InterRidge Japan Symposium

November 12-13, 2013

DAY 1

Integrated Study on Mid-Ocean Ridge Process

November 12, 2013

東京大学大気海洋研究所共同利用研究集会

DAY 1

海底拡大系の総合研究：現状と将来
-InterRidge-Japan 研究集会-

日　　時：平成２５年１１月１２日（火）１０:００～１７:３０

場　　所：東京大学大気海洋研究所２Ｆ　講堂

〒277-8564　千葉県柏市柏の葉 5-1-5　TEL 04-7136-6011

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プログラム

１１月１２日（火）

10:00-10:05　　**開会の挨拶**　　沖野郷子（東大大海研）

10:05-10:30

1. **南マリアナトラフ熱水地域における地震波速度構造と地震活動**
   佐藤利典・水野真理子・高田裕能（千葉大学）・山田知朗・一瀬建日・望月公廣・篠原雅尚（東大地震研）・島伸和（神戸大）

10:30-10:55

2. **南部マリアナトラフにおける熱水循環系の解明：ウラシマサイトの化学組成**
   多和田美紀・土岐知弘（琉球大学）

10:55-11:20

3. **IODP 第 331 次航海掘削試料の解析結果から考える伊平屋北海丘熱水域の海底下鉱化作用**
   井上博靖・石橋純一郎(九州大)・IODP 第 331 次航海乗船研究者

11:20-11:45

4. **地球化学的手法と生態学的手法による熱水活動史の解析**
   熊谷英憲・渡部裕美（JAMSTEC)・石橋純一郎（九州大)・小島茂明（東大大海研)・中井俊一（東大地震研)・豊田新（岡山理科大）

11:45-12:10

5. **Google ship, R/V Falkor　での HROV Nereus による Cayman Trough 調査航海と大深度海底熱水系の未踏課題**
   中村光一（産総研）

12:10-12:20　　InterRidge-Japan 連絡

12:20-13:45　昼食　兼　懇親会

PM　International Session

"Mid-ocean ridges and hydrothermal activity in the Indian Ocean"

joint-hosted by Japan-Korea Marine Geoscience Symposium on Global Open Ocean Studies

13:45-13:50　　**Opening Remarks**　　Jin-Oh PARK (AORI)

13:50-14:15

6. **Similarity and diversity in fluid geochemistry of four hydrothermal fields at CIR**
   Shinsuke KAWAGUCCHI (JAMSTEC)

14:15-14:40

7. **Deep-sea hydrothermal vent fauna in the Central Indian Ridge**
   Hiromi WATANABE (JAMSTEC), Grish BEEDESEE (Mauritius Oceanography Inst.), Tomomi OGURA (JAMSTCE), Suguru NEMOTO (Enoshima Aquarium), Takuya YAHAGI (AORI), Satoshi NAKAGAWA (Hokkaido University), Kentaro NAKAMURA (JAMSTEC), Ken TAKAI (JAMSTEC), Meera KOONJUL (Albion Fisheries Res. Centre), Daniel E.P. MARIE (Mauritius Oceanography Inst.)

14:40-15:05

8. **Population genetic study of endosymbiotic bacteria of deep-sea hydrothermal vent tubeworms and bivalve mussels**
   Yong-Jin WON, Phuong Thao HO, Eunji PARK, Ye-Seul KWAN, Kang-Chon KIM, Sook-Jin JANG (Ewha Womans University), Soon Gyu HONG (Korea Polar Res. Inst.), and Robert C. VRIJENHOEK (MBARI)

15:05-15:30

9. **Geophysical investigations of Rodriguez Triple Junction and southern Mariana Trough back-arc basin**
   Nobukazu SEAMA (Kobe University), Tomoaki YAMADA (ERI), TOshinori SATO (Chiba University), Tetsuo MATSUNO (NIPR), Taichi SATO (AIST), Eri IIZUKA, Haruka SHINDO (Kobe University), Yui NOGUCHI (Chiba University), Takahiro BABA (Kobe University), Akihiro KONO , Hirohoshi TAKADA (Chiba University), Takehi ISSE (ERI), Kyoko OKINO (AORI), Masanao SHINOHARA (ERI), Yoshifumi NOGI (NIPR), Kimihiro MOCHIZUKI (ERI), and Takeshi TSUJI (Kyushu University)

15:30-15:45 **Coffee Break**

15:45-16:10

10. **Deep-sea Magnetic Survey at the Yokoniwa-Rise, the Central Indian Ridge**
Masakazu FUJII (AORI), Taichi SATO (AIST), Kyoko OKINO (AORI), and Kentaro NAKAMURA (JAMSTEC)

16:10-16:35

11. **Preliminary result of Korean Australian-Antarctic Ridge expeditions**
Seung-Sep KIM (CNU)

16:35-17:00

12. **Upper mantle electrical resistivity structure beneath the Southwest Indian Ridge 37º**
Tetsuo MATSUNO (NIPR), Keiko MIZUMA, Nobukazu SEAMA (Kobe University), Yoshifumi NOGI (NIPR), and Kyoko OKINO (AORI)

17:00-17:25

13. **Ancient residual mantle peridotites preserved along the Prince Edward fracture zone of the Southwest Indian Ridge**
Hiroshi SATO (Senshu Univ), Ryoko SENDA (JAMSTEC), Tomoaki MORISHITA, Akihiko TAMURA (Kanazawa Univ), Katsuhiko SUZUKI (JAMSTEC), and Shoji ARAI (Kanazawa Univ)

17:25-17:30 **Closing Remarks**

Research Meeting in Kashiwa Campus
DAY 1

Integrated Study on Mid-Ocean Ridge Process
-InterRidge-Japan Symposium-

Date：November 12, 2013（Thu）10:00～17:30

Venue：Auditorium

Atmosphere and Ocean Research Institute, The University of Tokyo

5-1-5 Kashiwanoha, Kashiwa-shi, Chiba 277-8564, JAPAN

Tel: +81-4-7136-6011

Conveners:

Kyoko OKINO, The University of Tokyo (okino@aori.u-tokyo.ac.jp)

Michinari SUNAMURA, The University of Tokyo (sunamura@eps.s.u-tokyo.ac.jp)

Toshiya FUJIWARA, JAMSTEC (toshi@jamstec.go.jp)

program

AM: InterRidge-Japan Symposium (in Japanese)

10:00-10:05 **Opening Remarks** Kyoko OKINO (AORI)

10:05-10:30

1. **Seismic structure and seismicity around the hydrothermal area in the Souther Mariana Trough**

   Toshinori SATO, Mariko MIZUNO, Hirokazu TAKADA (Chiba University), Tomoaki YAMADA, Takehi ISSE, Kimihiro MOCHIZUKI, Masanao SHINOHARA (ERI), and Nobukazu SEAMA (Kobe University)

10:30-10:55

2. **Hydrothermal circulation system in the southern Mariana Trough: geochemical composition of Urashima Site**

   Miki TAWADA and Tomohiro TOKI (University of the Ryukyus)

10:55-11:20

3. **Sub-seafloor mineralization process in the Iheya North hydrothermal area: results of IODP Exp. 311 core analysis**

   Hiroyasu INOUE and Jun-ichiro ISHIBASHI (Kyushu University), and IODP Exp.311 onboard scientific party

11:20-11:45

4. **Geochemical and ecological approaches to analyze the history of hydrothermal activity**
   Hidenori KUMAGAI, Hiromi WATANABE (JAMSTEC), Jun-ichiro ISHIBASHi (Kyushu University), SHigeaki KOJIMA (AORI), Shunichi NAKAI (ERI), and Arada TOYODA (Okayama University of Science)

11:45-12:10

5. **HROV Nereus Survey report on Cayman Trough by Google ship, R/V Falkor: unexplored targets in ultra-deep hydrothermal system**
   Koichi NAKAMURA (AIST)

