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# The Impact of Offshore Seismic Studies on the Marine Environment

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***ABSTRACT :*** *The exploitation of oil and gas resources in the Black Sea is a desideratum of the Romanian state, both to ensure the energy security of Romanian consumers and to provide economic competitiveness on the European market.*
*Following the analysis of geophysical studies carried out over the years (1969-2019), as well as research and exploitation drillings, it was found that there are free gas deposits in the Eocene, Albian, Oligocene and Lower and Upper Cretaceous (Senonian).*
*But in order to achieve a development of the oil field and to ensure a safety in its exploration, it is recommended to restore the geophysical research in 3D (because in the vast majority of previous research technologies were used that did not ensure a safe interpretation of these results).*
*The present study presents the effect of geophysical research on the marine environment, accepting also the measures that must be taken to reduce these pollutions necessary for the development of deposits of useful substances.*
***KEYWORDS oil, offshore, seismic, environment***.

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## I. INTRODUCTION

Considering, on the one hand, stopping the decline of domestic hydrocarbon production, and on the other hand, access to modern technologies for the discovery of new resources, the Romanian government, through the National Agency for Mineral Resources, organized several rounds of tenders, for concession to explore offshore and onshore perimeters. As a result of these auctions, the concessioned areas were leased, specialized companies, which have at their disposal the financial funds and the necessary technologies for the development of hydrocarbon prospecting and exploration activities.

The oil and natural gas industry cannot develop without the support of the research sector, respectively the seismic prospecting.

Seismic prospecting is a very complex activity, which aims to investigate the basement through its own working method, necessary to discover productive geological structures and various relationships between already known structures. Lately, more and more subtle traps are being sought in areas with complicated geology, which requires more attention both in the design and execution of procurement works, and in the processing and interpretation of the information collected.

In this field of activity, each project brings to attention a new geological problem, specific to the researched area. From the point of view of the geologist / geophysicist, this means obtaining a correct and clear image of the subsoil in the investigated area, especially at the level of the geological objective pursued. Solving geological problems through the seismic method starts from collecting seismic information which has the role of ensuring the interpretation of the geological environment, seen as an indeterminate system, with many unknowns.

The interpretation of the 2 D seismic data collections from the Offshore marine deposits, made in 1980, 1990, 2000 corroborated with the reprocessing data from 2011-2012 and with the geological information

obtained from the drilled wells identified several Offshore geological structures that contain reserves of crude oil and associated gas or natural gas may be economically exploited [1].

Free gas saturations in the Eocene, Oligocene and Upper Cretaceous (Senonian) have been highlighted.

Because the quality of old seismic data in the database is quite poor and seismic lines are typically recorded at a distance ranging from 1 km to over 4 km, it is necessary to exploit marine deposits in the Black Sea. carry out an extensive 3 D seismic acquisition program.

Seismic prospecting works include the following phases:

a. the data acquisition phase which consists in carrying out measurements on the entire area proposed for geophysical investigations;

b. the phase of processing and interpretation of the obtained data and the elaboration of the reports of presentation and interpretation of the obtained data

## II. CARRYNG OUT THE WORKS

The development of marine seismic prospecting works involves the completion of stages, so as to achieve a collection and evaluation as quickly as possible and at the highest possible standards of geophysical data, minimizing downtime.

a. In the initial stage of pre-mobilization, a project director is delegated, who will coordinate the development of all phases of the contract and will keep a close relationship with the executor of the works, in all stages of the project. Also during this stage, a team leader will be appointed, who will be responsible for the investigation operations carried out on board the prospecting vessel, having previously established a plan for carrying out the proposed investigations.

b. Another step will cost in mobilizing equipment and staff. At this stage, the equipment necessary for the works will be placed on board the prospecting ship, the specialists designing the investigation network using the coordinates communicated by the project owner. At the end of the mobilization stage, the testing and calibration stage of the equipment will be performed.

The prospecting vessel will also move to the work area where the source calibration and streamer balancing will be performed.

c. Seismic acquisition is the stage of seismic data collection.

e. The demobilization stage involves the withdrawal of ships from the work area, after the investigations.

For the good development of the prospecting works, during their execution in the work perimeter, the prospecting ship will be accompanied by an auxiliary ship, which has the role of "chaser boat" - ensures the rear (end of the streamer) in position For work.

