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Datasheet for the decision of 13 December 2011

Case Number: T 1057/10 - 3.4.03

Application Number: 01902538.6

Publication Number: 1256019

IPC: G01V 3/12

Language of the proceedings: EN

Title of invention:
Method for determining the nature of subterranean reservoirs

Patent Proprietor:
Electromagnetic Geoservices AS

Opponent:
OHM Limited

Intervener:
Schlumberger Holdings Limited

Headword:
-

Relevant legal provisions:
EPC Art. 54 (3)

Relevant legal provisions (EPC 1973):
EPC Art. 100(a)(b), 54(2), 56

Keyword:
"Sufficient disclosure (yes)"
"Inventive step (yes)"

Decisions cited:
T 0410/99

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1057/10 **-** 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 13 December 2011

Appellant: (Patent Proprietor)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 19 March 2010 revoking European patent No. 1256019 pursuant to Article 101(3)(b) EPC.

Composition of the Board:

Chairman: G. Eliasson
Members: T. Häusser
T. Bokor

Summary of Facts and Submissions

I. The appeal concerns the decision of the opposition division in relation to the European patent No. EP-B-1256019.

II. An opposition had been filed by, inter alia, OHM Limited (opponent) raising the grounds of insufficient disclosure and lack of novelty and inventive step. Furthermore, an intervention had been filed by Schlumberger Holdings Limited (intervener).

III. In the decision under appeal the opposition division decided that the patent was revoked as the invention according to the main and 1st auxiliary request did not involve an inventive step and that the intervention was inadmissible.

The patent proprietor and the intervener appealed this decision.

IV. The respondent (opponent) had requested in writing to uphold the decision under appeal and subsequently informed the board that it had been acquired by the appellant (proprietor) and would thus no longer take part in the proceedings.

The appeal by the intervener against the decision in relation to the admissibility of the intervention was withdrawn.

V. At the oral proceedings of 13 December 2011 before the board, the appellant (patent proprietor) requested that the decision under appeal be set aside and the patent

be maintained on the basis of any of the main or 1st auxiliary request filed with the letter dated 12 February 2010 and underlying the decision under appeal.

VI. Reference is made to the following documents:

D7: US 4,617,518
D10: WO 00/00850
D14: WO 00/13046
D24: H. Passalacqua, ***Electromagnetic fields due to a thin resistive layer***, Geophysical Prospecting 31 (1983), 945-976
D37: Alan D. Chave et al, ***Electrical Exploration Methods for the seafloor***, chapter 12, Electromagnetic methods in applied geophysics, volume 2 (applications), Society of Exploration Geophysicists, M. N. Nabighian (ed) (1991)
D51: Rob L. Evans et al, ***The shallow porosity structure of the Eel shelf, northern California: results of a towed electromagnetic survey***, Marine Geology 154 (1999), 211-226

Document D24 was not admitted by the opposition division.

VII. The wording of independent claim 1 according to the main request reads as follows (board's labelling):

(i) "A method of performing a survey of subterranean strata in order to search for a hydrocarbon containing submarine reservoir

(35), or to determining the nature of a submarine reservoir (35) whose approximate geometry and location are known, which comprises:

(ii) applying a time varying electromagnetic field to the subterranean strata;

(iii) detecting the electromagnetic wave field response;

(iv) seeking, in the wave field response, a component representing a refracted wave (43,43 C);

(v) and determining the presence and/or nature of any reservoir (35) identified based on the presence or absence of a refracted wave component (43,43C);

(vi) in which the transmitted field is in the form of a wave, and in which the distance between the transmitter (37) and a receiver (38) is given by the formula $0.5\ \lambda \leq l \leq 10\ \lambda$;
where λ is the wavelength of the transmission through the overburden (34) and l is the distance between the transmitter (37) and the receiver (38)."

VIII. In relation to the main request the appellant (proprietor) argued essentially as follows:

(a) Sufficiency of disclosure

It followed from the description that "determining the *nature* of the reservoir" meant to determine whether it was likely to contain hydrocarbons or not and in particular whether it contained hydrocarbons or water.

The geophysicist in the oil industry would know – based on the surrounding geological formation - whether a reservoir was likely to be filled with fresh water or with hydrocarbons. Furthermore, the patent did not promise absolute certainty but offered merely an improvement in the success rate in predicting the nature of the reservoir.

