



Crna Gora
Ministarstvo ekonomije

MONTENEGRO OFFSHORE HYDROCARBONS
EXPLORATION AND PRODUCTION PROGRAM

- DRAFT -

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1 INTRODUCTION

1.1 Hydrocarbons exploration background in Montenegro

The first written record of oil dates back in 1865 when the English Consul in Shkodra expressed interest in “oil coming out of the Crmnica rocks near the village of Sotonići”.

The first analysis related to oil exploration in Crmnica was published in 1882 by certain Mr. Schwartz. Still, the first serious exploration was yet to take place in 1914 when the National Assembly of Montenegro adopted the Law on Exploitation Concession. The concession was granted for the period of 50 years to a Dutch entrepreneur G. J. Kokare. However, as we are aware, in that year the “great war” began so the endeavour was terminated even before it actually started.

The first well in the area of Crmnica dates back in 1922 and it was at 215m of depth where nothing significant was discovered.

According to the Decision by the Yugoslav Directorate for Oil and Gas the company “Nafta Crna Gora” (Montenegro Oil) was established in 1949. The works commenced in 1950 in the area of Ulcinj, and expanded to include Buljarica in 1951 and Crmnica in 1952 as well. By the time of 1966 (when the company Nafta Crna Gora ceased to exist due to financing changes) there were 16 wells. The deepest well was located in the area of Ulcinj (the well named UK-1) and it was 5,300 m deep. Oil was discovered in this well. In the area of Crmnica the well C1 was drilled to 2,200 m of depth when an accident took place, and another well C2 reached the depth of 1,270 m.

Exploration results were published 6 years later, i.e. in 1972 when an agreement was concluded between the American Company “Butte Gas and Oil” and Jugopetrol Kotor. According to the data from the wells in the area of Crmnica Triassic limestone is located at the depth of around 1,500 m, while in the area of Ulcinj and Buljarica at the depth of around 5,000 m. It should be noted that the well Buljarica 5 reached the depth of 4,444 m, and yet the Triassic limestone was not found.

Based on geological maps and the position of Triassic limestone which is on the sides covered by Jurassic-Cretaceous limestone, the Director of Chevron Exploration Company, Mell Boys claimed in 1975 that the area of Crmnica was ideal for drilling. However, different administrative obstacles prevented this Company to get engaged in exploration.

Naftagas from Novi Sad concluded an agreement on exploration of the coastal area of Montenegro in 1983. Seismic surveys in the profile length of 600km were carried out at that time too.

1.2 Legislative framework and enabling regulations

The key Montenegrin laws relevant for hydrocarbons exploration and production are as follows:

- The Law on Hydrocarbons Exploration and Production (OGM 41/10 and 10/11) is harmonised with the EU Directive (94/22/EC). Having adopted it, Montenegro provided the possibility for the future hydrocarbons production to be carried out in a transparent way and in accordance with the best international practice.
- The Law on Hydrocarbons Tax (OGM 31/14). The Parliament of Montenegro adopted the Law on Hydrocarbons Tax on 16 July 2014, and introduced a new fiscal duty and created the policy for taxation of profit from oil and gas production, as well as the profit from construction and use of facilities and ancillary equipment for production, delivery and transport of oil and gas. The Parliament also adopted several amendments of which the most important one is related to the tax rate level amounting to 54%.

The Law on Hydrocarbons Exploration and Production created the conditions for great investments. The legal assumptions have been established for energy development and competitive conditions in hydrocarbons exploration and production, whereas the special emphasise is placed on optimisation in exploitation of mineral resources, while adhering to the principles of protecting national interests of Montenegro and ensuring security and stability of investments and business for investors. In the course of drafting the mentioned regulations considered were the long-lasting world practice accepted by many countries that are successful in the production of hydrocarbons, as well as the standpoints of the European Union countries related to foreign investments.

Based on the Law on Hydrocarbons Exploration and Production, the Government of Montenegro adopted the following:

- Decree on the method of relinquishment of blocks and access of third parties to upstream facilities (Official Gazette of Montenegro, no 40/11, 56/13), which regulates the detailed terms, conditions and methods of relinquishment of the allocated area of the block, terms and conditions for access of third parties to facilities and upstream piping network, operation of the upstream pipeline network, and terms and conditions for decommissioning and removal of the facilities;
- Decree on the methods of calculation and payment of fees for oil and gas production (Official Gazette of Montenegro, no 14/14), which regulates the amount, criteria and methods of payment of the annual fee for the area used by the concessionaire for the production of hydrocarbons under the concession contract, the criteria for determining the amount, methods of calculation, the base documentation for calculation, and other

issues of importance for the calculation of fees for the produced oil and gas for the extracted hydrocarbons on monthly level;

- Decision on designation of blocks for hydrocarbons exploration and production (OGM 17/11, 51/14), which specifies blocks for exploration and production of hydrocarbons based on the coordinate network (GRID system) with dimensions 12 arcmin in East-West and 10 arcmin in North-South.
- Decision on designation of blocks for award of hydrocarbons production concession contracts in the offshore of Montenegro (OGM 42/12), which specifies blocks to be awarded for the hydrocarbons production concession contracts in the offshore of Montenegro.

In accordance with the provisions of the Law on Hydrocarbons Exploration and Production, the Ministry of Economy drafted and adopted the following:

- Rulebook on conditions for drilling and construction of facilities for exploration and production of hydrocarbons (Official Gazette of Montenegro, no 7/14), which defines procedures for the drilling of wells, the design and construction of facilities for exploration and production of hydrocarbons, preparation and content of drilling plans and programs, reporting on the drilling operations, sampling and delivery of samples;
- Rulebook on the hydrocarbons development and production (Official Gazette of Montenegro, no 7/14), which regulates the detailed content of hydrocarbons development and production programs, content, methods and deadlines for submission of applications for approval of production testing, approval for hydrocarbons production, and production reports.

On the other side, the Ministry of Sustainable Development and Tourism, pursuant to Article 60 of the Law on Hydrocarbons Exploration and Production adopted the following:

- Rulebook on the conditions for environmental protection during the hydrocarbons operations (Official Gazette of Montenegro, no 60/12), which defines the measures to be undertaken during the hydrocarbons exploration and production activities, aiming to protect the environment.

1.3 Adriatic Hydrocarbons Exploration and Production Contracts

The subject matter of a hydrocarbons exploration concession contract may be the right to geological, geophysical or other detailed exploration of the crust, save the drilling of wells, aimed at establishing of structural and tectonic features of the environment and appraisal of

the presence of hydrocarbons. The contract is awarded after the completed Tender procedure, for the period of two years.

The objective of this contract lies in the intent of the state to enhance the knowledge regarding the offshore parts that have not been explored sufficiently. This contract is not exclusive, which means that it may not be converted into a hydrocarbons production concession contract.

Based on the award of the of the hydrocarbons production concession contract the company acquires the right to hydrocarbons production in the offshore of Montenegro. The contract is awarded based on the completed Tender procedure.

The hydrocarbons production concession contract is divided in two phases, as follows:

- Exploration phase
- Hydrocarbons production phase

The exploration phase together with the reserve verification phase may take maximum six years for onshore blocks, or seven years for offshore blocks. Based on the request by the concessionaire and only in the cases specified by the law, the exploration phase may be extended by up to two years.

Hydrocarbons production phase begins from the day of commencement of the first extraction of hydrocarbons from the reservoir and lasts until the expiry of the deadline envisaged by the production concession contract, or maximum up to 20 years. Still, the production phase may, at request by the concessionaire, be extended maximum by the half of the period of the production phase specified by the production concession contract, i.e. by 10 years maximum.

The decision on the award of the hydrocarbons exploration contract is to be made by the Government of Montenegro, while the decision on the award of the hydrocarbons production contract is to be made by the Parliament of Montenegro, at proposal by the Government.

The hydrocarbons production concession contract may be concluded with one concessionaire for the area covering maximum 50% of the total area of blocks designated for production.

The hydrocarbons exploration contract or hydrocarbons production contract may cover several blocks, provided that they are physically connected into a single whole.

2 EXPLORATION AREA

Pursuant to Article 8 paragraph 3 of the Law on Hydrocarbons Exploration and Production, the Government of Montenegro, at the session held on 3 March 2011, adopted the Decision on designation of blocks for hydrocarbons exploration and production. This Decision

designates blocks for hydrocarbons exploration and production, based on the coordinate network (GRID system) with the dimensions of 12 arcmin in East-West and 10 arcmin in North-South.

The Government of Montenegro also adopted the Decree on the method of relinquishment blocks and access of third parties to upstream facilities, which regulates the detailed terms, conditions and methods of relinquishment of the allocated area of the block, terms and conditions for access of third parties to facilities and upstream piping network, operation of the upstream pipeline network, and terms and conditions for decommissioning and removal of the facilities.

Pursuant to Article 17 of the Decree on the Government of Montenegro (OGM 80/08) in conjunction with Article 2 of the Decision on designation of blocks for hydrocarbons exploration and production (OGM 17/11), the Government of Montenegro adopted the Decision on designation of blocks for award of the hydrocarbons production concession contracts in the offshore of Montenegro.