## III. DESCRIPTION OF THE DATA ACQUISITION PHASE

The area proposed for seismic investigations is covered by profiles, arranged in a grid.

The vessel with which the prospecting works are carried out moves along each profile with an adequate speed to obtain recordings with optimal resolutions.

The seismic source (airgun) generates a series of acoustic signals, which propagate in the geological substrate. The acoustic signals are reflected by the boundaries between the geological layers encountered, being received by hydrophones (underwater microphones placed on a seismic cable - streamer), and the recordings thus obtained are stored and processed using specialized equipment on board the ship, to be subsequently processed. and interpreted geologically.

Seismic prospecting consists in the use of a specialized vessel, which will perform the following activities:

- the emission of seismic waves by a seismic source, by producing an initial impulse (due to the violent expansion of a volume of compressed air), which will result in a series of pulsations of decreasing amplitude with each oscillation;
- the reception of the waves reflected by the encountered geological layers and the marking of the reception time of these waves by the hydrophones;
- recording the reception time of seismic waves and the reception angle;
- data processing, by analyzing the response time of seismic waves and the response angle, depending on the nature of the layer traversed by the wave;
- handing over the data to the project owner and correlating the seismic data with the geological ones

## IV. THE EFFECTS OF NOISE ON MARINE ORGANISMS

After describing the technical parameters of sound waves (frequencies, amplitude, spectral pressure) that have seismic sources (air cannons) used on the ship, it can be seen that the most vulnerable organisms in the perimeter of the seismic works are the three species of marine mammals living in the Black Sea - dolphins

Tursiops truncatus, Phocoenaphocoena and Delphinus delphis - because they emit and receive sounds in the frequency band specific to seismic sources used in the acquisition [1,2,3].

As for the seal Monachusmonachus, another species of marine mammal in the Black Sea, it has as preferential habitat the area of Cape Kaliakra (which is quite far from the Offshore exploitation area in Romania).

Reading data from the literature, it is shown that, depending on the intensity of the source, the distance the animal is from the source and the duration of exploitation, the effects of noise on marine mammals are:

- direct: bodily and / or auditory traumas, going up to chronic effects and stress effects, manifested by the decrease of the individual's viability, increased vulnerability to diseases, increased potential for the impact of cumulative negative effects, noise awareness, etc. ;
- indirect: reducing food availability, increasing vulnerability to predators.

Given the importance of marine mammals for both the economy of the marine system and for humans, special instructions are in place on board the ship with the aim of minimizing the acoustic effects on marine mammals which provide for:

- recognition of the perimeter, before starting the works on each profile; the works will start only if there are no animals within a radius of 500 m in the area;
- the procedure of progressively increasing the detonation pressure in the first 30 minutes of prospecting, the so-called "soft start".

Considering the characteristics of the sounds emitted during the prospecting, in collaboration with the sound reception capacities of the three dolphin species, with the frequency ranges in which they emit, but also with the special instructions for activating the air cannons, it is concluded that [4,5,6]:

• the respective seismic prospecting works will not produce major disturbances in the sound activity of dolphins, the only species in which more important disturbances may occur, but only in the case of low frequency sounds, is Tursiops truncatus;

• the cycles of radiolocation used by dolphins for guidance will not be affected either.

The only possible impact of airborne noise on dolphins would be the temporary removal from the area.

## V. EQUIPMENT USED

Seismic research consists of the use of a vessel specialized in such activities that will perform the following activities:

a. Emission of seismic waves emitted by the artificial source by air jet firing (fig.1, fig 2),
b. Reception of waves and especially marking of the reception time of these waves (fig 2, fig 3),
c. Recording the seismic wave reception time and the reception angle (fig 3),
d. Data processing by analyzing the response time of seismic waves and especially the response angle, depending on the nature of the layer pierced from where.

## VI. CONCLUSION

***Effects on species of benthic invertebrates and fish.***

The literature shows that sounds specific to seismic prospecting can cause trauma only in the early stages of development of benthic invertebrates and fish (eggs, larvae and juveniles) and only in an extremely small radius.

Given the depth of the water in the area of geophysical research (60-1100 m) and the depth at which the loads from the firing cannons are launched (as close as possible to sea level), it is estimated that the projected works have no effect on demersal fish species.

