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Magnetoacoustic Method at Exploration the Black Ore Mineral Deposits on Shelves of the Seas.

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ABSTRACT

The goal of this research is to consider placer deposits allocation on the shelf on the example of the territory of Russia is given. A specification on fields of the useful minerals (tin, gold, platinum, minerals of Ti, Fe, Zr and amber) is given for mentioned placer deposits. The map of placement of underwater objects in shelf regions of Russia is submitted. In article the description of a new efficient magnetoacoustic method of searches in a shelf zone which principle of application is based on studying of change of magnetic properties of a deposit at local reorganization of its structure due to dynamic influence is also given. The essence of a method consists in carrying out primary and repeated high-precision hydromagnetic survey on the same object of researches. Retakes are carried out by results of seismoacoustic monitoring, which serves for fixing of geodynamic influence. The special attention is paid to deposits of black ore minerals as the most widely developed in coastal and shelf zones of the seas. The magnetoacoustic method will keep not only the considerable financial, human and time expenses for placer accumulation identification, but also health and longevity of people.

Keywords: fields of black ore minerals, magnetoacoustic method for placers search, Russia shelf placer deposits, new method of shelf mineral deposits research.

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INTRODUCTION

In underwater exogenesis mineral deposits of shelf areas the considerable resources of minerals are concentrated, at the same time the class of placer mineral deposits is predominating. Special mining-and-geological conditions of bedding are characteristic of underwater objects that define the methodology of searches, investigations and exploration, principle differ from the land objects conditions. Practice of prospecting works shows that in shelf areas of the World Ocean there is a large number of underwater objects – placer deposits of tin, gold, diamonds, "black", rare-earth and other minerals, many of which are very profitable and are actively explored.

In general the modern ideas about underwater mineral deposits in shelf areas of the country are as follows.

On the shelf of the seas of Russia 12 placer mineral deposits and 30 placers (large manifestations with expected resources) - mainly in the East Arctic sector are established. Among them – two large-scale deposits of tin in the Gully Eterikan and average deposits in Vankiny and Chaunsky Gulfs, large gold-bearing objects in De Long Gully and a lagoon Rypilkhin. Under water there are 55% of resources and 80% of expected resources (P1+P2) of tin. Reserves of gold are concentrated mainly on the land, but 40% of expected resources of metal – in the underwater objects. Numerous placer mineral deposits (11 objects) and gold deposits (6 objects) are known in The Great Peter Bay. Placer deposits of "black" minerals of Ti, Fe, Zr in Tartary Gully are very perspective. Thus, the total of underwater objects with the estimated resources in shelf areas of the country comes nearer to 70 (Table 1 and Figure 1).

Table 1. Underwater mineral deposits on the Russia shelf

Object type	Mineral type	Objects' name and quantity ( )	Location of objects
placer deposits	Tin (cassiterite)	Placer mineral deposits group (2) and placers (2)	Eastern part of the Laptevs Sea
		Placer mineral deposit (1)	Vn'kina Bay
		Placer mineral deposits (2) and placers (3)	Chaun Bay
		placers (4)	Long Gully, East-Siberian Sea
	gold	Placer mineral deposits group (6) and placers (11)	Great Peter Bay in the Japanese Sea
		placers (2)	South of the Karskoe Sea near the Taimyr Peninsula
		Placer deposits group (2) and placers (2)	South of the East-Siberian Sea
		Placers group (4)	Southern part of Okhotskoe Sea
		placers (2)	Western part of the Okhotskoe Sea
		placers (2)	Eastern part of the Okhotskoe Sea
	platinum	placer (1)	Southern part of Okhotskoe Sea
	Ti, Fe, Zr minerals	placers (1)	Baltic Sea
		Placers group (over 20)	West of Tatarskiy Gully
		placer (1)	apanese Sea near the Hasan Peninsula
		Placer (1) Prostor Bay	Iturup Island
	amber	Placer shows near the coast of Sambiyskiy Peninsula	Baltic Sea
Notice: placer mineral deposits are the objects with calculated resources; placers are the objects with expected resources			

In world practice of mining one of the most important types of the mineral resources got from placer deposits of shelf zones of the World Ocean is cassiterite (the main mineral of tin). The leading place belongs to the countries of Southeast Asia - Indonesia, Malaysia, and Thailand. The share of placer deposits in the total amount of production is: on the World - 53,4% (in Asia - 80,5%), in Russia for the end of the 1990th it was 12,4%.