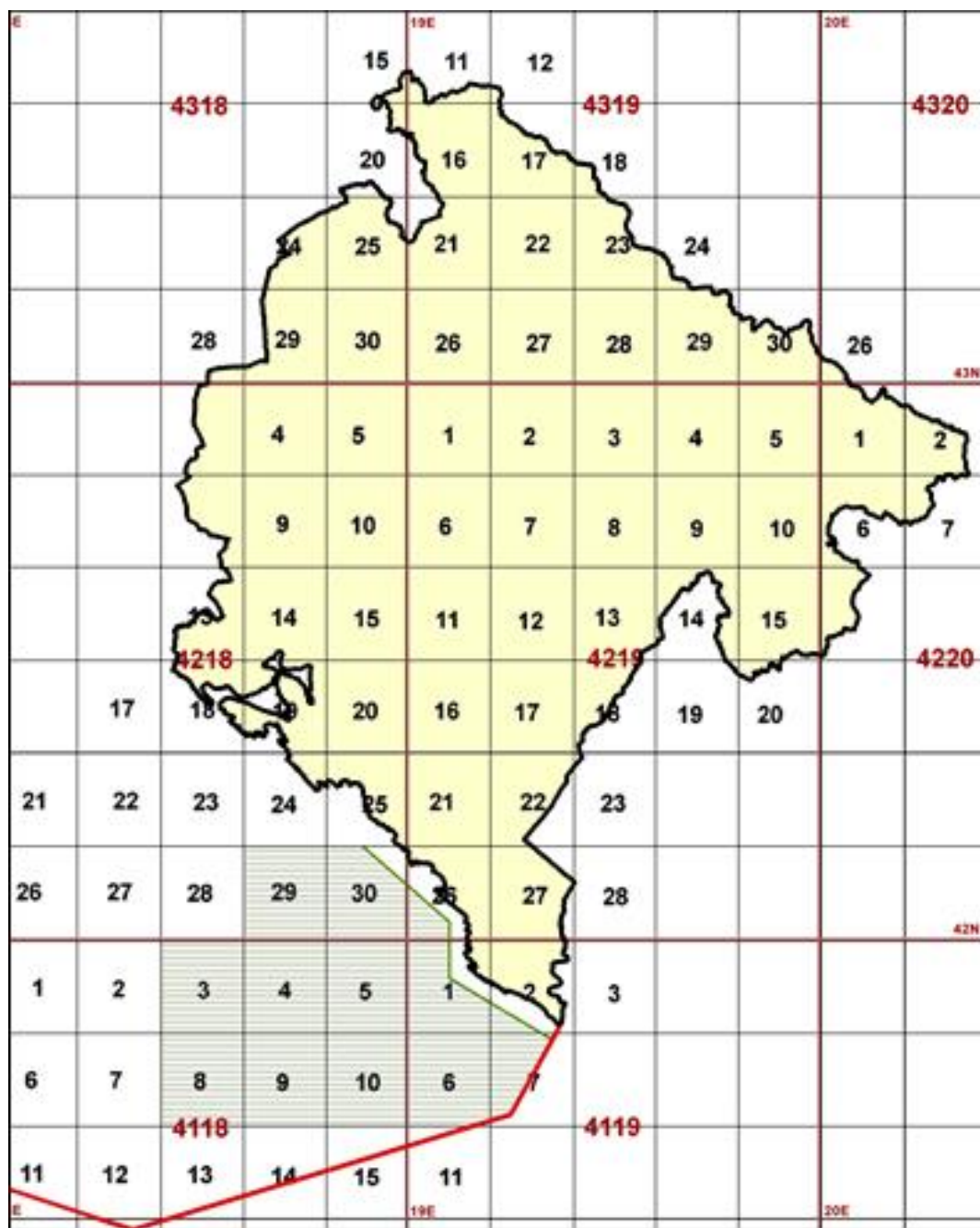


Figure 1. Blocks for award of hydrocarbons exploration concession contracts

Table 1. Blocks for award of hydrocarbons exploration concession contracts

Makro blok	Blok	Longituda			Latituda		
		stepen	minut	sekund	stepen	minut	sekund
4218	29	18	36	00	42	10	00
		18	48	00	42	10	00
		18	48	00	42	00	00
		18	36	00	42	00	00
	30	18	48	00	42	10	00
		18	53	49	42	10	00
		19	00	00	42	05	55
		19	00	00	42	00	00
		18	48	00	42	00	00
4118	3	18	24	00	42	00	00
		18	36	00	42	00	00
		18	36	00	41	50	00
		18	24	00	41	50	00
	4	18	36	00	42	00	00
		18	48	00	42	00	00
		18	48	00	41	50	00
		18	36	00	41	50	00
	5	18	48	00	42	00	00
		19	00	00	42	00	00
		19	00	00	41	50	00
		18	48	00	41	50	00
	8	18	24	00	41	50	00
		18	36	00	41	50	00
		18	36	00	41	40	00
		18	24	00	41	40	00
	9	18	36	00	41	50	00
		18	48	00	41	50	00
		18	48	00	41	40	00
		18	36	00	41	40	00
	10	18	48	00	41	50	00
		19	00	00	41	50	00
		19	00	00	41	40	00
		18	48	00	41	40	00
4119	1	19	00	00	42	00	00
		19	06	18	42	00	00
		19	06	16	41	55	50
		19	12	00	41	53	16
		19	12	00	41	50	00
		19	00	00	41	50	00
	2	19	12	00	41	53	16
		19	19	41	41	50	00
		19	12	00	41	50	00
		19	00	00	41	50	00
	6	19	00	00	41	50	00
		19	12	00	41	50	00
		19	12	03	41	40	30
		19	09	00	41	39	48
		19	00	00	41	40	00
		19	00	00	41	40	00
	7	19	12	00	41	50	00
		19	19	41	41	50	00
		19	21	00	41	49	18
		19	14	58	41	41	10
		19	12	03	41	40	30
		19	12	03	41	40	30
4219	26	19	00	00	42	05	55
		19	06	18	42	01	43
		19	06	18	42	00	00
		19	00	00	42	00	00

2.1 Public Invitation

On 7 August 2013, the Ministry of Economy on behalf of the Government of Montenegro published the first Public Invitation for award of concession contracts on hydrocarbons exploration and production in the offshore of Montenegro. The exclusive economic zone of Montenegro covers the area of 7,745 km², which will be the subject of exploration. In the first bidding round, the Government offered the total of 13 blocks and portions of blocks in the Montenegrin offshore for Production Concession Contracts. They are shaded in Figure 2:



Figure 2. Blocks for award of contracts on hydrocarbons exploration concession in the off-shore of Montenegro

Explorers in the Montenegrin off-shore target different geological formations, depending on the depth where the explorations are carried out:

- Plio-Pleistocene plays ranging in depth from 600 - 1300 m under the seabed level. Biogenic gas is accumulated in high-quality turbiditic sands.
- Miocene plays underlying the Plio-Pleistocene bear gas reservoirs in marine shelfal sands as well as the Oligocene.

2.2 Features of the Adriatic (bathymetry)

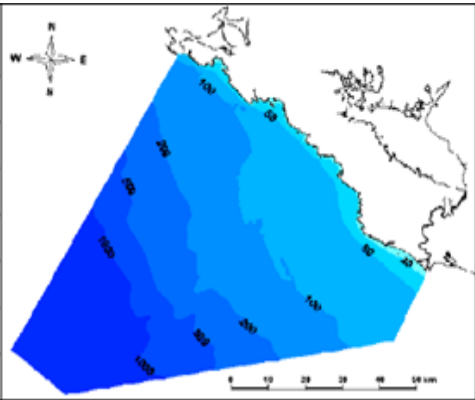
Bathymetry of the seabed is considered an important component of the Global Ocean Observing System (GOOS). In addition to the importance for preparation of marine maps, bathymetry is particularly significant for preparation of the models of natural processes used for studying the role of oceans in the climate system of the Earth. The overall understanding of geological processes, capacity to find and use ocean resources, to model natural processes in the sea and produce sea forecasts depend on the detailed knowledge of the sea and ocean bathymetry.

Knowledge of the sea currents and their interaction with the topography of the seabed is essential for understanding the fate of contaminants that might be potentially released into the deep waters or the sea.

The seabed morphology has been explored for over a century, but it was only after the technologies were developed at the end of the 20th century that it was possible to prepare high resolution bathymetric measurement.

For the preparation of bathymetric maps of Montenegrin off-shore used were the existent marine maps, and depth measurements were carried out based on the measurement by single-beam ultrasound, given that there are no modern digital systematic measurements in the area of interest. For the analysis of the open sea bathymetry used were the maps of Hydrographical Institute of Yugoslav War Navy (HI YWN). From the maps geo-referenced with GIS (Geographic Information System) tool, isobaths were digitalised and surfaces were calculated. Table 2.

Table 2. Area of Montenegrin off-shore bathymetric belts

Batimetrijski pojas	Površina (km ²)	Procenat (%)	
0 do 20 m	71	1.1	
0 do 50 m	245	3.9	
50 do 100 m	1 559	24.9	
100 do 200 m	1 656	26.5	
200 do 500 m	975	15.5	
500 do 1000 m	624	10.0	
preko 1000 m	1 131	18.1	

Based on the data from Table 2 the following can be concluded:

- The area of the continental shelf, bordered by the depth of 200 m, covers 57% of the off-shore area;
- Bathymetric belt, 500-1000 m of depth, covers only 10% of the off-shore area, which indicates a sharp transition from the shelf to the area of deep southern valley of the Adriatic;
- Bathymetric belt, over 1000 m of depth, covers 18.1% of the off-shore;
- Depths up to 20 m are located in a very narrow belt along the shore and make 1.1% of the off-shore (outside the Boka Kotorska Bay).

3 PHASES OF THE HYDROCARBONS EXPLORATION AND PRODUCTION PROGRAM

A specific program of hydrocarbons exploration and production activities may not be defined until the companies-operators have been awarded Exploration and Production Contracts. The contracts will specify the obligations of concessionaires related to the development of detailed plans of all individual activities including the exploration and production development plan.

The activities related to exploration and production include three main phases:

- Exploration phase: seismic survey, exploration wells and appraisal;
- Production phase: including development and production;
- Decommissioning phase.

3.1 Exploration phase

3.1.1 Seismic survey

The exploration begins by carrying out different geological and geophysical surveys, and it is known as prospecting. Such surveys are aimed at identifying potentials i.e. prospects of finding oil and gas. Most of these surveys are carried out before or during the licensing phase, where the companies interested to take part in the tender take into account the gathered data and collect and purchase them, as to be able to have their own interpretation and assess the possibility of finding oil and gas and study the risks associated to exploration.

In Montenegro different surveys were carried out as a part of previously undertaken prospecting. They include around 3,500km of seismic reflective profiles undertaken during previous years (1979, 1983, 1984, 1985, 1986, 1988 and 2000), as well as 3D seismic data obtained over the area of 311 km², (Figure 3). In addition, the onshore and offshore well data are available. They include litho-data, well log suites, cores and geochemical data. Figure 3 presents the obtained 2D seismic profiles (orange lines), 3D seismic profiles (green blocks) and exploration wells (black circles). Block delineation is represented by grey lines.

