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New Exploration Technology:

one dry wildcat instead of four

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The goal of the presentation is to explain how Binary Seismo-Electromagnetic (BSE) Technology can improve today's prospects.

Content **pp**

“No civilization can survive the physical destruction of its resource base.”
—Bruce Sterling

“First they ignore you. Then they laugh at you. Then they fight you. Then you win.”
—Gandhi

“It's difficult to get a man to understand something if his salary depends on him not understanding it.”
—Upton Sinclair

“Data always beats theories. 'Look at data three times and then come to a conclusion, ' versus 'coming to a conclusion and searching for some data.‘ The former will win every time.”
—Matthew Simmons, ASPO-USA conference, Boston, MA, October 26, 2006

2. Introduction

The new method and technology we want to bring to your attention were developed over a period of time of about twenty five years. In the development and testing of this system took part and participated several research and manufacturing establishments : Marine Geology Institute, St. Petersburg;
Black Sea Expedition, Odessa; Elkin, Ltd., St. Petersburg; SeismoSeiences, Inc, San Diego, and others.

The new method and technology at all stages were studied and designed by Dr. Berg. He is also the inventor of the patents US # 7,042,801; 7,245,560 and 7,330,790 concerning the method.

Objective data of this method and impressive results of marine surveys allow to hope that it will be put into practice of hydrocarbon exploration.

How does this method differ from once used today?

As it is known several geological factors are required to create a hydrocarbon field. In accordance with the Glossary of the Norwegian Petroleum Directorate we have:

"Play: A play is a geographically demarcated area where several geological factors occur together so that producible petroleum can be proven. These factors are:

1) Reservoir rock, which is a porous rock where petroleum can be preserved. Reservoir rocks to a specific play will belong to a given lithostratigraphical level.

2) Trap, which is an impermeable rock or a geological structure enveloping the reservoir rock so that the petroleum is retained and accumulates in the reservoir. The trap must be formed before the petroleum stops entering the reservoir.

3) Source rock, which is shale, limestone or coal containing organic material that can be converted into petroleum. The source rock must also be mature, that is to say the temperature and pressure must be appropriate for petroleum actually to be formed, and there must be a migration path enabling the petroleum to move from the source rock to the reservoir rock. A play is confirmed when producible petroleum is found in it. The production does not necessarily have to be profitable. If no producible petroleum has yet been found in a play, it is unconfirmed.

Probability of discovery: Describes the feasibility of proving petroleum in a prospect by drilling. The probability of discovery results from multiplying the probabilities of the existence of the play, the presence of a reservoir, a trap, the migration of petroleum into the field and the preservation of petroleum in the field (see Play)."

Obviously, the probability of discovery is given above for conventional exploration methodology which studies the geological factors separately. Graphically it is shown in Fig.1. For example, seismics is studying structure of traps (see factor 2) well enough. But other factors and contents of traps are mostly unknown. Absence of one of the factors or part of one eliminates any discovery. Therefore world petroleum industry has probability of discovery (exploration success rate) about 25%. It means at least three from four wildcats are waste.

Proposed method studies none of these factors, as it is based on completely different approach. Seismo-electromagnetic response can find the hydrocarbon deposit directly- not through other geological factors. However geological and geophysical information is useful, but lack of other information doesn't restrict application of the method.

For BSE Technology probability of discovery can be determined as follows: Describes the feasibility of proving petroleum in a BSE field outline by drilling. The probability of discovery results from outline BSE response intensity. Usually the probability is about 75%.
It means the BSE technology has one waste hole only from four drilled wildcats. The definite advantage of the BSE technology in saving of time and money is obvious. So, BSE outline can improve today's prospects before drilling.
Why do we get this direct response from the deposit?
It is common knowledge, that all known geophysical methods use one or another physical field, like, for example, mechanical vibration, electrical , electromagnetic or magnetic field. Not one of them uses interaction of two fields which simultaneously impact investigating media. Below we will show how it works.

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3. Difference between conventional and new method.

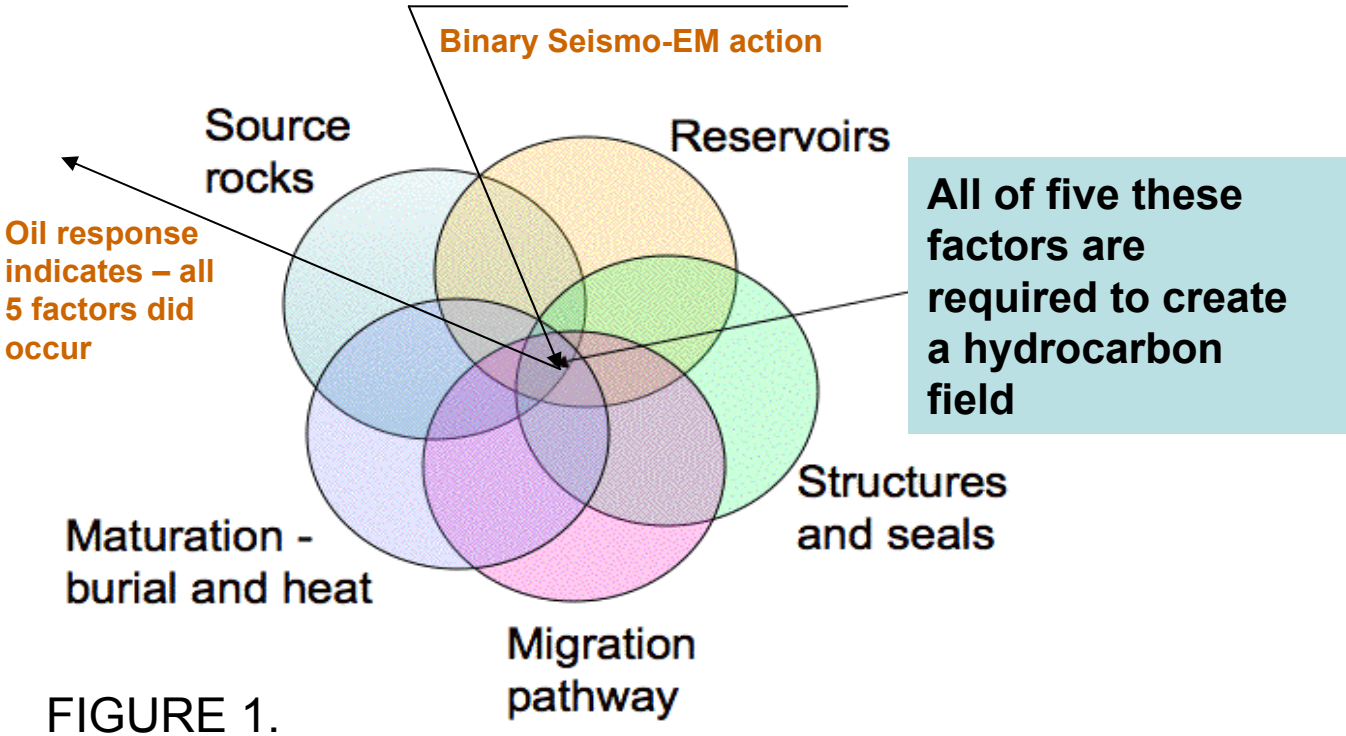


FIGURE 1.

Conventional oil exploration methods include: Seismics, Gravity, Magnetics, Electromagnetics, IP, Resistivity,SeismoElectrics, Geochemical, Satellite and so on

Companies drill lots of dry holes - normally the result of one of these 5 factors failing. For example, seal failure, no reservoir etc. Conventional methods give data about one or other factors required to create a hydrocarbon field (reservoirs, structures and so on). Proposed method uses Binary Seismo-Electromagnetic (BSE) action and gives data about hydrocarbon presence in BSE outline. Detection of an oil response discloses existence of oil accumulation indicating that all five factors did occur.

4. Initial point

In 1980 we studied transient process in media with binary seismo-electromagnetic action. Our observation line ran near production well which crossed upper and deep hydrocarbon layers. As is known, presence hydrocarbons in media increases electric resistivity and transient process have to be shorter than if hydrocarbon absent. However, we have got opposite sign of the anomaly.

So, we got initial Fact # 1:

binary seismo-electromagnetic (BSE) impact produces response in media with hydrocarbons opposite to response which we expect from electromagnetic theory. The response discloses a presence of hydrocarbon deposits in studied medium.

We have researched the phenomena and got the following.

You can see the result of impact of seismic and electric fields on artificial rock model (sample) in Fig. 2

The same effect over hydrocarbon media is shown in Fig.3.

Interaction between seismic and electric fields in porous spaces with a drop of oil is schematically shown in Fig.4.

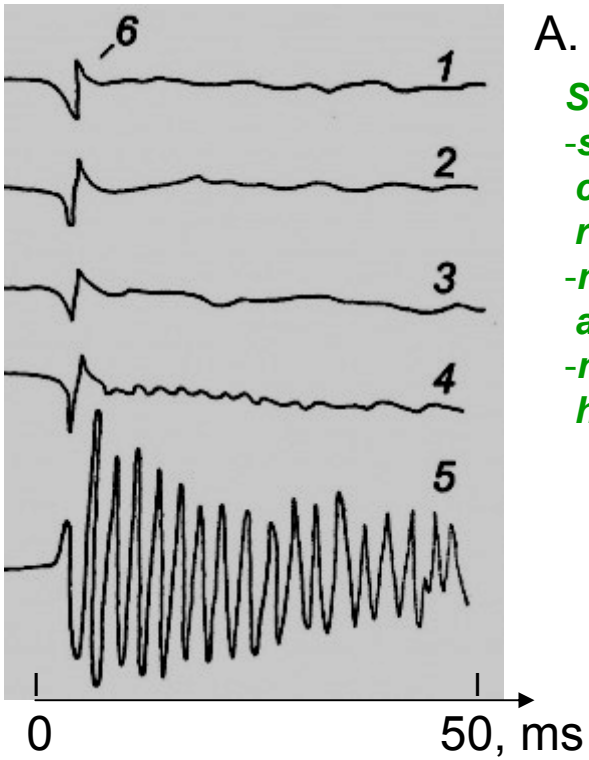
5.BSE responses on artificial samples of rocks

A. Homogeneous sample:

- 1 is record of seismo-electric effect, (acts only seismic wave),
- 2,3,4 are records of BSE responses with different electric current, acting prior to seismic wave turn on,
- 5 is record of seismic wave intensity,
- 6 is external pulse of acoustic disturbance.

B. ***Sample of contact of two mediums with different pore fluids:***

- 1 is record of seismo-electric effect,
- 2,3 are records of BSE responses with different electric current,
- 4 is record of seismic wave intensity.

