GLÖTZL Baumeßtechnik

AWID STRESS MEASURING DEVICE

Type: Awid

Art. No.: 96. . .

An absolutely measuring pressure pad according to the compensation procedure, developed by the company Gesellschaft für Strahlen- und Umweltforschung mbH Institut für Tieflagerung, Braunschweig.
A new system according to the method of absolutely measuring resistance jump pressure pad, abbreviated named AWID.
With this system, stress measurements can be carried out without entering of material parameters of pad or also temperature changes in the measurements. Therefore, calibration measurements are not required.

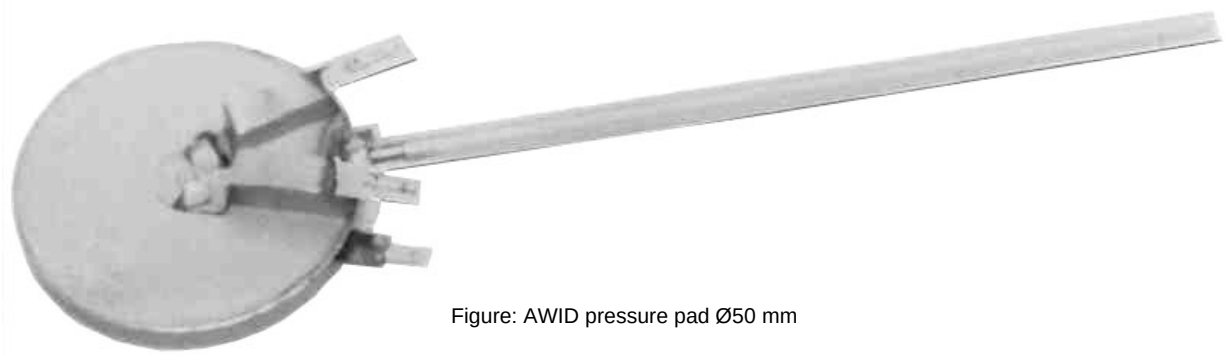
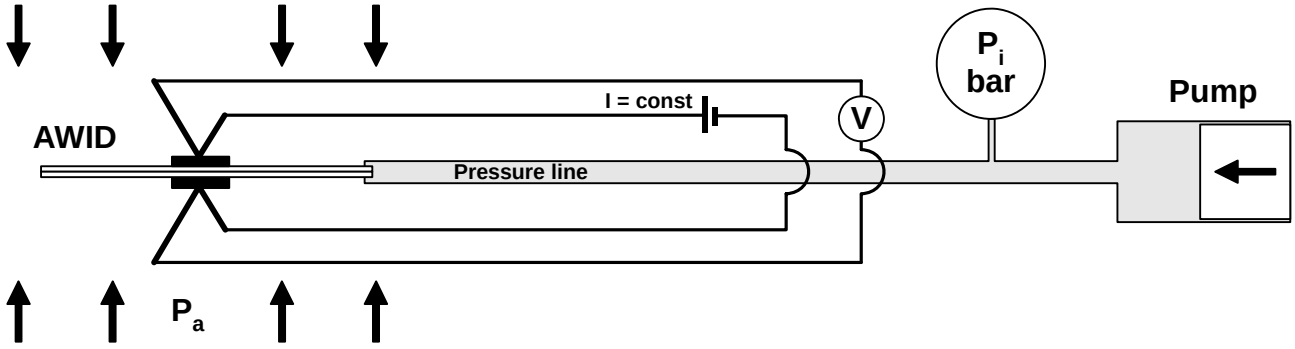


Figure: AWID pressure pad Ø50 mm

Function:



P_a = outer pressure
P_I = inner pressure
I = constant current supply
V = Voltage (Volt)

Dependent on application case, the inner pressure is produced hydraulically or pneumatically. Current supply is done by means of constant supply I. If the inner pressure P_I is exceeding the outer pressure P_a a little, the voltage drop V is changing rapidly.

