

SEISMIC SITUATION IN THE CASPIAN SEA AS A BASIS FOR JOINT ACTION

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Abstract Caspian Sea is one of the regions that attracts attention in terms of seismic activity. The presence of oil and gas deposits in the region and the export of oil and gas produced here to world markets make the seismic study of the Caspian Sea an international necessity. For this, it is necessary to strengthen the geological and seismic research of the region. In order to ensure the effectiveness of these studies, there is a need for regional cooperation of the relevant institutions of the states located in the Caspian basin. It is also important that international companies engaged in oil and gas production take part in the investigation of seismic processes in the Caspian Sea. In the article, the seismic situation of the Caspian Sea was studied, and the importance of the geopolitical aspects as well as the geophysical aspects of the issue was noted.

Keywords: region, seismic activity, Caspian Sea, geopolitical, oil

Introduction. The Caspian Sea is one of the seismically active regions. There are numerous earthquake foci at different depths in the Azerbaijani sector of the Caspian Sea. Therefore, the presence of earthquakes in the Caspian Sea is expected from time to time, and this is related to the seismicity of the area. The development of residual reserves of oil fields located in the Caspian Sea is of great economic importance for the Republic of Azerbaijan. Despite the fact that most offshore oil fields have been in development for a long time, each field, horizon and well is considered individually and appropriate geological and technical measures are taken to fully realize the reserves. For the first time in the world, the development of offshore oil fields began in Azerbaijan [1,2].

General analysis of the seismic situation in the Azerbaijani sector of the Caspian Sea.

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The beginning of the first work for the purpose of industrial production of oil and gas in the waters of the Caspian Sea dates back to 1906, when the Union of Oil Producers in Azerbaijan announced a competition to draw up a project for backfilling the shallow part of the Bibi-Heybat Bay on the outskirts of Baku. The excavation works started in 1909 were completed in 1922 and on the 350-hectare territory of the Bibi-Heybat Bay, which was filled up and reclaimed from the sea, on February 18, 1923. A year later, well No. 71, drilled at this field in Ilyich Bay from an artificial island built of wooden piles, became the first well in the world to produce a commercial flow of oil from under the seabed. The fountain of oil obtained from this well gave an impetus to the intensification of further prospecting and exploration work in the Caspian Sea [3].

Strong earthquakes have repeatedly occurred in the water area of the Caspian Sea. In the last century, 15 strong earthquakes with $M \geq 5.0$ occurred in this zone, with an intensity of VI-VIII points at the epicenter. They were felt in Baku and coastal areas up to V-VII points. A strong deep-focus earthquake that occurred in the Caspian Sea to the north of Absheron on September 18, 1961. with $M = 6.6$, it was felt up to 7-8 points on the northern coast of the republic (Siyazan, Gilazi, Nasosnaya), in Absheron and Baku up to 6 points on the MSK-64 scale. Another strong earthquake with $M = 6.2$, which occurred on January 27, 1963 north of Absheron, was also felt in Baku up to 6 points on the MSK-64 scale. In Baku, collapses of plaster, cracks in stone walls were observed. The earthquake that occurred on March 6, 1986 with $M = 6.2$ was felt on Oil Rocks with an intensity of 7-8 points, in Baku - up to V points. Earthquakes on August 24, 1989 with $M = 5.7$ in the northern marine subzone and on September 16, 1989 with $M = 6.2$ in the middle part of the Caspian were felt in the northern coastal regions of the republic and Baku with an intensity of V points.

The beginning of the century was characterized by an increase in seismicity in the southern marine subzone. In 2000, south of Absheron, a seismic event took place in the form of two shocks, which were felt almost throughout the entire territory of the republic, and in Baku and the surrounding areas, the intensity reached VI-VII points. This event was accompanied by a large number of aftershocks, some of which were tangible. In recent years, the level of seismic activity in certain sections of the Caspian Sea has increased, the amount of seismic energy released in the Central Caspian has increased several tens of times. Along with strong seismic events, a large number of weak earthquakes occur in the study area, which make it possible to study the seismicity of this region in connection with its deep structure. Note that the formation, migration and accumulation of hydrocarbons in the Caspian region occur in the sedimentary cover. Although various geological and geophysical studies have been carried out to date, no exploration work has been carried out in the region, taking into account the seismic geodynamic conditions of oil and gas and their patterns.

In the water area of the Caspian Sea, 90% of hypocenters are distributed at a depth of more than 35 km. However, there are also surface earthquakes. As can be seen from Figure 2, 10% of the hypocenters are distributed at a depth of 0-20 km, which corresponds to the Meso-Cenozoic sediment complex, which is promising in terms of oil and gas potential. The manifestation of earthquakes in the sedimentary cover indicates that the layers in this range are in a mobile energy state. The formation, migration and discovery of hydrocarbons are associated precisely with this interval. Recent studies have shown that there is a certain pattern between oil and gas fields and seismicity in the same interval. The relationship of seismic activity and its role, among other factors, in the formation of hydrocarbons in the indicated depth interval has been proven by experimental studies [4].