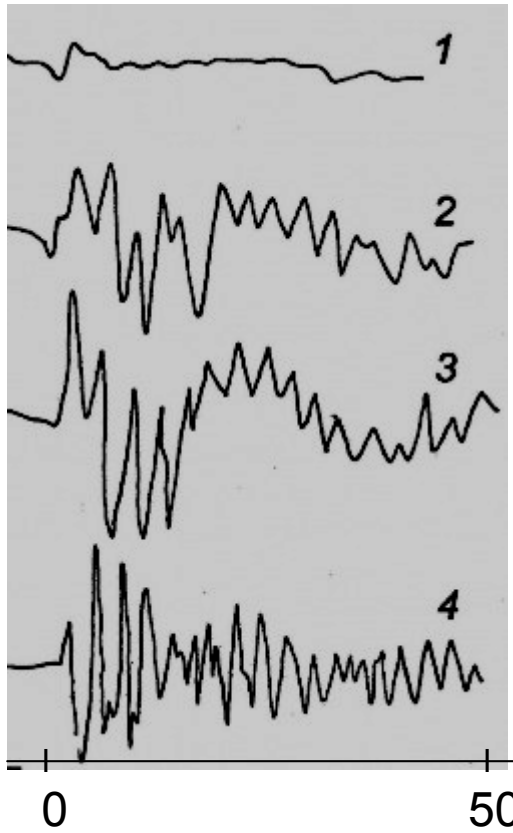


A.

So, we have FACT # 2:
-seismic wave plus electric current produce significant response from contact,
-no responses for separate action wave and current
-no responses for homogeneous sample.

Figure 2

(By Nazarniy and Komarov)



B.

6.Binary Seismo-Electromagnetic Phenomenon in Hydrocarbon Pay

FACT # 3:

As is known, electromagnetic field generates electrical charge σ on the interfaces of the hydrocarbon layer.

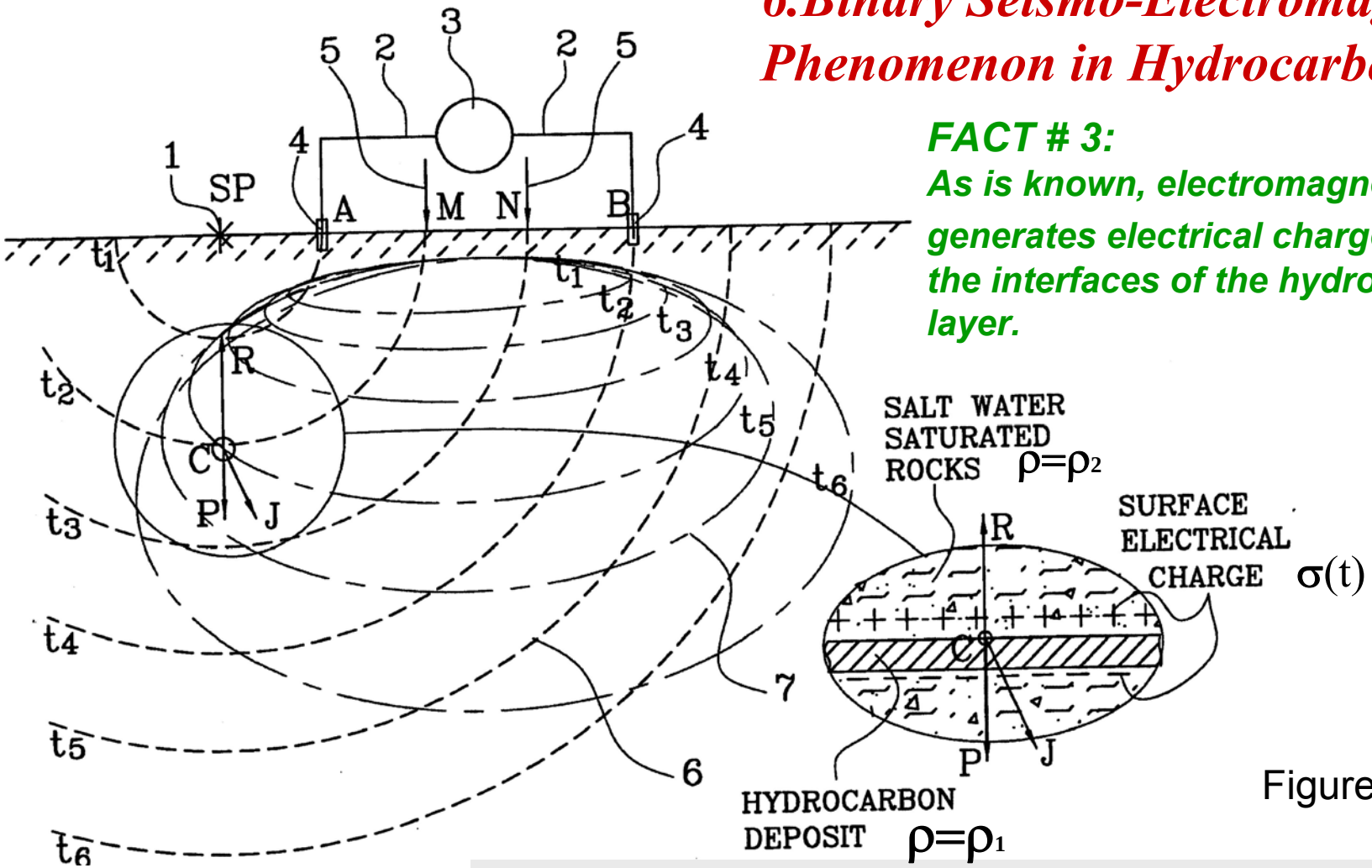


Figure 3

SP – shot point
A800M200N800B – Schlumberger array

For upper interface we have:

$$\sigma(t)=\varepsilon_0\varepsilon(\rho_1-\rho_2)J(t)$$

as $\rho_1>>\rho_2$, $\sigma(t)=\varepsilon_0\varepsilon\rho_1 J(t)$

7.Pore space with oil droplet under binary field action

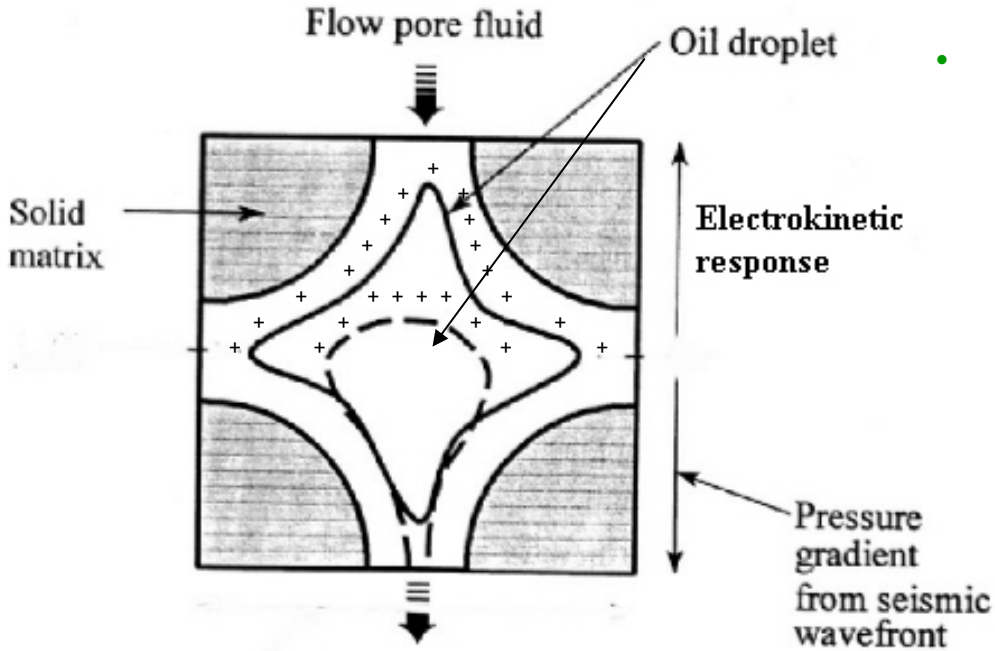


Figure 4.

FACT # 4:

- ***We assume that the charges + is placed on the surface of oil droplet in the pore space of the reservoir.***
- ***As is known, seismic wave moves pore fluid (the oil droplet) in the pore space (model Bio, 1956).***
- ***We assume, that electrical charges + moves together with oil droplet.***
- ***As is known, moving charges generate electromagnetic response.***

The electromagnetic field they produce in response is proportional to the electric resistivity of the pore fluid; therefore the response from hydrocarbons is much stronger than it is from water. Detection of the BSE response indicates high concentration of hydrocarbons directly and discloses existence of unknown accumulation.

8.Difference between hydrocarbon reservoir and other geological layers

1. Hydrocarbon reservoir (pay):

$$\sigma(t)= \varepsilon_0\varepsilon\,(\rho_1 - \rho_2)J(t),\quad \rho_1 >> \rho_2,\quad \sigma(t)= \varepsilon_0\varepsilon\,\rho_1\,J(t),$$

high permeability, large replacement of pore fluid with charge inside pore space, large replacement of charge produces detectable on surface the *BSE response.*

2. Water reservoir:

$$\rho_1 \cong \rho_2,\quad \pm\sigma(t) \to 0,\quad \textit{BSE response} \to 0.$$

3. High resistivity layer:

$$\rho_1 >> \rho_2,\quad \sigma(t)= \varepsilon_0\varepsilon\,\rho_1\,J(t)$$

low permeability, small replacement of fluid charge,

BSE response $\to 0.$

Conclusion: no other geological layer except hydrocarbon pays is able to produce detectable BSE response.

9.First detected responses from pays with depth 550 m (0.5 sec peak) and 2200 m (1.4 sec peak)

