

BAGUS

Beneficial and Advanced
Geothermal Use System

Newsletter No.1, December 2016



SATREPS Project

“Technology Development of Steam-spot Detection and Sustainable Resource Use for Large Enhancement of Geothermal Power Generation in Indonesia”

Greetings from Leaders



Following the agreements between Kyoto Univ. and Bandung Institute of Technology (ITB) by the second Joint Coordination Committee (JCC) held on 9th May 2016 at ITB, both University teams have advanced the BAGUS project during the last seven months. In addition to the daily research activities, big events in this term were (i) installation and set-up of the seven instruments at ITB (field portable spectrometer system for remote sensing, radon measurement system, mercury measurement system, gas chromatograph-thermal conductivity detector, X-ray diffraction system, scanning electron microscope system, and X-ray fluorescence analysis system) in July, (ii) implementation of shallow drillings and preliminary measurements of radon and mercury before and after the drilling in August and September, (iii) execution of two-weeks intensive geothermal course at Kyoto Univ. in September. This newsletter reports briefly these events. I am very pleased if this newsletter is useful to make known vigorous and diligent works of both University teams and hope the BAGUS project will furthermore advance towards the prime objectives of this project, detection of steam spots.

Katsuaki Koike

*Leader of BAGUS project
Professor of Graduate School of Engineering, Kyoto University*

BAGUS project is an international research schemes between Institute of Technology (ITB) and Kyoto University in the field of geothermal energy development. In this partnership, I on behalf of the ITB and the people of Indonesia welcomes for this cooperation, in addition to research and transfer of technology with the installation of advanced equipment in the field of geothermal exploration and geochemistry, the cooperation is also useful in terms of developing human resources in Indonesia. For example, the training given to ITB researchers, graduate students and professionals in geothermal industry provide great benefits for the individual and also create a positive academic climate that involving academia, government and professional. Recently, most of the equipment that has been installed at ITB provides tremendous benefits for researchers, faculty members and students to conduct advanced research in particular areas of geothermal, geochemistry, remote sensing, mineralogy, hydrogeology and environmental studies.

Sudarto Notosiswojo

*Project Director of Indonesia team
Professor of Faculty of Mining and Petroleum Engineering, ITB*

Report

Introduction of Equipment

In August 2016, following instruments are installed in ITB:

- Field portable spectrometer system for remote sensing: FieldSpec4 (ASD Inc., USA)
- Radon measurement system: RAD7 (DURRIDGE Company Inc., USA)
- Mercury measurement system: EMP-2 (Nippon Instruments Corporation Inc., Japan)
- Gas chromatograph-thermal conductivity detector/Flame ionization detector: GC-2014 with TCD-FID (Shimadzu Corporation Inc., Japan)
- X-ray diffraction system: Smartlab (Rigaku Corporation Inc., Japan)
- Scanning electron microscope system: JSM-6510A (JEOL Ltd., Japan)
- X-ray fluorescence analysis system: Supermini (Rigaku Corporation Inc., Japan)

Handheld instruments (b) and (c) have already been operated to monitor the concentrations of radon and mercury at the shallow drilling sites, Wayang Windu geothermal area. At August 27 and 28, 2016, we have invited a senior engineer from Shimadzu Corporation, Japan, and held a special lecture of GC-TCD-FID, instrument (d), in ITB.

We also introduced following instruments in KU:

- X-ray diffraction system: Smartlab (Rigaku Corporation Inc., Japan)
- Tritium Condensation Apparatus: TRIPURE (De Nora Permelec Ltd., Japan)

- Radon measurement system: RAD7 (DURRIDGE Company Inc., USA)
- Ion chromatography system: Prominence (Shimadzu Corporation Inc., Japan)
- Water isotope analysis system: L2130-i (Picarro Inc., USA)
- Gas chromatograph-thermal conductivity detector /Flame ionization detector: GC-2014 with TCD-FID (Shimadzu Corporation Inc., Japan)

These instruments have been driven for the feasibility studies at the Japanese geothermal area, Appi at Tohoku region (instruments (h), (j) and (m)) and Hatchobaru at Kyushu region (instruments (h), (i), (k), (l) and (m)). Some of the results were already released at the Japanese geothermal symposium on October 21-23, 2015 (Kubo *et al.*).