(b) Late-filed document D24

Document D24 was a purely abstract document describing a mathematical model, but not the conduct of any practical survey. Furthermore, it was concerned with a ground-based setup but not with performing a survey relating to a ***submarine*** reservoir. The final sentence of D24 raised the question in what way the model would be similar for sea water and how the results would be different in that case. Transferring electromagnetic methods from ground-based to marine-based was in fact not straightforward. D24 was therefore neither novelty-destroying for claim 1 nor closer prior art than D37. Hence the opposition division correctly refused to admit document D24.

(c) Novelty

Document D7 was a confusing document so that it was impossible to ascertain exactly what it proposed. Furthermore, D7 related to both hydrocarbon and mineral deposits, the latter being usually conductive. There was no mention in D7, either explicitly or implicitly, of a refracted wave.

In document D10, the presence of a refracted wave was expected to be present at all times, whereas the claimed subject-matter of the patent required the presence and/or nature of a reservoir to be identified based on the presence *or absence* of a refracted wave. Furthermore, the reference in the claimed subject-matter to a "wavelength in the overburden" was meaningless in the context of D10, since there was no relevant overburden through which the signal necessarily passed.

Document D14 was an earlier application which was published after the priority date of the patent and was only relevant for novelty purposes. There was no disclosure in D14 of the seeking in the wave-field response of a component representing a refracted wave; instead, reference was made to the comparison of a direct wave and a reflected wave. Furthermore, the attenuation of the reflected wave was *greater* than that of the direct wave, while for a refracted wave it would be expected to be *lower*.

(d) Inventive step

The *closest state of the art* was D37 which set out a modelling exercise illustrating the electric field response as a function of source-receiver separation for a half-space of one resistivity and another layer that was either ten times more or less resistive. The parameters used in the exercise were however inconsistent with a hydrocarbon reservoir and D37 did neither disclose searching for a hydrocarbon layer nor determining the nature of a submarine reservoir. There was also no disclosure of the formula relating offset

and wavelength of the transmission through the overburden.

The ***objective technical problem*** could be formulated to be the devising of a method to search for a hydrocarbon reservoir or to determine whether a known submarine reservoir contained hydrocarbon or water without the need to sink a borehole.

The real research team in the technical field of oil exploration did not comprise a specialist in controlled source electromagnetic (CSEM) methods because no one had the wit to bring one in.

The disclosure in D37 on page 951, left-hand column, that longer ranges were required to detect low conductivity material was part of the modelling example and did not lead the skilled person to new ideas. In particular, there was insufficient stimulation in D37 to say that Figure 16, which related to the modelling exercise, had some use in the oil exploration field. Submarine hydrocarbon reservoirs would be a target different in kind from those exemplified in D37 (permafrost, carbonate reefs, basalt).

There was no explanation why, had the idea been obvious, nobody had come up with the solution within the 9 years between the publication of D37 and the priority date of the patent. This and other ***secondary evidence*** (consensus that electrical methods had turned out disappointing in the field; change in the attitude to CSEM methods following the publication of the invention; contemporaneous comments on the invention by

specialists in CSEM methods; …) pointed to the presence of an inventive step.

IX. The respondent (opponent) argued essentially as follows with respect to the main request:

(a) Sufficiency of disclosure

The disclosure in the patent was not sufficiently clear and complete in relation to the feature of determining the nature of the reservoir based on the presence or absence of a refracted wave component. The appellant had stated that "determining the *nature* of the reservoir" meant to determine whether it contained hydrocarbons or water. However, a reservoir contained always a mixture of hydrocarbons and water (and could even contain other substances such as CO_2) and had therefore a resistivity that increased with hydrocarbon saturation. It was thus impossible to detect the difference between a reservoir containing a mixture with low hydrocarbon saturation and a reservoir containing no hydrocarbons at all.

Furthermore, it was well-known that submarine strata could also contain reservoirs of fresh water as evidenced in document D51. However, the presence of a refracted wave only indicated the presence of a high resistivity layer, which could be such a layer of fresh water rather than hydrocarbons. It might thus be impossible to distinguish a hydrocarbon reservoir from a fresh water reservoir. It was not convincing that the skilled person would also use his prior knowledge about the surrounding geological formation to distinguish

between hydrocarbons and fresh water, as that was not recited in the claim.

