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Gas hydrates, cold seeps, geothermal systems: methane-hydrogen release

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TECHNOLOGY AND INNOVATION CONCLAVE 1.0

POI FEB RAS

Vladivostok, Russia

Today, as a response to the global challenges of nature and the increasing needs of society, research at the intersection of environmental sciences and mineral resources is of great importance.

Scientific issue - the development of advanced technologies and of innovative methods of forecasting, prospecting for mineral resources and studying their impact on the environment.

The goal lies within the framework of solving applied problems:

- **Geo-mapping based on marine scientific research expeditions**
- **Development of methods for complex gas-geochemical monitoring and flows of methane and hydrogen**
- **Development of bioindication methods hydrocarbon deposits**

BIG CHALLENGES AND PRIORITIES

STRATEGY OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

ENERGY GENERATION AND CONSERVATION → ENVIRONMENTAL CLEAN ANDRESOURCE-SAVING ENERGY,NEW ENERGY SOURCES

DEPLETION OF NATURAL RESOURCESRESOURCES AND ECOLOGICAL PROBLEMS → EFFECTIVE INTERACTION MAN, NATURE AND TECHNOLOGY

The increasing interest of scientists in mechanisms of transformation, transfer, and circulation of various forms of carbon compounds in the oceans

close connection with the most important challenges of our time: the threat of exhaustion of oil and gas resources, environmental protection from industrial pollution, rational use of biological and mineral resources of the oceans

Assessment of natural ecosystems of the World Ocean

is an important area of research and requires the integration of various disciplines and a wide range of methods

Multidisciplinary studies of geochemical, geological and biological processes make it possible to predict their impact on the carbon cycle and deposition

Study of biogeochemical pathways, fluxes and transformations of methane, hydrogen, hydrocarbons and persistent organic compounds in the marine environment

- ✓ **complex indication of mineral resources and study of their impact on the marine environment**
- ✓ **the impact of methane emission on the global climate**

The role of the interrelationships of geochemical, geological and biological processes is still poorly understood:
we need systemic interdisciplinary research covering several fields of knowledge

Justification

- **Gas hydrates are important marine phenomena** which significance is growing up from year to year but still studied poorly in marine expeditions due to the lack of international cooperation.
- **Gas hydrates were found in many areas of the Western Pacific and Indian oceans**. Numerous unique gas hydrate accumulations nowadays are object of few focused projects studies in different countries.
- **Nature and evolution of the gas hydrate system** in the lithosphere and hydrosphere, which in respect to environmental agent is one of **the most uncertain and debatable problem** of World Ocean.
- **Fluxes of methane** from sea bottom are associated with gas hydrates located below surface sediments
- **Methane, carbon dioxide and hydrogen** fluxes from the marginal seas plays a significant climatic and social role.

We suggest to organize a long-term collaborative international project to study gas hydrates by Western Pacific and Indian oceans community on bases of mutual understanding, scientific, and administrative collaboration.

MODERN INTERNATIONAL RESEARCH PROGRAMS

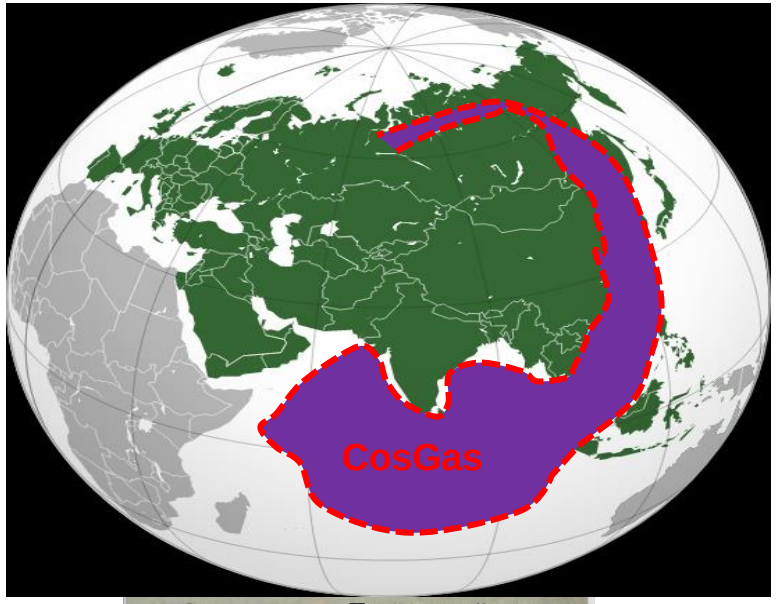
GAS HYDRATES AND METHANE-HYDROGEN EMISSION

National Action Plan for the UN Decade of Ocean Sciences for Sustainable Development has been approved

GEOSYSTEMS AND MINERAL RESOURCES IN THE TRANSITION "CONTINENT-OCEAN" ZONES AND OPEN OCEAN (GEOMIR)

geomapping and mineral resources data sharing by the science-based strategy based on marine expeditions, experiments and theoretical work to provide open asses of the mineral resources data bases

The head of the project is deputy director POI FEB RAS, Doctor of Sci. Shakirov Renat