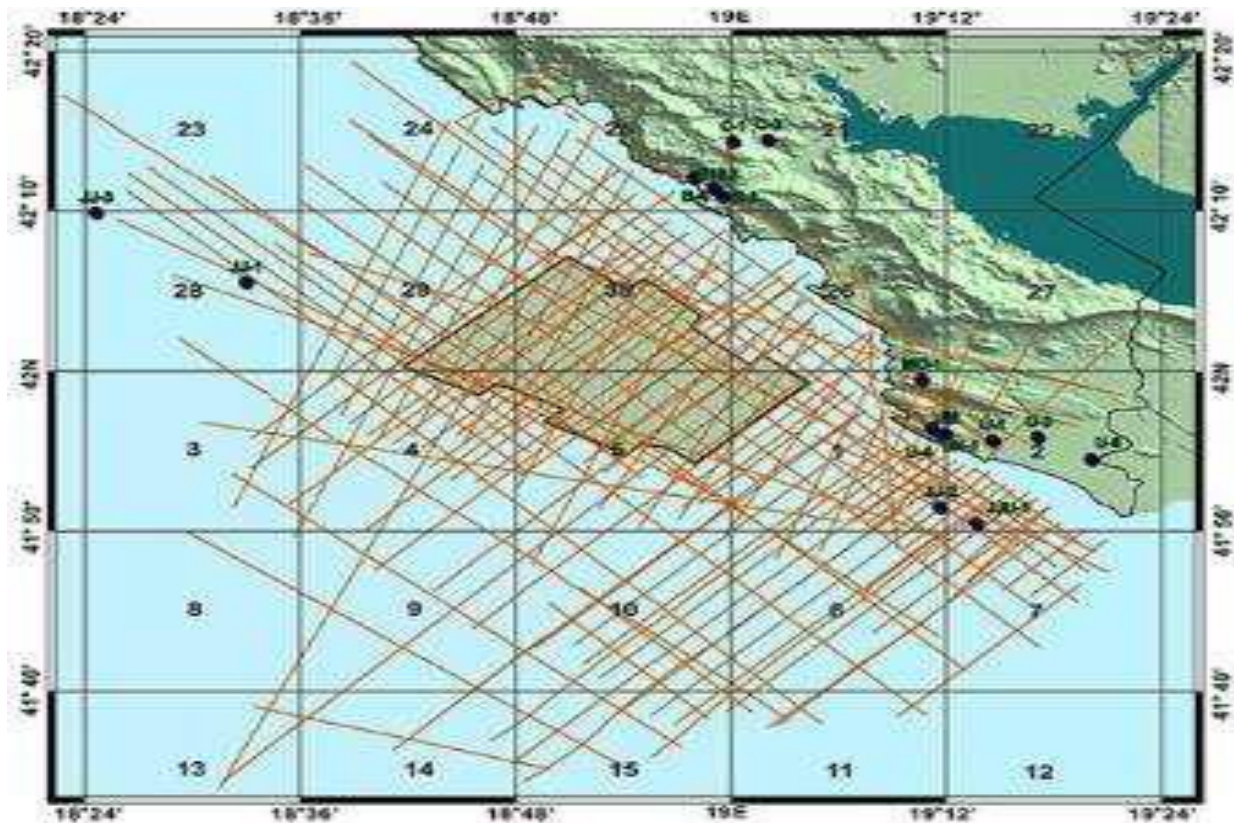


Figure 3. Existing seismic data and well data in Montenegro

Interpretation of obtained data facilitated identification of several prospects within the exploration zone. Several Pliocene prospects have been identified at the depths between 700m and 1,300m, in the waters from 75 to 120m of depth. The area of these prospects is covered by 3D seismic data and the risk for exploration carrying out is assessed as medium to low. Also, the possibility has been identified that oil exists within the Mesozoic carbonates. Both Mesozoic and Palaeogene carbonates form the primary target in the Montenegrin off-shore, given that such reservoirs provide significant quantities of hydrocarbons. The operator will carry out additional surveys (geological and geophysical, as well as environmental surveys) prior to proposing the final drilling site and mobilising the drilling equipment. This is required for better localisation of potential reservoirs and it is of great importance for surveying the seabed and shallow zones, particularly for the purpose of being able to anticipate and avoid drilling hazards.

Such surveys may include but are not limited to:

- Bathymetric survey, to produce a high resolution digital terrain model of the seabed.
- Side scan sonar, to identify the properties of the sea bottom.
- Sub-bottom profiling, to obtain a continuous and very high resolution image of geological conditions on small depths under the sea bottom.
- Magnetometric surveys, to search for ferrous objects lying on or buried immediately under the seafloor, or to attempt to identify the position of cables, pipelines or

abandoned wells that cannot be detected by acoustic surveys. A Gradiometer can be used for measuring the magnetic gradient between two or more closely spaced magnetometers for more precise results and surveys close to large structures such as platforms.

- 2D multi-channel high resolution seismic surveys, to explore top-hole geological conditions at proposed drilling locations across the area. If there are pre-existing 3D seismic surveys, they are considered to be appropriate substitute for this survey.
- 3D multi-channel high resolution seismic surveys, designed on a site specific basis where initial review or offset drilling experience indicates that the shallow section, or the perceived conditions are particularly complex.
- Seabed sampling, to ground truth seabed and shallow soil provinces that are defined during site survey, or that have been pre-defined during the desk study. For an anchored rig it may be necessary to acquire shallow seabed soil evaluation data using a suite of tools appropriate to the soil conditions (grab, box corer, piston corer, gravity corer, vibro-corer or CPT). Samples retrieved should be comprehensively logged and may need to be sent ashore for analysis. If sampling is aimed at defining suspected sensitive environments, care should be taken to acquire a control sample away from the suspect target area.
- Seabed photographs, to ground truth acoustic data and allow investigation of discrete areas of concern that are identified during a survey.

The scope of aerial survey depends on the type and quality of existing data, water depth and type of drilling equipment to be used.

The existing 3D data packages may substitute the above mentioned explorations, if their specification complies with industry standards, otherwise they may be enhanced by partial performance of the above mentioned surveys.

In the course of marine seismic surveys, a slow-moving survey vessel (generally streaming at 4 to 6 knots) tows an impulse emitting sound source (an array of multiple airguns). The sound reflects off the sea bottom and the seismic data are recorded and processed by onboard computers. After the interpretation of obtained data, submarine geological profiles are obtained, all for the purpose of identifying potential reservoirs of oil and gas. 3D vessels have multiple streamers (normally between 4 and 20), that are between 3 and 6 km in length, and are towed at a spacing up to 120 m from one another (Figure 4).

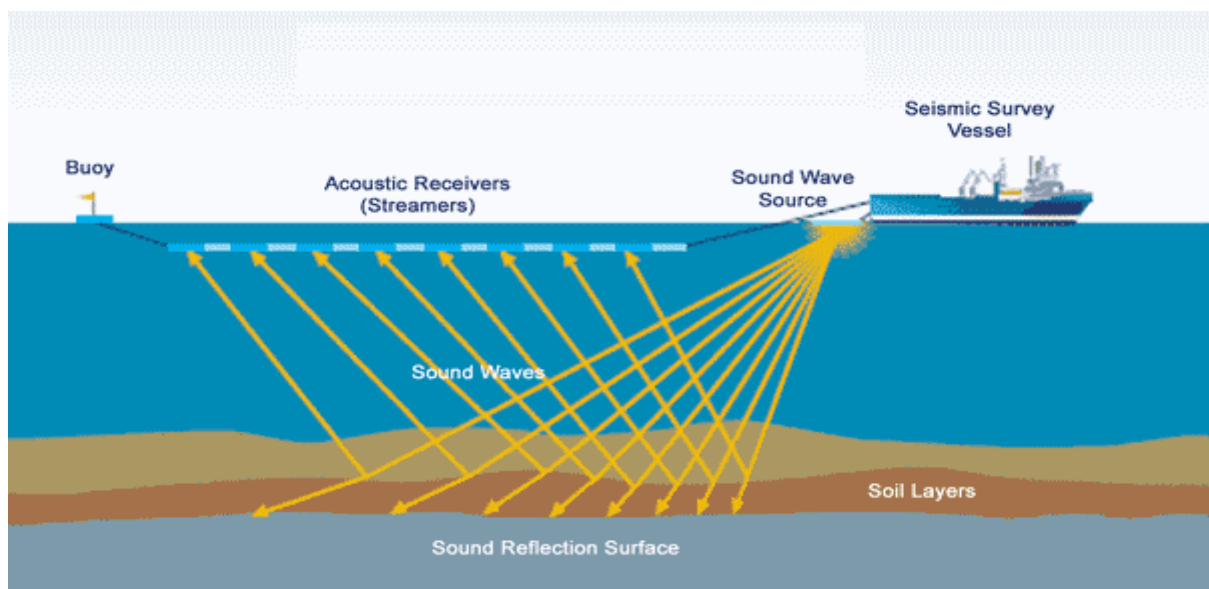
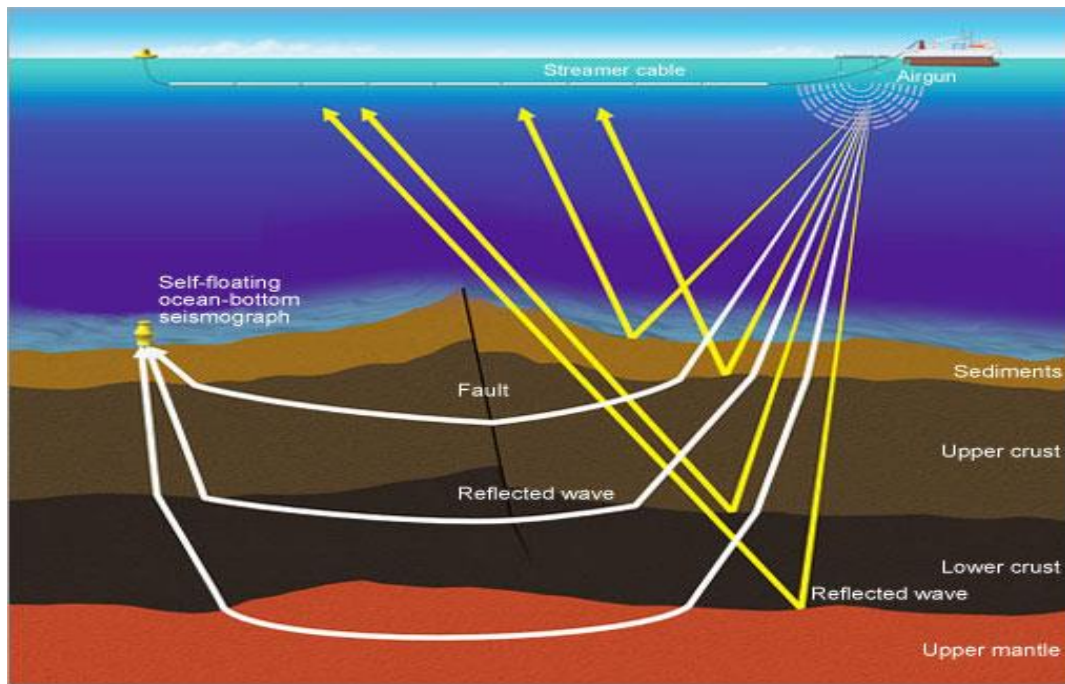


Figure 4. Illustration of the principle according to which off-shore seismic surveys are carried out

Sound sources (commonly referred to as "airguns") are underwater pneumatic devices from which high-pressure air is released into the water. These high energy, low-frequency sound waves (known as "shots") are produced by airguns and pulsed downward to the sea floor, from where they propagate through the seabed. The seismic waves bounce off the subsurface rock formations and return to the water surface, where an array of receivers (hydrophones) mounted inside the streamer cables detects the returning seismic energy. The sound source is submerged into the water, normally at a depth between 5 and 10 m.

