THE NIPPON FOUNDATION

OPRF

Ship & Ocean Newsletter

Selected Papers

No.16
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Ocean Policy Research Foundation

Director's Message

As mankind moves into the 21st century, integrated policies of ocean governance are necessary for the sustainable development and use of our oceans and their resources and for the protection of the marine environment.

Towards this end, the Ocean Policy Research Foundation (formerly: Ship & Ocean Foundation) orients its research on ocean issues in line with the mission statement "Living in Harmony with the Oceans".

The Ocean Policy Research Foundation aims to conduct cross-sectoral research in ocean related issues in order to initiate debate on marine topics and formulate both domestic and international policy proposals.

We publish a Japanese-language newsletter called the "Ship & Ocean Newsletter" twice a month. The "Ship & Ocean Newsletter" seeks to provide people of diverse viewpoints and backgrounds with a forum for discussion and to contribute to the formulation of maritime policies conducive to coexistence between mankind and the ocean.

Our Foundation believes that the Newsletter can expand effective communication on these issues by introducing timely research to abroad and informed readership. It also welcomes to responses from readers, some of which appear in the Newsletter.

"Ship & Ocean Newsletter Selected Papers No.16" contains English-language versions of papers from the Japanese Newsletter edition, published from No.271(2011.11.20) to No.290(2012.9.5).

It is our sincere hope that these Selected Papers will provide useful insights on policy debate in Japan and help to foster global policy dialogue on various ocean issues.

Hiroshi TERASHIMA
Executive Director

■Publisher

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Executive Director, Ocean Policy Research Foundation

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●The affiliation of the author and the contents of the article are exactly as they appear in the Ship & Ocean Newsletter.

Shell Mounds and the Great Tsunami —Developing Visions for the Future from the Jomon Period

[KEYWORDS] Jomon / shell mounds / tsunami

Junzo UCHIYAMA
Associate Professor, Research Institute for Humanity and Nature
(Ship & Ocean Newsletter No.272 December 5, 2011)

The tsunami that struck eastern Japan on March 11th washed away towns and villages, along with people's lives, all along the Pacific coast, but most of the many shell mounds in the Tohoku region were undamaged. It is said that in order to avoid another tragedy we should give more thought to the planning of future communities, but I believe we also have much to learn from the lives and thought of the Jomon people of the distant past.

The shell mounds remained

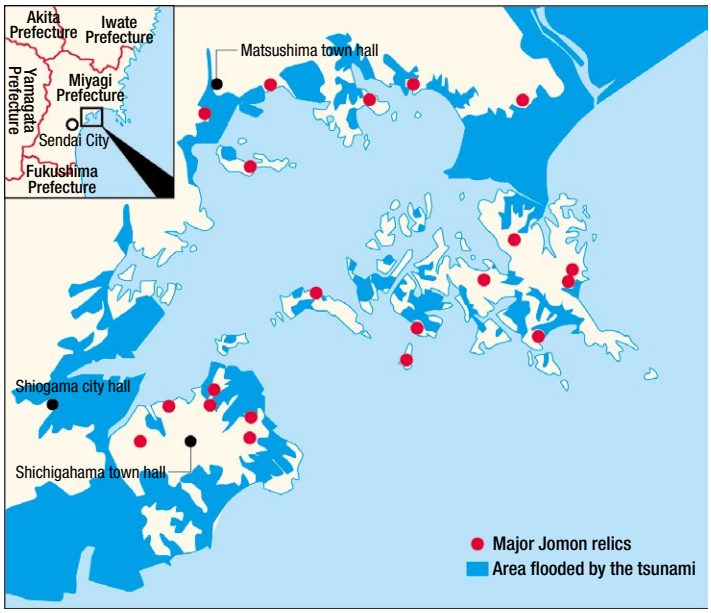
On March 11, an enormous tsunami triggered by a massive earthquake hit East Japan on the Pacific coast and swallowed up every corner of beautiful seaside villages and towns, taking many lives. I had the opportunity to visit some of the affected areas in Miyagi Prefecture in late May, roughly two months after the major catastrophe, and was staggered by the devastation of the landscape and the thought of what a long way it would be to full reconstruction.

The heavily-damaged coastal region of Sanriku is also known for having numerous shell mounds from the Jomon period (the period from roughly 3,000 to 16,000 years ago). The number of such mounds exceeds 300 in Miyagi Prefecture alone. Were not these shell mounds and other precious relics heavily damaged by the massive tsunami as well? I could not bring myself to believe it, and indeed there was a subtle gap between the distribution of the shell mounds and the area flooded by the tsunami as announced by the Geospatial Information Authority of Japan and other sources. So, as I surveyed the sites, I was not surprised to observe that so many shell mounds had been spared the tsunami's destructive force. One shell mound left a particularly strong impression on me, as right next to the restored pit house, Japan Self-Defense Forces personnel were camped and children were playing.

A lifestyle of work/home separation

Environmental archaeology is one of my specializations. More specifically, my research includes reproducing the landscape and how the environment was used during the Jomon period (3,000 to 16,000 years ago) via, for instance, animal and fish bones excavated from the shell mounds from that period.

Many of the shell mounds in the Tohoku region were formed in the mid- or late-Jomon period—that is, from 3,000 to 5,500 years ago. In textbooks, these shell mounds are described as the garbage dumps of the Jomon period. However, most shell mounds were directly adjacent to large settlements. This fact suggests that they played a central role in people's lives during that time. The animal bones remaining in these shell mounds indicate that Jomon people ate a truly wide variety of animals. They ate fish both from inner bays and from the ocean, including tuna, sea bream, and sardines. Their diet of mammals ranged from dolphins to deer, boars, bears, hares, raccoon dogs, and so on. Matsushima Bay in Miyagi Prefecture boasts a beautiful and unique assortment of complex rugged coastlines and islands; it is admired as one of the Three Majestic Views of Japan. Less well-known is the fact that this landscape dates in some respects from the Jomon period and later. The Japanese coastline in the mid-Jomon period was higher than it is today by three to five meters and so the shoreline was then much further inland and more rugged. However, the ground around



Major shell mounds along Matsushima Bay and the area flooded by the tsunami. Despite being located near the coastline, most of the shell mounds were spared the tsunami's destructive force (reprinted from "Lessons on work/home separation from the Jomon people," Asahi Newspaper for Elementary School Students, front page, October 24, 2011)

Matsushima Bay subsided at the same pace as the subsiding sea level, resulting in almost the exact coastline being preserved as back in the Jomon period.

Numerous shell mounds can be found here and to date about 70 have been studied. These relics appear to be in almost direct contact with the coastline. In reality, however, they are on high ground some 15 to 30 meters above sea level, which is why they were spared devastation. In other words, in those days, settlements were located at junctures between the sea and the mountains. In many cases, research has found no traces of the settlements having suffered disasters. As a rule, human habitats always leave some traces, so it is impossible that only settlements unaffected by tsunami have remained to this day. How, then, did these shell mounds escape disaster?

I believe the secret lies in the lifestyle of the Jomon people, who depended on the available natural resources and made the most of their very diverse environment for activities such as hunting, fishing, and gathering nuts. They attempted to collect food efficiently from easily accessible places in both the sea and the mountains—so perhaps this is the reason why the shell mounds are located on higher ground. After all, the Jomon people were using their diverse environment "extensively and yet moderately"—most probably in order to avoid localized disasters such as tsunami and landslides.

By contrast, traces of disasters are conspicuous in the relics of the following Yayoi period. For example, the Kutsukata relics of Sendai City, located four kilometers inland, escaped devastation by the tsunami thanks to the nearby highway, which served as a breakwater. Still, a recent study discovered that a massive tsunami roughly 2,000 years ago destroyed paddies in this area, rendering the area uninhabited for the next 400 years. Since the advent of a lifestyle centered on agriculture, people began to focus on investing in arable lands such as paddies and came to use a particular environment "narrowly and intensively." Home life came to revolve around the same location as the workplace, leading to increased productivity and population. At the same time, this new lifestyle was vulnerable to losing everything once disaster struck. Because people were attached to a particular tract of land, a tendency emerged that the same kind of disasters could strike again and again.

Acknowledging human limitations

I see a great difference in the conception of nature among people from the Jomon period compared with those of the Yayoi period. Jomon people did not separate the human world from the natural world, and indeed were keenly aware of the realm beyond human control, "another world." In their eyes, people and food were visitors from "another world" who return to that world after fulfilling their respective roles. Such guests were to be welcomed with utmost hospitality and then sent back to where they came from with wishes for them to visit again. Shell mounds may have been the site for precisely such rituals. As a matter of fact, human bodies have also been found buried in the shell mounds. Shell mounds are large because these kinds of activities were repeated by settlements over time. In the Yayoi period and thereafter, however, a clear distinction was made between the realm under human control and that of nature. Arguably, people came to assume that they could cultivate their own food and change nature by themselves.

The lifestyle of Japanese today seems similar to that of the Yayoi period. Just as the Yayoi people gathered into low lands suitable for growing rice and reclaimed portions of nature, so today people press forward by excessively developing nature in order to enable the population to concentrate in convenient spaces with easy access to jobs. Of course, it is only natural for people affected by the recent tsunami to yearn for their lives to be restored to the ways they used to be. Nevertheless, future designs of local communities must be devised in order to prevent such tragedies from being repeated. Though the Jomon people's experience would seem to be buried in the remote past, I believe that their lifestyle of work/home separation, using their environment "extensively and moderately," and their precept of always maintaining a vital link between their lives and nature, offer many lessons for us today.

Some have said that this disaster was a once-in-a-millennium event. In order to overcome the sorrow of our recent tragedy and to build up practical, lasting landscapes in a far-sighted manner, it is critical that we make the most of the wisdom of our remote ancestors by learning extensively from their history. ■

Promoting Ocean Education in All Schools

[KEYWORDS] specifically tailored educational activities / The Course of Study / Grand Design

Katsushi MIYAZAKI
Inspector, Elementary and Secondary Education Bureau, Ministry of Education, Culture, Sports, Science and Technology
(Ship & Ocean Newsletter No.273 December 20, 2011)

More than a few schools around the country can recount memorable episodes involving the ocean. While those schools provide learning opportunities about the ocean as part of their "specifically tailored educational activities," there is a need to expand ocean education to all schools nationwide. To accomplish this, measures need to be taken that will allow systematic instruction on ocean issues to take place within the framework of the current curriculum.

Ocean episodes and schools

[Episode 1]

On September 16, 1890, a Turkish cruiser, the Ertuğrul, was returning to Turkey after having visited Japan for almost three months. It had left the port of Yokohama when it was racked by a torrential wave caused by a typhoon off the coast of Kashinozaki, Kii Oshima, in the town of Kushimoto, Wakayama Prefecture. The cruiser hit a reef and sunk. Although 69 members of the crew were rescued by residents of Kashinozaki, the more than 540 remaining crew—despite every effort—died on duty. In the history of maritime accidents, this is the famous "Distress of the Ertuğrul." Regarding the accident, Prince Tomohito graciously contributed an article to our newsletter, entitled "Paragons of Private Diplomacy – A Friendship Borne of the Ocean" (No. 178; January 5, 2008).

Ever since this accident over a century ago, the town of Kushimoto has continued to serve as a bridge of Japanese-Turkish friendship and to engage in private diplomacy with Turkey. In particular, the Oshima Municipal Elementary School in Kushimoto plays a significant role in Japanese-Turkish exchange, as the pupils there sing a eulogy at the memorial ceremony held every five years and care for the monument.

