

Working group proposal submitted to SCOR 2024

Gas hydrates Multiple Effect in the Ocean
(GasMEO)

Co-Chairs:

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1. Summary/Abstract (max. 250 words)

GasMEO WG is the Arctic-Asian-Indo-Pacific interregional geoscientific WG aiming to improve oceanfloor's gashydrate system understanding in view of changing Ocean and its relations to the key Ocean processes including vision of UN Ocean Decade for sustainable development by the consolidation international efforts for research ocean gashydrates within the Ocean Geo- and Ecosystems and enable their sustainable monitoring and exploitation. The overall objective of the WG is the transformative considering geomapping and gashydrates manifestations data sharing by the science-based strategy to provide open asses of the non-conventional gashydrates and their effects to the multiple Ocean phenomena.

2. SCIENTIFIC BACKGROUND AND RATIONALE (max. 1250 words)

Gas hydrates - green energy resource of the future and active modern ocean phenomena, which are significantly growing up from year to year but still studied poorly in marine expeditions due to the lack of an international cooperative community. Gas hydrates were found in many areas of the World Ocean and evidently closely interrelated to the ecosystems, gas geochemistry, geology, geophysics, oceanography and environment of the Ocean, both seafloor and water column (gasgeochemical regime, earthquakes, fluid dynamics, hydrology, biodiversity, hydrochemistry, climate, resources, hydrooptics and ecotoxicology). Gas hydrate-bearing subseafloor sediments harbour a large number of microorganisms. Within these sediments, organic matter and ascending methane are important sources of carbon and energy, fueling a photoautotrophic biosphere. However, the type of metabolism that dominates the deep subseafloor of the gas hydrate zone is poorly constrained. Many basins area specific regions manifested by insufficient studied gas hydrates phenomena as a resource, climate link and geochemical drive force, methane and accompanying gases fluxes in the "seafloor-water column-atmosphere" system. Numerous unique gas hydrate accumulations nowadays are object of few focused projects studies in mainly in marginal basins and continental slopes. Most of gas hydrate accumulations located within the international waters and EEZ of many countries. The geopolitics is one of the factors of low intensive research of such gas hydrate clusters and offshore gas hydrate research opportunity in these countries is very different. Moreover, gas hydrate resources in the Arctic Ocean numerously discussed but almost not studied. There for, nature and evolution of the gas hydrate system in the lithosphere and hydrosphere of the Ocean, which in respect to energy resources and environmental agent is one of the most uncertain and debatable problem of World Ocean. We suggest organizing long-term complex study of the gas hydrates by worldwide community on bases of mutual understanding, scientific, administrative and diplomatic collaboration. The core of the GasMEO WG is a set of annual carefully planned actions including international expeditions on the research vessels in the gas hydrate promising basins. We expect that all countries involved into this WG will benefit greatly in all listed points and become leading gas hydrate association in the World. The important outcome is involving and attracting of the young scientists to the ocean sciences through the complex study on gas hydrates and related phenomena and processes.

3. TERMS OF REFERENCE (max. 250 words)

Objective: Define, estimate and clarify gas hydrates effects in World Ocean and their impact on climate, ecosystem and socio-economic development

- The study of unique geological and geophysical features in the gas hydrate prone basins
- The clarifying of unique biogeochemical and ecological features of the gas hydrate hosted sediment areas
- Investigation of microbial communities associated with gas hydrate-bearing marine sediments
- Estimation of the gashydrate resources
- Development of technology and equipment to recover submarine gas hydrates
- Investigation of gas hydrates impacts on ecosystems and human populations
- Remote sensing and atmospheric gas balance research in the gas hydrate prominent areas
- Generalization and complex interpretation of all available gashydrate information
- The WG will conduct the zoning of the World Ocean into gas hydrate provinces and belts, and analyze their relationship with the biogeography of ecosystems

Outputs:

- established network of the researchers interested in gas hydrates and methane fluxes in the World Ocean
- generalization and complex interpretation of all available gas fluxes, gas hydrate information from the Pacific, Indian and Arctic oceans
- new species of marine microorganisms with high biotechnological potential will be described
- raised awareness on the gas hydrates and methane problem
- preparation of a long-term international collaborative project under SCOR
- in terms of biogeochemistry and methane flux monitoring technology, and based on a large amount of atmospheric methane monitoring data and geochemical data, we will create a data set of the methane flux of natural gas hydrate decomposition gas at the sediment-water and sea-water-atmosphere interfaces.