3.1.2 Exploration wells and appraisal

After having identified potential locations of wells, the operator will mobilise the drilling equipment and create one or several exploratory wells within the borders of the awarded block. The objective is to prove the presence of hydrocarbons within the identified prospect. In the course of drilling, the penetrated formations will be appraised by studying the drill cuttings and obtaining the information on the lithology and the chemical and petrophysical properties of the formations, as well as properties of contained fluids through sampling of cores or logs by using Wireline techniques, i.e. continuous measuring of formation properties by electrical instruments.

Depending on the depth of water, targeted well depth and anticipated pressure in formations, as well as weather conditions during the offshore exploration and production activities it is expected that different rig types will be deployed. That may include bottom supported rigs, anchored or dynamically positioned rigs. Figure 5 presents the distribution of blocks in the offshore of Montenegro with pertaining depths of the seabed.

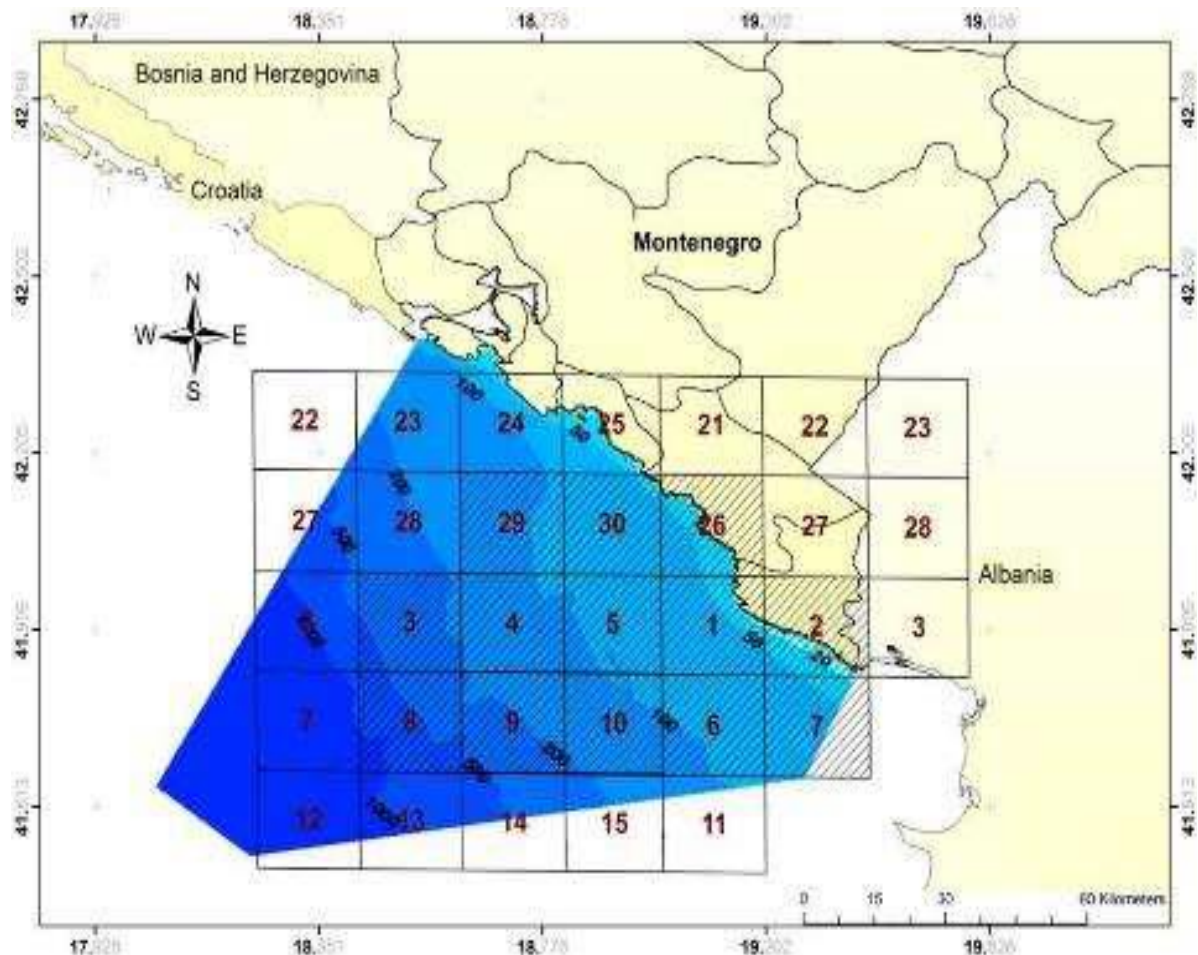


Figure 5. Illustration of the distribution of blocks for hydrocarbons exploration and production with pertaining depths of the seabed in Montenegro

In case that hydrocarbons are discovered in one of the wells, immediately and no later than 15 days from the discovery date, the concessionaire is to notify in writing the administrative

authority about the location and nature of the discovery and provide the data available. The well would be further searched for the purpose of appraising the cost-effectiveness of discovered quantities. It is carried out by testing that shows production capacity of the well, as well as other reservoir parameters, such as permeability and pressure, and this will help in delimiting the borders of the reservoir. This is defined as an appraisal phase.

Wells that get proved to be productive will be held and plugged in accordance with industry standards, in order to be subsequently completed and used for production. Depending on findings, the reservoir might be appraised by drilling additional wells and carrying out more tests.

Verification phase of hydrocarbons reserves includes:

- Operations required for reservoir contouring, including drilling of appraisal wells and geochemical surveys for the purpose of establishing the commerciality of the discovery.
- Prior to the commencement of the verification phase of hydrocarbons reserves the concessionaire is to provide to the administration authority a detailed verification program of hydrocarbons reserves with a request for commencement of the reserve verification phase.
- Administration authority is to make a decision regarding the issuance of the approval to the program referred to in item 2 within 30 days following the date of receipt of the request.
- The verification phase of hydrocarbons reserves commences on the date of delivery of the decision referred to in item 3 to the concessionaire consenting the detailed reserve verification program and approving the commencement of the hydrocarbons reserve verification phase.

If the discovered reservoir is not considered commercial, the wells will be permanently plugged with cement or mechanical plugs and abandoned. After that the site would be cleared for the purpose of its reinstatement.

Concessionaire is obliged as follows

- within eight days from the date of establishing the commerciality of the reservoir to notify the administrative authority in writing.
- provide data on appraised hydrocarbons reserves to the administrative authority in accordance with the law no later than 60 days following the date of the delivery of the notification referred to in item 1.

3.2 Field development and production plan

A Field Development Plan (FDP) is normally prepared based on exploration and appraisal results. It serves as a conceptual specification for subsurface and surface facilities, and the

operational and maintenance philosophy. After the approval of the plan, activities are carried out related to procurement of material for construction, fabrication and installation of equipment, as well as release into testing operation of all plant and equipment. Planning of the development and production is based on the anticipated production profile. It will determine the facilities required, and the number of wells to be drilled. The production profile results from a complicated simulation where a large number of data participates, including the reservoir pressure, the number and spatial layout of production wells. For the purpose of achieving maximum quantities of produced hydrocarbons, for maximum period of time, different methods for improvement of recovery factor are used. Recovery factor is a percentage of produced hydrocarbons in relation to the quantity of verified reserves. This factor is a very important performance indicator of production and makes a part of the production profile. Planning of activities required for achieving the maximum extraction factor needs to begin during the drafting of the development plan. Most frequent first activities that are undertaken include drilling of injection wells to which water or gas (if any) are pumped in. Subsequently, use of different chemical and physical methods for increase of productivity of the existing field may be included.

Production phase commences on the commencement date of the first extraction of hydrocarbons from the reservoir and lasts until the expiry of the deadline specified in the production concession contract, i.e. until the delivery date of the notification by the concessionaire to the administration authority saying that further production from the reservoir is not commercial. Production phase may last maximum 20 years following the production commencement date, and at request by the concessionaire, it may be extended by maximum half of the production phase period established by the production concession contract.

Production profile depends on the properties of the reservoir, i.e. conditions within the reservoir, and may be divided into three main periods:

- **Build-up period:** during this period new wells should be drilled;
- **Plateau period:** during this period it is still possible to bring new wells on stream, while the existing wells exhibit decline in production. In this period, the production equipment operates at full capacity and rate of production is maintained constant;
- **Decline period:** during this period production declines in all wells.

Different development and production systems may be used within the licensing area. The type of equipment that the operator will select is based on several factors, including water depth, reservoir type, as well as proximity to existing oil and gas infrastructure and support operations.

3.3 Decommissioning

When all economic reserves have been depleted, the field will be decommissioned. Operators normally try to postpone this phase, either by reducing operating costs or increasing hydrocarbon throughput. Advanced recovery techniques, i.e. increase of recovery factor are developed for such purpose.

It is required to develop a decommissioning plan for offshore facilities that considers well abandonment, removal of oil from flowlines, removal of facilities and sub-sea pipeline decommissioning along with disposal options for all equipment and materials. This plan can be further developed during the field operations and fully defined in advance of the end of field life. The plan is to include the details on the provisions for undertaking decommissioning activities and arrangements for post decommissioning monitoring and aftercare.

4 HYDROCARBONS EXPLORATION AND PRODUCTION FACILITIES

4.1 Hydrocarbons exploration facilities

4.1.1 Seismic survey vessels

These surveys are based on the analysis of seismic waves. In short, the process involves a seismic detector that shoots electromagnetic waves to a specific underwater point. By a complex analysis of the time required for the wave to refract back to its origin point determines whether that particular seabed area is feasible for drilling.

Seismic survey vessels are sophisticated vessels built with features to accommodate a team of seismic engineers and operatives, ship crew, operational deck, laboratory, instrument room, quiet engine, huge winches or reels to store streamer cables and additional mode of steering. These vessels are generally slow in speed and measure less than 100 meters in length.