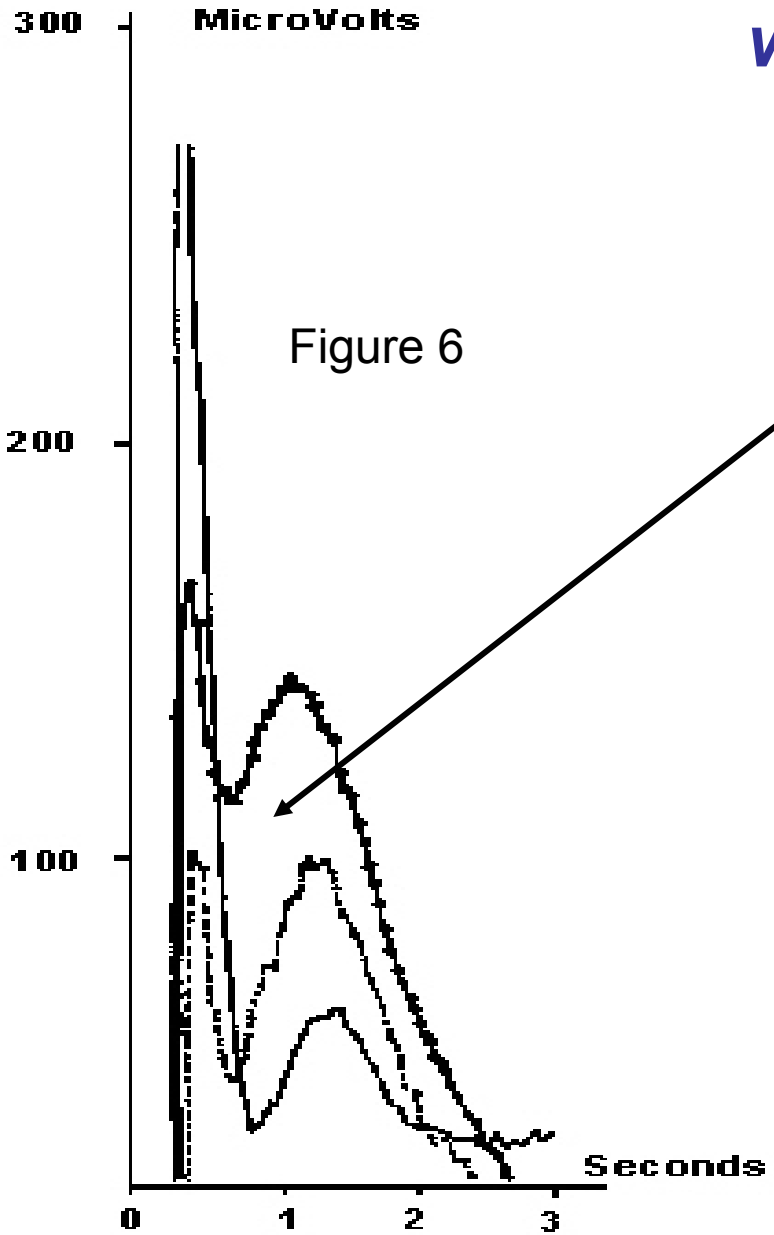
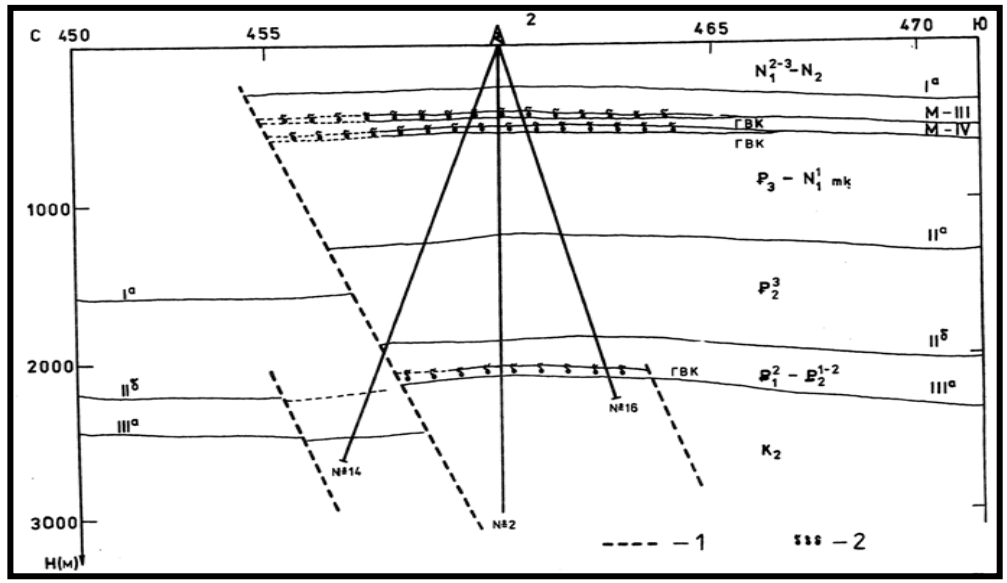


Figure 6

These BSE responses were recorded near production well in Black Sea. They proved that pays generates electromagnetic responses on binary seismo-electromagnetic action.



1 – fractures, 2 – gas and gas-condensate pays

10.Computer simulation: BSE magnitude is function of pay depth and size, seismic velocity, resistivity, power sources, sources - sensors array etc.

BSE response for previous slide conditions:

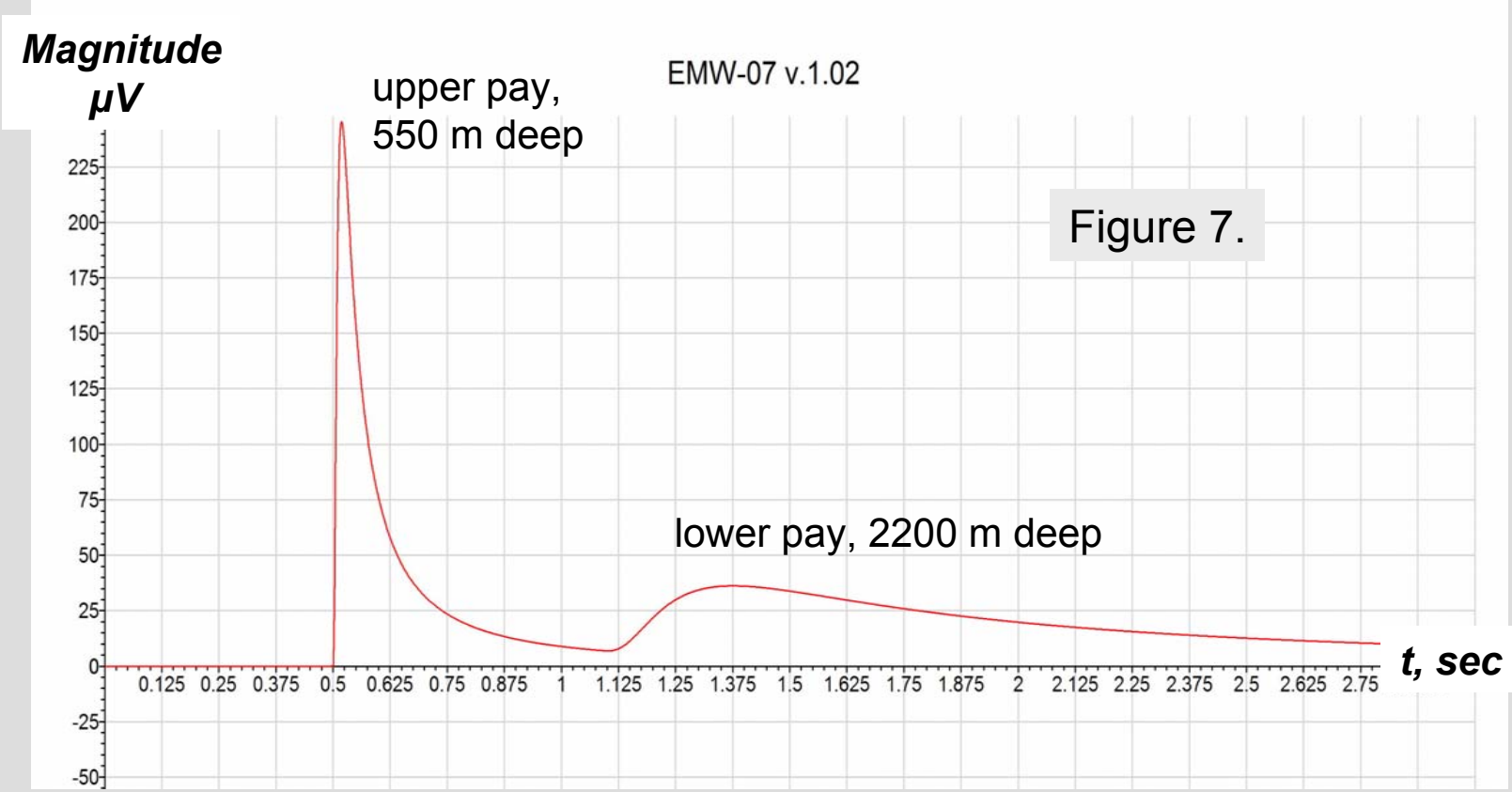
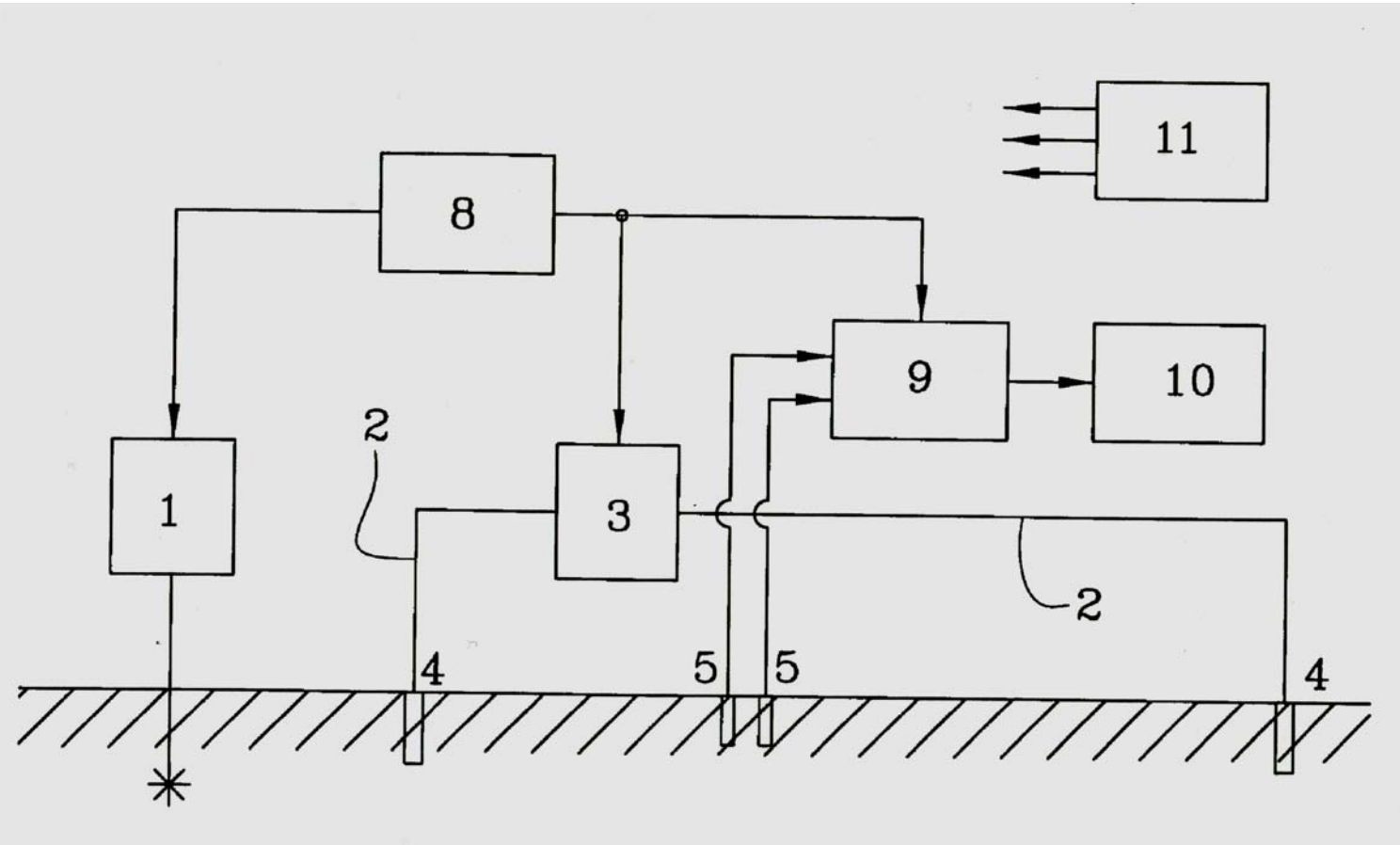


Figure 7.

11.Technical realization: Simplified diagram of BSE system.



