Report on the International Workshop for Large-scale Research Cruises

1. General information

Cruise Title: Exploration of the North to South West Pacific Ocean: Research for Air-Sea and Life-Solid-Earth Interactions

Moderator’s Name: Hiroyuki Yamamoto, Katsuhiko Suzuki, Hidenori Kumagai
Moderator’s Department: R&D Centre for Submarine Resources, JAMSTEC

Required cruise days (round-trip): Approximately 320 days in 2 years (2017 and 2018)
- R/V Kairei: 135 days
- R/V Mirai: 135 days
- New ship: 50 days

Major Survey Area: Western Pacific Ocean from Kuril to Mariana Trench, and Indonesian Archipelago to West Philippine Basin

Brief description of the scientific objectives and survey plan of the cruise(s) (up to 200 words)
This multidisciplinary proposal, covering three subprojects, requests the JAMSTEC research vessels to investigate air-sea and life-solid-Earth interactions from surface to sub-seafloor zones. Subproject I focuses on the deep trenches, from Kuril Trench to Challenger Deep in Mariana Trench. The objectives of subproject I are to understand: 1) the unique systems of hadal trench environments on biogeochemical processing, microbial ecology, trench associated vent system, and mechanism and history of seismic faulting breaching to the trench axes, and 2) the role of mantle peridotite serpentinization on highly alkaline ecosystem. The objective of subproject II is to explore the availability of resources and deep marine biodiversity at Ogasawara Plateau and Benham Rise. These sites are also unique for understanding the effect of smaller oceanic plateaus and seamounts on subduction and ocean circulation, including the potential hazards associated with them. Subproject III focuses on unique areas of Philippine Sea, Indonesian Archipelago, and western equatorial Pacific. The objective is to explore intra-seasonal-scale air-sea interactions of spring-to-summer, from April to August, which can modulate the seasonal climate march over the north-western tropical Pacific, i.e., Pacific warm pool area with the globally highest sea surface temperature and summer monsoon, which profoundly impacts Asian climate including Japan.

Keywords (up to 5): air-sea interaction, trench biosphere and ecosystem, oceanic plateau-trench seismogenic zones, biogeochemistry, submarine resources

Relationships to the JAMSTEC Mid-term program:
1) Climate changes
2) Extreme biosphere
3) Understanding seismogenic zones and Earth’s interior
4) Exploring untapped submarine resources
<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Organization</th>
<th>Country</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ronnie N Glud</td>
<td>University of Southern Denmark</td>
<td>Denmark</td>
<td>L14-04</td>
</tr>
<tr>
<td>2</td>
<td>Hiroshi Kitazato</td>
<td>JAMSTEC</td>
<td>Japan</td>
<td>L14-04</td>
</tr>
<tr>
<td>3</td>
<td>Yasuhiro Ohara</td>
<td>Hydrographic and Oceanographic Department, JCG</td>
<td>Japan</td>
<td>L14-22</td>
</tr>
<tr>
<td>4</td>
<td>Takuro Nunoura</td>
<td>JAMSTEC</td>
<td>Japan</td>
<td>L14-22</td>
</tr>
<tr>
<td>5</td>
<td>Royta Hino</td>
<td>Tohoku University</td>
<td>Japan</td>
<td>L14-25</td>
</tr>
<tr>
<td>6</td>
<td>Maria L G Tejada</td>
<td>JAMSTEC</td>
<td>Japan</td>
<td>L14-37</td>
</tr>
<tr>
<td>7</td>
<td>Seiichi Miuara</td>
<td>JAMSTEC</td>
<td>Japan</td>
<td>L14-37</td>
</tr>
<tr>
<td>8</td>
<td>Carlos Primo</td>
<td>University of the Philippines</td>
<td>Philippines</td>
<td>L14-37</td>
</tr>
<tr>
<td></td>
<td>David</td>
<td></td>
<td></td>
<td>L14-12 (PI)</td>
</tr>
<tr>
<td>9</td>
<td>Takuya Hasegawa</td>
<td>JAMSTEC</td>
<td>Japan</td>
<td>L14-52</td>
</tr>
<tr>
<td>10</td>
<td>Masaki Katsumata</td>
<td>JAMSTEC</td>
<td>Japan</td>
<td>L14-52</td>
</tr>
</tbody>
</table>
### Subproject I: Trench Ecosystem and Subduction System