Main seismic equipment used at these vessels is:

Tail-buoy, as the name suggests is a type of buoy, which is fitted with GPS and flashing light and is attached to the far end of each streamer cable. It keeps the streamer cables afloat. It gives position information, and also illuminates during night time.

Streamer cable or streamer is an optical cable that contains hydrophones to pick the seismic signals, electronic modules which transmit the data, stress membrane or kelvar and electrical transmission system. The streamers are divided into 100 meter sections or even lesser (helps in easy replacement of damaged items). The streamer cables are filled with fluids with

specific gravity less than 1, to make the streamer buoyant. Nowadays, the fluids are replaced with foams, which have less chance for leaks and are easy to maintain.

Birds are depth control units attached to the streamer and placed at regular intervals (not more than 300 meters). They control the depth of the streamer cable, and are fitted with motors and wings which are operated from the instrument room to maintain the desired depth of streamers.

Acoustics are attached to the streamers which have in-built transmitters and are placed at equal distance. Acoustics emit signals which are picked up by transducers located on the ship, giving relative positions of the cables.

Air Gun is equipment which is also called the seismic source. Air guns are comprised of two chambers, namely the upper control chamber and the lower discharge (firing) chamber and a solenoid valve. Control chamber sends an electrical impulse to the solenoid valve, which opens up for the air to discharge from lower chamber through ports. The opening of solenoid valve and filling of air in chambers is very rapid and takes only few milliseconds. This ensures continuous discharge (firing) and the time interval between each discharge depends on the speed of vessel.

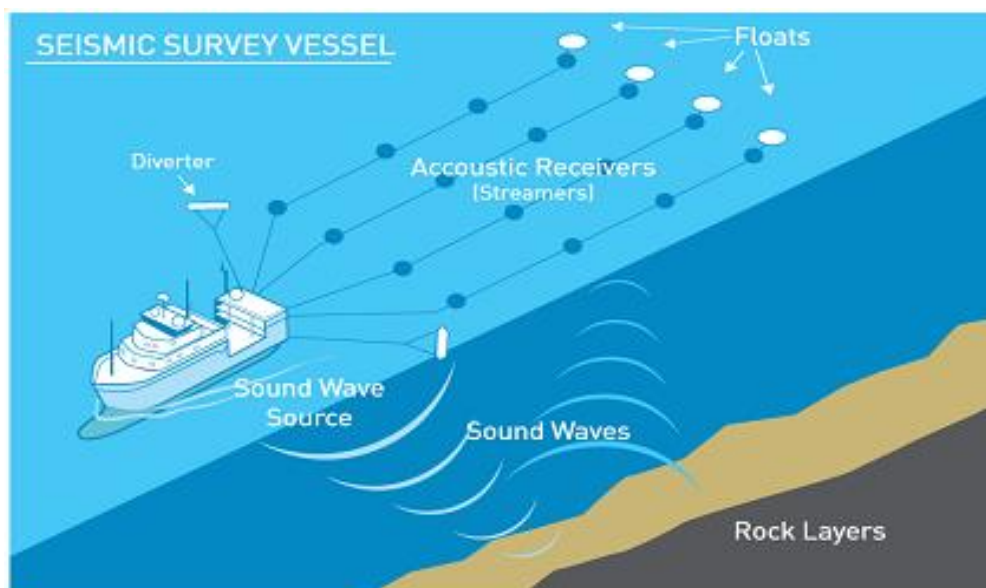


Figure 6. Seismic survey vessel with ancillary equipment

4.1.2 Floating facilities for hydrocarbons exploration

Offshore oil platform or drilling rig is a specific structure used to accommodate workmen, machines and equipment required to drill the ocean bottom, production of hydrocarbons, processing of hydrocarbons fluids and their transport to the shore by special ships (tankers) or appropriate piping. The size of an oil rig depends on the number and size of facilities to be mounted on it such as: derrick, helideck, accommodation quarters, space for storage of equipment, facilities for storage of crude and mud etc.

The selection of the offshore drilling rig mostly depends on the water depth, and it can be classified as follows:

- <350 m shallow waters
- <1500 m deep waters
- >1500 m very deep waters

Basic characteristics of the offshore drilling rig are mobility and maximum water depth for performance of works. Based on their characteristics there are two basic classifications of offshore drilling rigs.

The first classification is based on the mobility of the rigs and all the facilities are divided as follows:

- Mobile – facilities that have technical features to be simply dismantled and moved to another site after having finished operations at one location and to continue operating there.
- Fixed (non-mobile) – facilities which after having been towed to the location are fixed to the seabed and stay there until the end of their life. A large problem with these types of facilities is their removal after decommissioning. Previously they would be simply sunk to the sea bottom, but nowadays when environmental protection is a very important topic, it is no longer possible, and such facilities must be disassembled and towed to the shore in parts.

Another classification is based on the fact whether a facility rests on the bottom by any of its parts or not, and they are classified as follows:

- Bottom-supported
- Floating

It should be noted that all floating facilities belong to mobile units with the exception of TLP and mast platform. In theory, these facilities can be relocated, but not so fast or relatively simply like other units from the class of mobile facilities, and on the other hand their relocation is a very expensive process so it rarely takes place in practice.

4.1.2.1 Bottom supported facilities

The structure of bottom supported facilities rests on the seabed partially or with its entire surface. The main advantage of these facilities is that they provide stable operating conditions and are resistant to harsh climate, while their disadvantage is that they cannot be installed at small depths.

Bottom supported facilities that are suitable for the depths of the **Adriatic** include **Jack-up**.

Jack-up is a mobile facility used in water depths up to 180 m. The platform floats on its hull while towed to the site where it lowers its legs and rests them on the bottom, and then raises its hull to the desired height. This facility can be transported by a ship to the site.

Most modern platforms have hulls in the shape of a triangle with three legs, and other have a rectangle hull with four or more legs. The legs may be triangle open lattice structures as are nowadays most frequently made and may be cylinder piles.

There are two basic types of these platforms, and they are independent leg type and mat type.

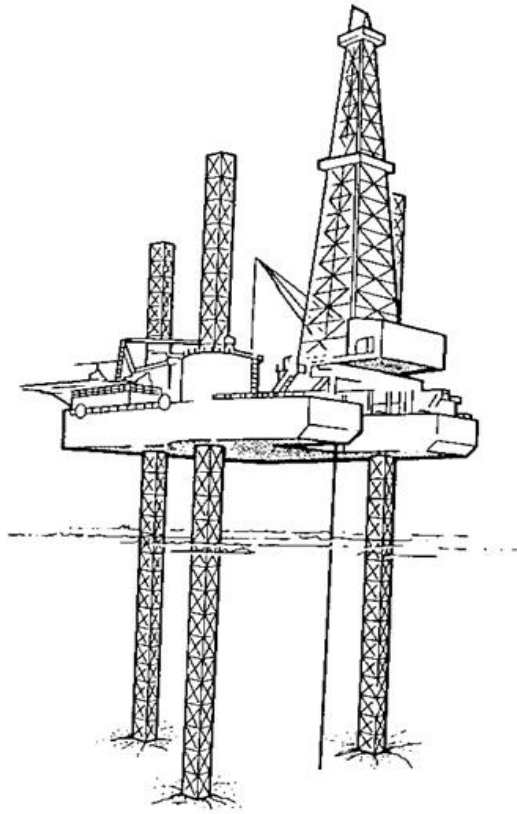


Figure 7. Self-elevating Jack-up

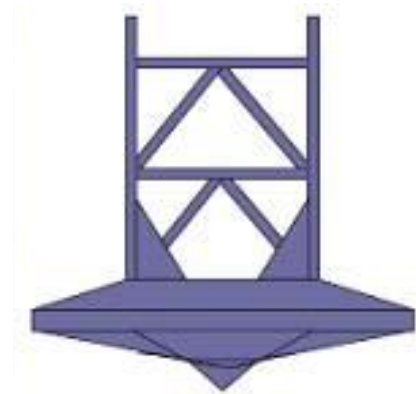


Figure 8. Supporting mats with cone bottom that all piles must have in case of self-elevating independent leg type platforms.

Independent leg type jack-up may be used anywhere, but they are most frequently used in the areas of firm seabed, coral or uneven seabed. Independent leg type jack-up depends on supporting mats with cone bottom at the end of each leg which may be round, square or multi-angled (Figure 8).

Self-elevating platforms may be towed or have their own power to manoeuvre.

In consideration what type of this facility to be used, the following should be taken into account:

- Water depth and environmental protection criterion
- Seabed type and density

- Required drilling depth
- Need to move the unit during the hurricane season
- How often the unit needs to be relocated
- Time taken for relocation
- Operating and loading restrictions of the unit

Self-elevating platforms make around 50% of the world drilling fleet.

4.1.2.2 Floating facilities

Floating facilities are the ones that do not rest on the seabed, but can be connected to it by wires or anchors. These units float on the surface of the water. Their basic feature is that they are operational in deep waters, however due to the fact that they are only connected to the seabed by ropes or wires the critical factor in case of these facilities is stability under harsh sea and ocean weather conditions. Floating facilities can be mobile and non-mobile.

Floating facilities suitable for the depths of the Adriatic include **semi-submersible facility**.

The units of these facilities were created by evolution of submersible facilities and they are mobile drilling rigs which can be towed or carried by ships to the site, and frequently these units have their own power to move to the location on their own (Figure 10). Semi-submersible platforms may be operational in waters with maximum depth of 3000m; however they are more frequently used in waters with depth ranging from 300m to 1000m. They are called semi-submersible due to the fact that in the drilling position the pontoons are submersed only a few meters under the water surface and they are not in contact with the sea floor.

Pontoon is a long, narrow and hollow steel buoy with rectangle or round cross section. During the platform transport pontoons are filled with air, however at the site for placing the platform sea water is pumped into them so the platform would submerge down to a specific depth. When the pontoons have been submersed the entire structure gains stability and becomes significantly more resistant to wind gusts and waves. The main deck lies on the top of large cylinder or square piles that stretch upward from the pontoon.

On the operation sites semi-submersible platforms are maintained based on two principles:

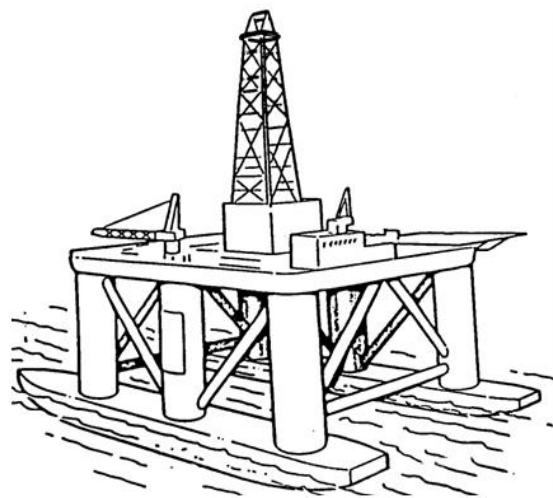


Figure 9. Semi-submersed platform.