[Episode 2]

The massive tsunami on March 11th this year resulting from the Great East Japan Earthquake devastated numerous communities along the Sanriku coast in the Tohoku region. Every year since 1988, Osawa Municipal Elementary School in the town of Yamada, one of the affected areas, has been staging "Shine, Ocean" as a school-wide play.

"Shine, Ocean" is a one-act play with six scenes involving everyone at the school that describes the transitions in the fishing livelihood of the people living in the area from the Meiji period to the present. The fourth scene depicts the tragedy of the 1896 Meiji-Sanriku Earthquake and Tsunami. As hinted at by the title, "Shine, Ocean," students introduce the bountiful fish of Sanriku and sing of the blessings of schools of shiny fish. This group play embodies the determination of the children to follow in the footsteps of their ancestors, who helped each other to overcome difficulties and to develop the local fishery while maintaining a deep respect for the ocean.

The title "Shine, Ocean" is also used for the school newspaper, which has often won the top ranking in the national school newspaper contest. Both the school and the local community share a common awareness of the inviolable relationship between humans and the ocean. The school has shouldered the role of passing on this message from generation to generation through its educational activities.

There are numerous other instances of ocean episodes and schools throughout Japan, including the Parent and Teacher Associations of an elementary school and a junior high school that continue to clean a beach to protect the habitat of loggerhead turtles so that they may lay their eggs more easily, as well as another junior high school that initiated a surfing class with the conviction that they should not be passively watching surfers from other prefectures surfing along their beach.

Many of these activities are integrated into the school curriculum as "specifically tailored educational activities by making use of originality and ingenuity" (general provisions, the Course of Study). Stated differently, these are special curricula for individual schools tailored to regional characteristics and local traditions; they are not the ocean education that is commonly and uniformly conducted at every school.

Ocean education and the curriculum guidelines

At present, school education in Japan is not carried out with oceans as an official subject. Still, "fisheries" are included as one of the technical subjects at the high school level, and this includes subjects with the term "ocean." For instance, the new curriculum to be implemented from fiscal 2013 enables schools to establish classes on "basic fisheries oceanography," "ocean information technology," "fisheries and ocean science," "marine communication technologies," "marine biology," and "marine environments."

Educational content for elementary and junior high schools related to "oceans" is presented in the table. As the

table indicates, there is limited scope for directly teaching about the oceans per se in the educational content defined by the C.S. Still, "oceans" are quite often touched upon in the educational materials, including both textbooks and the educational programs of individual schools. For instance, tales, novels, and poetry in the textbooks of Japanese language classes often feature the ocean. Likewise, schools near the ocean often plan activities on the beach as course units for life environmental studies.

An objection could be raised that uncoordinated education on the oceans through various subjects renders it difficult to build a solid, deep relationship with the oceans as an indispensable natural and social environment for we human beings. It is important to educate each child not only with such segmented pieces of knowledge, but also to help them develop a comprehensive image of the oceans as being deeply connected with human existence. The schools introduced in the above episodes have encouraged all of their students to form such a strong bond.

Promoting ocean education at every school

Systematic "ocean education" was proposed in the "Grand Design for Ocean Education in the 21st Century (Elementary School Edition): Ocean Education Curriculum and Unit Plans" drafted by Ocean Policy Research Foundation in March 2009, while I was serving as one of the board members. The grand designs for junior high and high schools were drafted in March 2010 and September 2011, respectively. The idea was to introduce a learning process featuring "oceans" and take the perspective of "oceans" when covering educational content as defined for each subject according to the C.S. For instance, the grand design for junior high schools pursues systematization of the content of ocean education according to four concepts, divided into twelve areas. The concepts are: becoming familiar with oceans; learning about oceans; protecting oceans; and harnessing oceans. The areas are: living, health, and safety; tourism, leisure, and sports; culture and art; history and ethnicity; earth and environment; materials; life; the environment and natural cycles; resources and energy; economy and industry; management; and international issues. The proposal suggested that ocean education can be systematically promoted even without changing the existing framework of school subjects.

This proposal offers a route to solid, effective ocean education in every school. It is the authors' hope that even if a student's school lies far from the ocean, has no historical ties with the ocean, and is located in an area whose traditional culture lacks any marine associations at all, the coming curriculum will enable them to develop an extensive, rich, and deep knowledge of oceans. ■

■Content of education related to "oceans" according to the curriculum guidelines for elementary and junior high schools (announced in 2008)

	Subject	Grade/Area	Educational content
Elementary schools	Social studies	Grade 5	○ Overview of the land and nature of Japan A. Major continents and oceans of the world, names and locations of major countries, location and territory of Japan
	Music	Grades 5 and 6	○ Main singing materials – common materials "Ware wa uminoko" (lyrics until the third section; song designated by the ministry)
Junior high schools	Social studies	Geography	○ Various regions of the world Provides an overview of the regional composition of the world while covering topics including latitude, longitude, distribution of continents and oceans, names and locations of major countries, and geographical divisions using the globe, world maps, and other tools. ○ Geographical characteristics of Japan compared to the rest of the world – (A) Natural environment Develops an understanding of the terrain and climate of Japan from a global perspective as well as the characteristics of a land surrounded by the sea. Provides an overview of Japan's natural environment while describing the characteristics of the terrain and climate as well as natural disasters and efforts to prevent them. ▽ Handling of the content "Characteristics and change in our territory" touches upon Japan's characteristics as a maritime nation and draws attention to the issues involving Japanese territories, such as the fact that the Northern Territories are also an integral part of Japan.
	Social studies	Civics	▽ Handling of the content "Achieving global peace" develops an understanding in light of basic concepts such as territory (including territorial waters and airspace), national sovereignty, mutual respect of sovereignty, and the role of the United Nations.
	Science	Ⅱ	○ Weather and its manner of change – Weather in Japan – (B) Atmospheric movement and influence from the ocean Associates weather in Japan with atmospheric movements and influences from the ocean while referring to weather satellite images and records from studies.

Japan's Ocean Policy

[KEYWORDS] Basic Act on Ocean Policy / Basic Plan on Ocean Policy / Ocean Policy Headquarters

Yoshikiyo ONO
Secretary-General, The Secretariat of the Headquarters for Ocean Policy, Cabinet Secretariat, Government of Japan
(Ship & Ocean Newsletter No.274 January 5, 2012)

While the Secretariat of the Headquarters for Ocean Policy has worked to implement the 1st Basic Plan on Ocean Policy, adopted in March of 2008, review of the plan will take place in 2012. The Secretariat has already begun the groundwork of determining progress in the current Basic Plan, as well as assessing new needs, and will now undertake work towards the setting of the new Basic Plan based on future policy developments.

Current status of ocean policy

In accordance with the Basic Act on Ocean Policy enacted in April 2007, the Headquarters for Ocean Policy (hereinafter referred to as the "Ocean Headquarters"), which consists of the Prime Minister (who serves as Director-General) and the rest of the cabinet members (who serve as constituent members), was set up in July 2007. At the same time, an organization to which I currently belong was set up in the Cabinet Secretariat as the secretariat of the Ocean Headquarters. At the outset, the first Basic Plan on Ocean Policy was formulated in March 2008, and since then the plan has begun to be implemented by appropriate methods according to circumstances; sometimes the cases are actually handled by the Secretariat of Ocean Headquarters itself and at other times cases are handled through cooperation between related ministries and agencies. Specifically, the major items we have achieved so far during the implementation of the first Basic Plan are shown as follows.

Submission to the Commission on the Limits of the Continental Shelf regarding the establishment of the outer limits of the continental shelf beyond 200 nautical miles and attendance at the consideration of the submission in the commission.

Establishment of the continental shelf beyond the outer limits of the EEZ over which sovereign rights for seabed natural resources can be exercised, pursuant to the UN Convention on the Law of the Sea.

Formulation of the Basic Policy concerning Preservation and Management of Islands for Management of the Sea

Formulation of policies such as preventive measures against destruction of low-water lines that serve as baselines for territorial waters, our EEZ, etc.; nationalization of land around low-water lines; and naming of isolated islands crucial for preservation of jurisdictional waters.

Drafting of the Act on the Preservation of Low-water Line and Development of Basic Infrastructure of Remote Islands for the Maintaining and Promoting Utilization of Exclusive Economic Zone and Continental Shelf, and formulation of the Basic Plan based on this Act

Designation of a "Low-Water Line Protection Areas" to prevent the destruction of low-water lines that serve as baselines for territorial waters, our EEZ, etc.; new rules regarding construction of harbour facilities on Minamitorishima Island and Okinotorishima Island.

Drafting of the Anti-Piracy Measures Law

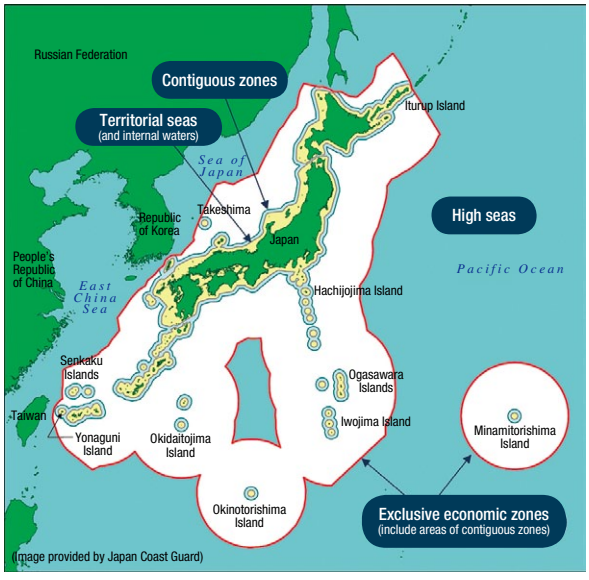
Ruling acts of piracy to be crimes, based on the UN Convention on the Law of the Sea; stipulation of issues necessary for cracking down on acts of piracy in the oceans including the high seas.

Participation in drafting of Bill on Partial Amendment of the Mining Act

Introduction of regulatory measures such as an approval system for exploring ocean energy and mineral resources (including exploration by foreign vessels) in our maritime jurisdictional zones (EEZ, etc).

In this connection, the Ocean Headquarters and the Secretariat of the Ocean Headquarters shall take charge with "drafting and the promotion of execution of the Basic Plan on Ocean Policy, as well as synthesis coordination of measures taken by relevant administrative bodies based on Basic Plan on Ocean Policy. In addition, planning and

■Maritime jurisdictional zones



drafting of important measures with regard to the oceans as well as synthesis coordination" (Article 30 of the Basic Act on Ocean Policy), which encompasses an extremely wide range of issues. Therefore, we often encounter situations in which we cannot dismiss problems that are deeply connected to foreign and security policy as "irrelevant to ocean policy."

Review of the Basic Plan on Ocean Policy and others

The Basic Act on Ocean Policy stipulates that "the Government shall review the Basic Plan on Ocean Policy almost every five years" (Article 16 paragraph 5) and "with regard to the Headquarters, comprehensive review shall be executed in five years after entering into force of the Act" (Supplementary Provisions paragraph 2). The fiscal year of 2012 marks the year in which these reviews are to be conducted. The Secretariat starts to be engaged in basic tasks such as an assessment of the implementation progress of the current Basic Plan on Ocean Policy and collection of new needs. The next stage is to carry out more in-depth discussions among the concerned parties while listening to the opinions of civilian experts before finally reaching a conclusion at the Headquarters in the latter half of the fiscal year of 2012.