Delivery Program:

- AWID pressure pads in different models — up to max. 600 bars
- AWID pressure pads as stress monitoring stations — up to max. 600 bars
- Manual measuring devices / change-over manifolds
- Automatic measuring devices with data recording

Figure: Stress monitoring station with 6 pressure pads for determination of stress tensor

General

For assessment of the stability of underground repositories, the knowledge of stress condition of the rock is of great importance.

Very complicated are the in-situ conditions when the material law of the rock bond is distinctly deviating from the elastic behaviour as - for example -in the case of rock salt. Here, the stress is entering the calculation in the dimension extent of the 5^{th} power.

Generally, the in-situ stresses have tensor features. The stress condition existing primary in rock without gaps can thus be composed of the pure weight components and thus resulting stresses, also due to transverse elongations. By erosion of overlying layers or by tectonic procedures, such a gravitative stress field can be changed or influeced.

By construction of an underground cavity, the primary stress condition is changed. By mining dynamic procedures which are typical for mining, timely variable stress changes may occur. These changes can also be induced by heat penetration in the rock, e.g.

For the registration of such stresses or stress changes by using technology of measurement, a variety of measuring methods has already been tested.

A prerequisite for an exact measurement is the appropriate instrumentation as apart from a pure guided connection also a frictional connection is of great importance. The work group „Bergmännische Gebirgsmechanik“ of the German Research Community has presented in the year 1975 in the chapter „Spannungsmessverfahren“ = stress measuring procedure some essential measuring procedures in short form which have been developed in the frame of research project of the work group. Here specially reference is made to the element of NATAU which is measuring nearly free of deformation for determination of stresses in visco-elastic-plastic rock. A series of further measuring methods has been introduced by different institutions, e.g. by the “Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)”. The evaluation of numerous marginal conditions of stress measuring procedures by the „Gesellschaft für Strahlen- und Umweltforschung mbH - Institut für Tieflagerung“, Braunschweig resulted in the development of a method complementary to or in continuation of the procedures already used according to the system of “**A**bsolutmessender **Wi**derstandssprung-**D**ruckkissen” (AWID) = absolutely measuring resistance jump pressure pad.

Technical Description of AWID Pressure Pad

The cell of the type AWID is an absolutely measuring pressure pad according to the compensation procedure. With this cell, stress measurements can be carried out without entering of material parameters of the pad or also temperature changes in the measurements. Therefore, calibration measurements are not required. With the pressure pad the standard component of the stress vector S_n effecting on the pad surface

