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Gashydrate Decomposition and Methane Flux in the Okhotsk Sea Area as Result of Seismo-Tectonic Activization

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Abstract: As a result of gasgeochemical research carried out in the Sea of Okhotsk by the Gasgeochemistry Laboratory of the POI FEB RAS for the period from 1984 to 2005, the background and anomalous fields of methane are explored in the seawater on the east shelf and slope near Sakhalin. It is revealed that on the boundary of 1988-1989 there was a sharp increase of methane concentration in the seawater of this area - background values by 2-3 times (70-80 nl/l), and anomalous ones by 1000 times and more (10 000 – 20 000 nl/l). Data analyses allow us to conclude that this phenomenon is conditioned by the increase of seismo-tectonic activity. The flux of natural gas became stronger from the sources to the seafloor, from the seafloor to the water and, finally, to the atmosphere due to renew of fault zones. Moreover, the amount of methane vents on the north-eastern Sakhalin slope has increased from 2-3 to more than 100 till now. The most representative hydroacoustic anomalies "flares" mapped there, are referred to the methane hydrates studied by direct methods. The received outcomes indicate the urgency of the study of the formation-dissociation mechanism of gashydrates and the influence of the methane flux from hydrocarbon sources on the environment.

Introduction

Presented are the explore results of gasgeochemical fields, methane sources (gashydrates, oil and gas deposits, etc.) in the Okhotsk Sea region and their influence on the environment received by the Gasgeochemistry Laboratory during 1984-2005. For this period a great number of gasgeochemical fields and methane anomalies has been revealed in the Sea of Okhotsk. They are referred to the zones of submarine gas discharge: "Obzhirov", "Gizella", "Ervin" - up to 23 000 nl/l of methane in bottom seawater (2000), "Chaos" - 2000 nl/l, "Obzhirov" – 260 000 nl/l (2003), etc. From 1998 to 2004 the complex geological, geochemical and geophysical research of the Okhotsk Sea area as a common natural system were carried out in collaboration with the GEOMAR Marine Center (Germany) within the framework of the Russian - German Program "KOMEX". The basic direction of the project research was the study of gashydrates, methane vents, their interaction with sedimentary complexes, geological structures and tectonics of the region. In 2003 and 2005 the more detailed study of the areas of gashydrate distribution on the north-eastern slope of the Sea of Okhotsk was carried out within the framework of the Russian – Japanese - Korean Projects CHAOS - 1 and CHAOS - 2, accordingly.

The basic purpose of the research was the study of gasgeochemical fields and seasonal methane concentration in the water and in the bottom sediments of the Sea of Okhotsk, the elucidation of the seasonal and annual variability of methane submarine discharge, and the definition of methane sources and role during the change of the state of surrounding natural environment, also. Special attention has been given to the all-round exploration of the mechanism of gashydrate formation and decomposition.

Methods

Water samples to measure methane were taken from Niskin bottles of the Rosett without contact with air. Gas is extracted from the water by a vacuum line and is analyzed by gas chromatography aboard the ship (Obzhirov, 1993). Sensitivity of the hydrocarbon analyses is 0.00001%. To check the correction of analyses we used the gas standard from the USA.

Results and discussion

The most intensive anomalous fields in the water of the Sea of Okhotsk, exceeding the background 100 times and more, are formed on the north-eastern shelf and slope of Sakhalin. Mainly, the methane discharge in this area is a result of the decomposition of gashydrates, located near by active deep faults (the natural gas vents "Obzhirov", "Gizella"). The process of methane discharge as a result of gashydrate decomposition for the first time was found in 1986 on the north-western slope of Paramushir Island [1]. Here, at the depth of about 800 m the gas bubbles (mainly methane) went from bottom sediments to the water column and created a sound-scattering flare (acoustic anomaly) in an echogram, which height was 200-300 m. As a result of the research carried out by the employees of the Institute of Volcanology and Oceanological Institute (Zonenshain, etc., 1987), in the methane vent area gashydrates were found in the seafloor sediments.

