

## Summer School on Earthquake Science 2013 実施報告

去る9月23-27日に、Summer School on Earthquake Science "Diversity of Earthquakes"と題して、国内外の大学院生・PDを対象としたサマースクールを開催した。当初予定していた参加者数40名に対して、80名を超える参加希望があったため、最終的に50名ほどの受講者を受け入れることとし、講師、世話係（LOC）と併せて計70名ほどが5日間箱根の会場（ラフォーレ強羅）に集い、日夜“地震の多様性”について活発な議論を行った。最終日に行ったまとめのセッションでは、米国の大学院生から「近年参加したカンファレンスのなかでは1-2の出来」という自発的な感想が出されるなど、主催者側のひいき目を差し引いても、大成功の会であったと言える。しかしながらスクールと云う割にはふつうのカンファレンスの形式で物足りないという意見もあり、今後の検討課題となった。必ずしもこの分野が専門でない報告者のひとり（川勝）としては、大変楽しく勉強をさせていただいた。また多くの講師から同様の感想を頂いた。スクールとして次世代人材の育成をうたうことで講師陣にも特別なモチベーションが出来るのか、どの講義も準備の行き届いた素晴らしいものであった。惜しむらくは、日本人のこの分野の大学院生の参加が少なかった。

開催中に SCEC 側の代表（Beroza, Ampuero 両教授）と意見交換し、今回の“成功”を受け、来年（度）SCECがホストする形で2回目のSummer School on Earthquake Scienceを開催する方向で双方準備することに合意した。今回は第1回ということで、所長裁量経費から多大な支援を頂いたが、持続可能な会にすべく、地震研の共同利用、学振の国際交流事業（「オープンパートナーシップ共同研究・セミナー」制度が最適と思われる）なども活用しつつ継続的に進めていくことが必要であろう。

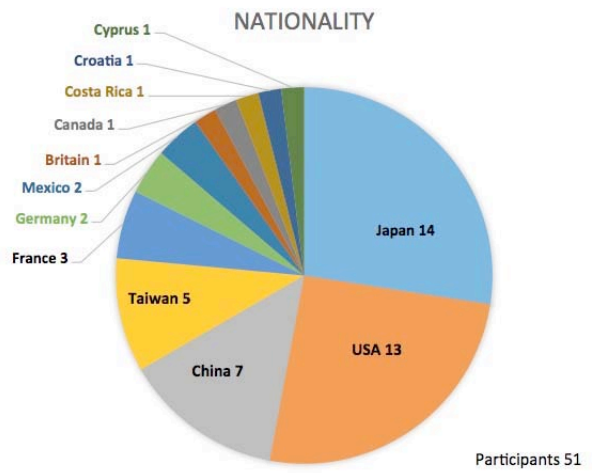
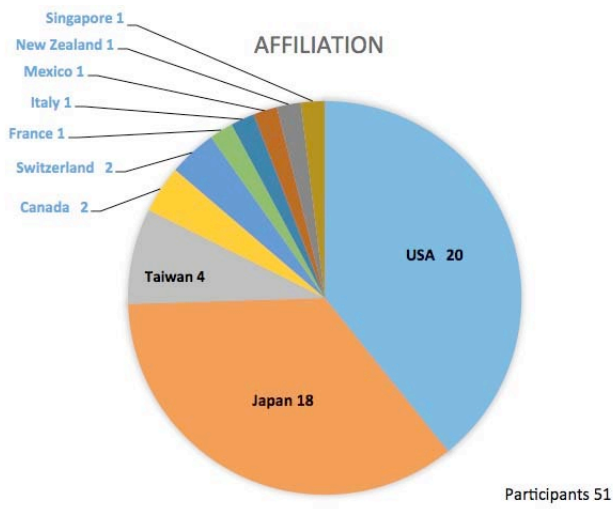
### ★開催経費について

所長裁量経費からは、国際室経由で650万円の支援を頂いた。今回は、講師の旅費、会場での滞在費（飲食費を含む）を主催者側（地震研）が支払うこととし、最終経費として6,649,943円（内訳：招聘交通費2,515,630円；スクール開催費4,096,069円；その他準備費38,244円）を支出した。