(b) Late-filed document D24

Document D24 described the variability of the electric and magnetic fields due to a horizontal electric dipole in the presence of a thin, resistive layer buried between two more conductive layers. It was furthermore mentioned in D24 that an oil-bearing sand layer could be modelled mathematically as such a thin, resistive layer. While the focus of the paper was on subterranean reservoirs, it was acknowledged in the last sentence that the method could also be applied underneath the sea. D24 disclosed therefore the subject-matter of claim 1. For this reason the opposition division erred in its decision not to admit document D24.

(c) Novelty

Document D7 disclosed survey equipment, geological formations and survey parameters which were identical to those in the patent. Therefore, the detected signal was due to the same physical phenomenon as in the patent. The anomaly signal measured in D7 was at least partly indicative of a buried high-resistive layer. The only difference was that what was called a "refracted wave" in the patent was called by a different name, namely "anomaly signal" in D7.

Even though document D10 related to a different scenario from that described in the patent, it read onto claim 1. In fact, claim 6 required the transmitter

to be located in an existing well just like it is the case in D10.

Document D14 also disclosed survey equipment, geological formations and survey parameters which were identical to those in the patent implying that the detected signal was due to the same physical phenomenon as in the patent. In D14 a strong electromagnetic field response was considered to originate from a high-resistivity sandwiched layer. The only difference was that in D14 the response was described as a reflection phenomenon whereas in the patent it was described as a refraction phenomenon.

(d) Inventive step

The ***skilled person*** was regarded to be an exploration geophysicist working in the oil industry and having considerable knowledge of CSEM methods as could be derived from textbooks in the field of geophysical exploration which comprise sections dedicated to CSEM methods.

Document D37 explicitly identified the potential commercial value of marine CSEM methods in its introduction. Furthermore, D37 was part of a textbook concerned with electromagnetic methods in applied geophysics whose introduction made it clear that the book should be read in the context of oil exploration. It was known to the skilled person that a hydrocarbon containing buried layer had typically higher resistivity than the surrounding layers. The skilled person would therefore consider that the modelling

exercise in D37 would work for a hydrocarbon reservoir as well.

The parameter values in D37 for the modelling exercise were "intended only to be illustrative" and the difference between solid Earth problems and exploration problems was "principally one of scale" (page 932, left-hand column; page 950, right-hand column). It was therefore clear that the scale of the parameters could be adjusted.

During the 1990s petroleum companies were pushed into progressively deeper water to meet their production needs. Only such deep water allowed the efficient use of CSEM methods, which explained the changing attitude towards those methods around the turn of the century.

Reasons for the Decision

1. Admissibility

The proprietor's appeal is admissible.

2. Marine controlled source electromagnetic methods

In marine controlled source electromagnetic (CSEM) methods a transmitter of electromagnetic waves, e.g. an electric dipole antenna, is located near the sea-floor. The emitted electromagnetic waves are influenced by the subterranean structure, especially due to its conductivity, and are measured by receivers which are situated near the sea-floor at various distances from

the transmitter. These measurements allow deductions to be made about the subterranean structure.

There are frequency domain CSEM methods, in which a continuous signal is emitted by the transmitter, and time domain CSEM methods, in which a pulse is emitted. The present invention is concerned with the former.

3. Discussion of the requests

In the following - under points 4. to 9. - the main request will be discussed.

4. Amendments

The opposition division held that the amendments satisfied the requirements of Article 123(2) and (3) EPC. This was not challenged by the respondent (opponent). The board agrees, also regarding the amendments effected by the appellant (proprietor) in relation to the description (see point 9. below).

5. Sufficiency of disclosure

5.1 According to the view of the respondent (opponent) the disclosure in the patent was not sufficiently clear and complete in relation to the feature of determining the nature of the reservoir based on the presence or absence of a refracted wave component (feature (v) of claim 1). The respondent (opponent) adopted the interpretation that "determining the nature of the reservoir" meant to determine whether it contained hydrocarbons or water.