**Pre-proposal:** L14-04; -22; -25

The deep trenches represent one of the remaining oceanic frontiers. In particular the trench system in the West Pacific is unique underlying a strong north-south gradient in oceanic productivity and with the segment of the southern Mariana Trench as a unique feature. Because of the presence of a torn and narrow subducted slab, opening of the southern Mariana Trough (a back-arc basin), and the collision of the Caroline Ridge, this region is deforming rapidly, resulting in the presence of the deepest place on Earth, the Challenger Deep. Here, the biology in this region is highly dependent on the geological process. Furthermore, trenches can be sources of extraordinary tall tsunamis when seismic slip along thrust faults breach to the seafloor at trenches, and impact to adjacent and even remote environments, as appeared in the 2011 Tohoku Earthquake. Comprehensive study based on geophysical, geochemical and marine biological data acquisition is required to uncover important processes at trenches. The scientific objectives are: 1) exploration and quantification of benthic biogeochemical processes to determine the contribution of hadal trenches to deep-sea marine carbon and nitrogen cycles, 2) exploration of microbial community structure and viral controls on microbial populations in hadal trench sediments, 3) exploration of the geobiological ecosystem of the world’s deepest place the Challenger Deep, 4) understand the role of serpentinization of mantle peridotite on highly alkaline vent systems and associated ecosystem, 5) understand the mechanical behavior of shallow thrust faults at present and in the past.

### Subproject II: Oceanic Plateaus

**Pre-proposal:** L14-37, -12

Oceanic plateaus colliding with subduction zones are a common feature around the Pacific and West Philippine basins. Understanding the collision style and potential earthquake hazards they pose, the submarine resources present, effect on ocean circulation, and the diversity of marine life associated with the intermediate water depths above them are important but are less studied. We propose to conduct a comparative study of the two less known oceanic plateaus, Benham Rise and Ogasawara Plateau; to 1) understand their origin and the earthquake hazards connected with oceanic plateau-subduction zone collision better, 2) explore potential resources, 3) investigate the effect on ocean current circulation, and 4) discover the type of marine ecosystem associated with them.

### Subproject III: Air-sea interactions

**Pre-proposal:** L14-52

The seasonal climate march of spring-to-summer over the northwestern tropical Pacific is characterized by a large northward extension of the Pacific warm pool area with the highest sea surface temperature (SST) in the world and overlying summer monsoon, which profoundly impacts Asian climates including Japan. The scientific objective of this project is to investigate intraseasonal-scale (shorter than 90 days) air-sea interactions of spring-to-summer, from April to August, which can modulate the seasonal march through three unique combinations of upper-ocean variations and atmospheric effects; 1) SST variation in Philippine Sea (P: The area is shown in the
map in below) due to heat transport from oceanic eddies and atmospheric variability, 2) SST variation in Indonesian Archipelago (I) due to complicated coastal currents and winds from both the Indian Ocean and the Southern Hemisphere, and 3) SST variation in western equatorial Pacific (W) due to equatorial currents and winds from the Southern Hemisphere. Representation and predictability of such seasonal march and its modulation still remain challenging. Therefore, the proposed intensive observations are beneficial to promote vast range of studies on climate changes and to establish more sustainable and resilient society. The present project will be extended to future observations of fall-to-winter. The comprehensive observation advances studies on interannual-to-decadal climate changes.
4. Survey Plan of the cruise(s) (maps required)

The survey plan can be achieved by two cruises in 2017 and 2018 using three research vessels.

**Subproject I: Trench ecosystem and subduction system**

**Total ship time:** 135 days  
**Platforms:** R/V Kairei with Kaiko Mark IV and CTD-water sampler, New Ship with MCS and coring, Mirai for oceanographic survey.

1) Kuril Trench and abyssal reference site (10 days, spring and summer seasons)  
As biogeochemical study, benthic lander system will be deployed at central trench and recovery, in situ observations in adjacent area of the trench.

2) Japan Trench and abyssal reference site (45 days, spring season)  
Same biogeochemical survey will be conducted. Deployment of broad-bands ocean-bottom seismograph with pressure sensors (BBOBSP) and acoustic distance meters (ADMs) will be performed by ROV, and 10 dives for maintenance ever year. Onboard operation of GPS/A geodetic system for 30 days will be needed. Piston coring and MCS will be conducted by New ship.

3) Izu-Bonin Trench and abyssal reference site (10 days, spring season)  
Same biogeochemical survey will be conducted. The ship-time should be shared with Subproject II.

