

METHOD AND SYSTEM FOR MEASURING THE RESISTIVITY OF SUBSOIL

TECHNICAL FIELD

5 The present invention relates to a system for measuring electrical characteristics of the subsoil around a borehole, and to a method of characterizing the subsoil by using such a measuring device.

10 **STATE OF THE ART**

 The present invention relates more particularly to a method and to a device for measuring the electrical resistivity of the subsoil, in which an electric current is injected into the subsoil and (simultaneously) the
15 electric potential differences that result in the subsoil from injecting the current are measured.

 For this purpose, it is general practice to use sets of four electrodes entombed in a borehole and forming a set of four poles. Depending on the respective positions
20 of the two electrodes of the set of four that serve to inject current and of the two electrodes that serve to measure a potential difference, the corresponding measurement method may be referred to as the Wenner method, the Schlumberger method, or the dipole-dipole
25 method, in particular.

 The invention relates in particular to a device for measuring electrical characteristics of the subsoil, which device comprises a sounding appliance provided with a plurality of electrodes placed in contact with the
30 subsoil, a power supply module for injecting electric current into the subsoil via a pair of electrodes of the sounding appliance, and a unit for acquiring, processing, and remotely transmitting measurement data resulting from

electric voltage measurements made between another pair of electrodes of the surrounding appliance.

Patent EP 1 923 725 describes such a measuring device in which the electrodes are secured to a tubular electrode support that extends inside a borehole dug in the ground.

In order to be able to scan the electrodes in succession and in order to be able to connect the electrodes to the desired current injection or potential measurement terminals, patents EP 1 923 725 and US 2005/078011 provide four addressable switches situated close to and connected to each electrode, which switches serve to select the desired function for the electrode under consideration.

In patent EP 1 923 725, those addressable switches are connected to the data acquisition and processing unit via an address bus that serves to transmit state commands for the addressable switches in order to obtain in succession the electrical connections that correspond to the desired measurements (equipotential connections between the electrodes and the power supply unit and also between the electrodes and the acquisition unit).

It has been found that such devices operate correctly only when the number of addressable switches is limited to a few tens of units. This leads to a very limited number of usable electrodes.

That drawback is made worse when a plurality of voltage measuring devices are used for measuring the potential differences, as described in patent US 2005/078011.

It has also been found that proper operation of such devices can be ensured only when the electrodes and the associated addressable switches are situated at a short distance from the voltage (potential difference) measurement appliance.

Document WO 2011/158103 describes a transportable resistivity measurement device that includes one

measurement module per electrode, the voltage measurement modules being connected by cables by an injection current generator, and that includes a centralized control module for managing and recording the voltage measurements that
5 are obtained.

Each measurement module has a measurement unit or system comprising an amplifier, an analog-to-digital converter (ADC), and a microcontroller.

Each measurement module also includes a unit for
10 storing voltage measurement data, a switch device, and a remote communication device for receiving commands and for transmitting measurement data to a remote unit, which are connected to the microcontroller.

The switch device is controlled by the
15 microcontroller and serves to connect the electrode associated with the measurement module either to one of the cables connected to the current generator, or to the input amplifier of the measurement system, or to a reference junction.

20 Measurement data is transmitted from the microcontrollers to the centralized control module by means of a transmission circuit including one or more cables, or by wireless transmission.

The measurement modules are connected to the cables
25 by pluggable connectors and they include automatic location-determining means that operate by measuring the resistance of the cables and/or by performing satellite positioning of the global positioning system (GPS) type.

That device is not suitable for being installed
30 permanently in a borehole and for performing measurements over a long duration.

Document US 2005/264295 describes a device for measuring the resistivity of the subsoil via a conductive casing of a borehole with the help of an appliance
35 suspended from a cable and movable inside the casing, together with return electrodes placed in contact with the casing or engaged in the soil around the borehole.

The movable appliance includes an injection electrode and a plurality of voltage measurement electrodes, together with a control and processing unit for controlling the injection of current and for managing the voltage measurement data delivered by ADC converters associated with the respective voltage measurement electrodes.

That device is likewise not suitable for being permanently installed in a borehole in order to take measurements over a long duration.

SUMMARY OF THE INVENTION

An object of the invention is to provide a device for measuring resistivity of the subsoil continuously, a system for characterizing the subsoil and including the device, and a method of characterizing the subsoil by using the device, which is/are improved and which remedy(ies) at least in part the shortcomings or drawbacks of known methods, devices, and systems for characterizing the subsoil on the basis of measurements of electric voltages that result from injecting current into the subsoil.

