ANNIVERSARY SEMINAR

5TH ITB INTERNATIONAL GEOTHERMAL WORKSHOP 2016

March 30 - 31, 2016

# Proceeding

# The New Era: Initiatives, Strategies, Opportunities, and Challenges toward Geothermal Development in Indonesia


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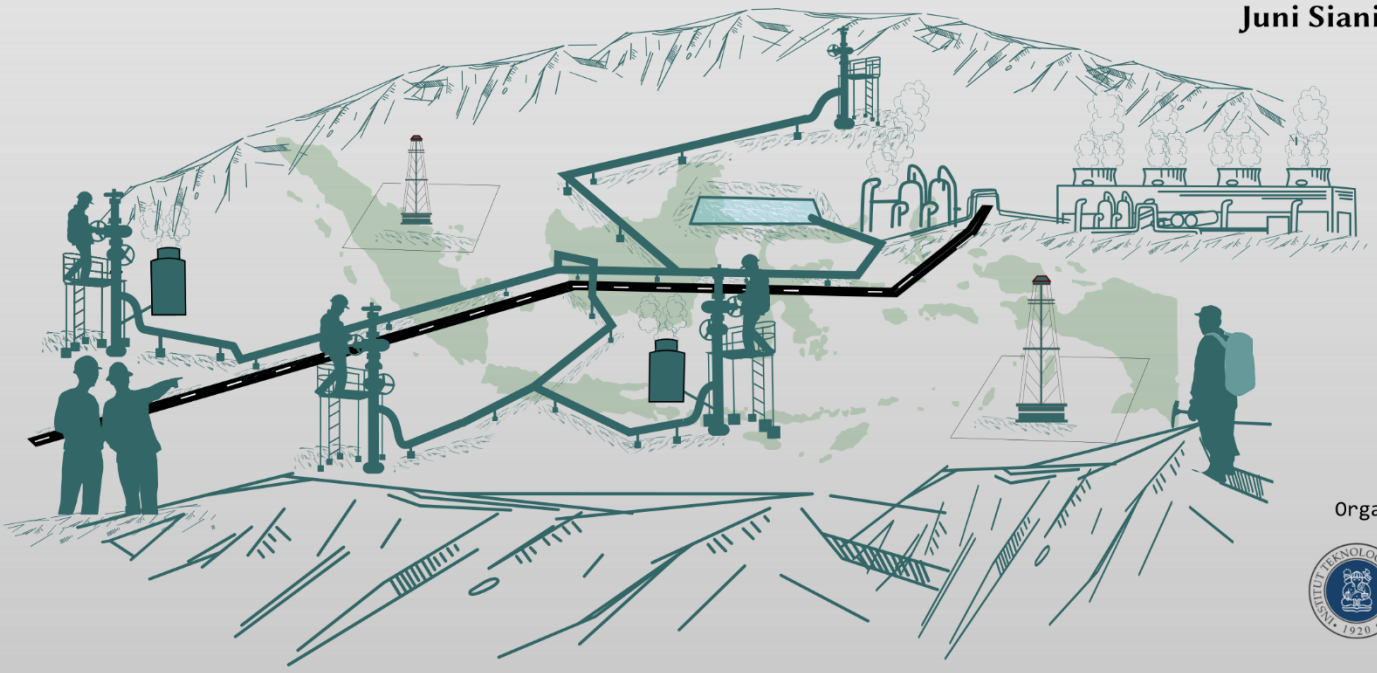


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# ANNIVERSARY SEMINAR

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# PREFACE

ITB International Geothermal Workshop (IIGW) is an annual event, which is organized by *Prodi Teknik Panas Bumi, Fakultas Teknik Pertambangan dan Perminyakan (FTTM), ITB*. The workshop celebrated its 5th anniversary this year. It was held on March 30 – 31, 2016 and has become a special moment in supporting geothermal development acceleration program in Indonesia.

The objective of the workshop was to create a knowledge-sharing forum among the key stakeholders in energy and extractive resource sectors on the status of geothermal development in Indonesia. It focused on the latest condition after the approval of new regulation of geothermal energy law No 2014. The conference featured distinguished speakers, scientists, engineers, financiers, and other key players in geothermal and energy sectors worldwide.

Participants benefit the exchanges of view, knowledges, and experiences on latest technologies and researches by bringing together scientists, engineers, academicians, experts, and industrial stakeholders involved in geothermal studies and developments.

As part of this year commitment, outstanding papers are published as an open access volume of *IOP Conference Series: Earth and Environmental Science*. Other papers are published in the conference proceeding in print version. We hope wider geothermal communities will gain the same benefits as our conference attendee.

# WORKSHOP WELCOME REMARKS

Held on March 30–31 2016 in Bandung, Indonesia, 5th ITB International Geothermal Workshop 2016 was a very successful event. Over 300 delegates attended and participated in the six day pre-workshop, workshop, mid workshop, exhibition, field trip and field camp, which brought together managers, geologists, engineers, experts and students from several countries involved in all aspects geothermal knowledge and technology.

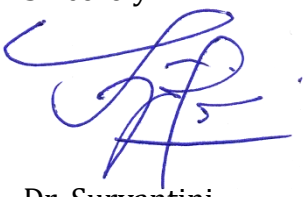
The theme of this year's event was "*The New Era: Initiatives, Strategies, Opportunities, and Challenges toward Geothermal Development in Indonesia*" brought new information about current research, innovation and results exploration and engineering activities regarding geothermal developments. The chairman of 5th ITB International Geothermal Workshop 2016 welcomed delegates, before the Workshop was officially opened by Prof. Sri Widyantoro, Dean of Faculty of Mining and Petroleum Engineering ITB.

High quality technical papers were presented with topics of geothermal from geochemistry, geophysics, geology, integrated exploration, utilization, socio-economic, environment, international collaboration and education.

Overall, the event was divided into 6 main parts: *Pre-Workshop Courses*, *Workshop* (technical and panel sessions), *Mid Workshop, Exhibition*, *Field Camp* and *Field Trip*. The panel session attended by experts in geothermal industry as speakers: Abadi Poernomo from Chairman of Indonesian Geothermal Association (INAGA), Member of National Energy Council (DEN), Yunus Saifulhak from Director of Directorate of Geothermal-Ministry of Energy and Mineral Resources, Andang Bachtiar from Chariman of National Exploration Committee (KEN), Ali Mundakir from PT. Pertamina Geothermal Energy, Peter Wijaya from Star Energy Geothermal, Alex Smillie from Tawau Green Energy Malaysia, Sanusi Satar from GEOCAP, Sukmandaru Prihatmoko from IAGI, Sudarto Notosiswojo from Institut Teknologi Bandung (ITB) and Katsuaki Koike from Kyoto University.

A thank you is extended to the Geothermal Technology Magister Program Staff; all chair persons, authors, presenters, reviewers and all the workshop sponsors and exhibitors for assistance and cooperation in support of this event.

Sincerely



Dr. Suryantini
Chairman of 5th ITB International Geothermal Workshop 2016

## WORKSHOP EVENTS

Geothermal Technology Magister Program of Insitut Teknologi Bandung continued to contribute development of geothermal industry by further enhancing the contents of the Workshop and providing an excellent setting for business interest. This year, 5th ITB International Geothermal Workshop 2016 was divided to 6 main events; pre-workshop courses, workshop (technical and panel sessions), mid workshop, exhibition, field camp and field trip from Monday, 28th March to Saturday 2nd April 2016.

Visitors were mostly students and delegates from industry; PT. Pertamina Geothermal Energy, PT. Supreme Energy, PT. Geo Dipa Energi, PT. Patra Nusa Data, Geological Agency, Star Energy, IF Technology, KEMA, Geocap, GFZ, Institut Teknologi Bandung, Universitas Indonesia, Universitas Diponegoro, Universitas Negeri Lampung, Universitas Negeri Manado, Universitas Padjajaran, Universitas Brawijaya, Institut Teknologi Sepuluh Nopember Surabaya and Universitas Pembangunan Nasional "Veteran" Yogyakarta.

# IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE

available at http://iopscience.iop.org/issue/1755-1315/42/1

## IDENTIFICATION OF SURFACE MANIFESTATION AT GEOTHERMAL FIELD USING SAR DUAL ORBIT DATA

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**ABSTRACT**
The Wayang -Windu Geothermal Field located in West Java, Indonesia is a geothermal field under tropical zone which is identified by high precipitation, dense vegetation, and extensive weathering/alteration. The clouds due to high precipitation and vegetation conditions on the tropical zone inhibit the identification of surface manifestation using optical remote sensing techniques. In this paper, we reduced these inhibiting factors using microwave remote sensing techniques termed as Synthetic Aperture Radar (SAR). The SAR dual orbits were used to observe the targets on the surface by minimizing the effects from the clouds and dense vegetation cover. This study is aimed to identify surface manifestation based on Geo morphologic and Structural Features (GSF) of the SAR in Ascending and Descending orbits. The Linear Features Density of SAR (lifedSAR) method was applied to quantify the linear features of the ground surface and served as basis of surface manifestation identification. Based on the lifedSAR and field observations, the surface manifestations could be detected succesfully at Wayang and Cibolang craters with density about 45%. The soil measurements were used validate the result and to interpret the correlation between LFD and surface manifestations.

http://dx.doi.org/10.1088/1755-1315/42/1/012001

## GEOCHEMICAL STUDY OF AMPALLAS GEOTHERMAL AREA, MAMUJU DISTRICT, WEST SULAWESI PROVINCE

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**ABSTRACT**
Ampallas is one of the areas with geothermal potential which located in Mamuju district, near from the capital city of West Sulawesi. This research was carried out to understand the characteristic of this geothermal field based on chemistry of the surface manifestation, including fluid characteristic and soil anomaly. Geothermal research in Ampallas area focused on 4 hot springs; Ampallas, Batupane, Karema, and Gantungan. With average temperature around 34 - 67°C. Ampallas 1,2,3,4,7,8 hot springs water type is chloride - bicarbonate, which means it came from the reservoir while Batupane, Gantungan, Karema and Ampallas 5 are all bicarbonate type. Ampallas 1,2,3,4,7,8, Karema and Gantungan hot springs fluid plotted in partial equilibrium zone while Batupane and Ampallas 5 plotted in immature water zone. It means the Ampallas hot springs (except Ampallas-5) mixed with meteoric water right after reached the equilibrium state. It is also concluded that Ampallas 5 hot springs came from the same reservoir with Batupane, but not Gantungan and Karema hot springs. The speculative resource potential of Ampallas geothermal system is estimated around 30 MWe. But if detailed geophysical method was applied the result could be more accurate.

http://dx.doi.org/10.1088/1755-1315/42/1/012002

## IDENTIFICATION OF LINEAR FEATURES AT GEOTHERMAL FIELD BASED ON SEGMENT TRACING ALGORITHM (STA) OF THE ALOS PALSAR DATA

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**ABSTRACT**
Indonesia has about 40% of geothermal energy resources in the world. An area with the potential geothermal energy in Indonesia is Wayang Windu located at West Java Province. The comprehensive understanding about the geothermal system in this area is indispensable for continuing the development. A geothermal system generally associated with joints or fractures and served as the paths for the geothermal fluid migrating to the surface. The fluid paths are identified by the existence of surface manifestations such as fumaroles, solfatara and the presence of alteration minerals. Therefore the analyses of the liner features to geological structures are crucial for identifying geothermal potential. Fractures or joints in the form of geological structures are associated with the linear features in the satellite images. The Segment Tracing Algorithm (STA) was used for the basis to determine the linear features. In this study, we used satellite images of ALOS PALSAR in Ascending and Descending orbit modes. The linear features obtained by satellite images could be validated by field observations. Based on the application of STA to the ALOS PALSAR data, the general direction of extracted linear features were detected in WNW-ESE, NNE-SSW and NNW-SSE. The directions are consistent with the general direction of faults system in the field. The linear features extracted from ALOS PALSAR data based on STA were very useful to identify the fractured zones at geothermal field.