12:10-12:20 **InterRidge-Japan Business Meeting**

12:20-13:45 **Luncheon**

PM International Session (in English)

"Mid-ocean ridges and hydrothermal activity in the Indian Ocean"

joint-hosted by Japan-Korea Marine Geoscience Symposium on Global Open Ocean Studies

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15:30-15:45 **Coffee Break**

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17:25-17:30 **Closing Remarks**

Day 2

Date：November 13, 2013（Wed）10:00～17:30

Venue：Auditorium

Atmosphere and Ocean Research Institute, The University of Tokyo

5-1-5 Kashiwanoha, Kashiwa-shi, Chiba 277-8564, JAPAN

Conveners:

Jin-Oh Park, AORI, The University of Tokyo (jopark@aori.u-tokyo.ac.jp)

Sang-Mook Lee, SEES, Seoul National University (smlee@snu.ac.kr)

Kyoko Okino, AORI, The University of Tokyo (okino@aori.u-tokyo.ac.jp)

Program

10:00-10:25

1. **Consideration of time-dependent slab age and convergence rate in subduction model and its comparison with geochemical evidence for slab melting**
   Yoon-Mi Kim, Changyeol Lee, and Sang-Mook Lee

10:25-10:50

2. **Alaska Megathrust: Imaging the megathrust zone and Yakutat/Pacific plate interface in the Alaska subduction zone**
   YoungHee Kim, Geoffrey A. Abers, Jiyao Li, Douglas Christensen, Josh Calkins, and Stéphane Rondenay

10:50-11:15

3. **Characteristic of gigantic underthrust earthquakes, 2004 Sumatra, 2011 Tohoku, and 17th Century Hokkaido earthquake**
   Yuichiro Tanioka, Aditya R. Gusman, and Ioki Kei

11:15-11:40

4. **The Nankai tsunamigenic décollement moisturized by Miocene fan turbidites**
   Jin-Oh Park and Hajime Naruse

11:40-12:05

5. **Stagnant slab and mantle transition zone under the Caroline plate in the equatorial western Pacific**
   Sang-Mook Lee

12:05-13:05 Lunch Break

13:05-13:30

6. **The Tectonic activity along Sunda Arc after 2004 Sumatra-Andaman giant earthquake: Review of research activities, results and the possibility of future earthquake in Indonesia**
   Udrekh, Yusuf Surachman, Teguh Fayakun, Haryadi Permana, Digital Marine Resource Mapping Team, and 2004 Sumatra-Andaman Earthquake consortium

13:30-13:55

7. **Updates on marine geological and geophysical studies in Myanmar**
   Moe Kyaw, Soe Thura Tun, and Thura Aung

13:55-14:20

8. **The nitrogen cycle in the Indian Ocean**
   Sunyoung Park

14:20-15:00	Discussion	
15:00-15:05	Closing Remarks	Sang-Mook Lee
15:30-17:30	Business Meeting	

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Poster

#1 **Distribution and deformation of submarine faults in the outer-arc high off northwest Sumatra**

Kenji Hirata, Ayanori Misawa, Leonardo Seeber, Kohsaku Arai, Juichiro Ashi, Riza Rahardiawan, Udrekh, Hisatoshi Baba, Masataka Kinoshita, Toshiya Fujiwara, Hidekazu Tokuyama, Yasuyuki Nakamura, Haryadi Permana, and Yusuf. S. Djajadihardia

南マリアナトラフ熱水地域における地震波速度構造と地震活動
Seismic structure and seismicity in the southern Mariana Trough and their relation to hydrothermal activity

佐藤利典*、水野真理子、高田裕能（千葉大）、
山田知朗、一瀬建日、望月公廣、篠原雅尚（東大地震研）、
島伸和（神戸大）

Toshinori Sato*, Mariko Mizuno, Hiroyoshi Takata *(Chiba Univ.)*,
Tomoaki Yamada, Tatehi Isse, Kimihiro Mochizuki,
Masanao Shinohara *(ERI, Univ. Tokyo)*, Nobukazu Seama *(Kobe Univ.)*

The southern Mariana Trough is an active back-arc basin with hydrothermal activity. We investigated relations between the back-arc spreading system and the hydrothermal system in this area by conducting a seismic reflection/refraction survey and a three-month campaign of seismic observations using ocean bottom seismometers. From a 3D seismic velocity structure analysis, we mapped a low-velocity structure just beneath the spreading axis, a high-velocity structure beneath an off-axis knoll, and a thickening of layer 2 (to about 3 km) over the refraction survey area compared with normal mid-ocean ridges. We found very low seismicity in the hydrothermal area and high seismicity in areas of high topographic relief that probably represent paleo-arc volcanoes. The low-velocity structure at the axis suggests that there is some magmatic activity beneath the axis in the form of sheetlike mantle upwellings. These may constitute the hydrothermal heat source at this site. The high velocity at the off-axis knoll indicates a thickening of layer 3 and suggests the presence of off-axis volcanism there. The very low seismicity suggests that this volcanism has ceased, thus residual heat may contribute the heat for hydrothermal activity at this site. A comparison of the velocity structure with other back-arc spreading zones and mid-ocean ridges shows that the southern Mariana Trough has a relatively thick layer 2 with lower seismic velocities, suggesting that the crust was formed by magmas with high volatile contents, consistent with upwelling mantle influenced by subduction. The very low seismicity at the hydrothermal sites indicates that there are no faults or fractures related to the hydrothermal activity. This suggests that the activity is not related to tectonic stresses there.

南部マリアナトラフにおける熱水循環系の解明：ウラシマサイトの化学組成

Geochemistry of hydrothermal fluids from the Southern Mariana Trough hydrothermal fields: Urashima site

多和田美紀*・土岐知弘（琉球大）

Miki TAWATA and Tomohiro TOKI *(Univ. Ryukyus)*

【はじめに】

マリアナトラフは現在活動中の背弧拡大系であり，背弧拡大軸と島弧火山が近距離に存在している。南部マリアナトラフでは，背弧拡大軸に直交する方向に複数の熱水活動が報告されており軸側から離れていく方向へスネイルサイト，アーケアンサイト，ピカサイトと並んでいる。ウラシマサイトは，2010 年 8 月にピカサイトの北側約 500m の麓に発見された新しい熱水系である。本研究では 2012 年 9 月に行われた NT12-24 航海中にウラシマサイトにおいて採取した成分の分析を行いサイト内の違いを比較した。

【採取方法および分析方法】

熱水試料と周辺海水試料は保圧式採水器を用いて採取した。保存性に乏しいとされる二価の鉄については，専用の保圧式採水器を用いて，海底下での採取と同時に発色を行った。「ハイパードルフィン　3K」揚収後，「なつしま」船上において pH，硫化水素，二価鉄およびアンモニアを速やかに測定した。得られた水試料を持ち帰り，陽イオン（ICP-発光分析及び原子吸光光度法）及び陰イオン（モール法及びイオンクロマトグラフ）の測定を行った。また，溶存ガス成分について，同位体質量分析計によりヘリウム同位体比（$^{3}He/^{4}He$），ヘリウム/ネオン比（$^{4}He/^{20}Ne$）および二酸化炭素の炭素同位体比（$\delta^{13}C_{CO2}$）を測定した。それぞれの結果より各成分の熱水端成分を求めた。Fe(Ⅱ)及び H_2S については，理想の混合直線を仮定し，相対的な差を求め補正を行うことで Fe(Ⅱ)と H_2S が反応する割合を概算した。

【結果】

ウラシマサイト内７ヶ所で採取した試料について，Mg 濃度が最もゼロに近い試料の pH の値は，約 2.8 であり中央海嶺の熱水系より低い値を示した。Si と CO_2 の端成分に，場所ごとの違いはなく，両者とも単一端成分であった。一方，Na，H_2S 及び Fe(Ⅱ)では，２つ以上の端成分が存在し熱水端成分が複数であることが示唆された。

【考察】

熱水端成分の塩素濃度が海水より高く，気液分離による影響，もしくは，火山ガスによる影響が示唆された。しかし，温度-圧力条件によると海底下で沸騰した形跡は無く，二酸化炭素濃度が中央海嶺に比べ高いことや，二酸化炭素の炭素同位体比及びヘリウム同位体が，スラブ起源を示したことから気液分離より火山ガスの影響を強く受けたものと考えられる。また，Fe(Ⅱ)及び H_2S のそれぞれの補正値より，Fe(Ⅱ)および H_2S が 3:4 の割合，もしくは，1:1 で反応したと思われる。このことから，マグネタイトやピロータイトの鉱物が析出した可能性が示唆される。

IODP 第 331 次航海掘削試料の解析結果から考える伊平屋北海丘熱水系の海底下鉱化作用

Mineralization beneath the seafloor at the Iheya North Knoll hydrothermal field based on mineralogical study on IODP Expedition 331 drilling cores.