In an aspect of the invention, there is provided a device for measuring resistivity of the subsoil, the device comprising:

- an electrode support extending over the height of the borehole and supporting several tens of electrodes E1 to E3 put into contact with the subsoil and distributed along the support;

- a processor and telecommunication unit UAT arranged to process measurement data that results from measuring electric voltages between a pair of electrodes E1 to E3 of the support, and to transmit it remotely;

- a power supply module for injecting an electric current into the subsoil via a pair of electrodes (E1 to E3);

· a function selector S associated with each electrode for connecting it either to the power supply module or to voltage measurement means; and

· means for controlling the states of the function selectors, which means co-operate with the unit UAT for processing and remotely transmitting measurement data;

the measurement device further including, for each electrode, a converter unit AD for converting an analog voltage into digital measurement data, which unit is connected to a terminal of the function selector S, and a communication and control unit P, CS that is connected to the function selector S, to the converter unit AD, and to a bus B for conveying measurement data, which bus is connected to the processor and telecommunication unit UAT; and the communication and control unit P, CS associated with each electrode is arranged (programmed) to control the function selector S and the converter unit AD, and to transmit voltage measurement data delivered by the converter unit AD to the processor and telecommunication unit UAT via the bus B for conveying measurement data.

The means for controlling the state of the selectors may be connected to or incorporated in the processor unit UAT.

In particular, the state of the selectors is preferably controlled by the communication and control unit P, CS as a function of instructions sent by the unit UAT over the bus.

The bus B for conveying data is then arranged and used for conveying state command data for the function selectors respectively associated with the electrodes, the data being conveyed from the processor and telecommunication unit UAT to the communication and control units P, CS associated with the electrodes, with this control data being used in each communication and control unit P, CS to control the state of the function selector of the corresponding electrode.

In a preferred embodiment, the measuring device includes, for each electrode, a microcontroller (μ C) including the analog-to-digital converter unit AD and the communication and control unit P, CS.

5 As a result of the invention, the measuring device may have as many electrodes as it has microcontrollers (and/or communication and control units P, CS) with which the bus serving to convey measurement data and more generally state control data can communicate.

10 In practice, the measurement device may thus comprise one or more hundreds of electrodes, and as many microcontrollers.

It also results that voltage measurements are performed and converted into digital data as close as possible to the function selectors associated with the electrodes, thereby reducing or preventing degradation of these measurements.

The invention also makes it possible to use more than two electrodes to measure substantially simultaneously the electric potentials induced by injecting current into the subsoil.

In particular, the invention makes it possible, on each current injection, to measure the electric potentials induced and the corresponding potential differences via all of the electrodes associated with the electrode support other than the electrodes used for injecting current into the subsoil.

In an embodiment, the measurement device includes, for each electrode, a filter inserted between the voltage measurement terminal of the function selector and the analog-to-digital converter unit AD, in particular a lowpass filter having a cutoff frequency that may be of the order of 1 hertz (Hz) to 10 Hz, approximately. This serves to improve the quality of the voltage measurements taken, by eliminating one or more interfering components from the measured voltage.

In an embodiment, the measurement device includes, for each electrode, an amplifier inserted between the voltage measurement terminal of the function selector and the analog-to-digital converter unit AD, in particular
5 between said filter and the converter unit AD. This also serves to improve the quality of the voltage measurements taken, by adapting the voltage applied to the input of the analog-to-digital converter to the dynamic range of that converter.

10 Specifically, and in addition, calibration data may be stored in a memory incorporated in or associated with the processor unit UAT in order to correct or to compensate the voltage measurement data as delivered by the respective corresponding converters as a function of
15 the sensitivity and/or linearity characteristics specific to each "measurement system", i.e. specific to each converter associated with each of the electrodes, and where appropriate to the corresponding filter and amplifier.

20 The invention makes it possible to arrange the microcontrollers and the function selectors of the electrodes in the borehole, in particular on the electrode support, together with the filters and the amplifiers, if any. Alternatively, these components may
25 be arranged at the surface, in the proximity of the borehole.