However, from the description of the patent, in particular paragraphs [0001], [0004], [0008] and [0020], it emerges that determining whether a reservoir contained hydrocarbons or water was a particular embodiment of determining the nature of a submarine reservoir, thus suggesting that the latter was to be interpreted somewhat broader than the particular embodiment. Furthermore, the absence of a refracted wave is merely due to the similarity between the properties of the overburden and the reservoir.

Finally, the invention only aims to increase the success rate in predicting the nature of the reservoir without alleging to determine the nature of the reservoir with certainty (paragraph [0008]). The board is thus persuaded by the appellant (proprietor) that "determining the nature of the reservoir" means to determine whether the reservoir is likely to contain hydrocarbons or not.

5.2 The opponent held that a reservoir always contained a mixture of hydrocarbons and water and that it was impossible to detect a reservoir when the hydrocarbon saturation was too low. In the board's opinion, it is evident from the description (see paragraphs [0008] and [0009]) that the invention only works if the resistivity contrast between the reservoir and the overburden (i.e. the matter between the seabed and the reservoir) is large enough. It is however well-known to the skilled person, an exploration geophysicist working in the oil industry (see section 8.3 below), that this requires a sufficiently high hydrocarbon saturation of the formation. For the purposes of sufficiency of disclosure it is therefore regarded to suffice that the

intended result is achieved at least in cases of sufficiently high hydrocarbon saturation of the formation.

5.3 Furthermore, the respondent (opponent) argued that the method according to the invention only indicated the presence of a high resistivity layer, which could be a layer of fresh water rather than hydrocarbons. It might thus be impossible to distinguish a hydrocarbon reservoir from a fresh water reservoir.

5.3.1 The opposition division held in the decision under appeal that it was possible for the skilled person to discern a hydrocarbon response from a fresh water response in the electromagnetic signal since fresh water did not necessarily have the same resistivity as hydrocarbons and since the skilled person had prior knowledge about the geological context and the expected prevailing pore fill and its parameters.

5.3.2 In the board's view the decisive issue for sufficiency of disclosure is whether the invention is disclosed in a manner sufficiently clear and complete to be carried out by the skilled person with knowledge of the patent *and on the basis of the person's common general knowledge*.

The skilled person, an exploration geophysicist working in the oil industry, can be expected to have considerable knowledge of geological formations. It is therefore appropriate to consider whether the skilled person would be able to implement the invention on the basis of that knowledge.

In particular, the respondent (opponent) referred to document D51 in this context, which is concerned with a marine CSEM survey on the continental shelf near the Eel River, northern California, for measuring resistivity profiles to a depth of 20 m beneath the seafloor. The survey was conducted using a transmitter-receiver spacing between 4 m and 40 m. On the inner shelf at water depths less than 60 m a high resistivity region extending to within a few meters of the seafloor was observed. In view of that region lying between the axis of the Freshwater syncline to the north and the Little Salmon fault to the south, one of the explanations advanced by the authors for the high resistivity was that fresh water was channelled to the seafloor through thrust faults thereby lowering the salinity of the water filling the sediment.

The circumstances of a submarine hydrocarbon survey envisaged in the patent are indicated in the example of the patent, in which it is aimed to detect a hydrocarbon layer of about 50-100 m thickness situated 1000 m below the seafloor using a transmitter-receiver spacing of 4000 m.

There is no evidence that fresh water below the seafloor would be a common occurrence at depths of the order of 1000 m, and the board is also not aware that this would be the case. The depths reported in D51 are two orders of magnitude smaller. The board is therefore satisfied that the skilled person could distinguish – based on his common general knowledge – a possible fresh water response from a hydrocarbon response at least to within the necessary degree of likelihood (see point 5.1 above), especially when taking into

considerations his knowledge of any fresh water sources and thrust faults in the region of interest.

5.4 Therefore, the board is satisfied that the patent describes the method according to the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Articles 83 and 100(b) EPC 1973).

6. Late-filed document D24

6.1 Document D24 was introduced by the respondent (opponent) at a late stage of the opposition proceedings in relation to the assessment of inventive step. The opposition division decided not to admit the document into the proceedings because it was regarded to be not more relevant than the documents on file. During the appeals proceedings the respondent (opponent) raised for the first time an objection of lack of novelty of the subject-matter of claim 1 in view of document D24.