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## REPEAT ABSOLUTE AND RELATIVE GRAVITY MEASUREMENTS FOR GEOTHERMAL RESERVOIR MONITORING IN THE OGIRI GEOTHERMAL FIELD, SOUTHERN KYUSHU, JAPAN

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**ABSTRACT**
Repeat hybrid microgravity measurements were conducted around the Ogiri Geothermal Field on the western slope of Kirishima volcano, southern Kyushu, Japan. This study was undertaken to detect the short-term gravity change caused by the temporary shutdown of production and reinjection wells for regular maintenance in 2011 and 2013. Repeat microgravity measurements were taken using an A-10 absolute gravimeter (Micro-g LaCoste) and CG-5 gravimeter (Scintrex) before and after regular maintenance. Both instruments had an accuracy of 10 μgal. The gravity stations were established at 27 stations (two stations for absolute measurements and 25 stations for relative measurements). After removal of noise effects (e.g., tidal movement, precipitation, shallow groundwater level changes), the residual gravity changes were subdivided into five types of response. We detected a gravity decrease (up to 20 μgal) in the reinjection area and a gravity increase (up to 30 μgal) in the production area 1 month after the temporary shutdown. Most of the gravity stations recovered after the maintenance. The temporal density changes in the geothermal reservoir were estimated based on these gravity changes.

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## THE EFFECTIVENESS OF HYDROTHERMAL ALTERATION MAPPING BASED ON HYPERSPECTRAL DATA IN TROPICAL REGION

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**ABSTRACT**

Hyperspectral remote sensing could be used to characterize targets at earth's surface based on their spectra. This capability is useful for mapping and characterizing the distribution of host rocks, alteration assemblages, and minerals. Contrary to the multispectral sensors, the hyperspectral identifies targets with high spectral resolution. The Wayang Windu Geothermal field in West Java, Indonesia was selected as the study area due to the existence of surface manifestation and dense vegetation environment. Therefore, the effectiveness of hyperspectral remote sensing in tropical region was targeted as the study objective. The Spectral Angle Mapper (SAM) method was used to detect the occurrence of clay minerals spatially from Hyperion data. The SAM references of reflectance spectra were obtained from field observation at altered materials. To calculate the effectiveness of hyperspectral data, we used multispectral data from Landsat-8. The comparison method was conducted by comparing the SAM's rule images from Hyperion and Landsat-8, resulting that hyperspectral was more accurate than multispectral data. Hyperion SAM's rule images showed lower value compared to Landsat-8, the significant number derived from using Hyperion was about 24% better. This inferred that the hyperspectral remote sensing is preferable for mineral mapping even though vegetation covered study area.

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## NUMERICAL SIMULATION FOR NATURAL STATE OF TWO-PHASE LIQUID DOMINATED GEOTHERMAL RESERVOIR WITH STEAM CAP UNDERLYING BRINE RESERVOIR

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**ABSTRACT**

Hydrothermal reservoir which liquid-dominated hydrothermal reservoir is a type of geothermal reservoir that most widely used for power plant. The exploitation of mass and heat from the geothermal fluid will decrease the pressure in the reservoir over time. Therefore the pressure drop in the reservoir will have an impact on the formation of boiling zones or boiling will increase. The impacts are an increase in the fraction of steam, dryness, in the reservoir and with good vertical permeability will form a steam cap underlying the brine reservoir. The two- phase liquid dominated reservoir is sensitive to the porosity and difficult to assign average properties of the entire reservoir when there is boiling zone in some area of the reservoir. These paper showed successful development of two-phase liquid dominated geothermal reservoir and discussed the formation of steam cap above brine reservoir through numerical simulation for state natural conditions. The natural state modeling in steam cap shows a match with the conceptual model of the vapor-dominated developed. These paper also proofed the presence of transition zone, boiling zone, between steam cap and brine reservoir.

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## PERFORMANCE ANALYSIS OF MINERAL MAPPING METHOD TO DELINEATE MINERALIZATION ZONES UNDER TROPICAL REGION

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**ABSTRACT**
Geothermal explorations and productions are currently being intensively conducted at certain areas in Indonesia such as Wayang Windu Geothermal Field (WWGF) in West Java, Indonesia. The WWGF is located at wide area covering about 40 km2. An accurate method to map the distribution of heterogeneity minerals is necessary for wide areas such as WWGF. Mineral mapping is an important method in geothermal explorations to determine the distribution of minerals which indicate the surface manifestations of geothermal system. This study is aimed to determine the most precise and accurate methods for minerals mapping at geothermal field. Field measurements were performed to assess the accuracy of three proposed methods: 1) Minimum Noise Fraction (MNF), utilizing the linear transformation method to eliminate the correlation among the spectra bands and to reduce the noise in the data, 2) Pixel Purity Index (PPI), a designed method to find the most extreme spectrum pixels and their characteristics due to end-members mixing, 3) Spectral Angle Mapper (SAM), an image classification technique by measuring the spectral similarity between an unknown object with spectral reference in n- dimension. The output of those methods were mineral distribution occurrence. The performance of each mapping method was analyzed based on the ground truth data. Among the three proposed method, the SAM classification method is the most appropriate and accurate for mineral mapping related to spatial distribution of alteration minerals.

http://dx.doi.org/10.1088/1755-1315/42/1/012007

## GEOLOGY STRUCTURE IDENTIFICATION BASED ON POLARIMETRIC SAR (POLSAR) DATA AND FIELD BASED OBSERVATION AT CIWIDEY GEOTHERMAL FIELD

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**ABSTRACT**
Geological structure observation is difficult to be conducted at Quaternary volcanic field due to the classical problem at tropical region such as intensive erosion, dense vegetation covers, and rough terrain. The problem hampers the field observation especially for geological structures mapping. In order to overcome the problems, an active remote sensing technology based on Polarimetric Synthetic Aperture Radar (PolSAR) data was used in this study. The longer wavelength of microwave than optical region caused the SAR layer penetration higher than optics. The Ciwidey Geothermal Field, Indonesia was selected as study area because of the existence of surface manifestations with lack information about the control of geological structures to the geothermal system. Visual interpretation based on composite polarization modes was applied to identify geological structures at study area. The color composite Red-Green-Blue for HV-HH-VV polarizations provided highest texture and structural features among the other composite combination. The Linear Features Density (LFD) map was also used to interpret the fractures zones. The calculated LFD showed high anomaly about 3.6 km/km$^2$ with two strike directions NW-SE and NE-SW. Interestingly, the surface geothermal manifestation agreed with the low anomaly of LFD. The geological structures consisted of ten faults were successfully detected and mapped. The faults type mainly are oblique-slip with strike directions NE-SW and NW-SE.

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## GEOLOGICAL, ISOTHERMAL, AND ISOBARIC 3-D MODEL CONSTRUCTION IN EARLY STAGE OF GEOTHERMAL EXPLORATION

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**ABSTRACT**

Construction of geology, thermal anomaly and pressure distribution of a geothermal system in the early stage of exploration where data is limited is described using a 3-D software, Leapfrog Geothermal. The geological 3-D model was developed from a topographic map (derived from DEM data), geological map and literature studies reported in an early geological survey. The isothermal 3-D model was constructed using reservoir temperature estimation from geothermometry calculated from chemical analyses on surface manifestations, available shallow gradient temperature hole data and the normal gradient temperature (3°C/100m) for a nonthermal area. The isobaric 3-D model was built using hydrostatic pressure where the hydrostatic pressure is determined by the product of the fluid density, acceleration due to gravity, and depth. Fluid density is given by saturated liquid density as a function of temperature. There are some constraints on the modelling result such as (1) within the predicted reservoir, the geothermal gradient is not constant but continues to increase, thus, creating an anomalously high temperature at depth, and (2) the lithology model is made by interpolating and extrapolating cross-sections whereas usually only two to three geology sections were available for this study. Hence, the modeller must understand the geology. An additional cross section was developed by the modeller which may not be as suitable as the geologist constructed sections. The results of this study can be combined with geophysical data such as gravity, geomagnetic, micro-tremor and resistivity data. The combination of geological, geochemical, isothermal, isobaric and geophysical data could be used in (1) estimating the geometry and size of the geothermal reservoir, (2) predicting the depth of top reservoir, and (3) creating well prognosis for exploration and production wells.

http://dx.doi.org/10.1088/1755-1315/42/1/012009

## A COMPREHENSIVE WELL TESTING IMPLEMENTATION DURING EXPLORATION PHASE IN RANTAU DEDAP, INDONESIA

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**ABSTRACT**

This paper describes the implementation of comprehensive well testing programs during the 2014-2015 exploration drilling in Rantau Dedap Geothermal Field. The well testing programs were designed to provide reliable data as foundation for resource assessment as well as useful information for decision making during drilling. A series of well testing survey consisting of SFTT, completion test, heating-up downhole logging, discharge test, chemistry sampling was conducted to understand individual wells characteristics such as thermodynamic state of the reservoir fluid, permeability distribution, well output and fluid chemistry. Furthermore, interference test was carried out to investigate the response of reservoir to exploitation.

http://dx.doi.org/10.1088/1755-1315/42/1/012010

# ECONOMIC AND THERMODYNAMIC ANALYSIS FOR PRELIMINARY DESIGN OF DRY STEAM GEOTHERMAL POWER PLANT (GPP) WITH MULTIFARIOUS GAS REMOVAL SYSTEM (GRS) IN KAMOJANG, WEST JAVA, INDONESIA

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**ABSTRACT**

Indonesia has great number of geothermal potential separated by two kind of potential, 16.13 GW for high enthalpy and 7.88 GW for low enthalpy speculative resources [4]. In the end of 2013, Ministry of Energy and Mineral Resources stated that Geothermal Power Plant (GPP) in Indonesia have been built about 1.34 GW in capacity and wanted to seriously develop geothermal potential up to 6.64 GW by 2025 [8]. Cost is one of famous obstacle in Indonesia's GPP Development. To reduce grand total cost of GPP, this paper will present the relation between thermodynamic and economic analysis in purpose to find the most economical gas removal system in GPP. By gleaning data at Kamojang Steam Field on behalf of PT Pertamina Geothermal Energy, this study will thermodynamically analyze and calculate a GPP preliminary design with software, named as Cycle Tempo 5.0. In additional, writers create motive steam calculator (based on C++ language) to enhance thermodynamic analysis for gas removal system (GRS) and adapted the results in Cycle Tempo 5.0. After thermodynamic analysis has been done, economic study will be undertaken by Net Present Value Analysis to compare the utilization cost of three different GRS and find which kind of GRS is more economical for nearly 30 years operation. For the result, Dual LRVP has higher performance than the others, spend less utilization cost and more economical for nearly 30 years operation. Moreover, the economic analysis for replacement of gas removal system shown in this paper too. In conclusion, GPP with Dual LRVP is proper to be developed in the future Geothermal Power Plant or to replace the existing GRS in some existing GPP in Indonesia.

http://dx.doi.org/10.1088/1755-1315/42/1/012011

# IDENTIFYING THE DISTRIBUTION OF ALTERATION ZONE USING VERY LOW FREQUENCY METHOD IN CANDI GEDONG SONGO, UNGARAN, SEMARANG, CENTRAL JAVA

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**ABSTRACT**

The alteration zone could be a key link and a proof to know where the paleo heat source was previously located. An electromagnetic survey to identify and to map the lateral and vertical distribution of alteration zone had been done at geothermal area Candi Gedong Songo, Ungaran, Central Java, from 9th - 19th of June 2014, using VLF method. The survey consisted of 6 profiles, with NW - SE direction, which were located nearby the fumaroles spots and then went down to the observed alteration zone. Each profile was 600 m long and the distance between each profile was 20 m. The space between each measurement point of a profile was 20 m. In this study, tilt and ellipticity data with frequency of 19.8 kHz (Japan) and 24 kHz (Panama) were used. First, the data was processed to get the cross features anomaly between tilt and ellipticity data on the chart. Then, the derivative fraser and the relative current density pseudosection were also made to support the cross features anomaly. The interpretation of this data was done qualitatively using fraser and relative current density pseudosection. The result shows that the alteration zone gives high response of conductivity compared to its surrounding area. This is supported by the anomaly cross features between tilt and ellipticity data on the chart, also by high value of fraser and relative current density. Thus, the alteration zone are located in meter 150 - 250 in V1 and V2 profiles, also in meter 180 - 250 in V5 and V6 profiles. This result indicates that the ancient heat source was previously located nearby the fumaroles area and it is physically shown by the presence of sulphuric clay mineral content at the alteration surface area.