In 2 years from now, following instruments will be installed in ITB and KU:

ITB side:

- Ion chromatography system
- Stable isotope ratio mass spectrometry system
- Inductively coupled plasma mass spectrometry system
- Water isotope analysis system
- Gas chromatograph-electron capture detector system

KU side:

- Field portable spectrometer system for remote sensing



Installation of BAGUS project equipment X-Ray equipment and the Scanning Electron Microscope machine at ITB. Until November 2016, there have been seven machines installed at ITB i.e. XRD, XRF, SEM, GC, Field Spectrometer, Radon and Mercury Analyzer. The other equipment was planned arrived and installed at ITB by March 2017.



Training activity of X-ray machines (XRF and XRD) by Rigaku experts was followed by ITB students and researchers (left). Researchers at ITB doing sample preparation for XRD and XRF measurement at laboratory (right)



Training activity of Gas Chromatography (GC) machine by Shimadzu GC expert was followed by ITB students and researchers (left). Research activity using GC machine, student and researcher doing measurement and discussion about Gas Component from samples (right).





Recent research activities of XRD and XRF laboratory by graduate students, researchers and lecturers at ITB, XRD analysis (left) and XRF analysis (right). The machines use by researchers, lecturers, and graduate students from geothermal, mining engineering, geology.



Scanning Electron Microscope (SEM) observation by researcher, the SEM including X-ray energy Dispersive Spectrometry system use for observing mineral and structure of the mineral, including element map of the samples.

Completion of First Stage of Shallow Drilling

One of the main research contents in this fiscal year is implementation of shallow drilling in the Wayang Windu area. This drilling is aimed to identify the hydrothermally altered minerals using dug soils, measure concentrations of radon and mercury in borehole gas, and analyze the gas components by gas-chromatography. These data are expected to be available as a geothermometer and geo-indicator for the temperature and pressure states in geothermal reservoirs, to identify permeable fractures that act as paths of ascending fluids and steams, and to detect steam spots, which is the prime objective of the BAGUS project.

Based on the fault distribution map prepared by Star Energy Geothermal, drilling sites were preliminarily determined to consider the intersection sites of two or more long faults on the map. But, by the effort of field survey by Dr. Saepuloh's students, some sites were impossible to be approached due to steep cliffs, deep bushes, and wet lands. Finally 18 sites were selected in the farm lands and near fumaroles, hot springs, and well pads. We appreciate deeply the ITB team's very hard,

diligent works to get permissions of drilling at 18 sites, which took much time and labor.

The drilling depth was initially planned as 5 m to obtain deep information that may be appeared in mineral and gas properties. Some holes were shallower than 5 m because of shallow groundwater table. We are ready to repeatedly gas sampling and measurement as monitoring. There may be a possibility to add drilling sites if more point data become necessary, the present state is termed the first stage.



Drilling activity to make monitoring point for Radon and Mercury also for gas sampling, total there are 18 holes were dedicated for monitoring points (left).

Radon and Mercury monitoring at observation point by ITB students, the monitoring activities were conducted weekly from October 2016 until February 2017, but monitoring period can be extended when necessary (right).

Soil sampling and soil mineralogy description at site. Soil samples were brought and analyzed using BAGUS instrument at ITB. Mineralogy and soil geochemistry are very useful to determine alteration type and inferred temperature.