- Active anchoring. Consists of application of dynamic positioning system,
- Passive anchoring. Consists of application of conventional anchors, wires and chains by which the platform is secured to the sea floor.

However, nowadays a combination of these two principles is used.

Advantages of semi-submersible platforms are:

- Mobility of the facility
- Large operational areas
- Solid stability under bad weather conditions

The main disadvantages of these facilities are:

- High manufacturing costs
- High operating costs
- Structure is subject to material endurance limit
- Complicated drilling and platform maintenance operations on the location in case of extremely rough sea



Figure 10. Principle of transport of semi-submersible platform to the location.

Transport by ship (upper left);

Own powered platform movement (lower left);

Platform towed to the location by tugs (right)

4.2 Hydrocarbons production facilities

An offshore production platform is rather like a gathering station; hydrocarbons have to be collected, processed and evacuated for further treatment or storage. However, the design and layout of the offshore facilities are very different from those on land for the following reasons:

- A platform has to be installed above sea level before drilling and processing facilities can be placed onshore;
- There are no utilities offshore, so all light, water, power and living quarters, etc. also have to be installed to support operations
- Weight and space restrictions make platform-based storage tanks non-viable, so alternative storage methods have to be employed.

Normal practice is that only stabilisation of hydrocarbons is carried out offshore to enable further transport to a processing facility or a tanker. Most frequently it implies separation of water, and also depending on the type of hydrocarbons it may include other elements (separation of condensates, associated saturated gas). This practice results from high costs of offshore hydrocarbons processing due to spatial restrictions and energy supply.

An offshore production platform is rather like a gathering station; hydrocarbons have to be collected, processed and evacuated for further treatment or storage. Offshore platforms can be split broadly into two categories: fixed and floating. Fixed platforms are generally classified by their mechanical construction.

There are two main types:

- steel jacket platforms,
- gravity-based platforms.

Floating platforms can also be categorised into three main types:

- semi-submersible vessels,
- ship-shaped mono hull vessels (such as floating production, storage and offloading, FPSO),
- SPAR platforms.

4.2.1 Steel jacket platforms

Steel piled jackets are the most common type of platform and are employed in a wide range of sea conditions, from the comparative calm of the South China Sea to the hostile North Sea. Steel jackets are used in water depths of up to 150 m and may support production facilities a further 50 m above mean sea level. In deepwater, all the process and support facilities are normally supported on a single jacket, but in shallow seas it may be cheaper and safer to support drilling, production and accommodation modules on different jackets. In some areas, single well jackets are common, connected by subsea pipelines to a central processing platform (Figure 11).

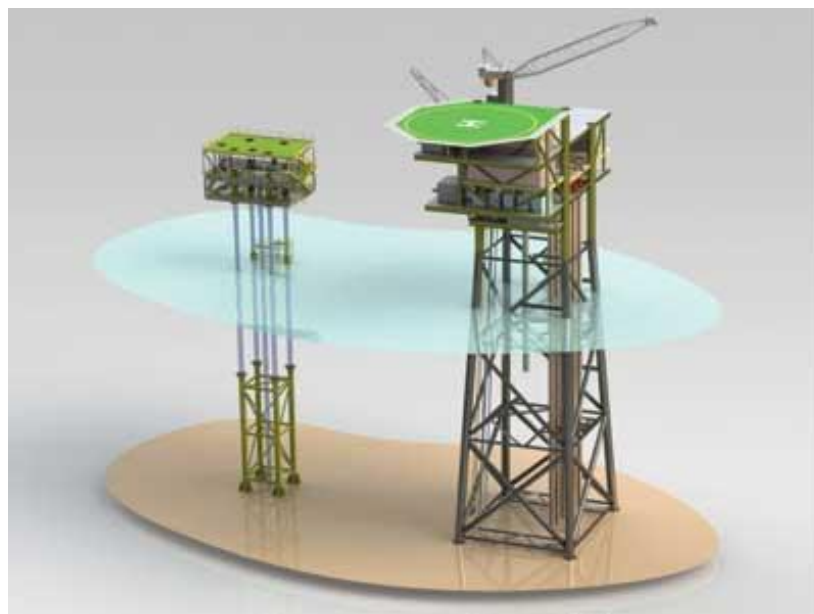


Figure 11. Steel jacket platform

4.2.2 Concrete or steel gravity-based structures

Concrete or steel gravity-based structures can be deployed in similar water depths to steel jacket platforms. Gravity-based platforms rely on weight to secure them to the seabed, which eliminates the need for piling in hard sea beds. Concrete gravity based structures (which are by far the most common) are built with huge ballast tanks surrounding hollow concrete legs. They can be floated into position without a barge and are sunk once on site by flooding the ballast tanks.



Figure 12. Concrete production platform

4.2.3 Floating production platforms

Floating production, storage and offloading (FPSO) have the capacity to deal with much more variable production streams and additionally provide for storage and offloading of crude oil. The newer vessels can provide all services which are available on integrated platforms, in particular three-phase separation, gas lift, water treatment and injection of water into the reservoir (in order to increase pressure and stimulate production).

Ship-shaped FPSOs must be designed to ‘weather vane’, meaning it must have the ability to rotate in the direction of wind or current. This requires complex mooring systems and the connections with the wellheads must be able to accommodate the movement. The mooring

systems can be via a single buoy or, in newer vessels designed for the harsh environments, via an internal or external turret (Figure 13).

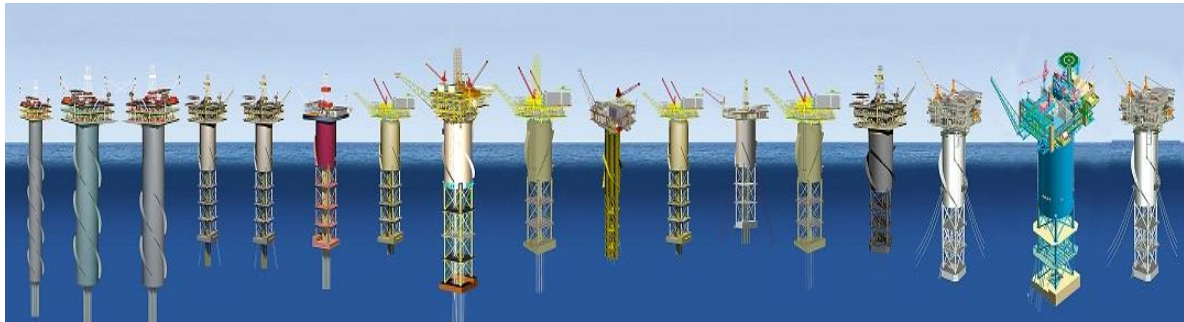


Figure 13. Floating production platforms

The typical process capability for FPSOs is around 100,000 barrels per day, with storage capacity up to 800,000 bbls. However, in the recent deepwater developments in West Africa some FPSOs exist which are over double this capacity.

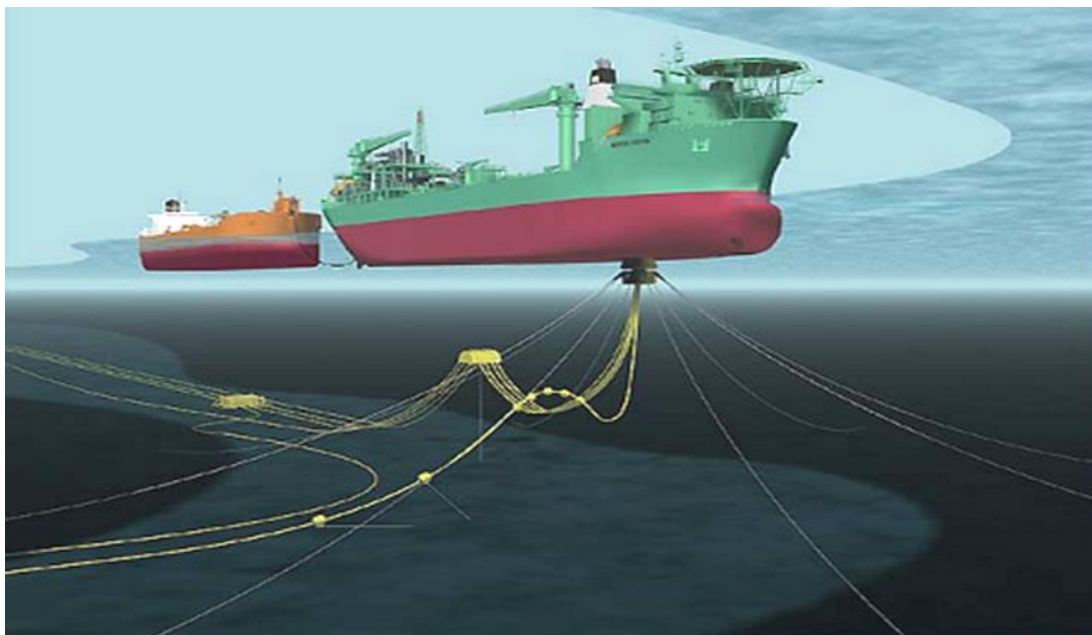


Figure 14. FPSO with offshore loading to a shuttle tanker

SPAR platforms were first employed as a concept by Shell, when it was used as a storage facility for the Brent Field in the North Sea. It had no production facilities but was installed simply for storage and offshore loading (Figure 15). More recently, SPAR structures have incorporated drilling, production, storage and offshore loading facilities as an integrated development option.