★謝辞：開催に当たっては、国際室の全面的な支援を受けた。事務支援に当たっていただいた、板倉さん、中村さん、伊集院さん、またたくさんのおすてきな写真撮影をして下さった広報アウトリーチ室の福井さんに感謝します。最後にLOCメンバー（石山、加藤、福田、前田、三宅、中川、西田）の諸氏にも多くの時間と労力をさいてスクールを成功に導いていただいたことを感謝します。将来のスクールでは、このうちの何人かが主催者または講師に名を連ねるようになることを期待します。

主催者代表 川勝均・小原一成

参考資料 1. 国別受講者



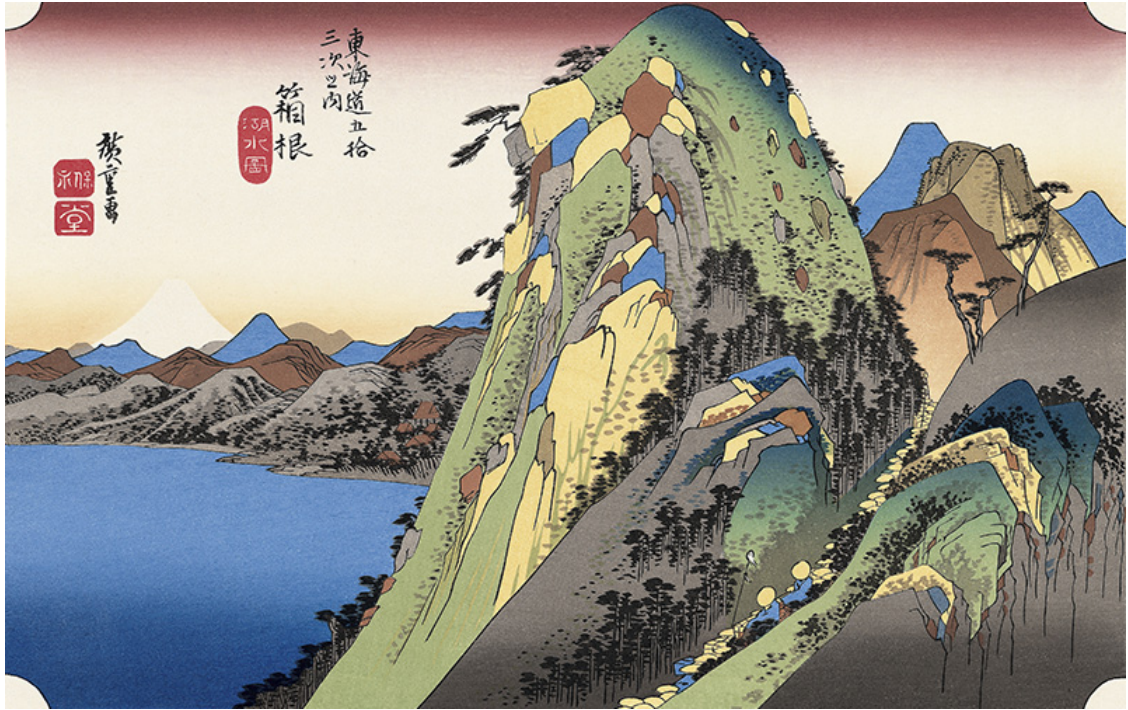
参考資料 2. スクール風景





参考資料 3 : プログラム

# The Summer School on Earthquake Science “Diversity of Earthquake”



September 23-27, 2013  
Laforet Gora, Hakone, Japan



This summer school is organized by the Earthquake Research Institute of the University of Tokyo and the Southern California Earthquake Center.

# The Summer School on Earthquake Science “Diversity of Earthquakes”

## Introduction:

The Earthquake Research Institute of the University of Tokyo (ERI) and the Southern California Earthquake Center (SCEC) organize an international summer school on Earthquake Science in September 23-27, 2013 in Hakone, Japan. This is the first of *hope-to-be-a-series* similar summer schools on Earthquake Science in the future. We encourage Ph.D. students and postdocs in the field of the international community to participate.

Date: September 23-27, 2013

Place: Laforet Goura, Hakone, Kanagawa, Japan

Scope: - International summer school on Earthquake Science  
- Invite top-level scientists for key-note lectures  
- Encourage postdocs' and Ph.D. students' presentations  
- Well-equipped & spacious poster sessions for discussion

Participants: 50 postdocs and Ph.D. students

Sessions: The program is divided into three sessions.