井上博靖*, 石橋純一郎（九大院・理）, IODP 第 331 次航海乗船研究者

Hiroyasu Inoue, Jun-ichiro Ishibashi *(Faculty of science, Kyushu University)* and IODP Expedition 331 scientists

2010 年の IODP（統合国際深海掘削計画）第 331 次航海において，中部沖縄トラフ伊平屋北海丘の熱水活動域で掘削航海が実施された. さらに翌年 2011 年には BMS を用いた掘削航海(TAIGA11 航海)が同じ海域で実施された．掘削の結果，多くの熱水性鉱物が見出された. 本報告では熱水性鉱物および粘土鉱物に着目して反射顕微鏡観察, XRD, EPMA 分析などを用いた鉱物学的解析の結果を報告し, 海底下で鉱化作用が起こる可能性について議論する.

今回報告するのは，IODP SiteC0016 HoleB (掘削長=44.9m), SiteC0013 HoleE (掘削長=45.155m), C0013 HoleF (掘削長=7.5m), C0013 HoleC (掘削長=9.5m), および BMSI-4 サイトで採取されたコア試料の解析結果である．SiteC0016 は熱水活動域の中心である熱水地帯マウンド, SiteC0013 は熱水マウンドから東へ約 100m 離れた地点，BMSI-4 サイトは東へ約 200m 離れた地点となる.

産出を確認した鉱物は海底下の深度により大きく異なっていた. 多産する鉱物により Zone1 (硫化鉱物), Zone2 (硫酸塩鉱物), Zone3 (粘土鉱物), Zone4 (石英) に分類した. これらの分類は全てのサイトで共通である.

Zone1 と Zone2 に産出する銅鉱物と硬石膏および粘土鉱物を比較した. Zone1 では低温・酸化的な環境で安定と考えられる硫砒銅鉱・砒四面銅鉱・銅藍が銅鉱物として多産していた. 硬石膏はほぼ見られず, 確認されたものは低温により溶けたと思われる跡が多く見られた. また 100~200℃で安定と考えられるスメクタイト・カオリナイト・コレンサイトが粘土鉱物として産出していた. Zone2 では高温・還元的な環境で安定と考えられる黄銅鉱が銅鉱物として多産していた. また高温を保っていることを示唆する大量の自形の硬石膏が見られた．また 200℃以上で安定と考えられるクロライトが粘土鉱物として多産していた. これらの鉱物の産出状況から，Zone1 と Zone2 はそれぞれ異なった温度・酸化還元環境の層であることが示唆され，Zone1 はやや低温・酸化的, Zone2 は高温・還元的な環境であると考えられる．また, EPMA の BSE 像では粘土鉱物の隙間をさまざまな粒径の硫化鉱物と硫酸塩鉱物が埋めている組織が目立ち, 1μm くらいの微細な粘土鉱物を硫化鉱物と硫酸塩鉱物が包有した組織も多く見られた. このことは堆積物が熱水変質した後，あるいは同時に，硫化鉱物と硫酸塩鉱物が沈殿したことを示唆する.

以上のことは, 海底面からしみ込んだ海水が熱水と混合して鉱化作用が起こったモデルを考えると調和的に説明ができる.

地球化学的手法と生態学的手法による熱水活動史の解析

Challenges by geochronological and ecological analyses for interpretation of hydrothermal system evolution

Hidenori Kumagai*, Hiromi Watanabe *(JAMSTEC)*;
Takuya Yahagi, Shigeaki Kojima *(AORI, Univ. Tokyo)*; Shun'ichi Nakai *(ERI, Univ. Tokyo)*,
Shin Toyoda *(Okayama Univ. Science)*, Jun-ichiro Ishibashi *(Faculty of Science, Kyushu Univ.)*

Jamieson et al., Geochem. Geophys. Geosyst., 2013

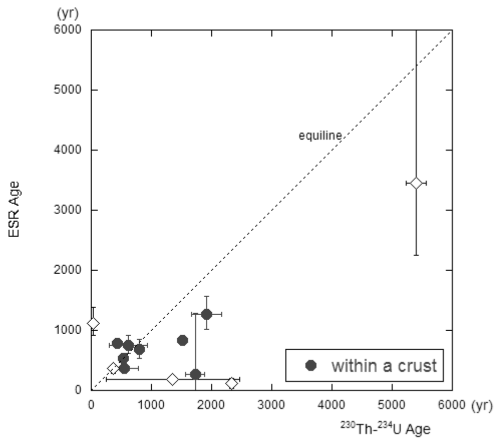

図 1：U-Th 非平衡法と ESR 法とで得られた年代値の比較

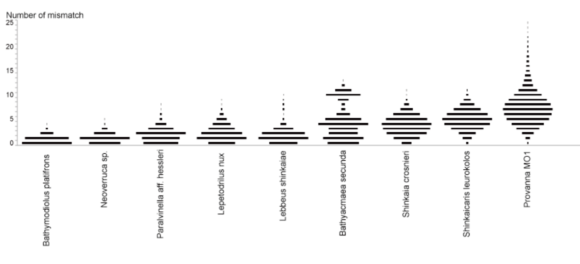

図 2：沖縄トラフでの種別の遺伝子多様度。グラフが縦に延びるほど塩基配列の不一致が多いことを示す。

Google ship, R/V Falkor での HROV Nereus による Cayman Trough 調査航海と大深度海底熱水系の未踏課題

Google ship, R/V Falkor cruise in the Cayman Trough (Caribbean) with HROV Nereus and future research targets in very deep hydrothermal systems

中村光一（産業技術総合研究所 地質情報研究部門 海洋地質研究グループ）
Ko-ichi Nakamura *(AIST, Tsukuba)*

Google の前 CEO である Eric Schmidt とその(元)妻 Wendy Schmidt が 2009 年に設立した Schmidt Ocean Institute は 2 隻目の海洋調査船としてドイツの漁業巡視船を改造して、Falkor 号を造った。船名はミヒャエル・エンデの『はてしない物語』で主人公を運ぶ幸いの竜に由来している（映画『The Never Ending Story』での呼び名。原作の日本語訳ではフッフール)。公募に基づく研究航海を 2013 年から実施し、この航海は FK008 航海である。航海提案者に対して航海実施経費は全く課されないが、研究資金や必要な機材は調達できていることが前提である。継続的に航海募集と審査が行なわれており、現在 2016 年航海の募集、2015 年航海の提案審査中である。改造に際して USBL を含む最新の音響機器が装備され、ROV の操縦室を兼ねる充実したメインラボがあり、航海データや操作記録を一元的に船内ネットワークで管理する。3 人の船上技術員が常駐し、調査作業用途に合わせた入力インターフェースの改造も行ない、船内の全ての端末からアクセスと入力が可能である。船員および技術員は国際的な構成で、ドイツ人と英国人を最大の構成員とし、FK008 では米国人は一人もいなかった。インターネットは常時接続で、全員が制限無しに利用してストレスを感じない転送速度を維持できている。