1 – seismic source,
2 – power cable,
3 – EM impulse generator,
4 – current electrodes,
5 – sensors,
8 – synchronizer,
9 - microvoltmeter
10- PC,
11- power supply.

Figure 8.

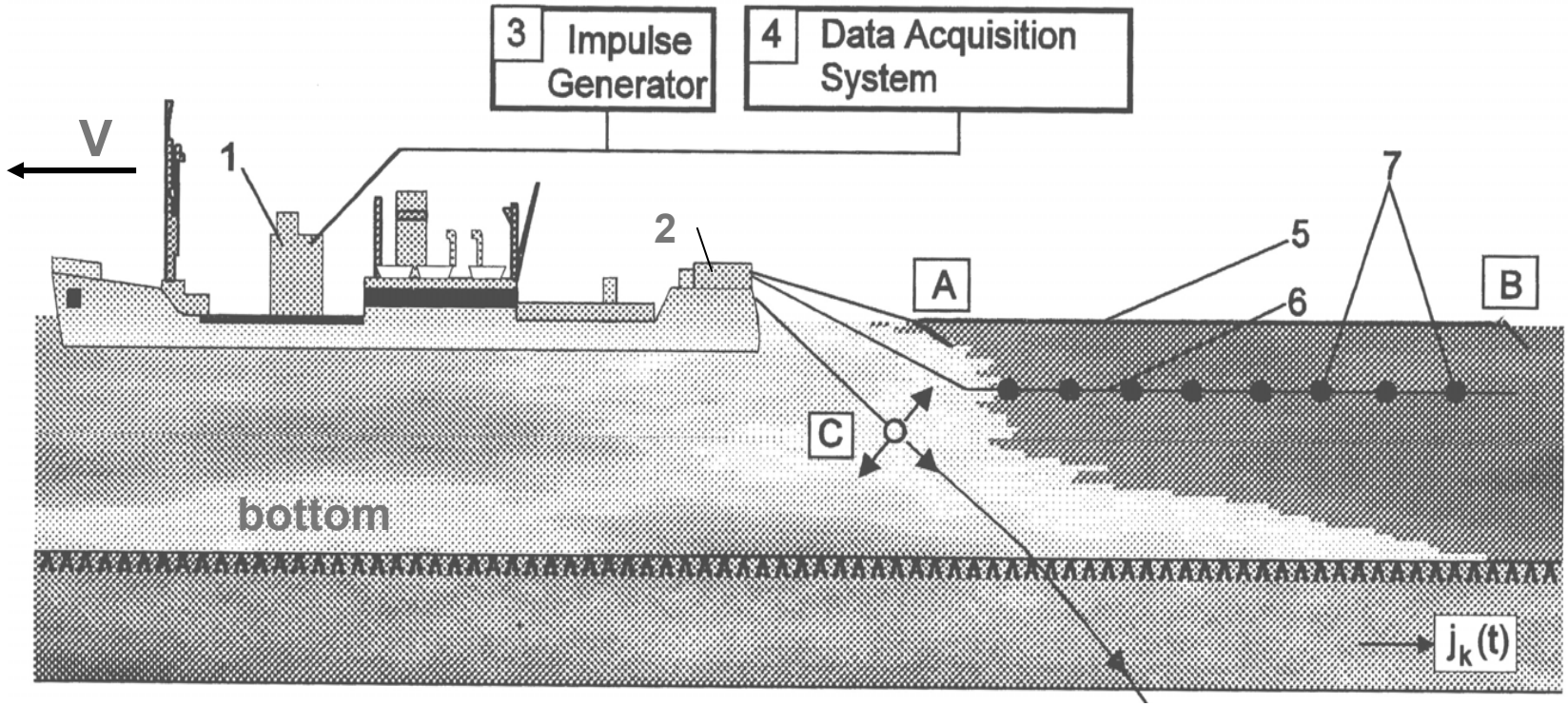
In this Fig. 8 reference numeral 1 identifies a seismic source of any design, for example sparker or airgun. A receiver of electrical signals for example a digital microvoltmeter is identified with reference numeral 9. A personal computer 10 is connected with an output of the microvoltmeter. A synchronizer 8 provides a timely turning on of the seismic source, the generator of electrical pulses, and the microvoltmeter. A source of electrical energy 11 provides power supply to all blocks. Electrical sensors 5 are used, and formed for example as receiving electrodes for measurements of an electrical field, or magnetical sensors are used for measurements of a magnetic component of the field.

When all elements shown in Fig. 8 are connected, the synchronizer 8 sends a signal to turn on the seismic source 1, the pulse generator 3 and the microvoltmeter 9. The turning on of the pulse generator can be delayed up to 3 seconds, if it is necessary to carry out scanning of the investigating area over depth. This possibility is provided because the electromagnetic field propagates in general faster than the seismic wave. It is possible to select the delay so that the seismic wave and the electromagnetic transient process will reach the desired depth simultaneously. In this case the deposits located in an upper part of the medium will not be activated before passage of the seismic wave for generating a response, and the obtained signals will be connected only to deeper deposits.

On the other hand, the turning on of the generator can be carried out before the turning on of the seismic source by substantially three seconds. In this case the investigated area of the earth will be uniformly illuminated by the electromagnetic field, and the seismic wave will initiate a response from the deposit at any depth of its location. Therefore the binary radiation allows to study the investigated objects in a more detailed fashion.

The response which is initiated in the deposit propagates upwardly and is detected by the sensors5. The electrical signal of the response is supplied to the input of the receiver and then is supplied into the personal computer, where it is processed and stored. A geometrical location of the sources of the electromagnetic field, sources of seismic waves and electromagnetic sensors is selected based on the geological conditions of carrying out of the investigating works. The number of the sources and the receivers can be arbitrary, and is selected for economical considerations.

12.Offshore BSE system



1 – vessel
2 – cable winch
5 – power cable
6 – signal cable
7 - sensors

A,B – current electrodes
C - acoustic source
V – vessel speed
(4-5 knots)

A vessel 1 tows electromagnetic (EM) source A,B; seismic source C and sensor streamer 6. EM and seismic sources work simultaneously.
.

Figure 9.

13.Winch with floating cable designed and manufactured by PskovCable Plant (Russia).

Figure 10.

14.Field test on known field *: - red outlines are two fields by BSE data, recorded on the area. 600 km observation lines was fulfilled here.*

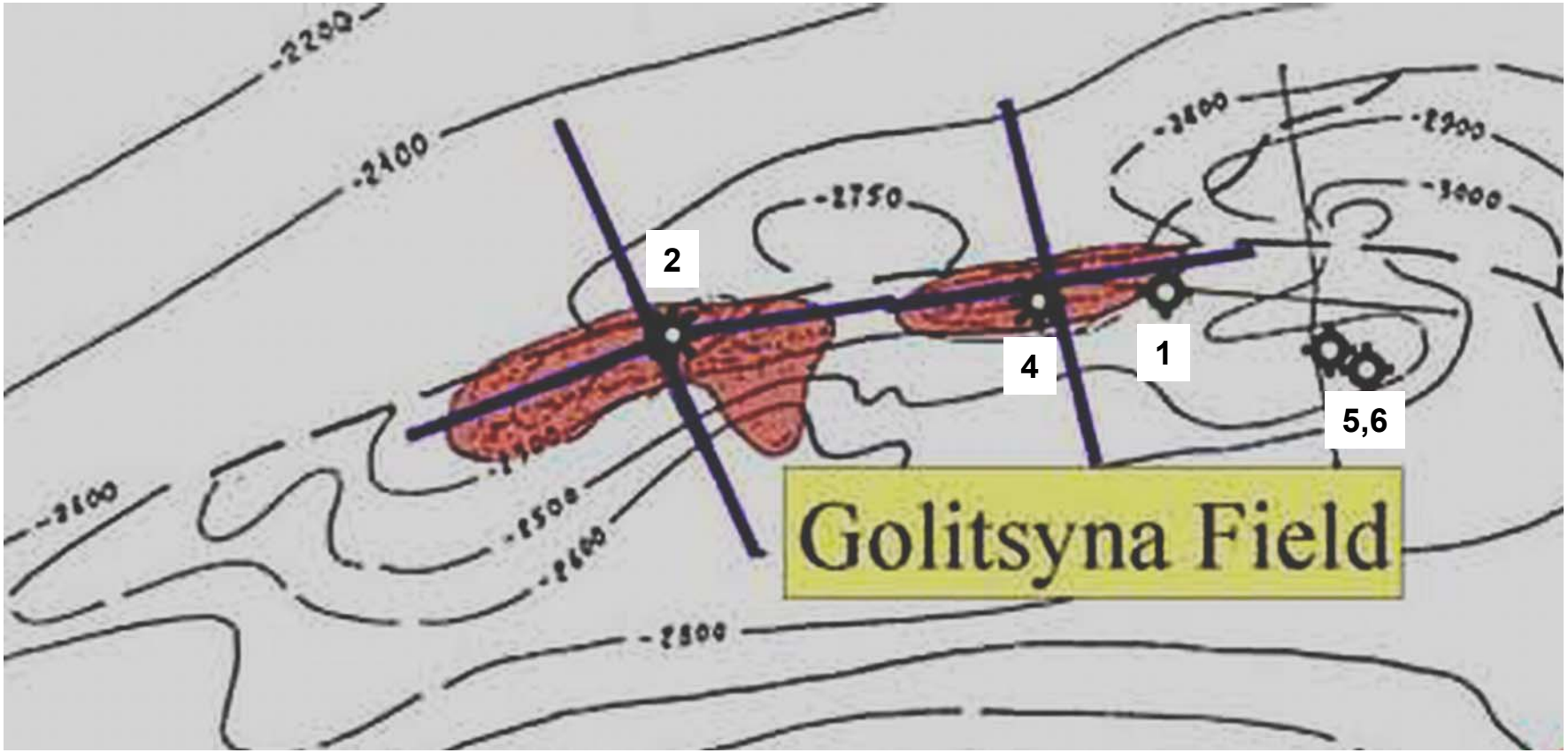
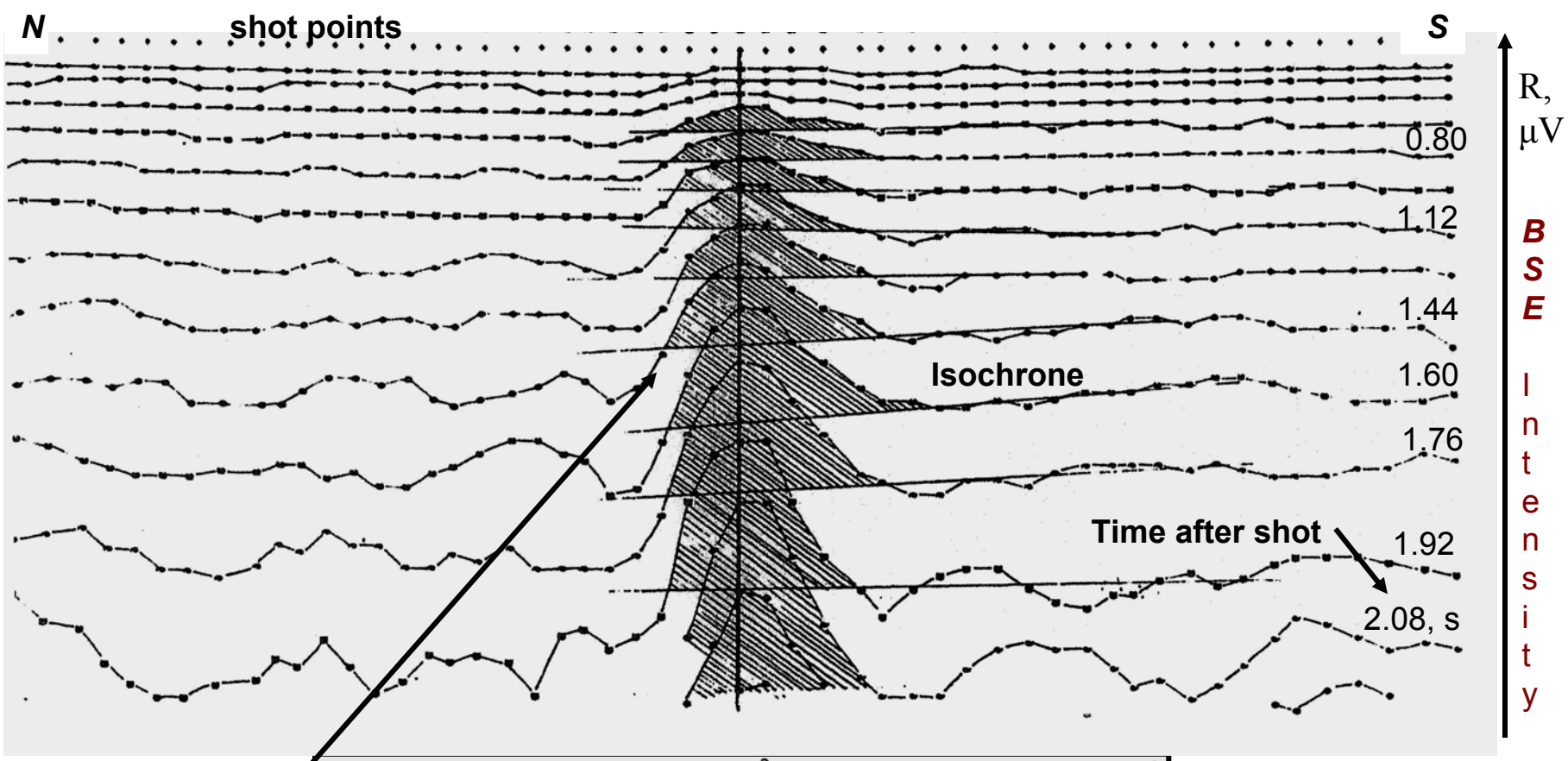
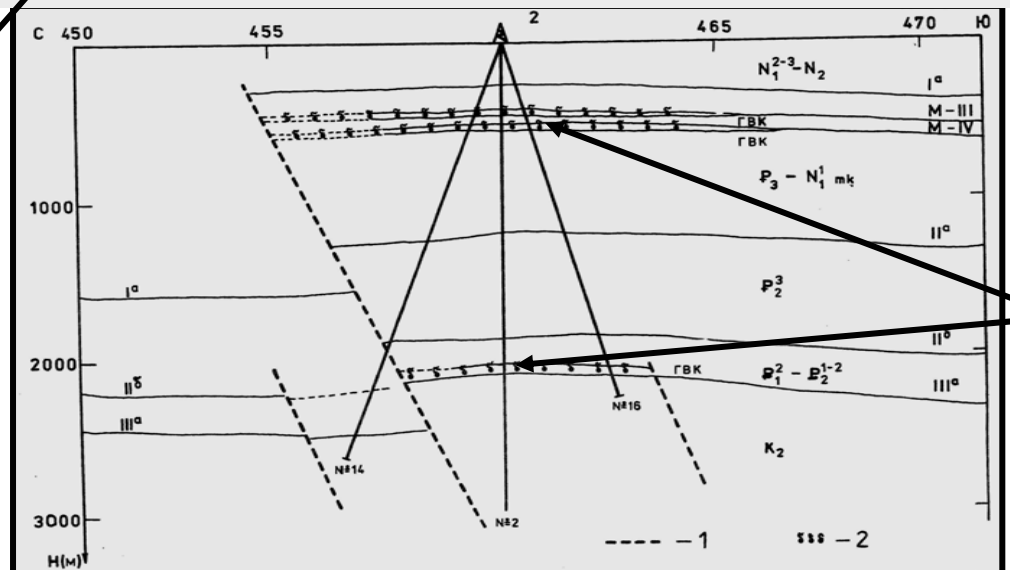