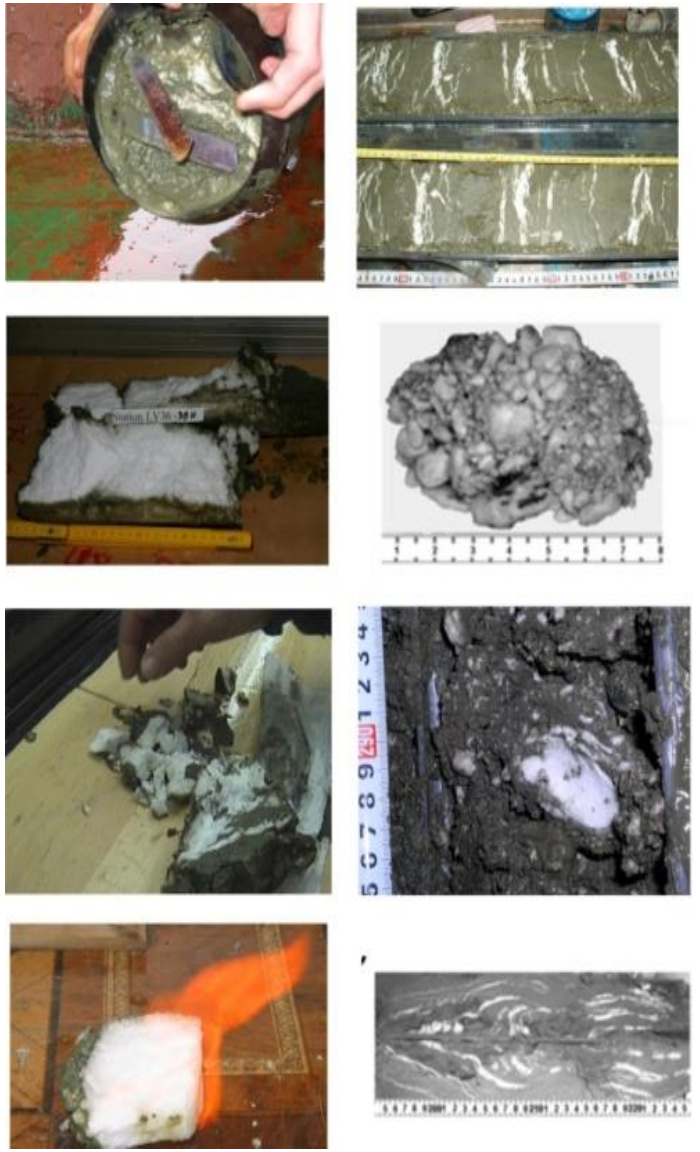
Working Group (April 2021) on Gas hydrates and Methane Fluxes in the Indo-Pacific-Arctic region (CoSGas)

Study gas hydrates and methane fluxes

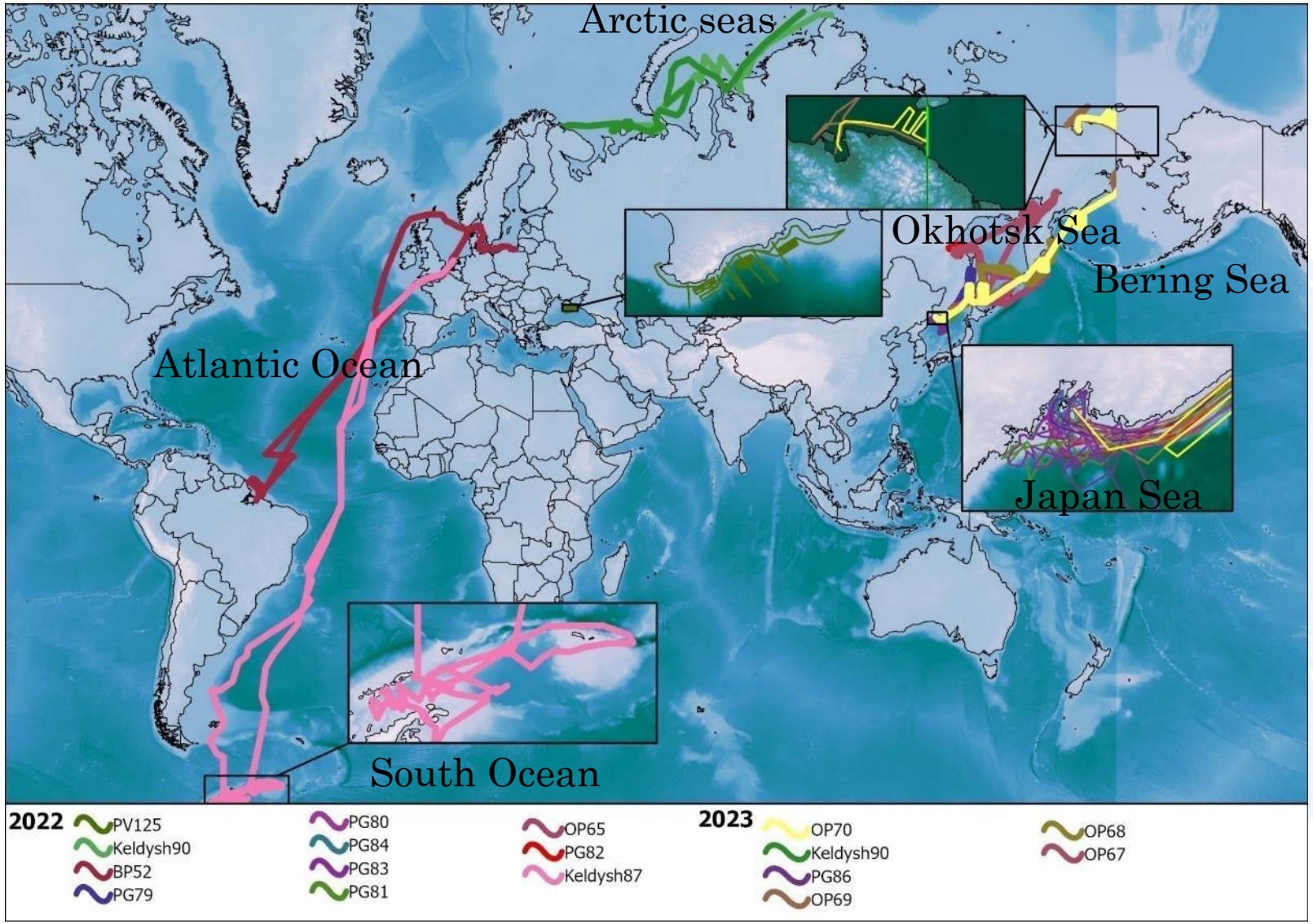
Co-heads of the group are Doctor of Sci. Shakirov R.B. (Russia) and Professor Nengyou Wu (China)