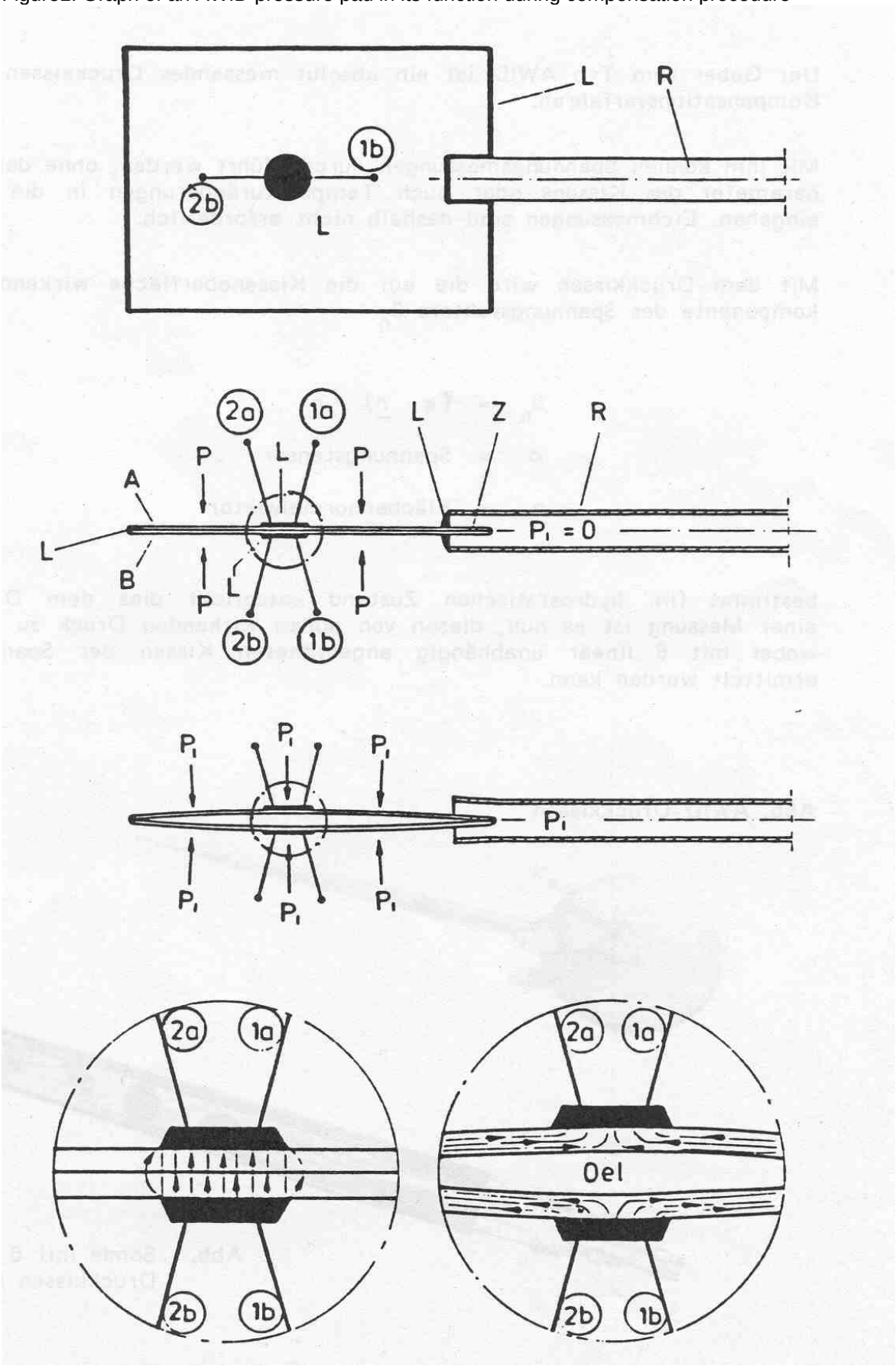
S_n = $(\sigma \times \underline{n}) \times \underline{n}$
σ = Stress tensor
$\underline{n}$ = Area standard vector

is determined (in hydrostatic condition this corresponds to the pressure). The purpose of such a measurement is to determine the pressure effecting from outside, whereby the stress tensor can be determined with 6 linear independently arranged pads.

Figure: AWID pressure pad

Figure: Probe equipped with 8 AWID pressure pads

Figure1: Graph of an AWID pressure pad in its function during compensation procedure



The following measuring principle is characteristical for the AWID measurements:

a) At the beginning of measurement (figure 1) the pressure pad installed in the rock is compressed by the outside adjacent pressure. By the contacts 1a and 1b a direct current is supplied. This current is effecting a voltage drop between the contacts 1a and 1b which is measured by the voltage pick-up 2a and 2b. The electric resistance existing between 2a and 2b is essentially deter-mined by the chromium-nickel sheets A and B. The resistance of the soldering joint can be neglected. As shown, the current flows according to the shortest way from 1a and 1b and not over the soldering joint L at which the both sheets A and B are welded together at the rim.

b) The inner pressure in the pressure pad can be produced either by oil or also by gas. At the beginning, the oil resp. the gas pressure in the pressure tube R is increased. As long as this pressure is smaller than the outside adjacent pressure, the transition resistance remains constant in ideal case. When exceeding the outside adjacent pressure, the transition restistance will rapidly be increasing as in this case the current has to take a long way in the relatively bad conductive chromium-nickel steel over the solder joint. The measured pressure Pi at the time of jump in resistance corresponds to the pressure Pa adjacent at the pressure pad (figure 2).

As only the resistance jump is evaluated and the material parameters of the pressure pad and also those of the surrounding material have only an influence to the height of the jump, an evaluable measurement can be regarded as absolute measurement.