As for pelagic fish species, the physical effects of the acoustic wave on fish depend on the maximum pressure, the duration of the pressure increase, the decomposition time of the pressure wave.

The air guns used, whose maximum acoustic intensity is 260dB, have the role of reducing the noise with the distance from the source. This noise can have deadly effects on fish species in the area only at distances of less than 5 m from them.

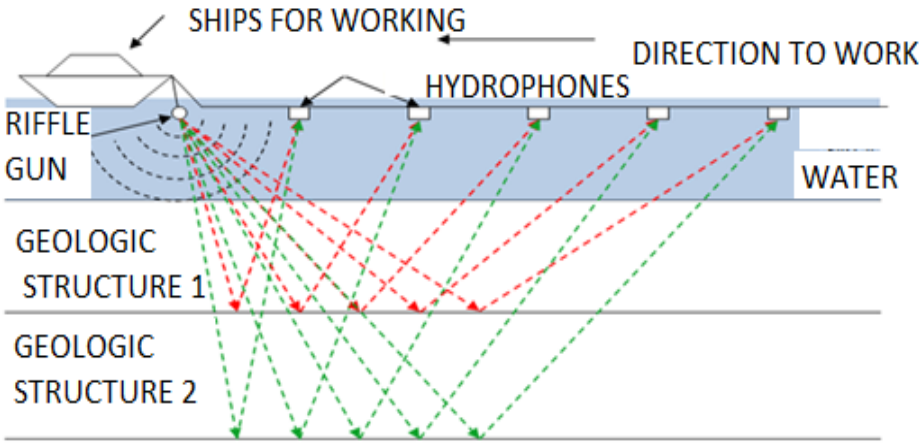


**Fig.1. Geophysical data collection method**

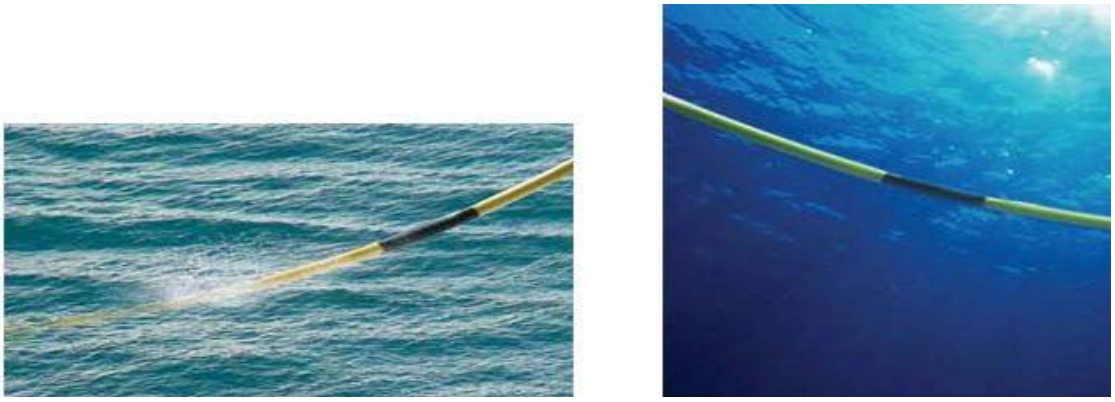

**Fig.2. Seismic signal reception cables**

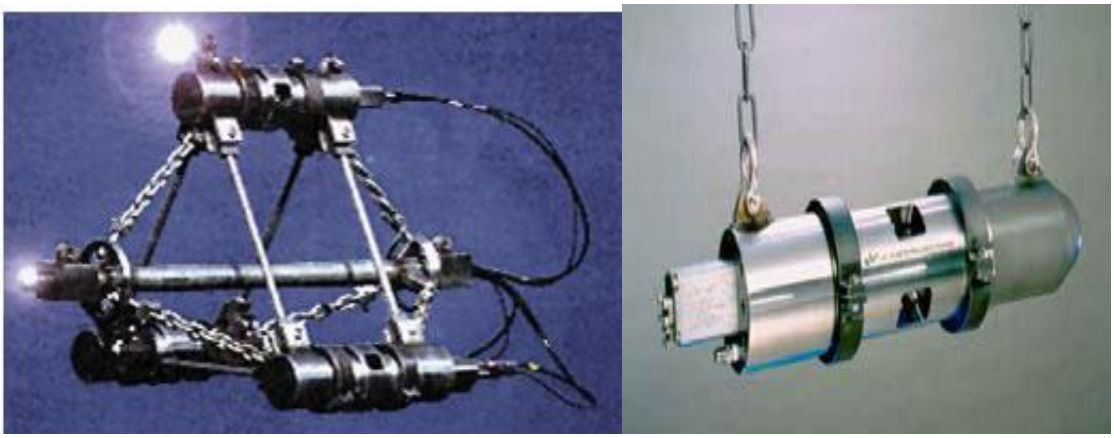

**Fig.3. Air blowing systems**

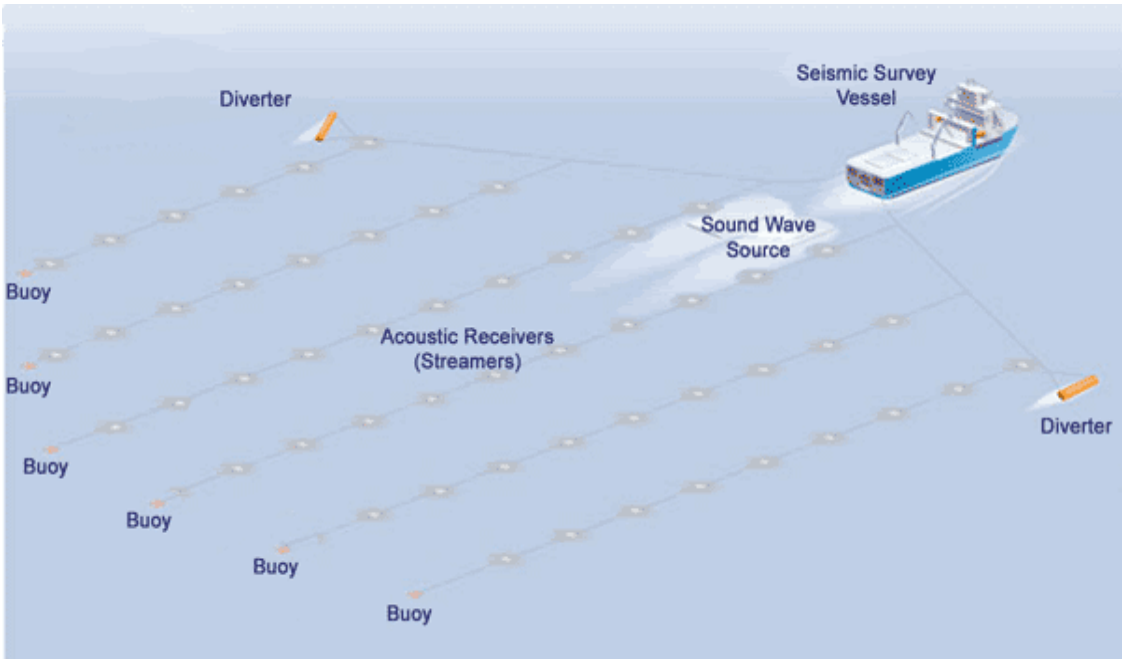


**Fig. 4. How to collect geophysical data**

An experimental study, showed a mortality of 0.018%, in the case of the most unfavorable scenario, negligible compared to the average mortality rate of 10% per day.

The only documented effects with certainty are the behavioral effects of the fish in the area, namely the temporary removal from the area, with a reduction in fishing during the prospecting period and about 5 days after their cessation.

After this interval, the local fish stocks gradually recover, quickly reaching the previous values.

Given the duration of the works of about 1 month and the fact that the prospecting area is not an intense fishing area, it is estimated that the impact of the works on fishing activities will be minimal and limited in time.

***Effects on planktonic organisms***

Planktonic organisms of animal and plant origin are the only ones on which the effects of noise produced by seismic prospecting can be lethal. It is estimated, based on data from the literature, that these mortality will be lower than natural mortality, and their effects will be quickly annihilated by diffusion and mixing processes, and dead animals will be replaced quickly due to their short life cycles.

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