POI FEB RAS has extensive experience in marine scientific research for gas and gas hydrates since the 1980s

- **POI research in western Pacific in 1980-th;**
- **KOMEX Project (Russia-Germany, 1997-2004), Okhotsk Sea;**
- **CHAOS Project (Russia-Japan-Korea, Belgium, Germany, 2003-2005), Okhotsk Sea;**
- **SAKHALIN project (Russia-Japan-Korea, 2005-2006), Okhotsk Sea;**
- **SSGH Project (Russia-Japan-Korea, 2007-2015) Okhotsk and Japan Seas;**
- **MULTISGAS Project (Belgium-Russia, Japan, 2002-2004), Lake Baikal**
- **Nowadays – developing projects with Vietnam, South-China Sea (3 expeditions 2017-2019)**
- ***and 40 years research in western Pacific and nowadays in Arctic***



POI FEB RAS marine expeditions in 2022-2023



Assessment of mineral resources and natural ecosystems

- Gasgeochemistry, geochemistry
- Geomicrobiology
- Biochemistry
- Oceanology
- Geology, geophysics
- Geoecology
- Remote sensing

multidisciplinary research

Scientific research of the POI FEB RAS is aimed not only at the development of fundamental science, but also has its customers from business

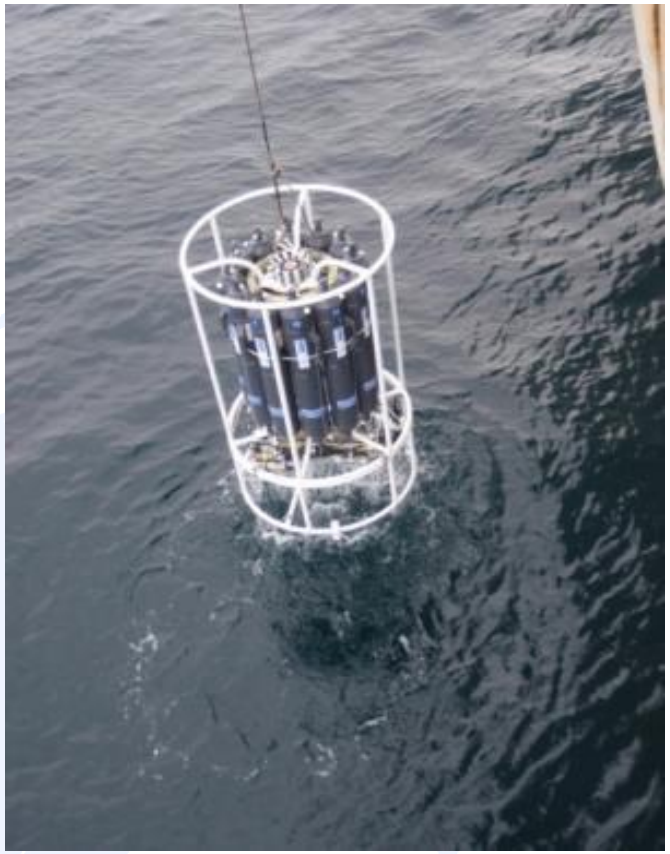
Marine research was also carried out with sediment and water sampling

R/V «Academic M.A. Lavrentiev»

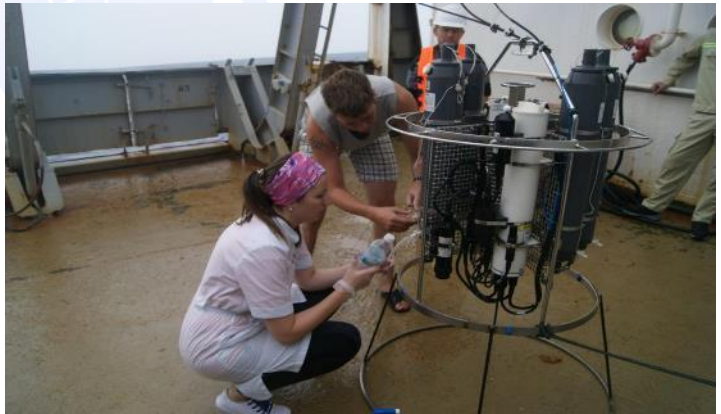
Hydrostatic core sampler

Gas hydrate sediment core

R/V «Academic Oparin»