http://dx.doi.org/10.1088/1755-1315/42/1/012012

## MATHEMATICAL MODELLING OF SILICA SCALING DEPOSITION IN GEOTHERMAL WELLS

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**ABSTRACT**
Silica scaling is widely encountered in geothermal wells in which produce two-phase geothermal fluid. Silica scaling could be formed due to chemical reacting by mixing a geothermal fluid with other geothermal fluid in different compositions, or also can be caused by changes in fluid properties due to changes pressure and temperature. One of method to overcome silica scaling which is occurred around geothermal well is by workover operation. Modelling of silica deposition in porous medium has been modeled in previously. However, the growth of silica scaling deposition in geothermal wells has never been modeled. Modelling of silica deposition through geothermal is important aspects to determine depth of silica scaling growth and best placing for workover device to clean silica scaling. This study is attempted to develop mathematical models for predicting silica scaling through geothermal wells. The mathematical model is developed by integrating the solubility-temperature correlation and two-phase pressure drop coupled wellbore fluid temperature correlation in a production well. The coupled model of two-phase pressure drop and wellbore fluid temperature correlation which is used in this paper is Hasan-Kabir correlation. This modelling is divided into two categories: single and two phase fluid model. Modelling of silica deposition is constrained in temperature distribution effect through geothermal wells by solubility correlation for silica. The results of this study are visualizing the growth of silica scaling thickness through geothermal wells in each segment of depth. Sensitivity analysis is applied in several parameters, such as: bottom-hole pressure, temperature, and silica concentrations. Temperature is most impact factor for silica scaling through geothermal wellbore and depth of flash point. In flash point, silica scaling thickness has reached maximum because reducing of mole in liquid portion.

http://dx.doi.org/10.1088/1755-1315/42/1/012013

## VOLCANOSTRATIGRAPHY FOR SUPPORTING GEOTHERMAL EXPLORATION

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**ABSTRACT**
Volcanostratigraphy is stratigraphy related to volcanism and its products. This includes stratigraphy for a general scoping of a regional area and detailed analysis in a local area. On the basis of Indonesian Stratigraphic Code 1996, from low to high rank, volcanostratigraphic units are Hummock (*Gumuk*), Crown (*Khuluk*), Brigade (*Bregada*), Super Brigade (*Manggala*), and Arc (*Busur*). For more detailed stratigraphic study these ranked units can be classified into genetic rock units based on source location, processes and absolute age. Genetic processes include transportation and cooling or deposition mechanisms. These lead to physical- and chemical- properties of the volcanic rocks and provide the history of volcanism and potentially geothermal processes in an area. For many areas in Indonesia the understanding of the volcanostratigraphy is an important dataset for geothermal exploration.

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## IDENTIFYING NON-VOLCANIC GEOTHERMAL POTENTIAL IN AMOHOLA, SOUTHEAST SULAWESI PROVINCE, BY APPLYING THE FAULT AND FRACTURE DENSITY (FFD) METHOD

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**ABSTRACT**

Indonesia has numerous volcanic areas that lead to a significant geothermal potential. The geothermal potential could be produced by volcanic and non-volcanic processes. To date, geothermal possibilities by volcanic process are the most commonly known and explored in several areas in Indonesia, whereas, geothermal potential by non-volcanic process is rarer. Therefore, Indonesia is likely has a promising non-volcanic geothermal also. Non-volcanic geothermal systems could be identified by using Fault and Fracture Density (FFD) method, lineaments analysis from SRTM and topography data, as well as using earlier research models by previous researchers. By using those methods, the existing of fractures and possibility level of area that being recharge and discharge zones for geothermal might be predicted. Thus, the result could be the next target of exploration. This paper describes the application of those methods for the Amohola region and surrounding areas in Southeast Sulawesi Province. In general, the study area has complex geological characteristics. Consequently, the methods could be applied to identifying the presence of non-volcanic geothermal system in this study area.

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## CHARACTERISTIC OF GEOTHERMAL FLUID AT EAST MANGGARAI, FLORES, EAST NUSA TENGGARA

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**ABSTRACT**

The research area is located in East Manggarai and its surrounding area, Flores. In the study area there are two geothermal systems, i.e. Mapos geothermal system which is associated with Anak Ranakah volcano and Rana Masak geothermal systems which is associated with Watuweri volcano. The difference within these systems is shown by the relative content of conservative elements of Cl, Li and B. Geothermal surface manifestations in Mapos include 4 hot springs having temperatures of 34.3-51.4°C and bicarbonate and sulphate-bicarbonate waters; the discharge area in Rana Masak consist of 3 hot springs with temperatures of 38-46.6°C and chloride and chloride-bicarbonate water. Stable isotopes $\delta^{18}O$ and $\delta D$ analyses showed that the geothermal fluid derived from meteoric water. The Mapos geothermal system is a high temperature system having reservoir temperature of 250-270°C with natural heat loss of 230 kW. The Rana Masak geothermal system is a low temperature system having reservoir temperature of 120-140°C with natural heat loss of 120 kW.

http://dx.doi.org/10.1088/1755-1315/42/1/012016

## ENERGY OPTIMIZATION MODELING OF GEOTHERMAL POWER PLANT (CASE STUDY: DARAJAT GEOTHERMAL FIELD UNIT III)

R H M Sinaga[1] and P S Darmanto[2]

[1]Engineering Management Study Program,
Del Institute of Technology, Laguboti, Toba Samosir 22381, Indonesia
[2]Mechanical Engineering Study Program, ITB

**ABSTRACT**

Darajat unit III geothermal power plant is developed by PT. Chevron Geothermal Indonesia (CGI). The plant capacity is 121 MW and load 110%. The greatest utilization power is consumed by Hot Well Pump (HWP) and Cooling Tower Fan (CTF). Reducing the utility power can be attempted by utilizing the wet bulb temperature fluctuation. In this study, a modelling process is developed by using Engineering Equation Solver (EES) software version 9.430.The possibility of energy saving is indicated by Specific Steam Consumption (SSC) net in relation to wet bulb temperature fluctuation from 9°C up to 20.5°C. Result shows that the existing daily operation reaches its optimum condition. The installation of Variable Frequency Drive (VFD) could be applied to optimize both utility power of HWP and CTF. The highest gain is obtained by VFD HWP installation as much as 0.80% when wet bulb temperature 18.5 °C.

http://dx.doi.org/10.1088/1755-1315/42/1/012017

## EXPERIMENTAL STUDY OF ISOTHERMAL PLATE UNIFORMITY FOR BLOOD WARMER DEVELOPMENT USING GEOTHERMAL ENERGY

J Hendrarsakti[1,2] and Y Ichsan[1]

[1]Faculty of Mechanical and Aerospace Engineering, ITB
[2]Geothermal Master Program, ITB

**ABSTRACT**

This research was conducted to assess the direct use of geothermal energy for blood warmer. The heating plate was made form aluminium plates with dimensions of 100 x 200 mm and then fed from the hot water heater. Tests were conducted in the laboratory where geothermal source water is replaced with the heat generated from the heater. The hot water from the heater in the temperature range 55°C - 60°C flowed into vertical chamber. Setting the temperature of the hot water heater is done by changing the flow of hot water coming out of the heater. Results showed that the value of a standard deviation of plate temperature was about 0.42 °C, so it can be said isothermal accordance with design requirement and objective. The test data used for the analysis of the manufacture of the heating plate in the blood warmer to regulate the discharge of hot water at intervals of 21.47 mL/s to 24.8 mL/s to obtain a temperature of 37.20 °C - 40.15 °C. Geothermal energy has the potential for blood warmer because blood warmer is part of the energy cascade in a temperature range of 40°C to 60°C

http://dx.doi.org/10.1088/1755-1315/42/1/012018

## ELECTRICITY GENERATION FROM HYDROTHERMAL VENTS

Y Aryadi[1,2], I S Rizal[1,2], and M N Fadhli[2]

[1]Department of Petroleum Engineering, ITB
[2]Department of Mechanical Engineering, ITB

**ABSTRACT**
Hydrothermal vent is a kind of manifestation of geothermal energy on seabed. It produces high temperature fluid through a hole which has a diameter in various range between several inches to tens of meters. Hydrothermal vent is mostly found over ocean ridges. There are some 67000 km of ocean ridges, 13000 of them have been already studied discovering more than 280 sites with geothermal vents. Some of them have a thermal power of up to 60 MWt. These big potential resources of energy, which are located over subsea, have a constraint related to environmental impact to the biotas live around when it becomes an object of exploitation. Organic Rankine Cycle (ORC) is a method of exploiting heat energy to become electricity using organic fluid. This paper presents a model of exploitation technology of hydrothermal vent using ORC method. With conservative calculation, it can give result of 15 MWe by exploiting a middle range diameter of hydrothermal vent in deep of 2000 meters below sea level. The technology provided here really has small impact to the environment. With an output energy as huge as mentioned before, the price of constructing this technology is low considering the empty of cost for drilling as what it should be in conventional exploitation. This paper also presents the comparison in several equipment which is more suitable to be installed over subsea.

http://dx.doi.org/10.1088/1755-1315/42/1/012019

## DESIGN OF TOMATO DRYING SYSTEM BY UTILIZING BRINE GEOTHERMAL

W Afuar[1], B Sibarani[1], G Abdurrahman[1] and J Hendrarsakti[1,2]

[1]Geothermal Master Program ITB, Bandung, Indonesia
[2]Faculty of Mechanical and Aerospace Engineering ITB, Bandung, Indoensia

**ABSTRACT**
Cultivation of tomato plants in Indonesia has been started since 1961.Tomatoes generally will rot in three days if left on storage. Moreover, low quality tomatoes have cheaper price. After harvested, tomatoes need to be treated by drying process so it can last longer. Energy for drying tomatoes can be obtained by utilizing heat from geothermal brine. Purpose of this research is to design a tomato drying system by extracting heat of geothermal brine from separator with certain flow rate to heat up water by using a heat exchanger. Furthermore, this water will be used to heat up the surrounding air which is circulated by blower system to heat up the tomatoes chamber. Tomatoes drying process needs temperature range of 50-70°C to evaporate water content from 95.7% to 26%. After that treatment, the tomatoes are expected to have better durability. The objective of this study is to determine the quantity of hot brine which is needed for drying tomatoes and to design a drying system so that tomatoes can last longer.

http://dx.doi.org/10.1088/1755-1315/42/1/012020

## ASSESSING THE POSSIBILITY OF ENHANCED GEOTHERMAL SYSTEM IN WESTERN INDONESIA

R N Hendrawan and W A Draniswari

Geological Engineering, Master Program, ITB

**ABSTRACT**

Enhanced Geothermal System (EGS) is one of geothermal system where abnormally hot masses of low permeability rocks are found at depth. Most of EGS are related to thick and deep sedimentary basin with plutons. EGS focused on drilling at hot crystalline rock and create fractured reservoirs. Indonesia has a complex tectonic setting. There were more than 86 basins in Indonesia. Most of sedimentary basins in Indonesia were tectonically stressed. Moreover, the tectonic setting which is generally a part of the Active Continental Margin also allows the formation of plutons that can be act as hot dry rock. Several hot springs or other geothermal manifestation were found in several areas within the basin and its surrounding area. This study compares structural controls and models in different tectonic setting of main basin in Western Indonesia to get the most suitable potential reservoir for EGS. The characteristic of the South Sumatra Basin, North Sumatra Basin, East Java Basin and Tarakan Basin were evaluated and compared based on its geology and geophysics characteristic. As the result, South Sumatra Basin is the first rank for EGS suitability in Western Indonesia.

http://dx.doi.org/10.1088/1755-1315/42/1/012021

## SUBSIDENCE: CAUSES, EFFECTS, AND MITIGATIONS IN GEOTHERMAL FIELD

A Sektiawan[1], G A Prasetyo[2], D P Adli[3], and E Yuantoro[3]

[1]Petroleum Engineering Department,
[2]Geophysical Engineering Department,
[3]Geological Engineering Department,
ITB, Bandung, Indonesia

**ABSTRACT**

Subsidence is the motion of the ground surface as it moves down relatively. It can occur in a wide range of area. It is an impact of production of large mass and volume of saturation from the reservoir. It doesn't happen especially in geothermal fields only, but also in oil and gas industry. Large fluid volume production leads to the decrease of pore pressure inside reservoir. This decline disturbs the pressure stability and overburden pressure compress the pores. It results the drop in ground surface. The decrease in ground surface level induces a devastating effect in the construction of some facilities, such as building, pipeline, canal, and river. It may interrupt the balance in the ecosystems nearby. Good management and several survey methods (such as levelling and gravity) will reduce the risk of subsidence and the other effects related to it. This discussion output can be used as a guide for minimizing subsidence impact in the geothermal field in general.

