Borehole Explorations

Boreholes are among the most frequently used methods of exploration in engineering geology and rock-related construction. The greatest yield of geotechnical data is obtained from these boreholes when the borehole walls are investigated in addition to the core. Investigations of this type are possible by geophysical means and especially by optical methods.

The further development of borehole exploration methods was triggered by the need to supplement core drillings particularly in those areas where it often proves impossible to obtain any results because the rock - weakened and decomposed - reaches the surface completely broken into lumps by the drill bit. It is precisely these rock areas, however, that can be of exceptional geomechanical significance so that their detailed exploration assumes special importance.

Optical borehole explorations are possible in several ways:

- The simplest method is to use an optical system consisting of a lens, several extension tubes, plus an objective tube with lamp and prism for deflecting the image.

- The second method works with a miniature TV camera that functions together with a rotating inclined mirror to present a picture of the borehole wall on the TV screen. Viewing direction is determined by means of a compass that is mounted in the TV camera and which also appears on the monitor.

- The most modern method uses a borehole scanner presenting the borehole wall via a truncated cone mirror. The truncated cone images that are taken when monitoring the borehole give, joined together, a deformed reproduction of the explored borehole section. By means of an arithmetical rectification of the images with the help of geometric relations a continuous image of the borehole wall is created on the screen.

Optical explorations are ideal not only for monitoring and petrographic assessment of borehole walls but also for measuring the spatial position of layer and fissure surfaces and for determining the width of fissure openings and the degree of planar separation.

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The geophysical method of presenting the structural details of the borehole wall uses the fact that differences in rock strength and even fissures lead to different acoustic reflections.

As measuring principle the pulse echo method or Acoustic Televiewer (ABF) is used. A piezoelectric transducer, located in the probe, rotates six times per second, transmits ultrasonic pulses with a frequency of about 685 Hz and receives the echoes of the borehole wall.

With the help of a magnetic orientation system in the probe the evolution of the borehole wall can be recorded and presented line by line from the north to the north; one line corresponds to one rotation of the transducer. Thus, in connection with a depth measuring setup a profile similar to the optical image of the borehole wall develops.

Whereas the optical methods may be used in water filled as well as in empty boreholes, the acoustic method works only underwater. To compensate this drawback the acoustic methods have the advantage that the borehole must not be rinsed. With optical methods a long rinsing is absolutely necessary because just a slight turbidity detracts the visibility considerably.

With the optical methods the various borehole probes can be used up to a depth of about 800 m at present. With the purely optical system with ocular (endoscope) you can examine boreholes up to 34 m, whereas depths up to 5000 m and more with simultaneously high temperatures are possible with the acoustic borehole probes.

To use the systems for greater depths minimum borehole diameters of 101 mm are necessary, with the endoscope boreholes of 30 mm diameter can still be explored without difficulties.

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