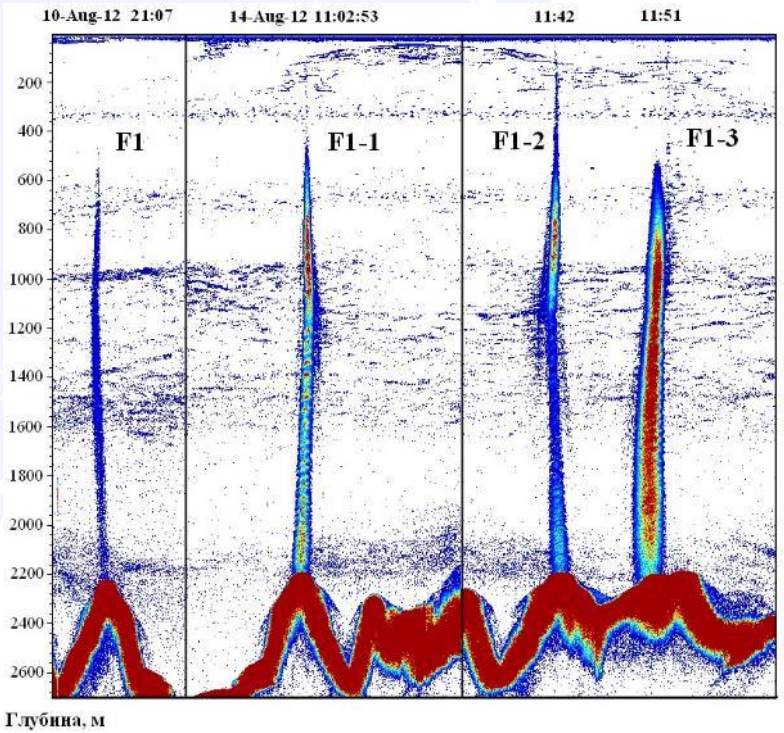


SBE ECO-55 carousel with 4 liter Niskin bottles



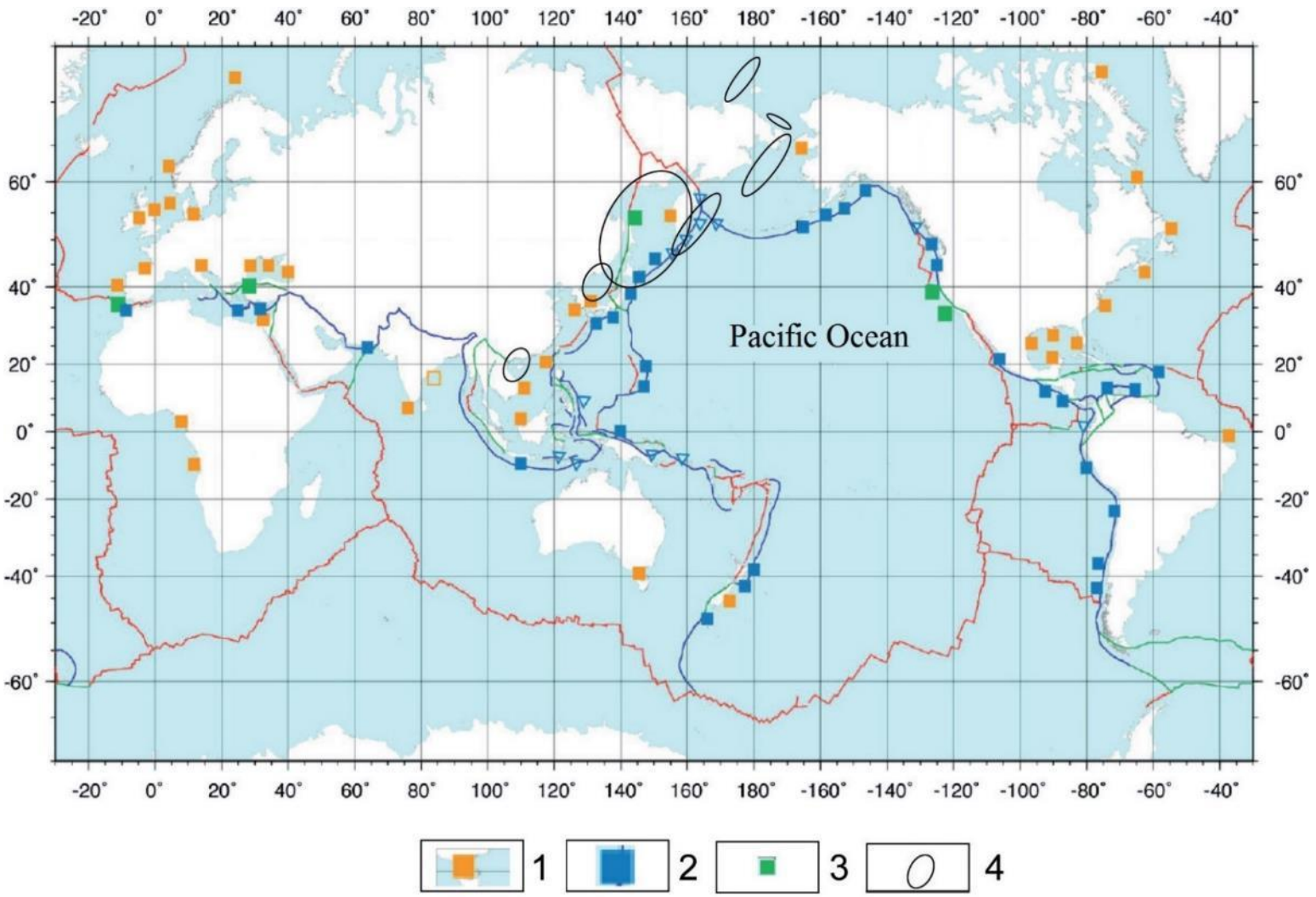
R/V «Professor Gagarinsky»