6.2 Document D24 relates to the effect of a thin resistive subterranean layer on the electromagnetic waves emitted by a source. In particular, a model is presented in which a dipole source is situated in the air above the Earth's surface and a thin resistive layer is situated at a depth h below the dipole source. Computer programs are used to evaluate the resulting electric and magnetic fields and the influence of various parameters on the electromagnetic fields is analysed, e.g. of the distance and angle between source and receiver and the transverse resistance of the thin layer.

6.3 D24 describes thus a land-based model whereas the subject-matter of claim 1 relates to searching for a hydrocarbon containing ***submarine reservoir*** or to determining the nature of a ***submarine reservoir***.

In the last sentence of D24 it is mentioned that "the model is similar to one obtained by substituting free space by a conducting medium, such as sea water". It is however neither indicated in D24 in what way the model would be similar nor how the detected signals would be affected in the case of sea water.

Furthermore, oceanic controlled source problems differ from land-based ones in important ways (see document D37, pages 932 and 948):

- the source and receiver are immersed in sea water, i.e. a conductive medium, which attenuates the electromagnetic waves;
- the electrical structures below as well as above the sea water influence the induction problem;
- the conductivity of the sea water is ***higher*** than that of most of the materials which lie at or below the seafloor;
- the uppermost sediments under the ocean are usually water-saturated.

6.4 Document D24 is therefore not regarded to be relevant in relation to submarine reservoirs. Consequently, the board sees no reason to reverse the opposition division's decision not to admit document D24 into the proceedings.

7. Novelty

7.1 Document D7

7.1.1 Document D7 (see column 3, line 23 – column 6, line 56; column 9, lines 29-41) is concerned with the detection of "hydrocarbons or other mineral deposits". A survey vessel 1 tows a cable 30 comprising an electric dipole current source 2 and detector electrodes 36-39, whose measurements are interpreted to permit the detection of the mineral deposits, which could be in the form of a buried layer 25. The resistivity of the buried layer 25 is described in document D7 to be ***different*** from the resistivity of the portion of the formation 23 above the buried layer 25.

"Mineral" is known to be a very broad term comprising apart from organic compounds such as hydrocarbons also sulfides, oxides, halides, sulfates, phosphates, etc. Minerals have a wide variety of different resistivities ranging from those of highly conductive to those of nearly insulating substances.

From the above it follows that according to the disclosure of D7, the buried layer 25 could well have a resistivity that is ***lower*** than that of the overburden. In that case, downward travelling electromagnetic waves are however expected to be bent towards the normal at the interface between the overburden and the buried layer 25. On the other hand, a refracted wave in the sense of the patent, with respect to which the hydrocarbon reservoir acts in some way as a wave guide (see the patent, paragraph [0009]), requires the

reservoir to have a resistivity that is ***higher*** than that of the overburden.

7.1.2 The opposition division held that the "anomaly signal" was indicative of the resistivity of the subfloor formation 23 but not of a sandwiched high-resistivity waveguide, so that feature (iv) of claim 1 of the main request (see point VII. above) had not been disclosed in D7.

The respondent (opponent) argued that the survey parameters were identical in document D7 and in the opposed patent and that the detected signal in D7 was therefore due to the same physical phenomenon as the detected signal in the patent.

7.1.3 Feature (vi) of claim 1 requires the distance between the transmitter and the receiver to be in a certain range in terms of the wavelength of the transmission through the overburden.

Only from the detailed embodiments described in column 5, line 42 – column 7, line 10, a relation between these quantities can be deduced, so that only these embodiments have the potential to be novelty destroying. However, it is not stated in document D7 whether these embodiments relate to a buried layer having (1) necessarily higher resistivity, (2) necessarily lower resistivity, or (3) either higher or lower resistivity than the overburden. In the absence of any statement to the contrary one would in fact assume that the method relates to a buried layer having a resistivity which is ***different*** from that of the overburden as it had been stated earlier in the

description, so that case (3) would apply. However, only in case (1) could the detected signal conceivably involve a refracted wave in the sense of the patent.