http://dx.doi.org/10.1088/1755-1315/42/1/012022

## FEASIBILITY OF GEOTHERMAL ENERGY EXTRACTION FROM NON-ACTIVATED PETROLEUM WELLS IN ARUN FIELD

M Syarifudin, F Octavius, and K Maurice

Department of Petroleum Engineering, ITB

**ABSTRACT**

The big obstacle to develop geothermal is frequently came from the economical viewpoint which mostly contributed by the drilling cost. However, it potentially be tackled by converting the existing decommissioned petroleum well to be converted for geothermal purposes. In Arun Field, Aceh, there are 188 wells and 62% of them are inactive (2013). The major obstacle is that the outlet water temperature from this conversion setup will not as high as the temperature that come out from the conventional geothermal well, since it will only range from 60 to 180$^{o}$C depending on several key parameters such as the values of ground temperature, geothermal gradient in current location, the flow inside of the tubes, and type of the tubes (the effect from these parameters are studied). It will just be considered as low to medium temperature, according to geothermal well classification. Several adjustments has to be made such as putting out pipes inside the well that have been used to lift the oil/gas and replacing them with a curly long coil tubing which act as a heat exchanger. It will convert the cold water from the surface to be indirectly heated by the hot rock at the bottom of the well in a closed loop system. In order to make power production, the binary cycle system is used so that the low to medium temperature fluid is able to generate electricity. Based on this study, producing geothermal energy for direct use and electricity generation in Arun Field is technically possible. In this study case, we conclude that 2900 kW of electricity could be generated. While for-direct utility, a lot of local industries in Northern Sumatera could get the benefits from this innovation.

http://dx.doi.org/10.1088/1755-1315/42/1/012023

## DECLINE CURVE ANALYSIS FOR PRODUCTION FORECAST AND OPTIMIZATION OF LIQUID-DOMINATED GEOTHERMAL RESERVOIR

I Hidayat

Department of Petroleum Engineering, ITB

**ABSTRACT**

Power projects in the geothermal field has a long span of about 30 years. The power supply should be maintained at a certain value across a range of time. A geothermal field, however, has the characteristics of natural production decline with time. In a geothermal field, development of decline curve model of steam production is important for forecasting production decline in the future. This study was developed using decline curve by production data along 3 years liquid-dominated geothermal reservoir in Ulubelu field. Decline curve in geothermal field based on decline curve in petroleum industry. The decline curve was correlated by reservoir management in geothermal. The purposes of this study to get best match model decline curve and forecasting production in the future. Based on decline curve analysis by production data in Ulubelu field, the result model decline curve is exponential model. From the model, we can get the value of decline rate in the field is 9.4 %/year. Then, the formula of forecasting steam flow used exponent decline to forecast in the future. By using separated system cycle in Ulubelu field, the minimal steam flowrate towards turbine was 502018.4 ton/month. Based on formula of forecasting production and minimal steam flowrate, we can get the time make up wells to maintain steam supply for stability in generator power capacity.

http://dx.doi.org/10.1088/1755-1315/42/1/012024

## CHARACTERIZING GEOTHERMAL SURFACE MANIFESTATION BASED ON MULTIVARIATE GEOSTATISTICS OF GROUND MEASUREMENTS DATA

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[1]Faculty of Mining and Petroleum Engineering, ITB
[2]Faculty of Earth Sciences and Technology, ITB

**ABSTRACT**
Mt. Wayang Windu is one of geothermal field located in West Java, Indonesia. The characterization of steam spots at surface manifestation zones based on the soil physical measurements of the area is presented in this study. The multivariate geostatistical methods incorporating the soil physical parameter data were used to characterize the zonation of geothermal surface manifestations. The purpose of this study is to evaluate the performance of spatial estimation method of multivariate geostatistics using Ordinary Cokriging (COK) to characterize the physical properties of geothermal surface manifestations at Mt. Wayang Windu. The COK method was selected because this method is favorable when the secondary variables has more number than the primary variables. There are four soil physical parameters used as the basis of COK method, i.e. Electrical Conductivity, Susceptibility, pH, and Temperature. The parameters were measured directly at and around geothermal surface manifestations including hot springs, fumaroles, and craters. Each location of surface manifestations was measured about 30 points with 30 x 30 m grids. The measurement results were analyzed by descriptive statistics to identify at the nature of data. The correlation among variables was analyzed using linear regression. When the correlation coefficient among variables is higher, the estimation results is expected to have better Linear Coregionalization Model (LCM). LCM was used to analyze the spatial correlation of each variable based on their variogram and cross-variogram model. In oder to evaluate the performance of multivariate geostatistical using COK method, a Root Mean Square Error (RMSE) was performed. Estimation result using COK method is well applicable for characterizing the surface physics parameters of radar images data.

http://dx.doi.org/10.1088/1755-1315/42/1/012025

## OCCURRENCE OF SARAWET HOTSPRING: WHAT AFFECTS THE OUTFLOW?

W A Draniswari and R N Hendrawan

Geological Engineering, Master Program, ITB

**ABSTRACT**
Geothermal systems located in volcanic arc are generally influenced by volcanic activities. But at the complex geological setting like Sulawesi the geothermal systems probably is not only influenced by volcanic activities but also structural geology features. Sarawet hot spring in Minahasa, North Sulawesi, Indonesia is a volcanic and fault influenced manifestations. Sarawet hot spring is located in north coast Minahasa. Our study shows that the surface geological-structural analysis in combination with the geochemistry and the heat flow investigation is the essential tools for geothermal systems or manifestation characterization. Tectonics, crust characteristic, heat flow, and surface structural could affect the manifestations and its geothermal systems. Geochemically the water is bicarbonate, peripheral-immature water, and characterized by a meteoric water-line trend. The composition of these thermal springs was controlled by a secondary process during ascent. Based on hydrologic gradient, heat flow characteristic and subsurface structural analysis, the mechanism of Sarawet hot spring is a lateral outflow that affected by dynamically maintained fractures system.

http://dx.doi.org/10.1088/1755-1315/42/1/012026

## VOLCANOSTRATIGRAPHIC STUDY IN CONSTRUCTING VOLCANO CHRONOLOGY AND ITS IMPLICATION FOR GEOTHERMAL RESOURCE ESTIMATION; CASE STUDY MOUNT SAWAL, WEST JAVA

F A Dermawan, H Hamka, R T A Malik, J Y Sianipar, and Q S Ramadhan

Magister Program of Geothermal Engineering, ITB

**ABSTRACT**

One of the researches that should be done before carrying out a preliminary survey on the geothermal exploration with a volcanic system or volcanic-hydrothermal is by studying the volcanic stratigraphy. Determining the center of the volcanic eruption and its distribution based on the volcanostratigraphic study will be very helpful in a direct mapping that will be implemented, given that the type and characteristics of volcanic rocks are nearly the same between one source of the eruption and the other. On this case, volcanostratigraphic study had been done on Mount Sawal, where a topographic map with a scale of 1: 100,000 is used to determine the center of eruption of each crowns, while another map with a scale of 1: 50,000 is used to identify the distribution of the monogenetic (Hummock) eruption products and crowns border in detail. It is found approximately three crowns, which are Langlayang, Sawal big crown, Pamokolan, and the Cikucang Hummock that is located on the southern edge of the Langlayang crater. These Hummock and Crowns collection will be grouped into Tasik Bregade. Based on the volcanostratigraphic analysis, DEM, and geology, the chronology of how Tasik Bregade is formed is originally from the Langlayang, Sawal big Crowns, and Pamokolan. Tasik Bregade is classified into sub-mature potential geothermal system, from the analysis results, the potential magnitude of the electrical capacity contained in the system is around 0.74 to 1.24 MWe for 30 years, but further research needs to be done because of the detailed geological and other support data that are still lacking.

http://dx.doi.org/10.1088/1755-1315/42/1/012027

## VOLCANOSTRATIGRAPHIC APPROACH FOR EVALUATION OF GEOTHERMAL POTENTIAL IN GALUNGGUNG VOLCANO

Q S Ramadhan, J Y Sianipar, and A K Pratopo

Magister Program of Geothermal Engineering, ITB

**ABSTRACT**

The geothermal systems in Indonesia are primarily associated with volcanoes. There are over 100 volcanoes located on Sumatra, Java, and in the eastern part of Indonesia. Volcanostratigraphy is one of the methods that is used in the early stage for the exploration of volcanic geothermal system to identify the characteristics of the volcano. The stratigraphy of Galunggung Volcano is identified based on 1:100000 scale topographic map of Tasikmalaya sheet, 1:50000 scale topographic map and also geological map. The schematic flowchart for evaluation of geothermal exploration is used to interpret and evaluate geothermal potential in volcanic regions. Volcanostratigraphy study has been done on Galunggung Volcano and Talaga Bodas Volcano, West Java, Indonesia. Based on the interpretation of topographic map and analysis of the dimension, rock composition, age and stress regime, we conclude that both Galunggung Volcano and Talaga Bodas Volcano have a geothermal resource potential that deserve further investigation.

http://dx.doi.org/10.1088/1755-1315/42/1/012028

## QUANTITATIVE COMPARISON OF TWO 3-D RESISTIVITY MODELS OF THE MONTELAGO GEOTHERMAL PROSPECT

W A van Leeuwen[1], Suryantini[2], and G P Hersir[3]

[1]IF Technology, Velperweg 37, 6813DP Arnhem, the Netherlands
[2]Institut Teknologi Bandung, Jl. Ganesha 10, Bandung 40132, Indonesia
[3]Iceland GeoSurvey (ÍSOR), Grensásvegur 9, 108 Reykjavík, Iceland

**ABSTRACT**

A combined TEM-MT survey was carried out in the Montelago geothermal prospect, situated on Mindoro Island, the Philippines, with the aim to obtain the dimensions and depth of the geothermal reservoir as well as to formulate the prospects' conceptual model. The acquired MT data are static shift corrected using the TEM measurements. Two different 3D inversion codes are used to create subsurface resistivity models of the corrected MT data set. The similarities and differences between the two resistivity models are quantitatively assessed using a set of structural metrics. Both resistivity models can be generalized by a three-layered model. The model consists of a thin heterogeneous, conductive layer overlying a thick resistive layer, while the basement has a decreased resistivity. Although this is a common characteristic resistivity response for the alteration mineralogy of a volcanic geothermal system, the temperatures at depth are lower than would be expected when interpreting the modelled resistivity model accordingly. Since the last volcanic activity in the area was about one million years ago, it is anticipated that the resolved resistivity structure is a remnant of a hydrothermal system associated with a volcanic heat source. This model interpretation is validated by the alteration minerals present in the exploration wells, where high temperature minerals such as epidote are present at depths with a lower temperature than epidote's initial formation temperature. This generalized description of the resistivity model is confirmed by both resistivity models. In this paper the two inversion models are not only compared by assessing the inversion models, but also by reviewing a set of gradient based structural metrics. An attempt is made to improve the interpretation of the conceptual model by analyzing these structural metrics. Based on these analyses it is concluded that both inversions resolve similar resistivity structures and that the location of the two slim holes drilled are well chosen.

http://dx.doi.org/10.1088/1755-1315/42/1/012029

## PERFORMANCE PREDICTION OF TWO-PHASE GEOTHERMAL RESERVOIR USING LUMPED PARAMETER MODEL

F Nurlaela and Sutopo

Magister Program of Geothermal Engineering, ITB

**ABSTRACT**

Many studies have been conducted to simulate performance of low-temperature geothermal reservoirs using lumped parameter method. Limited work had been done on applying non-isothermal lumped parameter models to higher temperature geothermal reservoirs. In this study, the lumped parameter method was applied to high-temperature two phase geothermal reservoirs. The model couples both energy and mass balance equations thus can predict temperature, pressure and fluid saturation changes in the reservoir as a result of production, reinjection of water, and/or natural recharge. This method was validated using reservoir simulation results of TOUGH2. As the results, the two phase lumped parameter model simulation without recharge shows good matching, however reservoir model with recharge condition show quite good conformity.