Magnetic research



Hydroacoustic research

Main areas of methane flows and distribution of gas hydrates



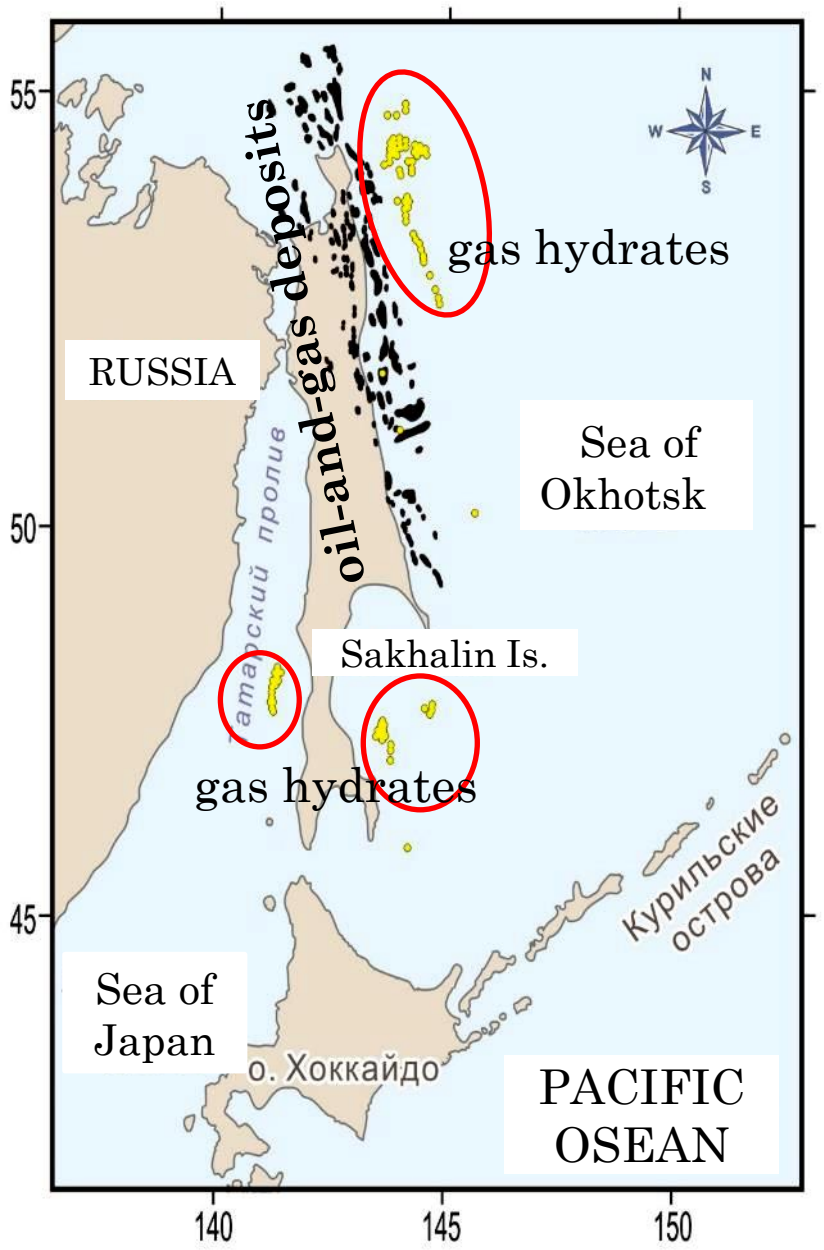
- ✓ Shallow methane hydrates are found widely: mostly 270-1500 m below sea surface; 50-700 cm below seafloor.
- ✓ Gas hydrates are associated to oil and gas deposits, coalbed methane, controlled by tectonics, sediment features, earthquakes, methane flux, seafloor morphology, micro- and macrobiology. Some time affected by volcanic processes.

1 cubic meter of gashydrate – 165 cubic meters of methane: most effective gas storage

Map of the main areas of methane flows and distribution of gas hydrates (Shakirov, 2018 (after Suess, 2014)

1 - groundwater and hydrocarbon fluid displays; 2 - active natural gas vents;
3 - most intense methane flows associated with gas hydrates; 4 - areas where research was conducted

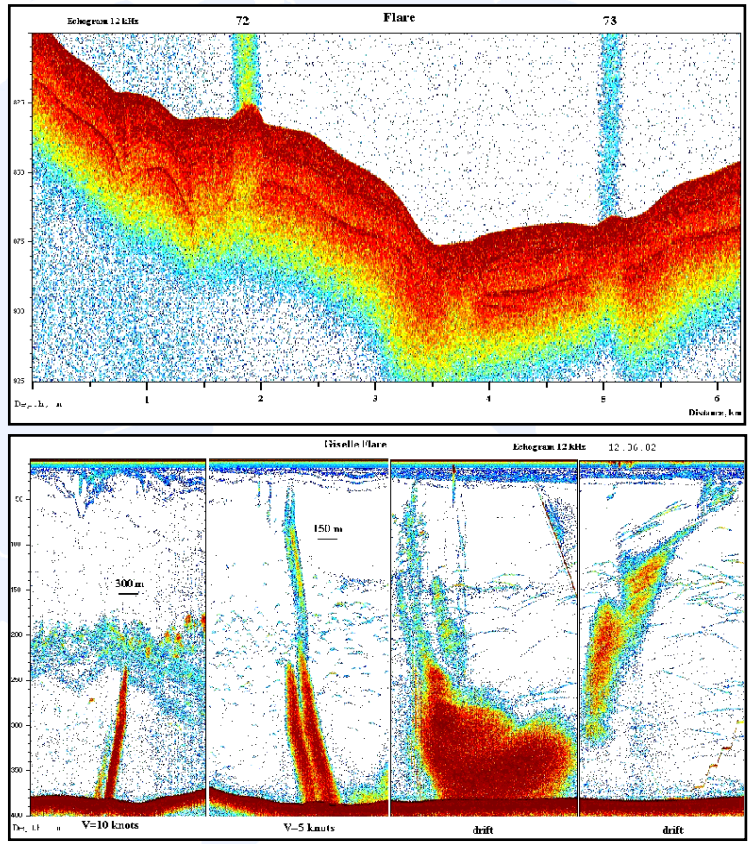
Assessment of the resource potential of Gas Hydrates and Methane and Hydrogen Fluxes in the Okhotsk Sea and Japan Sea



