The finer a soil or rock, the higher the proportion of adsorbed water. Molecular forces of attraction exert a high level of pressure on adsorbed water. If a piezometer is inserted in such material, the water will rise in the monitoring tube to a level corresponding to the pressure of the porewater between the soil grains.

If the volume of water in a piezometer rising tube is disproportionately large compared with the minimum reliable yield from the surrounding soil or rock, a rising tube will be unsuitable for determining changes of water pressure. In such cases it is advisable to use a porewater pressure transducer, which has the additional advantage of being able to measure vacuum. Fig 1 shows cases where piezometers and porewater pressure transducers produce different results.

Special types of porewater pressure transducers are suitable for pressing into cohesive soils. Porewater pressure transducers work according to the following principle: A ceramic or sintered metal filter is installed at the measuring location, with a small chamber filled with low-surface-tension water providing protection from contamination. If the water pressure in the soil or rock changes, the pressure of liquid in the chamber behind the filter will change by an equivalent amount. This change of pressure can be measured, for example, with a Glötzl valve transducer (see Fig 2). With this method, the air or oil pressure p_2 is increased via a valve pressure line (c) until the valve membrane (b) frees the return line (d). In this state, the air or oil pressure p_2 equals the liquid pressure p_1 in the chamber (e) behind the filter (a), and hence is equal to the water pressure in the rock.

An example of a measurement taken with four porewater pressure transducers is illustrated in Fig 2. To conduct the measurement you need connection and distribution boxes in which the pressure and return lines of the various porewater pressure transducers are connected. An air quantity regulator with matching precision manometers is required as a measuring instrument to determine the air pressure in the valve transducer; it is connected to the connection and distribution box with a quick-action coupling. The electric pressure sensor Type PWE may also be used instead of the pneumatic valve transducer.

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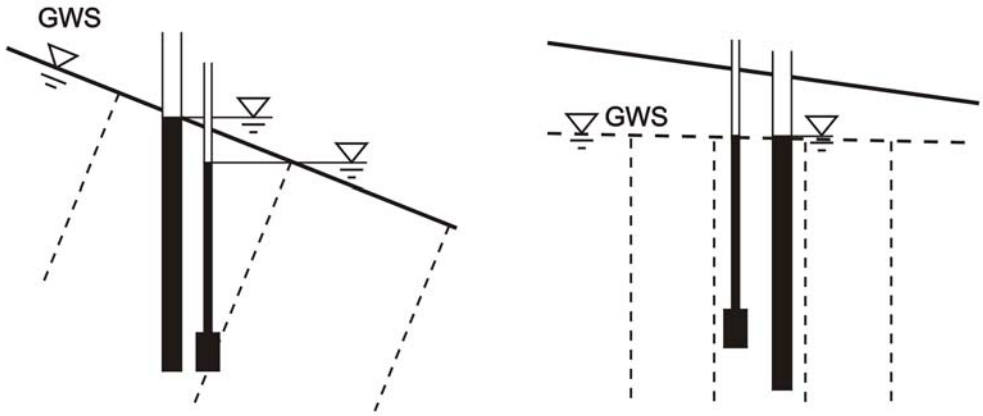

Fig 1 Typical reading of a piezometer installed in a water-saturated clayey skid slope and a porewater pressure transducer (left);
Typical ground water level in a sandy soil with identical readings of the two instruments (right).