In Russia one of the main tinny regions is the Northeast, however placer deposits of cassiterite in its shelf area still remain nonconventional, rather potential sources of tin. Such situation is bound, in particular, to poor study of a zone of the shelf and features of a shelf placer's formation, and also low experience of placer deposits exploration on the water area. Prospecting works on the shelf and islands of the East Arctic seas allowed to establish a number of placer deposits areas, including the considerable on scales and that is not less important, with high contents of tin in fields [1].

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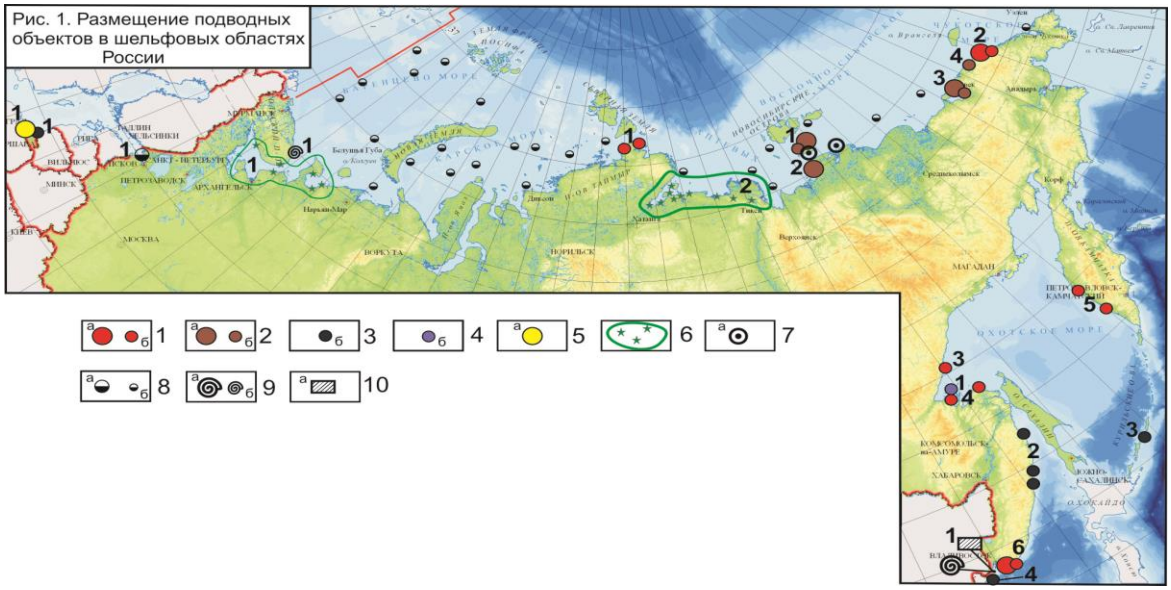