4) Mariana Trench and Challenger Deep segment (50 days, spring season)  
Same biogeochemical survey will be conducted. In situ observation to find new site of serpentinite-hosted community will be performed by Kaiko Mark VI (20 days). MCS should be operated by New Ship. OBS deployment, CTD cast and piston-coring at Challenger Deep can be performed by Mirai or New ship (20 days). Recovery cruise will be needed next year.

**Subproject II: Oceanic Plateaus**

**Total ship time:** 50 days  
**Platforms:** R/V Kairei with Kaiko Mark IV

- In situ observation of seafloor and sampling of sediment, rock and organisms will be conducted by ROV. Oceanographic survey and water sampling will be operated by either vessels of Kairei, Mirai, or New Ship.

1) Ogasawara Plateau (10 days)  
Geological and biodiversity surveys, observations, and sampling on the plateau will be conducted with ship-time sharing with subproject I.

2) Benham Rise (40 days)  
Geophysical surveys (MCS and OBS), geological sampling and deep-water biological observations will be conducted and some parts of the survey can be shared with the oceanographic survey leg of subproject III.

**Subproject III: Air-sea interactions**

**Total ship time:** 135 days  
**Platform:** R/V Mirai
The proposed cruise is operated over the three regions (P, I, and W) in the northwestern tropical Pacific from April to August in 2018 (135 days of total ship time), consisting of four legs. Outline for each leg is shown below. As the ship-time sharing with subproject I and II, oceanographic survey and recovery of OBS in the Marina area can be operated.

**Leg 1: Regions P and I in April**
Deployment of subsurface moorings, deployment and recovery of TRITON buoys, and launch of both surface drifters and Argo floats, inclusively.

**Leg 2: Region W in May**
Deployment / recovery of TRITON buoys and cross-sectional / stationary ship observations, inclusively.

**Leg 3: Region I in June**
Cross-sectional / stationary ship observations and recovery of the subsurface moorings.

**Leg 4: Region P in July-August**
Cross-sectional / stationary ship observations and recovery of the subsurface moorings.

In addition to modern instruments (underway-CTD, wave-gladder, and shipboard dual-polarimetric Doppler radar), traditional instruments (CTD/LADCP, radiosonde, etc.) are utilized. The project will be conducted under cooperation with land-observations using surface, radiosonde, and Doppler radar in coastal areas in Philippine, etc.
5. Relevance to other scientific projects in Japan and/or abroad

Subproject I would greatly facilitate and strengthen the ongoing work of an existing scientific consortium of researchers from world-class European and Japanese institutions exploring hadal biogeochemistry and microbiology: University of Southern Denmark; Scottish Association for Marine Science; University of Copenhagen; Max Planck Institute for Marine Microbiology, National Oceanographic Center in UK; Okinawa Institute of Science and Technology in Japan, and JAMSTEC. Regarding in particular the Mariana Trench, it was one of the focus sites of the US-NSF MARGINS program to understand the “subduction factory” processes. Although the MARGINS program is now replaced with the GeoPRISMS program, Japan-US collaborative work on the Mariana Trench has been continuing up to now.

Subproject II will explore untapped submarine resources (living and non-living) in the important extended continental shelf areas and is intended to initiate a long-term collaboration for marine research between Japan and the Philippines. The governments of Japan and the Philippines have partially done survey and been granted their legal extended continental shelf areas under the United Nations Law of the Sea over the Ogasawara Plateau and the Benham Rise areas, respectively. Below are URLs of the relevant information.


The Philippine government is currently pursuing active exploration of the Benham Rise area and complementary funding is available to the proponent of L14-12 and L14-37.

Subproject III will strongly collaborate with the YMC (Years of the Maritime Continent) projects, which will be conducted in the present JAMSTEC’s medium-term research plan, and with researchers belonging to various research institutions including University of Hawaii, Scripps Institution of Oceanography, Ateneo de Manila University, and Philippine Atmospheric and Geophysical and Astronomical Services Administration. This subproject will also contribute to the TPOS 2020 (Tropical Pacific Observing System 2020) by providing scientific evidences regarding the air-sea interactions over the Pacific warm pool region, which is the one of the important areas of the TPOS 2020.

6. Remarks

The collaborations between subproject’s cruise plans have been discussed and achieved some of ship-time sharing. The moderator would like to encourage continuous consideration for cruise planning, which can fulfill their scientific goals.