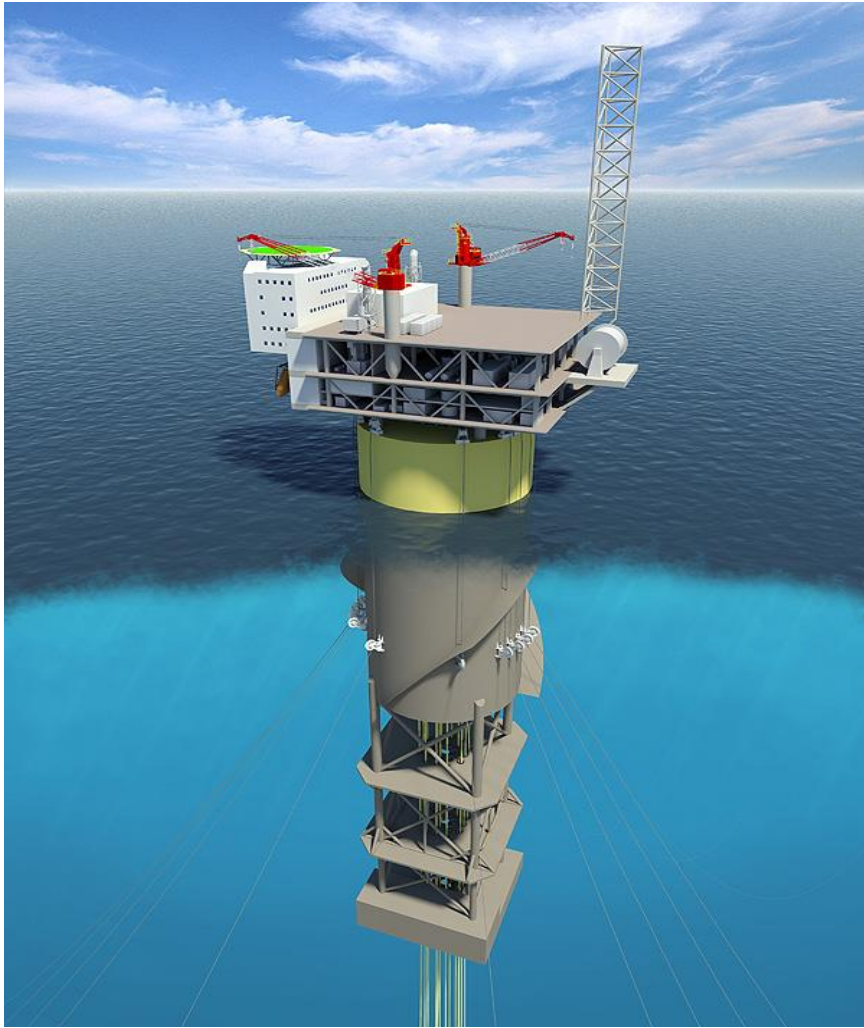


Figure 15. SPAR platform

4.2.4 Subsea production systems

Subsea production systems are an alternative development option for an offshore field. They are often a very cost-effective means of exploiting small fields which are situated close to existing infrastructure, such as production platforms and pipelines. They may also be used in combination with floating production systems. Typically, a subsea field development or subsea satellite development would consist of a cluster of special subsea trees positioned on the seabed with produced fluids piped to the host facility. Control of subsea facilities is maintained from the host facility via control umbilicals and subsea control modules. Subsea production systems create large savings in manpower as they are unmanned facilities. However, these systems can be subject to very high operating expense from the well servicing and subsea intervention point of view as expensive vessels have to be mobilized to perform the work. As subsea systems become more reliable this OPEX will be reduced (Figure 16).



Figure 16. Typical subsea field development options – tied back to a host facility

The most basic subsea satellite is a single subsea wellhead with subsea tree, connected to a production facility by a series of pipelines and umbilicals. A control module, usually situated on the subsea tree, allows the production platform to remotely operate the subsea facility via its valves and chokes.

5 TECHNICAL RESTRICTIONS RELATED TO ADRIATIC BLOCKS AND ENVIRONMENTAL PROTECTION

5.1 Technical restrictions

Selection of exploration facilities depends on numerous parameters, namely:

- Price and availability
- Technical conditions: water depth at the site, wind strength and wave height, seabed geomechanical properties, site seismicity, harsh weather conditions and their likelihood;
- Mobility / transport possibility;
- Target area depth and expected pressure in formations;
- Crew experience related to seismicity, drilling and production (history of safety at work, health care and environmental protection).

Bathymetry is directly linked to the selection of facilities and drilling rigs.

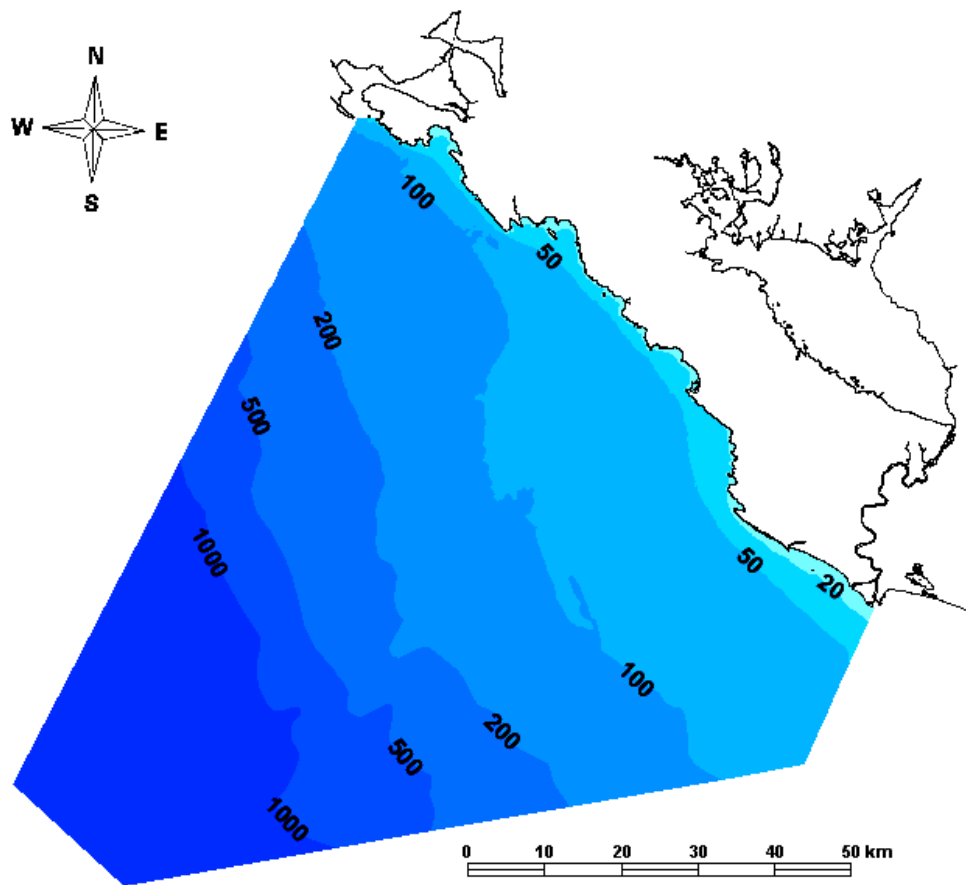


Figure 17. Adriatic bathymetry

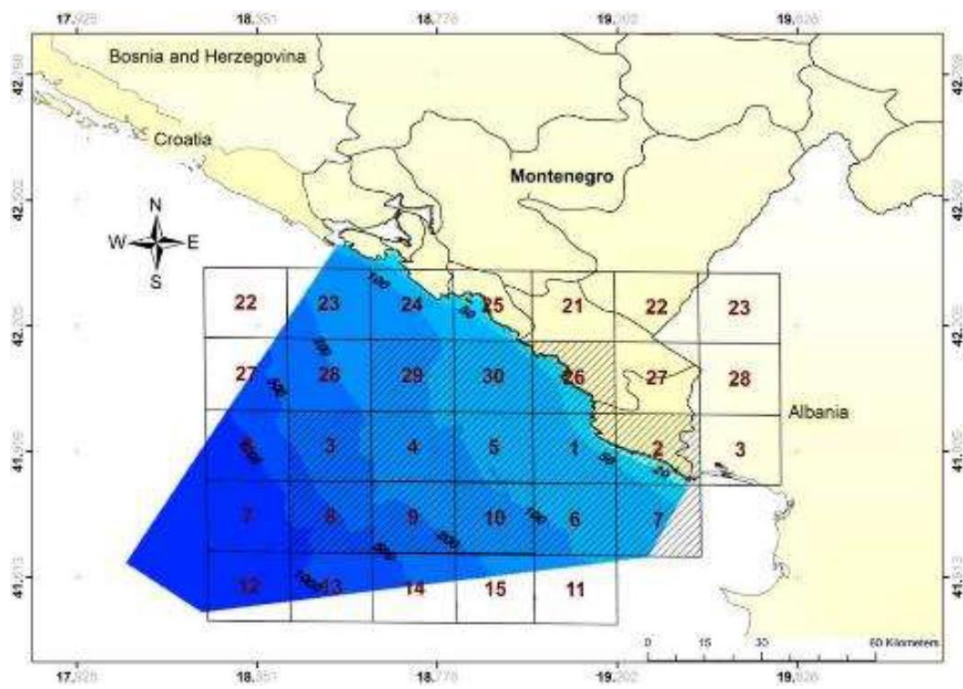


Figure 18. Block depths

5.1.1 Division of blocks depending on depth and supporting drilling facilities

5.1.1.1 Depth from 0 to 200 m

This depth includes the following blocks:

4119 – 1, 2, 6, 7, 11

4219 – 26

4218 – 23, 24, 25, 28 (block portion), 29, 30

4118 – 4, 5, 9 (North-East portion of the block), 10, 15

- Seismic survey: Seismic survey vessel
- Drilling facilities: Jack Up
- Production facility: Steel or concrete jacket platforms