Future developments in ocean policy

Here, I will set out the issues, just as they occur to me, that I believe personally and as of the time of this writing need to be considered, regarding the planning and implementation of future ocean policies. Also, I would like to add that I do not mean to imply that issues not stated here are of no importance.

(1) Promotion of the use of renewable energy from the ocean

As physical restrictions on on-shore wind-power generation continue to be identified, the use of renewable energy sources in the ocean, such as off-shore wind-power generation and wave-power generation, are said to have great potential and cannot be excluded from discussions of the future of energy. However, to promote the use of such sources, many technological and institutional problems remain to be solved, unlike the situation for on-shore power generation. To solve such problems, I believe that the parties concerned need to work harder than ever.

(2) Promotion of the development and utilisation of ocean energy and mineral resources

Currently, based on the Ocean Energy and Mineral Resources Development Plan (formulated by the Ministry of Economy, Trade and Industry; approved by the Ocean Headquarters) formulated in March 2009, exploration and development of useful technologies are being diligently conducted, but it appears important that Japan should develop such technologies independently in the context of economy, national security, etc. To this end, an examination should be conducted as to whether the current level of resources being injected into exploration and other activities is sufficient or not.

(3) Strategic fostering of marine industries

In my view, the government should work more strategically towards strengthening the international competitiveness of device manufacturers involved in ocean-based renewable energy and fostering of private-sector being responsible for commercial production of ocean energy and mineral resources. I also think that the marine transportation business and ship building industries, which are indispensable to us, as a country surrounded by the ocean, should be strategically maintained and fostered.

(4) Appropriate management of maritime jurisdictional zones

Japan possesses one of the world's largest jurisdictional waters. To ensure our future economy and security, the region must be managed appropriately and used effectively. To this end, specific measures, such as centralized management of marine information, should be steadily implemented. In implementing such measures, however, it should not be forgotten that un-delimited maritime boundaries still exist between Japan and the neighbouring countries.

(5) Dealing with changes in the global environment

Global warming is a large challenge to be solved, but phenomena such as the decrease of ice in the Arctic Ocean are considered unavoidable before the global environment begins to stabilize. Therefore, concerned countries are beginning to enthusiastically tackle the development of ocean energy and mineral resources in the Arctic Ocean and utilise it as a maritime transport route. As Japan has strong interests in the utilisation of the Arctic Ocean, I believe the time has come to consider efforts by the government as a whole.

Conclusion

We will spend approximately a year formulating a new Basic Plan on Ocean Policy, which will serve as a guideline for future policies of the government as a whole as well as a guideline for the activities of our Secretariat. Maintaining an awareness of the above issues, we are determined to make the plan as concrete as possible while listening earnestly to a variety of issues raised by those concerned. We appreciate your further cooperation in promoting our ocean policy. ■

Towards the Development of the Rich Mineral Resources of the Deep Seabed

[KEYWORDS] deep seabed minerals / marine industries / round table

Toshifumi TAKEI
Chair of the Board, Ocean Mining Industry Promotion Roundtable
(Ship & Ocean Newsletter No.274 January 5, 2012)

There is great resource potential on the ocean floor of Japan's 200nm Exclusive Economic Zone. It is important to develop these promising resources, a kind of great natural gift, to contribute to the economy of our nation. It is my hope that promotion of this development will be executed not only by the ocean industry but also by other related industries, including the mining industry, working together with a wide range of academic and research organizations for the good of the whole country.

The enormous resource potential of the Japanese 200 nautical mile zone

In March 2009, the government determined the "Ocean Energy and Mineral Resources Development Plan," based on the "Basic Plan on Ocean Policy," which was determined in 2008. This plan is for provision of technology and assessment of economic profitability aimed at achieving commercialization by FY2018, and contains ambitious intermediate stage plans for test mining in sea areas.

The determination of these positive initiatives amply demonstrates that there is rich resource potential in the 200 nautical mile zone, which is a combination of Japan's territorial waters and the Exclusive Economic Zone (EEZ). It is known that large quantities of methane hydrate exist within the 4.47 million km^2 of Japan's sea zone—this zone being the 6th largest in the world—but there are also mineral resources known as deep seabed hydrothermal deposits and cobalt rich crusts, and these also represent major resources at the global level.

The Izu and Ogasawara sea areas, and the ocean area around Okinawa, are locations with promising seabed hydrothermal deposits. It is possible that we may expect to mine around 5 million tons from a single location, and since it is said that there are likely to be around 10 such locations within the Japanese 200 nautical mile sea zone, the overall quantity of resources are estimated to amount to roughly 50 million tons. Cobalt rich crust covers a wide area within the 200 nautical mile sea zone around the remote Pacific islands—such as Minamitorishima—and the region outside this area in international waters.

Today, with the securing of metallic mineral resources—such as rare metals and rare earth metals—being matters of national concern, the importance of this ocean resource potential is continuously increasing. It is therefore crucial that industry, academia, and government make all efforts in initiatives for developing these natural resources—which are indispensible to the entire national economy—thereby allowing such resources to contribute to the future development of Japan.

The main seabed hydrothermal deposits in the ocean areas around Japan (source: Japan Oil Gas and Metals National Corporation (Independent Administrative Corporation) (JOGMEC) documents)

Meeting the challenge of deep seabed development

However, in order to establish ocean resource development on a commercial basis, there are a large number of problems that need to be overcome. Apart from the obvious considerations regarding investigation and mining systems in the unknown, harsh environmental conditions of the deep sea floor, environmental conservation, industrial development, related legislation, and international trends all need to be examined from a wide range of perspectives.

Seabed hydrothermal deposits exist in the areas around the hydrothermal vents (known as chimneys due to their shape) present on the surface of the sea floor several thousands of meters down in deep-sea areas, and around chimneys that are no longer hydrothermally active. In addition to copper and zinc, these deposits include trace amounts of gold and silver. Cobalt rich crusts are aggregated mineral deposits containing large quantities of cobalt, which is indispensible to cutting edge industries. They exist as crusts covering seamounts, and stretch from summit to foot.

The development process for deep seabed minerals can be thought of as a large-scale sequence of operations in which ore is collected on the sea floor, pumped up through a pipe suspended from the mother ship, and transported to a processing plant on land where the desired mineral is smelted, extracted, and finally put on the market. Naturally, environmental measures must be included in these processes and, in particular, since it is said that ecosystems of rare fauna and flora exist in the vicinity of deep seabed deposits where hydrothermal activity still continues, development planning must give consideration to corresponding conservation measures. In itself, the process of executing this work on the deep seabed poses an enormous technical and industrial challenge.

Exchanges of a variety of opinions and cooperation aimed at development of these currently untapped resources

In the midst of this, as well as among opinions being strongly voiced that the government plan should accelerate the pace of experimental mining and actively encourage progress, there was also an undercurrent of opinion taking the position that, in order to promote sustainable mineral resource development, it is necessary to fully understand the sequence of processes given above and to proceed carefully whilst incorporating a commercial perspective. Hence, in order to avoid divergent courses being followed by holders of these two groups of opinions, an opportunity evolved for recognizing the necessity of creating a new forum in which interested parties with various opinions and perspectives could come together to achieve mutual communication and cooperation; this is how the Ocean Mining Industry Promotion Roundtable (referred to below as RT) came to be established.

This entailed the industries dealing with design and construction of ocean development equipment, and the mineral resource industries, whose resource development activities are focused on land, to mutually cross the boundaries of their respective domains and gather round a single table to construct a new framework. Of course, not only these two industries but also surrounding, related industries participate in RT. The establishment of RT has provided the government and related independent administrative corporations with an entity that has come to act as a channel through which calls for action aimed at industry and academia can be made. This represents another significant function fulfilled by the establishment of RT.

To date, RT has held seven plenary meetings, organized visits to 3D geophysical exploration vessel “Shigen,” deep sea drilling vessel “Chikyu,” and deep-sea mineral exploration vessel “Hakurei Maru No. 2,” and held an excursion to examine hydrothermal deposit sample cores. At the plenary meetings, the responsible department heads from the Cabinet Secretariat for Ocean Policy, MEXT (Ministry of Education, Culture, Sports, Science and Technology), and MLIT (Ministry of Land, Infrastructure, Transport and Tourism) gathered together and gave talks regarding their respective initiatives relating to deep-sea resources. It is only through the unique nature of RT that it has been possible to implement activities such as these. In the midst of the national issue of reconstruction following the Great East Japan Earthquake, the Mining Act was amended for the first time in 60 years in the summer of 2011, and a legislative system promoting the development of ocean resources was formulated. Through the development of the rich potential resources lying in our oceans, we of the RT intend to strive to fulfill our part in opening up a bright economic future for Japan. I would therefore like to close by requesting the renewed support and cooperation of all those working in related fields. ■

Greetings delivered by President Takei and four vice-presidents at inaugural party. (December 16, 2009. From left) President Takei (Chair of the Board of Research Institute for Ocean Economics), Vice-president Mimura (Chairman of General Energy Investigation Committee), Vice-president Okada (Chairman of Japan Mining Industry Association), Vice-president Kawano (President of JOGMEC), and Vice-president and Deputy President Motoyama (Chairman of Committee on Oceanic Resources of Keidanren)

Logo and symbol of Ocean Mining Industry Promotion Roundtable

Lessons Learned from the Great East Japan Earthquake: Activities of the Experts Committee for Earthquake and Tsunami Reduction Policies

[KEYWORDS] Great East Japan Earthquake / disaster mitigation / multi-layered defense

Yoshiaki KAWATA
Dean, Faculty of Safety Science, Kansai University
(Ship & Ocean Newsletter No.275 January 20, 2012)

Based on a report on earthquake and tsunami responses by a committee of experts that incorporates lessons learned from the Great East Japan Earthquake, this article introduces the main characteristics of the recent earthquake and tsunami, current suppositions on future tsunamis, and practical measures for mitigating tsunami damage and dealing with future large scale earthquakes.

The author presided over the Expert Panel on Earthquake and Tsunami Countermeasures in Light of the Lessons Learned from the Great East Japan Earthquake [1] and compiled the following report after 12 rounds of panel meetings.

Characteristics of the damage from the earthquake and tsunami

The massive and unexpected magnitude 9.0 earthquake and tsunami resulted in almost 19,000 people dead or missing and economic damage amounting to 16.9 trillion yen. The disaster was compounded by the Japan Meteorological Agency's immediate underestimate of the earthquake's magnitude, which led them to believe the epicenter was off the coast of Miyagi Prefecture, excessive dependence on shoreline protection facilities such as seawalls, and insufficient issuance of a major tsunami warning due to changing forecasts.

Approach to tsunami scenarios and tsunami countermeasures

Future scenarios assume the following two levels of tsunami. The first scenario assumes a level of tsunami that occurs only once every 50 to 150 years. In such cases, disaster may be limited by stemming tsunami damage through the use of seawalls and other facilities. In the second scenario, that of an extremely infrequent massive tsunami, the response is to be based on multiple defenses by applying the concept of disaster reduction. In this case, response will consist of a combination of hard measures such as shoreline protection facilities as well as soft measures centering on evacuation through hazard mapping and improved evacuation routes.

