From boreholes structural and hydraulic conductivity data to fracture system modelling

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Ultramafic rocks of New Caledonia are actively mined for Ni and Co. They present extensive fractures at all scales, resulting from several pre- to post-obduction tectonic event.

Four 200 m deep boreholes have been drilled on the Koniambo Massif which is one of the major Peridotite klippes of the New Caledonia West coast. Detailed study of 4 x 200 m of fractured peridotites and hydraulic conductivity tests performed at several depths during drilling allowed characterizing the fracture system, conceptualizing and modelling its hydrodynamic behavior.

A methodology of fracture description has been established including dip, macroscopic mineralogy of coating or infilling, and stage of weathering grade of the peridotite. Two types of fractures are observed: discrete fractures and highly fractured and/or weathered zones. Both discontinuity types are considered when defining fractures frequency as they may impact the groundwater flow. From these observations, discrete fractures spacing is estimated around 30 cm. Snow model is applied to define discrete fracture aperture which is validated with hydraulic tests. The value of 0.1 mm gives a hydraulic conductivity around 10-6 m/s which is consistent with field measurements. Highly fractured zones and weathered zones have been considered individually to extract an equivalent hydraulic conductivity from field test results. These parameters are then used to build a fracture system model of peridotites including (i) discrete fractures, (ii) porous matrix corresponding to non-fractured and non-weathered peridotites, and (iii) variable conductive zones corresponding to weathered and/or highly fractured zones. Percolation and equivalent hydraulic conductivity of the system are calculated and compared to field data.