4. DELIVERABLES (max. 250 words)

- Peer-reviewed papers in open-access journals: 10
- Special issue of a peer-reviewed journal (e.x. Deep Sea Research),
- Dataset of World Ocean Gashydrates compiled by the group and made openly accessible. Open Access Reports of WG.
- An open access report on gas hydrates studies and associated phenomena in the Ocean
- White and grey papers;
- Capacity trainings of experimental apparatus and numerical softwares related to gashydrates for ECS;
- Contributions to related actions of Ocean Decade for sustainable development.
- Joint international marine expeditions for gashydrates investigation.

5. WORKING PLAN (logical sequence of steps to fulfill terms of reference, with timeline. max. 1000 words)

MAIN ACTIVITIES TO BE CARRIED OUT

2024-2025- Studies on key fundamental regional challenges associated with gas hydrates. Planning and coordination of WG.

SCOR WG GasMEO Proposal

2025-2026–GH Impact investigations research consists of environmental review to characterize the effects exploration or extraction and design effective mitigation measures to avoid, minimize, or eliminate adverse environmental effects.

2027– Discussing WG results and report. Discussing future work

| SCOR Working Group | | | | | Funding Required | | Remark |
|--------------------|--------------------------|--|--------------------------------------|----------------------------------|------------------|---|---|
| | Activities | Objectives | Expected outputs/outcomes | Date and place | SCOR | Other sources (i.e. from national or international) | |
| GasMEO | 1. Introductory workshop | To fix a list of WG members and establish communication, draft action plan | A list of members, Action plan | September-October, 2024, on-line | | | On-line, And face-to-face During SCOR meeting 2024 in Qingdao |
| | 2. First workshop | To develop the implementation plan | Implementation plan | December, 2024 | | | Online |
| | 3. Second workshop | Discussion on main WG results and key items | Draft report, draft project proposal | May, 2025, Russia | | | On-line |
| | 4. Third workshop | Discussion on WG report and new project on Gas-hydrates | WG report, new project proposal | Dec, 2026, on-line | | | On-line |

Report and inventory on the status of the gas hydrates studies and associated phenomena in the Ocean

1. National and international GH programs of each member (overview)
2. Methods and equipment, approaches for modern research and exploration
3. Distribution of gas hydrates
4. Distribution of methane flares/fluxes
5. Gas hydrates: geological aspects (stratigraphy, tectonics, mineralogy, geochemistry)

6. Gas hydrates: geophysical aspects (any relations to geophysical fields etc)
7. Gas hydrates: oceanography and climate (modern and paleo-) relations (temp, salinity, currents, etc)
8. Gas hydrates: methane biotransformation reaction under the action of microorganisms
9. Gas hydrates: biological aspects
10. Gas hydrate Provinces and Belts and their relations to biogeography Provinces
11. Resources to discussions (up to members)
12. Social effects (young scientists, gender, etc.)
13. Summary and conclusion

6. Capacity Building (How will this Working Group build long-lasting capacity for practicing and understanding this area of marine science globally. max. 1500 words)