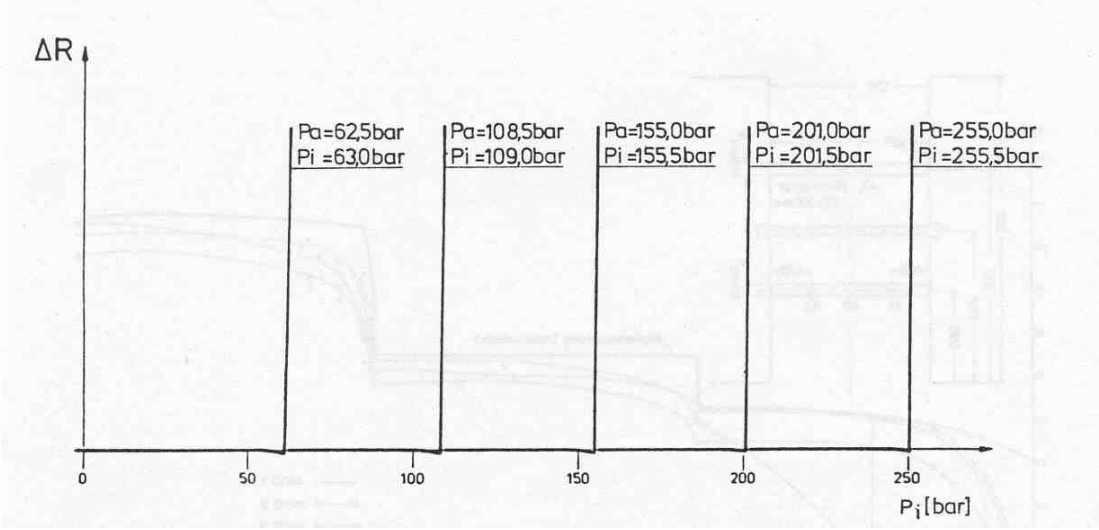


Fig. 2: Measurement with the AWID in a sheath pressure unit at slow pump speed and suppressed stress zero point when starting the measurement
Pa = adjusted pressure in pressure tank Pi = with pressure determined by the pad

Measurement at a defined loaded rock pillar

3 AWID cells (figure 4) have been installed at a rock pillar defined loaded by a hydraulic pad in younger rock salt at the „Schachtanlage Asse" (figure 3).

Figure 5 is showing the measured values at the AWID cells determined in dependance of the load. Already a short time after installation of the AWID pads, the load existing in the pillar could well be measured.