http://dx.doi.org/10.1088/1755-1315/42/1/012030

# IIGW 2016 PAPERS

## *Exploration*

***Engineering***

## Organizing and Technical Commitee

| | |
|---|---|
| **Steering Committee** | Nenny Miryani Saptadji and Staff of Geothermal Technology Study Program, FTTM – ITB<br>Antonie de Wilde (SATE PTE LTD-Singapore) |
| **Chairman** | Suryantini |
| **Vice Chairman** | Ali Fahrurrozie, Akhmad Kunio Pratopo |
| **Secretary General** | Angga Alfandi Ahmad, Evanda Eko Putra, Fitri Oktaviani Purwaningsih |
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| **Pre – Workshop Course** | Dimas Taha Maulana, Allen Haryanto Lukman, Fikri Adam Dermawan, Famelia Nurlaela |
| **Technical Session & Planning** | Asep Saepuloh, Suryantini, Nurita Putri H, Juni Yesy Sianipar, Setya Drana Harry Putra, Anggie Rengganis, Agastyo Nugroho, Heru Berian Pratama |
| **Field Trip & Field Camp** | Qodri Syahrur Ramadhan, Silvester Dimas Sanjaya, Mahesa Pradana, Ratih Nurruhliati |
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| **Logistic** | Qodri Syahrur Ramadhan, Welly Todheus, Fhandy Pandey |

## Workshop Venue Map

### ITB Campus Map

Opening, Plenary Sessions, Gala Dinner - Venue :
East Hall

Poster Session, Limited Exhibition - Venue :
Gallery, East Campus Center

Mid Workshop - Venue :
Room 3, East Campus Center

Technical Sessions - Venue :
Auditorium, Room 6, Room 5, Room 4
East Campus Center

Pre Workshop Course 1 - Venue :
Auditorium, East Campus Center

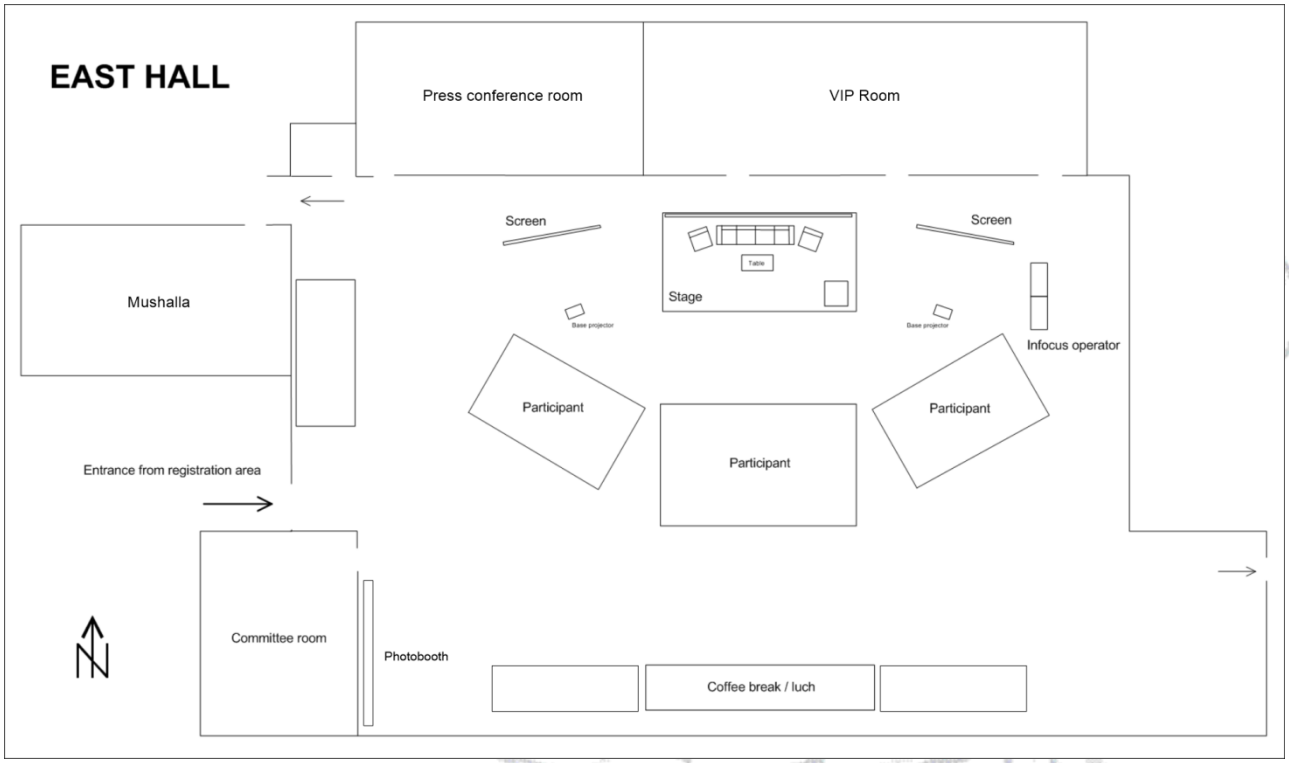
Pre Workshop Course 2 - Venue :
Room 5, East Campus Center

Pre Workshop Course 3 - Venue :
Room 6, East Campus Center

Closing Ceremony - Venue :
Auditorium, East Campus Center

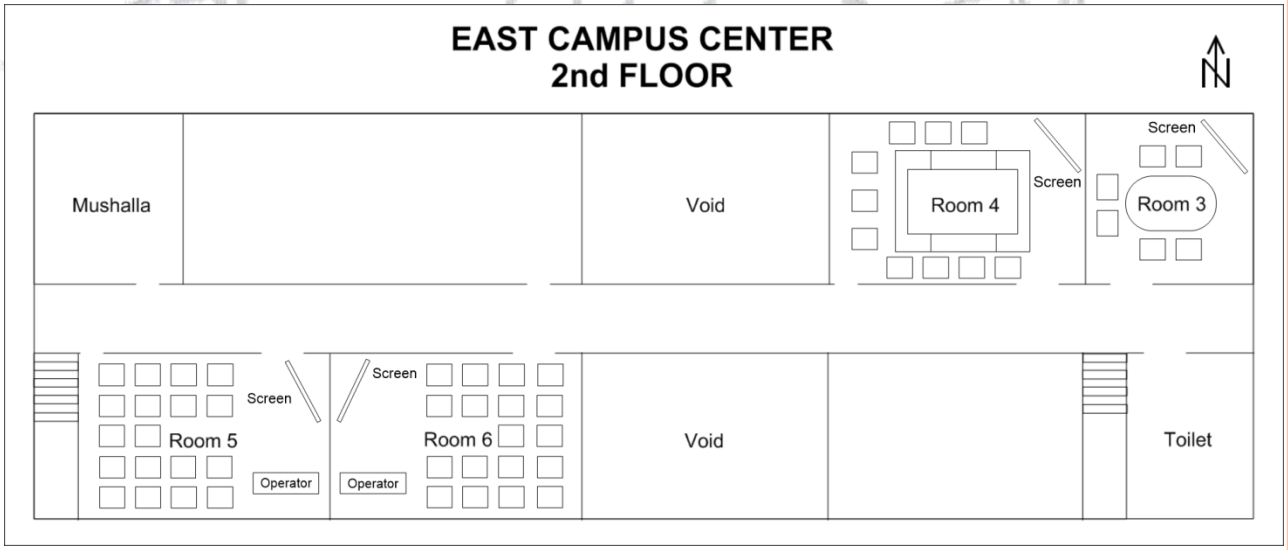
## Workshop Venue Map

### Room Layout




## Parallel Technical Session Venue Map

### Room Layout



**PROGRAMME**

***Pre – Workshop Courses***

## Pre-Workshop Course 1

### Monday-Tuesday, March 28-29th 2016

| Geothermal Drilling and Negotiating Integrated Drilling Services Contract (ISOR, QED, SATE PTE LTD) | | |
|---|---|---|
| Venue | Auditorium Campus Center | |
| Lecturers | Antonie de Wilde (SATE), Sverrir Thorhallsson and Dadi Thorbjornsson (ISOR - Iceland), Renato Escalante (QED) | |
| **Day 1 :** | | |
| 08.00-10.00 | Overview of various types of geothermal systems. Implication on drilling approach and utilization<br>Exploration drilling vs. production drilling | ISOR |
| 10.00-10.30 | BREAK | |
| 10.30-11.45 | Geothermal well designs, large holes vs. slim holes | ISOR |
| 11.45-12.30 | LUNCH | |
| 12.30-13.30 | Selection of drilling equipment<br>Selection of drilling fluids and cementing procedures | ISOR |
| 13.30-15.00 | Chemical sampling and interpretation<br>Environmental impacts of drilling and testing | ISOR |
| 15.00-15.30 | BREAK | |
| 15.30-17.00 | Monitoring and use of rig data to improve drilling efficiency and solve drilling problems | ISOR |
| **Day 2 :** | | |
| 08.00-10.00 | Preparation of the "Drilling Program" document | ISOR-SATE |
| 10.00-10.30 | BREAK | |
| 10.30-11.45 | Drilling contracts | SATE |
| 11.45-12.30 | LUNCH | |
| 12.30-13.30 | Mud logging | ISOR |
| 13.30-15.00 | Well logging and well completion tests<br>Well testing<br>Flow rate measurements (Russel James and TFT) | ISOR |
| 15.00-15.30 | BREAK | - |
| 15.30-17.30 | Case Study: The Experience of drilling SH1 and SH2 in Mindoro | QED |
| 17.30-18.00 | Closing | |

## Pre-Workshop Course 2

**Monday-Tuesday, March 28-29th 2016**

| Environmental Assessment, Risk Analysis, and Project Decision (GEOCAP) | | |
|---|---|---|
| Venue | Meeting Room 5 and 6, 3rd Floor, East Campus Center | |
| Lecturers | Christian Bos (TNO, NL), Kees van den Ende (DNV GL), Rianne 't Hoen (DNV GL), Triarko Nurlambang (UI), Ali Ashat (ITB) | |
| **Day 1 :** | | |
| 08.00-10.00 | The energy landscape<br>- Paris COP21<br>- Energy transition strategies<br>- Renewable energy schemes | GEOCAP |
| 10.00-10.30 | Break | |
| 10.30-11.45 | Outlook Indonesian energy mix<br>- Roadmap development<br>- Geothermal policy framework<br>- Early experience/ lessons learned | GEOCAP |
| 11.45-12.30 | LUNCH | |
| 12.30-13.30 | Social License to Operate (Strategic environmental assessment)<br>- Environmental aspects (flora, fauna, soil, landscape, humans, cultural heritages) | GEOCAP |
| 13.30-15.00 | SEA criteria<br>- Consideration alternatives<br>- Methods of comparison (Leopold matrix)<br>- Significant effect and mitigation measures | GEOCAP |
| 15.00-15.30 | Break | |
| 15.30-17.00 | Working with SEA – exercises geothermal | GEOCAP |
| **Day 2 :** | | |
| 08.00-10.00 | Geothermal plant project phases and decision making<br>- Decision moments<br>- Decision criteria<br>- Bankability criteria | GEOCAP |
| 10.00-10.30 | Break | |
| 10.30-11.45 | Strategies for decision making<br>- Decision strategies and evaluation criteria<br>- Methodologies and processes<br>- Decision tree analysis<br>- Multi-criteria analysis | GEOCAP |
| 11.45-12.30 | LUNCH | |
| 12.30-13.30 | Risk analysis methods<br>- Sensitivity analysis | GEOCAP |

| | | |
|---|---|---|
| 13.30-15.00 | Risk mitigation<br>- Real option<br>- Costs of knowledge<br>- Portfolio management | GEOCAP |
| 15.00-15.30 | Break | |
| 15.30-17.30 | Decision making with confidence –exercises risk analyses and decision making geothermal | GEOCAP |
| 17.30-18.00 | Closing | |