- The GasMEO will implement the effective trans-national consolidation within marine biogeosystem research and management as key initial point of the general scientific gashydrate strategy. The key outcomes expected:
- Perfection of the scientific-methodological and organizational support of oceanic gashydrate research;
- - Improved education and capacity building, well-trained young generation of marine scientists;
- The taxonomy, biotechnological potential and ecological properties of obligate marine heterotrophic bacteria and microscopic fungi will be studied. The discovered strains of marine microorganisms will be deposited in the collections of the World Federation of Culture Collections;
- - established international system of coordination international marine gashydrates and education in the regions;
- - national and international decision-making overlapping geoscientific perspectives of every submarine basin of the regions to better manage a gashydrate resources and mutual assistance while providing solutions for sustainable resourcing;
- - adequate science-policy preparation for the global and urgent alternative fossil needs facing the planet;
- - solutions and advantages of the “ocean-continent” transition zones gashydrate resources in the marginal seas, deep water basins and adjacent areas.
- - gashydrate resources in the ecosystem cycle impact assessment—defining the path forward.
- World Ocean understanding of chemical elements related to gashydrates in the deep ocean water at ocean depths between 250 and 3000 meters.
- Developing of methods of the gashydrates mapping and marine surveying.
- Geodynamic Evolution Models of the gashydrates in the World Ocean.
- Methods developing for the prediction and economic assessment of marine and oceanic gashydrates deposits.
- Maintenance activities of the Scientific Editorial Boards on the international marine gashydrate research.
- Genetic and Resources Classification of the gashydrates in the Marginal Seas and open Oceans areas.
- Advanced scientific-and-methodological support of a network on marine gashydrate survey base lines, deep wells and seismotectonic gas zoning (deep geophysics).
- Advanced marine and oceanic geophysical bases for the different scale gashydrates zoning.
- Results on predictive gashydrates oceanic studies open assess.

- Deep sea gashydrates Outlines.
- Radioecology Reports on methane fluxes related to gashydrates
- Paleooceanography Charts of the marginal and open gashydrate prone sediment basins.
- Description on gashydrate dynamics in marine sediment basins as a Biennial Reports series.
- Geoinformation support of marine geological exploration for gashydrates and seeps reserves.
- Deep geological solid models of the first range gashydrate bearing structures (rifts, shear zones, spreading centers and others).
- Seismogeological models of submarine gashydrates bearing basins.
- Coal-methanebasins resources estimations related to gashydrates.
- Economic geological assessment of GH and associated combustible resources.
- Gasgeochemical Regimes descriptions of the studying marine and oceanic gashydrate bearing structures.
- New generations of the digital marine and ocean floor maps on different scales including microrelief features in the complicated gashydrates promising basins.
- Education and advisory on geoinformational technologies for the graduate and postgraduate education.
- Estimation of the trends and kinetics on sea floor erosion influencing gashydrates.
- Bioresources related for gashydrate collection «Marine Biobank» NSCMB FEB RAS (<http://marbank.dvo.ru/index.php/ru/>). The “Marine Biobank” included into the International BlueBank for shared references and usage.
- Technical instrumentation of the ocean gashydrates research instruments, equipment, vehicle for the underwater, distance and remote research development.

- **Communications strategy**
- This has the vision of WG becoming a global Ocean gashydrates observing consortium with a focus on new technologies, responsible use of resources, management of environmental change and resilience to environment hazards.

- **Objectives**
According to the objectives of the WG, the key objectives of its communication strategy are as follows:
 - 1. Joint development of open assess materials, such as publication series, catalogues; publishing research schemes, maps et cat.
 - 2. Publishing expedition reports for open access if the members involved.
 - 3. Holding open-access conferences and publishing the correspondent Proceedings to provide stakeholders and scientific community worldwide with the best available research regarding potential resources and environmental impacts associated with accessing seafloor features and mineral resources.
 - 4. Publishing annual bulletins on the program topics.

- **Audiences**
The key audiences of the WG are as follows:
 - 1. World scientific community via open-access publishing and conferences, public, government and other decision makers, education organizations, industry and private business, academia, WG staff and the wider community and the media. Communication with these audiences is largely through the broadcast media and the internet, with additional communication through the print media, and the public engagement activities of the WG.

