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METHODOLOGICAL FOUNDATION OF EFFECTIVE DEEP-WATER MINING IN THE CRIMEA

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МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ ЭФФЕКТИВНОЙ ГЛУБОКОВОДНОЙ ДОБЫЧИ ПОЛЕЗНЫХ ИСКОПАЕМЫХ В КРЫМУ

В статье изложены методологические основы эффективной глубоководной добычи полезных ископаемых в Крыму. В результате интенсивных наблюдений за существующим и возможным взаимодействием техногенных систем при морских горных работах на шельфе и в океане с природной фауной и флорой и по мере накопления данных и установления закономерностей можно ожидать формирования такой научной дисциплины, как морское горное дело. Морское горное дело формируется по мере изучения объекта разработки, его положения в природных системах. Основные научные задачи морской горной технологии на современном этапе включают в себя разработку принципов и методов добычи полезных ископаемых со дна моря.

МЕТОДОЛОГИЯ; ГЛУБОКОВОДНАЯ СИСТЕМА; УПРАВЛЕНИЕ; АВТОМАТИЗАЦИЯ ПРОЦЕССОВ; ЛОКАЛЬНЫЕ СТРАТЕГИЧЕСКИЕ ЦЕЛИ; ТЕРОТЕХНОЛОГИИ.

The article states the methodological foundation of effective deep-water mining in the Crimea. The authors observe the existing and possible interaction of technogenic systems during sea mining operations on the shelf sea and in the ocean with the fauna and flora. Accumulating data and establishing regularities may expect the formation of such a scientific discipline as sea mining. Sea mining is formed during investigating the object and its place in natural systems. The main scientific objectives of the off-shore mining technology include working out all the basic principles and methods of mineral resources mining from the sea.

METHODOLOGY; DEEPWATER SYSTEM; MANAGEMENT; AUTOMATION; LOCAL STRATEGIC OBJECTIVES; TEROTECHNOLOGIES.

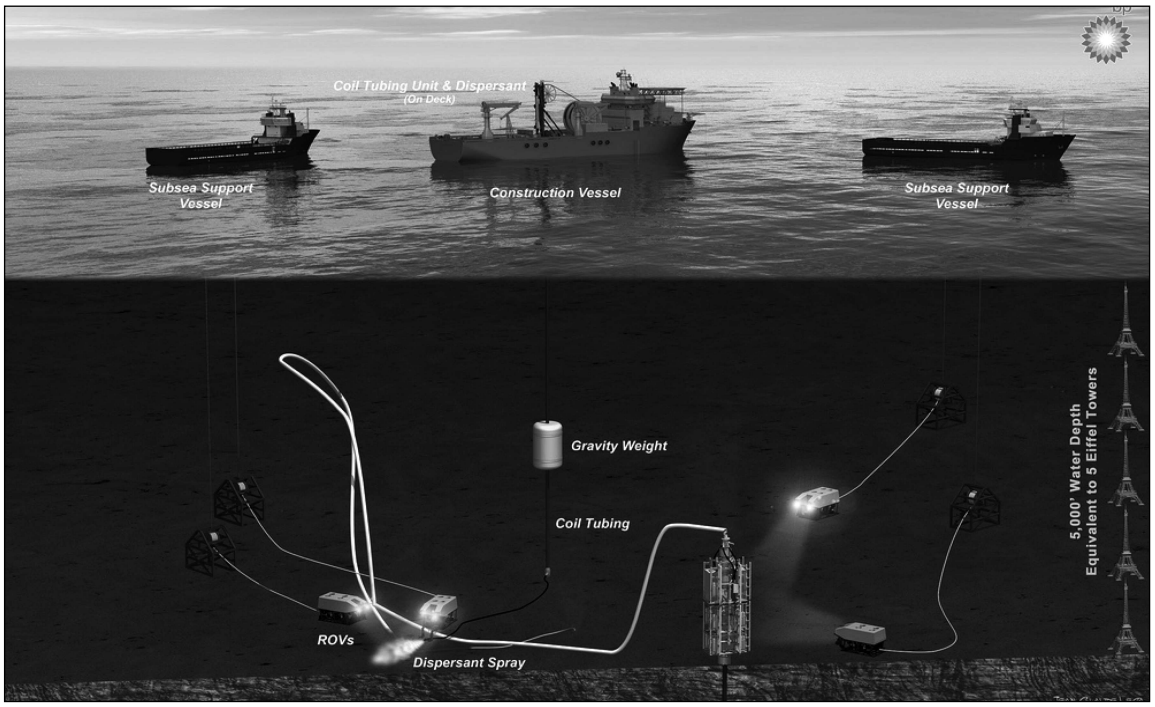
Introduction and Research analysis. In the XXI century the broad-scale development of the sea mineral resources base in the Russian Federation's and the Crimea's shelf zones with the purpose of sea mining gold, amber, tin, copper and other valuable mineral resources is extremely update. Therefore it is important to start the solution of the scientific tasks related to the development of special floating and underwater equipment and to design the technology of underwater mining from the bottom of rivers, lakes, seas and oceans already today [1].