Two Weeks Intensive Geothermal Course

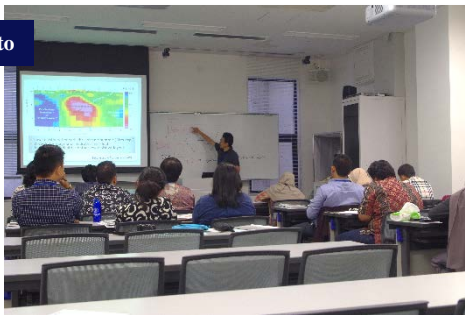
From 12th to 23rd September 2016, two weeks intensive geothermal course was programmed mainly at the Katsura Campus of Kyoto Univ. for selected 13 attendances, 10 ITB MS students from 4 different Departments: 2 from Hydrogeology, 1 from Geology, 4 from Geothermal, 3 from Mining Engineering, 1 ITB researcher of Geothermal Program, and 2 Engineers of PT Start Energy Geothermal. During this period, 14 subjects covering wide range of geothermal science and engineering from the basics to practices as well as social science and global leadership study for the success of geothermal power generation, one-day site visit at the Hatchobaru geothermal power station and field survey at the Komatsu Jigoku near the station, one-day site visit of geothermal sites in Beppu City, and one and half-days laboratory experiment and data analysis were underwent as the schedule table below. The subjects were interdisciplinary and given from seven affiliations with different specialties: Kyoto Univ., emeritus professor of Hokkaido Univ., Kyushu Univ., Kumamoto Univ., JAMSTEC, AIST, and Mitsubishi Materials Co. Every subject gave an assignment to deepen the understanding of class content. Although the schedule was tight, all participants submitted well-written reports for all the assignments. Another noteworthy point was their many good questions in all classes, which also proves their diligent and sincere attitudes to this course.

The field survey was unfortunately under rain because of approaching of a typhoon. Despite this bad weather condition, the field survey could be carried out on schedule including geological observation of hydrothermally alteration zones and fumaroles, samplings of rocks (almost soils), hot waters in a mud pool, and gasses from a fumarole. Using these samples, XRD, XRF, stable isotope, water chemistry, and gas-chromatography analyses were implemented in the Prof. Koike's laboratory room. Because to ride the Shinkansen was the first experience for all participants, it added furthermore good memory to this course. Around two hours riding of the Shinkansen between Shin-Osaka and Kokura Stations was comfortable and enjoyable.

As the report of this laboratory experiment, all participants were requested for 15 minutes presentation including question and answer in the afternoon on the last day, but most presentations were much over than this time because of abundant materials. Students of Prof. Koike's lab. joined this meeting and asked many questions. All presentations were excellent to summarize the experiment results, evaluate the data accuracy, and conceptualize the Hatchobaru geothermal system based on the data.

Soon after the end of meeting, farewell was held at a cafeteria in the Katsura Campus with the lab. students. It was also an enjoyable party and very good opportunity to deepen the friendship between Kyoto Univ. and ITB.

Dr. Goto



Prof. Mikada

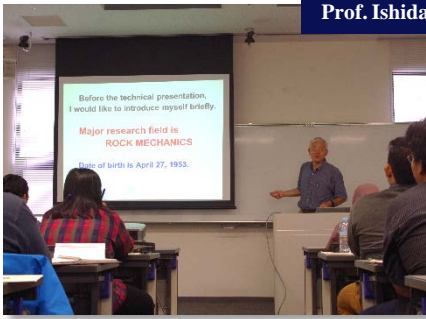


Prof. Sakurai



No.	Day	9:30 - 11:30	13:30 - 15:30	15:45 - 17:45
1	11 (Sun)	Arrival at Kyoto and Orientation		
2	12 (Mon)		Dr. Goto Electromagnetic Geophysics	Prof. Mikada Seismic Geophysics
3	13 (Tue)	Prof. Sakurai Global Leadership	Prof. Koike Fundamental Geology	Prof. Ishida Geomechanics
4	14 (Wed)	Prof. Koike Remote Sensing	Dr. Yamada Geothermal Drilling	
5	15 (Thu)	Dr. Kashiwaya Geochemistry	Prof. Yoneda Mineralogy	
6	16 (Fri)	Dr. Tenma Reservoir Engineering	Prof. Koike Mathematical Geology	
7	17 (Sat)	Trip to a Geothermal Site (Orientation of field training)		
8	18 (Sun)	Field training at a geothermal site (Hatchobaru, Kyushu)		
9	19 (Mon)	Return Trip to Kyoto (including geothermal site - visit s in Beppu city)		
10	20 (Tue)	Laboratory experiments		
11	21 (Wed)	Data Analysis	Prof. Toshi Social Science	
12	22 (Thu)	Prof. Fujimitsu Volcanology	Dr. Kato Geothermal Practice	
13	23 (Fri)	Self study	Presentation of Learning Result	
14	24 (Sat)	Return to Indonesia		