## Pre-Workshop Course 3

**Monday-Tuesday, March 28-29th 2016**

| Geothermal for Everyone<br>(ITB Geothermal Study Program) | |
|---|---|
| Venue | Meeting room 4, 3rd Floor, East Campus Center |
| Lecturers | Suryantini, Nenny Miryani Saptadji, Ali Ashat |
| **DAY 1** | |
| 08.00-10.00 | Geothermal System; Type, Worldwide Occurrence and Utilization |
| 10.00-10.30 | Coffee Break |
| 10.30-12.00 | Geothermal Manifestation and Geothermal Exploration |
| 12.00-13.00 | LUNCH |
| 13.00-15.00 | Engineering and Exploitation of Geothermal Energy |
| 15.00-15.30 | Coffee Break |
| 15.30-17.00 | Economic and Environmental Issue of Geothermal Energy Utilization |

**PROGRAMME**

***Workshop***

## Plenary and Technical Sessions
## Wednesday-Thursday, March 30-31st 2016

## PLENARY SESSION

## Wednesday, March 30th 2016

| PLENARY SESSION | | |
|---|---|---|
| Venue | East Hall (Aula Timur) ITB Campus, Jalan Ganesha 10, Bandung. | |
| Opening and Keynote Speaker | | |
| 09.00-09.05 | Welcoming remark from the Chairman of IIGW 2016 | Suryantini |
| **National Anthem : Indonesia Raya** | | |
| 09.05-09.15 | Opening Speech of the IIGW 2016 by the Dean of Faculty of Mining and Petrouleum Engineering | **Sri Widiantoro** /Dean FTTM |
| 09.15-09.45 | Keynote Speech-1: Geothermal Development Plan within National Energy Council Road Map; Will it be successful? | **Abadi Poernomo** / Chairman of Indonesian Geothermal Association (INAGA), Member of National Energy Council (DEN). |
| 09.45-10.15 | Keynote Speech-2: Geothermal Law Breakthrough; Latest Condition and Future Impact | **Yunus Saefulhak** /Director of Directorate of Geothermal-Ministry of Energy and Mineral Resources |
| **COFFEE BREAK** | | |
| **PLENARY SESSION 1**<br>**Overcoming the Stagnancy in Geothermal Development** | | |
| 10.30-11.00 | The Role of National Exploration Committee (KEN) in Accelerating Geothermal Development in Indonesia and its implication to Geothermal Industry, Government and Academic Society. | **Andang Bachtiar** / Chairman of National Exploration Committee (KEN)- Ministry of Energy and Mineral Resources |
| 11.00-11.30 | PGE strategy to support Government of Indonesia goal in 2025 | **Ali Mundakir**/ Director of Operation, PT PERTAMINA GEOTHERMAL ENERGY |
| 11.30-12.30 | **OPENING OF LIMITED EXHIBITION, PHOTO CONTEST and POSTER SESSION** | |
| **LUNCH BREAK** | | |

| PLENARY SESSION 2<br>Lesson Learned from Geothermal Development | | |
|---|---|---|
| 13.15-13.45 | Lesson learns from re-negotiating electric price | **Peter Wijaya** / VP Star Energy Geothermal |
| 13.45-14.15 | Learning from more than 60 years of Geothermal History-the benefits to Today's Developers | **Alex Smillie** (Tawau Green Energy Malaysia) |
| **COFFEE BREAK** | | |

| PLENARY SESSION 3<br>Expanding the role of national human resources beyond the country | | |
|---|---|---|
| 15.00-15.30 | GEOCAP plan for increasing the role of Indonesian Human Resources in International Geothermal Industry | **Sanusi Satar** (GEOCAP) |
| 15.30-16.00 | IAGI (Indonesian Association of Geologist) plan to advance and expand geothermalist skill and knowledge to face MEA (ASEAN Economic Community) | **Sukmandaru Prihatmoko** (Chairman IAGI) |
| 16.00-16.30 | SATREPS: Japanese Academic Institution strategy for strengthening geothermal community knowledge and skill in Indonesia | **Sudarto Notosiswojo** (ITB)-**Katsuaki Koike** (Kyoto University) |
| 16.30-17.00 | Gathering and Networking | **MC: Sanusi Satar-Nenny Saptadji** |
| **17.00-18.30** | Celebration of the 5th ITB International Geothermal Workshop: Speech, Dance and Music Performance Videos | |
| **18.30-20.00** | GALA DINNER | |

## Mid-Workshop Course

## Thursday, March 31th 2016

| Geothermal Exploration<br>(IAGI-Ikatan Ahli Geologi Indonesia/Indonesian Geologist Association) | |
|---|---|
| Venue | Meeting room 3, 3rd Floor, East Campus Center |
| Lecturers | Imam Baru Raharjo (PGE), Basuki Arif Wijaya (Independent Consultant, Former Chevron Geochemist), Arief Sunu (MEDCO) |
| Time | 13.30 – 15.30 (2 hrs) |

## Parallel Technical Session

## Information

**Power Point File Check-In**

For you who have not yet sent us your power point file via email in advance, you will be asked to give your powerpoint file on first day of workshop (March 30). Please visit the power point check in desk in **East Hall ITB** on March 30.

**Time Allowance**

The time allowance for each presentation in Technical Session is 15 minutes followed with a 5 minutes of Questions and Answers Session, which means that the total time you will have is 20 minutes. The speakers will be announced when the time lapse.
*First announcement: You will have 5 minutes to finish your presentation (10 minutes passed)*
*Second announcement: Your time is up (15 minutes passed)*

**Note for the Speakers:**

Please be present in the room where you will give presentation 15 minutes before your session starts.

**INVITED SPEAKER:**

| Speakers | Time |
|---|---|
| ISOR | **Auditorium ( 09.30-10.10)** |
| GEOCAP | **Auditorium ( 10.30-12.10)** |
| SATREPS | **Auditorium ( 13.30-15.10)** |
| Andri Dian Nugraha (ITB) | **Room 4 (09.30-10.10)** |
| Bonar Tua Halomoan Marbun (ITB) | **Room 4 (10.30-11.10)** |
| Tobias Fischer (New Mexico Univ. USA) | **Room 5 (09.30-10.10)** |
| Pri Utami (UGM) | **Room 5 (13.30-14.10)** |
| Wahyu Sri Gutomo (ITB) | **Room 6 (09.30-10.10)** |
| Clare Baxter (LEAPFROG) | **Room 6 (13.30-14.10)** |

**Thursday, March 31st 2016**
**VENUE: EAST CAMPUS CENTER**

| TIME | AUDITORIUM | ROOM 4 | ROOM 5 | ROOM 6 |
|---|---|---|---|---|
| **SESSION** | **ENGINEERING**<br>Chairperson: Ali Ashat & Famelia Nurlaela | **GEOPHYSICS**<br>Chairperson: Prihadi Sumintadireja & Dian Darisma | **GEOLOGY**<br>Chairperson: Arief Susanto & M. Nurwahyudi Yulianto | **GEOPHYSICS**<br>Chairperson: Hendra Grandis & Angga Bakti P. |
| **08:30 – 08:50** | Numerical Simulation for Natural State of Two-Phase Liquid Dominated Geothermal Reservoir with Steam Cap Above Brine Reservoir (Heru Berian Pratama and Nenny Saptadji-Geothermal ITB) **[042]** | Resistivity Method for Hydrothermal System Analyze in Way Ratai Geothermal Field (Widia A. and Bagas S.-UNILA) **[097]** | Volcanostratigraphy for Supporting Geothermal Exploration (Sutikno Bronto, Juni Yesy Sianipar, and Akhmad Kunio Pratopo,-PSG and Geothermal ITB) **[090]** | Gravity Modelling and Second Vertical Derivative Calculation to Analysis Subsurface Structure at Wayratai Geothermal Prospect Area, Lampung (Taufiq-Univ. Lampung) **[091]** |
| **08:50 – 09:10** | Performance Prediction of Two-Phase Geothermal Reservoir Using Lumped Parameter Model (Famelia Nurlaela and Sutopo-Geothermal ITB) **[121]** | Geophysical Exploration For Geothermal Low Enthalpy Resources In Ungaran Regency, Central Java (Udi Harmoko, Hiska Anggit, Gatot Yulianto, Sugeng Widada, Yusud D.-UNDIP, Semarang State Polytecnic) **[095]** | Volcanolostratigraphic Study in Constructing Volcano Chronology and its Implication for Geothermal Resource Estimation; Case Study Mount Sawal, West Java (Fikri Adam Dermawan, Hibban Hamka, Rully Tri Abdul Malik-Geothermal ITB) **[037]** | Identifying the Distribution of Alteration Zone Using Very Low Frequency Method in Candi Gedong Songo, Ungaran, Semarang, Central Java (Alfianto, A.D., Almas, S.A., Ambariani, S.G., Kurniawan, W.S., Sari, D.P., Suyanto, I - UGM) **[009]** |
| **09:10 – 09:30** | Resource Management using Numerical Modeling and Apparent Productivity Index (William L. Osborn, Dennis Kaspereit, William Rickard, Mary Mann, Magdalena Perez-Geothermal Resource Group, Momotombo Power Company) **[115]** | Literature Review Of Radar Remote Sensing Combined With Continuous GPS Measurements For The Monitoring Of Deformations Of Geothermal Fields (Jane Mbogo and Josephat Kebu-Kenya Electricity Generating Company) **[050]** | The Cooling History Of Residual Magma As Heat Source (I G.B. Eddy SUCIPTA and Isao TAKASHIMA-Geological Eng. ITB and Akita Univ Japan) **[112]** | Characterization Of Diwak-Derekan Geothermal System Using Magnetotelluric Data (Agung Wibawa, Udi Harmoko, Rahmat Gernowo – UNDIP) **[004]** |
| **09:30 – 09:50** | Geothermal Drilling Case History (ISOR) | Micro Earthquake: Principle and Case History for Geothermal Exploration and Exploitation (Andri Dian Nugraha-ITB) | Volcanic, Magmatic and Hydrothermal Gas Discharges (Prof. Tobias Fischer-New Mexico Univ. USA) | Magneto-telluric: Principle and Case History (Wahyu Sri Gutomo – ITB) |
| **09:50 – 10:10** | | | | |
| **10:10 – 10:30** | **COFFEE BREAK** | | | |

| TIME | AUDITORIUM | ROOM 4 | ROOM 5 | ROOM 6 |
|---|---|---|---|---|
| **SESSION** | **GEOCAP**<br>Chairperson: Chris Hecker & Ichwan Elfajrie | **DRILLING**<br>Chairperson: Dimas Taha Maulana & Andhika Akib | **GEOLOGY-GEOCHEMISTRY**<br>Chairperson: Mahesa P. Saputra & Rizki Trisna | **EXPLORATION**<br>Chairperson: Asep Saepuloh & Betseba Br. Sibarani |
| **10:30 – 10:50** | Quantitative Comparison of Two 3-D Resistivity Models of the Montelago Geothermal Prospect (W.A. van Leeuwen, Suryantini, G.P. Hersir-IF Technology, ITB, ISOR) **[096]** | Geothermal Drilling: Principle and Constrained (Bonar Tua Halomoan Marbun-ITB) | Characteristic Of Geothermal Fluid At East Manggarai, Flores, East Nusa Tenggara (Mochamad Iqbal, Niniek Rina Herdianita, Dikdik Risdianto-ITB) **[061]** | Geothermal Exploration Impact In Ground Water Level Case Study: Gedongsongo, Ungaran, Semarang, Jawa Tengah (Annisa Rizqilana, Hafidz Galant Amirul, Anindya Estiandari, Fandy Fahreza-UNDIP) **[015]** |
| **10:50 – 11:10** | Minigeo : Small Scale Geothermal Power for Remote Off-Grid Communities (N. Willemsen, J.H Kleinlugtenbelt, A. Willemsen-IF Technology) **[101]** | | Geochemical Study Of Ampalas Geothermal Area, Mamuju District, West Sulawesi Province (Fithriyani Fauziyyah, , Muhammad Ghassan Jazmi Shalihin, Dede Iim Setiawan, Anna Yushartanti-ITB) **[038]** | The Potential and Development of Way Ratai Geothermal Prospect Area as A Solutions of Electricity Crisis at Lampung Province (Evi Muharoroh-UNILA) **[031]** |
| **11:10 – 11:30** | Hydraulic Fracturing and Coupled Modelling for Geothermal Energy Applications (Peter Fokker-TU Delft) | A Collaborative Engineering Approach To Achieve Success In Geothermal Drilling Application (Yudi Indrinanto, Manuel Centeno Acuna, William Thomas, Michael Ari Dhanto, Agus Ziyad Kurnia, Erik Gunawan Supriatna, Bonar Marbun Noviasta, Donny Trias Ardianto, M.R. Yoan Mardiana-Schumberger) **[116]** | Geothermal Fluid Characteristic Based on Fluid Geochemistry Analysis, Kepahiang, Bengkulu (Novian Triandanu, Agil Gemilang R, Ichsan Alfan, Inge Sukma Y, Sapari Hadian G-UNPAD) **[075]** | Assessing The Possibility Of Enhanced Geothermal System In Western Indonesia (Hendrawan, R. N and Draniswari, W. A-ITB) **[041]** |
| **11:30 – 11:50** | Geothermal Exploration Indonesia by Means of Rock Petrology and Water Geochemistry (Fiorenza Deon-TU Delft) | Drilling Bit Optimization In Supreme Energy Geothermal Exploration Drilling (Bambang S. Roesdyoko, Dodi A. Gauzali, Gilang Rifki A. – Supreme Energy) **[017]** | Analysis on Scaling Problem in Injection Line: A Case from Muara Labuh Geothermal Field, Indonesia (Alfiady, Robi Irsamukhti, Alfianto Perdana Putra, Herwin Azis and Jantiur Situmorang-Supreme Energy) **[117]** | Subsidence Causes, Effects, and Mitigations in Geothermal Field (Akta Sektiawan, Ganung Adi Prasetyo, Dida Patera Adli, Ethis Yuantoro-ITB) **[008]** |
| **11:50 – 12:10** | Geology Structure Identification based on Polarimetric SAR (PolSAR) Data and Field Geological Mapping at Ciwidey Geothermal Field (Ratna Amalia Pradipta, Asep Saepuloh, and Suryantini-ITB) **[079]** | Optimal Geothermal Well Cementing A Case Of Olkaria Geothermal Field (Nahashon Karanja Nzioka-Kenya Electricity Generating Company) **[070]** | Occurrence Of Sarawet Hot-spring: What Affects The Outflow? (Draniswari, W. A and Hendrawan, R. N-ITB) **[111]** | Assessment Thermal Flow Direction of Geothermal Manifestation Based on Temporal Analysis of Temperature Distribution at Pine Forest Park, Tomohon, North Sulawesi (Roy Wenas, Cyrke A.N Bujung-UNIMA) **[131]** |
| **12:10 – 13:30** | **LUNCH** | | | |