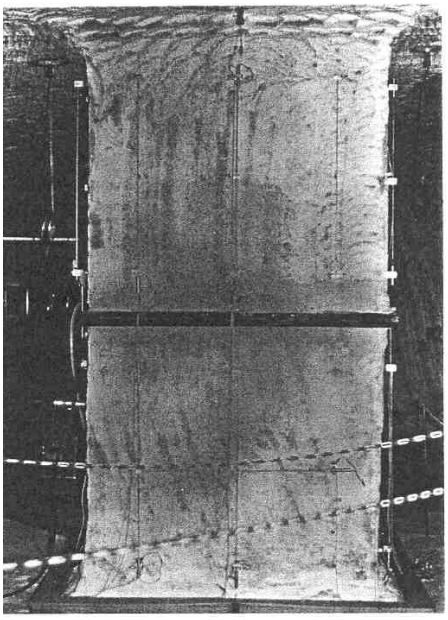


Figure 3: Rock pillar

Figure 4: AWID pressure pad

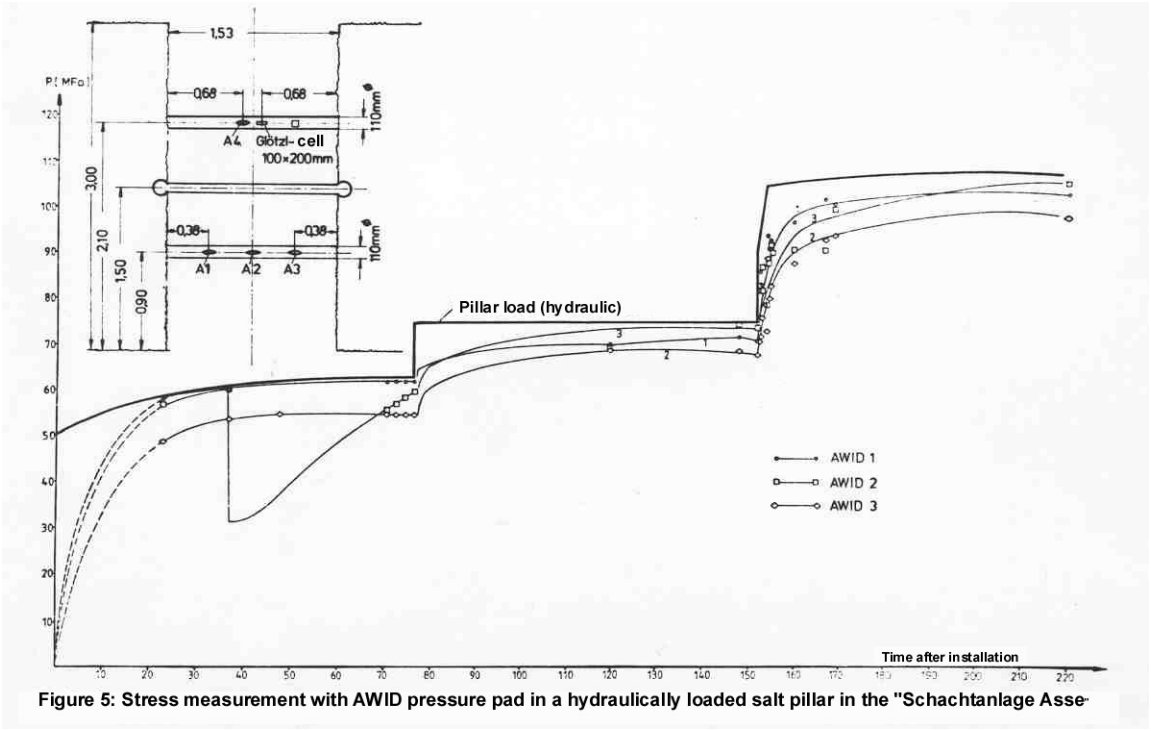


Figure 5: Stress measurement with AWID pressure pad in a hydraulically loaded salt pillar in the "Schachtanlage Asse-

Determination of thermo-mechanical stresses at heat entry in the rock

At final disposal of highly radioactive waste in salt rock, heat is entering the rock. By this, not only the mechanical features of the rock bond are changing, but also the existing stresses in the rock.

In the course of a special temperature test, the rock pressure occuring to a steel tube was determined for the first time by means of AWID cells. Figure 6 clearly shows the stress increase caused by the temperature introduced during the heating period.