Prof. Ishida



Dr. Yamada



Dr. Kashiwaya



Prof. Yoneda



Dr. Tenma



Prof. Koike



Prof. Tosha



Prof. Fujimitsu



Final presentation



Dr. Kato



Field trip and Analysis Training



Analytical Instrument Training

Practical training on instrumental analysis was conducted on 20th and the morning of 21st, Sep. The participants were divided into three groups, i.e., 1) water analysis group, 2) rock and mineral analysis group, and 3) gas analysis group, and tried to analyze the samples collected during the field trip in Komatsu-jigoku. The principles and configurations of the analytical instruments were explained by Dr. Kashiwaya in his lecture on geochemistry. The water analysis group used ion chromatograph to analyze concentrations of major ions dissolved in thermal water and river water samples.

Additionally, hydrogen and oxygen isotope ratios of the samples were determined using Cavity Ring-Down Spectrometer. The rock and mineral analysis group identified mineral species consisting the soil and altered rock samples using X-ray diffractometer and Rietveld method was applied for quantitative analysis of the minerals. Fluorescent X-ray analyzer was also used for determination of elemental compositions of the samples. Gas analysis group used gas chromatograph to determine gas compositions of the fumarolic gas sample and gas phase dissolved in the river water sample.

Comments from participants

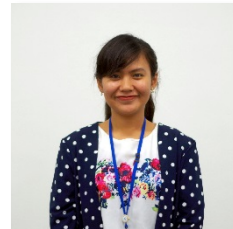


It was a great two-weeks training by JICA at Kyoto University and the best training I ever experience related to the geothermal resources. Hope I come back to Kyoto University.

Anwar Zulkhoiri : *Department of Hidrogeology, ITB*

It was a big honor for me to attend 2 weeks intensive training from JICA. The course exceeded my expectation. The lecturer was great about answering the question and the course, fieldtrip, lab experiments were very

informational. I was highly inspired by all lectures and plan to write a publication from the knowledge I got. I was awed not just by knowledge, but also by kind-hearted people in Japan. I am so glad I attended. Thank you.



Betseba Br. Sibarani : *Department of Geothermal, ITB*



Two weeks intensive training at Kyoto University giving me a new experiences and information. During the training I was given many class courses, fieldwork and laboratory experimental about Geothermal Science and Technology. Professor Katsuaki Koike and

other lecture bring the material with the good presentation, very informative, and always giving more the chance for discussion. This training is very useful for the Geothermal development in Indonesia. It's an honor for me to join this training. Many Thanks.

Candra : *Department of Mining Engineering, ITB*

This is an experience not to be forgotten, that is very memorable, add insight into the geothermal of course very useful. Although at the time of field trip hampered by the rain, but it was a memorable for my personal

experience in Japan. The lecturers are very knowledgeable, very happy to get knowledge and information from them. It was a big honor for me to attend this course. Thank you Kyoto, Thank you JICA, Thank you Japan.



Evanda Eko Putra Maris : *Department of Geothermal, ITB*



よくやった！ The unforgettable and wonderful two weeks geothermal training experience in Kyoto University. We learn any geothermal aspect theoretically and its application in

field and laboratory. Thank you JICA-ITB-Kyoto Univ. for this very best opportunities. 先生ありがとうございました。

Fikri Adam Dermawan : *Department of Geothermal, ITB*

Really great experience could take this training in Japan. Thanks to Professor Katsuaki Koike and lecture team to teach us well about geothermal. And also it was nice

trip from Kyoto to Beppu by riding Shinkansen. I hope this priceless experience can be beneficial for us in future for geothermal development in Indonesia. Thank you very much.