- 2. Education communities of the SCOR participant countries via joint educational initiatives (internships, visiting, international master`s degree programs).
- 3. Business community of the SCOR participant countries via annual bulletins and mass media.
- 4. Wide audience via mass media and social networks.
- 5. Russia government structures via research reports and press releases.

- **Messages**

The key messages to be delivered to the audiences of the strategy should include, but not be limited to the following.

- 1. Open and collaborative research with government and business support is crucial and the most efficient for studying and accessing mineral resources of the Ocean floor.
- 2. Human activity concerning the Ocean and its mineral resources has vast and not yet well studied impact on the Earth climate.
- 3. Marine geology and geophysical processes are among the key causes of environmental changes.

- **Tools and activities**

In order to elaborate productive communications ecosystem, we need to apply a multi-vector approach. The following means might be used:

- 1. Establishing small joint workgroups with multiple institutions membership, which communicates via instant messaging, videoconferencing and mailing lists.
- 2. Publishing research results in open-access journals and conference proceedings.
- 3. Publishing research results at institutional repositories, database websites, etc.
- 4. Establishing joint educational programs with the participants (internships, visiting, international master`s degree programs).
- 5. Establishing systematic collaboration with national and international mass media.
- 6. Promoting the Decade activities and results via social networks.
- 7. Promoting the Decade activities and results via institutional websites.
- GasMEO will make use of traditional, new and emerging communication channels to communicate its research with the following overarching themes: broadcasting – broadcast the ocean gas hydrates of the WG; science – demonstrate the impact of WG ocean geoscience; stories – tell the ocean geoscience stories of the gas hydrates.
- The following are the key communication objectives: make WG the ‘go to’ community for marine gashydrates news events in the World Ocean globally; use broadcast quality video to communicate the research of the WG; use infographics to illustrate the impact of WG research; engage a wider audience by telling the geoscience marine stories of the WG; create a website that is the first port of call for marine geoscience and mineral resources information; create a positive reputation and strong brand image for the WG using social media; create a novel digital publication channel to publish the research of the WG; actively work to promote ocean geoscience as a career choice and to explain WG exploration; create a more successful research community in WG by effective internal communication (both one-way and two-way).

- **Resources and timescales**

Implementation of the Strategy concerning the SCOR will be performed by the institution international department and press secretary aided by the institution website editorial board.

- **Evaluation and amendment**
 - Proper implementation of the Strategy must be ensured by its repeated re-evaluation. Semi-annual months check must be performed with the SCOR partners, mass media, and government structures and to some extent — with social networks audience.
 - Provisional list of questions is the following:
 - 1. What do you read/see/hear?
 - 2. What works/doesn't work?
 - 3. What do you want to see more of?
 - 4. What information do you need that you are not currently supplied with?
 - 5. How often do you want us to communicate with you?