Figure 11.



Field record (isochrone section), **moving vessel, real time processing.**

Figure 12



The Black Sea, Golitsino field:

- pays

Golitzina field, record with moving vessel and real time processing

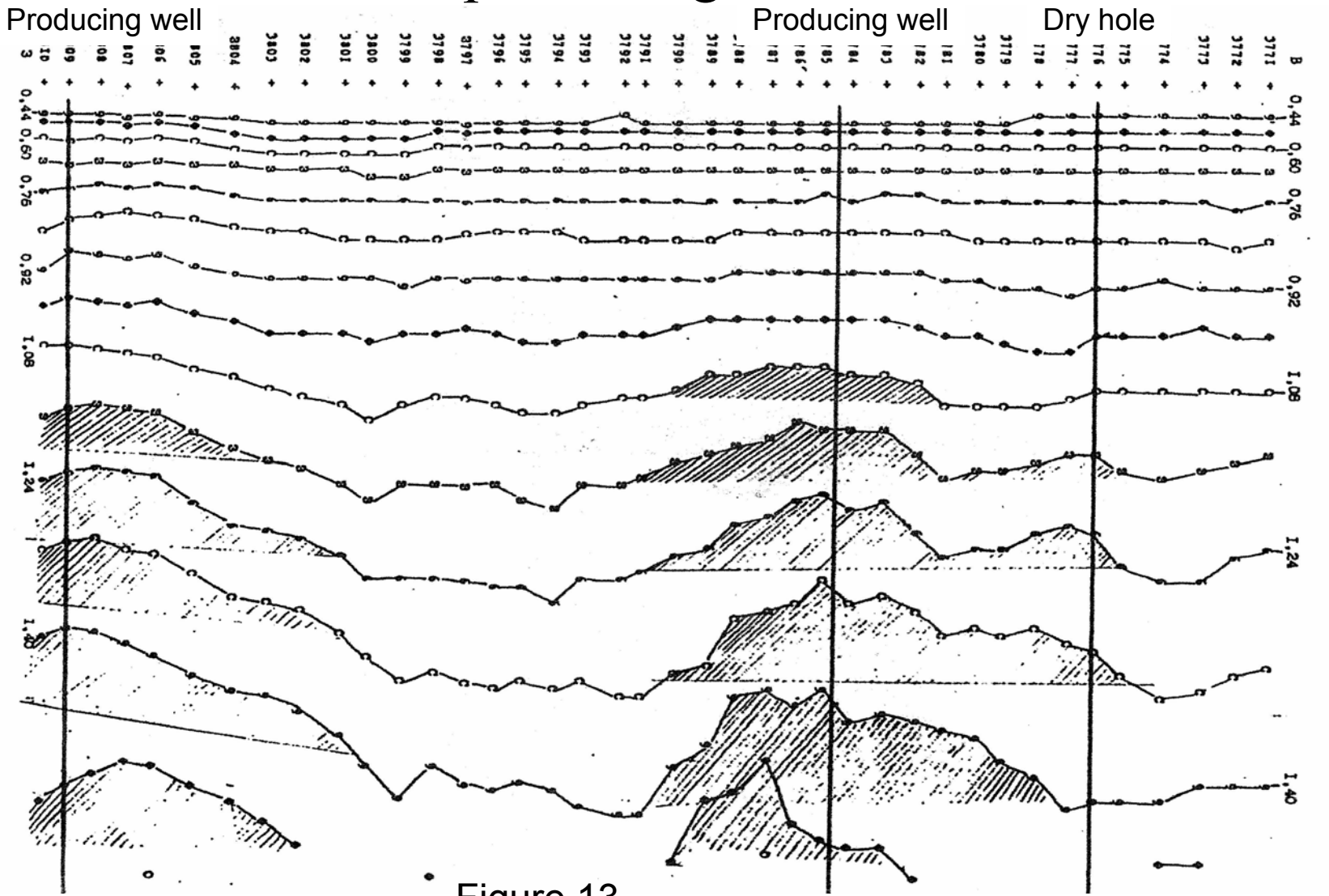


Figure 13.

Cross section near producing wells 2 & 4 and dry hole 1

Red = strong BSE signal; blue = weak signal
red correlates with known hydrocarbon fields at 2200 m deep

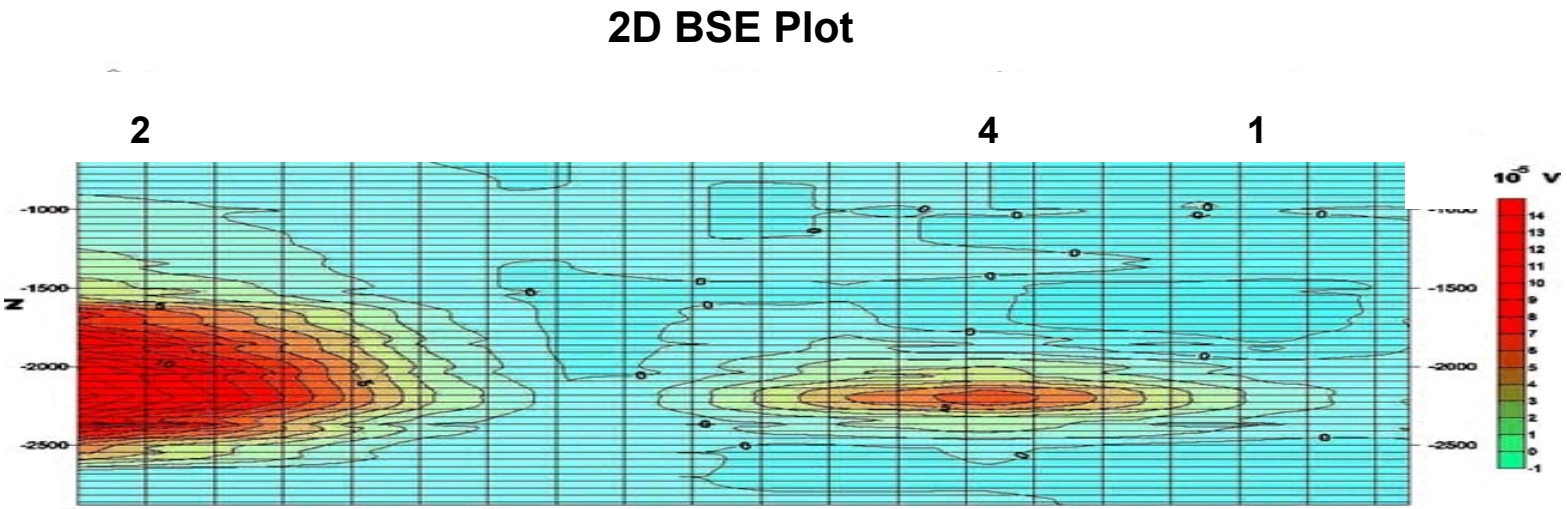


Figure 14.