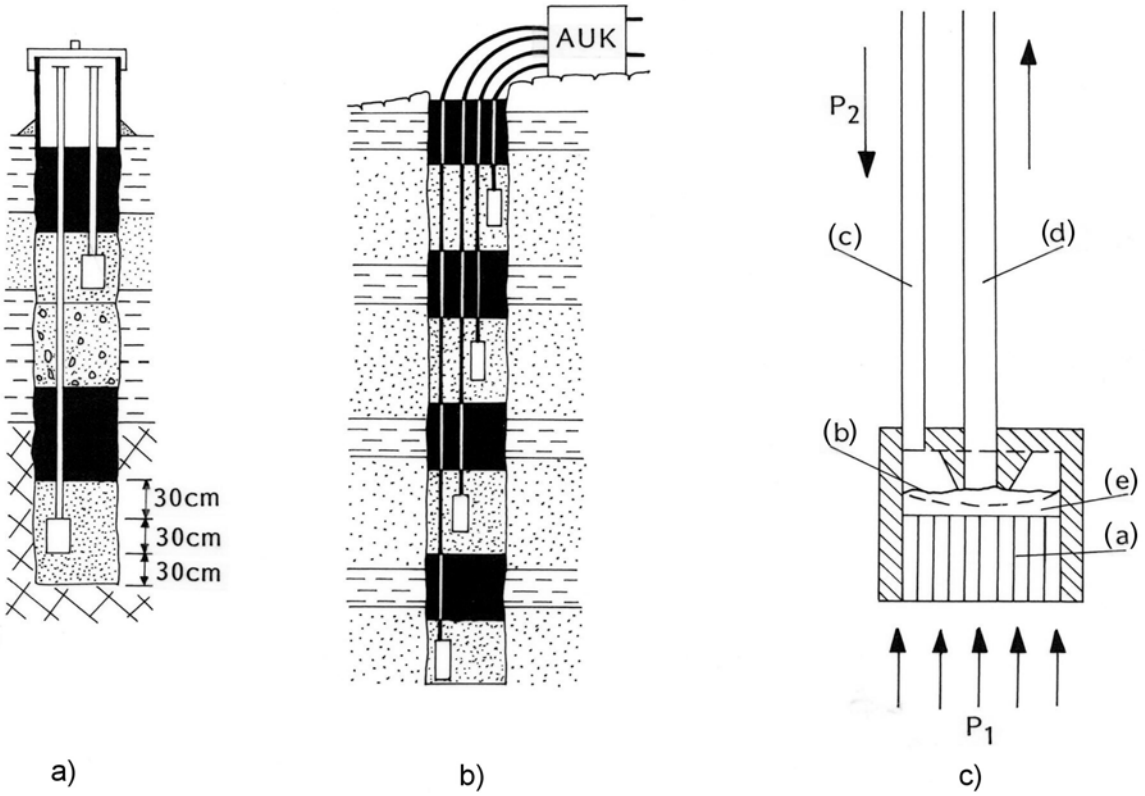

Fig 2 Measurement of water pressures in various aquifers
a) With rising tube
b) With porewater pressure transducers system Glötzl
c) Glötzl valve transducer (see text for explanations)

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The underlying principle of all porewater pressure transducers and piezometers is that a porous element (filter disk) is inserted in the ground (Fig. 1) or a borehole (Fig. 2). The porewater or rock water pressure acts on the water-saturated filter disk or water-filled chamber behind the filter. With the Glötzl valve transducer, the chamber pressure is measured pneumatically (up to 20 bar) or hydraulically (up to 50 bar).

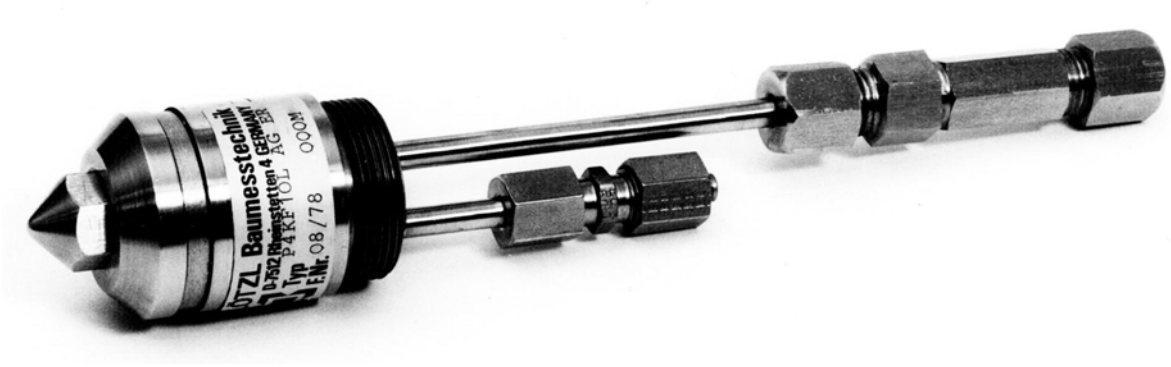

Fig. 1 Porewater pressure transducer Type P 4, SF, 20 L, AG ER with push-in tip for pneumatic measurements up to 20 bar

