Borehole stress relief with the borehole slotter is a 2-dimensional stress measurement method based on the principle of local stress relief in a borehole. By means of a small, pneumatically driven diamond saw relief slots are sawn parallel to the borehole axis (Fig. 1). The slots are about 1.0 mm wide and up to 20 mm deep.

Fig. 1 Borehole slotter at the end of the borehole

Directly next to the slot a specifically developed contact strain sensor is pressed with a specific force to the borehole wall (Fig. 2) during the slotting. The function of the sensor is to measure the tangential strain of the borehole wall during the slotting. At the scheme shown in Fig. 3 there is a complete local stress relief along the slot in the borehole wall followed by a proportionally tangential strain.

Normally the boreholes are monitored with a camera to eliminate unsuitable borehole sections.

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At the selected test location slots are successively sawn in different directions. At least three slots, 120 ° apart from each other, enable the determination of the 2-dimensional state of stress. But normally three additional slotting tests are made for a stress measurement at another borehole location 10 cm deeper or higher of the first point (Fig. 4) to verify the results by redundant dimensioning.

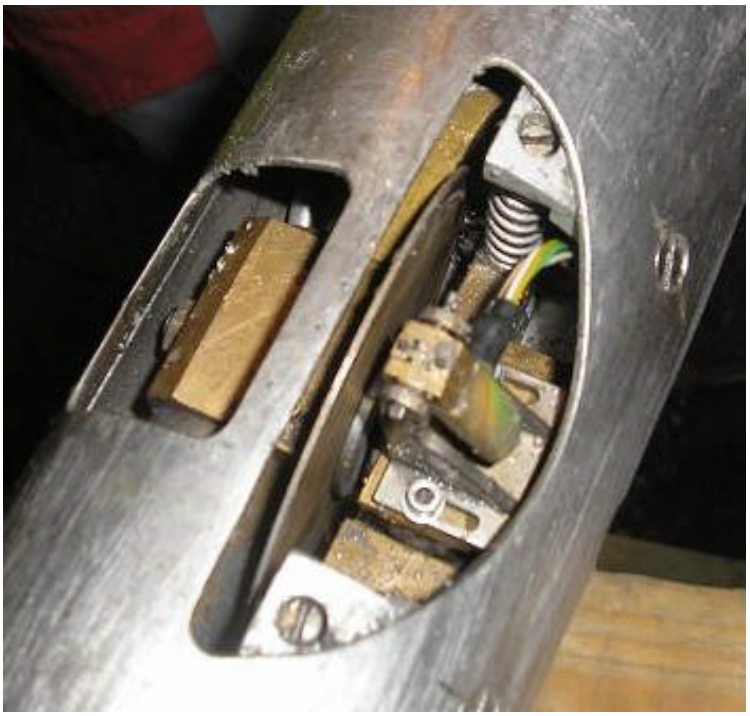

Fig. 2 Strain sensor besides the diamond saw blade

The resulting redundancy of the measured data allows a quantification of the data quality, f. e. in the form of a correlation coefficient. This possibility of internal control of the measured data has turned out to be extremely advantageous when performing and interpreting the borehole slotting tests. If f. e. the inner consistency of the measuring results seems to be insufficiently low during the test performance, additional slots can be directly sawn until an adequately consistent trend becomes apparent.

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For evaluation the tested area is taken as linear elastic, homogeneous and isotropic. By means of the perforated disc model the primary stress state is re-calculated with the equations of KIRSCH from the relief of the secondary state of stress when slotting in the borehole. As input values the modulus of elasticity and the Poisson's ratio must be determined from uniaxial compression tests out of cores taken from the borehole.