Crimea's water resources include the marine resources of the Black and Azov seas. The sea of Azov is the most shallow sea in the Crimea and has huge sea mineral resources (MR) not only under water, at the seabed, but also in the interior of the seabed. Oil and gas resources are the most potential MR in the water area. There are several gas fields around the Sea of Azov (Kerch-Tamanskaya area — in the South, the vicinity of the village Strelkovoye — in the West, Beysugskoye — in the East, Sinyavinskoye — in the Northeast). The main challenging oil-and-gas bearing stratum of the local water area is the deposits of lower cretacous, and in a smaller extent — Palaeocene, Eocene, Maikop, Miocene and even Pleiocene rocks. In terms of oil content the Maikop rocks are

the most promising ones. Azovo-Chernomorsky iron-ore of Neogene province represented by oolitic iron ores of Cimmerian age is exposed in the western part of the coast. Huge deposits of iron ores with the reserves of billions of tons are likely to be available in the Northwest part of the sea, within the so-called Molochansky trough. They are probably localized on the northern slope of the Azov dike and within this trough. The size of the sedimentary cover in the southern part of the sea in the Indolo-Kubansky trench is huge and reaches 14 km. The considerable part of this immense open-cast has a huge potential of oil and gas. The problem of their extraction is connected with the search for hydrocarbons, i.e. geological structures in which oil and gas are accumulated, in the south of Sea of Azov, in the Kazantipsky and Arabatsky gulfs, the regions of the Strait of Kerch. Iron ores mines of Kamysh-Burunsky and Eltigen-Ortelsky deposit of Kerch pool were developed. The scales of mining were considerable, up to 7.5 million tons annually. The future development depends on iron ores' exploration and mining in the local water area. Quite high concentrations of sandy material, such as aggradation terraces, bars and so forth, are available here. These concentrations are studied and explored in a number of sea's areas, in particular, in the water area of the Utlyuksky firth. Some sand deposits are known to have been found in the water area of Kerch Strait. Mining here is restricted due to nature conservation reasons (protection of the coast against erosion, preservation of spawning areas) [2]. Offshore mineral resources (MR) are difficult and expensive in terms of mining operations (Figure 1). The proportion of risk and possible profit from the production of mineral raw materials, both from the oceanic and the alternative land sources is the criterion in the assessment and choice of mining underwater nonconventional technology.

According to the statistics of American sea mining companies, underwater mining is supposed to be profitable if the return is not less than 30% per 10–15% of land deposits. In the course of preliminary estimation the requirements of the UN should be followed about the assignments in currency approximately 10% of metals' sales revenue a year on average for 20 years of operation.

It is possible to predict today that the deposits with the expected profit not less than 22–50% will be blocked out in the ocean. With the use of technology and the construction of sea floating mining platforms the objects located not only within the given water area, but also within the whole sea subregion



Process of deep-watering mining

(Azovo-Chernomorsky) will have to incorporate gravel deposit on the shelf. There should be the reserves not less than 0,5 million m^3 of gravel on the sea shelf and not less than 2 million m^3 on the shelf of the sea subregion (Azovo-Chernomorsky). All the gravel of the shelf in the subregion with the reserve of more than 10 million m^3 can be incorporated at the grade of the useful component 25% greater than the limit grade. Such parameters are determined by efficiency, technology and the structure of sea geotechnology mechanization on the deposits of the continental shelf [3, 9]. Efficiency is defined by the proximity of dredging and process devices. The most effective structure of complex mechanization and automation are schemes with the maximum proximity of the dredging process to the place of dredging, i.e. with the location of mining and process mechanisms onboard of the mining vessel.

The formation of such structures is carried out taking into account the peculiarities of hydrodynamic processes in case the position of the devices' vertical axis oscillates due to wave impact on a vessel.

The peculiar type of a mining vessel, floating mining and dressing plants (FMDP) [4–6] equipped with dredging and process plants is developed. It is obvious that running such plant depends on the vessel's stability, i.e. influence of the perturbations appearing due to a vessel rolling on the concentration and mining processes. The parameters of a mining vessel process plants for mineral resources need to be chosen so that the production on the vessel would reach its calculated maximum according to the prescribed efficiency.

Broad experimental verification was observed on the vessels of various displacement (from 500 to 5000 t) and the possibility of implementation of all the technological processes in conditions of sea vessels was confirmed.

Problem statement. The purpose of the research is the development of sea mining basic technological principles and problems in terms of physics, geotechnology and engineering. The sea mining technology passed a number of stages and represents today a complex of a number of the disciplines studying fundamental interaction between natural and technogenic phenomena in their interrelations in the process of carrying out mining operations in a marine environment.

The material of research. First of all, it is necessary to refer to applied oceanology which studies the deformation of the bottom of the formed mine and formed bank under the influence of sea waters movement, and the peculiarities of sea waters hydrodynamics change during the mining operations as well as the peculiarities of mass transfer and the stability of coastal and underwater natural landscapes [4, 7–9] to these disciplines. Research in this area is necessary for defining the prospects of development and designing the systems of exploitation allowing us to carry out dredging of minerals without impoverishment.

It is advisable to be guided by the background knowledge of sea mining hydrodynamics uncovering the variability of mineral and size distribution at a certain hydrodynamic situation, the process of natural formations washing out, the process of saturation; the deficiency of sea flows, the peculiarities of formation and pulp flows movement, etc. All this should be taken into account for the restoration processes of the sea placers known more as the regeneration of sea objects (the deposits of Indian coast, Ceylon coast, etc). The background knowledge of underwater mining in the field of acoustic and other fluctuations propagation in pulp flows, and also the peculiarities of coordinates transfer to underwater ranges as well as the supervision of the processes on oceanic ranges are necessary in order to achieve the efficiency of mining operations.

The principle of underwater mining operations organization and production on the placers of the World Ocean based on complex mechanization and automation of mining operations underlies the sea mining technology as a field of research.

The scientific basis of shelf deposit mining technology with the use of floating ore mining and processing platforms with mining and processing equipment installed on sea vessels is being created now, including [1, 4]:

the method of operation and the stripping scheme of working floors' ranges as well as the location and size of underwater trenches and canals;-

the type of mining system and construction, field of work;

the system of complex mechanization and automation of shelf placers production and processing;

the hydrodynamic theory of quasistationarity of the processes on board the mining vessel.

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