カリブ海の短い海嶺系ケイマントラフでは 2010 年春に海底で熱水サイトを数箇所同定している。Leg 1 (2013 年 5 月 30 日 St. Petersberg, Florida〜6 月 17 日 Montego Bay, Jamaica)は WHOI の HROV Nereus を AUV で運用するとともに、CTD 調査を行い、さらに熱水サイトを同定することを主要目的とし、既知のサイトの研究のための CTD による採水も実施した。Leg 2 (6 月 18 日〜6 月 30 日 Montego Bay 出入港)は主に既知のサイトでの ROV モードでの Nereus 調査で、演者は Leg 1 に参加した。

ケイマンは非常に水深の深い海嶺で、*Nature Communications* 論文では高い熱水温度が推測されたが、その後の調査の実測はそれを支持していない。いずれ、世界のどこかで超臨界状態の熱水の存在が実証されるであろうが、それに向かう現状と課題を述べる。

Reference: Falkor cruise website. http://www.schmidtocean.org/story/show/1187

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http://www.pnas.org/content/107/32/14020.short

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Similarity and diversity in fluid geochemistry of four hydrothermal fields at CIR

Shinsuke Kawagucci *(JAMSTEC)*

On the Central Indian Ridge (CIR), we now know four high-temperature hydrothermal vent fields, Kairei (Gamo et al., 1996; 2001), Edmond (van Dover et al., 2001), Solitaire, and Dodo (Kawagucci et al., 2008; Nakamura et al., 2012). In general, the endmember fluid of the CIR hydrothermal fields has a chemical composition similar to the hydrothermal fluids sampled from sediment-starved mid-ocean ridges in the Pacific and the Atlantic oceans, suggesting typical interactions between hot fluid and mid-ocean ridge basalts in the subseafloor reaction zone. In turn, each of the four fields is characterized by notable chemistry, and these chemical characteristics are likely linked with topographic/geological/tectonic settings of each field: a R-R-R triple junction (Kairei), great water depth (Edmond), a Ridge-Hotspot meeting point (Solitaire), and great lava plain (Dodo). The Kairei fluid, the most studied CIR field, shows high H_2 concentration although moderate H_2 concentration is expected from its basalt-hosted geological setting. The unique geological setting of the Kairei field, where deep crustal rocks are emplaced in the shallower part of oceanic crust, is considered to be responsible for the H_2 enrichment of the Kairei hydrothermal fluids. The Edmond field hosts one of the most Cl-enriched fluids of the world's vent systems due to subseafloor fluid phase separation at supercritical conditions. The Solitaire fluid shows somewhat high $^3He/^4He$ ratio compared with those of typical Mid-Ocean Ridge fluids ($^3He/^4He$ = ~8), suggesting input of hotspot-derived components into the hydrothermal fluid. The Dodo fluid has anomalously ^{13}C- and ^2H-depleted CH_4 that has never been observed in sediment-starved hydrothermal systems. It could be explained by thermal decomposition of organic matter just beneath the basalt glass seafloor, such as vent faunal community covered by lava flow, for example. I will talk about the history of the CIR high-temperature hydrothermal vents discoveries, fluid geochemical characteristics and their linkage with topographic/geological/tectonic settings, and a plan to discover the fifth (and more) hydrothermal vent field on the CIR by future international cooperation.

Deep-sea hydrothermal vent fauna in the Central Indian Ridge

Hiromi Watanabe *(JAMSTEC)*, Girish Beedesee *(Mauritius Oceanography Institute)*, Tomomi Ogura *(JAMSTEC)*, Suguru Nemoto *(Enoshima Aquarium)*, Takuya Yahagi *(AORI, the University of Tokyo)*, Satoshi Nakagawa *(Hokkaido University)*, Kentaro Nakamura, Ken Takai *(JAMSTEC)*, Meera Koonjul *(Ministry of Fisheries, Albion Fisheries Research Centre)*, Daniel E. P Marie *(Mauritius Oceanography Institute)*

Dispersal ability plays a key role in the maintenance of species in spatially and temporally discrete niches of deep-sea hydrothermal vent environments. On the basis of population genetic analyses in the eastern Pacific vent fields, dispersal of animals in the mid-oceanic ridge systems generally appears to be constrained by geographical barriers such as trenches, transform faults, and microplates. Four hydrothermal vent fields (the Kairei and Edmond fields near the Rodriguez Triple Junction, and the Dodo and Solitaire fields in the Central Indian Ridge) have been discovered in the mid-oceanic ridge system of the Indian Ocean. In the present study, we monitored the dispersal of four representative animals, Austinograea rodriguezensis, Rimicaris kairei, Alviniconcha and the scaly-foot gastropods, among these vent fields by using indirect methods, i.e., phylogenetic and population genetic analyses. For all four investigated species, we estimated potentially high connectivity, i.e., no genetic difference among the populations present in vent fields located several thousands of kilometers apart; however, the direction of migration appeared to differ among the species, probably because of different dispersal strategies. Comparison of the intermediate-spreading Central Indian Ridge with the fast-spreading East Pacific Rise and slow-spreading Mid-Atlantic Ridge revealed the presence of relatively high connectivity in the intermediate- and slow-spreading ridge systems. We propose that geological background, such as spreading rate which determines distance among vent fields, is related to the larval dispersal and population establishment of vent-endemic animal species, and may play an important role in controlling connectivity among populations within a biogeographical province.

Population genetic study of endosymbiotic bacteria of deep-sea hydrothermal vent tubeworms and bivalve mussels.

Yong-Jin Won[1*], Phuong Thao Ho[1], Eunji Park[1], Ye-Seul Kwan[1], KangChon Kim[1], Sook-Jin Jang[1], Soon Gyu Hong[2], and Robert C. Vrijenhoek[3]

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Deep-sea hydrothermal vents along the global mid-ocean ridge systems have opened unique chemosynthetic habitats to a variety of invertebrate animals that depend on chemoautotrophic bacteria for their nourishment. Hydrothermal vent vestimentiferan tubeworms (Annelida: Siboglinidae) and mussels (Mollusca: Mytilidae) rely mostly on sulfur-oxidizing endosymbionts that appear to be environmentally acquired during their early life stages. While there has been a remarkable progress in our understanding of geographic relationships among host invertebrate species, the feature of their endosymbionts on this regard is scarcely known.

We will present a population genetic approach to understand the geography of genetic variation of sulfur-oxidizing symbionts and its potential causal forces in the East Pacific Rise (EPR), Juan de Fuca and Gorda ridges. As methodological model cases, symbionts of tubeworms Ridgeia pieces and Riftia pachyptila and bivalve mussel Bathymodiolus thermophilus will be introduced and compared in the light of geographical structure of ridge systems as well as their host species. This investigation includes new development of multiple polymorphic markers of bacterial protein coding genes and application to many populations representing the entire region of EPR and Juan de Fuca and Gorda ridges. Our approach and technical solutions in dealing with large amount of bacterial DNA data can be served as a standard for the study of symbioses in other mid-ocean ridge systems such as Indian Ocean Ridge.