The development of geological exploration and large-scale hydrocarbon production in the future will lead to new major discoveries, new major economic projects and intensive development of the oil and gas complex in the region. In this regard, the study of the history of the formation and development of the oil and gas complex of the Caspian region is an urgent task and, undoubtedly, the analysis of history can contribute to the development of the oil and gas complex. For further development of the territory of the Caspian Sea, it is necessary to intensify the development of geological exploration and the introduction of innovative technologies into the practice of hydrocarbon production, which in the future will allow developing the oil and gas complex in the region at the proper level. On the other hand, the effect of earthquakes on the process of involvement in the filtration flow of oil is the greater, the smaller the depth of the earthquake source that caused filtration pressure waves in the deposit. Taking into account the fact that in recent years the level of seismic activity in certain sections of the Caspian water area has increased, and the amount of seismic energy released in the Central Caspian has increased several tens of times, it can be assumed that the change in oil production in many offshore fields in the northern part of the Absheron-Pribalkhan fold system is associated precisely with this. The development of oil and gas resources in the territory of the Caspian Sea is currently an urgent problem, the solution of which largely determines the growth of reserves and the growth of oil and gas production.

Method. Factors to consider before and after oil and gas production. Oil production in the Caspian Sea is also important for other Caspian countries. It is for this reason that Caspian countries are trying to take advantage of the opportunities of the oil and gas sector of the sea. However, in order to properly use the resources of the Caspian Sea, seismic factors must be taken into account. It is necessary to take advantage of the seismic methods used in the process of drilling boreholes in the relevant literature. One of them is seismic exploration. Seismic exploration is used to solve the following geological issues: a) seismo-geological zoning of territories and identification of rock complexes; b) tracking and mapping of geological boundaries in the sedimentary cover; c) study of the relief of the surface of the crystalline foundation; d) identification and detailed study of traps; e) detection of tectonic faults, etc. There are two main methods in seismic exploration: the method of reflected waves and the method of refracted waves. The method of reflected waves is based on the registration of seismic waves that have bounced off the boundaries between rocks with different wave resistances. The method of reflected waves is carried out along profiles, on which, at certain distances, points of excitation of seismic waves and recording devices are located. Seismic waves are excited by explosive charges located on the surface, in wells, in water, or by non-explosive sources (vibration or impulse). Reflected seismic waves are recorded by seismic receivers, which. Fluctuations are converted into electric charges transmitted by cable to a seismic station, where after filtering they are recorded in the form of seismograms [8].

The intensification of oil and gas production in large oil and gas regions, in turn, causes changes in the natural (geological) environment, including a significant restructuring of hydro-gas-dynamic and geodynamic processes in the earth's crust to depths of up to ten or more kilometers in areas up to several tens of thousands of square kilometers, creating conditions for the emergence of a number of environmental problems that

significantly affect the development of nature and the quality of life of the population in the region. As a result, dangerous physical-geological and techno-natural processes develop in large oil and gas regions, causing an increase in seismic activity with unpredictable consequences. The solution to this problem is possible on the basis of an interdisciplinary comprehensive study of the processes occurring in the subsoil under the influence of hydrocarbon (HC) production using a number of scientific disciplines - mathematics, physics, geology, hydrogeology and hydraulics, technogenesis teachings, accounting for technological processes and much more. Basically, only at the intersection of sciences is it possible to effectively solve the tasks set for the study of technogenesis in the bowels. The knowledge of these processes will allow answering many questions on improving the safety of oil and gas production, their transportation by pipeline transport, ensuring the safety of the population and its activities in the region. The complexity of the problem lies in the coverage by technogenesis of large volumes of the upper part of the complex in structure and natural dynamics of the earth's crust [5]. The solution of geocological problems caused by hydrocarbon production is based on the results of a study of natural and technogenic changes in geophysical and geodynamic processes in the areas of developed oil and gas fields and the identification of geophysical, geodynamic and other indicators of technogenic transformation of the geological environment.

Discussion. On the necessity of seismic cooperation between the countries of the region. Cooperation in the seismic field in the Caspian Sea and between the countries of the region in general is important. There are also some examples in this field. General Director of the Republican Seismological Service Center under ANAS, Gurban Yetirmishli, participated in the discussions on "Mineral raw material base of the Caspian region" organized by the Russian State Geological Exploration University named after Sergo Orjonikidze of the Ministry of Education and Science of the Russian Federation. Q. Yetirmişli also held a number of meetings on the development of bilateral cooperation. Also, an Agreement on "Scientific-technical cooperation" was signed between the Russian State Geological Exploration University named after Sergo Orjonikidze and the Republican Seismological Service Center under ANAS. The document was signed by Vadim Kosyanov, rector of the Sergo Orjonikidze State University of Geological Exploration of Russia, and Gurban Yetirmishli, director general of the RSXM. The agreement envisages the expansion of relations within the framework of bilateral cooperation, mutual exchange of experience, conducting joint scientific research on the Caspian Sea basin, studying environmental risks [6].