Future direction of tsunami countermeasures

For this reason, the first priority in the event of a tsunami is to save lives. When a strong quake lasts for more than one minute and renders people unable to remain standing, the basic procedure is to evacuate to high ground immediately, without waiting to be urged to evacuate. In areas where an evacuation recommendation or order was issued, it was reported that the majority of residents who evacuated themselves to designated evacuation areas had participated regularly in evacuation drills. This fact demonstrates the importance of participation in evacuation drills. It was thus determined that community development must be pursued to ensure evacuation within five minutes, especially in areas where tsunamis can reach quickly. Municipalities should not treat this as an impossible task. Instead, they should proactively develop the tsunami-resistance of their communities before other tsunami disasters take place, pursuant to the "Act on Regional Development for Tsunami Disaster Mitigation," which was enacted in an extraordinary Diet session (approved in the upper house on December 7, 2011). This is the first such attempt in our country's history. The third supplementary budget has secured approximately one trillion yen for disaster preparedness measures nationally in order to prevent future havoc. As the majority of media outlets remain unaware of this measure however, there is some concern over the low level of information literacy.

In order to establish a system and rules for ensuring smooth evacuations, the following five necessary actions must also be emphasized:

(1) Tsunami warnings and disaster preparedness

In order to facilitate prompt evacuations, review and modify the content of tsunami warnings and how they are issued, based on the perspective of the users of the

Continuous flooding in the city of Rikuzentakata associated with ground subsidence following the earthquake

An Ishinomaki municipal elementary school devastated by the massive tsunami, which took the lives of numerous schoolchildren and teachers

information.

(2) Improvement and strengthening of the system for conveying information

In anticipation of extensive blackouts and disasters affecting government buildings, ensure that necessary information is conveyed to the municipalities and residents through multiple means, including disaster-response government radio and area mails.

(3) Strengthening of earthquake and tsunami observation systems

In light of blunders, which included the Japan Meteorological Agency's seismometers failure to keep records, as almost all went off the scale, and the loss of eight tidal observation points that were washed away, the observation system must be radically overhauled. It is critical to apply real time information on tsunamis measured in the wave source area during earthquakes, especially now that the risk of a Tokai-Tonankai-Nankai coupled earthquake is an increasing concern.

(4) Development of buildings for tsunami evacuation, evacuation areas, and evacuation routes

Implement such facilities while as a part of community development in accordance with the principle of multiple defenses.

(5) Formulation of rules for actions related to evacuation operations and disaster response

Rules for necessary actions are to be established, bearing solemnly in mind the sacrifices of 254 fire corps volunteers and 27 firefighters who died in the line of duty when the tsunami struck. Furthermore, it should be pointed out that while the importance of disaster preparedness education goes without saying, in order to be effective, continued long-term efforts must be stressed, as education comes to fruition only when pupils and students become parents and pass on their knowledge and experiences to their own children.

Future steps

In anticipation of a major earthquake, the following five priority items are stressed:

(1) As Japan lies over four tectonic plates, there is the risk that tsunamis associated with earthquakes could occur anywhere in the country. All possible preparedness measures must therefore be taken against earthquakes and tsunamis.

(2) The Tokai-Tonankai-Nankai earthquake feared to occur on the Nankai Trough is likely to be of three large, linked shocks. However, the resultant tsunami waves may not behave in that manner. Therefore, all possibilities must be considered, instead of focusing only on the rupture process such as occurred in the Great East Japan Earthquake and Tsunami. Since these coupled earthquakes and tsunami are expected to significantly impact the entire country, disaster prevention and reduction require a grand design from a national perspective.

(3) Taking account of the recent compound disaster (which included the earthquake, tsunami, and nuclear disaster), future considerations must take heed of complex disasters involving inter-plate earthquakes, inland earthquakes, and wind- as well as flood-related disasters.

(4) Emphasis must be placed on business continuity planning (BCP) of the corporate sector, with regard to supply chain issues, taking account of the nationwide economic damage that ensued when manufacturing centers and spare parts plants in the Tohoku region sustained enormous damage. Such issues are also relevant for ensuring the continuity of municipal administrative services.

(5) As a countermeasure against a vertical shock earthquake in the capital area, the possibility of earthquakes comparable to the 1923 Great Kanto Earthquake must be considered, while taking note of the unfelt yet increasingly frequent micro earthquakes occurring in the Greater Tokyo Area.

In addition, the Expert Panel noted the necessity of totally overhauling the tsunami disaster prevention measures defined in the Basic Disaster Prevention Plan. Likewise, the panel determined that it is important that the knowledge gained and lessons learned from the experience of the Great East Japan Earthquake and Tsunami be passed on to future generations, both in Japan and throughout the world. ■

1) Expert Panel on Earthquake and Tsunami Countermeasures in Light of the Lessons Learned from the Great East Japan Earthquake: Established in the Central Disaster Management Council on April 27, 2011. This report, released on September 28, 2011, was based on the findings of 17 expert advisors during 12 rounds of panel meetings. http://www.bousai.go.jp/jishin/chubou/higashinihon/index_higashi.html

A New Seafloor Mineral Deposit: Discovery and Development of "Rare-Earth Element-Rich Mud"

[KEYWORDS] frontier resources / deep sea deposits / resource security

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(Ship & Ocean Newsletter No.276 February 5, 2012)

Huge rare-earth deposits have been discovered on the deep-sea floor in the Pacific Ocean. This discovery is expected to serve as a major check on China, who has been able to use its heretofore monopoly on rare-earth resources as a trump card in international diplomacy.

The problem of rare earth resources

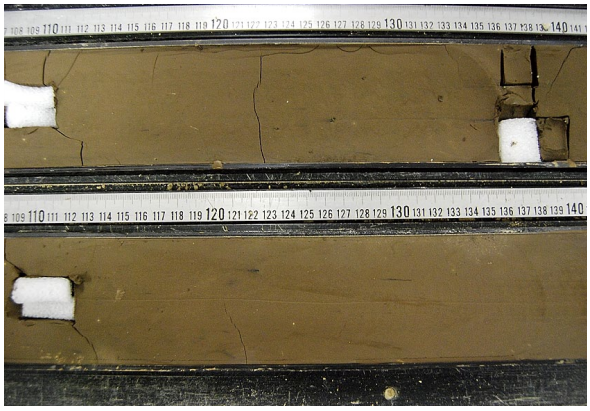
Rare earth elements are the most important resource supporting leading edge industries in Japan, but 97% is produced in one country—China—resulting in a fragile supply system. Since 2005, however, China has fluctuated sharply between policies that encourage export and policies that strongly control it, thereby raising fears of insufficient supply of rare earths and sudden rises in their prices. Furthermore, in response to the fishing boat collision incident that occurred near the Senkaku Islands in 2010, China has suspended or restricted the export of rare earths, creating a global "rare earth shock" involving not only Japan, but also America and Europe.

Even now, rare earth prices continue to increase, and a sudden, abnormal rise occurred from January to June 2011, with prices tripling in that period. In addition, China is also using rare earth resources as a diplomatic bargaining chip, so that securing cheap rare metal resources can be said to be an urgent problem for Japan.

Discovery of 4th major seabed mineral resource

In the midst of this situation, our research group has discovered mud that contains high concentrations of rare earths (rare earth mud) covering an extensive area on the deep seabed of the Pacific Ocean at depths exceeding 4000m, and we have reported on this discovery in the British Journal "Nature Geoscience" [1]. News of the discovery was published on the front page of nearly all major Japanese newspapers on July 4, and was the top story of the NHK 7:00 a.m. news broadcast. Furthermore, it was also widely reported by the major overseas media, including Reuters, the BBC, and the Wall Street Journal. The indispensability of rare earth resources to leading edge industries is probably not the only factor in the background to this extensive, global coverage. It is also likely to be not unconnected with the fact that America and European countries also attach the greatest importance to rare metals from a security perspective, since these materials are necessary to the latest military technology.

Rare earth mud can be said to be an ideal seabed mineral resource, since it has many advantageous characteristics, as follows: (1) it contains large quantities of rare earths rivaling those found in Chinese land deposits (ion adsorption type deposits) (∑REY (total quantity of 15 rare earth elements plus yttrium) = 400 to 2,230 ppm, ∑HREE (total quantity of the 8 relatively heavy rare earth elements from gadolinium to lutetium) = 70 to 430 ppm); (2) the quantity of resources is enormous, and exploration is easy; (3) radioactive elements such as thorium and uranium, which would hinder the development process, are largely absent; and (4) rare earths can easily be extracted using dilute sulfuric or hydrochloric acid, and collection is extremely simple. After hydrothermal sulfide deposits, manganese crust deposits, and manganese nodule deposits, it is expected that rare earth mud will represent the 4th major seabed mineral resource.



Rare earth mud core

Distributed widely over the coastal waters of Tahiti and the ocean around Hawaii

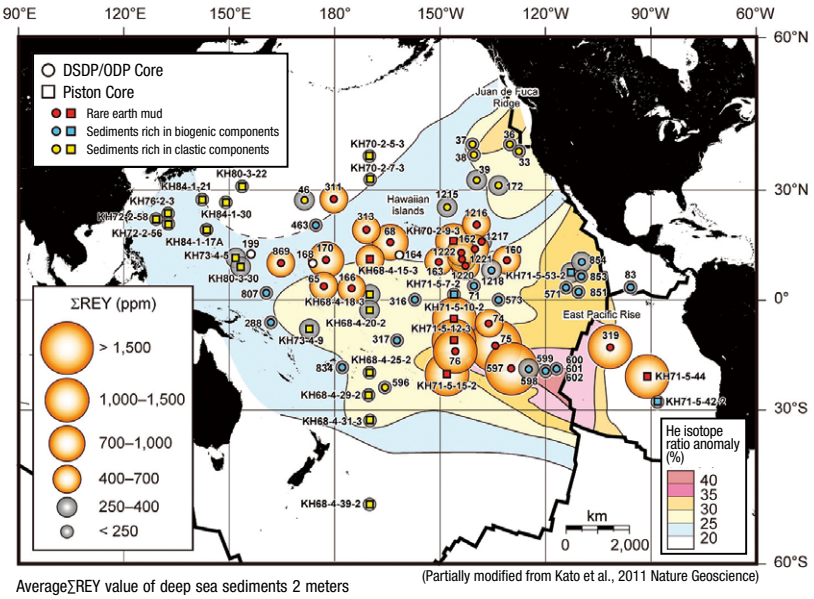
The samples used in the study (total number: 2,037) were obtained from 27 piston cores (total core length = 206 m, average 7.6 m) collected at locations all over the Pacific by Professor Emeritus Kazuo Kobayashi et al. of the University of Tokyo, Ocean Research Institute in 1968–1984 for research on paleomagnetism, and from 51 excavation cores (total core length = 2,491 m, average 49 m)—also from the Pacific—collected by the international Deep Sea Drilling Project/Ocean Drilling Project (DSDP/ODP).

Whole rock chemical composition analysis carried out using inductively-coupled plasma mass spectrometry (ICP-MS) equipment clearly showed that mud containing

high concentrations of rare earths exists over a wide area in the south eastern Pacific region off the coast of Tahiti (5–20°S, 90–150°W) and in the central Pacific (3–20°N, 130°W–170°E) (Figure 1).

The mud in the south eastern Pacific has an average layer thickness of 8.0 m, and gives an average ΣREY of 1,054 ppm, while that in the central Pacific has an average layer thickness of 23.6 m and an average ΣREY of 625 ppm, from which it can be gathered that an enormous amount of rare earth mud exists in these two areas of ocean, representing 800 times the quantity of land deposits. Depending on location, it would be possible to supply 1/5 of the global annual consumption of rare earths by the development of only 1 square kilometer. In addition, it is also clear that rare earth mud also contains high concentrations of rare metals such as vanadium, cobalt, nickel, and molybdenum.