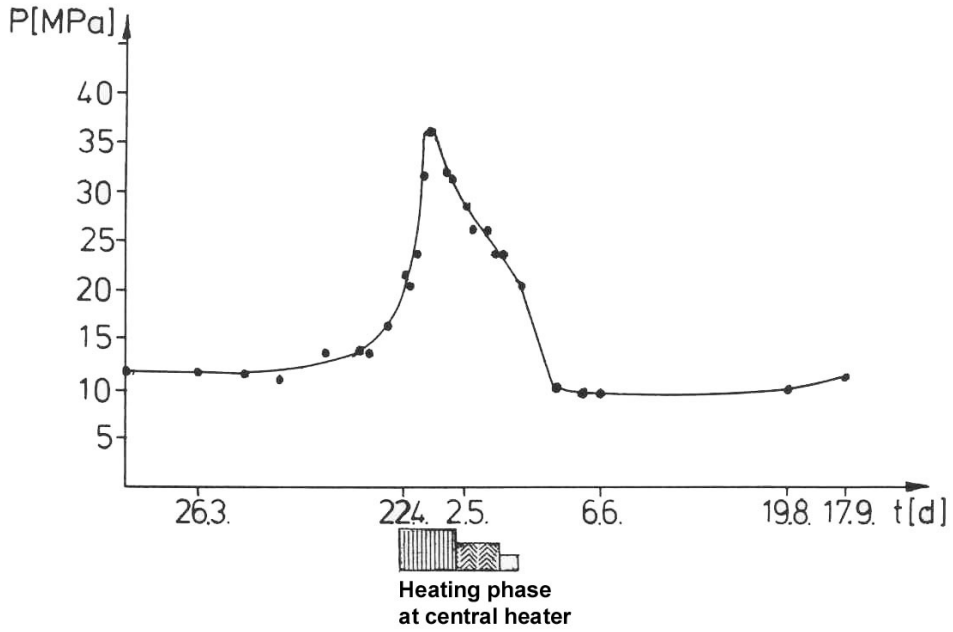


Figure 6: Pressure measurement at a steel tube with an AWID pressure pad during heating up of salt rock

In a 650 m deep borehole drilled from a 750 m level at the „Schachtanlage Asse“, an AWID measuring probe with 6 directionally oriented cells have been installed to determine the primary stress condition of the rock and the stress tensor. Figure 7 shows the measuring results from beginning of measurement till the 360th day after installation of the cells. A gas has been used as pressure producing medium.