 - **Coordination to the other SCOR WG**
 - WG actively will communicate and coordinate activity taking into account priorities, activity and achievement of other SCOR's WG.
 - The building of capacity for ocean science in developing countries is a major goal of SCOR. Each working group should consider how it could build capacity on its topic. Past WGs have used a variety of approaches, such as holding a training workshop in conjunction with a WG meeting, involving younger scientists in WG activities, and holding WG meetings in developing countries. The SCOR Committee on Capacity Building will provide advice to all WGs that are approved on how they can improve their capacity-building activities.
 - SCOR can provide a modest amount of extra funding to WGs to enhance their capacity building, for example, to bring developing country scientists to training workshops and to bring Associate Members from developing countries to WG meetings.
 - GasMEO will organize training courses for younger scientists from all over the world, especially the scientists from developing countries. The training courses cover research methodologies related to gas hydrate: 1) hydraulic, mechanical, and pore-scale structured properties measurement and operation of the apparatuses. 2) numerical modeling of the thermal, hydraulic, chemical, and mechanical coupled process related to gas hydrate, including the usage of TOUGH+HYDRATE and QIMGHyd-THMC software. These training courses will be provided by the Key Laboratory of Gas Hydrate, Ministry of Natural Resources of China and gas geochemical Laboratory of POI FEB RAS. Two in-person training courses related to operation of apparatuses will be held in conjunction with the WG meetings. Extra training courses of the software and analytical techniques and modeling approaches will be provided online. To increase involvement of scientists from developing countries, we will: firstly, hold the WG meetings and training courses in developing countries allowing the scientists to attend easily; secondly, take advantage of live streaming to broaden participation of these courses; finally, facilitate participation and attendant by collaborating with ongoing programs, such as the training courses held in academic conferences and some open school programs.
- 7. Working Group Composition (as table). Divide by Full Members (10 people) and Associate Members (max. 10 people), taking note of scientific discipline spread, geographical spread, gender balance, and participation by early-career scientists. Proponents may also include a short rationale for the composition and balance. (max. 500 words)**
- The WG Steering Group shall consist of all member states of SCOR interested to participate. Each Country, through its SCOR national committee shall designate one or two members with gashydrates expertise in consultation with WG SG. The Group is encouraged to conduct the work through correspondence. However, they shall meet if

needed at the expense of the participating countries as far as possible. Other participants may be invited as observer if deemed necessary.

FUNCTIONS:

- The Project Steering Committee is established to meet the scientific, managerial implementation, and resource needs of the WG. It has overall responsibility for the formulation of strategy, and for the planning and coordination of GasMEO WG.
- The Group will carry out the following functions:
 - 1) Review the interregional concerns GasMEO, and identify the project requirements;
 - 2) Promote efficient and cost-effective implementation of the WG and prepare recommendations on this implementation to the SCOR and IOC's Intergovernmental Panel;
 - 3) Identify the resources necessary to meet WG needs;
 - 4) Ensure effective interaction and communication with GasMEO and IOC' Intergovernmental Panel as well as other regional intergovernmental (NOWPAP, PEMSEA, PICES) and non-governmental (e.g., SCOR) organizations involved in research on gashydrates;
 - 5) Reports.

Draft list of Steering Committee: *The group's membership should include no more than 10 Full Members and 10 Associate Members, with no more than two from a single country and no more than one from a single institution. SCOR pays specific attention to gender balance and inclusion of members from developing and countries with emerging economies. The proposed membership should include at least one Full Member who is an early-career scientist (less than 10 years post-Ph.D. and under 40 years of age).*

Full Members (no more than 10, please identify chair (s))

| | Name | Gender | Early career status | Place of work | Expertise relevant to proposal |
|---|---------------------------|--------|---------------------|---|--|
| 1 | Renat Shakirov (Co-chair) | Male | | V.I. Il'ichev Pacific Oceanological Institute FEB RAS, Russia | The leading specialist in the field of marine geology, lithology, and geochemistry of seafloor sediments, oil and gas geology, hydrocarbon geochemistry. Has many years of experience in solving fundamental problems of geoecology in geology, environmental management, study of background and anomalous states of the geospheres in the ocean-continent transitional zone. For many years was heading Russian and international marine expedition projects. Leader of GEOMIR project in Ocean Decade for sustainable development (2021-2030) |

