Ocean Science Journal (2022) 57:298–304
https://doi.org/10.1007/s12601-022-00073-z

Online ISSN 2005-7172
Print ISSN 1738-5261

EDITORIAL

New Opportunities in Global Ocean Research for Academia and Industry

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Received: 28 February 2022 / Revised: 7 April 2022 / Accepted: 13 April 2022 / Published online: 10 June 2022

Abstract
Since 2017, requesting ship time has become possible for university researchers and businesses on research vessels. They include Isabu and Onnuri of the Korea Institute of Ocean Science and Technology (KIOST) and the icebreaking research vessel Araon of the Korea Polar Research Institute (KOPRI). There was no regulation barring the chartering of the significant national scientific infrastructure in the first place, but the exorbitant cost of ship time had made their usage virtually impossible. Shared Use Committee (SUC) was set up to handle applications and coordinate the cruises. A modest amount of research funds is also granted. Currently, the KIOST vessels conduct surveys in the Pacific and the central Indian Ocean annually. The KOPRI vessel routinely operates around Antarctica during the austral summer and in the Arctic seas during the boreal summer. Other government-supported institutions are likely to follow this shared used example. Here I provide a brief historical background leading to the shared use of research and information for potential applicants. The description is given from the perspective of geological oceanography, and thus some accounts may differ in other fields of study. A case study is given where a team of international university scientists successfully conducted a joint experiment to investigate the upper mantle structure by deploying ocean bottom instruments and recovering them one year later in the Pacific using Korean research vessels. Finally, some long and short-term recommendations are made to improve the system further.

Keywords Global ocean research · The state-of-the-art research vessels · A recent shared-use program with academia and industry · Shared-Use Committee

1 Introduction

The global open ocean is a vital part of the Earth system that enables the sustainment of life and our prosperity on this planet. Understanding the fundamental process of the hydrosphere and its interaction with the surrounding domain, such as the atmosphere and lithosphere, constitutes an essential activity of society and stewardship.

A clear difference exists between developed and developing countries regarding marine scientific priorities (e.g., Wong 1996; Lee 2022). The former has a long tradition of understanding the importance of basic sciences and tends to view the ocean as an area to explore and discover. Understanding the importance of basic science is guaranteed. On the other hand, in developing countries, public economic benefits and the well-being of the states are given higher priority. Addressing immediate needs is considered more important than mere scientific curiosity and understanding. The debate continues as to which one is a better model.

From the geological oceanography standpoint, the presence of Korea in the global open ocean research was perhaps not felt until the late 80s, when policymakers realized the potential of mineral resources in the open ocean of the Pacific. They included manganese nodules that lay over vast regions on the ocean floor and cobalt-rich manganese crusts formed along the rims of submerged seamounts. The decision was made to explore these resources, and for that purpose, a state-of-the-art research vessel was needed. This period coincides with a renewed interest in mid-ocean ridges and deep-sea hydrothermal systems by scientists in the US and France, which was quickly picked up by their counterparts in the UK, Germany, and Japan. InterRidge was formed around this time.

While those in the developed countries were marveling at the unprecedented sets of data becoming available of

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the seafloor by the new high-resolution multibeam echo sounders of the seafloor and the subterranean regions by multichannel seismic surveys, Korea was focused on what-then-seemed lucrative mineral deposits that lie on the most uneventful sections of the ocean floor. The contrast between the developed and developing countries could not have been more significant. The deep-sea mineral resources programs continue the flagship government project.

A turning point was reached around 2014. Korea Institute of Ocean Science and Technology (KIOST), former KORDI (Korea Ocean Research and Development Institute), was about to get a new research vessel, Isabu, which was more than four times bigger than its predecessor Onnuri in terms of tonnage. There was a consensus among researchers that the new ship must be shared with the academic community by this time. The following section will give a detailed background story leading to the construction and the agreement for shared use.

The responsible government branch of ocean-related affairs is the Ministry of Oceans and Fisheries (MOF). We also have the Ministry of Science and Technology (MOST), but their role in marine science is somewhat limited. Under decree number 252 of MOF, a committee was set up to handle the shared use of research vessels owned by KIOST (hereafter referred to as SUC, Shared Use Committee). The committee members were drawn from KIOST and academia. It was a landmark in that university researchers were given the right to utilize the critical scientific infrastructure for global marine scientific research independently for the first time. Before the program, diversity researchers could only participate in the open ocean cruises set up by KIOST through calls or personal networks. Here the term 'open ocean' refers to big oceans like the Pacific and Atlantic.