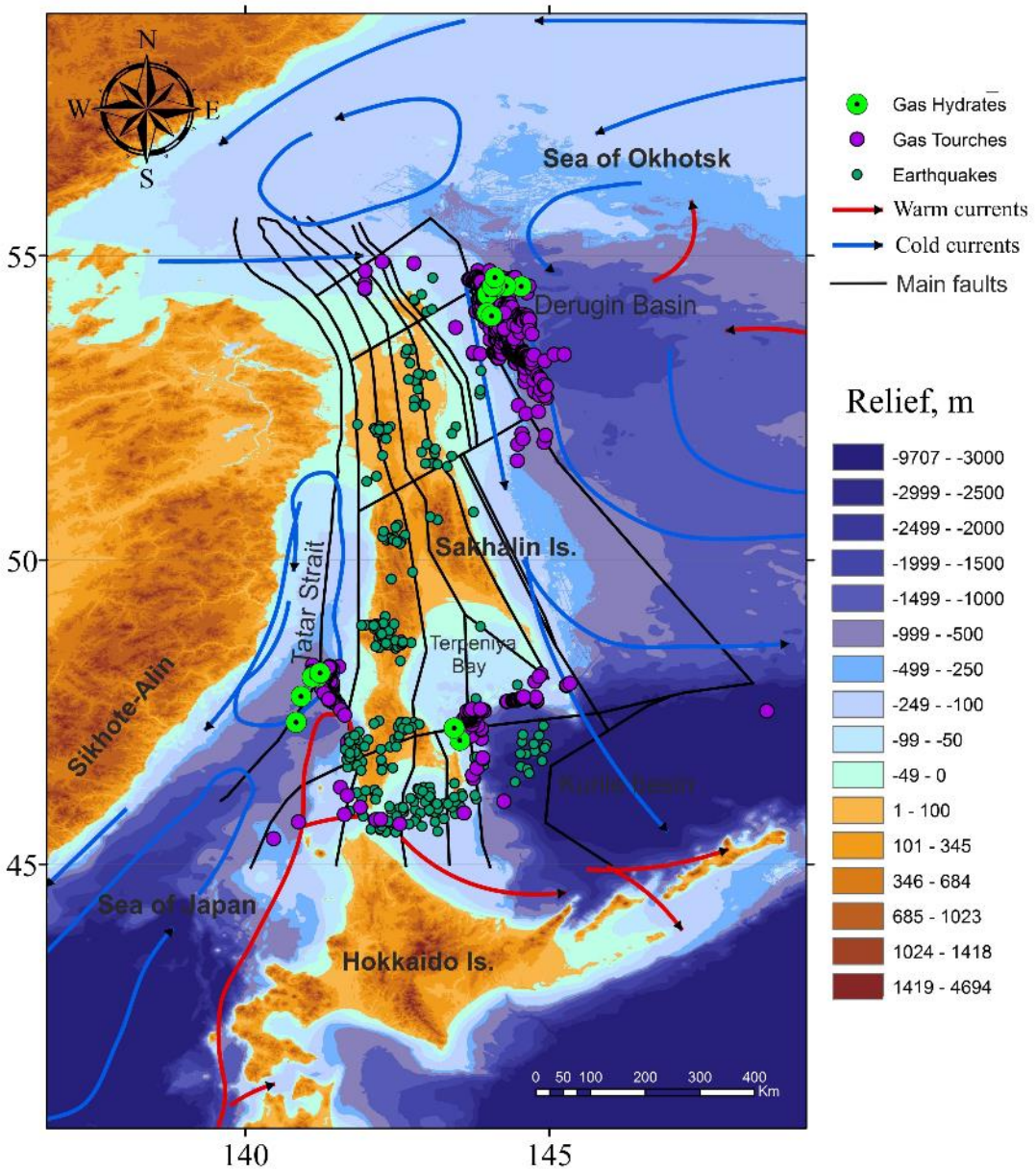
Fluxes of methane

It is base of method to search gas hydrate, oil-gas deposit and to determine zone fault (Syrbu et al., 2023)

- We studied **in details the features of the formation and decomposition of gas hydrates** in the Sea of Okhotsk and the Sea of Japan, as well as these processes from an ecological point of view.
- We identified the **sources of natural gases for the formation of gas hydrates**, which is necessary for further calculations of the resource potential and **assessment of methane and hydrogen flow** and the impact on the environment.



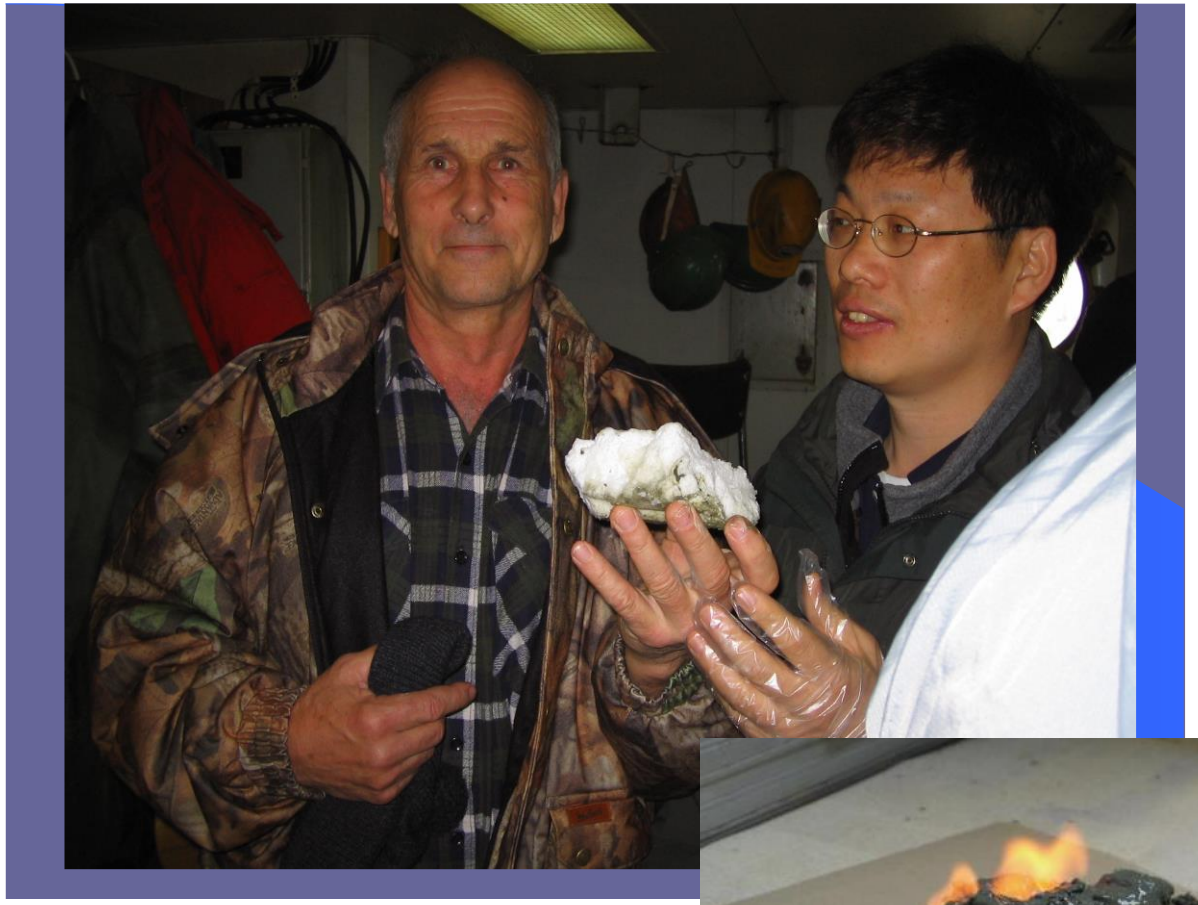
Underwater gas discharge - the eastern shelf and slope of Sakhalin Island and the western part of the Deryugin Basin, the southwestern shelf and slope of Sakhalin Island