SCOR WG GasMEO Proposal

| | | | | | |
|----|------------------------|--------|-----|---|--|
| 2 | Pawan Dewangan | male | | National Institute of Oceanography, India | Geophysics, oceanography and biology of gashydrate system in Indian Ocean |
| 3 | Nengyou Wu (Co-chair) | male | | Laoshan Laboratory, China Qingdao Institute of Marine Geology, China Geological Survey | Has extensive experience in the theory of gas hydrate migration and accumulation system, heat and mass transfer related natural gas hydrate, and the development of apparatuses for gas hydrate simulation and experimental tests. He is co-chair of the CosGas WG. |
| 4 | Carolina Bueno | female | ECS | Oceanografía y Ecología Marina, Instituto de Ecología y Ciencias Ambientales, Facultad de Ciencias, Universidad de la República, Iguá 4225, Montevideo, Uruguay e-mail: cbueno@fcien.edu.uy | Geochemistry and ecology application in aquatic systems, Atlantic Ocean, Southern Ocean |
| 5 | Kusaykin Mikhail | male | | G.B. Elyakov Pacific Institute of Bioorganic Chemistry FEB, Russia mik@piboc.dvo.ru | Marine biochemistry and microbiology, marine natural products for healthcare |
| 6 | Le Duc Anh | male | ECS | Institute of Marine Geology and Geophysics (VAST), Vietnam | Magmatic geology in gashydrates prone basins |
| 7 | Dileka Samaranyake | female | ECS | National Aquatic Resources Research and Development Agency, Sri Lanka, dileka.kariyawasam@gmail.com. | carrying out and co-coordinating research development and management activities on the subject of aquatic resources in Sri Lanka marine basins. |
| 8 | Andrianarivelo Norbert | male | | Institute d'Enseignement Supérieur d' Anosy (IESA) de l'Université de Toliara République de Madagascar | South-western Indian Ocean (SWIO) issues for marine mammal biodiversity. The Indian Ocean Network for Cetacean Research (IndoCet) was formed in 2014 and is dedicated to the research of all cetacean species across the SWIO and related aspects. Member of IOC Africa. |
| 9 | Rasoamananto Irene | female | | Institute Halieutique et des Sciences Marine (IH.SM) de l'Université de Toliara, Madagascar | Training and Research in the field of marine sciences, Fisheries and Aquaculture, marine and coastal environment. |
| 10 | Wenxi Zhu | male | | Technical Secretary, IOC WESTPAC, Thailand, Bangkok | Consultant on international collaboration issues based on WESTPAC IOC representative |

Associate Member (no more than 10)

| | Name | Gender | Early career status | Place of work | Expertise relevant to proposal |
|----|--------------------|--------|------------------------|---|--|
| 1 | Nadezhda Syrbu | female | Early career scientist | POI FEB RAS, Russia | Gasgeochemistry and environment applications of gas hydrate systems |
| 2 | Susilo Hadi | male | | Research Centre for Marine Geology, Indonesia | Geophysics, geotectonics and basin analyses for gashydrate and petroleum systems |
| 3 | Leila Brito Neves | female | ECS | National Committee for UN Decade of ocean science for sustainable development (2021-2030), Cabo Verde | Socio aspects of natural marine processes and phenomena |
| 4 | Phùng Văn Phách | male | | Institute of Marine Geology and Geophysics, Vietnam Academy of Science and Technology | has a great experience in research Geodynamic Mechanism of formation and development of marginal seas of West pacific tectonic belt (Implication: the basins inside Russia and Viet Nam seas). |
| 5 | Nugroho D. Hananto | male | | Indonesian Institute of Sciences – Deep Sea Research Centre, Indonesia | Marine geology, and oceanography |
| 6 | Min Zhang | female | | First Institute of Oceanography, China | Climate applications of gashydrate systems |
| 7 | Feisal Dirgantara | male | ECS | BRIN, Indonesia | Geophysical tectonic applications of the gashydrate systems |
| 8 | Jiapeng Jin | male | ECS | Laoshan Laboratory, China | Fluid flux variations of active gashydrates systems |
| 9 | Glen Snyder | male | | Atmosphere and Ocean Research Institute, University of Tokyo., Japan. | Geochemistry and ocean chemistry of the gashydrate systems, Leader of COESS project in Ocean Decade for sustainable development |
| 10 | Yizhao Wan | male | ECS | Qingdao Institute of Marine Geology, China Geological Survey, China | Experimental and numerical investigation for the biochemical processes in gashydrate system |

- *Other members currently invited under consideration (Uzbekistan, Belarus, Philippines, Malaysia and others)*

8. Working Group contributions (max. 500 words)

Detail for each Full Member (max. 2 sentences per member) why she/he is being proposed as a Full Member of the Working Group, what is her/his unique contribution?