Geophysical investigations of the Rodriguez Triple Junction and the southern Mariana Trough back-arc basin

Nobukazu Seama, Eri Iizuka, Haruka Shindo, Takahiro Baba *(Department of Earth and Planetary Sciences, Kobe University)*,
Toshinori Sato, Yui Noguchi, Akihiro Kono, Hiroyoshi Takada *(Graduate School of Science, Chiba University)*,
Tomoaki Yamada, Takehi Isse, Masanao Shinohara, Kimihiro Mochizuki *(Earthquake Research Institute, University of Tokyo)*,
Tetsuo Matsuno, Yoshifumi Nogi *(National Institute of Polar Research)*,
Taichi Sato *(Geological survey of Japan, National Institute of Advanced Industrial Science and Technology)*, Takeshi Tsuji *(Kyusyu University)*, and
Kyoko Okino *(Atmosphere and Ocean Research Institute, University of Tokyo)*

The Rodriguez Triple Junction is one of the best locations to investigate dependence of the seafloor-spreading system on a parameter of spreading rate, because it is a junction between the central and southeast Indian Ridges spreading system that shows different spreading rates with different topographic characters. In the first segment of the slower spreading central Indian Ridge, the "Kairei" hydrothermal vent site exists and extrudes hydrothermal fluid with richer hydrogen content compared to other hydrothermal vents in the world. We conducted three different geophysical approaches using two JAMSTEC Yokosuka cruises in January and March, 2013; 1) observation of magnetic and electric field variations at the ocean bottom across the central and southeast Indian Ridges near the Rodriguez Triple Junction, 2) seismic observation at the ocean bottom and active seismic surveys near the "Kairei" hydrothermal vent site, and 3) surface geophysical surveys in the area surrounding. These data will be analyzed to derive upper mantle structure, crustal structure, and hypocenter distribution, which will provide important constraint on following four main points to understand the seafloor-spreading system in a wide range of scales; 1) melt delivery to the spreading axis, 2) production and character of the crust, 3) relationship between melt supply and crustal formation, and 4) pathway and heat source for hydrothermal circulation related to its formation. On the other hand, we also conducted a similar experiment using two JAMSTEC Yokosuka cruises in 2010 to target at the southern Mariana Trough back-arc basin. The characteristic features of this spreading system are 1) asymmetric spreading, 2) fast spreading type morphology and gravity even though the full spreading rate of 45 km/Myr is categorized as slow spreading, and 3) the presence of five hydrothermal vents within 5 km near the spreading axis that extrude different water contents. In this presentation, we will show the outline of our experiment in the Rodriguez Triple Junction. Then, we will present results from our experiment in the southern Mariana Trough back-arc basin, which clarify the purposes of our experiment in the Rodriguez Triple Junction.

Deep-sea Magnetic Survey at the Yokoniwa-Rise, the Central Indian Ridge

Masakazu Fujii *(AORI, Univ. Tokyo)*, Taichi Sato *(AIST)*, Kyoko Okino *(AORI, Univ. Tokyo)*, and Kentaro Nakamura *(JAMSTEC)*

Deep-sea magnetic survey is an effective method to reveal the differences of rock types and/or degrees of low-temperature alteration (weathering), as well as chronological crustal history from magnetic reversal polarity. Hydrothermal alteration processes can destroy magnetic minerals in volcanic host-rocks and create magnetic minerals by serpentinization in ultramafic host rocks, then decrease and increase magnetization of crust. But it has been very difficult to detect those signatures from sea-surface data because the small scale of hydrothermal systems is below the limit of resolution. Near-bottom magnetic surveys can provide direct information on the magnetization of the shallower crust and facilitate seafloor geological feature.

We conducted deep-sea magnetic measurements using submersible "Shinkai 6500" during the R/V Yokosuka cruise YK13-03 at the Yokoniwa Rise in the Central Indian Ridge. Yokoniwa Rise locates in the southeastern side of non-transform offset massif at the depth between 2500 m and 3000 m. In the shallowest area, serpentized peridotite, gabbro, pillow basalt, dead chimneys, and low temperature vents were discovered in previous studies.

During these cruises, vector geomagnetic field are successfully obtained along the all dive tracks at an altitude of ~ 10 m. After calibrating the effects of magnetizations of the submersible body and subtracting the IGRF from the corrected observed data, we obtained geomagnetic vector anomalies in geographical coordinate. The distributions of crustal magnetization are estimated by vertical and horizontal components of magnetic anomalies using the 2-dimesional forward modeling method and frequency analysis.

In this presentation, we report the preliminary results of magnetization distribution and compare magnetic character with geologic features based on submarine videos. Finally we discuss the geometry of magnetized body through comparison with the higher-altitude data obtained by AUV to understand what the sources of magnetic signals.

Preliminary result of Korean Australian-Antarctic Ridge expeditions

Seung-Sep Kim[1], Jian Lin[2], Sung-Hyun Park[3], Hakkyum Choi[3], and Sang-Mook Lee[4]

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[2] *Woods Hole Oceanographic Institution, Woods Hole, MA, USA*

[3] *Korea Polar Research Institute, Incheon, Korea*

[4] *SEES, Seoul National University, Seoul, Korea*

Recently the Korea Polar Research Institute (KOPRI) conducted three successive expeditions to the eastern end of the Australian-Antarctic Ridge (AAR) to investigate the tectonics, geochemistry, and hydrothermal activity of this intermediate fast spreading system. On board the Korean icebreaker R/V Araon, the science party collected multiple types of data including multibeam bathymetry, gravity, magnetics, as well as rock and water column samples. In addition, Miniature Autonomous Plume Recorders (MAPRs) were deployed at each of the wax-core rock sampling sites to detect the presence of active hydrothermal vents. In this study, we present a detailed analysis of a 360-km-long super-segment at the eastern end of the AAR to quantify the spatial variations in ridge morphology and investigate its respond to changes in melt supply. The study region contains several intriguing bathymetric features including abrupt changes in the axial topography, alternating between rift valleys and axial highs within relatively short ridge segments; overshooting ridge tips at the ridge-transform intersections; systematic migration patterns of hooked ridges; a 350-km-long mega-transform fault; and robust axial and off-axis volcanisms. To obtain a proxy for regional variations in magma supply, we calculated residual mantle Bouguer gravity anomalies (RMBA), gravity-derived crustal thickness, and residual topography for seven sub-segments. The results of the analyses revealed that the southern flank of the AAR is associated with a shallower seafloor, more negative RMBA, thicker crust, and/or less dense mantle than the conjugate northern flank. Furthermore, this N-S asymmetry becomes more prominent toward the super-segment of the AAR. Such regional variations in seafloor topography and RMBA are consistent with the hypothesis that ridge segments in the study area have interacted with the Balleny hotspot, currently lies southwest of the AAR. However, the influence of the Balleny hotpot is not dominant in the axial morphology of the AAR super-segment. The axial topography of this super-segment exhibits a sharp transition from axial highs at the western end to rift valleys at the eastern end, with regions of axial highs being associated with more magma supply as indicated by more negative RMBA. The eastern AAR will be further compared with other intermediate fast spreading ridges, such as the Juan de Fuca Ridge, Galápagos Spreading Center, and Southeast Indian Ridge west of the Australian-Antarctic Discordance, to better understand the influence of ridge-hotspot interaction on ridge magma supply and tectonics.