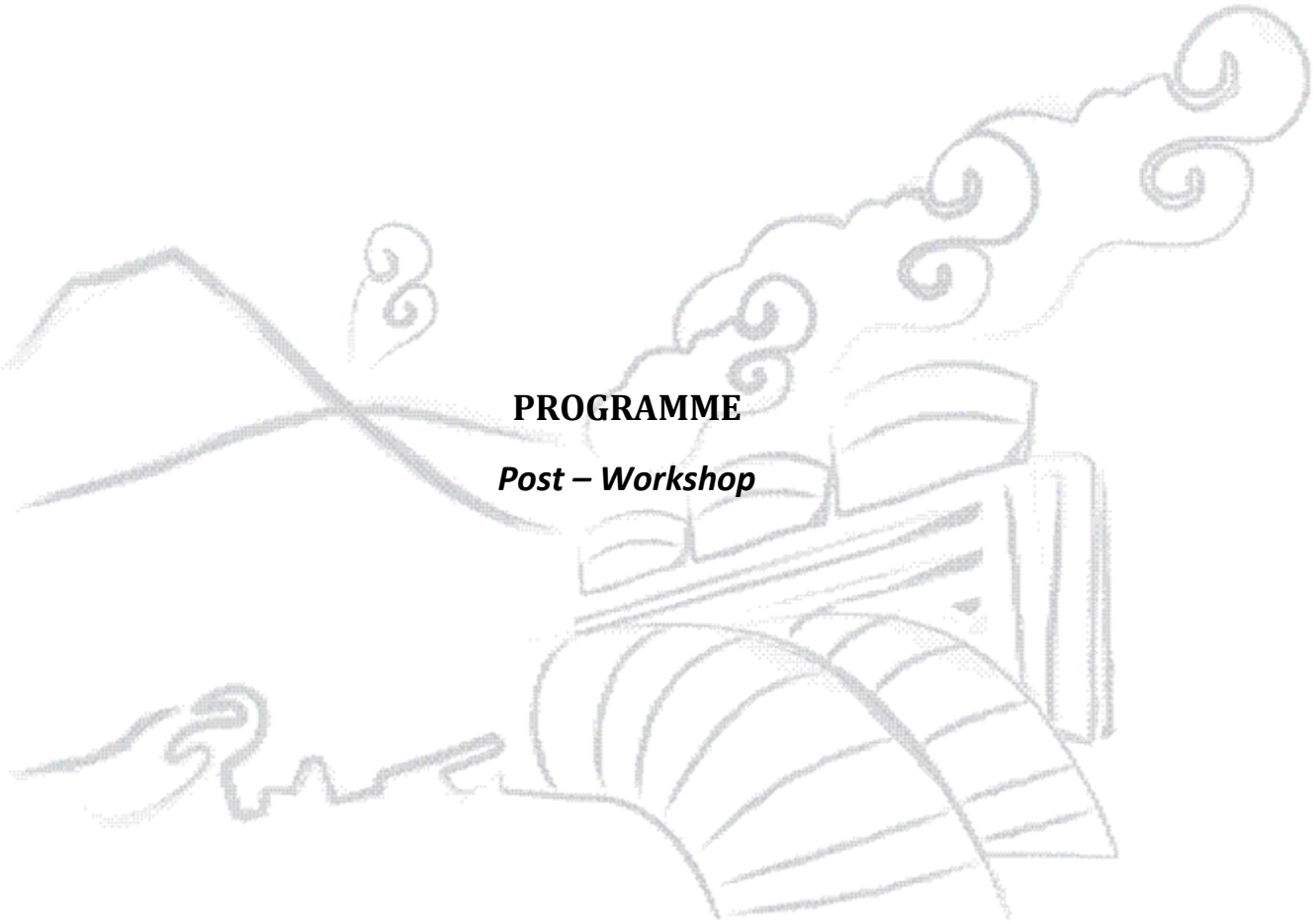
| TIME | AUDITORIUM | ROOM 4 | ROOM 5 | ROOM 6 |
|---|---|---|---|---|
| **SESSION** | **SATREPS**<br>Chairperson: M. Nur Heriawan & Reyno | **ENGINEERING**<br>Chairperson: Sutopo & M. Mirza | **EXPLORATION GEOLOGY**<br>Chairperson: Fiorenza Deon & Yosi Amelia | **EXPLORATION**<br>Chairperson: Anggie Rengganis & Mona Natalia S. |
| **13:30 – 13:50** | Studies Design for BAGUS SATREPS Project (Prof. Katsuaki Koike, Kyoto Univ. Japan) | A Comprehensive Well Testing Implementation During Exploration Phase in Rantau Dedap, Indonesia (Muhammad Tamrin Humaedi, Alfiady, Alfianto Perdana Putra, Rudy Martikno, Jantiur Situmorang-Supreme Energy) **[119]** | Hydrothermal Alteration; Identification and its importance in geothermal exploration and exploitation (Pri Utami-UGM) | 3D Geothermal Conceptual Modeling (Clare Baxter-LEAPFROG) |
| **13:50 – 14:10** | | Numerical Model of Unsteady Two-phase Flow in Geothermal Production Well (Keisuke Yamamura, Ryuichi Itoi, Toshiaki Tanaka, Takaichi Iwasaki-Kyushu Univ, Japan) **[054]** | | |
| **14:10 – 14:30** | Radon Prospecting at Wayang Windu (T. Kubo, and K. Koike, Kyoto Univ. Japan) | On the Feasibility of Geothermal Heat Production from A Hot Sedimentary Aquifer : A Case Study of the Jababeka District, West Java (Nurita Putri Hardiani, Setya Drana Harry Putra – Geothermal ITB) **[134]** | Conceptual Model Of Sorik Marapi Geothermal System Based On 3-G Data Interpretation (Birean D. Sagala, Vicky R. Chandra, and Dorman P. Purba-SORIK MARAPI GEOTHERMAL POWER) **[019]** | Geological, Isothermal, and Isobaric 3-D Model Construction in Early Stage of Geothermal Exploration (Mahesa Pradana Saputra, Suryantini, Danilo Catigtig, Riky Regandara, Sitti Nur Asnin, Angga Bakti Pratama – Geothermal ITB, Emerging Power Inc., Philippiners) **[107]** |
| **14:30 – 14:50** | Hydrogeochemistry Study at Bandung Basin (Andre, Irwan Iskandar, Sudarto N.-ITB) | Mathematical Modelling of Silica Scaling Deposition in Geothermal Wells (Muhammad Nizami and Sutopo-ITB) **[066]** | Use Of Sub-Terrain Technology In Geothermal Exploration (George Barber, Madjedi Hasan and Anton Wahjosudibjo-IEP and PENConsulting) **[122]** | Classifying Hot Water Chemistry: Application Of Multivariate Statistics (Prihadi Sumintadireja, Dasapta Erwin Irawan, Yuano Rezky, Prana Ugiana Gio, Anggita Agustin-ITB, USU) **[114]** |
| **14:50 – 15:10** | Characterizing Geothermal Surface Manifestation Based on Multivariate Geostatistics of Ground Measurement Data (Ishaq, M. Nur Heriawan, Asep Saepuloh-ITB) **[048]** | Decline Curve Analysis in Liquid-Dominated Geothermal Reservoir for Optimizing and Forecasting in Production (Iki Hidayat-ITB) **[044]** | Influence of Hydrothermal Alteration on Petrophysical Properties of Rocks in the Cibolang Area, Bandung (Arif Susanto-ITB) **[132]** | Geology and Prospecting for Hidden Geothermal System of Manglayang Volcano Complex of Bandung-West Java (Subandrio, AS., Sumintadireja, P., Irawan, D., and Suryantini (ITB) **[135]** |

| 15:10 – 15:30 | COFFEE BREAK | | |
|---|---|---|---|
| **TIME** | AUDITORIUM | ROOM 4 | ROOM 6 |
| **SESSION** | **SATREPS – Remote Sensing**<br>Chairperson: Roy Wenas & Akhmad Kunio Pratopo | **DIRECT USE**<br>Chairperson: Jooned H. & Waldy Afuar | **POWER PLANT**<br>Chairperson: Nur Santy Elizabeth & Fuad |
| **15:30 – 15:50** | The Effectiveness of Hydrothermal Alteration Mapping based on Hyperspectral Data under Tropical Region (Reyno Rivelino D.M and Asep Saepuloh-ITB) **[081]** | Experimental Study of Isothermal Plate Uniformity For Blood Warmer Development Using Geothermal Energy (Y. Ichsan, J. Hendrarsakti-ITB) **[098]** | The Development of Integrated Plant Model by Utilizing Wasted Heat in Water-dominated Geothermal Source (Cukup Mulyana, Aswad H. Saad, M. Ridwan Hamdani, Fajar Muhammad-UNPAD) **[022]** |
| **15:50 – 16:10** | Identification of Surface Manifestation at Geothermal Field Using SAR Dual Orbit Data (Dinul Akbari and Asep Saepuloh-ITB) **[024]** | A Preliminary Research Of Direct Contact Geothermal Steam Condensation In The Presence Of Non Condensable Gas (Vivi A, Willy A, Ari D. Pasek, YB. Agastyo N, Candra M. S, Abdurrachim-ITB) **[118]** | Economic And Thermodynamic Analysis For Preliminary Design Of Dry Steam Geothermal Power Plant (GPP) With Multifarious Gas Removal System (GRS) in Kamojang, West Java, Indonesia (A. Damar P, Sihana, Kutut S, Fiki R. S-UGM) **[002]** |
| **16:10 – 16:30** | Identification of Geothermal Fluid Paths at Ground Surface on Segment Tracing Algorithm (STA) of the ALOS PALSAR Data (Haeruddin, Asep Saepuloh, and M. Nur Heriawan-ITB) **[039]** | Geothermal Direct Use Development To Optimize Renewable Energy Utilization For Agricultural, Aquacultural And Tourism Activities In Indonesia (Nicolas Jalu Pangesty, Muhammad Dzulfikri Firdaus, Adidanu Saputra-UNDIP) **[074]** | Energy Optimization Modeling Of Geothermal Power Plant (Case Study: Darajat Geothermal Field Unit III) (Rizal Sinaga-DEL) **[083]** |
| **16:30 – 16:50** | Performance Analysis of Mineral Mapping Method to Delineate Mineralization Zones Under Tropical Region (Muhamad Hardin Wakila, Asep Saepuloh, and M. Nur Heriawan-ITB) **[062]** | Feasibility Of Geothermal Energy Extraction From Non-Activated Petroleum Wells In Arun Field (Muhammad Syarifudin, Kalvin Maurice, Franky Octavius-ITB) **[067]** | |
| **16:50 – 17:10** | **CLOSING CEREMONY (DOOR PRIZE, BEST POSTER AND BOOTH ANNOUNCEMENT)** | | |