Figure : AWID meas. probe, grouted

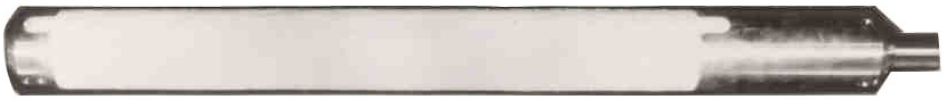


Figure: AWID meas. probe not-grouted

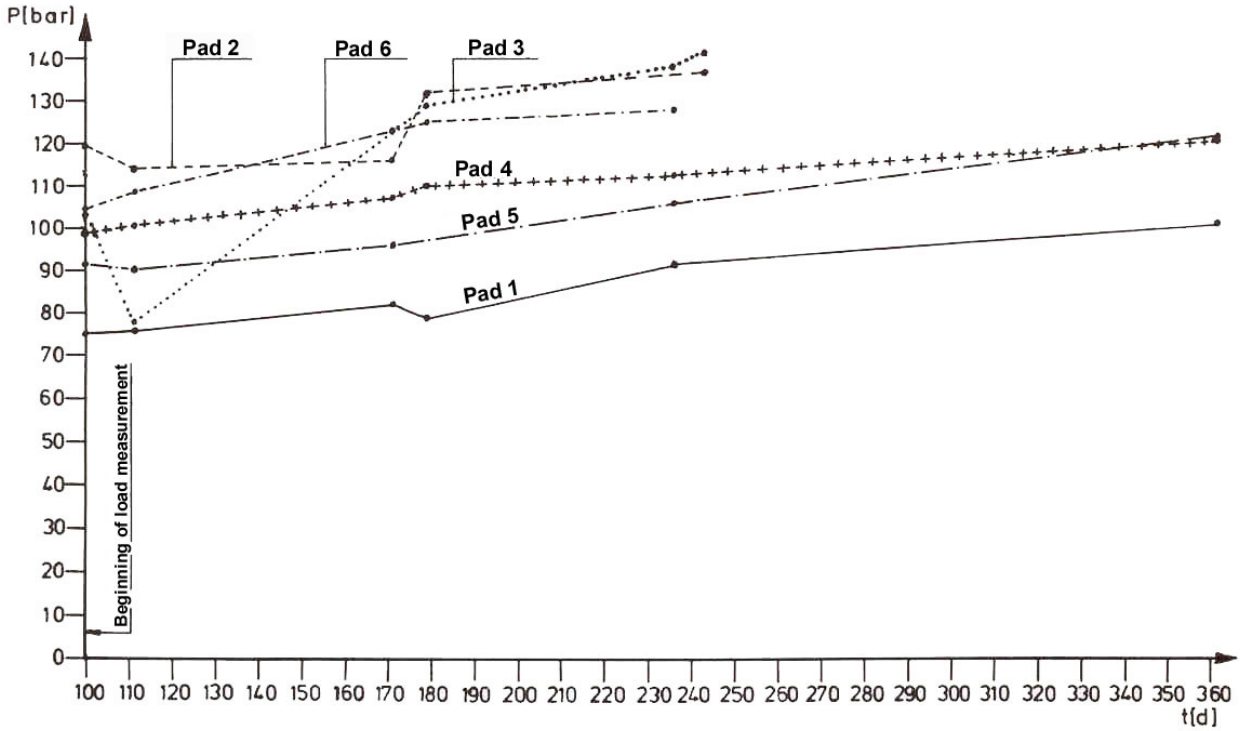


Figure 7: Stressmeasurement with AWID-ECN650 in a 650 m deep boring in the salt mine asse

Further application ranges:

In mineral coal mining and also sometimes in salt mining, considerable rock impacts may occur during underground mining of mineral resources. By early knowledge of arising rock stresses, preventive measures can be planned to avoid the occurance of rock impacts or to reduce their destructive effects.

On account of the small dimensions of the AWID pressure pad, an installation without problems will be possible, also of already premanufactures probe elements in the quarrying of borings. By independece of outside influences as temperature and material features, rock pressures can be measured immediately and directly with the AWID pressure pad.

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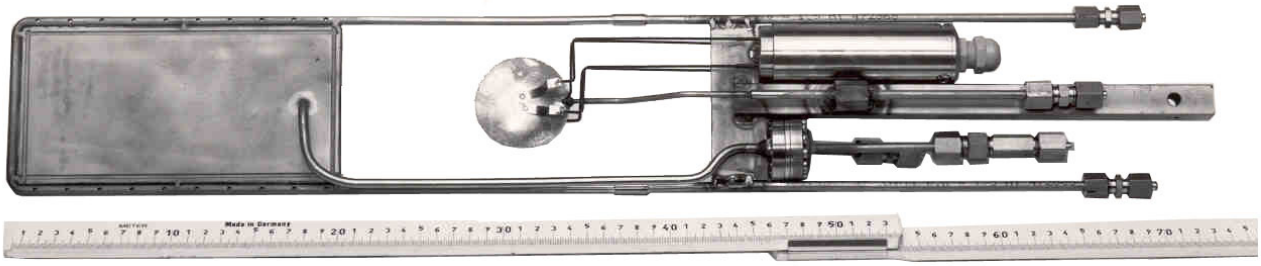
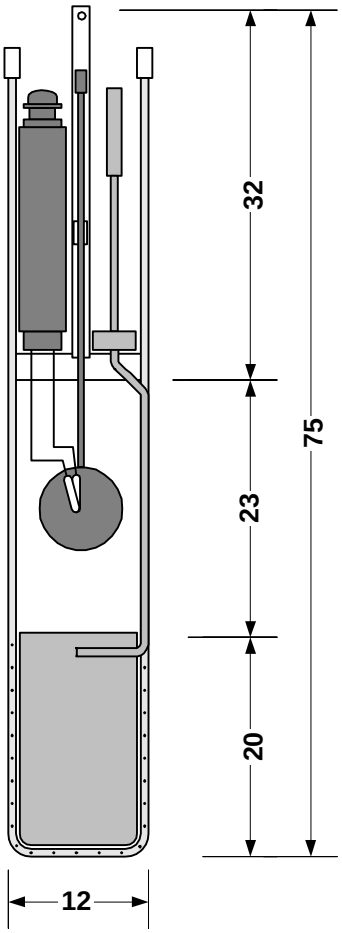
Stress Measuring Probe for installation in boreholes, consisting of:

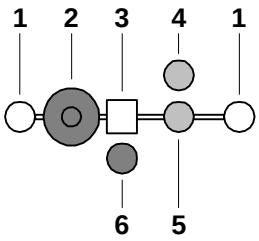
1 Pressure pad system GSF – AWID, Ø 60 mm, load ranges 0 up to 400 bars
1 Pressure pad system Glötzl, 100/200 mm, load ranges 20/50/200/400 bars
with perforated ring injection line and rods connection