The shared-use program is likely to spread to other institutions. For instance, the Korea Institute of Geosciences and Mineral Resources (KIGAM) is expected to launch a state-of-the-art seismic vessel (Tamhae 3) by 2024. Another is the second icebreaker to expand Korean Marine Science into the Arctic and northern Atlantic. There is also a discussion for a research vessel dedicated to the academic community.

However, there are challenges both from inside and outside for the shared use program as with any system. In this paper, I begin by providing a brief background on the history. Information on SUC is given, including the organization and typical call for proposals, evaluation of the proposals, assignment of ship time, and final evaluation. Lessons have been learned, and the users have made suggestions. I provide recommendations that can take effect immediately and be done over the years. I introduce an international collaboration as a case study.

2 Historical Background

In the late 80s, the Korean government became interested in exploring and developing mineral resources in the Pacific. Korea did not have a research vessel large enough to conduct surveys. Initial studies were conducted together with the US Geological Survey (USGS) on chartered research vessels. The economy was good following the 1988 Seoul Olympics. Pressures were mounting for Korea to purchase foreign goods. The government decided to build a state-of-the-art research vessel using foreign loans. A company in Norway won the bidding, and in 1992, 1442-ton RV Onnuri was delivered to KORDI (presently KIOST). She was 64 m long and 12 m wide, with state-of-the-art scientific equipment, including SeaBeam high-resolution multibeam echosounder and a modest multichannel seismic survey system. A multibeam system is usually the most expensive and essential in many modern scientific surveys.

In 1996, KIGAM acquired RV Tamhae 2, a 2085-ton seismic survey vessel also built in Norway. She had Simrad EM 12 multibeam echosounder. Ships after Tamhae 2 were built in Korea. Around this time, the hydrographic office also acquired a large vessel, Haeyang 2000, equipped with a multibeam echosounder. However, except for Onnuri, the two ships did not go outside Korean waters**.** As a result, their existence is less well known around the world.

KIOST used RV Onnuri for as much as 3–4 months a year to conduct ocean floor mineral resources surveys in the Pacific with regular port calls in Guam and Hawaii as part of a large government contract. Fortunately, there are in-house projects whose topics could be chosen more or less independently from the government. Much of the basic scientific research was supported under this pool of money. For instance, from 1999 to 2002, a multidisciplinary investigation of the Western Pacific was performed using RV Onnuri to investigate the tectonic processes of a less well-known segment of the mid-ocean ridge system (Ayu Trough) and underwater hydrothermal systems in Manus Basin, Papua New Guinea for basic knowledge of geological and biological processes. In addition, investigations were made to understand the origin of Kuroshio Current in the southern Philippines Sea and the migration path of some fishes and their spawning ground in the deep ocean. This tradition of using the in-house fund for basic science continues.

Around the early 2000s, KIOST began asking to construct a new research vessel. In Korea, for government expenditure exceeding a certain amount (which in this case was about US$50 million), a preliminary feasibility study has to be conducted. The first attempt failed. Then only after changing their proposal to share with the academic community, the construction of RV Isabu (more than four times larger than Onnuri) was conditionally approved.

Around 2014, signs appeared that MOF might not honor the stipulation of sharing the new research vessel with academia. One of the reasons may be that KIOST became part of MOF. The merger included the movement of KIOST to Pusan. To receive the assurance that the government will honor the promise made with academia, on October 26, 2014, I testified under oath at National Assembly during the annual inspection of government by the legislative body. I reminded MOF of the conditions of the approval. It is rare that a professor can deliver his opinion directly to the government. My action received public attention and materialized into our new law (decree number 252 of MOF). A new chapter had opened in the history of marine sciences. Nature later reported it (Zastrow 2015).