15. ***An example of commercial survey*** is shown in Fig. 15. BSE had outlined only one field (shown in dark red), and the well drilled inside this contour discovered the largest gas field in the Black Sea (off Ukraine). Other six holes were drilled based on conventional data turned out dry. About 2000 km of observation line with 2D offshore system was carried out on the area shown partly below.

Results objectivity:

All field BSE records were received with moving vessel and real time processing, so nobody can change or reprocess the data. During recording all characteristics of on-board and out-board equipment remain constant.

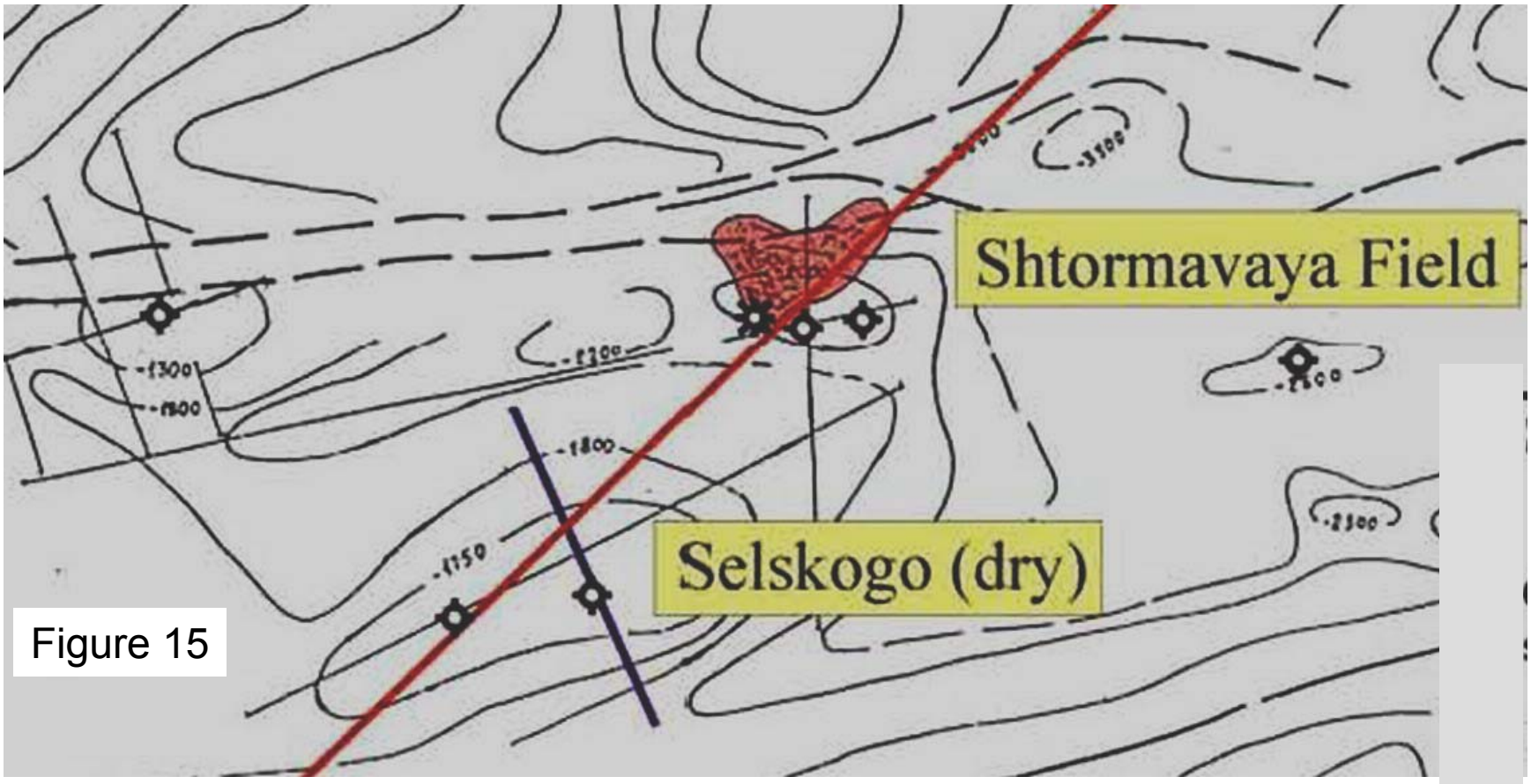


Figure 15

BSE prospect at a depth of about 6,750 ft

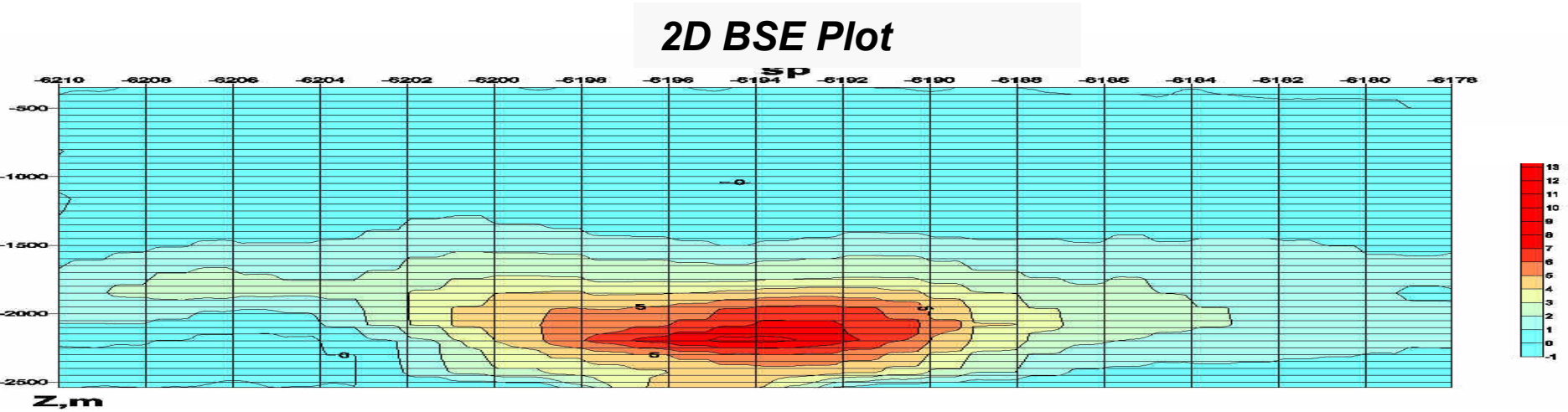


Figure 16

3D BSE prospect

(hydrocarbons are concentrated at depth 6,750 ft)

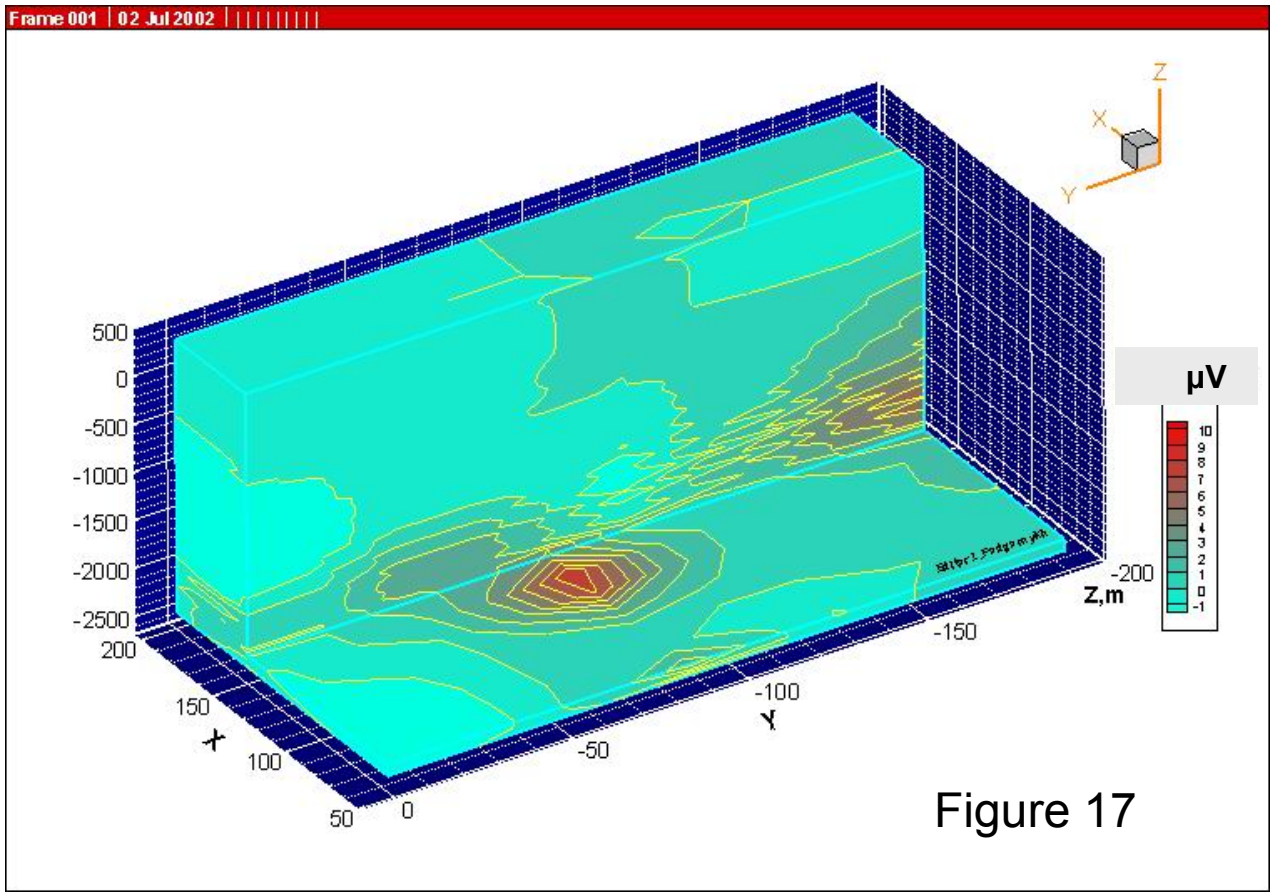


Figure 17

16.Selskogo Prospect, Black Sea, field record with moving vessel , real time processing