■**Figure 1: Distribution of rare earth mud in the Pacific Ocean**



(Partially modified from Kato et al., 2011 Nature Geoscience)

Average ΣREY value of deep sea sediments 2 meters below the ocean floor (top 2 m). Areas exceeding 400 ppm have potential as a rare earth resource.

By examining a large amount of chemical analysis data using independent component analysis, it was discovered that the rare earths were concentrated by a mechanism in which suspended iron-containing solids (released by mid-ocean ridge hydrothermal activity) and phillipsite (a form of the mineral zeolite) cause the rare earths present in seawater to be adsorbed. Because they are only loosely adsorbed, 85% to 97% of the rare earths contained in the mud can be extracted in 1 to 3 hours by soaking in dilute sulfuric or hydrochloric acid at room temperature.

Aiming for sustainable ocean resource development

Our preliminary research also shows that there is an extremely high probability of this rare earth mud existing in Japan's Exclusive Economic Zone. If this rare earth mud can be utilized, it may open up the road towards Japan being able to supply itself with the rare earths indispensible to its leading edge industries.

However, many resource researchers contend that it is fundamentally impossible for these deep sea resources to compete economically with the cheap rare earth resources that are mined—without regard for the environment—in China. Nevertheless, the Chinese rare earth resources that we currently use are processed using the extremely rough technique of extracting them by directly exposing outcrops in argillic zones to acid. Some deep reflection is called for regarding our dependence on an inhumane resource development industry that carries out mining under inferior environmental conditions that are far from sustainable. New resource development is required in order to overcome this situation.

With regard to sea floor mineral resources such as rare earth mud, if Japan, with its excellent environmental conservation technologies, could lead the world in carrying out sustainable resource development that is truly considerate of the environment, then it would no longer be a distant dream to consider it as a major player in the development of ocean resources. ■

1) Kato, Y., Fujinaga, K. Nakamura, K., Takaya, Y., Kitamura, K., Ohta, J., Toda, R., Nakashima, T. and Iwamori, H.: Deep-sea mud in the Pacific Ocean as a potential resource for rare-earth elements. Nature Geoscience, vol. 4, 535-539, 2011.

Formulation and Implementation of Marine Biodiversity Conservation Strategy

[KEYWORDS] ecosystem / marine protected area / Ministry of the Environment

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(Ship & Ocean Newsletter No.276 February 5, 2012)

The bounty of the ocean that is indispensable to our daily lives is made possible by marine biodiversity. With conservation and sustainable use as its goals, the Marine Biodiversity Conservation Strategy of Japan indicates the concept of MPAs and provides direction for future measures. Through the review by a panel of experts, it was formulated by the Ministry of the Environment in March of 2011. We hope to base our future cooperation with relevant ministries on this strategy.

Background to formulation of Marine Biodiversity Conservation Strategy

As a result of the 10th meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP10) held in Nagoya in 2010, the word "biodiversity" has come to be heard often in Japan, but the issue itself had attracted attention in marine related fields from some time before.

Internationally, in addition to the aim stated in the United Nations Convention on the Law of the Sea (UNCLOS) for promoting preservation of marine living resources, and encouraging research into and protection and conservation of the marine environment, ocean conservation has also been debated at the Conference of the Parties to the Convention on Biological Diversity (CBD COP) and at the World Summit on Sustainable Development (WSSD), with various aims being adopted.

In Japan as well, in addition to the word "environment" being included in many laws relating to the ocean, Article 18 of the Basic Act on Ocean Policy, enacted in 2007, stipulates conservation of the marine environment and makes a clear reference to "ensuring the diversity of marine organisms," as well as to reducing pollution load and preventing the discharge of waste.

Against this background of heightened awareness of marine biodiversity, both within and outside Japan, the Ministry of the Environment formulated the Marine Biodiversity Conservation Strategy in March 2011. In formulating this strategy, public comment was invited, in addition to its being examined by specialists in marine biology, fishing, and the Law of the Sea. We would like here to thank all those who contributed their opinions.

Concept of Marine Biodiversity Conservation Strategy

The Marine Biodiversity Conservation Strategy aims to implement measures—with respect largely to the Exclusive Economic Zone over which Japan exercises jurisdiction—to conserve biodiversity, which provides sound marine ecological structure and function, and to use ecosystem services (the bounty of the sea) in a sustainable manner. The strategy consists of the following four parts:

1) The functions and biodiversity of the ocean, and the ecosystem services that originate from them

The ocean, through the circulation of water, fulfills functions such as transporting heat and curbing sudden changes in climate, and supports an environment in which a large variety of organisms are able to live and breed. In addition, it performs the role of three-dimensionally linking, through water, the completely different ecosystems of the Euphotic zone—i.e., the layer down to 200 m from the ocean surface into which sunlight penetrates—and the deep ocean. Furthermore, the ocean, at the same time as containing a large quantity of carbon, also acts as a large absorber of carbon dioxide through the primary production of phytoplankton. As ecosystem services originating from these ocean functions and biodiversity, we may cite "provisioning services," such as seafood and genetic resources that are used for medicine, "regulating services," such as stabilization of the climate and water purification, "cultural services," which provide bathing and other recreation together with psychological benefits, and "supporting services," such as circulation of nutrient salts and photosynthesis.

2) Current status of marine biodiversity and effects of human activity

Japan's combined territorial waters and Exclusive Economic Zone—which with an area of 4.47 million km^2 represents one of the largest in the world—is in a location where four tectonic plates meet, and since it covers a wide range of climatic zones ranging from the tropical to the subarctic, it not only encompasses many cold and warm currents such as the *kuroshio*(warm) and *oyashio*(cold), it also includes a variety of environments, from seaweed beds, tidal flats, and coral reefs to remote islands, seamounts, and the deep ocean. For this reason, of the approximately 230,000 marine species known worldwide, around 34,000 (approximately 15%) have been confirmed to exist in the waters under Japan's jurisdiction, with around 1,900 species being endemic to Japan.

With regard to Japan's rich marine biodiversity, how-

North part of Yonara Channel, famous as a diving spot

ever, not only has there been a great reduction in the scale of tidal flats and natural coastline due to development and change—particularly that which occurred during the period of the post-war high economic growth—there have also been new fears in recent years regarding intensification of coastal erosion, introduction of alien species, and the effects of global warming. At the global level also, attention is being drawn to degradation of marine biodiversity, such as the rapid loss of coral reefs and mangrove forests, and decreases in ocean fishing resources—in particular, those due to overfishing of fish species that are high in the food chain.

3) Five fundamental perspectives

The Marine Biodiversity Conservation Strategy offers five fundamental perspectives: (1) recognition of the importance of marine biodiversity, (2) comprehensive ocean management that considers connection to land areas, ocean continuity, and the large areas over which marine life migrates, (3) measures that accord with the special characteristics of the sea areas around Japan, (4) effective measures that utilize local knowledge and technology, and (5) summary of the concept of marine protected areas. Amongst these, "(5) marine protected areas" is considered one of the effective means of conservation, but since there has hitherto been no official definition of marine protected areas in Japan, the strategy adopts the following definition.

"marine areas designated and managed by law or other effective means, in consideration of use modalities, aimed at the conservation of marine biodiversity supporting the sound structure and function of marine ecosystems and ensuring the sustainable use of marine ecosystem services."

In addition, areas based on existing systems that may correspond to this definition are shown on the Ministry of the Environment webpage [1].

4) Development of future measures

With respect to the Marine Biodiversity Conservation Strategy, we may cite the following as challenges on which particular emphasis should now be placed: enhancement of scientific information and knowledge, identification of marine areas of particular importance for conservation of biodiversity, identification of factors influencing marine biodiversity and implementation of measures to mitigate their effects, promotion of measures that give consideration to the characteristics of individual marine areas, enhancement of marine protected areas and promotion of their networking, and facilitation of public acceptance and involvement of various actors.

Amongst these, when considering "enhancement of marine protected areas and promotion of their networking," we must bear in mind the Aichi Biodiversity Targets, adopted at CBD COP10, which includes the target to conserve 10% of coastal and marine areas. In addition, it is important not only to increase the physical area of marine protected areas, but also to enhance the management performed within them.

Implementation of Marine Biodiversity Conservation Strategy:

After the formulation of the Marine Biodiversity Conservation Strategy, "The State of Establishment of Marine Protected Areas in Japan" was approved at a meeting of the Headquarters for Ocean Policy (Director General: the Prime Minister). This represents the result of discussions by relevant government ministries based on a requirement of the Basic Plan on Ocean Policy, and the definition of marine protected areas given in the Marine Biodiversity Conservation Strategy, along with the information on areas that may correspond to this definition, is used within it.

As we will be cooperating with related government ministries in order to pursue initiatives in line with the strategy, we would respectfully request your support for our efforts. ■

1) With regard to the Ministry of the Environment Marine Biodiversity Conservation Strategy, please refer to http://www.env.go.jp/nature/biodic/kaiyo-hozen/other/pdf.html, "Collected Documents regarding Marine Biodiversity Conservation Strategy," 2. Existing systems in Japan that can be considered to correspond to marine protected areas.

Symbiosis with the Ocean: On the Marine Biomass Town Concept

[KEYWORDS] Ishinomaki City / Disaster Recovery Plan / marine biomass town

Hiroshi KAMEYAMA
Mayor, Ishinomaki City, Miyagi Prefecture
(Ship & Ocean Newsletter No.278 March 5, 2012)

As part of its recovery from the Great East Japan Earthquake, Ishinomaki City has vowed to again enjoy a "symbiosis with the ocean," and is now giving its best to bring that about. Last December, the city finalized a basic Disaster Recovery Plan based on the principles of "protecting, building, and connecting." In order to bring about a recycling society using new energy forms and to become the world's leading eco-town, we want to make the marine biomass town concept, which uses marine microalgae, a reality.

Introduction

The earthquake off the Pacific coast of Tohoku struck at 2:46 on the afternoon of March 11, 2011. Its epicenter lay 130 km east-southeast of the Oshika Peninsula, and a violent quake the likes of which people had never before experienced, along with a subsequent gigantic tsunami, inflicted enormous damage on the Ishinomaki area. The maximum height of the tsunami measured over 8.6 m at an observation site in Oshika district, and the earthquake became an unprecedented catastrophe, resulting in 3,280 deaths and 595 people missing (as of January 30, 2012). The search for dead and missing people still continues even one year after the earthquake, a fact that conveys how dreadful and distressful the tsunami damage has been. This past year has been filled with pain and suffering.

In addition, the tsunami caused the flooding of approximately 73 km^2 of coastal area, including the city center, which comprises approximately 30% of the lowland. 53,742 houses, accounting for approximately 70% of all houses, were damaged, while 22,357 houses, accounting for approximately 40% of damaged houses, were fully destroyed. Therefore, the construction of housing where the victims can live while they rebuild their lives as well as that of educational facilities has become an urgent issue. Regarding full-scale recovery from this great earthquake, various challenges have accumulated, including proper disposal of huge amounts of disaster waste; restoration of damaged ports, fishing ports, and fisheries; restoration of submerged agricultural land; construction of a new city, including commercial and residential districts; and the creation of new jobs for earthquake victims.