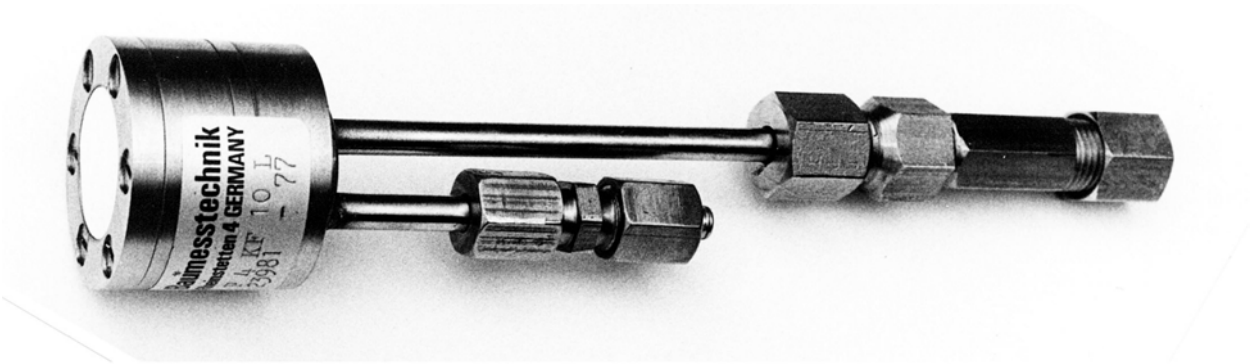

Fig. 2 Porewater pressure transducer Type P 4, KF, 10 L, for installation in a borehole and pneumatic measurements up to a maximum of 10 bar

Porewater pressure transducers are made of rust-proof and acid-resistant steel and have an outer diameter of 40 mm. Prior to installation, the filter must be wet with low-surface-tension water and the filter chamber filled with low-surface-tension water. Normally, sintered metal filters (SF) are used, but the use of ceramic filters (KF) is also possible in special cases.

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To measure negative porewater pressures we can supply type P 4, SF, - 0.6/3 L AG, ER, load capacity from - 0.6 to + 3 bar, for air operation with sintered metal filter, control accuracy ± 0.005 bar.

Please quote the following data when ordering porewater pressure transducers P 4:

1. Sintered metal filter (SF) or ceramic filter (KF)

2. Load capacity:

- 0.6/3 L	=	up to 3 bar for air operation, control accuracy ± 0.005 bar
5 L	=	up to 5 bar for air operation, control accuracy ± 0.005 bar
10 L	=	up to 10 bar for air operation, control accuracy ± 0.005 bar
20 L	=	up to 20 bar for air operation, control accuracy ± 0.01 bar
10	=	up to 10 bar for oil operation, control accuracy ± 0.01 bar
20	=	up to 20 bar for oil operation, control accuracy ± 0.02 bar
50	=	up to 50 bar for oil operation, control accuracy ± 0.05 bar

3. Without push-in tip or with push-in tip (ER) and connection thread (AG) for the push-in sleeve.

4. Length of connection line (including length of line up to the connection and distribution box).

At the measuring point, the lines leading to the various transducers are joined together in a connection and distribution box (Fig. 3). Usually a concrete base is provided for mounting the box. Dimensions of the box: 200 mm high, 80 mm deep, 240 mm long for two measuring points, plus 80 mm for each additional measuring point.