Russia, Shakirov Renat is the leading expert in the field of marine gashydrates, geology, lithology, and geochemistry of seafloor sediments, oil and gas geology, hydrocarbon geochemistry. Has many years of experience in solving fundamental problems of geocology in

geology, environmental management, study of background and anomalous states of the geospheres in the ocean-continent transitional zone.

China, Nengyou Wu has extensive experience in the theory and practice of gas hydrate migration and accumulation system, heat and mass transfer related natural gas hydrate, and the development of apparatuses for gas hydrate simulation and experimental tests. He is co-chair of the CosGas WG. Co-chair of CosGAS WG WESTPAC.

Vietnam, Le Duc Anh experts will contribute experience in research Geodynamic Mechanism of formation and development of marginal seas of West Pacific tectonic belt and gashydrate resources potential estimation for South-China Sea (Implication: the basins inside Russia and Viet Nam seas). Member of CosGAS WG WESTPAC.

India, Pawan Dewangan lead the basic research teams for integrated study of gashydrate systems in the Indian Ocean. Member of CosGAS WG WESTPAC.

Uruguay, Carolina Bueno, is a leading scientist in the region for coastal and shelf aquatic ecology and chemistry in southern Atlantic, will contribute ecological aspects of gashydrates influence to eco- and geosystems.

Russia, Kusaykin Mikhail, will contribute marine products bioorganic chemistry and medical issues for the species habitants within the gashydrates systems. We expect unusual features in organisms substances in extreme gashydrate medium.

Sri Lanka, Dileka Samaranayake carrying out research development and management activities on the subject of aquatic resources in Sri Lanka as well as pay attention for gashydrate prone marine basins. Member of CosGAS WG WESTPAC.

Madagascar, Norbert Andrianarivelo (Director) contributes for south-western Indian Ocean (SWIO) issues of importance for marine mammal biodiversity. The Indian Ocean Network for Cetacean Research (IndoCet) was formed in 2014 and is dedicated to the research of all cetacean species across the SWIO and related aspects, Member of IOC Africa.

Wenxi Zhu, Thailand. Consultations from Technical Secretary, IOC WESTPAC, Thailand, Bangkok. Consultant on international collaboration issues based on WESTPAC IOC representative.

Madagascar, Rasoamananto Irene (Director): Training and Research in the field of marine sciences, Fisheries and Aquaculture, marine and coastal environment. The IH.SM is primarily responsible for the Training of Senior Technicians - fisheries Engineers scientists and oceanographer biologists (Bachelor, Masters and PhD).

9. Relationship to other international programs and SCOR Working groups (max. 500 words)

Coordination with various international marine organizations and programs active in the region (CCOP, PICES, WESTPAC, GEOTRACERS, PACON etc.) is very important. To have closer and more efficient dialogs with leading organization and programs joint working groups would be established.

- WG on Complex Study of the Gas Hydrates and Methane fluxes in the Indo-Pacific Region (CoSGas) was proposed by Russian Federation and was established by the decision of 13th

Intergovernmental Session of WESTPAC on April 27-29, 2021 with the objective to prepare of the international project to study gas hydrates and methane fluxes in the Indo-Pacific region and their impact on climate, ecosystem and socio-economic development.

The Members took part in the sessions of the Intergovernmental Council of the Intergovernmental Oceanographic Commission of UNESCO. Leader of GEOMIR action of Ocean decade, R.B. Shakirov - deputy director of POI FEB RAS is a permanent member of Russian delegation on IOC UNESCO. The members create within the framework of WESTPAC, a new working group (2021-2024): “Complex Study of Gas Hydrates and Methane Fluxes in the Indo-Pacific Region (CosGAS)”, and this WG is effectively functioning. The working group integrates the achievements of complex marine scientific research on gashydrates, an important oceanographic phenomenon and an alternative energy resource in the region, and plans a joint project and expeditions. Russia, China, India, Japan, New Zealand, Indonesia, Vietnam successfully cooperate within the group.