"Protect, restore, and connect" as a basic philosophy

Last December, aiming to recover from the Great East Japan Earthquake and Tsunami and realize new development, the City of Ishinomaki formulated the Basic Plan for Disaster Revitalization, with "building a disaster-resistant city," "rebuilding the economy and industry," and "forming a harmonious society through bonds and cooperation" as the basic philosophy. With the theme of "from the worst devastated city to a model of city reconstruction for the world," the concept that runs through the basic plan is expressed by three verbs: "protect," "restore," and "connect."

Energized with courage and hope for the future like a dragon (this year's Chinese zodiac animal) climbing into the sky, we wish to continue to pursue our various measures and policies with a strong faith and passion, to ensure that Ishinomaki makes a full-scale recovery from the Great East Japan Earthquake and Tsunami and that new industries are created. However, we must always remember that this reconstruction is predicated on the sacrifices of a great many people.

Main projects presented in the Basic Plan for Disaster Revitalization and projects related to restoration and recovery number into the hundreds over the next ten years. As suggested by the following words of wisdom from Zen—"go one step further in one's efforts than what seems enough, reaching a height as high as the top of a 100 shaku (roughly 30 meters) bamboo pole"—we are making efforts toward achieving the Basic Plan, summoning the courage to always take another step forward, even beyond the top of the 100 shaku pole.

In addition, by realizing the goals set last October by the Ishinomaki Chamber of Recovery and Cooperation Project, to develop a recycling society that uses new sources of energy and to become a world-leading eco-town, we are attempting to create industries and jobs as well as to promote industry-academia-government cooperation projects in order to rebuild Ishinomaki as an attractive city.

Aiming to promote the use of new sources of energy such as electricity generation via biomass, solar power, and wind power, as well as the realization of a recycling society, we have been promoting the introduction of solar power generation to public facilities and the application of our own subsidy system to ordinary households and business facilities since fiscal 2009. Faced with global-scale problems such as global warming and the depletion of oil resources, promotion of biomass usage is an urgent issue. In particular, Ishinomaki is a city located at the mouth of the Kitakami River

and has long benefited from the ocean's natural bounties.

To recover from the Great East Japan Earthquake and Tsunami, fishermen vow "to live with the ocean" and to vigorously stand up together to grow marine products, grow bonds among themselves, and grow the future of the coast.

Marine biomass town concept

Incidentally, among the tiny single-celled algae living in the ocean, there are oil-producing microalgae that produce via photosynthesis a great amount of carbon hydride having a carbon number ranging from 30 to 40. Methods are being devised to produce biofuels by culturing such microalgae.

Currently, a search is underway to find microalgae with a high reproduction rate and high fat and oil content. For some microalgae, carbon hydride content accounts for 75% of their dry weight. Biofuels produced from microalgae are used mainly as a substitute for diesel oil. As biofuels, it is possible to use vegetable oils such as palm oil, sunflower oil, and rapeseed oil, but microalgae can be cultured throughout the year so long as light is available. In addition, microalgae have been reported to possess an efficiency of 10 to 20 times that of palm oil, which has the highest fuel efficiency among vegetable oils. Furthermore, as culturing microalgae does not require fertile land nor fields and microalgae can be propagated in any season, production of microalgae is extremely efficient compared to other biomasses used for producing biofuels. Thus, the application of microalgae as a fuel has been judged to be highly feasible.

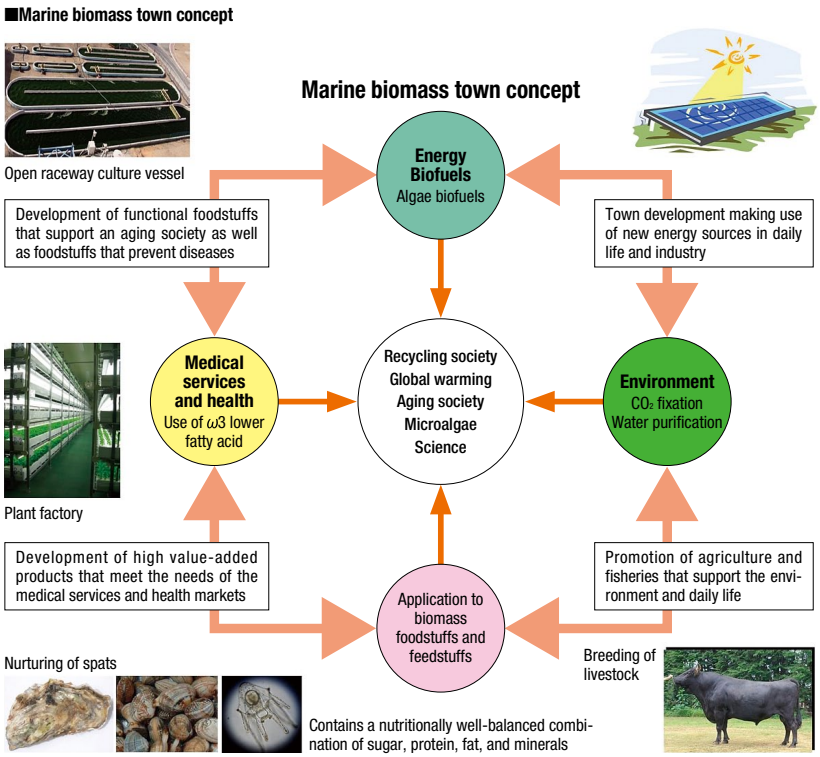
One area of biotechnology where the application of microalgae is particularly feasible is the area related to medical services and health, which includes medicinal products, physiologically active substances, and functional foodstuffs and which focuses on the functional substances produced by microalgae and endeavors to utilize the same. Also, in the area related to agricultural, water, and environmental biotechnologies, which aims to produce feedstuff for grass-eating livestock and bivalves as well as environmental purification, it is primarily microalgae themselves that are effectively utilized. Further, their importance to the fish/shellfish culture industry in the fisheries field is expected to continue to increase going forward.

In consideration of the above points, the concept I am envisioning of a marine biomass town will be realized through the creation of a science industry that contributes to the energy, environmental, medical, and foodstuff fields by making full use of the functional components of microalgae, as shown in the figure.

Microalgae are among the first creatures that emerged in the earth's oceans about three billion years ago. As they replaced carbon dioxide, which was the principal component of the atmosphere at that time, with oxygen through photosynthesis, they served as the driving force behind the formation of the current composition of the atmosphere. Microalgae created the current global environment and continue to feed off of the earth's living matter; human beings enjoy considerable benefits thanks to the resources produced by microalgae.

Microalgae will play a large role in solving the problems that threaten the existence of humanity, including global warming, the depletion of oil resources, and food shortages. We wish to rebuild our city to serve as a precedent illustrating how microalgae can be used proactively. ■

■Marine biomass town concept



The Challenge of Reconstruction

[KEYWORDS] Miyako City / Basic Guidelines for Reconstruction / town building

Masanori YAMAMOTO
Mayor, Miyako City, Iwate Prefecture
(Ship & Ocean Newsletter No.278 March 5, 2012)

With a year having passed since the earthquake and tsunami, 2012 marks the beginning of Miyako City's full-scale efforts at disaster reconstruction. In order to bring back the vitality and smiling faces of its citizens as soon as possible, concrete planning for reconstruction is already underway but we realize that it will be a challenge of historical proportion. It is with this sense of mission that we hope to proceed with our rebuilding.

Beginning after March 11, 2011

Miyako, in Iwate Prefecture, is a provincial city on the easternmost tip of Honshu, located midway along the Rikuchu coast. The city owes its prosperity to the immense bounty of the ocean. Adjacent to the prefectural capital of Morioka across the Kitakami Mountains, Miyako was reorganized to integrate four municipalities during the major merger of administrative districts in the 2000s. With a population of roughly 60,000 and an area of 1,260 km^2, the city is the eighth largest geographically in Japan. In recent years, substantial industrial clusters of electronics manufacturers, of molds and connectors, for example, have formed within the city, and this has begun to account for an important share of the city's industries. Fisheries and tourism, however, continue to form the core of the city's economy.

In what seems like the blink of an eye, almost a full year has passed since that day upon which we were confronted by brutal reality. The Great East Japan Earthquake and Tsunami that struck on March 11 last year took away a tremendous number of precious lives and assets. The number of dead and missing in the city exceeded 500 and 4,675 buildings, including housing, were completely or partially destroyed. The fishing industry was devastated. Other industries including commerce, manufacturing, tourism, agriculture, and forestry were severely affected; the local economy suffered an unprecedented heavy blow. Further, regional disaster waste disposal has been obstructed by contamination caused by radioactive materials associated with the accidents at TEPCO's Fukushima Daiichi Nuclear Power Station as well as harmful rumors.

A host of challenges too numerous to list here make the road ahead far from an easy one. And yet, we have time and time again renewed our determination to rebuild our city as we look into the eyes of our fellow Miyako citizens, who are steeling themselves against hardships, as we encounter smiling children, and as we receive heartfelt assistance from the entire nation.

Every morning over the three-month period beginning three days after the disaster, as well as once a month ever since, I have been conveying my message through the disaster-response government radio, declaring that "Miyako City shall rise again." I have done this to encourage everyone to look to the future and press ahead, regardless of whether that be one step or even half a step. My fellow citizens have said that, after hearing this message they would start each day of work, such as participating in the cleanup, with greater resolve. Some listeners have told me that, "We could carry on, thanks to the message." In hindsight, it may well be that I myself was the one most encouraged by this ritual, though at the time of course I was only trying to encourage my fellow citizens.

Striding toward reconstruction

One year after the disaster, with the efforts toward reconstruction intensifying, we increasingly feel a need to revisit our relationship with the ocean.

At present, we are in the final stage of defining a strategic program that integrates specific reconstruction projects and a community development plan for the affected districts. This program will be implemented in fiscal year 2012. The community development plan is being developed by having residents in affected districts devise their own plans for reconstruction in study panels set up for their respective districts. Although various opinions have been exchanged during these meetings, it appears that discussions have increasingly focused on the choice between the traditionally close ties with the ocean (i.e., living near the workplace) or

Exchange of ideas for community development between the mayor and junior high school students (February 1, 2012)

limiting the community's symbiosis with the ocean to economic activities alone. Being in a position responsible for protecting the lives of residents and their assets, I am also reconsidering our relationship with the ocean, as my yearning for reconstruction grows ever stronger.

Towards the ocean, I feel admiration, gratitude, and awe—with this mixture of conflicting feelings, my desire is to "re-locate the residential area to a safe location outside the reach of tsunamis and to establish the area within the reach of tsunamis as a place for economic activities that benefit from the bounty of the ocean." We would like to develop a new community without destroying our old one; we will do this with a sense of mission as we undertake this reconstruction as a historic challenge. One of our ideas is to pursue development of a compact community tailored to Miyako by consolidating the functions of regional public facilities, welfare facilities, and other urban facilities, as well as developing more public housing and with a view to introducing a new public transportation system connecting the urban areas with Jodogahama, the pride of the Rikuchu coast and famous for its scenic beauty. Having such plans in mind certainly does not conflict with the core principles of respect for and prioritization of the consensus of local residents.

Fiscal year 2012 marks the beginning of the city's full-fledged efforts toward post-disaster reconstruction. In the Basic Guidelines for Reconstruction in Response to the Great East Japan Earthquake, "rebuilding and stabilizing the lives of citizens" and "providing a safe and comfortable living environment" are noted as the fundamental concepts of reconstruction. Particular emphasis is placed on the three pillars of "rebuilding houses and livelihood," "industrial and economic recovery," and "development of a safe community." Reconstruction projects are being promoted while strategizing the best preventive measures against the next tsunami disaster. We consider it imperative to reinforce disaster preparedness and enhance the safety of the city.