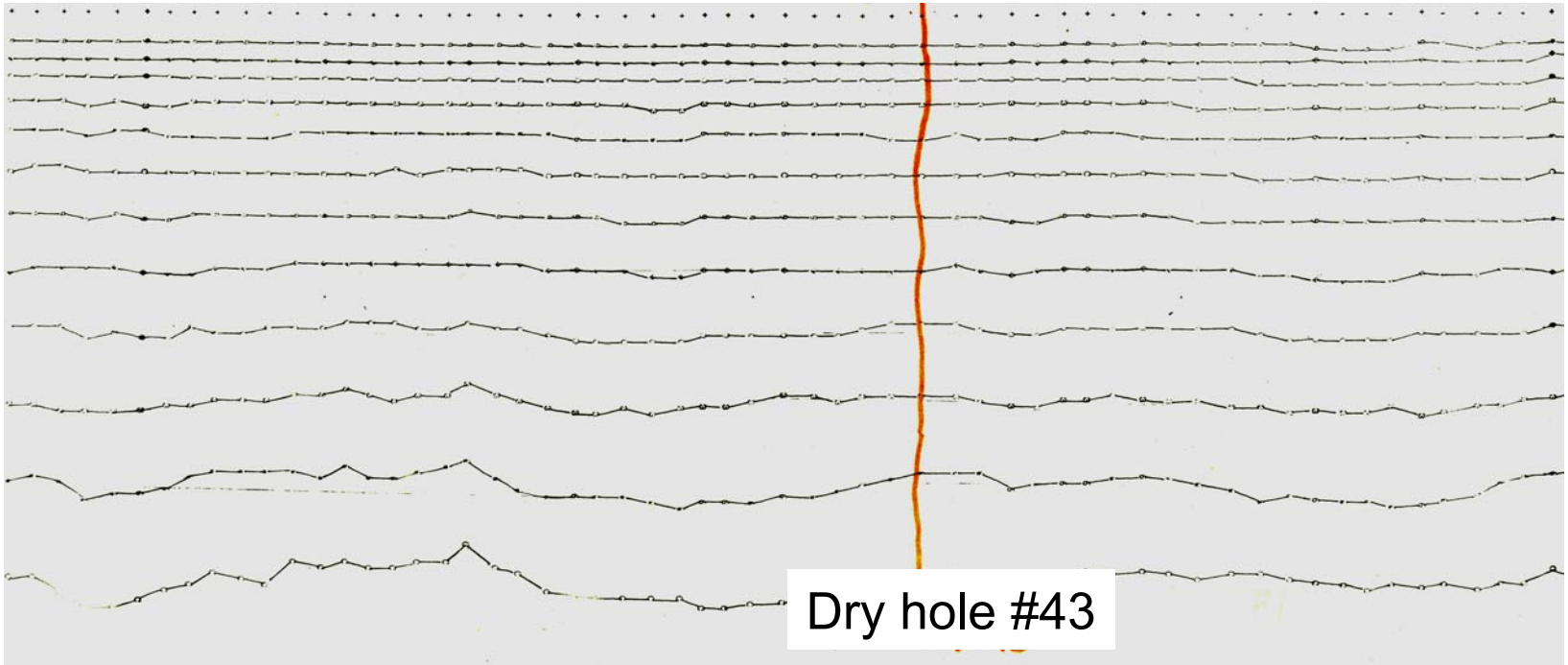


Figure 18.

Selskogo Prospect, field record

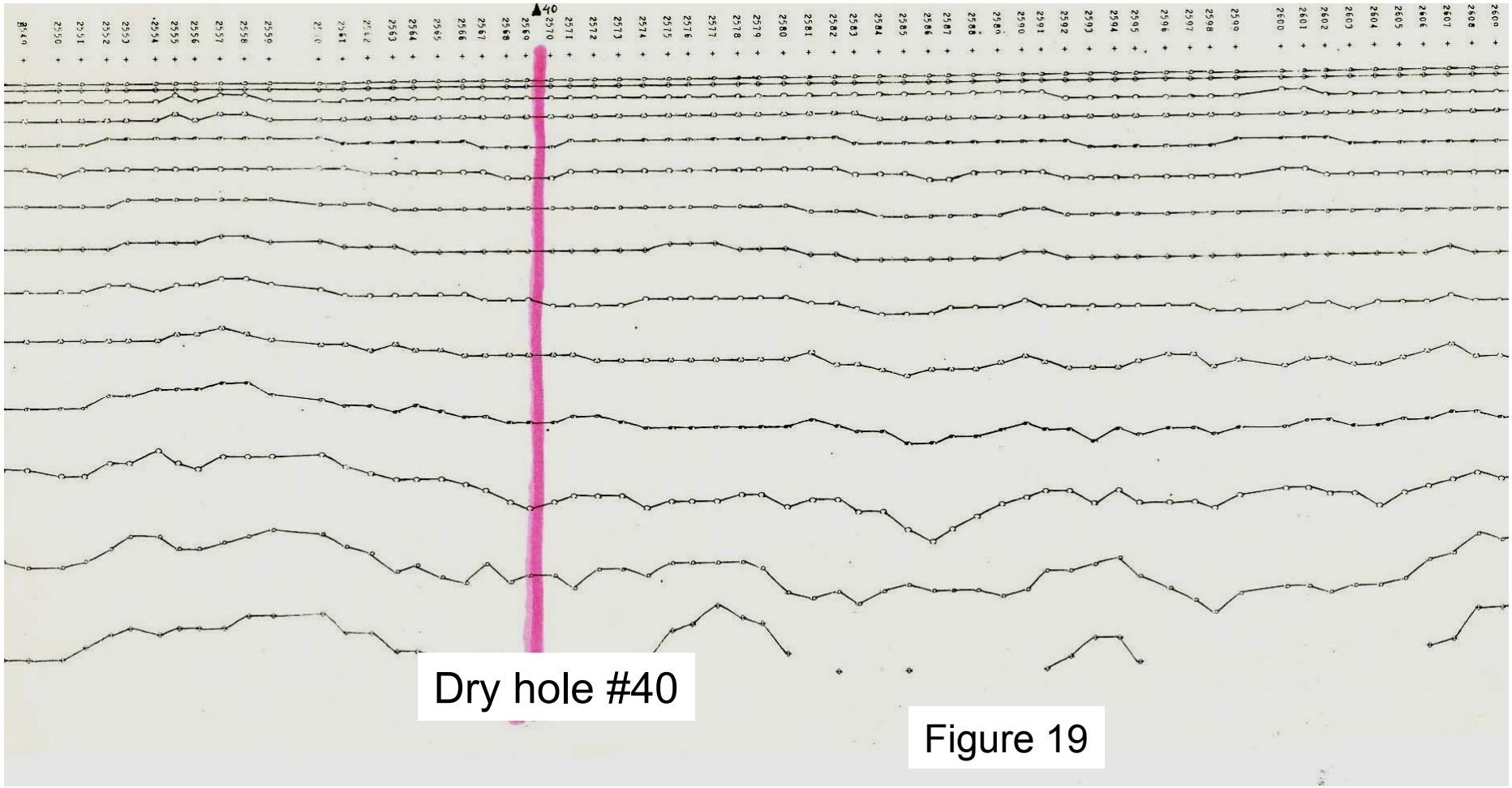
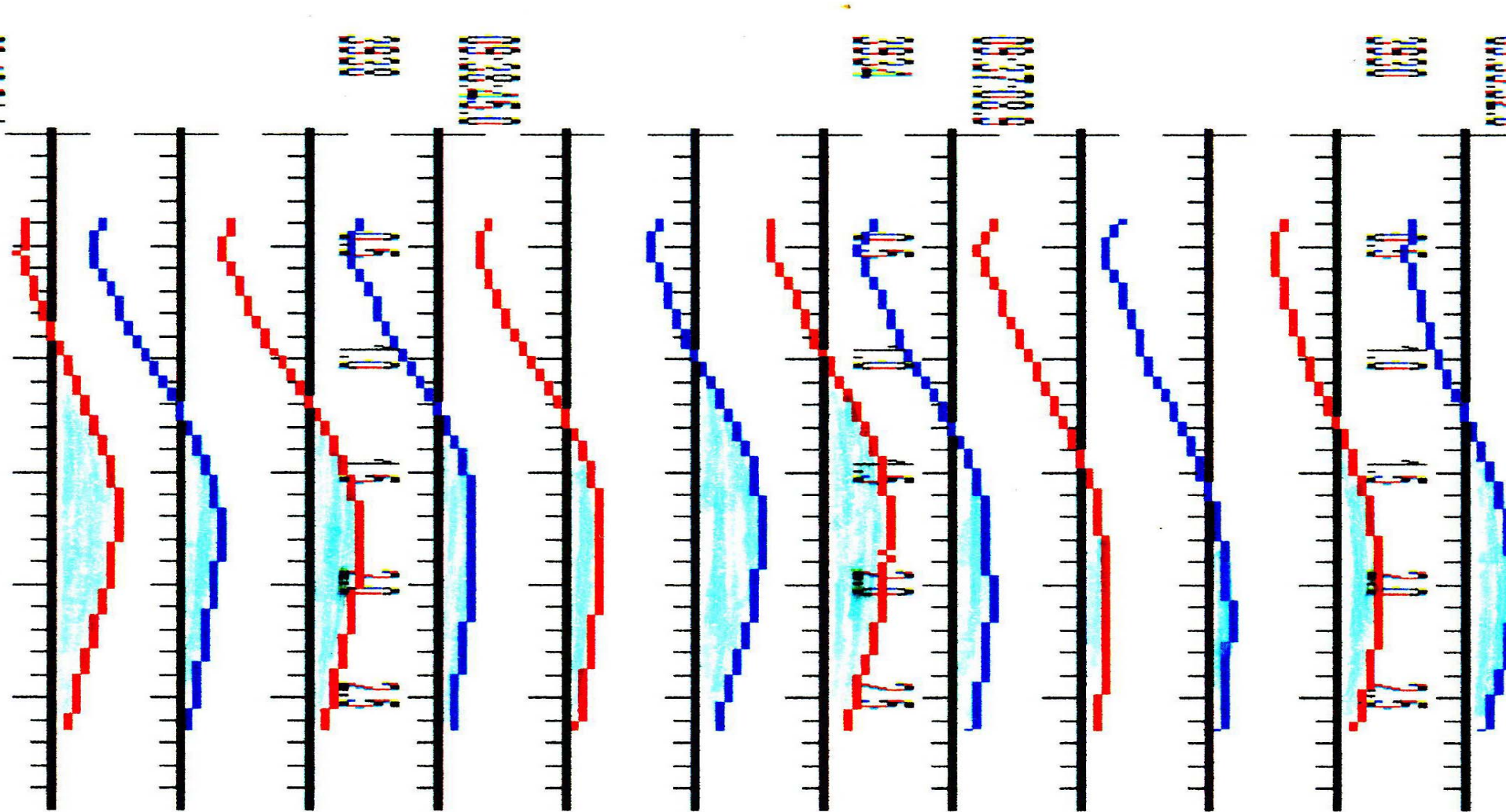