Figure 1. Underwater objects location in shelf area of Russia

Explanation

1-7 – placer deposits and their number on the scheme (а – deposit, б – large-scale shows): 1 – gold (1 – Palanderskiy and Unginskiy knots, 2 – Ryveemskiy knot, 3 – Aianskiy knot, 4 – Prishantarskiy area, 5 – Bol'sheretskiy area, 6 – Yuzhnoprimorskiy area); 2 – stannum (1 – Liakhovskiy area, 2 – Chokurdakhskoe field, 3 – Pevekskiy knot, 4 – Billingskiy knot); 3 – titanium, iron and zirconium minerals (1 – Kurshskaya placer, 2 – Vostochnoprimorskiy area, 3 – Kuril area, 4 – Khasanskiy knot); 4 – platinum (1 – Feklistovskiy knot); 5 – amber (1 – Sambiyskiy area); 6 – prognostic diamonds zones (1 – Belomorsko-Barentsevskaya, 2 – Yuzhnolaptevskaya); 7 – mammoth bone (Severoyakutskaya province).
8-10 – others mineral deposits (а – fields, б – deposits): 8 – shelf iron-manganese concretions (1 – Vostochno-Finskiy area); 9 – shell rock (1 – Sviatonosskaya province, 2 – Yasnoe field); 10 – organic-mineral sludge (1 – Yuzhnoprimorskiy area).

MATERIALS AND METHODS

As far as placer concentration of minerals contents, besides the useful components, in the significant number of heavy fraction minerals, in particular, a magnetite, titanomagnetite, an ilmenite which existence leads to formation of the abnormal magnetic field of various intensity. In 2015 in VNIIOkeangeologia V. K. Palamarchuk offered a new magnetoacoustic method of searches of placer mineral deposits on the shelf. The offered method allows separating the anomalies created by magnetic minerals accumulation from anomalies, the bound to other magnetorevolting objects which do not have a direct connection with minerals, for example, rocks on which placer deposits are located. This method is applied when studying coastal and sea placers [2].

It is offered to carry out such division of anomalies according to their natural sources in the monitoring mode, by tracking of the structural changes of a magnetic field caused by structural changes of the productive horizon of a placer, quite often characterized by restructuring of layer as a result of wave influence. In more exceptional cases restructuring is possible on the placer deposits localized in regions of neotectonic ("living") faults. Existence of faults is characteristic of tectonic ledges placers: tectonic failures define conditions of formation and localization of objects of this major geological and production type of large-scale and unique deposits.

EXPERIMENTAL

The essence of a method is carrying out primary and repeated magnetic surveys on the same object of research. Retakes surveys carry out by results of an assessment of daily monitoring of energy of microearthquakes. Searching is carried out on detection of typical difference anomalies in a magnetic field of Earth.

The contours of anomaly detected by difference map are transferred to the map of a magnetic field, and the quantitative interpretation of anomalies is made for an assessment of a depth of the lower edge (sole) of placer layer. Further on an infrequent network approbation is implementing (not necessarily on all anomalies), and the assessment of the useful components concentration of placer layer is carried out. Anomalies of the useful components are determined by excess of their contents over a background on 1 — 3 errors of determination of their concentrations.

As a result the location of perspective for new placer deposits sites detection is realized. Such preliminary (qualitative) contouring of the detected deposits allows reduce the volumes ща geological testing and, as a result, to lead to the considerable decrease of cost indexes of prospecting works.

RESULTS AND DISCUSSION

Placer accumulation and black ore minerals deposits (mainly magnetite and ilmenite) widely developed in coastal and shelf areas. Their generation as result of physical and chemical rotting of rocks and minerals usually accompanied with transferring of land waste by water and air flows and their sedimentation, repeated washing up and heavy minerals resedimentation on sea bottom and in coastal zones as a result of hydro- and litodynamics. The applicable processes are also influenced on placer deposits with natural (such as a volcanic eruption, neotectonic motions, climatic factors and etc.) and technogenic genesis. The applicable processes often have short-term and unexpected character, but considerably change regularities of formation of placers accumulation on certain squares of shelf zones of the seas already on stages of their origin.

Russian geologists studying the placer mineral deposits on coastal and shelf zone of Arctic and FarEast seas since 1950th (their genesis, content, conditions of formation and development) from the moment of VNIIOkeangeologia creation.

In a coastal zone of the seas the waves and flows sort minerals by specific weight and the size, by their resistance to chemical aeration and a mechanical attrition. Most often ores concentrate on sites of coast' scouring from which the light minerals are easier taking away. Here the surface of the beach is covered with layer of black color sediments. Layers of concentrates are found also in the thickness of deposits at a digging or drilling. The diluvia or buried placer deposits of black ore minerals are typical for coastal zone of the seas of Russia, China, Vietnam, India and other countries.