Jodogahama Beach

The first sale in the fish market in Miyako City (January 4, 2012)

Development of community through closer human ties

To date, we have benefited from the tremendous support and cooperation provided by the national and prefectural governments as well as municipalities, various organizations, and a host of volunteers inside and outside the prefecture. We express our sincere gratitude to all involved.

We discovered the importance of mutual support, felt our bonds with people throughout Japan in our bones, and more than once shed tears of joy. Appreciating the many layers of human bonds between families, friends, community, and the nation, we are determined to continue to strengthen these countless bonds both today and tomorrow, never letting them falter or become severed.

Through no choice of our own, we became living witnesses to history as we experienced the Great East Japan Earthquake and Tsunami.

We painfully recognize our mission to swiftly restore Miyako to its traditional vibrancy as well as to restore smiles to the faces of all Miyako's residents by re-developing our community in a manner that will prevent a repeat of 2011's sad history.

Today, a new day has begun. The rising sun shines on the calm waters of Miyako Bay as though to suggest that nothing happened on March 11, 2011. In order to welcome a yet brighter tomorrow, we intend to continue to engage with the ocean.

"Miyako City shall rise again."

Believing this motto and united as citizens, we aspire to walk tall and with our heads high. ■

Basic Strategy of Life, Created in the Ocean

[KEYWORDS] origin of life / water / protein

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(Ship & Ocean Newsletter No.282 May 5, 2012)

Although life came into existence because this is a planet of water, water is curiously not always necessarily an ally of life activity. Water acts to greatly inhibit synthesis of the proteins and nucleic acids that represent the basic molecules of life.
Water is a paradoxical entity, in that it is able to support life activity precisely because it is detrimental to it, and the existence of life is founded on the tension between itself and water. Recognizing this leads to an understanding of the basic principles of life's strategy.

Introduction

The ocean is the birthplace of life. When searching for life outside the earth, the existence of water in liquid form, i.e., oceans, is regarded as a precondition. This precondition, however, although self-evident to everyone, that water is indispensible to life, is actually perceived as puzzling by researchers in biology like myself—and in particular by researchers into biopolymers such as proteins and nucleic acids—and presents a paradox. Fully understanding the strangeness of water creating life, as well as leading to an answer to the question of what life is, also provides important hints in our consideration of the characteristics of current life-forms and their societies, i.e., life-form networks.

The paradox of the water planet

The biopolymers of which life is composed consist of polymerized monomers. For example, proteins, which are polymers of amino acids, are a product of the polymerization reaction [1] represented by the following formula.

Amino acid $\rightleftarrows$ protein + water

This reaction produces water molecules whenever polymerization occurs, that is to say, it is a dehydration reaction. Genetic material, i.e., nucleic acids, consists of nucleotide monomers, and the polysaccharides (such as starch) that store energy consisting of monosaccharides (such as glucose); each is synthesized by a corresponding dehydration polymerization reaction.

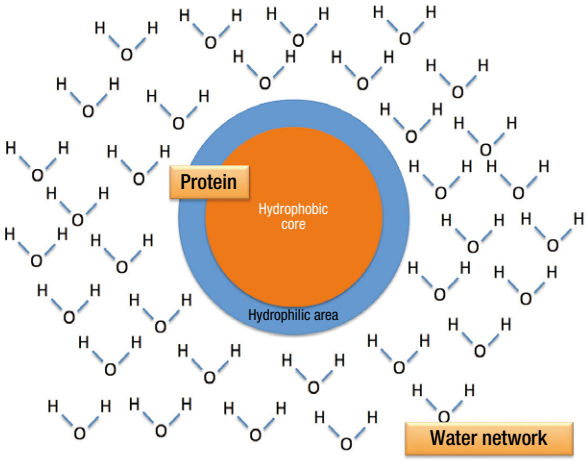
Hence, in an environment in which there is a large amount of water, the reaction shown in the formula will not proceed in the right hand direction. In the ocean, the biopolymers of which life consists are constantly being decomposed, and huge polymers such as DNA cannot form. In reality, when trying to synthesize biomolecules using organic chemistry, the greatest consideration is given to removal of water from the reaction system, and organic solvents are frequently used for this purpose. A large difficulty for research on the origin of life is the chemical paradox embodied in the fact that a planet of water is not at all suitable for life creation. In a sense, protein and nucleic acid molecules could be said to be extremely strange children for a parent like the earth to produce.

Solving the paradox

How could these "strange children" have been born in an environment so full of water? Leaving aside the primordial earth, let us examine the biosynthesis that occurs in living cells today. The synthesis of nucleic acids from nucleotides is catalyzed by enzymes, and protein polymerization occurs through amino acids being polymerized inside macromolecules known as ribosomes composed of proteins and RNA. The point to note is that, despite nucleotides and amino acids being small molecules, the enzymes and ribosomes that catalyze them are enormous in comparison, being several thousand times their size or greater. These giant molecules, by enclosing the amino acids and proteins, completely exclude water molecules from the area in which the reaction occurs. This is similar to organic chemists excluding water by the use of organic solvents.

Protein as self awareness

Why are enzymes and ribosomes able to exclude water molecules? The secret lies in their structure. These catalyst molecules have the ability to form structures spontaneously, and the driving force behind this ability is the hydrophobic bond. H_2O is a very strange molecule, which forms strong



networks even in the liquid state. This is the reason that water has a higher specific gravity than ice. Molecules that have been excluded from the water network form their own insular communities, and these are due to the hydrophobic bond. There is a Japanese expression, "like oil and water;" the fact is not, however, that oil is attracted to itself, but rather that it is expelled from the water community through repulsion and so has no alternative but to gather together in its own group. The cell membrane that marks the boundary of the cell is composed of lipids (i.e., oil), the filmy nature of which is due to it escaping from the water and gathering together to maintain a dual-membrane structure. In the same way, although enzymes and ribosomes are fundamentally thread-like in structure, because they are expelled from the water community they form a spherical structure like a ball of yarn, with a (hydrophobic) area repelled by water at the center (see figure). It is impossible for any water molecules to encroach on this central area, so that it provides a location in which dehydration polymerization reactions can proceed at high efficiency. It can be said that, as a result of their exclusion from the cool-headed water community, biopolymers have nurtured an insular system of their own.

So what kind of proteins and nucleic acids came into being on the primordial earth? Unfortunately, there is no established theory of chemical evolution as yet, but we can conjecture as follows.

It is reasonable to suppose that the primordial earth was at high temperature. Under those conditions, it was probably a dry planet with no oceans. If amino acids and nucleotides existed, the high temperature would cause polymerization reactions to progress rapidly, possibly resulting in a blanketing of the whole surface of the earth. When the earth cooled, large quantities of water turned into liquid and poured down to form the oceans, so that the nucleic acids and proteins found themselves in an environment in which they were surrounded by—hitherto absent—water; a considerable upheaval! Undoubtedly, the ocean water network excluded these polymers. We may surmise that the proteins and nucleic acids, in order to escape persecution by the water, formed structures or gathered together to create internal hydrophobic spaces. We might envisage this along lines similar to the manner in which persecution gave rise to the creation of secret Christian organizations. Before the oceans came into being, biopolymers enjoyed complete freedom, but in the adversity caused by the sudden appearance of water, they probably constructed strong defense systems against it. This was the origin of biological systems. In short, water was not an ally of life, but first appeared as a hostile presence and, in order to cope with it, biopolymers formed the communities that we term life, by which means they managed to survive.

Poison and medicine

In living phenomena, there are several examples of something which was originally harmful changing into something which is indispensably useful, just as in the case of water. The same is true of oxygen. Originally, oxygen atoms were highly harmful and damaging to biopolymers, but now, through respiration, that same oxygen is taken full advantage of as an electron acceptor. Since the nuclear accident, there has been an active debate as to whether radioactivity is dangerous or safe. Radioactivity increases the frequency of mutations, and although it naturally also increases the rate of incidence of cancer, it must at the same time be said that life could not evolve without mutations. The same is true of ultra-violet rays. It can be said that the history of life as we see it today has been one of taking such dangers and turning them into something useful.

The starting point of life's formidable basic strategy of using its enemies as allies began with the birth of the oceans. It is where risk exists that life actually thrives, and the risk management involved in turning poison into medicine can be said to represent life's fundamental essence. Building up illusory myths of absolute safety is contrary to the essence of life. ■

1) Polymerization reaction: designates a group of chemical reactions whose purpose is to synthesize polymers

The Ocean, Humans, and Muroto Geopark: How Can a Local Community Exist Sustainably?

[KEYWORDS] Geoparks / relationship between humans and nature / sustainable development

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(Ship & Ocean Newsletter No.283 May 20, 2012)

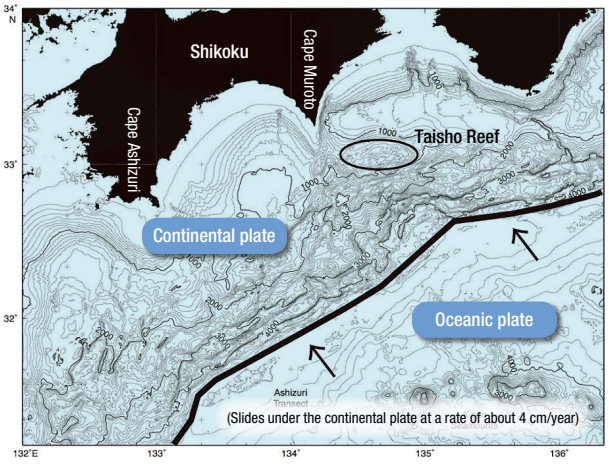
Muroto Geopark, which was granted membership in the Global Geoparks Network in 2011, is a place for thinking about the relationship between humans and nature. By making use of a variety of geological environments that formed due to subduction of an oceanic plate, Muroto has been flexible in making changes to its fisheries in accordance with changes in its social conditions. Traditionally, the ocean has been used to achieve self-sufficiency. Based on this historical relationship between humans and nature, we must seek a way for our local community to exist sustainably in the future.

What is Muroto Geopark?

At 3 a.m. on September 18, 2011, nearly 200 people waited in Muroto's city hall for Muroto Geopark to be granted membership in the Global Geoparks Network. The moment the call came from the site of the international conference in Langesund, Norway, notifying that membership had been granted, cheers arose from the crowd and a storm of applause continued for quite a while. This event had such a strong impact on the residents of Kochi Prefecture that it ranked second among news items published in the Kochi Shimbun newspaper in 2011, as selected by the residents of Kochi Prefecture (the Great East Japan Earthquake and Tsunami came in first place).

What is this "geopark" that is attracting such attention? Geopark literally means "park of earth." Geoparks are a practical program under the stewardship of UNESCO which take "excellent geological heritage" (nature) and "excellent activities" (humans) as subjects and aim to protect and make the best use of them. This program began when the Global Geoparks Network (GGN) was launched in 2004 and a system for examining and certifying Geoparks was established. As of the end of October 2011, 87 sites worldwide have been granted membership in Global Geoparks, including 5 sites in Japan.