Upper mantle electrical resistivity structure beneath the Southwest Indian Ridge 37ºE

Tetsuo Matsuno *(National Institute of Polar Research)*,
Keiko Mizuma, Nobukazu Seama *(Department of Earth and Planetary Sciences, Kobe University)*,
Yoshifumi Nogi *(National Institute of Polar Research)*, and
Kyoko Okino *(Atmosphere and Ocean Research Institute, The University of Tokyo)*

It is inferred that the Southwest Indian Ridge (SWIR) is related to the underlying mantle through specific mechanisms to the ultraslow spreading ridge system. In addition, the mantle near the SWIR 37ºE is probably affected by the mantle upwelling producing the Marion hotspot due to its proximity at present and in the past. To elucidate the geophysical state of the upper mantle (for example, the content of melt and water, melt productivity, thermal structure) of the region by electrical resistivity that is largely sensitive to the content and interconnectivity of melt and water, and temperature, a marine electromagnetic experiment was carried out on a subsegment of the SWIR at 37ºE. The subsegment is not magmatically active as revealed by surface geophysical studies but may be within an area of high melt production as deduced from the presence of nearby magmatically active segments, an extensive gravity anomaly low, local high axial topography, and rock chemical compositions such as local low Na8. Seven ocean bottom electromagnetometers were deployed along a ~110 km transect across the SWIR axis at 37ºE to acquire time-variation of the electromagnetic field at the sampling rate of one minute for almost one year in 2008. The acquired time-variation data were clean, and they were processed by the magnetotelluric technique. A preliminary 2-D electrical resistivity structure shows a resistive area just below the ridge axis, and a roughly layered structure (resistive above ~100 km depth and conductive below the same depth) under the 2-D transect. The resistive area just below the spreading axis suggests that the content of melt is very small. The upper resistive layer reflects residual mantle without melt and water after differentiation of mantle and melt extraction at the ridge, and the underlying conductive layer suggests the presence of melt and water at the depth. The content of melt and water inferred from the resistivity of the conductive layer is smaller than that observed at other ridges at faster spreading rate. The electromagnetic field data is not fully explained by the 2-D electrical resistivity structure, probably requiring 3-D structures and bodies in addition to the 2-D structure. Some expected 3-D structures and bodies were examined, which include adjacent segmented structures, melt areas below the adjacent ridge axes, and a structure of the Marion hotspot. The result shows that the influence of these structures and bodies on the data is weak. Other structures and bodies are required by the data under the study area.

Ancient residual mantle peridotites preserved along the Prince Edward fracture zone of the Southwest Indian Ridge

Hiroshi SATO *(Senshu Univ.)*, Ryoko SENDA *(IFREE/JAMSTEC),*
Tomoaki MORISHITA, Akihiko TAMURA *(Kanazawa Univ.)*
Katsuhiko SUZUKI *(IFREE/JAMSTEC)*, Shoji ARAI *(Kanazawa Univ.)*

Abyssal peridotites form as the residues of melt extraction beneath mid-ocean ridges. Recently, refractory abyssal peridotites with highly depleted $^{187}Os/^{188}Os$ compositions were recovered at the Gakkel Ridge (Liu, C.-Z. et al., 2008, Nature). These peridotites are not related to modern melt extraction events but are residues from ancient melt extraction events. These findings imply a long-term preservation of refractory domains in the mantle, which is contrary to the notion that the mantle beneath the ocean ridges is well homogenised via convection.

We demonstrate that refractory abyssal peridotites from the Prince Edward fracture zone at the central part of the ultraslow-spreading Southwest Indian Ridge (SWIR) have highly depleted Os isotope ratios with T_{RD} model ages of up to 1 billion years. Thus, the heterogeneous distribution of the refractory mantle domain might be similar beneath other ultraslow-spreading ridges. Peridotites from the Prince Edward fracture zone indicate no evidence of enrichment following the melt extraction event and preserve their initial depleted compositions. These features have not been observed in other sections of the SWIR, suggesting that the peridotites along the Prince Edward fracture zone are essential to understanding the evolution of the mantle after the breakup of the Gondwana supercontinent (Meyzen, C. M. et al., 2007, Nature) as well as the mantle heterogeneity beneath the SWIR and the Marion rise (Zhou, H. & Dick, H. J. B., 2013, Nature).

DAY 2

The 2nd Japan-Korea Marine Geosciences Symposium on Global Open Ocean Studies

November 13, 2013

Day 2

Date：November 13, 2013（Wed）10:00～17:30

Venue：Auditorium

Atmosphere and Ocean Research Institute, The University of Tokyo

5-1-5 Kashiwanoha, Kashiwa-shi, Chiba 277-8564, JAPAN

Conveners:

Jin-Oh Park, AORI, The University of Tokyo (jopark@aori.u-tokyo.ac.jp)

Sang-Mook Lee, SEES, Seoul National University (smlee@snu.ac.kr)

Kyoko Okino, AORI, The University of Tokyo (okino@aori.u-tokyo.ac.jp)

Program

10:00-10:25

1. **Consideration of time-dependent slab age and convergence rate in subduction model and its comparison with geochemical evidence for slab melting**
   Yoon-Mi Kim, Changyeol Lee, and Sang-Mook Lee

10:25-10:50

2. **Alaska Megathrust: Imaging the megathrust zone and Yakutat/Pacific plate interface in the Alaska subduction zone**
   YoungHee Kim, Geoffrey A. Abers, Jiyao Li, Douglas Christensen, Josh Calkins, and Stéphane Rondenay

10:50-11:15

3. **Characteristic of gigantic underthrust earthquakes, 2004 Sumatra, 2011 Tohoku, and 17th Century Hokkaido earthquake**
   Yuichiro Tanioka, Aditya R. Gusman, and Ioki Kei

11:15-11:40

4. **The Nankai tsunamigenic décollement moisturized by Miocene fan turbidites**
   Jin-Oh Park and Hajime Naruse

11:40-12:05

5. **Stagnant slab and mantle transition zone under the Caroline plate in the equatorial western Pacific**
   Sang-Mook Lee

12:05-13:05 Lunch Break

13:05-13:30

6. **The Tectonic activity along Sunda Arc after 2004 Sumatra-Andaman giant earthquake: Review of research activities, results and the possibility of future earthquake in Indonesia**
   Udrekh, Yusuf Surachman, Teguh Fayakun, Haryadi Permana, Digital Marine Resource Mapping Team, and 2004 Sumatra-Andaman Earthquake consortium

13:30-13:55

7. **Updates on marine geological and geophysical studies in Myanmar**
   Moe Kyaw, Soe Thura Tun, and Thura Aung

13:55-14:20

8. **The nitrogen cycle in the Indian Ocean**
   Sunyoung Park

14:20-15:00	Discussion	
15:00-15:05	Closing Remarks	Sang-Mook Lee
15:30-17:30	Business Meeting	

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Poster

#1 **Distribution and deformation of submarine faults in the outer-arc high off northwest Sumatra**

Kenji Hirata, Ayanori Misawa, Leonardo Seeber, Kohsaku Arai, Juichiro Ashi, Riza Rahardiawan, Udrekh, Hisatoshi Baba, Masataka Kinoshita, Toshiya Fujiwara, Hidekazu Tokuyama, Yasuyuki Nakamura, Haryadi Permana, and Yusuf. S. Djajadihardia

Distribution and deformation of submarine faults in the outer-arc high off northwest Sumatra

Kenji Hirata[1,2,*], Ayanori Misawa[3,#], Leonardo Seeber[4], Kohsaku Arai[5], Juichiro Ashi[3], Riza Rahardiawan[6], Udrekh[7], Hisatoshi Baba[8], Masataka Kinoshita[2], Toshiya Fujiwara[2], Hidekazu Tokuyama[3], Yasuyuki Nakamura[2], Haryadi Permana[9], Yusuf.S.Djajadihardia[10]

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A huge ocean-wide tsunami, with average heights of more than 20 meters along the west coast of the northern tip of Sumatra followed the 2004 Sumatra-Andaman earthquake (Mw9.2). Several working hypotheses have been proposed, but the generation mechanism for this tsunami remains unresolved. Several hypotheses suggest a possible coseismic slip on splay faults in the outer-arc-high off northwest Sumatra [e.g., Sibuet et al., 2007]. Among these splay faults, the Middle Thrust(MT) (or possibly the Lower Thrust(LT)), can best account for features of the Indian Ocean tsunamis observed at regional and ocean-wide distances [Hirata et al., 2008]. In 2009, we conducted KY09-09 bathymetry survey offshore northern Sumatra and recognized many geological structures, including candidate traces of these splay faults in the outer-arc-high. In 2010, we conducted the KH-10-5 high-resolution MCS survey with a total of 18 seismic lines to image the subsurface structure associated with LT, MT, and the Upper Thrust(UT) in the outer-arc high.