In another aspect of the invention, a system is proposed for measuring resistivity of the subsoil that comprises a device of the invention and a remote server
30 that is arranged, in particular that is programmed, to communicate with the processor and telecommunication unit UAT of the measuring device.

The server may be a computer capable of exchanging data with the unit UAT via a telecommunications network.

35 The server is generally arranged, in particular programmed, to cause the processor and telecommunication unit UAT to transmit to the server voltage measurement

data stored in a memory connected to or incorporated in the processor and telecommunication unit UAT.

The server may also be arranged, in particular programmed, to transmit voltage measurement configuration data to the processor and telecommunication UAT and/or to determine the conductivity of a pore fluid contained in a region of the subsoil surrounding the borehole containing the electrode support of the measurement device as a function of electric voltage and/or resistivity data transmitted to the server by the processor and telecommunication unit UAT.

The processor and telecommunication unit UAT is preferably arranged to act in independent and self-contained manner to modify the acquisition of resistivity measurements as a function of voltage measurements that have already been taken, as a function of measurement data concerning parameters of the surroundings of the device, and/or as a function of voltage measurement configuration data.

In another aspect, there is provided a method of measuring characteristics of the subsoil in which use is made of a measuring device or system of the invention.

The measuring device of the invention may be installed on a site in order to operate permanently and independently on a continuous basis without requiring on-site intervention.

Other aspects, characteristics, and advantages of the invention appear from the following description which refers to the accompanying figures and relates to preferred embodiments of the invention without any limiting character.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a diagram showing the main components of a measuring device of the invention together with their interconnections, in one embodiment.

Figure 2 is a diagram showing in greater detail the microcontroller associated with each of the electrodes of a measuring device of the invention.

5 DETAILED DESCRIPTION OF THE INVENTION

Unless indicated explicitly or implicitly to the contrary, elements or members that are structurally or functionally identical or similar are given identical references in the various figures.

10 The measurements delivered by a device of the invention may be based on the following electrical investigation method: two electrodes are selected for injecting current into the subsoil, and two other electrodes that are located in the proximity of the first
15 two electrodes serve to measure the voltage as generated/induced in the subsoil, which voltage is a function of the resistivity of the medium, and more particularly of the fluid contained in the rock.

Such a method serves in particular to detect
20 variations in the conductivity of the water of aquifers. In saturated surface soils and rocks, detecting variation in electrical conductivity depends directly on knowledge of the initial state of the system, simultaneously from a geological point of view (three-dimensional variability
25 of the medium), from a hydrogeological point of view (electrical conductivity of the pore fluid), and from the petrophysical point of view (porosity, connectivity between pores).

A petrophysical characterization of the natural
30 medium based on logging and on cores makes it possible to subtract from the electrical measurement results all of the generally constant contributions at high frequency in time, thus enabling the measurement system based on these methods to be calibrated.

35 The invention facilitates dynamic tracking of water conductivity, measuring the resistivity of the medium by

electrical investigation, and in particular measuring the conductivity of the water, which increases with salinity.

Specifically, the resistivity depends on the surface conductivity (Cs) that is generally associated with the presence of clays, on the topological structure of the pores, on the degree of saturation of the porous medium, and on the conductivity of the pore fluid as a function of salinity and temperature.

In an implementation of a measurement method of the invention, the electrical resistivity data transmitted to a server by a measuring device is automatically converted into conductivity data of the pore fluid present in the subsoil around the electrode support of the measuring device.

With reference to Figures 1 and 2, the device 10 for measuring the characteristics of the subsoil comprises a plurality of electrodes E1 to E3 that are substantially identical, being secured to a common support SU (shown in part) that extends along the full height of a well or a borehole made in the ground, e.g. a vertical borehole extending over a depth of several tens or hundreds of meters.

The support SU may be a tubular support made of an electrically insulating material with electrodes of annular shape being crimped on its outside surface.

Alternatively, the support SU may be constituted essentially by a bundle of insulated conductors, with one end of each conductor being connected to an electrode.

The device 10 also includes identical measurement cards CM1 to CM3, there being the same number of cards as there are electrodes.

Each measurement card is connected to a single electrode by a conductor 11 forming an equipotential connection.

Each measurement card is also connected to a cable 14 by two conductors 12 and 13, and also to a power supply cable 17 by two conductors 15 and 16.

The cable 14 has two conductors connected respectively to the positive and negative terminals of a source of current AL1 designed for delivering an electric current for injecting into the subsoil.