■A variety of geological environments caused by subduction of the oceanic plate



As for its area, Muroto Geopark encompasses all of Muroto City; its theme is "the front line where the ocean and earth meet to give birth to new land." Approximately 140 km off the coast of Muroto, an oceanic plate subducts under a continental plate. Such a place, where evidence of the movement of the oceanic plate can be clearly observed from land, is rare in the world. In particular, since the rocks on the coast around Cape Muroto remarkably demonstrate such movement, Muroto Geopark is often considered to be equivalent to the rocks of Cape Muroto. However, GGN does not regard a collection of geologically important sites as a Geopark, but rather calls for an organic connection to be found among natural, social, and cultural history. From the comprehensive viewpoint of protection, education, and sustainable development, stories that convey the relationship between the people in the area and nature are important.

The ocean and the lives of people in Muroto

How have the people of Muroto lived amongst the variety of geological environments caused by subduction of the plate? This section describes people's lives by taking the example of the local fisheries.

Muroto (especially the former Muroto-cho and former Muroto-misaki-cho [1]) flourished based on whaling from the Edo to the early Meiji period. Various types of whales inhabit the ocean around Muroto due to the variety of ocean floor forms that differ between its eastern and western parts. Baleen whales, which love shallow waters, inhabit the western part, and toothed whales, which love deep waters, inhabit the eastern part, where there are steep drops and the ocean floor extends outwards at a depth of approximately 1,000 meters. The whaling culture flourished thanks to these geological forms. However, during the Meiji period, when a whaling method that made use of guns was introduced, the number of whales decreased rapidly and whaling came to an end. Instead, bonito fishing, which had until that time been conducted only to supplement incomes from whaling, attracted attention. During the Taisho period,

Taisho Reef (Taisho-ji) was "discovered" off the coast of Muroto, and, in tandem with the advent of motorized vessels, bonito fishing flourished. Taisho Reef is situated on an elevated portion of the ocean floor formed in association with the subduction of the plate and was a good fishing spot because plankton gathered there. During the Showa period, the main target of fishing shifted from bonito to tuna, and, by applying techniques developed for whaling, fishermen went fishing as far as the offings of Hokkaido and Okinawa. In 1946, the Nankaido earthquake occurred and the ground in Muroto was elevated approximately 1 m. That caused the depth of the water at the fishing port to decrease, rendering vessels unable to enter, but the fisheries were revived by re-digging the fishing port. During the post-war period, in accordance with the increases in vessel size and the development of freezing techniques, deep-sea tuna fishing prospered and fishermen sailed the world's oceans chasing tuna. At the height of its prosperity, Muroto was one of Japan's main deep-sea tuna fishing bases. Later, deep-sea tuna fishing declined due to the oil crisis and the issue of 200-mile exclusive fishing zones. Starting about 1975, alfonsin fishing centering on Taisho Reef also flourished, but these days the catches have rapidly decreased in number.

Rocks formed as sand and mud deposited on the ocean floor were pushed out by the movement of the oceanic plate (Cape Muroto)

Geopark practice and sustainable development

GGN regards development of economic activities within the framework of "sustainable development" [2] as one of the main strategic goals of Geoparks. What, then, is sustainable development for Muroto? As mentioned previously, Muroto has been flexible in making necessary changes to its fisheries by making use of its geological environments. However, as seen in one fisherman's statement, that "Muroto has exploited all of its resources, such as whales, tuna, and alfonsin, but from now on we must focus on preserving our resources to some degree," fishing was conducted without regard for sustainability. Still, there are people in coastal settlements who continue to live independent of the money economy. For example, local laver gathered from the rocky coast during midwinter is used in a self-sufficient manner by the local residents. It should be noted that in the local community, this laver is given as a gift to others as a token of gratitude for daily care. This works only because people understand the hardship incurred in producing such laver, and a tradition of exchanges of gratitude that do not involve money has taken root in the local community.

Painstakingly made local laver

In terms of industry, the relationship between the people of Muroto and the ocean may have taken shape as the exploitation of fisheries. However, in terms of people's lives on a micro scale, the use of the ocean cannot be grasped by traditional economic principles. In Geopark practice, it is important to clarify the various values of the people who have lived in harmony with nature in such a manner and to seek out natural areas that ought to be preserved for future generations. Furthermore, as Geoparks put strong emphasis on education, diffusion and regional development, a four-year re-examination system has been established. Depending on the results of the examination, membership as a Global Geopark may be revoked. The Geopark practice is truly a system for seriously contemplating and asking the question of how people should live in harmony with nature today. ■

Muroto Geopark website http://www.muroto-geo.jp/www/

1) Hane-mura, Kiragawa-cho, Muroto-cho, Muroto-misaki-cho, and Sakihama-cho were merged in 1959 to establish the City of Muroto. Muroto-cho is generally said to have flourished thanks to whaling, but the main livelihood varied among each city area corresponding to a former town or village.

2) Defined in 1987 by the World Commission on Environment and Development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Devising Innovative Ships According to New Physics-based Stability Criteria

[KEYWORDS] Second generation intact stability criteria / physics / new ship models

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(Ship & Ocean Newsletter No.284 June 5, 2012)

The International Maritime Organization (IMO) is currently attempting to develop new physics-based stability criteria for ships, an effort that is being led by countries such as Japan. The aim is to free designers from the constraints of relying on experience, in order to facilitate the construction of new types of ships that protect human lives and prevent global warming.

Introduction

MS Hikawa Maru, a pre-war cargo-passenger liner, is now moored in the port of Yokohama for preservation. Modern passenger cruise ships frequently dock at Osambashi Pier (South Pier) right next to this historic liner. Comparing these new and old passenger ships, numerous differences can be identified by their appearances alone. For instance, the upper structure of MS Hikawa Maru is a low silhouette (i.e., the center of the area surrounded by the outline is not very far from the level of the upper deck). In contrast, the upper structure of a modern passenger cruise ship is tall and may appear to be unstable. Upon closer inspection, however, the modern passenger cruise ship proves to be much wider than MS Hikawa Maru. This helps to ensure that the ship is able to accommodate the increase in passenger space in the upper section and to prevent the ship from capsizing. Nevertheless, is it possible to notice significant connections between the two? Indeed, one can, for the passenger cruise ships of our time are designed according to stability [1] criteria that rely on the experiences of ships in the 1930s such as MS Hikawa Maru.

Modern intact stability criteria

At present, the intact stability of passenger ships and cargo ships constructed for international voyages (i.e., ability of an intact ship to prevent itself from capsizing in heavy weather, etc.) is designed in accordance with the 2008 International Intact Stability Code (IS Code) of the International Maritime Organization (IMO). It consists of both empirical rules obtained from statistical analysis of wrecked ships and semi-empirical rules based on a simplified model simulating beam sea and beam wind.

The former empirical rules are based on a statistical analysis of several dozen wrecked ships and were first adopted in 1968. Specific examples include the rule: "the maximum righting lever shall occur at an angle of heel not less than 25 degrees." The latter rules are based on a set of Japanese rules for ship stability defined in 1956 and known as "weather criteria." They are classified as semi-empirical rules because of the approximate treatments made in modeling wind, waves, and hull movements. Moreover, the wind velocity, which is the most essential parameter, was tuned by comparing the resulting models and actual ship casualty. Actual ship casualty records were obtained from nine passenger ships, two cargo-ships, and two war vessels, most of which are pre-war Japanese ships.

It is no exaggeration to say that today's passenger cruise ships are built based on actual recorded data from the time when MS Hikawa Maru was constructed. The applicability of the weather criteria has been ensured for the final step involving comparison with the records. Meanwhile, significant progress has been made in theories of ship dynamics since 1960 and it appears that various components used in the weather criteria, such as wave exciting moment, can easily be upgraded. In fact, European members of the IMO, such as Germany and Italy, have repeatedly criticized the criteria and identified room for improvement. Nevertheless, such criticism has been dismissed every time the issue was raised on the grounds that such partial modification would disrupt the integrity with the actual records in the final step.

MS Hikawa Maru (completed in 1930: moored today in the port of Yokohama)

MS Independence of the Seas (completed in 2008: photographed in the port of Southampton)

As just described, the current stability criteria consist of empirical and semi-empirical rules. Moreover, the data serving as the basis was taken in the 1950s or earlier. Still, all may be well if there are no problems. Nevertheless, there have been numerous reports of incidents, albeit not rollover accidents, that make it increasingly difficult to state with certainty that the intact stability criteria can be perfectly applied to recent ships. For instance, in 1998, a post-Panamax container ship rolled nearly 40 degrees in head waves and nearly 800 containers were damaged. In 2003, a pure car carrier rolled approximately 50 degrees. In addition, numerous incidents of substantial heeling of large car ferries by 20 degrees or more have been reported, including the overturning of a Tokyo-Okinawa route car ferry in 2009. In the first place, there were no container ships, pure car carriers, nor long-range car ferries in the 1950s. These ships appeared in response to subsequent needs. While it is possible in principle to create new empirical rules based on the new sets of accident statistics, fortunately the number of recent maritime accidents is few enough to render them statistically insignificant. In addition, developments in maritime transportation are ongoing in order to transport raw materials to China, the world's workshop, as well as to transport products from China to the world's markets. Pressures to curb greenhouse gas emissions from such ships by changing their designs will intensify as the ships are considered to be contributors to global warming. For these reasons, even newly developed empirical rules may well end up being obsolete by the time these new model ships appear.

Significance of the transition to a physics-based approach

In consideration of the above, new stability criteria should be based on physics instead of empirical rules. Such a transition not only ensures that the criteria are compatible with both aged and modern ships, but also ensures compatibility with the ships of tomorrow. Furthermore, it relaxes the constraints imposed by the previous criteria in achieving optimal designs of ships according to intended use, thereby opening up the possibility of creating new ship types according to technological capabilities. In other words, this clears the way for developing innovative ships that cut greenhouse gas emissions without being constrained by past experiences. To date, various new ideas no doubt have had to be abandoned due to restrictions based on past experiences for securing safety under vague environmental conditions in oceans. In addition, the designing of essentially new ships has been rendered inherently difficult under the constraints of empirical rules, and technological capabilities have seldom been translated into competitiveness when ships were ordered and constructed. Removal of the constraints imposed by the empirical rules will lead to international competition in designing ships from scratch and will result in a more desirable environment, one conducive to giving birth to a series of new ship types that contribute to both the prevention of global warming and to international economic development.

Second generation intact stability criteria

In recognition of the above, the pace of the discussion on developing new physics-based intact stability criteria has accelerated in the IMO since 2008. Japan has assumed the role of coordinator with the correspondence group. Given the fruit of research to date, estimation of the probability of hazardous phenomena actually experienced by ships in the present day (e.g., parametric rolling, broaching [2], and loss of stability in following seas) via computer simulation is within the range of technological possibility. Nevertheless, application of such methods to all ships is a waste of design capacity. Discussions are therefore ongoing, taking the approach of first determining the hazardous phenomena that could potentially occur to each respective target ship by simple computations based on vulnerability criteria, so that the probabilistic evaluation by leading-edge simulation can be limited to being performed only when necessary.

Japan has proposed to draft IMO vulnerability criteria for almost all possible phenomena as well as probabilistic assessment procedures. Some of Japan's proposals are gaining international consensus. While seeking greater understanding of such efforts, we would be pleased if the new criteria were recognized as a new business opportunity and this stimulated endeavors in the conceptual design of innovative ships that contribute to the prevention of global warming as well as other key goals. ■

1) Stability = The disposition of a ship to attempt to revert to its original position after being heeled, which is paramount for ensuring safety
2) Broaching = Loss of directional control of a ship in astern seas