### 1. Huge earthquakes

The first session focuses on “Huge earthquakes”. Especially, we are interested in synthesizing the lessons learned from the Tohoku earthquake and in constraining the largest possible earthquake that a fault system is likely to generate. The Tohoku earthquake has been studied by many researchers; however there are still many open questions. Therefore, the compilation and discussion of the remaining and newly rising problems is important in order to determine the targets for further efforts based on the combination of seismology, geodesy, geology, tectonics, modeling and simulation studies. Large earthquakes along the San Andreas Fault and elsewhere will be also discussed and compared to each other.

### 2. Fault zones

The second session focuses on the “Fault zone” as the structure hosting a diversity of earthquake phenomena. Constraints on the structure and mechanical properties of active fault zones are obtained from laboratory experiments, geophysical studies, field observations of active and exhumed faults, and natural-scale laboratories. Incorporating this diverse information into mechanical models of earthquake behavior is an important challenge. The session aims at integrating observations and models over this broad range of scales.

### 3. Transient phenomena

The third session focuses on “Transient phenomena”. Episodic Tremor and Slip and other slow events occur between the locked zone and stable sliding zone. Repeating earthquakes also occur on the transition zone where small asperities are isolated in the stable or transient slip zone. Understanding of the physical mechanism governing such transient phenomena is important in order to understand the interaction between transient slow events and large earthquakes. Tremor, slow slip and repeaters in the San Andreas Fault, the Nankai subduction zone and the Tohoku earthquake source area will be discussed. Global comparison of these phenomena along the Pacific Rim might be important to resolve the regional differences of subduction systems that affect seismogenesis.

# Program

*September 23*

15:00- Registration

18:00- Icebreaker

*September 24, Session 1: huge earthquakes*

07:30-08:30 Breakfast

08:45-09:45 Lecture

**Thorne Lay** (University of California, Santa Cruz)

Great Earthquake Process Characterization by Seismic, Geodetic and Tsunami Modeling

09:45-10:00 Coffee break

10:00-12:00 Two lectures

**Shuo Ma** (San Diego State University)

Uncovering the Mysteries of Tsunami Generation and Anomalous Seismic Radiation in the Shallow Subduction Zone

**Kelin Wang** (Geological Survey of Canada)

Deformation cycle of great subduction earthquakes in a viscoelastic Earth

12:00-13:00 Lunch

13:30-15:00 Poster viewing

15:00-16:00 Two shorter presentations

**Quentin Bletery** (University of Nice Sophia Antipolis)

The 2011 Mw9.0 Tohoku-Oki earthquake spatiotemporal complexity inferred from Geodesy, Seismology and tsunami records

**Andreas P. Mavrommatis** (Stanford University)

Decadal transient deformation in northeastern Japan prior to the 2011  $M_w$  9.0 Tohoku-oki earthquake

16:00-16:30 Coffee break

16:30-18:30 Two lectures

**James J. Mori** (DPRI, Kyoto University)

How can we explain the huge slip of the 2011 Tohoku earthquake?

- Satoshi Ide** (University of Tokyo)  
Modeling scale-independent heterogeneities of earthquake dynamic rupture
- 18:30- Discussion
- Satoshi Ide** (University of Tokyo)
- 19:30- Dinner
- Free discussion

*September 25, Session 2: fault zones*

- 07:30-08:30 Breakfast
- 08:45-09:45 Lecture
- Thibault Candela** (Penn State University)  
Feedback between earthquakes and hydro-mechanical properties of faults
- 09:45-10:00 Coffee break
- 10:00-11:00 Lecture
- Richard H. Sibson** (University of Otago)  
Structure and Hydraulics of Active Reverse Faults
- 11:00-12:00 Two shorter presentations
- Marieke Rempe** (Università degli Studi di Padova)  
Clast-cortex aggregates and slip localization in experimental and natural carbonate-bearing fault zones
- Ming-Che Hsieh** (National Central University)  
Earthquake Rupture on a Conjugate-faulting System in Central Taiwan Revealed by Efficient Waveform Inversions
- 12:00-13:00 Lunch
- 13:30-15:00 Poster viewing
- 15:00-16:00 Two shorter presentations
- Junle Jiang** (California Institute of Technology)  
Depth Extent of Large Earthquake Ruptures and Pattern of Microseismicity: the Effect of Enhanced Dynamic Weakening below the Seismogenic Depth
- Elizabeth H. Madden** (University of Massachusetts - Amherst)  
Mechanical evaluation of fault strength and questions of its depth dependence
- 16:00-16:30 Coffee break