According to established jurisprudence of the boards of appeal, a prior art disclosure is novelty destroying if it discloses ***directly and unambiguously*** the subject-matter in question (see T 410/99, reasons 3.2). In view of the above, the board is of the opinion that document D7 does not directly and unambiguously disclose either the step of seeking a component representing a refracted wave or the step of determining the presence or nature of any reservoir based on the presence or absence of such a refracted wave component, i.e. features (iv) and (v) of claim 1. The subject-matter of claim 1 is therefore new over document D7.

7.2 Document D10

7.2.1 Document D10 (see page 1, lines 4-9; page 7, lines 5-29; page 11, line 20 – page 12, line 24) relates to measuring the resistivity in the geological formations 9 surrounding a well 2. A transmitter antenna 4 for the emission of electromagnetic waves and sensors 5 for their reception are arranged in the well 2. The detected signals are analyzed allowing the resistivity of the formation to be deduced.

7.2.2 The waves emitted by the transmitter 4 are refracted in the rock strata in the geological formation such that the refracted wave is radiated out from the well 2 and back again to be sensed by the sensors 5 (page 2, first paragraph; page 11, last paragraph). Figure 2a apparently shows such a refracted wave which is

refracted towards the normal at a first interface and away from the normal at a second interface to be radiated back to the well 2. Since the formation layers in document D10 do not act as a wave guide, document D10 is not regarded to disclose a "refracted wave" in the sense of the patent, with respect to which the hydrocarbon reservoir acts in some way as a wave guide (see the patent, paragraph [0009]).

Furthermore, the resistivity of the rocks determines the attenuation of the electromagnetic waves. This is utilized in the method of document D10 in that the resistivity is determined on the basis of the amplitude and phase of the received waves (page 12, lines 20-24). This is in contrast to the method of the invention according to which the step of determining the presence and/or nature of the reservoir is based on the ***presence or absence*** of a refracted wave component.

7.2.3 Consequently, the board is of the opinion that document D10 does not disclose features (iv) and (v) of claim 1 and that therefore the subject-matter of that claim is new over document D10.

7.3 Document D14

7.3.1 Document D14 is a PCT application with filing date (26.08.1999) before the priority date of the patent (02.02.2000) and publication date (09.03.2000) after that priority date. The parties neither contested the validity of the priority in relation to claim 1 nor disputed the proper entry into the European phase of the PCT application D14. The board does not see any reason to raise such doubts either and thus regards D14

to be relevant for the assessment of novelty under Article 54(3) EPC.

7.3.2 Document D14 describes (page 6, line 25 – page 7, line 30) a vessel 16 laying a cable 17 on the seabed 14, the cable 17 comprising an electromagnetic transmitter 18 and several receivers 21-23. The transmitter 18 is activated to transmit an electromagnetic wave. The receivers 21-23 detect a direct wave 24 from the transmitter 18 as well as reflected waves 25-27 which are reflected by a reservoir layer 12 underlying the overburden 11. The direct wave 24 and reflected waves 25-27 are analysed and a judgement is made as to the nature of the reservoir layer 12.

7.3.3 The respondent (opponent) argues that the survey equipment, geological formations and survey parameters used in the survey of document D14 were identical to those in the patent and that therefore the signal picked up at the receiver in D14 had to be due to the same physical phenomenon as in the opposed patent.

However, in relation to the practical example described in the patent it is stated (paragraphs [0034] and [0035]) that reflected and refracted waves were ***both*** present. Furthermore, in the two detailed examples on pages 8 and 9 of document D14 it is described that the reflected wave suffers ***more*** attenuation (-210dB and -145dB) than the direct wave (-150dB and -95dB, respectively) implying that the reflected wave is ***weaker*** than the direct wave. In the patent, on the other hand, it is described that the refracted wave is ***stronger*** than the direct wave (see paragraph [0042]; compare also paragraph [0032]).

The board is thus satisfied that the "reflected wave" in D14 and the "refracted wave" in the patent relate to different phenomena and that consequently, features (iv) and (v) of claim 1 have not been disclosed in document D14. The subject-matter of that claim is therefore new over document D14.

7.4 Conclusion

Claims 2 to 16 are dependent on claim 1 providing further limitations of the method according to claim 1. The subject-matter of these claims is therefore also new over the documents discussed above.