5 The cable 17 has two conductors respectively connected to the positive and negative terminals of a second current source AL2 designed for electrically powering the measurement cards.

10 The device 10 also has a bus B, which may be an RS485 type serial bus, that serves to convey measurement data delivered by the cards CM1 to CM3, and to convey commands for the processors P of the microcontrollers μC of the cards CM1 to CM3.

15 The measurement device also includes an electronic processor and telecommunication unit UAT that may be constituted essentially by an industrial computer of the personal computer (PC) type provided with or connected to a radio transceiver, such that the unit UAT can transmit data remotely, in particular measurement data resulting
20 from electric voltage measurements between pairs of electrodes of the support SU, and can receive command data, in particular data designed to modify its operation.

25 The unit UAT serves in particular to control and monitor the operation of the power supply modules AL1, AL2, and also of the bus B to which the unit UAT is connected via a bus interface IB.

30 Each of the measurement cards CM1 to CM3 includes a function selector S for connecting the electrodes associated with the card in question either to one of the conductors of the injection current conveying cable 14 or else to the input of a voltage measurement system.

35 Each selector S may be constituted essentially by a three-position switch for switching between the three functional positions shown in Figure 1, in which:

· the selector S of the measurement card CM1 provides an equipotential connection between the

conductors 11 and 12 so as to connect the electrode E1 to the positive terminal of the injection power supply AL1;

- the selector S of the measurement card CM2

provides an equipotential connection between the

5 conductors 11 and 13 in order to connect the electrode E2 to the negative terminal of the injection power supply AL1; and

- the selector S of the measurement card CM3

provides an equipotential connection between the

10 conductor 11 and an input terminal (reference 18 in Figure 2) of a voltage measurement system in order to connect the electrode E3 to the measurement system.

In order to avoid overcrowding Figure 1, only three electrodes and their associating measurement cards are
15 shown.

In practice, for each resistivity measurement, at least one fourth electrode is used together with a fourth measurement card for which the function selector S needs to be put into the same switching state as that shown for
20 the card CM3. The resistivity of the subsoil is then measured on the basis of the difference between the voltages measured respectively by the analog-to-digital converters AD of the card CM3 and of the fourth measurement card.

25 Each of the measurement cards CM1 to CM3 also includes a microcontroller μ C serving firstly to control the function selector S of the measurement card of which it forms a part, and secondly to measure the voltage between the measurement terminal 18 of the selector S and
30 a conductor 19 connecting the measurement cards and serving as a common reference equipotential for the voltage measurement.

Each microcontroller μ C is connected to the bus B via a connection 20 serving firstly to receive state
35 commands for the selector S, and secondly to address the result of the voltage measurement that has been performed to the unit UAT.

Each microcontroller μC has a processor P together with a memory M, an analog-to-digital converter AN, and a selector control port CS, all of which are connected to the processor P.

5 Each control port CS is connected to the selector S via a connection drawn as a dashed line.

Each analog-to-digital converter AD is connected to the measurement terminal 18 of the selector S via a filter F and an amplifier A that are connected in series
10 between the terminal 18 and an input of the converter AD.

In order to control the position of the selector S of a measurement card as a function of a state command transmitted to the card in question over the bus B, the processor P of the card transmits a switching signal to
15 the selector S via the port CS of the microcontroller.

When the state command is for placing the switch of the selector S in the switching state shown for the card CM3 in Figure 1 for the purpose of performing a voltage measurement, the processor P also transmits a command
20 signal to the converter AD so that it takes a measurement and converts the voltage present on its input terminals, and then it causes the data resulting from this conversion to be stored in the memory M.

The electrical measurements may be acquired by the
25 unit UAT in compliance with measurement parameters stored in an initial configuration file in a memory of the UAT and determining how the measuring device is to operate.

The measurement parameters may comprise the voltage, the current, the waveform of the injection current
30 delivered by the power supply AL1, the number of electrodes used, the number of measurements to be taken in succession, and a voltage measurement detection threshold.

The configuration file may be modified by the unit
35 UAT as a function of measurement configuration modification data transmitted to the UAT by a remote server (not shown).

The configuration file may be modified by the unit UAT as a function of the results of voltage and/or resistivity measurements that have already been taken.

