

On electrical signals in underground cavity: exchange between rock-atmosphere

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The underground quarries are more and more used for specific ecological goals or as geophysical systems with well defined constraints. In this study, different geophysical problems are presented: self potential recorded on a set of pillars during several months in an limestone quarry (Meriel, France), Self potential and rock and atmosphere temperature measurements in a Vincennes quarry (France), apparent resistivity measurements in an underground cavity at Aburatsubo (Japan). It is shown, in each case, that the electrical potential values are related to the evolution of the rock saturation. The first objective is to look for the driving mechanism in the different contexts and to eliminate others: changes in the atmospheric parameters (humidity, temperature, atmospheric pressure), changes in applied stress (gravimetric tide), or the geothermal gradient always present. In each case, the boundary condition at the strong discontinuity rock-atmosphere plays a most important role. So we devote most of this study to the understanding of the possible exchanges through the discontinuity. We propose an intermediate approach, between the "porous media" studies at the pore scale, and the "hydrological" studies, appropriate for the time and space scales of our problems; this approach allows us to use a few number of free parameters. One starts from the full non-linear Richard's equation in the rock volume; analytic and numerical solutions, with the appropriate boundary condition at the interface rock-atmosphere, allows us to explain the different observations: permanent SP distribution on the pillars of the Meriel quarry, correlation of SP and atmospheric pressure variations, time variation with a daily period of the apparent resistivity at Aburatsubo, oscillations of temperature and SP at the floor of the Meriel quarry.