- 16:30-18:30 Two lectures  
**Masao Nakatani** (ERI, University of Tokyo)  
 Microfractures on natural faults stressed by mining  
**Fabio Corbi** (Roma Tre University)  
 The seismic cycle at subduction megathrust: insights from analog modelling
- 18:30- Discussion  
**Jean-Paul Ampuero** (California Institute of Technology)
- 19:30- Dinner  
 Free discussion

*September 26, Session 3: transient phenomena*

- 07:30-08:30 Breakfast
- 08:45-09:45 Lecture  
**John Vidale** (University of Washington)  
 Review of tremor and slow slip; what is and what should never be
- 09:45-10:00 Coffee break
- 10:00-11:00 Lecture  
**Timothy I. Melbourne** (Central Washington University)  
 Geodetic constraints on the moment budget of Cascadia slow slip
- 11:00-12:00 Two shorter presentations  
**Takeshi Akuhara** (ERI, University of Tokyo)  
 Segmentation of intraslab stress beneath the Kii Peninsula, southwestern Japan  
**Chastity Aiken** (Georgia Institute of Technology)  
 Tectonic Tremor Triggered along Major Strike-Slip Faults around the World
- 12:00-13:00 Lunch
- 13:30-15:00 Poster viewing
- 15:00-16:00 Two shorter presentations  
**Naofumi Aso** (University of Tokyo)  
 Physical Model of Volcanic Deep Low-Frequency Earthquakes  
**Aaron G. Wech** (U.S. Geological Survey)  
 Tremor and plate coupling in the central Aleutians
- 16:00-16:30 Coffee break



- 16:30-18:30 Two lectures  
**Michael G. Bostock** (University of British Columbia)  
Structural Constraints on the Nature of Episodic Tremor and Slip  
**David R. Shelly** (U.S. Geological Survey)  
Dynamics of San Andreas Fault tremor: lower-crustal deformation in high definition
- 18:30- Discussion  
**Kazushige Obara** (ERI, University of Tokyo)  
**Heidi Houston** (University of Washington)
- 19:30- Banquet

*September 27, Session 3: transient phenomena (continued)*

- 07:30-08:30 Breakfast
- 08:45-09:45 Lecture  
**Allan M. Rubin** (Princeton University)  
Episodic slow slip in subduction zones: Theoretical considerations and observational constraints
- 09:45-10:00 Coffee break
- 10:00-11:00 Lecture  
**Naoki Uchida** (Tohoku University)  
Slow slip and repeating earthquakes in the northeastern Japan subduction zone
- 11:00-12:00 Summary  
**Gregory C. Beroza** (Stanford University)
- 12:00-13:00 Lunch  
Adjourn

# Committee

## **Steering Committee**

Hitoshi Kawakatsu	(ERI, University of Tokyo)
Thomas H. Jordan	(University of Southern California)
Thorsten W. Becker	(University of Southern California)
James J. Mori	(DPRI, Kyoto University)
Kenji Satake	(ERI, University of Tokyo)

## **Program Committee**

Kazushige Obara	(ERI, University of Tokyo)
Gregory C. Beroza	(Stanford University)
Satoshi Ide	(University of Tokyo)
Jean-Paul Ampuero	(California Institute of Technology)

## **Local Organizing Committee**

Tatsuya Ishiyama	(ERI, University of Tokyo)
Aitaro Kato	(ERI, University of Tokyo)
Hiroe Miyake	(ERI, University of Tokyo)
Jun'ichi Fukuda	(ERI, University of Tokyo)
Takuto Maeda	(ERI, University of Tokyo)
Kiwamu Nishida	(ERI, University of Tokyo)
Shigeki Nakagawa	(ERI, University of Tokyo)

## **Secretariat**

Satoi Itakura	(ERI, University of Tokyo)
Naomi Nakamura	(ERI, University of Tokyo)
Yuka Ijuin	(ERI, University of Tokyo)

Summer School on Earthquake Science  
School Report by Ana C Aguiar

Over all, the summer school was a great success given it was the first time it has been done and the topics discussed during those four days were of great interest. Even though I learned a lot and the meeting was very productive in research discussions, I would like to address a few things I think that could be improved for future schools.