In particular, the unit UAT may be programmed to
5 cause the following to take place periodically for each set of four measurement poles: a first injection of current, followed by collecting measured parameters for this injection (in particular the injection current and voltage), and also the voltages measured by the two
10 electrodes of the set of four used for measuring the voltages induced by the injection.

The unit UAT may be programmed to adjust the injection power for subsequent measurements as a function of the measurement results of this first injection, in
15 particular for the purpose of optimizing the amplitude of the measured induced voltages as a function of the measurement dynamic range of the converters AD of the cards CM1 to CM3, and/or as a function of ambient noise.

This may also serve to avoid saturating the
20 converters AD. For this purpose, each processor P may be programmed to detect such saturation and under such circumstances to transmit corresponding data to the UAT via the bus B.

The unit UAT may be programmed to adapt the state
25 commands of the function selectors associated with the electrodes as a function of command data for the measurement method used (dipole-dipole, Wenner, Schlumberger, ...) as transmitted to the UAT by the server, in order to determine the measurement method that
30 is best suited to the characteristics of the subsoil and to the electrical measurements.

The processors and telecommunication unit UAT is arranged to modify the acquisition of resistivity
35 measurements as a function of measurement data concerning parameters of the environment of the device.

In particular, the unit UAT may be programmed to increase, or on the contrary to decrease, the frequency

with which measurements are acquired or the magnitude of the current injected into the soil, as a function of the quantity of electrical energy available in batteries, and/or delivered by solar collectors or some other energy source, used for powering the measuring device. To this end, the measuring device may include an appropriate sensor that is connected to the unit UAT.

Likewise, when, during injection, the processor P of one of the measurement cards detects that a voltage is being measured that is less than an amplitude corresponding to ambient noise (as previously recorded), that processor may be programmed to send corresponding information to the unit UAT, which can then order an increase in the electrical power that is to be injected into the subsoil so as subsequently to obtain a measurement that is above noise while avoiding saturation (within the power limit of the injection power supply).

The unit UAT is programmed to control the measurement cards by sending them commands over the bus B, in particular in order to determine their parameters or settings in terms of current injection or voltage measurement.

Thus, by controlling the switching state of the switch of the selector S, each electrode of a quadripole may be given one of the four following functions: positive injection (+), negative injection (-), positive measurement (+), and negative measurement (-).

To this end, each card/microcontroller is identified by the bus B with a unique number, e.g. coded on six bits, and each processor P is programmed to decode instructions for setting the measurement card of which it forms a part, e.g. encoded on the two most significant bits, as sent thereto by the UAT and conveyed over the bus.

Three instructions for controlling the function selector may for example be encoded as follows:

00: voltage measurement by the converter AD of the card, the voltage being measured relative to the voltage reference and put into the buffer memory (M);

01: ("injection -") closing a relay in the selector S in order to connect the electrode to the negative terminal (-) of the injection power supply AL1; and

10: ("injection +") closing a relay of the selector S to connect the electrode to the positive terminal (+) of the injection power supply AL1.

10 On this assumption, the unit UAT sending the code "10000011" over the bus B serves to control the switching state of the function selector of measurement card number 3 ("000011") so that the electrode connected to that card is given the "injection +" function.

15 For each card CM1 to CM3 used for performing a voltage measurement, the measurement data delivered by the converter AD of the card is stored temporarily in the memory of the card until the processor P of the card detects a measurement read instruction and transmits the data to the unit UAT over the bus.

20 In order to perform an acquisition, the unit UAT may by way of example send the following sequence of instructions over the bus B:

1: place the selector S of the card CM1 in the state corresponding to the "injection +" function;

2: place the selector S of the card CM2 in the state corresponding to the "injection -" function;

3: place the selectors S of the other measurement cards that are connected to the bus B in the state corresponding to voltage measurement; and

30 4: reading the memories M of all or only some of the other measurement cards.

The unit UAT may be programmed to correct the voltage measurement data delivered by the converters of the measurement cards and transmitted over the bus with the help of calibration data that has previously been recorded in a memory of the unit UAT.

The unit UAT may also be programmed to perform mean and standard deviation calculations on the measurements transmitted over the bus in order to record the measurement results and in order to transmit those results to a remote server, in particular in response to a request made by the server.

The invention provides a system for measuring the resistivity of the subsoil around a borehole made for this purpose, which system makes it possible in simple and independent manner to obtain data concerning resistivity and other characteristics of the subsoil associated with resistivity over a duration that may be as long as several years.