## Wednesday-Thursday, March 30-31st 2016

| No. | Paper Title | Paper ID |
|---|---|---|
| 1 | Usage of Zheolite-Chitosan as Impurities Filter to Reducting Corrosion Turbine on Geothermal Plant<br>(**Ainul Yaqin Abror A,Jesica Indah O.Wildan Ichsan S,Risko Pratama Y-UNIBRAW**) | 007 |
| 2 | New Challenges: Feasibility Study of New Drilling and Production Technologies for Offshore Geothermal Resources in Indonesia<br>(**Deni Setiawan, Muhammad Syarif Ali Akbarsyah-ITB**) | 023 |
| 3 | The Functional Shift of Old Central Sumatra Basin as Hydrocarbon Wells to Non-Volcanic Geothermal Field: Optimization Injection Wells and Production Wells as an Effort to Create National Energy Sovereignty<br>(**Djati Wicaksono Sadewo, Nicholas Bastian, Ridwan Chandra, Sekar Indah Tri Kusuma-UNDIP**) | 025 |
| 4 | Integration of MT-CSAMT and Resistivity Log for Determining Geothermal Reservoir Model Based on Convection Heat Energy Transfer<br>(**Faid Muhlis and Risca Listyaningrum-University of Pembangunan Nasional "Veteran" Yogyakarta**) | 032 |
| 5 | Identifying Non-Volcanic Geothermal Potential in Amohola, Southeast Sulawesi Province, By Applying Fault and Fracture Density (FFD) Method<br>(**Fajar Mulyana, Gian E. Tsani, Kiddy Nahli, M. Aulia Alwan, M. Hilman Darojat, Rezky N. Hendrawan-UNPAD**) | 033 |
| 6 | Geothermal System of Mount Ungaran, Central Java, Indonesia: Characterization, Conceptual Model, and Potential<br>(**Ibnu Dwi Bandono Wahyudi-Patra Nusa Data**) | 043 |
| 7 | Repeat Absolute and Relative Gravity Measurements for Geothermal Reservoir Monitoring in Ogiri Geothermal Field, Southern Kyushu, Japan<br>(**Jun Nishijima, Chika Umeda, Yasuhiro Fujimitsu, Jun-ichi Takayama, Naoto Hiraga and Satoru Higuchi-Kyushu University, Japan**) | 051 |
| 8 | Volcanological Approaching for Evaluation of Geothermal Potential in Galunggung Mountain<br>(**Qodri Syahrur Ramadhan, Akhmad Kunio Pratopo, Juni Yesy Sianipar-Geothermal ITB**) | 052 |
| 9 | Characteristic of Geothermal Reservoir Based on Analysis of Surface Manifestation, Fluid Geochemical and Rock Alteration; Case Study of Ungaran Volcano Geothermal Area, Central Java, Indonesia<br>(**Muhammad Afkarul Haq, Farchan Nauval, Nashir Idzharul Huda-UNDIP**) | 063 |

| No | Paper Title | Paper ID |
|---|---|---|
| 10 | The Concept of Steam Field and Geothermal Power Plant (PLTP) Development Plan, Case Study at Mount Rajabasa<br>(**Nanda Hanyfa Maulida and Suharno-UNILA**) | 072 |
| 11 | Estimation of Geothermal Speculative Resource Potential Using Geochemistry Method in East Manggarai Regency, East Nusa Tenggara Province<br>(**Teguh Rahat Prabowo, Muhammad Ghassan Jazmi Shalihin, Aton Patonah, Fithriyani Fauziyyah, Andri Eko Ari Wibowo-UNPAD, ITB, PSDG**) | 093 |
| 12 | Electricity Generation from Hydrothermal Vents<br>(**Yuzar Aryadi, Imam Saiful Rizal, and Muhammad Nur Fadhli-ITB**) | 099 |
| 13 | Design of Tomato Drying System by Utilizing Geothermal Brine<br>(**Afuar Waldy, Sibarani Betseba, Abdurrahman Gugun, J. Hendarsakti-Geothermal ITB**) | 104 |
| 14 | Contamination of Thermal Water to Groundwater in Kertasari Area, Bandung<br>(**Arif Susanto, Suryantini, Joshua Satriana, Munib Ikhwatun Iman, Noriyoshi Tsuchiya-ITB, Badan Geologi, Tohoku Univ, Japan**) | 133 |
| 15 | Natural State Modelling in Hululais Geothermal Field Based on Exploration Data<br>(**Pudyo Hastuti, Sutopo and Marihot Silaban-Pertamina Geothermal Energy and ITB**) | 129 |
| 16 | A Comparison Analysis between Russel James Equation and Hiriart Equation in Horizontal Discharge Lip Pressure for Production Test at Geothermal Well Using Statistical Method<br>(**Muhammad Nizami-ITB**) | 065 |



**PROGRAMME**

***Post – Workshop***

## Field Trip

### Friday, April 1st 2016

The Patuha geothermal system is a vapor-dominated reservoir located about 40 kilometers southwest of Bandung on western Java, Indonesia. The geothermal system consists of a cap rock, an underlying steam cap and a deep liquid-dominated reservoir. The reservoir is provided with heat by a main heat source below Kawah Putih and the Patuha volcano. The flow of fluid takes place through fault zones and in the low permeability reservoir rock. . The first Unit (55 MW) at Patuha was completed in 2014 and since 2015 it has been producing at full capacity (with an availability rate of over 98%).

**Purpose**

This one full day field trip to Patuha Geothermal Plant provides an introduction to geothermal resources and their utilization. The trip may include visits to Patuha Power Plant, Steam Field, Surface Facilities and observations to the surface features/manifestations of the Patuha thermal areas.

**Transportation**

We will provide participants with mini-buses for mobilization purposes. Participants will not drive their own vehicles to and from the destined locations. The provided buses will depart from Bandung on April 1st morning to Patuha Geothermal Plant.

**Instructors**

The Field Trip will be guided and instructed by the lectures and graduate students of the ITB along with Geo Dipa representatives.

**Run Down:**

| **April 1st , 2016** | |
|---|---|
| 05.45-06.00 | Gather at ITB campus gate |
| 06.00-08.00 | Travel to PT. Geodipa (Patuha) |
| 08.00-09.00 | Safety Induction |
| 09.00-09.15 | Coffee Break |
| 09.15-11.30 | Introduction about power plant from PT. Geodipa |
| 11.30-13.00 | Break and Lunch |
| 13.00-17.00 | Trip to power plant |
| 17.00-19.00 | Travel to Bandung (ITB) |

## Field Camp

### Friday-Saturday, April 1st-2nd 2016

**What you will learn?**

The participant will learn the full circle of applied geochemical work for geothermal survey. This includes the theory on geothermal geochemistry, the practical work on collecting samples, carry out the laboratory analyses, interpret the results and presenting the data.

**What are the activities?**

During 2 days program, the participant will stay one night in Geothermal Field Campus at Lembang about 5 km south of Tangkuban Perahu Volcanoe, have class acticities in the camp, visit the Tangkuban Perahu Geothermal Surface Manifestation and visit Thermochem Lab Facilities. The program cover class activities such as theory, data analysis and data presentation, and practical field to collect gas and water samples, and analyze the samples at the Thermochem Laboratory.

**Who should attend**

Earth scientist interested in geochemical survey such as geologist, geochemist, chemist, field sampling operator, environmental scientist, or just beginner learn about geochemical sampling and survey in particular for geothermal.

**Purpose**

In particular, the goal of geothermal field camp is to provide participants with basic knowledge and practical field techniques of geothermal exploration. These skills would be complemented by basic data collection, sampling and theoretical data analysis that is fundamental for any interpretation and assessment of reservoir potential.

All exercises will be completed in Domas Crater and Ratu Crater, in which these fields allow the integration of field based structural geological analysis, observation and sampling of geothermal manifestations as hot springs and sinters and also ultimately of structural geology and surface geochemistry. This program introduces basic methods used in exploration geology to study both, fault and fracture systems and fluid chemistry to give a better understanding of the selective fluid flow along certain fractures and faults. Field geology covered the systematic measurement of faults and fractures, fault plane and fracture population analysis. In addition, field hydro-geochemistry focused on sampling techniques and field measurements onsite.

**Transportation & Accommodation**

We will provide participants with vans for mobilization purposes. Participants will not drive their own vehicles to and from camp locations. The provided vans will depart from Bandung on April 1st evening to stay overnight at the geothermal campus located in Lembang (± 45 km from Bandung) soon after the workshop closing ceremony. The field camp participants will return to Bandung on April 2nd evening.

**Instructors**

The field camp courses are taught by Prof. Tobias Fischer from New Mexico University, USA, the lecturers and graduate students of the ITB Geothermal Magister Degree Program: Instructor to participant ratios is ~ 4:1.

**Run Down:**

| **Day – 1 ( April 1st , 2016)** | |
|---|---|
| 06.00-06.30 | Gather at ITB campus gate |
| 06.30-07.30 | Travel to Geothermal Field Campus, Lembang |
| 08.00-10.00 | Morning class lecture: Geothermal Geochemistry |
| 10.00-11.00 | Travel to Tangkuban Perahu Volcano |
| 11.00-12.30 | Observation of Ratu and Upas Crater, Friday Praying for Moeslem, Lunch |
| 12.30-13.00 | to Domas Crater |
| 13.00-17.00 | Practical : collect gas samples at Fumaroles in Domas Crater , collect water samples, alteration observation |
| 17.00-18.00 | to Geothermal Field Campus Lembang |
| 18.00-19.00 | Private time |
| 19.00-20.00 | Dinner |
| 20.00-21.00 | Night discussion and lecture |

| **Day – 2 ( April 2nd , 2016)** | |
|---|---|
| 07.00-08.00 | Travel to Thermochem Lab (Participant bring all the lugage, we will not go back to Lembang field campus) |
| 08.00-12.00 | Practical : using Gas Chromatrography, and other facilities at Thermochem Laboratory |
| 12.00-13.00 | Lunch Break |
| 13.00-16.00 | Data Interpretation and Presentation |
| 16.00-16.30 | Closing of the field camp program |
| 16.30-18.00 | Travel to Bandung (ITB) |

# COMMITTEE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Nenny Miryani Saptadji and Staff of Geothermal Technology Study Program, FTTM-ITB, Antonie de Wilde (SATE PTE LTD - Singapore)

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### Field Trip & Field Camp
Qodri Syahrur Ramadhan, Silvester Dimas Sanjaya, Mahesa Pradana, Ratih Nurruhliati

### Exhibition
Mahesa Pradana Nawie, Rully Tri Abdul Malik

### Logistic
Qodri Syahrur Ramadhan, Welly Todheus, Fhandy Pandey

# DOCUMENTARY PICTURES


Participant at Pre Workshop 1:
Geothermal Drilling and Negotiating Integrated Drilling Services Contract.


Speaker and Participant at Pre Workshop 2:
Environmental Assessment, Risk Analysis, and Project Decision

Mr. Ali Ashat as Speaker with participant at Pre Workshop 3:
Geothermal for Everyone


One of Plenary Session at 5th ITB International Geothermal Workshop 2016.

Participant at 5th ITB International Geothermal Workshop 2016.


Lecture from Prof. Tobias Fischer as invited speaker


The entire Field Trip participants at Patuha Power Plant.


All participants and Instructos at Domas Crater.

Prof. Tobias Fischer as Instructor at Thermochem.

Mrs. Suryantini as Chairman of 5th ITB International Geothermal Workshop 2016 with Mrs. Miranti as Director of Thermochem.


Exhibition booth


5th ITB International Geothermal Workshop 2016.