3 Shared-Use Program

The Shared-Use Committee (SUC) was established in 2016. Committee members were chosen from KIOST and universities. KIOST held the Secretariat. The committee was divided into two subcommittees: the science subcommittee, which considers all scientific matters, including evaluating proposals and the scientific results. The operational subcommittee handles the ship time assignments and logistics issues. We tried to model after the UNOLS (University-National Oceanographic Laboratory System, https://www.unols.org/) in the US but quickly realized that many circumstances were different in Korea. The gap in views between the scientists at KIOST and the universities was large. However, a routine was developed in operation for several years. Figure 1 is the organization of SUC.

The most important activity of SUC is to select the proposals. In general, a proposal is judged on its scientific merit and the availability of ship time (that is, the ship's schedule). A good proposal can be suggested for a different year. An agreement has to be reached between the proponent and the operators. Shared use program is different from ordinary programs in that it only supports those proposals that require real ship time. A modest amount of research funds is given to assure travel for participating members and field sampling and primary processing. The expenditure of money and scientific results have to be reported like other programs. A solid ethical code is in place. Figure 2 summarizes a general timeline of annual application processes.

The ship tracks by KIOST research vessels would be provided at the beginning of the year based on the projects that they have to execute that year. This outline provides the basis for university scientists and those in the industry to make their proposals. Those along the KIOST track line will naturally have the advantage. Basically what the shared-used program encourages is to make piggyback proposals on existing transit track lines.

A typical ship track line of Isabu and Onnuri is shown in Fig. 3. In the case of Isabu, 4–5 months of transit is made from Korea, through Western Pacific, and to the Central Indian Ridge, and back. Port calls are generally made in Guam, Singapore, Sri Lanka, and Mauritius where scientific parties change hands. A typical ship time assigned to a successful proposal was, on average, a few days not counting the transit. It was a far cry from what is available in developed countries, but many considered the opportunity a meaningful beginning.

In general, the Shared-Use Program was a success beyond expectation. In 2017, 17 proposals were submitted for four slots in the first year. The situation was similar in 2018 and 2019. The government (MOF) was extremely pleased with its popularity and performance that in 2019 increased the annual budget from $1.6 million to $2.6 million. A more significant number of proposals were granted as a result.

Although research vessels belonging to KORPI were included in the shared-use program, only in 2020 was the application for ship time on IBRV Araon was accepted. At the time, KORPI asked for a second icebreaker to extend its operation deep into the Arctic Ocean. With the melting of ice in the polar regions, many countries, including China and Japan, were considering shipping through the Arctic Circle since it would take less time to reach Europe. After failing three times on the preliminary feasibility surveys, KORPI got approved on the fourth attempt only with the commitment to change its practice and allow shared use with the academic community.

For IBRV Araon, a separate committee was set up because KORPI operated on a different schedule than KIOST. During the Austral summer months of October–April, she is in the Antarctic and only in the northern hemisphere from

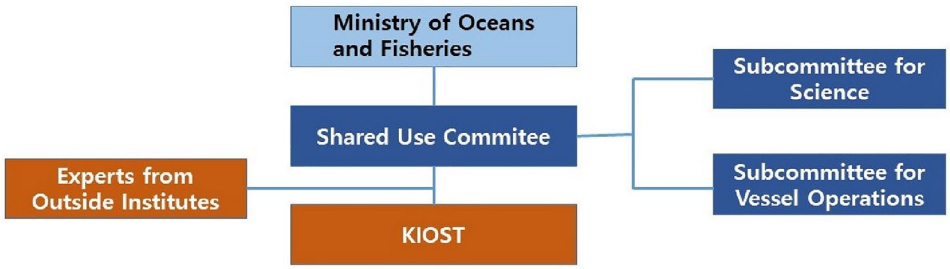

Fig. 1 Organization and structure of the Shared-Use Committee (SUC)