George Mikhail Pesik : *Department of Mining Engineering, ITB*



Thanks for all the lecture, knowledge, and facility from Kyoto University that was given to us. It was very extraordinary program. Hopefully, I can come back to Kyoto University for my doctoral program.

Hifdzul Fikri : *Department of Mining Engineering, ITB*

This short intensive training course was a great experience for me. This is my first time to go abroad and I feel proudly to have this chance. Many things I learned from this training. Finally I visited Japan, knew about Japan, the subway, the train, even I had the chance to experience Shinkansen, the fastest

train in the world. And not only Japan, but also I learned many things from Professors, Mentors and Lecturers (Sensei). Thank you so much for having great discussion with us, we learned many new experiences with you. This training was the best experience I have ever had. 驚くほど素晴らしいです。ありがとうございました。



Juni Yesy Sianipar : *Department of Geothermal, ITB*



First of all, I would like to thanks to JICA for funding this training, to ITB for facilitate and give me opportunity to attend this training, and also to Kyoto University for the facility and accommodation during the training. Also for Koike-sensei and all the sensei who gives us very good lectures in the class. And not forget thanks to Tada-san, Kubo-san and Rios-san who accompanied us during the training. Over all, this training is very good to me. This improve my knowledge about geothermal especially in the lab exercise and field sampling. I have never tried it before, so this is a new experience for

me. There are some complain that I need to tell for the better training in the next year. First, the schedule of course in the class and homework is too tight. So there are no room for us to enjoy Japan. I recommend two days of holiday in the middle of training and at the end of training. So we can be more relaxed in the class. Second thing is I found some lecture that not related or not too useful for geothermal. And there is no lecture about alteration mineral. Maybe this can be a lesson for next year. End of words, it's a pleasure to attended this training and got some experience. Thank you all.

Mochamad Iqbal : *Department of Geology, ITB*

If I have to summarize my two-week experience in Kyoto University in a few words, I would like to say that I have the best time ever in Japan. AWESOME! The Professors, lecturers and mentors (Sensei) are amazing human beings to whom I can ask

any questions at ease. The program is very useful, a bit tight but still fun. It is my pleasure to get this opportunity, and I feel very lucky to get inspired to do some research back home. Thank you so much. Really appreciated.



Hardiani Nurita Putri : *Researcher, Geothermal Program, ITB*



Being one of participants of JICA programme is such an honorable and an unforgettable moment of my life. From this

programme I can learn many thing, not only knowledge but also many many new friends and new culture that I can learn. I hope I can come back to Kyoto University. Sayonara.

Wijayanti Ashuri : *Department of Hidrogeology, ITB*



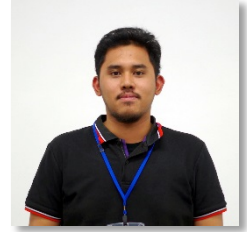
The JICA Geothermal Training Program at Kyoto University gave us a broad knowledge about geothermal development from the technical aspect through a non-technical aspect such as leadership and social issues that is also an important key to the successful

development of the geothermal field. The practical and technical applicability from this course are also valuable for the participant to be implemented. Moreover, it is a very good learning experience in Japan, especially at Kyoto University.

Rifqa Agung Wicaksono : PT Star Energy Geothermal

Two-weeks Intensive Training at Kyoto University is very good to give us knowledge about geothermal exploration especially in Japan. The different geothermal system between Indonesia and Japan will give us variety how to develop geothermal in Indonesia not only focus with Hydrothermal

system also Hot Dry Rock system itself. Another things that we can learn is the way Japan people to live, the culture of Japan people is very nice we can get that experience. Thank you JICA, thank you Kyoto University especially Koike sensei who welcomed us very kind while we stay in Japan for two weeks.