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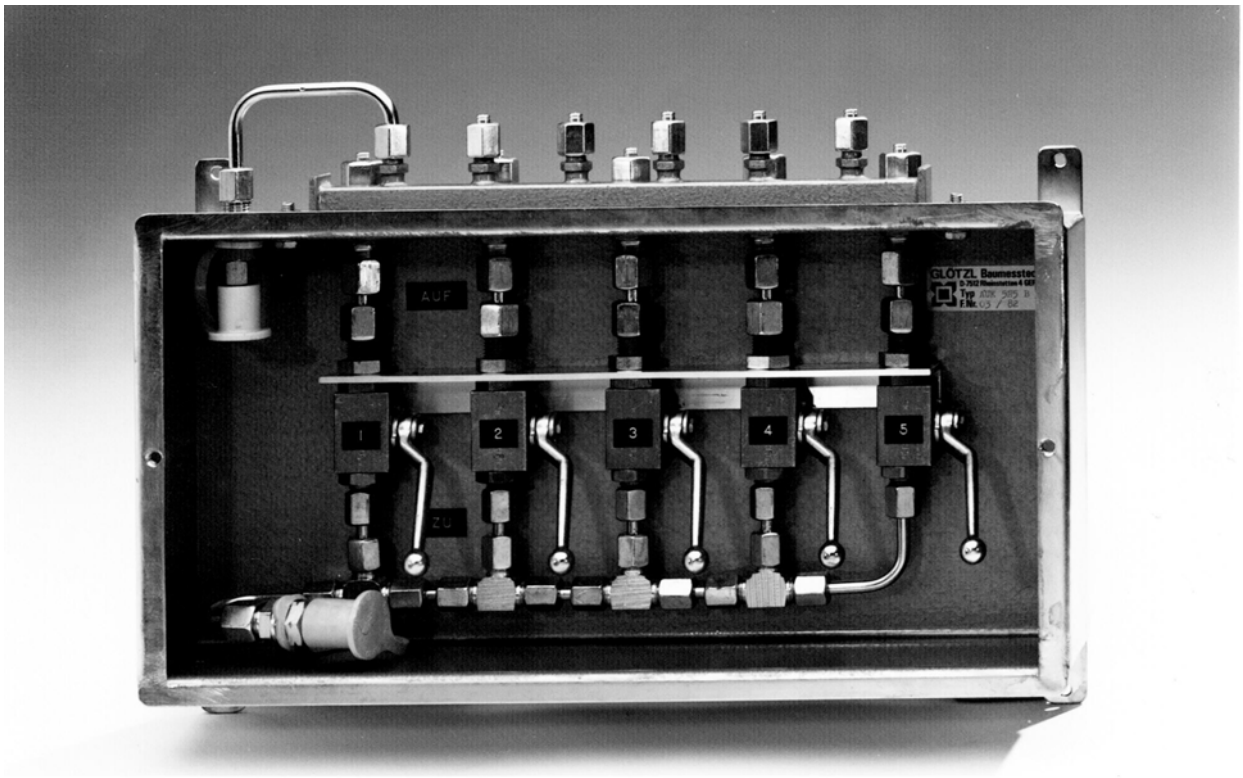

Fig. 3 Connection and distribution box Type AUK 5 R 5 B 50 SK for five pressure and return lines and oil operation up to 50 bar

When ordering connection and distribution boxes for pneumatic or hydraulic transducers, please quote the following data:

1. Number of pressure line connections (2 to 12 are possible),
   number of return line connections
2. Oil or air operation of the transducers
3. With or without quick-action coupling for connection to the instrument

Customized versions can be supplied for more than 12 measuring points.

We have an extensive range of instruments for taking water measurements in the filter chamber; portable, stationary and automatic instruments are all available.

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Fig. 4 shows a portable hand-operated air quantity regulator Type T 1, ALR in a splash-proof case.

Fig. 4 Hand-operated air quantity regulator Type T 1, ALR with integrated compressed air cylinder

When ordering instruments for piezometers, please quote the following data:

1. Oil or air operation
2. Measuring range of the precision manometer
3. Version with one or two manometers
4. Stationary operation or portable design

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Sales Information

5.2.1.1	Pore water pressure transducer with ceramic or sintered metal filter, load capacity up to 3, 5, 10, 20 or 50 bar, d = 40 mm
5.2.1.2	Pore water pressure transducer with ceramic or sintered metal filter, load capacity up to 3, 5, 10, 20 or 50 bar, equipped with push-in tip and connection thread for push-in sleeve, d = 40 mm
5.2.1.3	Pore water pressure transducer with ceramic or sintered metal filter, load capacity up to 3, 5, 10, 20 or 50 bar, d = 30 mm
5.2.1.4	Pore water pressure transducer with sintered metal filter, load capacity up to 3, 5, 10, 20 or 50 bar, equipped with push-in tip and connection thread for push-in sleeve, d = 30 mm
5.2.1.5	Connection thread for push-in sleeve, d = 30 or 40 mm, l = 240 mm
5.2.1.6	Pre-mounted pressure and return line (polyamide), d = 6/3, for pore water pressure transducer
5.2.1.7	Connection box for up to 12 pressure and return lines
5.2.1.8	Instrument for pore water pressure transducer and precision manometer class 0.6