Figure 19

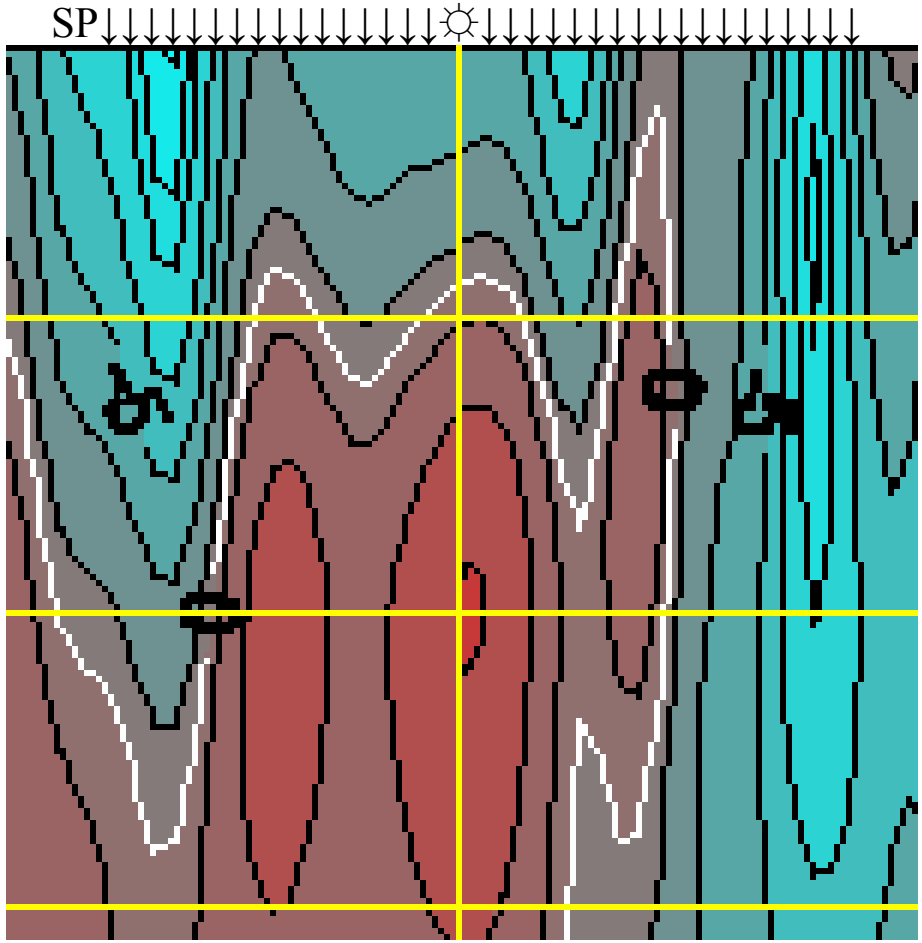
17.Field record with moving vessel over pay with 15,000 ft depth

Figure 20.



BSE over gas field with depth of about 15,000 ft

Figure 21.



- numbers are BSE response in microvolts,
- red spot is 7-10 microvolts
- white line is zero microvolts

18. *Geological Results:*

1. Altogether about 2000 miles were recorded with BSE technology on the Black and the Barents Seas, as well as in the Gulf of Mexico.
2. BSE recommendations were confirm in 21 cases. Two recommendations were wrong.

Result Objectivity:

1. All field BSE records were received with moving vessel and real time processing. Nobody can change or reprocess these records.
2. During the record all tool characteristics remain constant.
3. Control records are carried out periodically on selected observation lines.

19.Two ways to find oil

As is known, industry discovery rate is 25% on average. It means one discovery in four drilled wells. BSE provides 75% rate or three discoveries in four. It is illustrated in Fig. 22. This figure shows two ways to find oil. The first way uses conventional methods (seismics, etc.) This way gives one discovery in four drilled well. It means that three wells go to waste and about two new discoveries are lost.
The second way uses BSE technology and provides three discoveries in four wells for the same time and money. Obviously BSE can verify seismic prospects too.

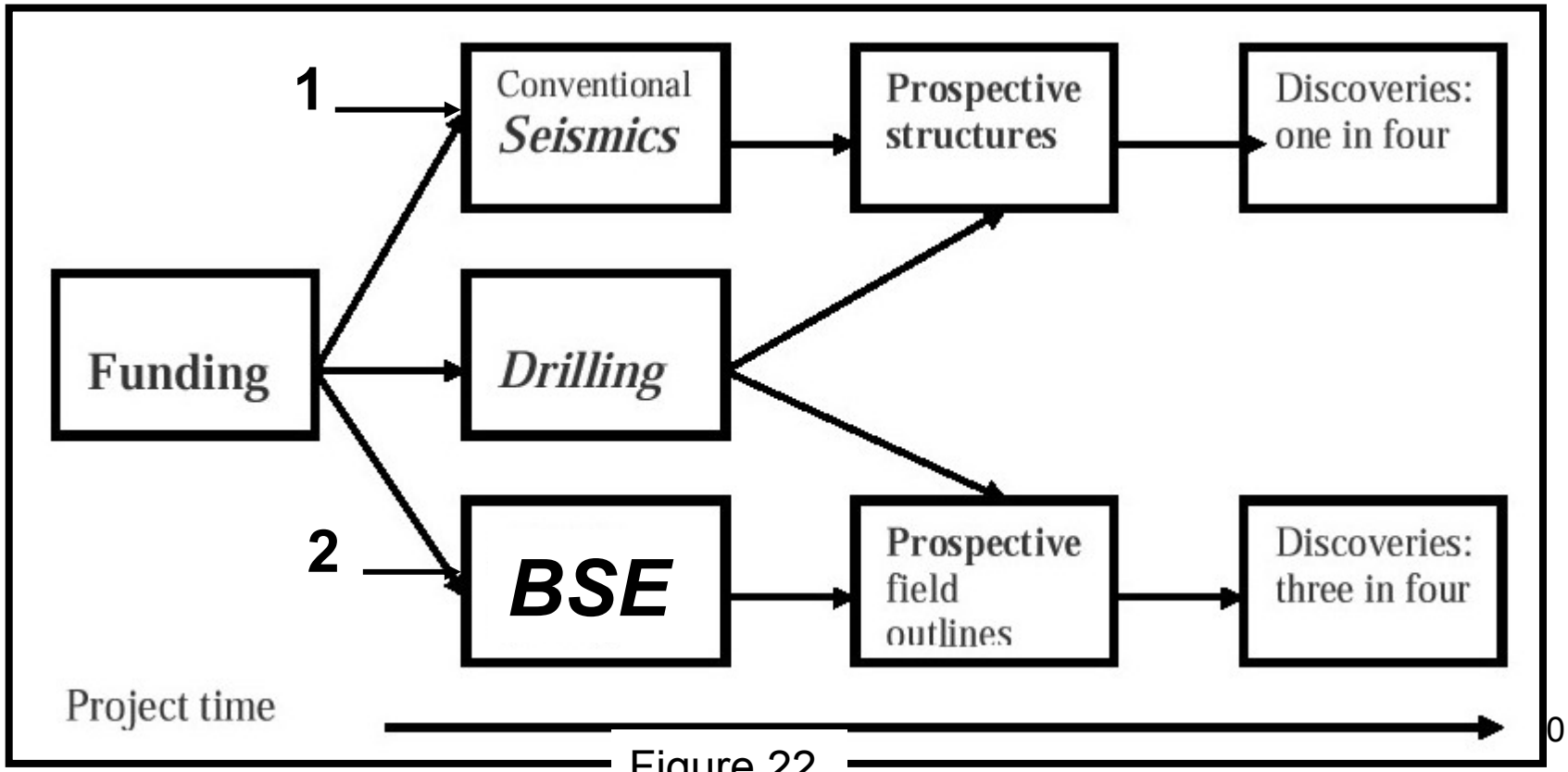


Figure 22.

20. Glossary (by NPD, etc.)

Discovery rate: The technical discovery rate is the relationship between the number of technical discoveries and the number of wildcat wells. The economic or commercial discovery rate is the relationship between the number of discoveries that are developed or are clearly profitable today and the number of wildcat wells.

Discovery: A petroleum deposit, or several petroleum deposits combined, discovered in the same well, and which testing, sampling or logging have shown probably contain mobile petroleum. The definition covers both commercial and technical discoveries. The discovery receives the status of a field, or becomes part of an existing field when a Plan for Development and Operation (PDO) is approved by the authorites (see Field).

Isochrone – a line on a map or diagram connecting places from which it takes the same time to travel to a certain point.

Isochrone section – 2D image of isochrone lines, for example lines of intensity of electromagnetic (EM) field along observation line.

Exploration well: A well drilled to prove a possible deposit of petroleum or obtain information to delimit a discovered deposit. The term covers both wildcat and appraisal wells.

Field: One petroleum deposit, or a number of concentrated petroleum deposits, covered by an approved Plan for Development and Operation (PDO), or for which exemption from such a plan has been granted.

Observation well: Production or test production well used to measure specific well parameters.

Petroleum: The term for all liquid and gaseous hydrocarbons found in a natural state in the substrate, and also other substances recovered in connection with such hydrocarbons.
Petroleum deposit: An accumulation of petroleum in a geological unit, delimited by rock types at structural or stratigraphical boundaries, contact surfaces between petroleum and water in the formation, or a combination of these, such that the petroleum concerned is everywhere in pressure communication through liquid or gas.
Play: A play is a geographically demarcated area where several geological factors occur together so that producible petroleum can be proven. These factors are: 1) Reservoir rock, which is a porous rock where petroleum can be preserved. Reservoir rocks to a specific play will belong to a given lithostratigraphical level. 2) Trap, which is an impermeable rock or a geological structure enveloping the reservoir rock so that the petroleum is retained and accumulates in the reservoir. The trap must be formed before the petroleum stops entering the reservoir. 3) Source rock, which is shale, limestone or coal containing organic material that can be converted into petroleum. The source rock must also be mature, that is to say the temperature and pressure must be appropriate for petroleum actually to be formed, and there must be a migration path enabling the petroleum to move from the source rock to the reservoir rock. A play is confirmed when producible petroleum is found in it. The production does not necessarily have to be profitable. If no producible petroleum has yet been found in a play, it is unconfirmed.
Probability of discovery: Describes the feasibility of proving petroleum in a prospect by drilling. The probability of discovery results from multiplying the probabilities of the existence of the play, the presence of a reservoir, a trap, the migration of petroleum into the field and the preservation of petroleum in the field (see Play).
Probability of discovery by BSE Technology: Describes the feasibility of proving petroleum in a BSE field outline by drilling. The probability of discovery results from outline BSE response intensity. Usually the probability is near 75%.
Production well: Collective term for wells used to recover petroleum, including injection wells, observation wells and possible combinations of these.

Reserves: Remaining, recoverable, saleable volumes of petroleum in petroleum deposits which the licensees have decided to recover and the authorities have approved a PDO or granted exemption from a PDO. Reserves also include volumes of petroleum in deposits which the licensees have decided to recover, but whose plans have not yet been approved by the authorities in the form of a PDO or exemption from a PDO.

Seismic (geophysical) investigations: Seismic profiles are acquired by transmitting sound waves from a source above or in the substratum. The sound waves travel through the rock layers which reflect them up to sensors on the seabed or at the surface, or in a borehole. This enables an image of the geology in the substratum to be formed. Seismic mapping of the Norwegian continental shelf started in 1962.

Stratigraphy: The succession of beds of rock that are deposited on one another (= lithostratigraphy) or the age of the various beds of rock relative to geological time periods (= chronostratigraphy).

Undiscovered resources: The volumes of petroleum that, at a given moment in time, are estimated to be recoverable from deposits that have still not been discovered by drilling.

Well: A hole drilled to find or delimit a petroleum deposit and/or produce petroleum or water for injection purposes, inject gas, water or another medium, or map or monitor well parameters. A well may consist of one or more well paths and may have one or more terminal points.

Wildcat well: An exploration well drilled to find out whether petroleum exists in a possible deposit.

“Wildcat exploration”: Exploration using wildcat wells.