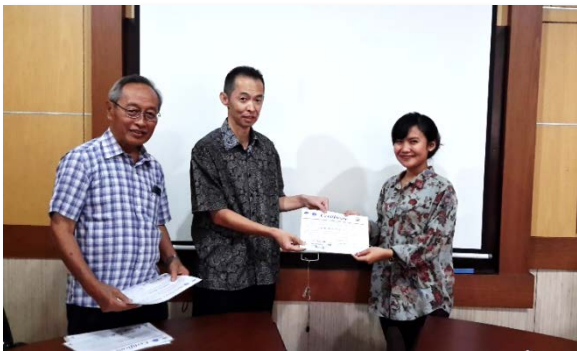


Rio Nugroho : PT Star Energy Geothermal

Best Score Award

Ceremony of handover certificate JICA trainees at ITB, the training was held in Kyoto University Japan on September 2016. Delivery of certificates awarded by JICA representative

Mr. Fumiharu Sato and witnessed by Indonesian side Project Director, Prof. Sudarto Notosiswoyo.



Best Score Award



The JICA-JST SATREPS Project for "Technology Development of Steam-spot Detection and Sustainable Resource Use for Large Enhancement of Geothermal Power Generation in Indonesia: Beneficial and Advanced Geothermal Use System (BAGUS)" awarded:

Betseba Br. Sibarani Bandung Institute of Technology

for the best score achievement in the two-weeks intensive geothermal course from 12nd to 23rd September 2016 held at the Katsura Campus, Kyoto University, Japan in the framework of this project.

Kyoto, September 23, 2016

Katsuaki Koike

Katsuaki KOIKE (小池克明)
Leader of the BAGUS project
Professor, Department of Urban Management
Graduate School of Engineering
Kyoto University



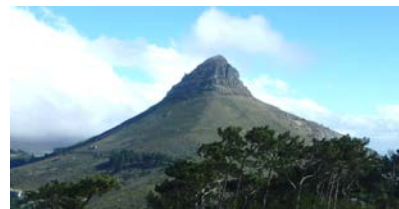
Research News

35th IGC

Prof. Koike presented a part of the BAGUS researches concerning the lineament analyses and radon gas measurement at the Appi (a geothermal area in western Iwate Pref., northern Japan) and Wayang Windu areas on 31 August 2016 at the 35th International Geological Congress (IGC), held at the Cape Town International Convention Centre, South Africa (<http://www.35igc.org/>). The IGC is one of the traditional and world-largest conferences of Earth Sciences, which has been held once every four years. This time IGC gathered the participation of the 4052 delegates from 117 countries. The presentation was entitled “*Detection of fractures acting as hydrothermal fluid path by lineament analysis and radon gas measurement*” and included in the session “Energy in a Carbon Constrained World” in a core topic, Geoscience in the Economy. Main result of this presentation was clarification of essential characteristics of radon to detection of fluid path

fractures such as small decrease in radon-222 concentrations with the elapse time. The characteristics signify large volume and high ascent velocity of radon carrier gases originated from the degassing of hydrothermal fluids. The estimated fluid path fractures were verified by a conceptual geological model constructed from the drillhole data in each geothermal area.

Cape Town was a nice place, well-known for the beautiful scenery with Table Mountain and Lion’s Head. I found these mountains were composed of sedimentary rocks, mostly sandstones.



Geoinform 2016 Received the encouragement award

Risa Uchikura, 2nd year Master course student of Prof. Koike’s lab, was selected for the encouragement award 2016 by the Japan Society of Geoinformatics (<http://www.jsgi.org/>) for her presentation “Extraction of hydrothermal alteration zones from satellite imagery with application to estimation of fluid paths” at the annual meeting of this society (Geoinform-2016), held on 16-17 June 2016 at Osaka City University. Her presentation was related to a part of the BAGUS project to

correctly detect and identify hydrothermal alteration zones from satellite imagery. The preliminary result in the Appi area showed a correspondence between the detected alteration zones from a Landsat 8 image and the zones by field surveys. As a MS thesis, she is now trying to improve the identification accuracy of minerals using reflectance spectra of rock samples and ASTER images and to reduce the vegetation effect on the zone detection.