Accordingly, the board is satisfied that the subject-matter of claims 1 to 16 is new (Article 54(1), (2) EPC 1973 and Article 54(3) EPC).

8. Inventive step

8.1 Closest state of the art

8.1.1 In selecting the closest state of the art, the first consideration is that it should be directed to the same purpose or effect as the invention. Otherwise it cannot lead the skilled person in an obvious way to the claimed invention (see "Case Law of the Boards of Appeal of the European Patent Office", 6th edition 2010, I.D.3.2).

From the description of the patent it emerges (see paragraphs [0001] to [0006]) that the purpose of the invention is to identify hydrocarbon reservoirs.

8.1.2 Document D37, considered by both parties to represent the closest state of the art, is a chapter in a two-volume compendium entitled "Electromagnetic methods in applied geophysics". It relates in detail to five different electrical exploration methods for the seafloor, namely magneto-telluric, direct current resistivity, magneto-metric resistivity, self potential, and CSEM methods.

8.1.3 In the decision under appeal the opposition division expressed the opinion (section 2.13.2 of the decision) that a method of performing a survey of subterranean strata to determine the nature of a submarine reservoir was known from document D37, page 947, first paragraph of the section "CONTROLLED SOURCE EM METHODS". As it was described in the introduction of D37 (page 931, right column, second paragraph) how an electromagnetic survey was carried out as a subsequent, complementary technique after a seismic survey, the approximate geometry and location of the reservoir was known. The opposition division thus concluded that the use of CSEM methods in the oil industry was known from D37.

However, the board notes that in the passage concerning CSEM methods it is merely described that the electric or magnetic signature of currents inside the conducting Earth, which are induced by dipole sources used in CSEM methods, can yield a measure of the electrical conductivity of the underlying rock. There is no indication that the underlying rock contained a reservoir. Furthermore, in the introduction of D37 it is only mentioned that alternative, complementary geophysical techniques were required to study certain

marine geological terrains. Which geophysical techniques were envisaged for that aim is not explicitly mentioned in D37 and it cannot be inferred from its disclosure which of the five different electrical methods described in D37, if any, could serve the aim. The board is therefore of the opinion that the above passages of document D37 do not disclose the use of CSEM methods for identifying hydrocarbon reservoirs.

8.1.4 The section on CSEM methods in D37 contains frequency domain modelling exercises related to an ocean half-space overlying a rock half-space of lower conductivity than the ocean. In other modelling exercises the rock half-space contains a 1 km thick buried layer, which is ten times more or less conductive than the rock and is centred at depths of 1.5 km or 5.5 km.

Since a buried hydrocarbon layer is typically about 50-100 m thick (see the patent, paragraph [0039]), the buried layer in the above modelling exercises cannot be regarded to be representative of buried hydrocarbon layers. These exercises are therefore not concerned with identifying hydrocarbon reservoirs.

Furthermore, D37 describes actual frequency domain CSEM surveys carried out in the deep ocean on the East Pacific Rise and in the North Pacific: in the former a basalt layer of 1 km to 1.5 km thickness was found to be underlain by a layer of lower conductivity and having a thickness of several kilometres; in the latter a layer of very low conductivity penetrating to a depth of at most 30 km underlies a 5 km thick crust of higher conductivity. Finally, a survey for mapping resistive

features such as permafrost layers and basalt flows on the continental shelf is described. These surveys are therefore not concerned with identifying hydrocarbon reservoirs, either.

8.1.5 However, in its introduction on page 931, right-hand column, document D37 describes the offshore search for petroleum reserves, extended into progressively deeper water, using the seismic method as geophysical tool. As this exploration method is directed to the same purpose as the invention it is regarded to constitute the closest state of the art.

8.2 Objective technical problem

Seismic methods are able to reveal the location and shape of a ***potential*** reservoir, but cannot reveal the presence and/or nature of the reservoir. This is the object of features (ii) to (vi) of claim 1 (see point VII. above), in which the subject-matter of claim 1 differs from the closest state of the art. The objective technical problem is therefore (see the patent, paragraphs [0001] to [0008]) ***to determine, with greater certainty, the presence and/or nature of a submarine reservoir, without the need to sink a borehole***.