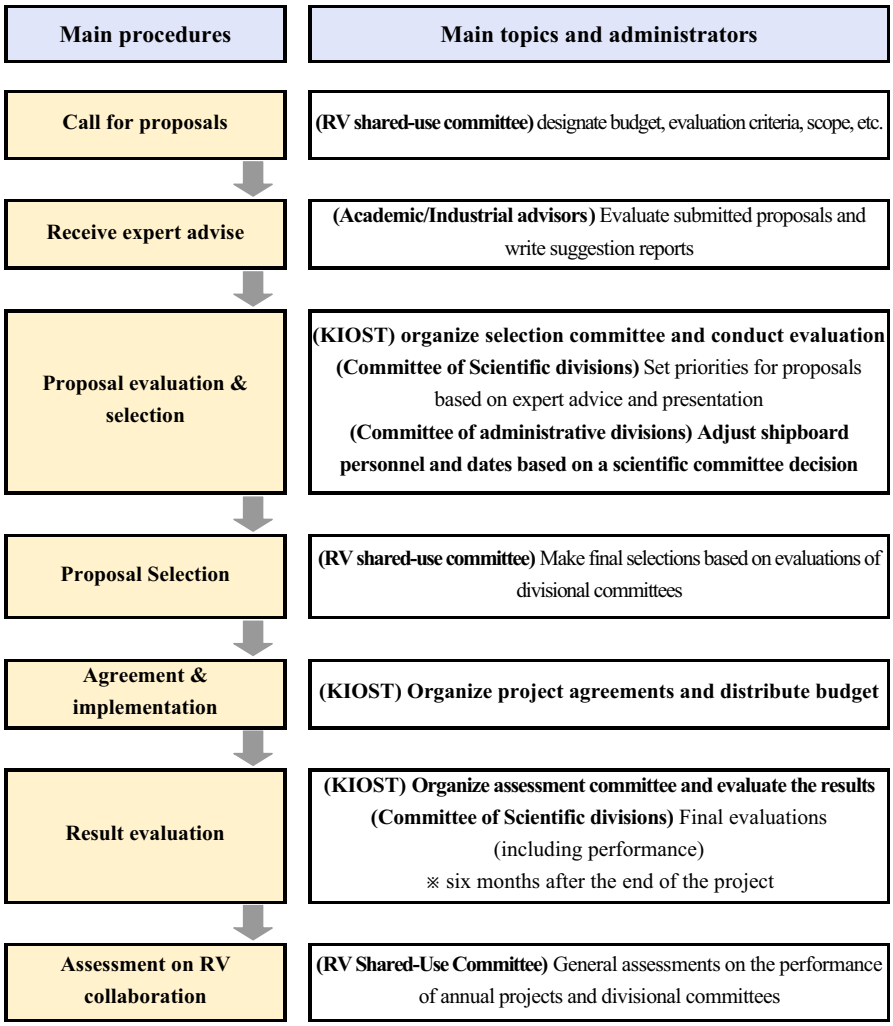

Fig. 2 Timeline of proposal-relatedevents

Management Timeline	
August	Plan collaborative usage of research vessels by the RV collaboration committee
September–October	Call for RV shared-use project proposals (60 days)
November	Proposal evaluation and selection by scientific divisional committee
December	Evaluation of vessel operation dates by RV administration divisions
	RV Shared-Use Committee evaluation and decision
January–December (Following year)	Organize agreement (Jan. next year) and implement projects
August (2 years later)	Result assessment
September (2 years later)	RV Shared-Use Committee evaluates and finalizes assessment reports