7th International Symposium of Hanoi Geoengineering 2016

Prof. Koike introduced the BAGUS project and main research results so far as a keynote speech for 30 minutes at the 7th International Symposium of Hanoi Geoengineering 2016 on 21 October 2016 at the Le Van Thiem Hall, Vietnam National University (VNU), Hanoi, Vietnam. The theme of this symposium, “Energy and Sustainability”, was very fitted to the introduction of BAGUS project. Researchers at VNU are interested in the BAGUS project, because there are more than 400 hot springs in Vietnam and geothermal resource assessment has started recently. An interesting feature is that most hot springs are along active faults, but to find the high potential geothermal zones is difficult at present according to

VNU. A meeting was held on the next day for a possible, future collaboration between the BAGUS project and VNU.



Annual Meeting of GRSJ

Taiki Kubo and Kota Baba presented parts of BAGUS researches by poster at the annual meeting of the geothermal research society of Japan held on 19-21 October 2016 at Koriyama (Hukushima Pref.). The geothermal research society of Japan (GRSJ) is the major organization of Japan which promote the science and technology for exploration, development and utilization of geothermal resources. This

meeting gathered the 138 presentation including 48 posters. The topics of Kubo presented was the result of radon and mercury measurements carried out at August and September 2016. Baba presented the improvement of TOUGH2, geothermal reservoir simulator. They exchanged information and knowledge with researchers who used similar instruments and software.

Honda Y-E-S Forum 2016 *Received the Audience Award*

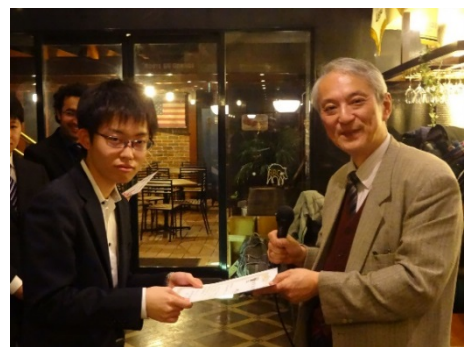
Riostantieka Mayandari, 1st year Doctor course student of Prof. Koike's lab, was awarded as the Audience Award of the Honda Y-E-S Forum 2016 held at Univ. Tokyo on Nov. 19 for poster presentation of introducing BAGUS project, entitled "How BAGUS project benefits geothermal energy?" (http://www.hondafoundation.jp/yes_forum2016.html). This award was selected by the vote of 100 participants or more from Honda Foundation, JST, Embassies, Japanese and Foreign Universities, etc. This vote was for each participant to select only one best poster presentation. Riozz-san got the largest number of "best" by this voting. Congratulations, Riozz-san! Her PhD research will be advanced greatly by the encouragement of this award.



13th Conference of MMIJ Kansai Branch *Received the Presentation Award*

Kota Baba, 2nd year Master course student of Prof. Koike's lab, was selected for the excellent presentation award of the 13th young researcher and student conference for his presentation "Development of a geothermal reservoir simulator with superior expandability", held on 9 December 2016 at Campus Plaza Kyoto. This conference was organized by the Kansai Branch, Mining and Materials Processing Institute of Japan. He has developed a new simulator that is easier to incorporate external functions than the most famous simulator, TOUGH2 and can shorten the calculation time of natural state simulation. He is now improving furthermore this simulator and trying to add a module of supercritical condition for simulating wide depth range in geothermal area. Certificate of

this award was given from Prof. Mikada, Head of the Kansai Branch and also a BAGUS core member.



BAGUS Newsletter No.1

Day of issue : 10th December, 2016

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<http://www.geoenv.kumst.kyoto-u.ac.jp/bagus1.html> (Kyoto University)
<http://bagus-satreprs.fttm.itb.ac.id/> (ITB)