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Determination of depth, permeability, and fluid pressure of hydraulically active fractures in the COSC-1 borehole and their correlation with chemical and geophysical logging data

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The Flowing Fluid Electricity Conductivity (FFEC) logging method has been applied to the 2.5-km fully-cored COSC-1 borehole in Sweden, both during and after the drilling period. The method is based on the fact that the drilling fluid has a lower electric conductivity (EC) value (about 200 μS/cm) compared to the formation water. Thus, by scanning several times along the borehole while it is being pumped at a low rate, Q, the locations of inflow zones can be identified as EC peaks at these depths. An analysis of the shape of the EC peaks will yield the local inflow rates and the formation water EC at each of the inflow zones. Further, by conducting the logging more than once with two values of Q, the initial or inherent fluid pressure at each inflow zone can be calculated. In the case of the COSC-1 borehole, the method has identified nine discrete inflow zones between 250 m depth and the borehole bottom of 2500 m depth. The permeability values are small and spread over more than one order of magnitude. The fluid pressures in the inflow zones show two groups of similar values with the shallow inflow zones having a higher pressure than those in the deeper part of the borehole.

Correlation of the FFEC logging results with other information and data from the COSC-1 borehole are underway. First, rock cores were carefully examined at the depths of the inflow zones identified by FFEC logging. We were able to identify the fractures which may be responsible for the flow. It appears that each inflow zone can be correlated with one single fracture. The cores with these hydraulically active fractures have been transferred to the laboratory for detailed study. Second, COSC-1 fracture logs were reviewed. The majority of the fractures in the borehole are not hydraulically active and the active ones represent only about 1-2 % of the total number of fractures, consistent with previous statistical studies of fractures in crystalline rocks. Breakout logs were also studied and it appears that the depths of the breakout zones do not correspond to the depths of the hydraulically active fractures. Chemical analyses of water samples from the borehole as a function of depth are currently being conducted. Correlation of these findings with the FFEC results will be presented.