- We established for the first time, the correlation of anomalous geophysical fields, the distribution of gas flares, gas hydrates, anomalous fields of hydrocarbon gases and methane fluxes into the atmosphere on the shelf and slope of Sakhalin Island.
- The most intense methane flows and hydrogen fields are found over gas-saturated sediments and gas hydrates.
- The established pattern can be used to predict accumulations of gas hydrates in other water areas.
- The bioindicator features used made it possible to conduct geomicrobiological mapping and show significant differences in gas hydrate and non-gas hydrate areas.

Gas hydrate in the subsurface sediment when gas hydrate is formed

Gas hydrate is a white color substance in the sediment core taken in the Okhotsk Sea

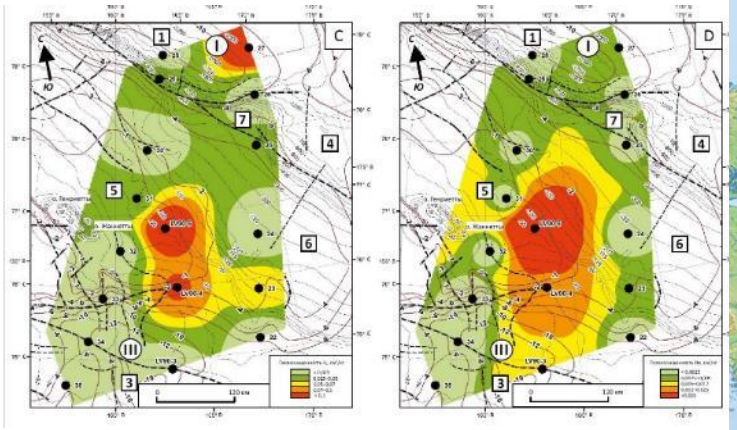


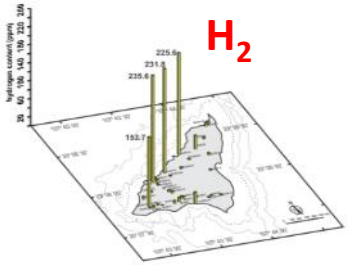
Gas hydrate in the hands of scientists Anatoly Obzhirov (left) and Young Keun Jin (right)

Shows of endogenous gases - HELIUM AND HYDROGEN

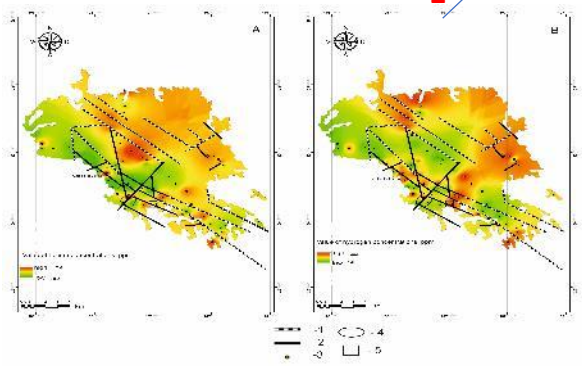
The outer shelf of the East Siberian Sea