Probe Construction



Connections



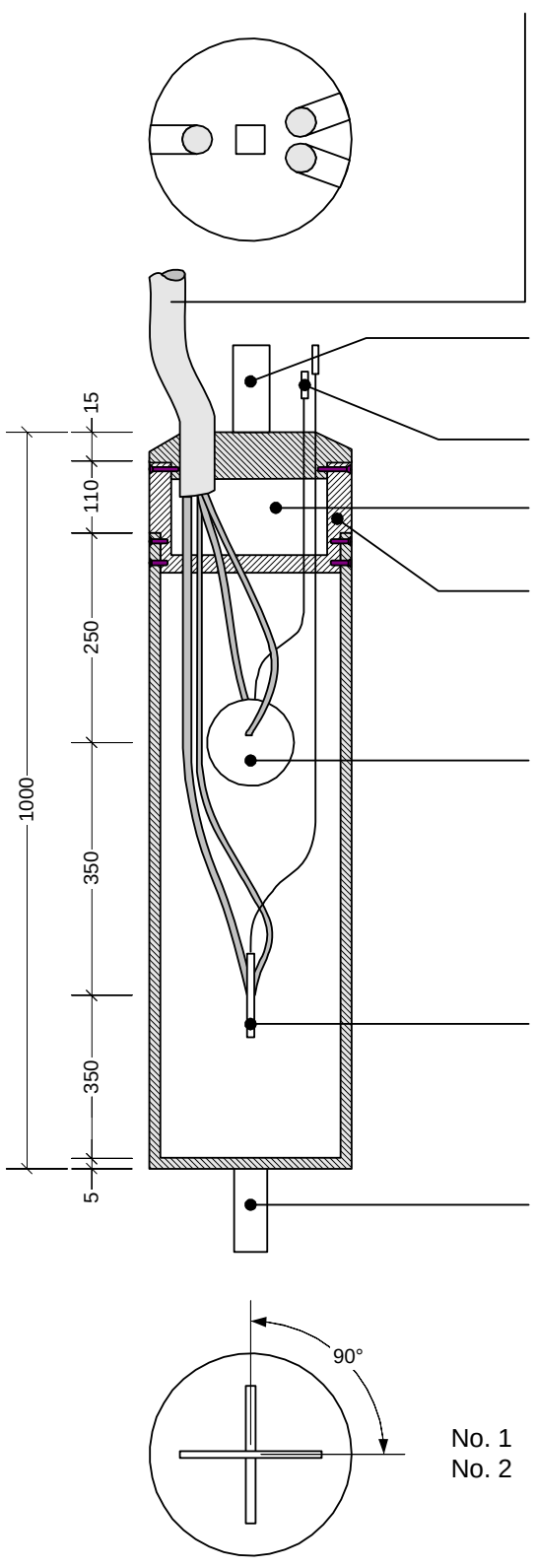
1 Injection line
2 Electr. connection AWID
3 Rods connection 20/20 mm
4 Return line for cell
5 Pressure line for cell
6 Pressure line for AWID

Transducer No.:
.....

Preload value of cell in bar: .....

Connections AWID:

Cable No.:	Col.:	Signal:
1	red	I+
2	white	I-
3	yellow	A+
4	blue	A-



Connection cable:	7 x 0.75 mm
Construction:	Screen of galvanized steel matting,beneath silicon cover fine-strand cord with No.-code
Temperature range:	-60 °C up to +180 °C
Short-time:	+220 °C
Min. bending radius:	20 x cable diameter
Nominal voltage:	500 V

Rods connection square 20x20 mm

Screwing 2xG4LL VA tube

Sealing w. insulat. comp.

Connection housing

AWID pad No. 1

AWID pad No. 2

Rods connection square 20x20 mm

No. 1
No. 2

Pad arrangement

Connections

VA Line		Pad 1 electric				Pad 2 electric			
1	2	1	2	3	4	5	6	7	4
Pad 1	Pad 2	I+	I-	A+	A-	I+	I-	A+	A-

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