GEOPHYSICAL BOREHOLE LOGGING

Optical and acoustic televiewer – Visual borehole logging

Ramboll conducts borehole loggings in connection with mapping of fresh water resources and for construction purposes. Our logging programme includes temperature, flow, resistivity, natural gamma, EM-induction, deviation, calliper, acoustic- and optical televiewers, magnetic susceptibility, density, porosity, and full-wave-form sonic logs.

In addition to these methods we can use cross-hole tomography to illuminate the structures as well as shear- and pressure wave velocities in between boreholes.

With an increasing desire to gain more information from our boreholes, we have achieved technological assistance from the acoustic- and optical televiewers.

Besides improved geological information, the televiewers make it possible to perform a far better inspection of the borehole than previously obtained by e.g. video inspection.

Method

Optical Televiewer

The optical televiewer makes a 360° continuously oriented optical picture of the borehole wall using a CCD camera. The camera records digital pictures of the borehole reflection in a conical mirror. To orientate the picture, the probe uses a triaxial magnetometer and a three component accelerometer.

Acoustic Televiewer

The acoustic televiewer makes an illustration of the borehole by transmitting ultrasound from a piezoelectric transducer. The ultra sound waves are then reflected on to the borehole by using a rotating mirror. A receiver measures the amplitudes and the travel time from the signals reflected on the interface between the borehole liquid and the borehole wall. The travel time of the reflected signal represents the shape and diameter of the borehole. The amplitude is then an indication of the material characteristics of the borehole wall.

The acoustic televiewer is also orientated by means of accelerometers and magnetometers.

Limitations

Due to the substantial amount of data both the optical and the acoustic televiewers are sensitive towards the speed of the probe. In order to optimize the speed it is essential to choose the correct horizontal and vertical resolution, which again depends on the diameter of the borehole. Polluted water or mud in the hole reduce the visibility of the optical televiewer as well as the traditional video logging,

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Based on the optical picture and the acoustic illustration of the borehole detailed information can be drawn like:

- **Fissure zones - localization, extent and orientation of fissures that intersect the borehole**
- **Thin layers - localization, thickness, moulding and inclination of the geological layers in the borehole**
- **The shape and stability of the borehole – high resolution 360° caliper**
- **Condition of casing and filter pipes**

whereas the acoustic televiewer remains insensitive, however, it requires liquid in the borehole.

Case example

In connection with the environmental assessment and integrated geotechnical pre-investigation for a planned tunnel at Nordhavnsvej, a large field investigation was initiated. The field investigation included, among other methods, several core drillings where a full logging programme was executed.

The presentation of the logging results, at the bottom of this page is from one of the boreholes conducted at the Nordhavnsvej Project. The borehole was drilled with a geobor-S, which ensures a relatively smooth borehole wall.

In the first column travel time is illustrated. The green curve is the average diameter of the borehole calculated from the acoustic travel time. The blue curve shows the natural gamma emission of the formation. The gamma curve is used to correlate with the core sample description. In the next column the amplitude of the reflected signal from the acoustic televiewer is shown. The third column represents the optical televiewer. A clean and plain borehole wall is registered. This enables a more easy identification of fractures, small lithology changes or beddings.

The orange and red curves illustrate open fractures while the green curve indicates lithological changes. The next column shows the core photos.

Here the problem with core loss in the drilling process is illustrated. The optical televiewer has a perfect coverage in comparison. The next two columns show different ways of illustration dip and strike. The induration plots indicate a good comparison between the logs and the core description. But the fracture counts are very different. Several fractures identified in the cores are induced by the drilling process.