The first and most important thing I want to address is that the meeting was called “summer school”. When we applied we were under the impression that we would be learning about the three main topics in a lecture setting, were the lecturer would have a detailed introduction of the topic to discuss. But most of the talks we had were prepared for a regular meeting instead of a school. Some of the lecturers did address it for what it was, and gave a lecture, not just a talk. To my understanding, the main reason of a school is for all of us to learn something regardless of our research interests. Because of this, a bit more time should have been dedicated to introduction on each talk, so that people who don't know the topic in great detail have a better chance in understanding the results presented. For this school in particular, this was definitely necessary given that there were three major topics discussed during the 4 days. Some of the lecturers did address this and presented their talk like a formal lecture, which made it easier for everyone to follow their presentation, but others did not, and ended up talking for 1 hour showing mostly all of their results. In these cases, specifically on the lectures that were not related to my main research interests, it was very hard to stay focused and understand everything. And I think this was mostly the case on the second day, when the fault zone models were discussed. I think this should be a clear suggestion for presenters that will participate and present a lecture in the future.

A second comment that I would like to make is that the poster sessions were somewhat disorganized and needed a bit more direction. Even though there were not a lot of posters, we had three full days, so maybe having poster sessions related to the topic discussed that day would have been better and easier to follow. The reason I mention this is because I found myself focusing mostly on the posters that were most related to my research and did not dedicate enough time to other posters, that even though were also interesting, I did not have an immediate interest and made it easy to skip some of them. I think having more specific poster sessions would definitely address this, because then everyone would dedicate enough time to each poster and, as a school setting, learn more things not directly related to your main research interests as well.

Finally, the location where the school took place was an exceptional location but we did not have any time to see it; it would have been nice to have a few hours dedicated for a field trip to learn a bit about the geology of the area we were in and just to have a chance to walk around as well. We were mostly sitting inside from 8am to 7pm for three and a half days, and once the afternoon came around it got harder to stay focused, especially when there are so many different topics being presented. Maybe starting the day a bit earlier would have given a chance of having a small break before dinner to still have some daylight to walk around Hakone and stretch out our legs a bit more.

Over all, it was a great experience and gave me the opportunity to make new contacts and find new directions in my own research as well. I look forward to hopefully participating in future summer schools relevant to my research.

First, I would like to thank the organizing committee of the international summer school on the diversity of earthquakes. I greatly enjoyed my time in Japan and benefited from the many interactions and discussions with world-leading experts in earthquake science.

Overall my impressions of the program greatly reflect my gratitude for being able to be a part of the earthquake school. In short, I think it was fantastic. I feel that anytime you expose young researchers to such world-class expertise (and diversity) is a good thing. For me, this was certainly the case. The lectures were interesting and informative, and I particularly liked the selection of the three different themes for the school. I hope this school can continue as I feel it would greatly benefit young scientists. I know that I could have benefited from this kind of program earlier in my graduate career, and I have even heard from others beyond the post-doc stage that would have liked to attend because of the intellectual opportunities.

Though I think the program as a whole was a great success, I think there is definitely room for improvement as far as a “school” goes. My impression was that the program was set up more like a workshop than a school. This was fine for me, especially as a more experienced postdoc, but I think some thought should be given in future schools about how to encourage more learning and participation from students. While all of the lectures were interesting, they didn’t all necessarily fall into the category of what I think a school lecture should be. Several lectures were just like talks one would see at a conference. As the next generation of scientists, I think the students would benefit from more focused lectures that really define what we do and don’t know, what the challenges are, and where the science is going and why. Maybe follow those up with something like the “short presentations” that highlight a cool new result. Also, I had mixed feeling about the discussion sessions. First, I do feel they were too short. Second, they lacked significant student participation. This wasn’t all bad because just listening to a discussion among the more experienced scientists is very informative, but something could probably be changed to create a more student-friendly environment for sustained discussion...not just questions and answers.

Finally I really like the post-dinner socializing opportunity. Yes the sake and shochu were nice, but I thought it was a fantastic opportunity for students to be candid with one another and senior scientists. Lectures and poster conversations are great, but it is rare for students to have the chance to have a beer and one-on-one conversation with people like Vidale, Ide, Shelly, Lay, etc... I had many interesting conversations about science and policy and projects during this time and I witnessed many others. I think this was a huge success.

