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Research Report 2001-8

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Salt Permeability Testing- The Influence of Permeability and Stress on Spherical Hollow Salt Samples, Part 1

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PART 1
EXECUTIVE SUMMARY

Main Findings

Seventeen permeability tests have been performed on hollow spheres to investigate salt-permeability changes as a function of stress. Three types of pressure are controlled independently during the tests:

(i) the inner cavity pressure ;

(ii) the pore pressure at the external boundary of the sphere; and

(iii) the confining external pressure applied through a jacket to the external boundary of the sphere.

The pore pressure is made smaller than the inner cavity pressure to allow outward brine flow from the cavity to sphere's external boundary. Cavity pressure is less than confining pressure at the beginning of each test and is increased step-by-step to observe the evolution of sphere permeability as a function of the difference between confining (overburden) pressure and cavity pressure.

Tests ran for approximately 10 days, except for Test 17, which lasted 24 days.

Nine tests are considered to be successful (Tests 3,6,7,8,9,13,14,16,17). The eight remaining tests failed because of electronic or jacket-tightness problems (Tests 1,4,5,12), poor cavern leaching (Test 2), or poor initial salt permeability (Tests 11,15). For Test 10, no cavity had been leached out. An additional test was performed on a nylon sphere.

Figures 1 to 9 display test pressure history and computed permeability for the nine successful tests.

At the beginning of each test, permeability decreased for several days, probably due to compressive stress build-up in the sample.

After this re-confining phase, the observed sphere permeability is in the range $10^{-21} - 10^{-19}$ m^2.

When cavity pressure comes close to confining pressure, a slight increase in sphere permeability can be observed. Sphere permeability increases slowly when cavity pressure exceeds confining pressure by a small amount; a rapid increase in permeability can be observed when the cavity pressure excess is approximately 1.5 MPa, leading to the development of a fracture.

These tests confirm that a large permeability increase takes place before a discrete fracture appears. Although still tentative, this result provides some support for the existence of a final state of equilibrium in an abandoned cavern where pressure build-up is self-limited by the development of brine pressure migration to the rock mass.