Many of subsurface deformations that can be identified on MCS profiles are distributed along these major thrusts. For an example, more than ten of these MCS profiles show clear indication of subsurface deformation along MT. However, a fraction of subsurface deformations are distributed along other large faults existing between these major thrusts. 14 MCS lines cross basins adjoining MT. Several of these MCS profiles show that the uppermost sediment layers of the basins are deformed, either progressively tilted up to a horizontal sea floor, or sub-parallel tilted along with the sea floor. This suggests geologically “recent” deformation associated with slip along MT. However, other MCS lines did not image such a clear “recent” deformation structures near MT. This may imply lack of deformation, or lack of recent sediment along these profiles to record the deformation. Three MCS lines cross UT of Sibuet et al.[2007] or neighboring basins but we could not find any “recent” deformation signature there. 7 MCS lines crossed LT. Among them, however, only one MCS profile show possible “recent” deformation along LT. It is possible that MT was most active co-seismically during "recent" great earthquake.

This work is supported by research programs of (I)JSPS-LIPI, (II) SATREPS by JST-JICA-RISTEK-LIPI, and (III) KAKENHI (No.22403007) .

Keywords: 2004 Sumatra-Andaman earthquake, tsunami generation, splay fault, MCS

#: Present work: OYO Corporation.

Consideration of time-dependent slab age and convergence rate in subduction model and its comparison with geochemical evidence for slab melting

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The partial melting of subducting oceanic plate in subduction zones is geochemically evident by the existence of high-Mg andesites such as boninites, adakites, and sanukitoids. The partial melting of eclogitic oceanic crust requires special subduction environments: 1) young and warm converging oceanic plate (<25 Ma), 2) high shear stresses along the interface between the slab and mantle wedge due to flat or very shallow subduction and/or 3) inflow of hot mantle to the corner of the mantle wedge. A previous study suggests that time-varying age and rate of the converging oceanic plate are responsible for the genesis of high-Mg andesites in the western Aleutians, which implies the importance of time-varying subduction parameters on the partial melting of the subducting slab. Despite the importance of the time-varying subduction parameters on the slab melting, the subduction parameters are not considered in most of the subduction model experiments because steady-state subduction model experiments using the current subduction parameters. Therefore, it is not clear whether the time-varying subduction parameters explain the partial melting of the oceanic crust, especially the transient occurrence of the partial melting of the oceanic crust. In order to investigate whether time-varying subduction parameters are responsible for the slab melting in the subduction zones, we construct a series of two-dimensional kinematic-dynamic subduction models including the time-varying age and convergence rate of oceanic plate for the last 50 Myr; Izu-Bonin, Mariana, Eastern Japan, Kuril, Tonga, Java-Sunda, and Aleutians subduction zones are considered in the model experiments. Our modeling results show that partial melting of oceanic crust is consistent with the subduction parameters in the Izu-Bonin, Mariana, Eastern Japan, Kuril, Tonga, Southeastern Java-Sunda and Aleutians but inconsistent with the Northwestern Java-Sunda subduction zones. However, the steady-state subduction model only explains in the Northwestern Java-Sunda subduction zone, indicating that time-varying subduction parameters are crucial for the transient partial melting of the oceanic crust. We compare our results with observed geochemical and petrological evidences in subduction zones and as a result, modeling results are almost consistent with the geochemical record of arc volcanism in Izu-Bonin, Northwestern Java-Sunda and Aleutians. Our model calculations confirm that other geological processes such as back-arc extension, mantle plume and ridge subduction are important for the partial melting of the oceanic crust in in the Mariana, Eastern Japan, Tonga and Southeastern Java.

Alaska Megathrust: Imaging the megathrust zone and Yakutat/Pacific plate interface in the Alaska subduction zone

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We image the subducted slab underneath a 450 km long transect of the Alaska subduction zone. Densely spaced stations in southern Alaska are set up to investigate (1) the geometry and velocity structure of the downgoing plate and their relationship to slab seismicity, and (2) the interplate coupled zone where the great 1964 earthquake (Mw 9.2) exhibited the largest amount of rupture. The joint teleseismic migration of two array datasets based on teleseismic receiver functions (RFs) reveals a prominent, shallow-dipping low-velocity layer at ~25-30 km depth in southern Alaska. Modeling of RF amplitudes suggests the existence of a thin (3-5 km) low-velocity layer (shear wave velocity of ~2.0–2.5 km/s) that is ~20-40% slower than underlying oceanic crustal velocities, and is sandwiched between the subducted slab and the overriding North America plate. The observed low-velocity megathrust layer (with P-to-S velocity ratio of 1.9-2.3) may be due to a thick sediment input from the trench in combination with elevated pore fluid pressure in the channel. The subducted crust below the low-velocity channel has gabbroic velocities with a thickness of ~15 km. Both velocities and thickness of the low-velocity channel increase downdip in central Alaska, in agreement with previously published results. Our image also includes an unusually thick low-velocity crust subducting with a ~20 degree dip down to 130 km depth at approximately 200 km inland beneath central Alaska. The unusual nature of this subducted segment results from the subduction of the Yakutat terrane crust. We also show a clear image of the Yakutat and Pacific crust subduction beneath the Kenai Peninsula, and the along-strike boundary between them at megathrust depths. Our imaged western edge of the Yakutat terrane, at 25-30 km depth in the central Kenai along the megathrust, aligns with the western end of a geodetically locked patch with high slip deficit, and coincides with the boundary of aftershock events from the 1964 earthquake. It appears that this sharp change in the nature of the downgoing plate could control the slip distribution of great earthquakes on this plate interface.

Characteristic of Gigantic Underthrust Earthquakes, 2004 Sumatra, 2011 Tohoku, and 17th Century Hokkaido Earthquake

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The 2011 great Tohoku-oki earthquake of Mw 9.0 occurred off Tohoku, Japan. The major slip region extends all the way to the trench, and the large slip area extends 250 km long and 160 km wide. The extremely large slip amount, more than 40 m, was estimated at the plate interface near the trench (Gusman et al., 2012). This characteristic of the extremely large slip amount near the trench is also found for the 2004 great Sumatra earthquake of Mw 9.2 which occurred along the Sumatra-Andaman subduction zone. The largest slip, about 30m, was estimated at the plate interface off the northern Sumatra (Tanioka and Gusman, 2012) although the slip amount of the down-dip side of the plate interface was about 20m.

Using the paleotsunami data, the great Hokkaido earthquake in 17th century found to be occurred off the Tokachi coast in Hokkaido. The previous study (Satake, 2008) indicates that this earthquake was a large underthrust event with a large slip area extends 300km long (Mw8.5). Since then, paleotsunami studies were conducted extensively along the Pacific coast in Hokkaido. In order to explain all available paleotsunami data, tsunami deposit survey data, we found that the extremely large slip of 25m near the trench with a fault width of 30km was necessary. The moment magnitude of the earthquake is calculated to be 8.8.

Common characteristics of the extremely large slip near the trench with the large source area are found for three gigantic earthquakes of the 2011 Tohoku (Mw 9.0), the 2004 Sumatra (Mw9.2) and the 17th Century Hokkaido earthquakes (Mw8.8). As Gusman et al. (2012) suggested, when such a extremely large slip occurred the plate interface near the trench, the relatively soft sediment portion of the accessional prism should be deformed. In this case, such a deformation should be observed by the ocean bottom structural survey. The structural survey near the Japan trench in the extremely large slip area of the 2011 Tohoku earthquake has already been conducted and found that there was a large deformation area near the trench. This indicates that such a deformation along a trench is a key to found the previous large slip region caused by the previous gigantic earthquakes at least along the Japan trench and the Sumatra trench.

