Fracture density and scaling laws in granite massifs and their importance on site selection criteria for waste disposal

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Waste disposal sites represent environmental issues of master importance for the next decade or more. General geological studies, and fracture studies in particular, do not usually represent a primary concern for site selection and location. As a way to assess its importance, a fracture density study was undertaken in an area of about 7 Km^2 around a waste disposal site in operation for two years. The main goal is to provide probabilistic maps of fracture density and spacing, and to quantitatively determine the degree of fracturing of the granitic mass where it is located.

Variably fractured rock domains may bear an important role on contaminant dispersion if drain waters eventually leak through the impermeable barriers from these sites. Fractures are then the main conduits for fluid flow in crystalline rocks, controlling the dispersion of contaminated plumes. Therefore, for each sampled point in the field, we count the number of fracture intersections along chosen profiles and measure their orientation and location in the profile. Fractures were then grouped into different families, according to the main directions known to be regionally important. Spacing between fractures corresponds to the distance measured perpendicular to fracture direction for each family, and density is defined as the average number of fractures per unit length of the probed profile.

The obtained results seem to support that the site location under study is apparently in a favourable geological context, as it is close to one of the least fractured rock domains of the studied region, considering the most well represented fracture families. This is particularly true for the western part of the site, being the eastern part more densely fractured for these same families. The situation is reverse for the fractures with N160 to N-S direction, given their control on the distribution of large and relatively less fractured granitic blocks. Using empirical formulas that relate rock permeability to fracture density and aperture, we would expect permeabilities in excess of 10^{-12} to 10^{-11} m^2, assuming all fractures are conductive, and an average aperture of 0.5 mm. The probability that fracture density may be locally greater than considered is around 0.2 for most of the families considered and more than 0.5 for the N-S fracture family. Maps of the fracture pattern at several scales are currently being used to characterize fracture scaling laws. The work in progress should provide a way to define the appropriate scale to use and perform meaningful fracture studies for the problem under investigation. As a final remark, is also worth noting that results from preliminary geophysical and geochemical studies reveal strong consistency with the findings in this study.