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In its standard version, the electric porewater pressure transducer Type PWE consists of a rust-proof and acid-resistant ceramic filter, which is inserted in water-saturated condition in the foundation or borehole. Behind the filter is a small water chamber. The water pressure in this chamber is measured by a piezoelectric pressure sensor. All parts of the pressure sensor housing are made of special steel (see Fig. 1).

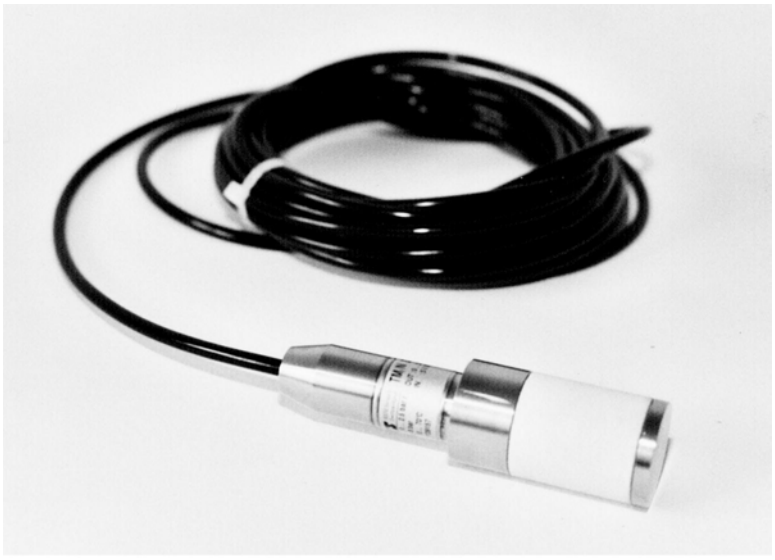

Fig. 1 Electric porewater transducer Type PWE

The pressure sensor is available with various measuring ranges to match the anticipated piezometric pressures (see page 2).

The transducer cable has a capillary tube, through which fluctuations of atmospheric air pressure have the same impact in the pressure transducer housing as in the ground water. Hence the only changes measured at the sensor membrane are those due to level fluctuations.

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Prior to installation, the filter must be wet with low-surface-tension water and the filter chamber filled with bubblefree water. This is done by unscrewing the filter tip. After filling, the filter tip is screwed back in place (make sure that the O-rings above and underneath the ceramic filter sit properly in their guide slots). The porewater pressure transducer should be stored under water until it is installed in the foundation.

The porewater pressure transducer type PWE is also used to observe the ground water level in gauge pipes.

Technical Data

Filter	Ceramic
Standard	1.5 µm pore diameter
Option	Sintered metal filter
Selectable pressure ranges	0...0.1; 0...0.16; 0...0.25; 0...0.4; 0...0.6; 0...1; 0...1.6; 0...2.5; 0...4; 0...6; 0...10, 0...16; 0...25 bar
Overload capacity	1.5 x measuring range
Burst strength	4 x measuring range or max 200 bar (the smaller value defines the maximum value)
Output	0....5 V, others optional
Statistical fault tolerance band	Typical ± 0.5 % fs,
Temperature range compensated	0...70° C
Installation depth	up to 200 m, more by agreement
Weight	375 g
Length	130 mm
Diameter	35 mm

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Sales Information

5.2.2.1	Porewater pressure transducer type PWE measuring range see page 2
5.2.2.2	Special cable with capillary tube for pressure balance
5.2.2.3	Manual indicating instrument, battery-operated
5.2.2.4	Stationary data logger with 6 channels for accumulator or battery operation, installed in steel housing 300 x 300 x 200 mm. Standard mono cell batteries or accumulator can be used
5.2.2.5	Software for data logger
5.2.2.6	Laptop with software for data read out and data logger programming

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