It is known that the memorandum on the "Dostluq" field is a new page in the history of the development of relations between Azerbaijan and Turkmenistan. This is an oil and gas field the estimated reserve of the field allows to put it in the same line as fields like "Karabakh". The important point here is that the reserves will be determined by modern seismic exploration methods. Scientific cooperation with neighboring countries, including Azerbaijan, is very important for Turkmenistan, according to the published material of the Institute of Seismology of the Academy of Sciences of Turkmenistan. Since extremely rare seismically active regions thousands of kilometers long are located within the same state. Each of these regions is usually characterized by the unity of seismogeodynamic development. In Turkmenistan, at this stage, a new map of the seismic zoning of the territory is being developed. Without information about the frequency and strength of earthquakes that occurred in the past in the border areas, it is impossible to build a reliable map of zoning (10). The new map is needed to assess the socio-economic and environmental vulnerability of territories, rational land use, earthquake-resistant construction and seismic risk reduction. The Scientific Research Institute of Turkmenistan notes that one of the innovations in early recognition and possible warning of earthquakes is the RNM ASP (Station of robust noise monitoring of anomalous seismic processes) seismoacoustic station created in the Republic of Azerbaijan. There are five such stations in Azerbaijan that monitor seismoacoustic noise. Specialists of the Institute of Cybernetics of the National Academy of Sciences (NAS) of Azerbaijan at international conferences held in Ashgabat have repeatedly presented reports on the results of experiments on monitoring anomalous seismic processes. Held on the initiative of President Gurbanguly Berdimuhamedov in the Avaza National Tourist Zone on August 12, 2019, the First Caspian Economic Forum launched the implementation of joint investment projects and programs, the development of joint promising areas of cooperation between the regions of the Caspian states. This forum also intensified cooperation between scientists from the Institute of Seismology and Atmospheric Physics of the Academy of Sciences of Turkmenistan and the Institute of Control Systems of the National Academy of Sciences of Azerbaijan. In order to implement the Program "Reducing seismic risk in seismically hazardous zones of Turkmenistan" approved on January 23, 2019 and in pursuance of the Order of the President of the country dated February 1, 2019 on the development of international scientific and technical cooperation with the countries of the Caspian region, Turkmen seismologists accepted the proposal of the Institute of Control Systems of the National Academy Sciences of Azerbaijan to create an intelligent system for

identifying information received by RNM ASP stations during the occurrence of anomalous seismic processes. The forthcoming cooperation plans include related work to connect the network of seismoacoustic stations operating in Azerbaijan with the future network of seismic acoustic stations in Turkmenistan. A lot of work preceded the signing of the Memorandum of Understanding between the two specialized institutions. Specialists of the Institute of Seismology and Atmospheric Physics of the Academy of Sciences of Turkmenistan got acquainted with the work of Azerbaijani stations, and analyzed the possibility of creating such a warning system in Turkmenistan. Scientists of the two countries have previously taken part in the discussion of the results of experiments on monitoring anomalous seismic processes. A site for one station was chosen, joint experiments were carried out that demonstrated the efficiency and information content of the seismoacoustic station, and places were identified for the construction of several stations, which, together with the Turkmen stations, will form a unified information system of advance warning [6]

On April 3, 2023, a conference on "Seismic data calibration" was held within the framework of the international project "Extension of the seismic network in the Caucasus and Central Asia" in the city of Almaty, Kazakhstan. Representatives of Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Ukraine, USA and other partner countries took part in the event. Azerbaijan was represented at the event by Sabina Kazimova, PhD in Geology and Mineralogy, Head of the Center's Department of Dynamics of Earthquake Centers. The main discussions at the conference were related to the construction of a velocity model to accurately determine the coordinates of earthquakes. It was reported that accurate data calculation about hypocenters, assessment of seismic hazard, clarification of the location of tectonic faults, obtaining an accurate geological model of the Earth's crust, etc. for this purpose, a new accurate speed model should be established. For that purpose, it was proposed to carry out a number of nuclear and industrial explosions, as well as to register these explosions in seismic stations. Representatives of the participating countries spoke at the conference and talked about currently used speed models. Sabina Kazimova made a presentation on "Seismic caliber experiments in Azerbaijan- past, present and future". At the end of the conference, a protocol was drawn up on the results of the meeting [9].

Conclusions. Thus, it is known that offshore oil and gas production is closely related to the course of seismic processes. The processes taking place in the world, especially the recent earthquakes and their volume, are already very complex. Prevention of these complications, as well as minimizing their consequences, requires regional and international cooperation. In a number of cases, it is possible to find examples of cooperation in the seismic field between the countries of the Caspian region. However, it should be further improved and brought to the form of joint activity of the seismic services of the countries of the Caspian region.

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