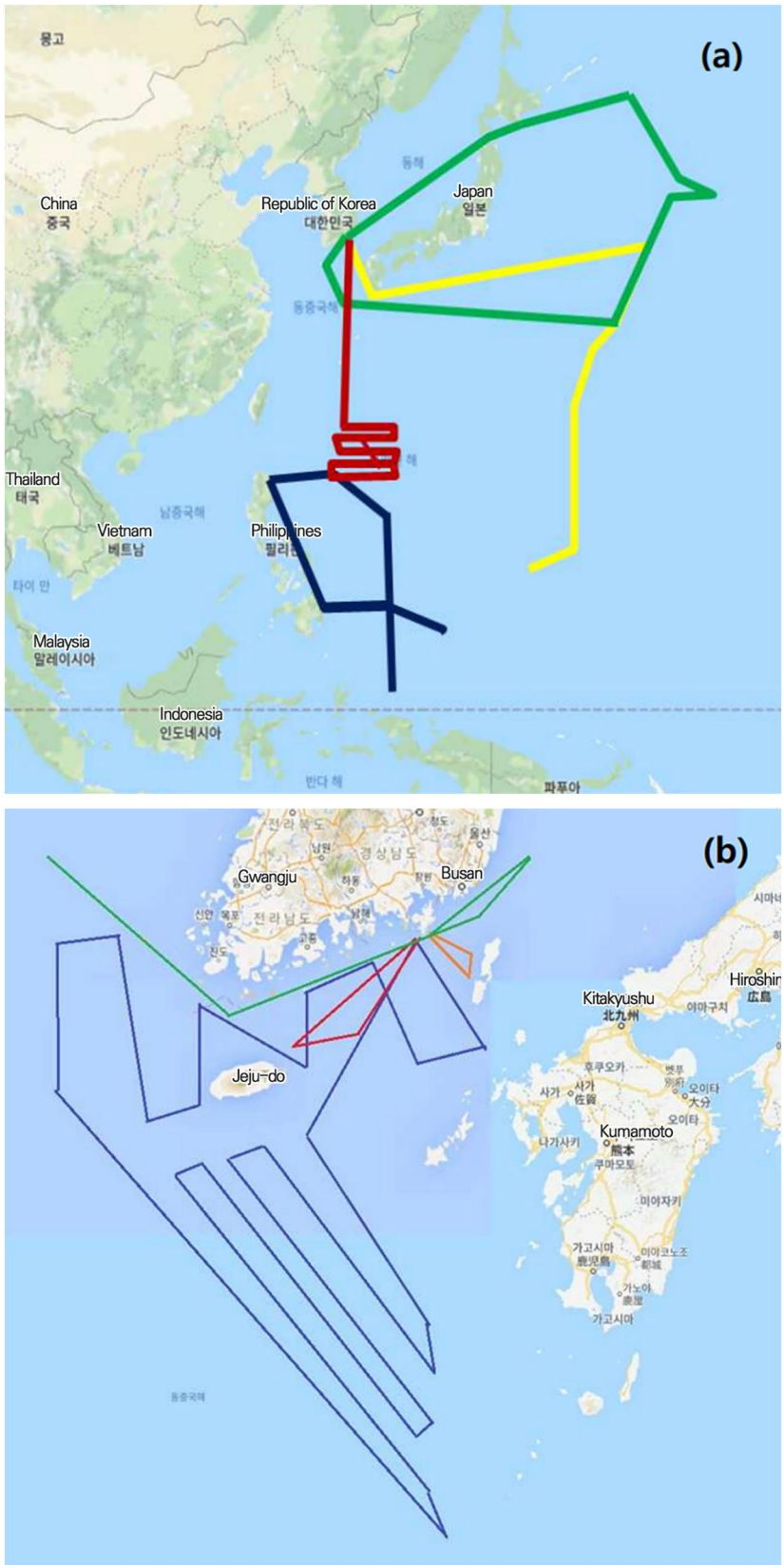

Fig. 3 A tentative cruise path for **a** RV Isabu and **b** RV Onnuri is given at the call for proposals. This is only an example for 2018. It does not show the track line in the Indian Ocean based on these paths, academic scientists propose as an add-on to the existing track lines. The survey sites of KIOST are more or less the same each year as the institute focuses on major government contracts surveys. A major one is in the Western Pacific around the Philippines Sea to study and track harsh weather conditions that might develop into typhoons. The other is in the Central Indian Ridge for massive underwater hydrothermal sulfide deposits and deep-sea biological studies related to deep-sea vending

May to early October. Korea Institute of Marine Science and Technology Promotion (KIMST) is currently acting as the Secretariat for the shared use of the vessel. SUC under KIOST and KORPI may be unified under KIMST. However, there are concerns because KIMST, as an agency in charge of evaluating R&D projects, has no experience with the operations of research vessels.

Aspired by new changes, oceanography professors in 18 different universities formed an association in 2021. One of the group's demands is to have a research vessel dedicated to the academic community. Talks are ongoing with MOF and other branches of government. A critical need is a vessel for coastal studies. However, like Japan, a global ocean class vessel is for longer surveys and meeting meaningful scientific targets that require well-planned surveys. Such demands are not met under the current shared use program, where a few days of ship time is given along the predesigned tracks, and the call for proposals is made on a year-to-year basis. It appears that the shared-use program has only whetted the appetite of those at universities as they want more.