- POI FEB RAS submitted application for multi-stage competitive selection by experts that was reported at meetings of the Interdepartmental Oceanographic Commission of the Russian Federation and the UNESCO IOC special Commission:

(GEOMIR) "GEOSYSTEMS AND MINERAL RESOURCES IN THE TRANSITION "CONTINENT-OCEAN" ZONES AND OPEN OCEAN" (GEOMIR, ID 164, UN Ocean Decade for sustainable development action), project leader, Deputy Director of the POI FEB RAS, Dr.Sc., Associate Professor Shakirov R.B.

April 2023, GEOMIR members including additional partners, agreed on creation new "China-Russia Center for Arctic Marine Science". - 14 marine expeditions were conducted during 2022-2024 under and with active participation of GEOMIR members.

FREM-PAMMS Ocean Decade project.

ECOP Programm, UN Decade of ocean sciences for sustainable development.

GEOMIR assumed that in the course of geological, geophysical and oceanographic expeditions, numerous manifestations of ore mineralization were discovered in the form of ferromanganese and cobalt-bearing formations, sulfides, sulfates (“Barite Hills” in the Sea of Okhotsk), phosphorites (Sea of Japan), metal oxides, carbonates, ore-bearing shales, rare earth elements etc. Prospective zones on the shelf for the search for deposits of titanium, vanadium, etc. have been identified. The "continent-ocean" transition zone and neutral waters can become the most important source of replenishment of the mineral resource base of these useful components

-NEAR GOOS. POI FEB RAS is a member of the Coordinating Committee of the Global Ocean Observing System Project for the Northeast Asia Region. The project is coordinated by the IOC Sub-Commission for the Western Pacific (WESTPAC) and covers the waters of the Japan, East China and Yellow Seas. The participating countries are: China, Korea, Russian Federation and Japan.

10. Key References (max. 500 words)

5 key publications related to the proposal should be listed.

- Shakirov, R.B., Luchin, V.A. & Petrova, E.A. Spatial Variability of the Methane Hydrate Stability Zone's Upper Boundary Parameters in the Water Column of the Sea of Okhotsk. Dokl. Earth Sc. (2024). <https://doi.org/10.1134/S1028334X24601901>
- Syrbu N.S., Snyder G.T., Shakirov R.B., Kholmogorov A.O., Zharkov R.V., Tsunogai U. Geochemical distribution of helium, hydrogen, carbon dioxide, and methane in Sakhalin Island mud volcanoes, hot springs, and cold seeps. Journal of Volcanology and Geothermal Research. 2022V. 431, 107667.
- C. Xu, N. Wu, Z. Sun, X. Zhang, W. Geng, H. Cao, L. Wang, X. Zhang, B. Zhai, Assessing methane cycling in the seep sediments of the mid-Okinawa Trough: Insights from pore-water geochemistry and numerical modeling, Ore Geology Reviews, 2020, doi: <https://doi.org/10.1016/j.oregeorev.2020.103909>
- Li, A., Cai, F., Wu, N., Li, Q., Yan, G., Sun, Y., Dong, G., Luo, D., & Wang, X. Gas Emissions in a Transtensive Regime Along the Western Slope of the Mid-Okinawa Trough. Frontiers in Earth Science, 2021, 9. <https://doi.org/10.3389/feart.2021.557634>
- Wan Y, Wu N, Chen Q, Li W, Hu G, Huang L, Ouyang W. Coupled thermal-hydrodynamic-mechanical-chemical numerical simulation for gas production from hydrate-bearing sediments based on hybrid finite volume and finite element method. Computers and Geotechnics, 2022, 145: 104692.

Appendix: Five key publications for each full member

Renat Shakirov, Russia:

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Wenxi Zhu, Thailand

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