Magnetite ($FeO{\cdot}Fe_2O_3$) is one of the main black ore minerals, contains 72,4 % Fe, and also Ti and V; the others are *ilmenite* ($FeTiO_3$), pyrrotine (Fe^{+2}, Fe^{+3})S and small parts of meteorites submitted by nickel iron. Black ore placers practically always accompanied by other valuable nonmagnetic (zircon) and electromagnetic minerals. Zircon $ZrSiO_4$ as a rule contents different rare elements and uranium who is very toxic.

Japanese Sea. Great Peter Bay. Studying of structure of placer accumulation of black ore minerals in a coastal zone of east seas of Russia, on example of the Great Peter Bay showed that in minerals of the "black" schlich among which the magnetite and an ilmenite prevails also the content of the platinum metals group placer, first of all Pd and Pt is usually large. Besides, minerals of the "black" schlich in placer deposits usually accumulating with gold which sometimes marks productive layer [3]. At the bottom of the Peter Great Bay, bottom sediments are characterized by existence of placers, placer deposits shows and the schlich auras of gold, silver, tin, a titanomagnetite, magnetite, ilmenite, zircon and other minerals and generally their area often coincide. SnO2 tin is frequent in sediments associates with a radioactive monocyte (Ce, La, Nd, Th) PO [4].

Russia Arctic seas. Analysis of mineral composition of Arctic seas bottom sediments including geology, neotectonic, physical geography and other factors defined the processes of sediment for each area of sea allows detecting the field with high contents of placer generating minerals in bottom sediments of Arctic seas of Russia[4]. As a result it was succeeded to reveal sharp regularity: Fields of the increased content of zircon, pomegranate, titanium and black ore minerals, along with percentage of heavy fraction minerals, in the Holocene sediments of the Arctic seas of Russia, often gravitate to each other that is caused by features of structure of sediments, individual characteristics of concrete minerals and constantly changing applicable physiographic and neotectonic factors.

Chinese coastal zone characterized by often detecting of placer accumulations or black ore mineral deposits on the beach [5].

Vietnam. Placer an ilmenite - titanium magnetite accumulations are widely developed in a coastal zone of the country. They usually associate with zircon. Along the coast of the South China Sea coastal and sea beach and dune titan-zirconium placers of the Holocene, and in the central part of Southern Vietnam – Pleistocene age are detected. Ilmenite-rutile-zircon placers are developed along all coastal line, over 40 placer deposits. The main commercial deposits are concentrated on the coast of the central Vietnam.

Black ore minerals deposits are widely developed in coastal zone of seas, especially in Asia; moreover they usually treated with other useful minerals and metals. But these accompanied minerals usually are toxic because of radioactive minerals content.

CONCLUSIONS

Most effective method of placer deposits search on water areas is high-precision magnetic survey, however, it is difficult to detect the “placer effect” in magnetic field anomalies. Offered magnetoacoustic method allows deciding this problem by tracing the changes of thin structure of magnetic field caused by dynamically local restructuring of a placer deposit. There is need to notice that such kind of dynamic changes attached to coastal placers, characterized by deposit’ restructuring as a result of wave influence.

At the magnetoacoustic method using the any minor change in structure of sediments and contents of magnetic and, partly, nonmagnetic, often radioactive minerals is possible. The magnetoacoustic method, on simplicity, high-speed parameters and speed of interpretation of the received results, thus, will keep not only the considerable financial, human and time expenses for placer accumulation identification, but also health and longevity of people.

Magnetoacoustic method implementation for black ore minerals placer search will allow getting the follow effects:

- Reducing of timetable and work expenses.
- Increasing the effectiveness of search.
- Decreasing the volume of geological testing.
- To expand mineral resources in short time (in comparison with traditional complex methods implementing).

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