Supplementary Materials 1 (SM1)

Methods

In order to carry out physical and mechanical tests, the specimens were dried at 105 ± 5 °C and the dry solid mass (m_D) was determined. The real volume (V_R) of undisturbed rock specimens, with:

$$V_R = V_S + V_C$$

where V_S is the solid phases volume of specimens and V_C is the volume of pores of the specimens that are closed to helium, was determined by helium Ultrapycnometer 1000 (Quantachrome Instruments). Then, the wet solid mass (m_W) of the samples was determined until constant weight. Through a hydrostatic analytical balance, the bulk volume (V_B) was calculated as:

$$V_B = V_S + V_O + V_C$$

where $V_O = V_B - V_R$ is the volume of pores open to helium and V_B is calculated as:

$$V_B = \left[\frac{(m_w - m_{HY})}{\rho_{WT}}\right] \cdot 100$$

where m_{HY} is the hydrostatic mass of the wet specimen and ρ_{WT} is the water density at a temperature of 25 °C.

Total porosity (Φ_T), water/helium open porosity (($\Phi_O H_2O$-He), water/helium closed porosity (Φ_C H_2O-He), weight imbibition coefficient (IC_W), saturation index (SI), bulk (ρ_B) and real (ρ_R) densities were computed as:

$$\phi_T = \left[\frac{(V_B - V_S)}{V_B}\right] \cdot 100;\ \Phi_{O\ H_2O} = \left\{\frac{\left[\frac{(m_W - m_D)}{\rho_{WTx}}\right]}{V_B}\right\} \cdot 100;\ \ \Phi_{O\ He} = \left[\frac{(V_B - V_R)}{V_B}\right] \cdot 100$$

$$\Phi_{C\ H_2O} = \Phi_T - \Phi_{O H_2O};\ \Phi_{C\ He} = \Phi_T - \Phi_{O He}$$

$$IC_w = \left[\frac{(m_w - m_D)}{m_D}\right] \cdot 100;\ SI = \left(\frac{\Phi_O H_2O}{\Phi_O H_e}\right) = \left\{\frac{\left[\frac{(m_W - m_D)}{\rho_{WTx}}\right]}{V_O}\right\} \cdot 100$$

$$\rho_R = \frac{m_D}{V_R};\ \rho_B = \frac{m_D}{V_B}$$

The punching strength index (PLT index) was determined with a Point Load Tester (mod. D550 Controls Instrument), according to ISRM Recommendations (ISRM, 1985). The puncturing resistance index (Is) was calculated as:

$$Is = \frac{P}{De^2}$$

where P is the breaking load and De is the “equivalent diameter of the cylindrical specimen” (ISRM, 1972, 1985) with:

$$De = \frac{4A}{\pi};\ A = W \cdot D$$

where W and 2L are the width perpendicular to the load direction and length of specimen, respectively, and D is the distance between the two conical punches. The index value is referring to a standard cylindrical specimen with diameter D = 50 mm, for which it has been corrected with a shape coefficient (F) and calculated as:

$$Is_{(50)} = Is \cdot F = Is \cdot \left(\frac{De}{50}\right)^{0,45}$$