The acoustic borehole scanner is a development of the oil industry, and since the late eighties it is more and more applied in ground exploration, too. In oil drillings, often very deep and filled with heavy mud, optical borehole exploration was not possible, which gave reason to the construction of acoustic scanners.

The acoustic borehole scanner uses the physical effect that differences in the dynamic rock properties, but also joints, lead to different acoustic reflections.

As measuring principle (Fig. 1) the impulse reflection method is used where a piezometric converter located in the probe sends ultrasonic pulses with a special repetition frequency and receives the echoes from the borehole wall. By electronic image editing a sort of "line image" of the wall can be recorded and be figured as continuous image. By moving the probe in the borehole a lot of individual "line images" are received which are put together to an overall picture of the borehole wall, which can be shown as continuous image or as virtual core in 3D.

For that purpose a depth measuring set-up and a magnetic orientation system based on gravity is installed in the probe, which helps orientating the continuous image of the borehole wall line by line from north to north and determining the borehole profile (dip and azimuth).

The method can only be used in water or mud filled boreholes. Basically cuttings or support media do not obstruct the procedure, but the ultrasonic impulses are attenuated which means that the maximum possible borehole diameter can only be scanned in case of clean water. The method cannot be used in dry boreholes.

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The radial image resolution of the acoustic scanner depends on the scanning of the borehole wall and the borehole diameter. The image resolution towards the borehole axis depends on the velocity with which the probe is moved in the borehole.

Fig. 1 Rotating ultrasonic transducer of the borehole scanner in oil bath

Strength (amplitude) and runtime of the reflection are recorded or the total waveform of the reflection. The amplitude is very responsive to changes of the elastic rock properties; therefore the amplitude image contains structural information as joint surface, bedding planes and schistosity planes, joint spacings, degree of separation, joint opening and filling. These structural information can be presented orientated and statistically evaluated in a global coordinate system by arithmetical consideration of the borehole running.

The runtimes of the reflections change according to the form of the borehole, thus the runtime image is a high-resolution caliber log; therewith for example open and closed joints can be distinguished and the exact borehole geometry can be recorded.

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The image resolution of the acoustic scanner from the company Century Geophysical Corp. used by us is 5 mm along the borehole axis, the borehole circumference is resolved with 254 pixels per line.

The method is suitable to determine the dip direction and the dip angle of distinctive joints, bedding and schistosity planes. It is used to detect joint spacings, wall outbursts or cavities. The quality of the produced images of the borehole wall cannot be compared with the visual image, on the one hand because the image resolution with the acoustic scanner is very rough, on the other hand because the false-coloured image does not give the possibility to the trained eye of the geologist to identify the rock (see Fig. 2).

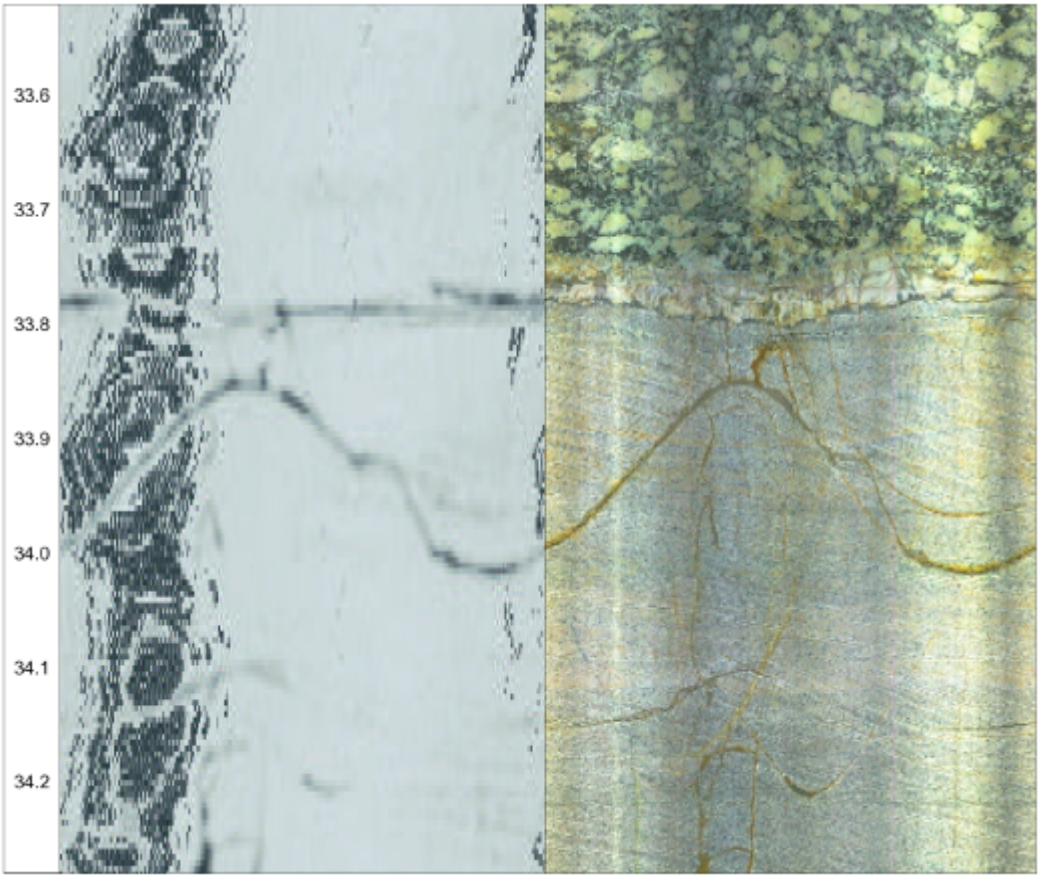

Fig. 2 Comparison of a borehole monitoring with acoustic scanner (left) and optical scanner (right)

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At present the application depth of our equipment is limited to 300 m. The minimum diameter of the borehole must be 74 mm. The maximum diameter of the borehole should not exceed 230 mm.

Technical Data

General Conditions

- Exploration of geological boreholes up to max. 300 m depth
- Pressure-water-tight up to 100 bars
- Borehole diameter from 74 up to 230 mm

Dimensions

Probe length	193 cm
Outer diameter	50.8 mm

Weight

Probe complete	14 kg

Orientation System

Resolution for inclination	± 0.5 °
Resolution for azimuth	± 2.0 °

Image Resolution

- Max. resolution along borehole axis 5 mm
- Resolution at borehole circumference 254 pixels

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