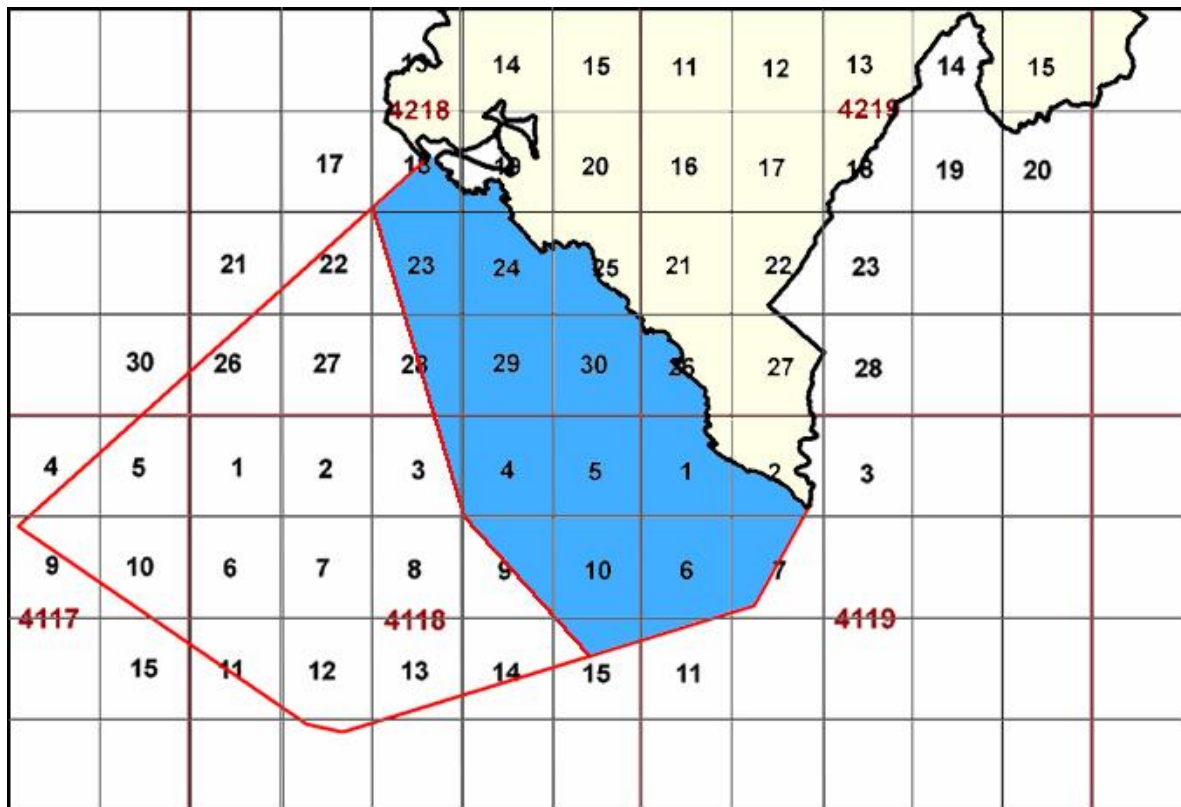


Figure 19. Blocks up to 200 meters of depth

5.1.1.2 Depth from 200 to 1000 m

This depth includes the following blocks:

4218 – 22, 27, 28 (block portion)

4118 – 2 (North-East part of the block), 3, 8, 9 (South-West portion of the block), 13 (North-East portion of the block), 14

- Seismic survey: Seismic survey vessel
- Drilling facilities: Floating semi-submersible facilities
- Production facilities: SPAR platform or production vessel

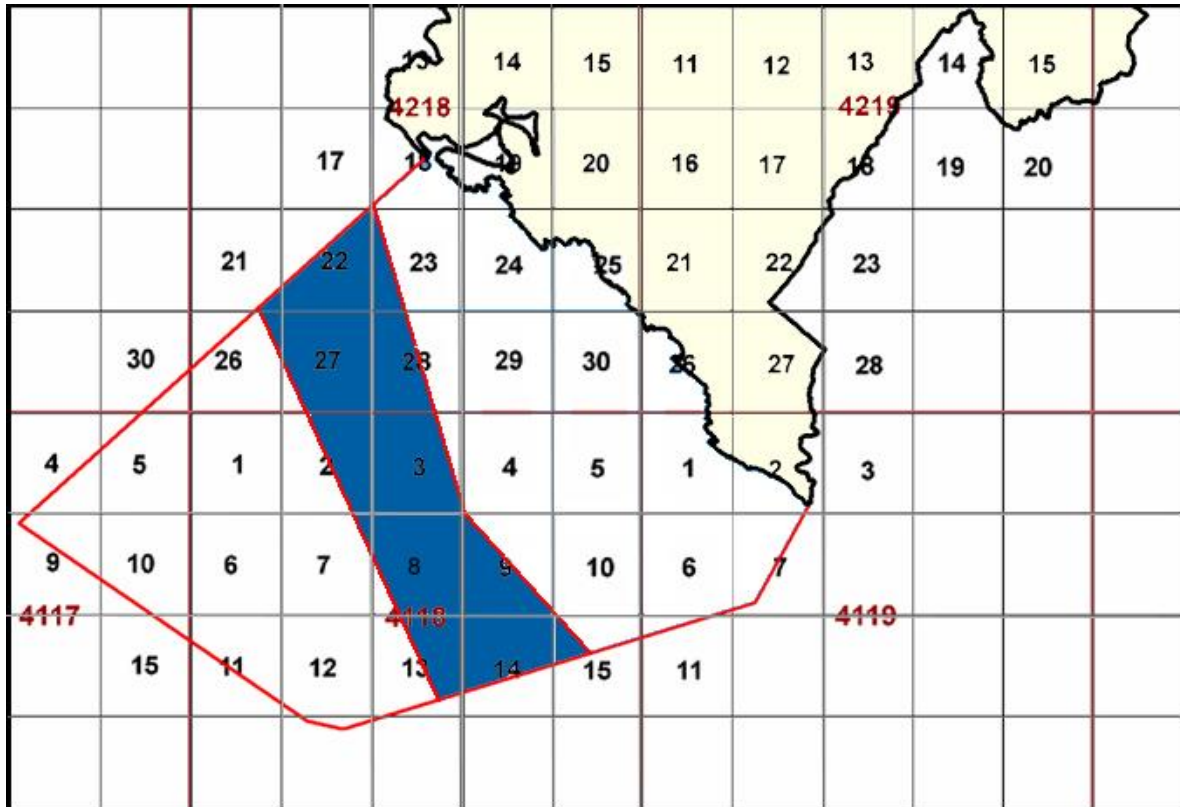


Figure 20. Blocks with 200 to 1000 meters of depth

5.1.1.3 Depth over 1000 m

This depth includes the following blocks:

4218 – 26

4117 – 5, 10, 9 (North-East portion of the block), 4 (South-East part of the block)

4118 – 1, 6, 7, 12, 14 (North-East portion of the block), 2, 13, (South-West portion of the block)

- Seismic survey: Seismic survey vessel
- Drilling facilities: SPAR platforms with derrick
- Production facilities: SPAR platform or production vessel

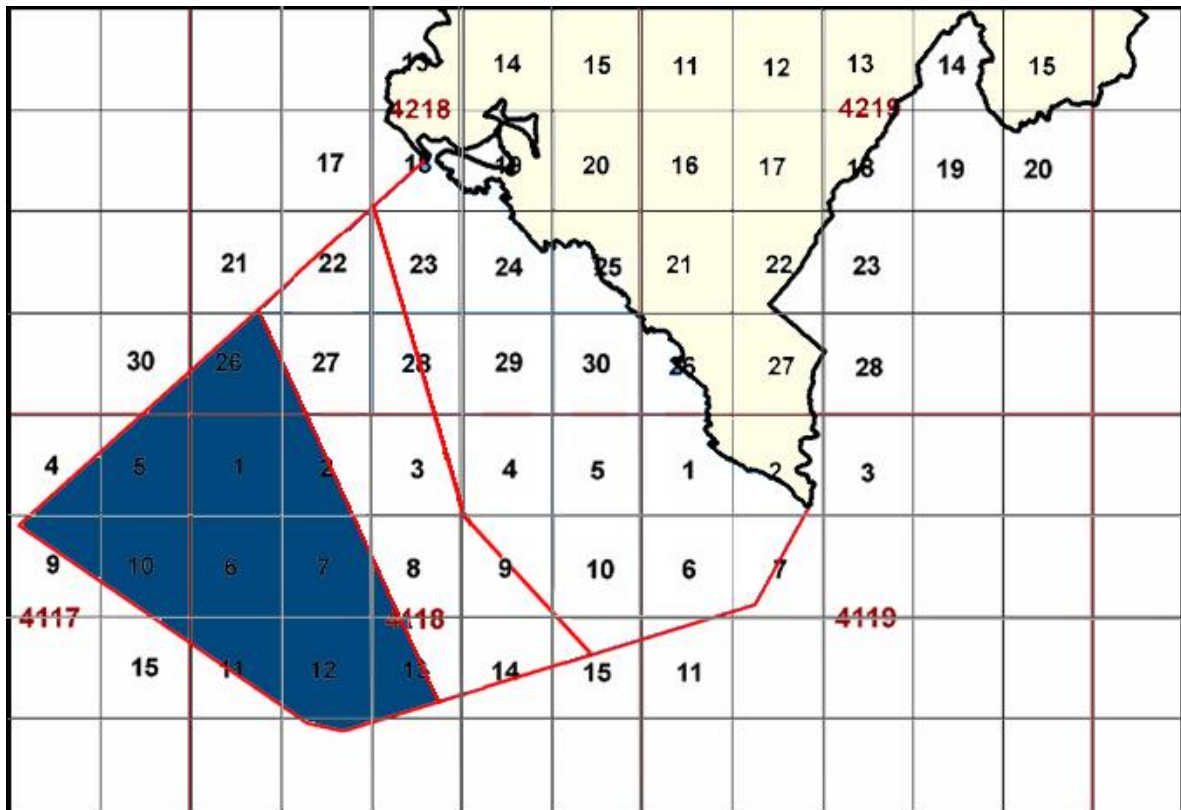


Figure 20. Blocks with over 1000 meters of depth

5.2 Environmental impact assessment conclusion

The Strategic Environmental Impact Assessment Study will assess impact of oil and gas exploration and production in Montenegrin offshore on the environment, society and health. In addition, after having verified the reserves of hydrocarbons, the operator will commence drafting of the field development plan, and at the same time be obliged to prepare the Environmental Assessment Study in relation to specifically proposed activities and sites where works will be performed.

6 TIMELINE OF DEVELOPMENT PLAN, TENDER ANNOUNCEMENT, HYDROCARBONS EXPLORATION AND PRODUCTION

2010	23 July	Invitation to express interest in awarding Concession Contracts
2010	24 December	Statement on award of the hydrocarbons production concession contract
2011	17 December	Data Room officially opened
2012	5 July	Government of Montenegro established the Decision on designation of blocks
2012	4 December	Public invitation for procurement of services related to implementation of software platform for hydrocarbons database
2012	30 November	Rulebook on the conditions for environmental protection in hydrocarbons operations
2013	27 February	Signed contract on software purchase
2013	22 July	Announced tender for development of SEA for Montenegro offshore
2013	25 July	Government of Montenegro adopted Tender Documents for the first Tender in Montenegro offshore
2013	7 August	First Tender – blocks for which bids are submitted
2014	30 January	Government adopted model contracts for hydrocarbons exploration and production
2014	10 February	Adopted enabling regulations from the area of oil and gas
2014	19 February	Adopted Proposal Law on Hydrocarbons Tax
2014	28 May	First Tender concluded – 6 companies submitted bids
2014	29 May	First Tender – blocks for which bids are submitted
2014	22 July	The Parliament adopted the Law on Hydrocarbons Tax