Gaspermeation Models Related to Dilatancy Development under Deviatoric Stress Conditions

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Abstract:

Permeability of 30 rock salt cores were measured under various deviatoric stress conditions. A triaxial cell was designed and built to measure the hydraulic properties respectively pore volume and permeability changes during the compression experiments. To determine the variations in pore volume a high precision pump was used and the pore volume changes as well as the gas permeabilities were recorded continuously as function of time and stresses. A permeability reduction in the compression stage is not obvious although the decrease of pore volume appears to be a controlling phenomenon of the compression. Similarly to previous studies, a spontaneous increase in permeability was observed shortly after the dilatancy boundary was exceeded, separating the compression from the dilatant deformation phase. At the end of the dilatant deformation, the permeability reaches a plateau value which afterward remains approximately constant for low stress rates up to the fracture pressure. This allows the percolation of gas along the extended grain boundaries of the salt crystals and through the inter-crystalline flow paths and yields an increase of the permeability of 3 to 6 tens of order. Combined acoustic emission measurements performed with 8 sensors showed that the percolation begins equally throughout the core at the same time. Dilatancy and permeability are found to be controlled by many factors,most importantly by the minimal principal stresses. The end porosities of the stressed cores were correlated with the permeability in the form of a Kozeny-Carman type relationship. Semi-empirical and percolation flow models were applied to match the observed flow characteristics of cores with corresponding properties of the excavation damaged zone in the Asse salt mine.