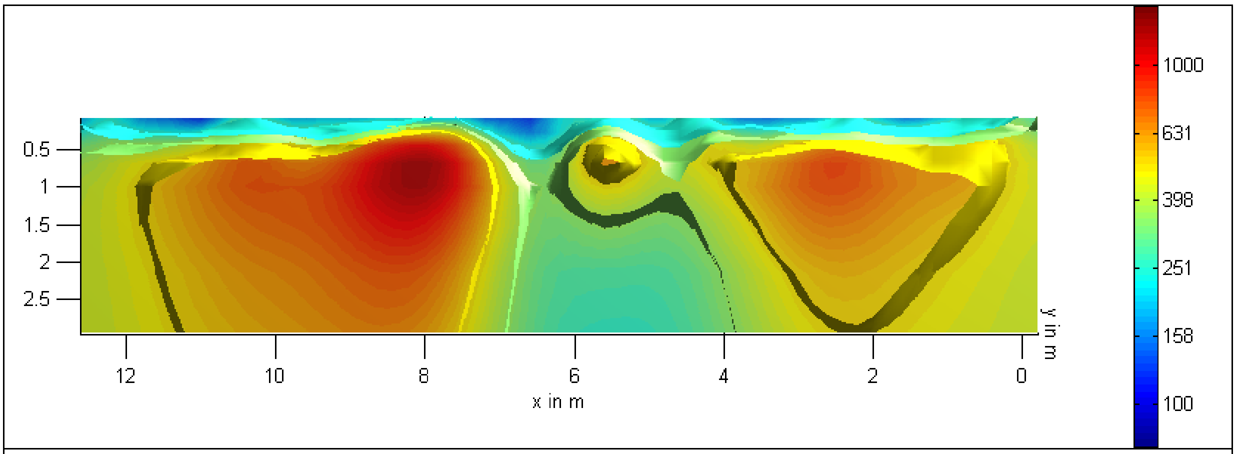

Figure 3: Results from 3D-inversion of the geoelectrical data, vertical slice along the roadway (distribution of resistivity in Ωm). The injection well is at x = 6.30 m.