4 A Case Study

Here I introduce an international collaboration between Korea and Japan where a total of 22 days (11 days in 2018 and 2019) were spent in the course of 2 years. The extended ship time was only possible because the international partner came with the extra money for the ship time, and the SUC provided a reduced daily rate. The site where the deployment of instruments on the seafloor and recovery a year later is some 3 days away from Guam. Scientists from both countries came up with the money for ship time.

It appears as a good model. The fact that our international partners partially paid for the survey (half of the ship time) suggests that the proposal has good scientific merit. The reviewers of the shared-use program are likely to provide good grades. A significant difficulty is that since the program is run on a year-by-year basis, there is no guarantee that the proponents in Korea will get the ship time. The outcome of the proposals is generally announced in spring. However, to enter the EEZ of another country, an application for Marine Scientific Research has to be made at least six months ahead which is tight. In our study, we wanted to deploy one instrument within the EEZ of Marshall Island but were unable to do so.

5 Concluding Remarks

Based on my experiences, several suggestions can be made for a better shared-use program. First, the short-term ones:

1-S Because the program is run on a year-by-year basis, well-designed research is not feasible. Good research may require pooling various resources from various groups and international collaboration, which can take years to coordinate.

2-S Currently, track lines are predefined by the sites that KIOST needs to survey (Fig. 3). Some studies under the shared-used program do not require being at the exact location, and the sampling can be done in the general vicinity. However, one should be mindful that the precise location is essential in many surveys, including those high-resolution studies of the ocean floor.

3-S A problem related above issue is the definition of transit. The shared-use program pays for the transit, but what is the start and end time for each survey? Is it the departure and entrance to the port of call? More realistically, the beginning of the study should be when the ship enters the survey area in the end when the boat leaves the survey area. This will clear much of the confusion and resentment.

4-S Another vital infrastructure is the tools for observation. At the moment, only those instruments fixed and mounted onboard the research vessel can be used. A national equipment pool must be established to maintain, rent and service observational tools such as ocean-bottom seismometers and mobile labs on shipping containers. Korea Basic Science Institute maintains expensive instruments that can be bought by individual researchers but only for indoor analytical facilities. There is no organization for observational tools at sea.

5-S After 2 years of ownership, the data collected under the shared-use program should be gathered and maintained on a central database for other researchers. Currently, Korea is considered a country where sharing data is complicated, hurting our reputation.

Next, problems that may require long-term to resolve are as follows:

1-L In Korea, the responsible agency for marine science is both MOST and MOF. According to the rule, basic science is handled by the former and applied science by the latter. However, it isn't easy to distinguish applied from basic research in many cases. Marine research projects carry both characteristics. The divide is very confusing for the researchers, and it is unclear where the responsibility lies in supporting infrastructures.

2-L Ways to use global open ocean research to train future scientists and engineers effectively should be considered. Like many countries, the number of students entering science is diminishing. However, with public awareness of earth environments like greenhouse gas

reduction and the hydrogen economy, a new opportunity may lie in front of us.

3-L An important goal as a nation is to increase the business opportunities related to the ocean, which is why MOF was created in the first place. Before being shared-used, the research vessels were owned, maintained, and used only by researchers at government-supported institutes (KIOST, KOPRI, and KIGAM). However, due to the shared-use program, those outside the institute will now be the users. Ship operators have to cater to these new customers. They might not go quiet if the cruise was ruined because an instrument was not well maintained or broke down. To accommodate the rising demand for higher quality service, the maintenance of scientific instruments can be outsourced to companies. This trend is already happening in many developed countries. An essential benefit of such a scheme is that many small businesses specializing in specific instruments will be created. Those businesses will, in turn, create new jobs.

Acknowledgements This research was supported by the Korea Institute of Ocean Science and Technology (KIOST, No. PE99656 and PE99796). Additional support was provided as a part of the project titled "Understanding the deep-sea biosphere on seafloor hydrothermal vents in the Indian Ridge" (No. 20170411), funded by the Ministry of Oceans and Fisheries, Korea. The author thanks the captain and crew members of RV Isabu and Onnuri for their outstanding support and excellent seamanship. A deep appreciation is extended to scientists and graduate students who participated in the field operation of the Pacific Array program.

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