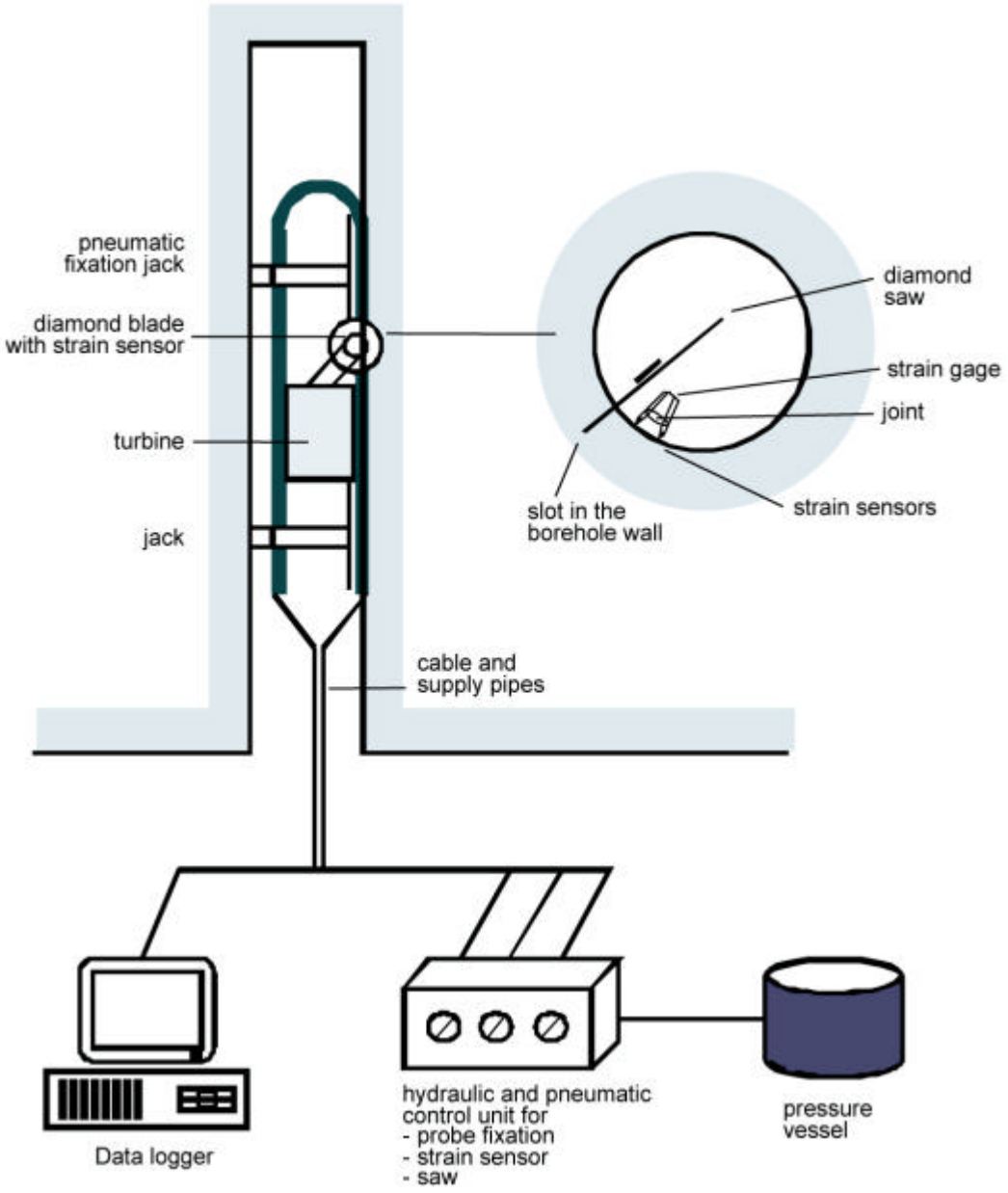

Fig. 3 Scheme of a borehole slotting equipment

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The accuracy of the primary stress measurement with the borehole slotter depends on the magnitude of the rock modulus and on the sensitivity of the contact strain sensor. For a rock with a modulus of elasticity of 40 GPa the accuracy is about +/- 0.5 MPa. Usually the resolution of the sensor is about 1 microstrain.

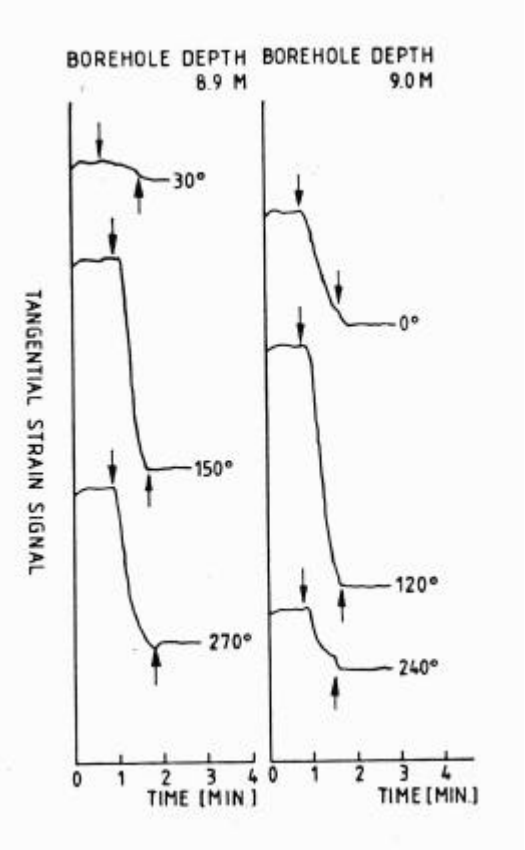

Fig. 4 Time-strain curves of 6 slotting tests, together resulting in a single, redundant 2-D stress measurement

To determine the 3-D stress state in rock the procedure must be conducted in three boreholes with different azimuth and dip angle. The dip directions and inclinations of the boreholes which should be as near as possible are to be exactly measured, as these values enter into the calculation of the stress tensor.

As drillings core drillings are necessary because the modulus of elasticity and the Poisson's ratio of the rock must be determined by laboratory tests at each measuring point to evaluate the stress state.

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Technical Data

Application conditions

- The exploration of geological boreholes is possible up to max. 30 m depth
- The method is not applicable underwater, it is therefore recommended that the boreholes are orientated either slightly upwards or vertical. A typical orientation of the boreholes to determine the 3-D in-situ stress state would be:
  Borehole 1: Subhorizontal about 5 ° up (perpend. to borehole 2 if possible)
  Borehole 2: Subhorizontal about 5 ° up (perpend. to borehole 1 if possible)
  Borehole 3: Vertical up
- Borehole diameter of core drillings: 96 – 103 mm. The borehole should be drilled with a diamond core bit.
- When measuring out of a tunnel or gallery the measurements should only be conducted in a depth deeper than 1.5 – 2 times of the cavity diameter.
- The borehole should always be at least 1 m deeper as the biggest desired measuring depth.
- The work space in front of the borehole should be at least 2 x 2 m due to the slide rods.

Dimensions

Borehole Slotter	L = 1300 mm, dia = 90 mm
Slide rods	LxWxH 1500x20x20 mm
Hydraulic / Pneumatic Control unit	LxWxH 660x390x650

Weight

Borehole Slotter	13.5 kg
Slide rods	1.0 kg / shot
Hydraulic / Pneumatic Control unit	28.0 kg

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