Reference:

Gusman, A. R., Y. Tanioka, S. Sakai, and H. Tsushima, Source model of the great 2011 Tohoku earthquake estimated from tsunami waveforms and crustal deformation data, Earth Planet. Sci. Lett., , doi:10.1016/j.epsl.2012.06.006, 2012.

The Nankai tsunamigenic décollement moisturized by Miocene fan turbidites

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One of the most interesting processes at subduction zone is slow tsunami earthquake that generates tsunamis anomalously large for its seismic energy. Most tsunami earthquake ruptures propagate along a shallow plate-boundary fault (i.e., décollement) up to near trench, exciting large tsunamis. A recent observation on very-low-frequency (VLF) earthquakes hypothesized that the shallow décollement could be a source of tsunami earthquakes. However, the shallow décollement as a tsunamigenic fault is poorly recognized at subduction zones worldwide, and its characteristics are less well documented. In this talk we present seismic reflection images of the tsunamigenic shallow décollement with variable reflection polarity and Miocene fan turbidites moisturizing the décollement in the Nankai subduction zone. We found that most VLF events associated with slow earthquake are observed in the region of wet (i.e., fluid-rich) décollement with negative polarity reflection. Furthermore, we found that a huge wet décollement region off Shikoku Island is in good agreement with tsunami source area of the A.D. 1605 Keicho (*M* 7.9) earthquake, suggesting that the wet décollement has a high potential of the slow tsunami earthquake. When the underthrusting turbidites drain vertically, both tectonic loading and fault sealing may cause and also help to maintain high fluid pressures at and below the décollement, eventually creating the wet décollement.

Stagnant Slab and Mantle Transition Zone under the Caroline Plate in the Equatorial Western Pacific

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In the Western Pacific and around Northeast Asia, there are several large volcanic providences that cannot be explained by traditional geologic processes such as arc volcanism and back-arc spreading. One mechanism that has been suggested is that some of these features may be triggered by the release of volatile from the mantle transition zone (MTZ) which ranges from 410-660 kilometers well after the slab has subducted into the upper mantle. Stagnant slab which exhibits a slightly higher seismic velocity compared to the surrounding region is considered to be a relatively wet section of the MTZ and the source of those odd volcanic features on the earth surface that do not fit with the classical explanation. On the basis of recent seismic tomography images, one area which is less well-known but where stagnant slab appears to exist is the MTZ below the Caroline Plate in the equatorial Western Pacific, north of New Guinea. The Caroline Plate is thought to have formed by two back-arc spreading centers with a large offset in between. However, the region where this offset is located is covered by a large submarine volcanic province called Euripik Rise whose origin is unclear because normally fracture zones are relatively cold section of mantle and, unlike spreading centers, areas of low extensional stress. One hypothesis that can be put forward is that the Euripik Rise is the consequence of magmatic upwelling from the MTZ beneath the Caroline Plate. If so, the detailed study of MTZ in this area may help us to understand the cause of many odd volcanic features in the Western Pacific and Northeast Asia and the role of stagnant slabs.

The Tectonic Activity along Sunda Arc After 2004 Sumatra-Andaman Giant Earthquake. Review Of Research Activities, Results And The Possibility Of Future Earthquake In Indonesia.

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The 26th December 2004 Sumatra– Andaman giant earthquake has attracted many scientists all over the word to investigate rupture area. This earthquake triggered catastrophic tsunami, killing over 230000 people in fourteen countries. More than 15 investigations were carried out in order to understand the subduction and accretion process which cause such kind of a huge earthquake and tsunami and to observe some geological evidences. These investigations have given us better understanding about tectonic process, historical earthquake, displacement, .etc, which are supported by various data such as bathymetric data along western part of Sumatra, ROV investigation, Seismic refraction and reflection data, OBS, Heat flow, and coring data. Through this various data, some interesting results have been published.

However, those investigations could not find any significant evidences of rupture area. Only small part of subsidence area was investigated. This result could not generate a huge ocean-wide tsunami with average heights of more than 20 meters. Bathymetric data could produce an interesting image of sea floor morphology. However, we cannot identify which rupture area can be claimed as the source of 2004 tsunami generation.

We have digital marine resource mapping survey acquired in 1990's. This data was compared to after 2004 earthquake bathymetric data. Some questions about subsidence and uplifting location may be answered from this evidence. Due to the lack of bathymetric data before 2004 earthquake, this result just provides small progress of understanding the earthquake phenomenon.

2004 Sumatra-Andaman giant earthquake seems triggered another earthquake. Relatively big earthquake occurs in Sunda Arc almost every year. 2005 earthquake in Nias region occured just 3 months after, caused more than 1300 of fatalities. Two earthquakes in near Jogja and Pangandaran in Java island, caused more than 6000 peoples died. 2007 earthquake hit the northern end of lake Singkarak of west Sumatra caused about 43.000 houses damage, while this area hit by bigger earthquake in 2009 with more than 1000 peoples died. M8.6 Indian ocean earthquake which is an undersea earthquake or interpolate earthquake struck near of Aceh province, caused huge panic of Aceh people. In 2013, Aceh province hit again by earthquake with an epicentrum near Sumatra fault. The quake killed 35 people, but 43000 houses were damage or destroyed (Wikipedia)

Indonesia government is focusing to set up some facilities for disaster risk reduction along western part of Indonesia. However, the eastern part of Indonesia, which has more complicated tectonic setting, may struck by big earthquake and Tsunami. Historical earthquake compiled by Wichman 1918, shows that a large number of earthquakes occurred in Indonesia since 1600. The study of Lovholt et al., 2012 also mentioned the very high possibility of tsunami occurred in the near future. The recurrence time is calculated to be 150 to 200 years (Ron Harris, personal discussion).

Updates on Marine Geological and Geophysical Studies in Myanmar

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Marine geological and geophysical studies in Myanmar made significant progress recently with successful marine survey from JAMSTEC-AORI. Survey was successfully taken for two weeks in August from JAMSTEC-AORI with R/V Hakuho-maru. The survey was not gone through smooth arrangements as application for permit took more than eight months and received permit at the last minute. However, the procedure which was not familiar to both sides, has set for the better and more efficient way of handling in the future. As part of the human resources training, three scientists from Myanmar joined the cruise, and will be core members for future collaboration cruises after getting more experience in the post-cruise research.

Linking to the marine research, river sampling was done as well along Ayeyawaddy and Sittaung rivers for geochemical and environmental studies from the AORI team as part of their study on broader view of Asian river systems. Since its establishment in 2009, Earth Observatory of Singapore has been in continuous work on Earthquake Geology of Myanmar through extensive field work where some results has recently been published (Yu Wang, 2013) and produced a neotectonic map of the region.

Part of the action items in 2012 Seoul Meeting, Marine geology and geophysics task force has been formed under Myanmar Geoscience Society (MGS) to work on establishing marine research institute and collaborate with foreign institutes/project teams. One member has already been participated in the AORI cruise and will be assigned to this project from next year.

The nitrogen cycle in the Indian Ocean

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The Indian Ocean contains one of the three major oceanic oxygen deficient zones. Oxygen deficient zones are interesting for studying nitrogen cycling because close coupling of aerobic and anaerobic processes can occur. Particularly, the Indian Ocean has both significant nutrient loading from land and continental outflow of nitrogen pollutants from south and southeast Asia. Therefore, the oxygen deficient zone in the Indian Ocean is recognized as an intense source of N_2O greenhouse gas. Despite its importance for the oceanic nitrogen cycle, estimates of nitrogen fluxes in the Indian Ocean remain in uncertainty. In this presentation, current knowledge of important processes such as denitrifiantion, nitrification, and N_2O emissions, and anthropogenic impacts on the nitrogen cycle in the region will be summarized. Stable isotopes of N_2O will also be introduced as a valuable tool to differentiate microbial production processes, nitrification versus denitrification.