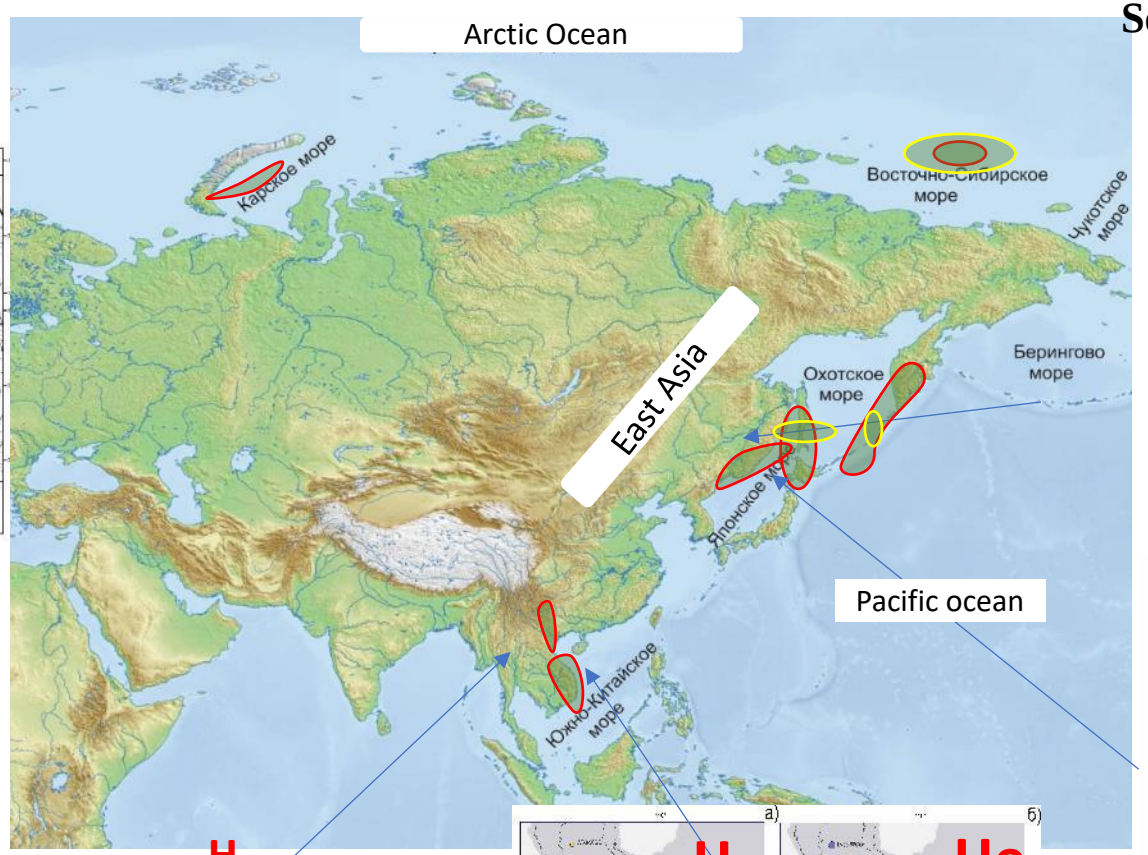
H_2 He



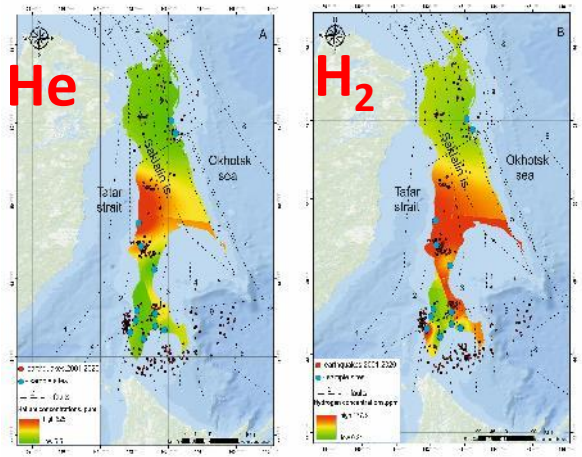


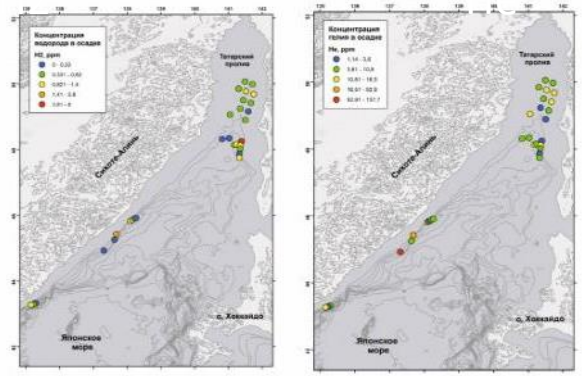
North Vietnam (Red River Rift) and the islands of the Gulf of Tonkin

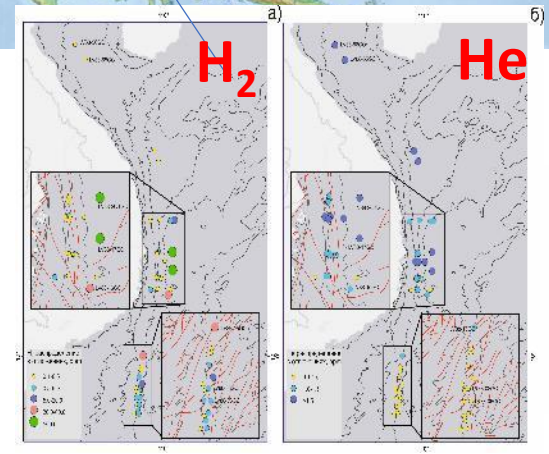


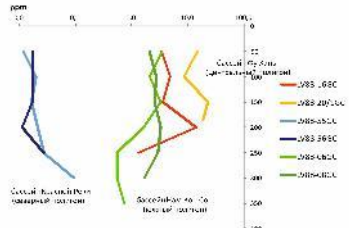


Sakhalin Island - shelf and slope of the Sea of Okhotsk and the Sea of Japan









Shelf and slope of South China Sea

Gas hydrate resource – huge but nobody knows

Methane hydrate – promising deposits – methane, helium and hydrogen flows – have to be explored in Asian Seas widely

WE PROPOSE: comparable study on gas hydrate phenomena

HOW?

Developing the Indo-Pacific COOPERATION in the frame of WESTPAC
Complex Study of the Gas Hydrates and Methane fluxes in the Indo-Pacific Region (CoSGas)

And

GLOBAL COOPERATION
THE BRICS WORKING GROUP ON OCEAN AND POLAR SCIENCE AND THECNOLOGY

JOINT EXPEDITIONS

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

unesco Intergovernmental Oceanographic Commission


Let's build scientific bridges!
Vladivostok
Russian Bridge