The study of gasgeochemical fields in the Sea of Okhotsk has shown that on the boundary of 1988-1989 there was a sharp increase of methane concentration in bottom seawater [1]. The sharp increase of methane concentration, probably, is connected with seismo-tectonic activization in the Okhotsk Sea area. As a result the thermal flow has amplified through fault zones, rock layer, containing gashydrates and blocking free gases, has broken. Natural gas began to come to the seafloor surface both from under gashydrate covers and during gashydrate decomposition with the escape of methane bubbles from the seafloor sediment to the water and in some place from the sea surface to the atmosphere. Methane fluxes going from gashydrate decomposition created sound-scattering flares (the acoustic anomalies of various forms) in an echogram. From oil-gas bearing layers methane migrated via fault zones to the water column like seep without acoustic anomaly. Originally 2 hydroacoustic anomalies describing methane fluxes have been discovered. By 1995 their amount has increased (about 30). The same year there was an earthquake on the north-east Sakhalin, in Neftegorsk area. By 2002 the amount of methane vents in the area of the Sea of Okhotsk has exceeded 100. As research shows, all these natural gas vents are referred to the intersection zones of the faults of the north-western and north-eastern direction controllable by the East Sakhalin fault zone, influencing the seismo-tectonic activity of the north-eastern shelf and slope of the Sea of Okhotsk [2]. Investigations point to the continuation of the activization of seismo-tectonic processes in the Okhotsk Sea region in 2002 and, as a consequence: the increase of the area of gashydrate decomposition and the amounts of methane vents from sediments to the water. Obtained data in 2003 – 2005, confirm the aforesaid and show to the further intensification of the seismo-tectonic activization process. The monitoring of methane content in the area of gas bubble vents has shown that its concentration (May- June, 2005) remained so high during research, as well as at the previous expedition (2003).

The research carried out in a gashydrate field on the slope of Paramushir Island shows that in the bottom seawater in the place of methane vents, since 1985, methane concentration constantly grow (from 120 up to 500 nl/l). At the beginning of October, 1994 the methane concentration reached 500 nl/l already. The measurements of gas contents after Kunashir earthquake show the increase of methane concentration by 2 times and more. The earthquake epicentre was situated 300 km from Paramushir Island, but due to the sharp increase of the methane concentration in a water column in the area of gas vents, it is possible to assume about the seismo-tectonic activization in the region of the Kuril Island Arch in October of 1994.

Conclusions

1. In the Sea of Okhotsk the significant amount of abnormal methane fields is revealed. The most intensive anomalous fields in the water of the Sea of Okhotsk, exceeding background values by 100 times and more, are fixed on the north-eastern shelf and slope of Sakhalin. Probably, it is connected with the increase of seismo-tectonic activization in the area.

2. The new flares are located mostly in line flares: "Erwin"-"Gisela"-"Obzhirov" (from the shelf to the slope in the north-east direction). This area is a fault zone. Methane escapes via the fault zone from the oil-gas bearing in sediment layers and sediments containing gashydrates. Methane bubbles come to the water column and create an acoustic anomaly.

3. As a result of the research of the relation of methane fluxes with the seismo-tectonic processes in the Okhotsk Sea area it has been revealed that the periods of methane concentration growth accompany the earthquake events in this region and after that the stabilization of submarine gas discharge takes place.

4. The gasgeochemical data (methane anomalies) can be used for the forecast of natural catastrophes (earthquakes, etc.).

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References

1. Obzhirov A.I., Astahova N.V., Lipkina M.I., Vereshchagina O.F., Mishukova G.I., Sorochinskaya A.V., Yugai I.G. Gasgeochemical zoning and mineral associations of the bottom of the Sea of Okhotsk. Vladivostok: Dal'nauka, 1999. P. 184.

2. Obzhirov A.I., Salyuk A.N., Shakirov R.B., Druzhinin V.V., Mishukova G.I., Ageev A.A., Salomatin A.S., Pestrikova N.L., Veselov O.V., Kudel'kin V.V. Methane flux and gashydrates in the Sea of Okhotsk // Science and technics in the gas industry. Moscow: Publishing house OOO "IRTS Gasprom", 2004. № 1-2. P. 20-25.