For younger students’ sake, I do hope this school can continue, and I’m sure it will continue to improve if it does. Again, I’d like to thank the committee for accepting me and allowing me to take part in such a wonderful opportunity. I learned a lot and I know it has broaden my scientific horizons.

- Aaron Wech

## Testimonial from participant

It was my first experience attending any kind of “Summer school” particularly in Japan. And this summer school was actually the first attempt on Earthquake Science for international community.

This summer school was held in Hakone where famous hot springs resort area in Japan. The length of the summer school was five days and had lectures from various excellent researchers and professors of diverse field of earthquake seismology from all over the world. All the lectures are for one hour long including discussion except there are several short presentations by participants. It was very interesting to see various approaches and perspectives towards the same problem.

Other than the short presentation, participants got to introduce their work via poster presentation. Posters were up for full length of summer school and the core time was assigned for 1 and ½ hours every day after the lunch. It made the poster viewing very nice and easy since there were plenty of chances to learn and discuss posters although one missed the core time.

Meals are great. They were not only Japanese cuisine but also arranged into fusion cuisine so that people from other countries can adjust to the food cooked from Japanese ingredients.

The only thing I regret was that I was not active enough to explore outside the hotel. I think it would be even better if there were any chances (e.g. field trip) to get me out from the hotel and explore the local geology and culture in Hakone at least once.

I appreciate all the members of steering committee, program committee, local organizing committee, and secretariats for making this summer school possible. And I hope to keep the friendship and collaboration I newly earned during the summer school.

(NIED, Tomoko E. Yano)

9月23日から27日にかけて、箱根で東京大学地震研究所（ERI）と南カリフォルニア地震センター（SCEC）によって、地震学の国際サマースクール「The Summer School on Earthquake Science “Diversity of Earthquake”」が催されました。

私がこの会への参加を決めた理由としては、ある教員の「世界的に有名な研究者に、自分の研究内容を聞いてもらえる絶好の機会だ」という主旨の強い勧めがあったからです。確かに私自身、国際学会でポスター発表をした経験がありましたが、ポスターの前に待機して、たまたまそこに訪れた人に説明をすることで精一杯で、高名な方に自身の研究内容をアピールするという機会は、望んでもなかなか得られないものでした。それならばこの恵まれた機会を逃す手はないと思い、参加を決意しました。その結果、思いもよらず、口頭発表の機会を頂けることになり、期待と不安が交錯したことを覚えています。

サマースクールの初日はアイスブレイクパーティーで始まり、次の日から講師として招かれた方々の講演、学生や若手研究者による口頭、ポスター発表が執り行われました。現地に着いてまず驚いたことは、実に様々な国の学生が参加しているということでした。ERIとSCECの共催であったので、参加者のほとんどは日本とアメリカから来るのだろうという期待は良い意味で外れ、フランス、中国、ニュージーランドなど、まさに全世界から地震学者を志す若者が集まってきたという感じでした。それだけ、各々がこのサマースクールに高い期待を抱いているのだろうと感じました。講師の方々は、地震学に携わっていれば必ず一度は論文等で目にするような有名な方ばかりで、1人1時間にも及ぶ講演をして下さいました。時折ジョークも交えながら、分かりやすく話して頂き、大変勉強になりました。ただ、私の英語能力はお世辞にも高いとは言えないものでしたので、もう少し英語が聞き取れるようになれば、得られる内容はより多かつたのだろうとやるせなさを感じることも多々ありました。

私の口頭発表は4日目に行われました。準備に時間をかけていたので、発表自体はスムーズに進み、最も心配していた英語での質疑応答では、多少周りの方に助けられた部分もありましたが、無事に終えることができました。そして何よりも良い経験となったことは、休憩時間や食事時間に、私の研究内容について議論を交わせたということ、そしてその議論を通して、海外の研究者や学生と知り合えたことです。今までずっと日本で研究を行ってきた私にとって、とても貴重な体験でした。

今回のサマースクールは初めての開催で、来年度以降も行われるということなので、またぜひ参加したいと思っています。そして次回までには、研究内容、英語力ともに磨きをかけ、より主体的な議論を行えるようになりたいという目標を持つことができました。最後になりますが、このような素晴らしい場を企画して頂いた関係者の皆様方に、心よりお礼を申し上げます。

悪原岳