CLAIMS

1. A system for measuring resistivity of the subsoil around a borehole, the system comprising:

i) a resistivity measuring device (10) comprising:

- 5 · an electrode support (SU) extending over the height of the borehole and supporting several tens of electrodes (E1 to E3) put into contact with the subsoil;
- a power supply module for injecting electric current into the subsoil via a pair of electrodes (E1 to 10 E3);
- a processor and telecommunication unit (UAT) arranged to transmit remotely measurement data resulting from electric voltage measurements made between pairs of electrodes (E1 to E3) of the support;
- 15 · a function selector (S) associated with each electrode for connecting it either to the power supply module or to voltage measurement means;
- control means for controlling the state of the function selectors, which control means are connected 20 to or incorporated in the processor and telecommunication unit (UAT);
- a bus (B) for conveying measurement data and connected to the processor and telecommunication unit (UAT); and
- 25 · for each electrode, a microcontroller (μ C) comprising an analog-to-digital converter unit (AD) connected to a terminal of the function selector (S) and forming part of the voltage measurement means, and a communication and control unit (P, CS) connected to the 30 function selector (S), to the converter unit (AD), and to the bus (B) for conveying measurement data; the communication and control unit (P, CS) associated with each electrode being arranged to control the function selector (S) and the conversion unit (AD), and to 35 transmit voltage measurement data delivered by the converter unit (AD) to the processor and

telecommunication unit (UAT) via the bus (B) for conveying measurement data; and

ii) a remote server arranged to communicate with the processor and telecommunication unit (UAT) of the device (10) for measuring resistivity and to transmit voltage measurement configuration data to the processor and telecommunication unit (UAT);

the processor and telecommunication unit (UAT) being arranged to modify the acquisition of resistivity measurements as a function of voltage measurements that have already been performed and as a function of voltage measurement configuration data.

2. A system according to claim 1, wherein the processor and telecommunication unit (UAT) is arranged to modify the acquisition of resistivity measurements as a function of data concerning measurements of parameters of the environment of the device.

3. A system according to claim 1 or claim 2, wherein the bus (B) for conveying data is arranged and used for conveying state command data for the function selectors respectively associated with the electrodes, the data being conveyed from the processor and telecommunication unit (UAT) to the communication and control units (P, CS) associated with the electrodes, with this control data being used in each communication and control unit (P, CS) to control the state of the function selector of the corresponding electrode.

4. A system according to any one of claims 1 to 3, including, for each electrode, a filter (F) inserted between a voltage measurement terminal of the function selector and the analog-to-digital converter unit (AD), in particular a lowpass filter.

5. A system according to any one of claims 1 to 4,
including, for each electrode, an amplifier (A) inserted
between a voltage measurement terminal of the function
selector and the analog-to-digital converter unit (AD),
5 in particular between said filter (F) and the converter
unit (AD).

6. A system according to any one of claims 1 to 5,
wherein calibration data is stored in a memory of the
10 unit (UAT) for the purpose of correcting or compensating
voltage measurement data delivered by the respective
converters (AD) as a function of sensitivity and/or
linearity characteristics specific to the converter
associated with each of the electrodes.

15 7. A system according to any one of claims 1 to 6,
wherein the microcontrollers and the function selectors
of the electrodes are arranged in the borehole, in
particular on the electrode support (SU).

20 8. A system according to any one of claims 1 to 6,
wherein the microcontrollers and the function selectors
of the electrodes are arranged on the surface, in the
proximity of the borehole.

25 9. A system according to any one of claims 1 to 8,
wherein the server is arranged to cause the processor and
telecommunication unit (UAT) to transmit to the server
voltage measurement data stored in a memory connected to
30 or incorporated in the processor and telecommunication
unit (UAT).

10. A system according to any one of claims 1 to 9,
wherein the support (SU) is a tubular support made of an
35 electrically insulating material, with electrodes of
annular shape crimped to its outside surface.

11. A system according to any one of claims 1 to 10,
wherein the server is arranged to determine the
conductivity of a pore fluid contained in a region of the
subsoil surrounding the borehole containing the electrode
5 support of the measurement device as a function of
electric voltage and/or resistivity data transmitted to
the server by the processor and telecommunication unit
(UAT) .
- 10 12. A method of measuring the characteristics of the
subsoil around a borehole in which use is made of a
system according to any one of claims 1 to 11.