8.3 Person skilled in the art

It is common ground between the parties that the skilled person is an exploration geophysicist working in the oil industry. Such a definition is also in line with the objective technical problem to be solved, which is defined above and should be the starting point

for determining the appropriate skilled person. The board has therefore no reason to deviate from the common opinion of the parties.

8.4 Obviousness

8.4.1 It remains to be considered whether it would be obvious for the skilled person to arrive at features (ii) to (vi) when attempting to solve the posed objective technical problem.

8.4.2 As mentioned above, the section on CSEM methods in D37 contains a description of frequency domain modelling exercises. As an introduction to the exercises concerning a buried layer of higher or lower conductivity than the surrounding rock the following is stated in document D37 (page 950, right-hand column, last paragraph):

> "It is instructive to examine the behavior of the horizontal electric field for geometric (range-dependent) and parametric (frequency-dependent) soundings in the presence of the simplest structural complication, a buried layer."

The rock half-space in these exercises has a conductivity of 0.05 S/m. The buried layer is 1 km thick, ten times more or less conductive than the rock and is centred at depths of 1.5 km or 5.5 km; the resistive buried layer has therefore a conductivity of 0.005 S/m. These values are described in D37 as "intended only to be illustrative" (ibid.). Furthermore, when reporting the dependence of the

electric fields on the range (see Figure 16), a transmitter frequency of 1 Hz is used.

In the same section on CSEM methods, actual frequency domain surveys are reported, one of them having been carried out on the East Pacific Rise. In this survey a transmitter is used with frequencies in the range of 0.25-2.25 Hz. Furthermore, a basalt layer of 1 km to 1.5 km thickness and a conductivity of about 0.05 S/m was found to be underlain by a layer of conductivity less than 0.004 S/m and having a thickness of several kilometres (page 958, left-hand column).

The board is of the opinion that the skilled person would read the passages in D37 relating to the modelling exercises in the context of the entire document, especially the passages relating to the actual surveys using the same technique. The parameters used in the modelling exercises are very similar to those in the East Pacific Rise survey. The reader would therefore understand the modelling exercises to be illustrative of the behaviour of the electric fields in circumstances which are similar to those in the East Pacific Rise survey.

8.4.3 Furthermore, in the modelling exercises the buried layer, which is less conductive than the surrounding rock half-space, is described in D37 (page 951, left-hand column) to behave as a "lossy waveguide" which traps and guides the signal and thus results in slower attenuation with range when compared to the half-space case. Longer ranges were "required to detect low conductivity material".

The opposition division pointed out that in the modelling exercise of D37, the electromagnetic wave in the rock half-space had a wavelength of about 14 km (point 2.13.3). In the buried layer which is ten times ***less*** conductive than the rock half-space the wavelength would be even larger than that value. In the board's view, it would therefore not be evident for the skilled person that a hydrocarbon layer, whose typical thickness is only about 50-100 m (see the patent, paragraph [0039]), i.e. one order of magnitude smaller than that of the buried layer in the modelling exercises, would be able to trap and guide the waves thus acting as a "lossy waveguide" like the buried resistive layer in the modelling exercises in D37.

8.4.4 For these reasons the board is of the opinion that it would not be evident for the skilled person that the results of the modelling exercises in D37 also apply to buried hydrocarbon layers. These modelling exercises would therefore not lead the skilled person to consider features (ii) to (vi) for solving the posed technical problem. The subject-matter of claim 1 therefore involves an inventive step.

Claims 2 to 16 are dependent on claim 1 providing further limitations of the method according to claim 1. Accordingly, the board is satisfied that the subject-matter of claims 1 to 16 involves an inventive step (Article 56 EPC 1973).

9. Other requirements of the EPC

In order to comply with the requirements of Article 84 EPC 1973 and Rule 27(1)(b) EPC 1973 the description has

been brought into conformity with the amended claims and has been supplemented with an indication of the relevant content of document D37. These requirements of the EPC are therefore also satisfied.

10. Conclusion

In view of the above the board is satisfied that the main request meets the requirements of the EPC. Consideration of the 1st auxiliary request is therefore not necessary.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent with the following documents:

Description	columns	1-2 as filed during the oral proceedings, 3-7 as granted
Claims	1-16	as filed with letter dated 12 February 2010 as main request
Drawings	Figs. 1, 2	as granted.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson