Welcome

It is a great pleasure and honor to welcome you to the 12th SEGJ International Symposium being held from November 18 to 20, 2015. Since its first symposium held in 1990, the SEGJ International Symposium has been a biennial event and has provided unique opportunities to deepen international networks in the field of applied geophysics. With more than 200 delegates from over 20 countries, the eleventh International Symposium held in 2013 was a great success. This year, under the theme of "Geophysical Imaging and Interpretation", the symposium aims to share, discuss, and explore most recent results and ideas, and new directions in applied geophysics.

Jun Matsushima

Jun Matsushima
General Chairperson
The University of Tokyo

Organizing Committee

Chair:

Jun Matsushima (The University of Tokyo)

Committee Members:

Tadanori Goto (Kyoto University)
Kohichi Hayashi (GEOMETRICS)
Nobuyasu Hirabayashi (Schlumberger)
Koji Kashihara (JAPEX)
Osamu Osawa (Schlumberger)
Takao Nibe (JGI)
Yoshinori Sanada (JAMSTEC)
Koya Suto (Terra Australis Geophysica)
Chisato Konishi (OYO Corporation)

Acknowledgement

We are grateful to the supporting societies and the people who served as reviewers of the papers. This conference was supported by JSPS KAKENHI Grant Number 15HP0305.

Instructions for Authors

◆ Language

The official language of the Symposium is English.

◆ Oral Presentations

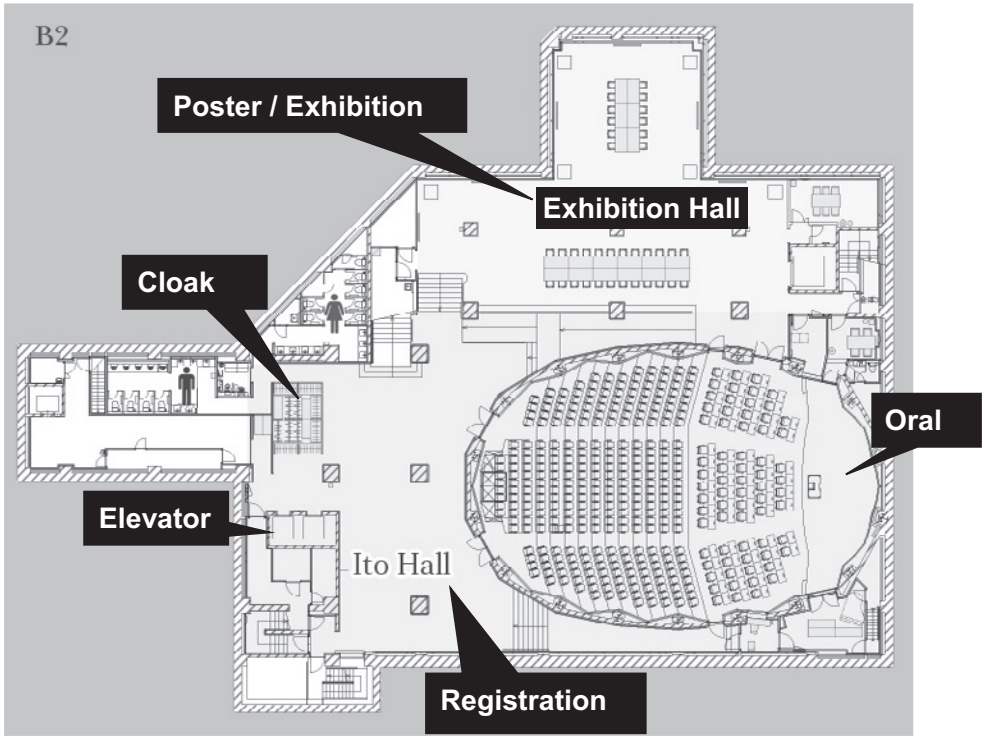
Oral presentations should be 15 minutes in length with 5 additional minutes allotted to each presenter for questions. A set of PC and LCD projector is available for presentation. The staff helps you to copy your Power Point file to the provided PC before your session starts. CD-ROMs and USB thumb drives are available. Checking your file preceding your presentation is strongly recommended. In case you use your own PC, an auxiliary cable and a display switch is provided. Be sure to connect your PC before your presentation time starts.

◆ Poster Presentations

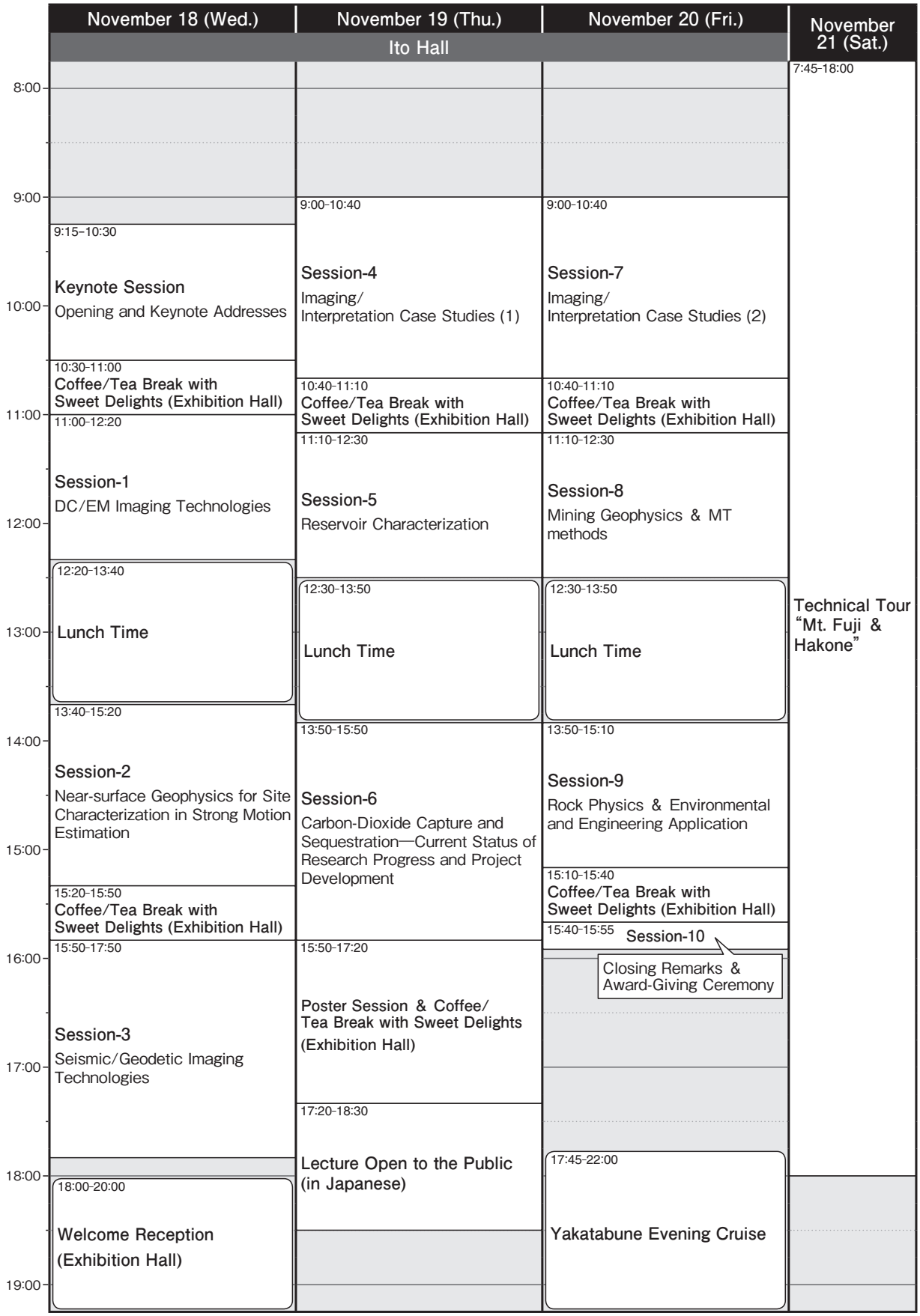
The poster panel of 90 cm in width and 200 cm in height are arranged in the poster presentation room. Put your posters on the panel under your presentation ID label at least before the poster core time. All the presenters are required to stay in front of their posters during the core time. Materials needed to put the posters onto the boards are available in the room. The posters should be displayed during the symposium, from 18th to 20th and should be removed by 13：00, 20th.

Venue Overview

Ito International Research Center



Program at a Glance



PROGRAM

November 17 (Tue.)

EAGE Education Tour (EET) 9, Satellite InSAR Data: Reservoir Monitoring from Space

Seminar Room 3F　9:00 – 17:00

○ Alessandro Ferretti

Tele-Rilevamento Europa - Milan, Italy

November 18 (Wed.)

Registration Opens

Ito Hall 8:00 –

Exhibition Hall Open

Exhibition Hall 9:30 – 17:00

Keynote Session

Ito Hall 9:15 – 10:30

Opening and Keynote Addresses

Chair: Jun Matsushima (Univ. of Tokyo)

【9:15 – 9:30】

Welcome and Keynote Address (SEGJ)

○ Hideki Saito

OYO Corporation

【9:30 – 9:45】

Keynote Address (SEG)

○ John Bradford

Boise State University

【9:45 – 10:00】

Keynote Address (HAGI)

○ Dick Rahmadi

SKK Migas

【10:00 – 10:15】

Keynote Address (AOGS)

○ Prabir Kumar Patra

JAMSTEC

【10:15 – 10:30】

Keynote Address (ASEG)

Coffee/Tea Break with Sweet Delights

Exhibition Hall 10:30 – 11:00

Session -1　　Ito Hall　11:00 – 12:20

DC/EM Imaging Technologies

Chairs: Masashi Endo (TechnoImaging)

Yoshihiro Yamashita (OYO Corporation)

【11:00 – 11:20】

S1-1 **3-D inversion of marine magnetotelluric data using unstructured tetrahedral mesh**

○ Yoshiya Usui

Tokyo Institute of Technology

【11:20 – 11:40】

S1-2 **Advanced methods of 3D inversion of towed streamer EM data for imaging offshore hydrocarbon reservoir**

Michael Zhdanov[1], ○ Masashi Endo[2], Johan Mattsson[3]

[1]TechnoImaging, U of U

[2]TechnoImaging

[3]PGS Technology AB

【11:40 – 12:00】

S1-3 **The characteristic and practical issue of resistivity measurement by multiple-current injection based on CDMA technique**

○ Yoshihiro Yamashita[1], Francois Lebert[2]

[1]OYO Corporation

[2]BRGM

【12:00 – 12:20】

S1-4 **Development of the multi-channel Electromagnetic survey system for geotechnical applications**

○ Takayuki Kobayashi[1], Koichi Hayashi[1], Douglas Groom[2], Fei Wang[2]

[1]OYO Corporation USA

[2]Geometrics Inc

Lunch Time

12:20 – 13:40

Session -2　　Ito Hall　13:40 – 15:20

Near-surface Geophysics for Site Characterization in Strong Motion Estimation

Chairs: Hiroaki Sato (CRIEPI)
Seiji Tsuno (RTRI)

【13:40 – 14:00】

S2-1 **Microtremor array exploration of shallow S-wave velocity structure in the vicinity of Tachikawa-Fault**

○ Kazuhiro Seita[1], Kosuke Chimoto[1], Koichiro Saguchi[1], Seiji Tsuno[2], Hiroaki Yamanaka[1]
[1]Titech
[2]RTRI

【14:00 – 14:20】

S2-2 **Site conditions of strong motion observation sites inside the Kathmandu Valley, Nepal**

○ Nobuo Takai[1], Michiko Shigefuji[1], Subeg Bijukchhen[1], Kosuke Sawada[2], Masayoshi Ichiyanagi[1], Sudhir Rajaure[3], Megh Dhital[4], Tsutomu Sasatani[1]
[1]Hokkaido University
[2]Obayashi-Corporation
[3]Dept. of Mines and Geology
[4]Tribhuvan University

【14:20 – 14:40】

S2-3 **Observation of microtremors and earthquake ground motion of aftershocks of 2014 Northern Nagano earthquake for estimation of site amplification**

○ Hiroaki Yamanaka[1], Kosuke Chimoto[1], Seiji Tsuno[2], Koichiro Saguchi[3], Hitoshi Morikawa[1], Kahori Iiyama[1], Hiroyuki Goto[4]
[1]Tokyo Institute of Technology
[2]Railway Technical Research Ins
[3]Nuclear Regulation Authority
[4]Kyoto University

【14:40 – 15:00】

S2-4 **Noninear site amplification at CCHG observed by strong ground motions during the 2011 off the Pacific coast Tohoku Earthquake**

○ Kohei Tanaka[1], Seiji Tsuno[1], Hiroaki Yamanaka[2], Kosuke Chimoto[2], Makoto Kamiyama[3], Shun'ichi Kataoka[4]
[1]RTRI
[2]Tokyo Institute of Technology
[3]Tohoku Institute of Technology
[4]Hirosaki Uniersity

【15:00 – 15:20】

S2-5 **Investigation on source azimuthal dependence for amplifications of long-period ground motions in the Kanto basin**

○ Masanori Noyori[1], Kosuke Chimoto[1], Seiji Tsuno[2], Hiroaki Yamanaka[1]

[1]Tokyo Institute of Technology

[2]RTRI

Coffee/Tea Break with Sweet Delights

Exhibition Hall 15:20 – 15:50

Session -3

Ito Hall 15:50 – 17:50

Seismic/Geodetic Imaging Technologies

Chairs: Takao Nibe (JGI)

Mikiya Yamashita (JAMSTEC)

【15:50 – 16:10】

S3-1 **Characterization of near-surface heterogeneity by integrating surface-wave phase velocity and attenuation**

○ Tatsunori Ikeda, Takeshi Tsuji

WPI-I2CNER, Kyushu University

【16:10 – 16:30】

S3-2 **Local angle domain migration for image improvements and its application to HTI fracture characterizations**

○ Karl Hosgood, Masako Robb, Zvi Koren

Paradigm Geophysical

【16:30 – 16:50】

S3-3 **Surface displacements of the Kanto plain, Japan, and subsurface structure: insight from persistent scatterer SAR interferometry**

○ Kazuya Ishitsuka[1], Pau Prats-Iraola[2], Matteo Nannini[2]

[1]Fukada Geological Institute

[2]German Aerospace Center

【16:50 – 17:10】

S3-4 **Investigation of shallow geological condition: application of tomographic seismic refraction survey in Bojonegoro, East Java, Indonesia**

○ Riskiray Ryannugroho[1], M. Rachmat Sule[1], Adree Octova[2]

[1]Institut Teknologi Bandung

[2]Universitas Negeri Padang

【17:10 – 17:30】

S3-5 **Implementation of non uniform memory address (NUMA) parallel computation in order to speed up the common reflection surface (CRS) stack optimization process**

○ Fernando Lawrens, Aditya Jiwandonoi, Rachmat Sule

Institut Teknologi Bandung

【17:30 – 17:50】

S3-6 **High-resolution velocity model building for a complex shallow overburden using reflection, refraction and multiple arrivals from dual-sensor streamer data**

Mazin Farouki[1], Grunde Ronholt[1], J.E. Lie[2], Oystein Korsmo[1], B. Danielsen[1], Sverre Brandsberg-Dahl[1], Samuel Brown[1], Alejandro Mavilio[1], Nizar Chemingui[1], ○Shinya Sakamoto[1]

[1]PGS

[2]Lundin Norway

Welcome Reception

Exhibition Hall 18:00 – 20:00

November 19 (Thu.)

Registration Opens

Ito Hall 8:00 –

Exhibition Hall Open

Exhibition Hall 9:00 – 17:00

Session -4

Ito Hall 9:00 – 10:40

Imaging/Interpretation Case Studies (1)

Chair: Chisato Konishi (OYO Corporation)

【9:00 – 9:20】

S4-1 **Integrated geological interpretation of HeliFALCON airborne gravity gradiometer data and HELITEM electromagnetic and magnetic data for geothermal exploration in the Kujyu area, Kyushu, Japan**

○ Jurriaan Feijth[1], Jackie Hope[1], Carlos Cevallos[1], Satoshi Machida[2], Junichi Kuwamura[3]

[1]CGG Multiphysics

[2]Sumiko Resources Expl. & Dev.

[3]Fugro Japan

【9:20 – 9:40】

S4-2 **Using FALCON airborne gravity gradiometry for oil and gas exploration: Recent case studies**

○ Simon Wetherley, David Moore

CGG

【9:40 – 10:00】

S4-3 **Large-scale 3D inversion of magnetotelluric data**

○ Masashi Endo[1], Martin Cuma[2], Alexander Gribenko[2], Michael Zhdanov[3]

[1]TechnoImaging

[2]TechnoImaging, U of U

[3]TechnoImaging, U of U, MIPT

【10:00 – 10:20】

S4-4 **3D inversion of HELITEM data in geothermal area, Japan**

○ Shunsuke Nogami[1], Masashi Endo[2], Leif H Cox[2], Junichi Kuwamura[3], Akihiko Chiba[1]

[1]SRED

[2]TechnoImaging

[3]Fugro Japan

【10:20 – 10:40】

S4-5 **Geophysical integrated survey result of ancient Turkic tombs in Bulgan province, Mongolia**

○ Tseedulam Khuut[1], Ochir Ayudai[2], Takayuki Kawai[3], Ichinkhorloo Byanmunkh[1], Batsukh Khuut[1]

[1]MUST

[2]Mongolian Academy of Science

[3]Niigata University

Coffee/Tea Break with Sweet Delights

Exhibition Hall 10:40 – 11:10

Session -5

Ito Hall 11:10 – 12:30

Reservoir Characterization

Chair: Koji Kashihara (JAPEX)

【11:10 – 11:30】

S5-1 **Geothermal reservoir characterization monitoring with poisson's ratio uses MEQ data in X Field, South Sumatra**

○ Yuanita Devyi, Marhendra Putri, Erpin Habibah

Gadjah Mada University

【11:30 – 11:50】

S5-2 **Energy-weighted AVO: a new AVO attribute**

○ Mohammed Farfour, Wang Jung Yoon

Chonnam National University

【11:50 – 12:10】

S5-3 **Identification of reservoir zones in geothermal field based on Vp, Vs and Vp/Vs**

○ Bambang Mujihardi[1], Andri D. Nugraha[2], Sri Widiyantoro[2], Djedi S. Widarto[1], Artini Sukotjo[1]

[1]PT. Pertamina

[2]ITB

【12:10 – 12:30】

S5-4 **Assessment of geopressure in the upper Oligocene Shale of the Cuu Long Basin by conventional and fuzzy methods**

○ Pham Huy Giao

Asian Inst. of Technology

Lunch Time

12:30 – 13:50

Session -6 Ito Hall 13:50 – 15:50

Carbon-Dioxide Capture and Sequestration—Current Status of Research Progress and Project Development

Chair: Ziqiu Xue (RITE)

【13:50 – 14:10】

S6-1 **P-wave velocity in CO2/brine saturated ultra-low-permeability rock**

○ Yi Zhang, Hyuck Park, Osamu Nishizawa, Takuma Ito, Ziqiu Xue

RITE

【14:10 – 14:30】

S6-2 **Fluid flow simulations for the safety injection of carbon dioxide in Gundih CCS site, Indonesia**

○ Kyosuke Onishi[1], Duc Tam Nguyen[1], Hikari Fujii[1], Takeshi Tsuji[2], Masami Hato[3], Toru Takahashi[4], Toshifumi Matsuoka[4], Mohammad Rachmat Sule[5], Wawan Gunawan A. Kadir[5]

[1]Akita University

[2]Kyushu University

[3]Waseda University

[4]Fukada Geological Institute

[5]ITB

【14:30 – 14:50】

S6-3 **Pilot study carbon capture and storage (CCS) in Indonesia: planning for the CCS pilot facilities at Gundih field**

○ C.B. Rasrendra[1], H.B.A Suprapto[1], H. Prabowo[2], D. Sasongko[3], R. G. Dewi[1], L. Mucharam[1], B. Marbun[1], A. Indarto[1]

[1]Institut Teknologi Bandung

[2]UTC Pertamina

[3]Pertamina EP

【14:50 – 15:10】

S6-4 **Simulation of time lapse seismic for CO2-injection monitoring: preliminary result**

○ Rachmat Sule[1], Ariesty Asikin[1], Awali Priyono[1], Takeshi Tsuji[2], Sigit Raharjo[3]

[1]ITB

[2]Kyushu University

[3]UTC Pertamina

【15:10 – 15:30】

S6-5 **Geological characteristic and fault stability of the Gundih CCS pilot project at Central Java, Indonesia**

○ Benyamin Sapiie[1], Harya Danio[1], Awali Priyono[1], Ariesty Ratna Asikin[1], Djedi S Widarto[2], Eko Widianto[3], Takeshi Tsuji[4]

[1]Institut Teknologi Bandung

[2]UTC PERTAMINA

[3]Trisakti University

[4]Kyushu University

【15:30 – 15:50】

S6-6 **Time-domain electromagnetic (TDEM) baseline survey for CCS in Gundih area, Central Java, Indonesia**

○ Wahyu Srigutomo[1], Warsa Warsa[1], M. Rachmat Sule[1], Akira Saito[2], Keiko Nakayama[2], Masami Hato[2], Trimadona Trimadona[1], Donny Prasetyo[1], Djedi S. Widarto[3]

[1]Bandung Institute of Tech.

[2]Waseda University

[3]Pertamina UTC

Poster Session & Coffee/Tea Break with Sweet Delights

Exhibition Hall 15:50 – 17:20

Lecture Open to the Public (in Japanese) Ito Hall 17:20 – 18:30

Exploration geophysicist as a doctor of the Earth

○ Kouichi Suzuki

The Central Research Institute of Electric Power Industry

November 20 (Fri.)

Registration Opens

Ito Hall 8:00 –

Exhibition Hall Open

Exhibition Hall 9:00 – 17:00

Session -7

Ito Hall 9:00 – 10:40

Imaging/Interpretation Case Studies (2)

Chair: Tadanori Goto (Kyoto Univ.)

【9:00 – 9:20】

S7-1 **Optimization of imaging the marine seismic data including CCS expected area: a case study offshore Korea**

○ Taeyoun Kim[1], Seonghyung Jang[2]

[1]UST

[2]KIGAM

【9:20 – 9:40】

S7-2 **Interpretation of electrical resistivity tomography monitoring data of the Boguchan hydroelectric power plant rockfill dam**

○ Evgeny Zerkal

Lomonosov Moscow State University

【9:40 – 10:00】

S7-3 **A case study of soil type identification for levee structure by electric survey with unified cone field test**

Mamoru Mimura[1], ○Yoshinori Iwasaki[2], Koichi Nakagawa[3], Akira Jomori[4], Mitsugu Yoshimura[5], Masaaki Fujiwara[2], Masanori Uno[1]

[1]Kyoto Univ.

[2]Geo Research Inst.

[3]Osaka City Univ.

[4]Neo Science

[5]Soil & Rock Eng.

【10:00 – 10:20】

S7-4 **Application of fine-tuned interval velocity model In Rengasdengklok, West Java, Indonesia**

○ Tania Meidiana, Mochamad Razi

Pertamina EP Asset 3

【10:20 – 10:40】

S7-5 **Fracture imaging of a sabo dam by a debris flow by means of GPR and high-resolution seismic survey**

○ Hiroshi Kisanuki[1], Kunio Aoike[2], Hideki Saito[2], Tomio Inazaki[1], Takeshi Shimizu[1], Hiroaki Izumiyama[1], Naoki Fujimura[1]

[1]PWRI

[2]OYO

Coffee/Tea Break with Sweet Delights

Exhibition Hall 10:40 – 11:10

Session -8

Ito Hall 11:10 – 12:30

Mining Geophysics & MT methods

Chair: Shinya Sakanaka (Akita Univ.)

【11:10 – 11:30】

S8-1 **Integration of downhole data sources with different resolution for improved boundary detection**

○ Katherine L Silversides, Arman Melkumyan

University of Sydney

【11:30 – 11:50】

S8-2 **Scenario to optimize nickel laterite exploration using ERT with gradient configuration**

○ Sabrianto Aswad[1], Yudi Surawan[1], Muhammad Altin Massinai[1], Wanni[2]

[1]Hasanuddin University

[2]Vale Indonesia Inc

【11:50 – 12:10】

S8-3 **Large fractures mapping around tunnels by detailed 3D seismic imaging**

○ Nicoleta Enescu, Calin Cosma

Vibrometric Oy

【12:10 – 12:30】

S8-4 **Accuracy evaluation of MT response calculated with particle method and higher-order particle method using the Taylor expansion**

○ Keiichi Ishizu, Tadanori Goto

Kyoto University

Lunch Time

12:30 – 13:50

Exhibiton Hall -Exhibitor Move-out and Tear down

Exhibition Hall　13:00 – 17:00

Session -9　　Ito Hall　13:50 – 15:10

Rock Physics & Environmental and Engineering Application

Chair: Tatsunori Ikeda (Kyusyu Univ.)

【13:50 – 14:10】

S9-1　Three-Dimensional magnetic resonance sounding tomography

○ Warsa Warsa, Hendra Grandis, Wahyudi W Parnadi

Institut Teknologi Bandung

【14:10 – 14:30】

S9-2　A practical method of nation wide Vs30 mapping with 250m grids for developing countries by automated topographical classification and published data in Japan

○ Sugio Imamura[1], Akihiro Furuta[2]

[1]CTGK ltd.

[2]ORCG co.

【14:30 – 14:50】

S9-3　Estimation of s-wave velocity and attenuation anisotropy from sonic waveform logs in methane hydrate bearing sediments

○ Jun Matsushima

Univ. of Tokyo

【14:50 – 15:10】

S9-4　Representation of the resistivity model using volume fraction of porous clay

○ Chisato Konishi

OYO Corporation

Coffee/Tea Break with Sweet Delights

Exhibition Hall　15:10 – 15:40

Session -10　　Ito Hall　15:40 – 15:55

Closing Remarks & Award-Giving Ceremony

Chair: Jun Matsushima (Univ. of Tokyo)

【15:40 – 15:50】

Award-Giving Ceremony

○Hideki Saito

OYO Corporation

【15:50 – 15:55】

Closing Remarks

○Hideki Saito

OYO Corporation

Yakatabune Evening Cruise

17:45 – 22:00

November 21 (Sat.)

Technical Tour “Mt. Fuji & Hakone”

7:45 – 18:00

Poster Session　Exhibition Hall　15:50 – 17:20

P1 **Experimental monitoring of CO2 drainage and brine imbibition in sandstone by complex electrical impedance and X-ray CT imaging**

○ Yi Zhang, Hyuck Park, Tamotsu Kiyama, Osamu Nishizawa, Ziqiu Xue
RITE

P2 **Experimental stidy of two-phase fluid flow in the porous sandstone by P-wave velocity and electrical Impedance measurement**

○ Keigo Kitamura, Hiroyuki Honda, Sinnosuke Takaki, Yasuhiro Mitani
Kyushu University

P3 **Repeat micro-gravity measurements using A10 absolute gravimeter for CO2 injection monitoring in Gundih gas field, Central Java, Indonesia**

○ Jun Nishijima[1], Yoichi Fukuda[2], Yayan Sofyan[3], Matomu Itakura[2], Eko Wahyudi[4], Toshifumi Matsuoka[2]
[1]Kyushu University
[2]Kyoto University
[3]University of Indonesia
[4]Bandung Institute of Technology

P4 **Application of microtremor exploration to shallow dipping layers under the assumption of horizontally stratified structure**

○ Kyosuke Okamoto[1], Seiji Tsuno[1], Naoyasu Iwata[1], Kimitoshi Sakai[1], Kohei Tanaka[1], Atsuhiro Usami[2], Kaoru Kobayashi[3], Masaya Hirabayashi[3]
[1]RTRI
[2]RTRI (present at JCC)
[3]JR-East

P5 **Estimation of deep s-wave velocity structures from microtremor array measurements in Zeytinburnu and Tekirdag, Turkey**

○ Kosuke Chimoto[1], Ozlem Karagoz[1], Seckin Citak[2], Oguz Ozel[3], Hiroaki Yamanaka[1], Ken Hatayama[4]
[1]Tokyo Tech
[2]JAMSTEC
[3]IU
[4]NRIFD

P6 **Detailed spatial variation of short-period earthquake ground motion in the vicinity of Tachikawa-Fault**

○Seiji Tsuno[1], Kosuke Chimoto[2], Koichiro Saguchi[2], Hiroaki Sato[3], Shinichi Matsushima[4], Michiko Shigefuji[5], Nobuo Takai[5], Tatsuo Kanno[6], Hiroaki Yamanaka[2], Hiroshi Kawase[4]

[1]RTRI

[2]Tokyo Tech.

[3]CRIEPI

[4]Kyoto Univ.

[5]Hokkaido Univ.

[6]Kyusyu Univ.

P7 **Characteristics of seismic wave attenuation in rock with velocity fluctuation based on deep borehole array observation**

○Hiroaki Sato[1], Naoki Nishizaka[2], Shunsuke Suzuki[2], Kozo Ohnishi[2], Yoshihiko Ishikawa[2], Shinichi Matsuzaki[2]

[1]CRIEPI

[2]Shikoku Electric Power Co. Inc.

P8 **Use of multiple core lengths and travel times to calculate propagation velocity in laboratory measurements**

○Kyosuke Onishi, Kazushi Yoshizawa, Hiroyuki Kosukegawa, Hikari Fujii

Akita University

P9 **Borehole seismic data processing and interpretation using standalone Matlab application**

○Mohammed Farfour, Wang Jung Yoon

Chonnam University

P10 **Tsunami waveform inversion using only observational sites at the vicinity of Tsunami source region: 2011 Tohoku-Oki Earthquake case**

○Satoru Fujihara, Mariko Korenaga, Takahiro Tamiya, Norihiko Hashimoto

CTC

P11 **Parallel computation for speedup the computation time of direct determination of common-reflection-surface (CRS) attribute**

○Fernando Lawrens

Institut Teknologi Bandung

P12 **IP effects on transient electromagnetic responses of deep-sea hydrothermal deposits**

○Hangilro Jang, Wansoo Ha, Hee Joon Kim

Pukyong National University

P13 **3D inversion of gravity data using Cuckoo optimization algorithm**

Reza Toushmalani[1], ○Hakim Saibi[2]

[1]Islamic Azad University

[2]Kyushu University

P14 **Geophysical exploration for skarn-type iron deposits in western Mongolia**

Arvisbaatar Navaanchimed[1], ○ Tseedulam Khuut[2], Byambasuren Turtogtokh[2], Munkhbaatar Sengee[2], Dugaraa Purev[2], Khosbayar Kh[3]

[1]NUM
[2]MUST
[3]Geomaster Engineering LLC

P15 **Toward understanding focal mechanism of hydraulic fracturing induced earthquakes using constrained inversion: method and synthetic tests**

Shuhei Iida, ○ Ahyi Kim

Yokohama City University

P16 **Geological investigations using cosmic ray muons: a trial to detect fault at the Mizunami Underground Research Laboratory**

○ Eiji Sasao[1], Keiichi Suzuki[2], Nobuto Yamada[3], Koji Kuboshima[2]

[1]Japan Atomic Energy Agency
[2]Kawasaki Geological Engin.
[3]Nihonchikatansa

P17 **Clarifying metal-enriched zones in landfills by Induced polarization measurement**

○ Ryuji Yokose[1], Takahiro Ito[1], Masahiro Kurokawa[1], Mutsuo Takeuchi[2], Hirokazu Tanaka[3], Kazuo Kamura[1]

[1]Waseda University
[2]Geo-vest Co. Ltd
[3]FPIOPHES

P18 **Short-range ground deformation measurement by InSAR time-series analysis**

○ Shuichi Rokugawa, Kosuke Nagakubo, Takako Nakamura

Univ. of Tokyo

P19 **Detailed geophysical surveys on an embankment slope of a mountain road for slope stability assessment**

○ Tomio Inazaki[1], Toshiyuki Kurahashi[2], Kei'ichiro Sakanishi[3], Sugio Imamura[4]

[1]PWRI
[2]CERI
[3]Mony
[4]CTGK

P20 **Model tests on quality evaluation procedure for an unsaturation method for liquefaction countermeasures**

○ Hiroshi Nakazawa[1], Koichi Nagao[2], Hisao Hayashi[3], Toshio Takagi[4], Kentaro Tabata[1]

[1]NIED
[2]Advanced Const. Tech. Center
[3]Geo-X Consultants Co. Ltd.
[4]Fukken Co. Ltd.

P21 **A trial extraction of crustal deformation from seafloor hydraulic pressure gauges to estimate interplate coupling for subduction plate boundaries**

○ Keisuke Ariyoshi[1], Akira Nagano[1], Takuya Hasegawa[1], Motoyuki Kido[2], Ryoko Nakata[1], Hiroyuki Matsumoto[1], Naoki Uchida[2], Toshihiro Igarashi[3]

[1]JAMSTEC

[2]Tohoku Univ.

[3]Tokyo Univ.

P22 **Using HeliFALCON airborne gravity gradiometer and HELITEM electromagnetic and magnetic data for geothermal exploration**

○ Jackie Hope[1], Jurriaan Feijth[1], Shane Mule[1], Satoshi Machida[2], Junichi Kuwamura[3]

[1]CGG

[2]SRED

[3]Fugro Japan

P23 **Reflection imaging of oceanic fine structure under strong ocean current in the Izu-Ogasawara region**

○ Mikiya Yamashita[1], Yoshio Fukao[1], Kanako Hasumi[2], Seiichi Miura[1], Shuichi Kodaira[1]

[1]JAMSTEC

[2]Taisei Corporation

P24 **Spectrogram inversion for obtaining large-scale subsurface velocity structure**

○ Jiho Ha, Wookeen Chung, Sungryul Shin

Korea Maritime and Ocean Univ.

P25 **Geophysics surveys in the Villa Antonini, Genzano (Roma)**

○ Fabiola Ragagnin[1], Michele Di Filippo[1], Maria Di Nezza[2]

[1]Sapienza University of Rome

[2]National Institute of Geophysics and Volcanology

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Ito Hall

Session -1 DC/EM Imaging Technologies

S1-1 3-D inversion of marine magnetotelluric data using unstructured tetrahedral mesh

○ Yoshiya Usui
Tokyo Institute of Technology

The finite element method using unstructured tetrahedral elements is one of the most effective methods to correct topographic distortions in the marine magnetotelluric data since it can precisely incorporate the bathymetry into computational grids without using too many elements. However, in relation to marine magnetotelluric problems, the use of he element has been limited to forward calculations. Therefore, the author applied a 3−D inversion scheme using unstructured tetrahedral mesh to a synthetic data of the marine magnetotelluric method and verified its effectiveness. Firstly, to confirm that the 3−D inversion code used can calculate response functions of the marine magnetotelluric method accurately, the forward part of the code was verified using the model incorporating bathymetry, and the verifications showed that the results were almost the same as those of another code. Next, the inversion code using unstructured tetrahedral mesh was applied to the synthetic data affected by sea floor topography. The model had an anomaly of 1 Ohm−m in a 50 Ohm−m homogeneous region. As a result of the inversion, the true resistivity structure was recovered properly. It was therefore confirmed that 3−D inversion using unstructured tetrahedral elements enables us to estimate reliable resistivity structure from the marine magnetotelluric data.

S1-2 Advanced methods of 3D inversion of towed streamer EM data for imaging offshore hydrocarbon reservoir

Michael Zhdanov[1] ○ Masashi Endo[2] Johan Mattsson[3]
[1]TechnoImaging, U of U [2]TechnoImaging [3]PGS Technology AB

The towed streamer EM system makes it possible to collect EM data with a high production rate and over very large survey areas. At the same time, 3D inversion of towed streamer EM data remains a very challenging problem because of the huge number of transmitter positions of the moving towed streamer EM system, and, correspondingly, the huge number of forward and inverse problems needed to be solved for every transmitter position over the large areas of the survey. We overcome this problem by exploiting the fact that a towed streamer EM system's sensitivity domain is significantly smaller than the area of the towed streamer EM survey. We have introduced the concept of a moving sensitivity domain, originally developed for airborne EM surveys, for interpretation of marine EM survey data as well, which makes it possible to invert the entire towed streamer EM surveys with no approximations into high−resolution 3D geoelectrical sea−bottom models. In order to improve the accuracy and reliability of the anisotropic 3D inversion results, we have developed 3D inversion method, which takes into account: 1) the variable background, 2) an a priori model constructed by anisotropic 1D inversion results, seismic data, and well−log data, and 3) bathymetry. We have applied this method to the anisotropic 3D inversion of towed streamer EM data from the Mariner field in the North Sea. The results show that our method can recover a more reliable and reasonable 3D geoelectrical model, and the technology has proven to be fast and efficient for large amounts of towed streamer EM data in a complex geological setting.

S1-3 The characteristic and practical issue of resistivity measurement by multiple-current injection based on CDMA technique

○ Yoshihiro Yamashita[1] Francois Lebert[2]
[1]OYO Corporation [2]BRGM

The method to measure resistivity and IP using multiple, simultaneous current injection method using Code −Division Multiple−Access technique has a characteristic of signal enhancement as same as signal stacking by the number of code length. In this method, we design current waveforms based on regulated combination of codes, +1 or −1 correspond to current polarity. To increase simultaneous current injection point, we need to use longer codes for current waveforms. It means that the more we use simultaneous current injection points, the more data qualities against random noise is improved. We also indicate a practical issue of this method that the instable current injection tends to be occurred when we use some common electrodes for simultaneous injection and it causes considerable measurement error. It is important to control current intensity during a set of injection meanwhile we can compensate this error to a certain extent.

S1-4 Development of the multi-channel Electromagnetic survey system for geotechnical applications

○ Takayuki Kobayashi[1] Koichi Hayashi[1] Douglas Groom[2] Fei Wang[2]
[1]OYO Corporation USA [2]Geometrics Inc

High quality and high density geophysical measurements have become more and more important in the exploration and geotechnical industries in order to make quick and smart decisions for cost reduction, safety practices, etc. For shallow oil and gas exploration, mining, and groundwater investigation, we are occasionally required to acquire higher quality data for large area and required to process faster than traditional methods with lower cost. Traditional electromagnetic survey systems have few channels, so we need to spend many resources to acquire huge data sets to achieve high resolution and high quality resistivity geophysical results. Thus, a new multi−channel 3D electromagnetic survey was developed for the cost effective survey. The system is a distributed system and the maximum channel that can be measured at once is 240. A measured resistivity and phase data obtained by the new system contain less noise and in a good quality. Therefore, the developed system has a capability of conducting 3D survey by much less cost and acquisition time compared to traditional ones.

Session -2 Near-surface Geophysics for Site Characterization in Strong Motion Estimation

S2-1 Microtremor array exploration of shallow S-wave velocity structure in the vicinity of Tachikawa-Fault

○Kazuhiro Seita[1] Kosuke Chimoto[1] Koichiro Saguchi[1] Seiji Tsuno[2] Hiroaki Yamanaka[1]
[1]Titech [2]RTRI

The shallow low velocity layers are responsible to variation of earthquake ground motion amplification in an area. It is important to estimate shear−wave velocity structure in near surface layers for precisely estimating or predicting strong−motion characteristics during an earthquake. Array exploration of microtremors has been gaining much popularity in Vs profiling, because to estimate a Vs structure requires only a simple circular array consisting of a couple of seismometer. If the microtremors are recorded by vertical sensors, they are often regarded to have the dispersive characteristics of Rayleigh waves. S−wave velocity structure was revealed by microtremor explorations in the vicinity of Tachikawa−Fault, Japan for estimation of earthquake ground motion. The survey was done at sites along the survey line across Tachikawa−Fault with separation of about 50m between each site and at spatially distributed sites. The dispersive features of the observed phase velocities of Rayleigh wave show the significant differences across the fault. A 1D S−wave velocity structure was estimated at each site along the line using a hybrid heuristic inversion. The soil models are also different across the fault. The S−wave velocity has a low S−wave velocity layer near the surface in the western part of the fault. The peak amplification factor calculated by the S−wave velocity profile was larger in the west part of the fault where the S−wave velocity of the top layer is lower.

S2-2 Site conditions of strong motion observation sites inside the Kathmandu Valley, Nepal

○Nobuo Takai[1] Michiko Shigefuji[1] Subeg Bijukchhen[1] Kosuke Sawada[2]
Masayoshi Ichiyanagi[1] Sudhir Rajaure[3] Megh Dhital[4] Tsutomu Sasatani[1]
[1]Hokkaido University [2]Obayashi-Corporation [3]Dept. of Mines and Geology [4]Tribhuvan University

On 25 April 2015, the Gorkha earthquake (Mw 7.8) occurred in the Himalayan Range of Nepal. Major damage occurred not only in Nepal, and in neighboring countries. The focal area detected about 200 km long and 150 km wide, with a large slip area under the Kathmandu Valley. The Kathmandu valley, formed with lake similar to Mexico City, consists of thick soft sediment below the center of city. Hence, the Kathmandu city has been damaged not only by near field earthquakes but also far field earthquakes in the past. Three people were killed by a collapsing wall during the 18th September 2011 Sikkim earthquake that occurred over 400 km away from Kathmandu. For the sake of better planning earthquake measures it is the most important thing to understand the strong motion character of the Kathmandu Valley. Therefore we installed strong motion seismometers in four stations to study characteristics site effect of strong ground motion in the Kathmandu valley at September 2011, and we got the records of this large main shock. They have features of near fault strong motion. In this article we introduce our study of site effects in Kathmandu Valley to help understanding the strong motion distribution and damage of this large earthquake.

S2-3 Observation of microtremors and earthquake ground motion of aftershocks of 2014 Northern Nagano earthquake for estimation of site amplification

○Hiroaki Yamanaka[1] Kosuke Chimoto[1] Seiji Tsuno[2] Koichiro Saguchi[3]
Hitoshi Morikawa[1] Kahori Iiyama[1] Hiroyuki Goto[4]
[1]Tokyo Institute of Technology [2]Railway Technical Research Ins [3]Nuclear Regulation Authority
[4]Kyoto University

Heavy damage was experienced in Hakuba village, Nagano prefecture during the 2014 Nagano−ken Hokubu earthquake. In particular many wooden houses were collapsed, in Horinouchi village. Characteristics of ground shaking during the main shock are not known in the village due to no availability of strong motion records. It has been known that this area was suffered in past several earthquakes. This suggests that site amplification may be one of the reasons for the heavy damage during the earthquake. We conducted aftershock observations and microtremor explorations at 13 stations in and around the damaged area to estimate site effects. Ground motion at periods of 0.5 to 1 second is dominant in the damaged area. Shallow soil down to 30 meters (AVS30) is responsible for the amplification. The comparison of seismic intensity estimated from the aftershock records with AVS30 indicated that the seismic intensity at the damaged area can be 6.5.

S2-4 Noninear site amplification at CCHG observed by strong ground motions during the 2011 off the Pacific coast Tohoku Earthquake

○Kohei Tanaka[1] Seiji Tsuno[1] Hiroaki Yamanaka[2] Kosuke Chimoto[2] Makoto Kamiyama[3]
Shun'ichi Kataoka[4]
[1]RTRI [2]Tokyo Institute of Technology [3]Tohoku Institute of Technology [4]Hirosaki Uniersity

Strong ground motion which has the large PGV over 100cm/s was observed at CCHG in Small−Titan network during the 2011 off the Pacific coast of Tohoku earthquake. In this paper, we purpose to evaluate the characteristics of strong ground motions by evaluating the site amplifications at CCHG. We carried out array observations of microtremors to estimate of S−wave velocity structure at CCHG. In case of linear, it is necessary to understand deep subsurface structures in order to explain the site amplification in CCHG in case of soil linear. Next, we tried to reproduce the ground motion observed at CCHG site during the 2011 off the Pacific coast of Tohoku earthquake, using the estimated S−wave velocity structure. However, the calculated ground motion by linear analysis can not explain the observed motion even if an amplification to deep subsurface is considered. Spectral ratio calculated by each earthquake before the 2011 off the Pacific coast of Tohoku earthquake becomes small in the high−frequency for large PGA. And we aim to configure that soil nonlinearity at CCHG slowly recovered according to the time elapsed from main shock using ground motions observed in aftershocks. As the result, the decrease of spectral ratio in high−frequency becomes small according to the time elapsed. Finally, we conduct that it needs to consider site amplification in deep subsurface and non−linear response in shallow soil layers to evaluate the strong ground motion at CCHG.

S2-5 Investigation on source azimuthal dependence for amplifications of long-period ground motions in the Kanto basin

○ Masanori Noyori[1] Kosuke Chimoto[1] Seiji Tsuno[2] Hiroaki Yamanaka[1]
[1]Tokyo Institute of Technology [2]RTRI

The long−period ground motions were dominant in the Kanto Basin during the the 2011 off the Pacific coast of Tohoku earthquake (Mw 9.0). However, it is suggested that they are relatively small in spite of the large scale of this Magnitude as compared with shallow moderate events. One reason of less amplifications of long −period ground motions observed in this event is supposed by the effect of source azimuthal dependence for amplifications of long−period ground motions in the Kanto Basin as suggested by Tsuno et al. (2012). In this paper, we investigated the amplification of long−period ground motions by the 3−D modeling in the Kanto Basin. First, we calculated surface/borehole spectral ratios at 3 strong motion stations using earthquake data which used by Tsuno et al. (2012). As a result, we also confirmed the source azimuthal dependence for the amplifications of long−period ground motions. Second, we performed long−period ground motion simulations for the 5 earthquakes and compared with the spectral ratios of velocity response using the simulation results to the observed spectral ratios. The source azimuthal dependence of long−period ground motions was confirmed in the simulation results as well as the observations. Finally, we concluded that the large amplification of long−period ground motions in the Kanto Basin is caused by the complex interference of seismic waves propagating in the Kanto Basin with the different incidence to the basin.

Session -3 Seismic/Geodetic Imaging Technologies

S3-1 Characterization of near-surface heterogeneity by integrating surface-wave phase velocity and attenuation

○Tatsunori Ikeda Takeshi Tsuji
WPI-I2CNER, Kyushu University

We propose an approach for detecting localized heterogeneities from surface−wave phase−velocity and attenuation using conventional multichannel seismic data. In most surface−wave analysis, only phase information of seismic data is used to obtain near−surface S−wave velocity profiles. However, we further utilize surface−wave attenuation extracted from amplitude information of seismic data. We focus on the sensitivity difference between local phase velocities and attenuation coefficients to localized heterogeneities such as lithological boundaries and localized fractures. To characterize such heterogeneities from lateral variation of attenuation coefficients and phase velocities, we perform numerical experiments for laterally heterogeneous models with a lithological boundary and a fracture zone. We observe lateral variation of attenuation coefficients near the lateral heterogeneities. As a result, the lithological boundary can be characterized by lateral variations of local phase velocities and attenuation coefficients near the boundary. On the other hand, the fracture zone can be characterized by low lateral variation in phase velocities and increase of attenuation coefficients near the fracture. Therefore, our propose method has the possibility to distinguish lithological boundaries from localized fractures. In fluid−injection experiments (e.g., CO2 geological storage), our approach has high potential in evaluating possible existence of localized fractures, which may serve as leakage path of injected fluid.

S3-2 Local angle domain migration for image improvements and its application to HTI fracture characterizations

○Karl Hosgood Masako Robb Zvi Koren
Paradigm Geophysical

The local angle domain (LAD) depth migration uses the entire wavefield of recorded seismic data to generate 'true−amplitude' angle dependent or angle and azimuth dependent image gathers (CIGs) in subsurface angle domain rather than surface offset domain (Koren and Ravve 2011). A dense set of rays are traced from every image point up to the surface performing a rich illumination from all available opening and dip/azimuth angles. All arrivals are taken into account, even in highly complex geological areas where wavefield includes multi−pathing. This imaging technology is of huge value when re−evaluating vintage seismic data in order to maximize use of the information within existing datasets, and also for processing new acquisitions. Furthermore, the true−amplitude, full azimuth gathers generated from the LAD migration on multi/rich/wide azimuth data has been intensively tested to obtain more reliable fracture information (orientation and intensity) than the traditional azimuthal analysis methods (i.e. sectoring). High−precision HTI anisotropy parameters are extracted from the amplitude variations with angle and azimuth analysis (AVAZ) of the full azimuth gathers (Canning and Malkin 2009).

S3-3 Surface displacements of the Kanto plain, Japan, and subsurface structure: insight from persistent scatterer SAR interferometry

○Kazuya Ishitsuka[1] Pau Prats-Iraola[2] Matteo Nannini[2]
[1]Fukada Geological Institute [2]German Aerospace Center

We estimated recent surface displacements around the Kanto plain, Japan, by means of persistent scatterer SAR interferometry (PSInSAR) with ALOS/PALSAR data acquired from January 2007 to March 2011 and TerraSAR−X data acquired from March 2011 to November 2012. Through the satellite data acquisition from space, PSInSAR analysis enables to estimate the spatial distribution and the temporal evolution of surface displacements. In this study, we investigated how surface displacement pattern of the Kanto plain has evolved before and after the 2011 Tohoku earthquake, and showed the advantage of PS−InSAR analysis for understanding the surface displacement phenomena. From the analysis of ALOS/PALSAR data, several subsidences due to groundwater extraction were identified. The subsidence at the central Kanto plain was well correlated with the geomorphological feature. On the other hand, the analysis of TerraSAR−X data revealed ground uplift around Tokyo, where significant displacements had not occurred just before the earthquake. This uplift may be associated with the visco−elastic rebound of the crust due to the 2011 Tohoku earthquake, and the uplift velocity has the spatial variation. We interpreted the variation is owing to the thickness of sediment layer, because the weight of the crust would affect the uplift velocity. Our results showed the advantage of PSInSAR analysis for the detailed mapping of surface displacements.

S3-4 Investigation of shallow geological condition: application of tomographic seismic refraction survey in Bojonegoro, East Java, Indonesia

○Riskiray Ryannugroho[1] M. Rachmat Sule[1] Adree Octova[2]
[1]Institut Teknologi Bandung [2]Universitas Negeri Padang

This paper presents the results of seismic tomography refraction survey on the planned track of gas pipe located in Bojonegoro, East Java, Indonesia. The tomography method uses the first arrival time of the seismic records as main input data, and is implemented in order to obtain the subsurface velocity profile. The survey is aimed to investigate the shallow geological condition and related hazard potentials due to the construction plan of the gas pipeline. The total length of seismic survey is 20 km. In this paper we only discuss one segment which consists of 6 spreads, which has a total length of about 720 m. Each seismic spread, which the distance between the nearest and the farthest geophones is 115 m, consists of 24 geophones with a geophone interval of 5 m. The seismic sources are generated by hammer hitting in 11 shot locations in and around the spread, with a distance of shot interval of 15 m. The tomography simulation shows that the seismic waves could propagate up to 25 m below the surface. The final image from processed data shows that there are no velocity anomalies that indicate hazard potentials along the seismic lines. We also interpret that the subsurface condition of the survey area consists generally of two layers: first is top soil, which is loose clay with a P−wave velocity of around 300−900 m/s.

S3-5 Implementation of non uniform memory address (NUMA) parallel computation in order to speed up the common reflection surface (CRS) stack optimization process

○Fernando Lawrens　Aditya Jiwandonoi　Rachmat Sule
Institut Teknologi Bandung

The Common Reflection Surface (CRS) Stack is an alternative method of seismic data processing, with an assumption that a reflector consist of a group of reflector segments. As implication, one must determine three wave attributes, i.e. emergence angle, radius curvature of normal−incident−point−wave and radius curvature of Normal wave, before stacking process is performed. The cascaded method is commonly used, which consist of four main steps: automatic CMP−Stack, the plane wave search at zero offset, the hyperbola search at zero offset and is finalized with the optimization of CRS−Stack attributes. Although this method will give better seismic section, especially if the subsurface condition is undulated, this method consumes longer computation time. To solve this problem, NUMA parallel computation scheme is applied in the optimization CRS −Stack step. In order to obtain good NUMA parallel computation performance, some tunning method are implemented, such as load balancing, disk I/O access optimization, and cache optimization. By using all these tunning methods, the maximum speed−up of NUMA parallel computation for CRS−stack is 11.3 times, if 12 −core system computer is used.

S3-6 High-resolution velocity model building for a complex shallow overburden using reflection, refraction and multiple arrivals from dual-sensor streamer data

Mazin Farouki[1]　Grunde Ronholt[1]　J.E. Lie[2]　Oystein Korsmo[1]　B. Danielsen[1]
Sverre Brandsberg-Dahl[1]　Samuel Brown[1]　Alejandro Mavilio[1]　Nizar Chemingui[1]
○Shinya Sakamoto[1]
[1]PGS　[2]Lundin Norway

We demonstrate the success of combining wavelet shift tomography, full waveform inversion (FWI) and separated wave−field imaging (SWIM) for pre−stack depth migration (PSDM) velocity model building and imaging. The data under investigation were acquired in 2009 using dual−sensor cables over the Utsira High area offshore Norway. The survey covers the largest exploration discovery offshore Norway in the last 30 years. Thin target sands spanning hundreds of square kilometers are situated below a complex chalk layer, leading to large uncertainty in estimating oil reserves. The aim of this study, a research collaboration between PGS and Lundin Norway, was to first accurately resolve velocity variations in the shallow overburden (to a depth of approx. 600m) associated with channels, pockmarks, and gas pockets, which directly impact the structural imaging and depthing at target level. Only then can attention be focused to resolving the deeper velocity anomalies associated with the complex chalk at target level. Dual−sensor streamer acquisition yields broadband seismic rich in low frequencies which are required for successful implementation of FWI. The FWI method employed utilizes the ultra low frequency refraction arrivals recorded in the raw hydrophone data. The dual−sensor SWIM application exploits the greater illumination available from multiples to provide a high resolution volume of the near surface, and SWIM angle gathers were generated for further refinement of the near surface velocity model. Finally, wavelet shift tomography, operating on traditional reflection arrivals, was used for model updating at the deeper reservoir level. The study illustrates how reflection, refraction, and multiple arrivals from dual −sensor data can contribute towards high−fidelity model building and imaging. Resolution of the complex shallow overburden leads to more accurate positioning and depth predictions for the reservoir, directly impacting estimation of reserves.

November 19, 2015

Ito Hall

Session -4 Imaging/Interpretation Case Studies (1)

S4-1 Integrated geological interpretation of HeliFALCON airborne gravity gradiometer data and HELITEM electromagnetic and magnetic data for geothermal exploration in the Kujyu area, Kyushu, Japan

○Jurriaan Feijth[1] Jackie Hope[1] Carlos Cevallos[1] Satoshi Machida[2] Junichi Kuwamura[3]
[1]CGG Multiphysics [2]Sumiko Resources Expl. & Dev. [3]Fugro Japan

An integrated geological interpretation has been successfully completed in the Kujyu area (Kyushu), Japan to evaluate the suitability of HeliFALCON airborne gravity gradiometer (AGG) data, in combination with HELITEM electromagnetic and magnetic data for the identification of prospective areas for geothermal energy generation in volcanic areas. Available geological data and published data from the existing geothermal fields, located in the Hohi Volcanic Zone, were integrated into the geological interpretation. The fault structure of the survey area was accurately mapped using the AGG data. Mostly dextral transtensional faults are interpreted to have controlled the location and migration of Pliocene and Pleistocene volcanic centres and the deposition of volcanics and volcaniclastics. Differences in density, related to the dominant volcanic and sedimentary facies were identified with the AGG data. Linear features identified in the magnetic data often coincide spatially with such features in AGG data, and areas of low magnetic susceptibility may indicate hydrothermal alteration, demagnetisation related to shallow intrusions (dykes and sills), or both. The concentration of conductive zones mapped from the electromagnetic data and areas of low magnetic susceptibility along faults in zones of fault interference strongly suggests structurally controlled hydrothermal activity. Based on the interpreted tectonic evolution and structure, an evolutionary model was developed for the volcanic and depositional history, particularly the shift in volcanic centers and the distribution of volcano−sedimentary depositional facies, and hydrothermal activity. Using knowledge from existing geothermal fields the resulting interpretation products were subsequently evaluated and used to identify additional geothermal prospectivity.

S4-2 Using FALCON airborne gravity gradiometry for oil and gas exploration: Recent case studies

○Simon Wetherley David Moore
CGG

Over recent years, AGG (airborne gravity gradiometer) data has been increasingly used in oil and gas exploration in a variety of geological environments. The popularity of AGG data is largely due to its low cost, rapid acquisition and ability to add significant value to seismic data. FALCON AGG is the only AGG system that has been custom designed for use in survey aircraft and as a result provides the highest resolution and lowest noise AGG data available. It is able to be deployed in both fixed wing and helicopter platforms enabling acquisition to be performed in all types of terrain. This paper presents three case studies from different parts of the world showing the application of FALCON AGG data to oil and gas exploration. An example of a survey in Gabon shows how AGG and seismic were combined to improve the imaging of complex salt structures. In Tanzania, an AGG survey was used to define both the intrasedimentary and basement structure of part of the East African Rift under Lake Tanganyika. In Addition, a basement model and sediment thickness map was produced from the magnetic data collected synchronously with the AGG data. An integrated structural interpretation of a survey in the Glyde Sub−basin in Australia provided an overview of the geometry of the key structures. A 3−D model was created as the end result of an integrated interpretation of AGG, magnetic and seismic data in the Canning Basin in northwest Australia.

S4-3 Large-scale 3D inversion of magnetotelluric data

○Masashi Endo[1] Martin Cuma[2] Alexander Gribenko[2] Michael Zhdanov[3]
[1]TechnoImaging [2]TechnoImaging, U of U [3]TechnoImaging, U of U, MIPT

We have inverted magnetotelluric (MT) data collected in nine states of the northwestern United States as a part of the EarthScope project for 3D imaging of electrical resistivity to a depth of 500 km using recent advantages in extremely large−scale electromagnetic modeling and inversion. The results of our mega−cell 3D inversion reveal multi−scale geoelectrical inhomogeneities in the upper mantle, which are closely related to major known tectonic features. Our geoelectrical model clearly shows a resistive structure associated with the Juan de Fuca slab subducting beneath the northwestern United States, and the conductive zone of partially melted material above the subducting slabe due to the release of fluids from the down going slab. We observe extensive areas of moderate−to−high conductive asthenosphere below 100 to 200 km. The geoelectrical model also shows a prominent conductive feature associated with the partially melted mantle plume −like layer of the Yellowstone hotspot. These results correlate reasonably well with P−wave and S−wave velocity models independently obtained from seismic tomography. In addition to the tectonic features, the metallogenic feature, i.e., the Carlin trend in Great Basin area, is clearly imaged by the geoelectrical model. We believe that the geoelectrical model obtained from our 3D MT inversion provide important complementary information to the published seismic models, and will help to better understand the complex tectonic processes responsible for the formation of the unique geological features of the North America subduction zone.

S4-4 3D inversion of HELITEM data in geothermal area, Japan

○Shunsuke Nogami[1] Masashi Endo[2] Leif H Cox[2] Junichi Kuwamura[3] Akihiko Chiba[1]
[1]SRED [2]TechnoImaging [3]Fugro Japan

For the exploration of geothermal resources, helicopter−borne time−domain electromagnetic (HELITEM) survey was conducted over the Kuju and Kirishima Areas in Kyusyu by Japan Oil, Gas and Metals National Corporation (JOGMEC). HELITEM data were analysed by using EMflow. But, in the resistivity distribution calculated by EMflow, unrealistic features tend to appear. For example, trend of enhancing layer model cause to appear very thin conductive layer near the surface. Also, background resistivity outputted as analysis result in resistivity distribution. On the other hand, EMflow has advantage in computational costs, therefore it is generally used for the qualitative interpretation of mass airborne electromagnetic (AEM) data. This time we got a permission to use HELITEM data for our research from JOGMEC. For the quantitative interpretation of the HELITEM data, which we propose in order to evaluate the geothermal potential, we have performed rigorous 3D inversion with EMVision for subset of the HELITEM data acquired along two lines in the Kuju survey area. Magnetotelluric (MT) and Controlled−source audio−frequency MT (CSAMT) surveys have been conducted in the same area, and we have compared results in order to validate the 3D inversion technology (EMVision). It was demonstrated that the rigorous 3D inversion with EMVision can be properly used for the quantitative interpretation of HELITEM data. One can clearly see the detailed geoelectrical structure with realistic and reasonable resistivity values, and the technology has been proven to be fast and efficient for large amounts of AEM data in a complex geological setting.

S4-5 Geophysical integrated survey result of ancient Turkic tombs in Bulgan province, Mongolia

○ Tseedulam Khuut[1] Ochir Ayudai[2] Takayuki Kawai[3] Ichinkhorloo Byanmunkh[1]
Batsukh Khuut[1]
[1]MUST [2]Mongolian Academy of Science [3]Niigata University

Archaeological methods involve excavation, which is time consuming. Sometimes, this effort may not be very cost−effective since there are risks of damaging or missing the archaeological remains. On the other hand, information about the location, depth, size and extent of buried archaeological remains may be determined by means of geophysical investigation, which is carried out easily and quickly on the surface without disturbing or damaging the buried archaeological structures. Mining activity associated with increased, small−scale miners using metal detectors to plunder and to damage archaeological objects in Mongolia. In order to protect archaeological objects and remains, we carried out archaeo−geophysical research work in Bulgan province, central Mongolia. Archaeologists believe ancient remains history related to seventh century. Magnetic, GPR and resistivity tomography survey were integrated to locate subsurface archaeological objects. In this study, we focus on the integration of geophysical methods, such as magnetic, electrical resistivity tomography and GPR survey to provide additional information of buried archaeological objects. Magnetic, GPR and resistivity tomography survey were conducted over buried archaeological sites at Bayannuur soum of Bulgan province and successfully detected the location of buried objects. This studies result confirmed that the application of magnetic, ERT and GPR techniques in archaeological prospecting gives useful information upon which archaeologists can relate further investigations to decrease the time, cost.

Session -5 Reservoir Characterization

S5-1 Geothermal reservoir characterization monitoring with poisson's ratio uses MEQ data in X Field, South Sumatra

○Yuanita Devyi Marhendra Putri Erpin Habibah
Gadjah Mada University

Indonesia is a country that has the greatest potential of geothermal energy in the world because it is located in the 3 active continental plate boundaries. Geothermal energy exploration has been done in several regions in Indonesia, such as in X field, South Sumatra. Geothermal reservoir monitoring is done to help the process of exploration, which is to control the process of extraction and re−injection of fluid that can lead to macroearthquake. In this study, microearthquake (MEQ) data was recorded by seismometer in 18 stations of the X field. Microseismic events are processed using Wadatti method to result the ratio of P wave velocity and S wave velocity in order to obtain the value of Poisson's ratio as an indicator of fracture in geothermal reservoir. According to 16 microseismic events were recorded in X field show the distribution of Poisson's ratio between 0.139516−0.483592 for each hypocenter of the microearthquake. The value of Poisson's ratio between 0.376101−0.483592 represent abnormal condition which indicates fluid saturation in the rock fractures. The saturation zone must be extracted and re−injected in order to reach the equilibrium of fluid. So, the subsidence as a trigger of the macroearthquake will be avoided.

S5-2 Energy-weighted AVO: a new AVO attribute

○Mohammed Farfour Wang Jung Yoon
Chonnam National University

Amplitude Variation with Offset (AVO) is a technique that has been widely used and proved to be a reliable indicator of hydrocarbons expression in seismic data. The technique uses mathematical approximations and approaches to estimate variations in seismic amplitude as function of incidence angle and relate them to lithology and fluids saturating the rocks in subsurface. In this work we introduce a new seismic attribute to investigate AVO anomalies associate with hydrocarbons. The Energy−weighted AVO (EAVO) attribute uses Zeoppritz approximations and exploits the fact that hydrocarbons−bearing sediments would show anomalous seismic responses relative to their backgrounds. The attribute attempts to emphasize hydrocarbons−associated effect and attenuate background signal. Unlike other conventional AVO attributes, the new attribute can be applied to both prestack and poststack data. We apply the attribute to synthetic data generated using Zoepprtitz equation and then we examine it on real detest. Intersting results have been obtained.

S5-3 Identification of reservoir zones in geothermal field based on Vp, Vs and Vp/Vs

○Bambang Mujihardi[1] Andri D. Nugraha[2] Sri Widiyantoro[2] Djedi S. Widarto[1] Artini Sukotjo[1]
[1]PT. Pertamina [2]ITB

This paper describes an attempt to investigate fracture zones in a geothermal field based on microseismic events. An important step in hypocenter determination is how to identify the phases of P− and S−wave arrival times at all stations. In this study, we applied filtering techniques (i.e. band−pass and low−cut filters) to suppress noise and conducted an S−transform analysis to improve the picking quality of unclear P− and S−wave arrivals. Initial locations of microseismic events were determined using the Geiger Adaptive Damping (GAD) method. We selected microseismic events with time residuals i.e. the difference between S−wave arrival time (ts) and P−wave arrival time (tp) less than 2 seconds. Our preliminary results show that the initial events are distributed in the central, southwestern and northeastern parts of the seiemographic station network. The events seem to be clustered in the same region at depths of 0−1 km below the mean sea level (MSL) in the central part, 0−2 km below MSL in the northeastern part and 0−8 km below MSL in the southwestern part. Vp/Vs from 3D seismic velocities clearly depicts low velocity anomalies, which are interpreted as steam. KEY WORDS: GAD, geothermal, fracture, 3D velocity.

S5-4 Assessment of geopressure in the upper Oligocene Shale of the Cuu Long Basin by conventional and fuzzy methods

○Pham Huy Giao
Asian Inst. of Technology

Estimation of geopressure profile for a reservoir is an important part of reservoir characterization. In this study, geopressure for Miocene and Oligocene formations in the Cuu Long basin, Vietnam was investigated using two different approaches, i.e., conventional and Fuzzy subtractive clustering. The target shale formation for geopressure analysis is the upper part of the late Oligocene to Early Miocene, which is a thick shale overlying the fractured granite basement. The results obtained by two methods provided a geopressure profile up to 3,600 m TVD with a high geopressure zone identified in Oligocene shale, which were also confirmed by DST results.

S6-1 P-wave velocity in CO2/brine saturated ultra-low-permeability rock

○Yi Zhang Hyuck Park Osamu Nishizawa Takuma Ito Ziqiu Xue
RITE

We conducted an experiment to measure P−wave velocity in a ultra−low−permeability rock at ultrasonic frequency during supercritical CO2 drainage. X−ray CT technique was used to image rock interior and calculate CO2 saturation. The obtained saturation−P−wave velocity relationship is located near the Gassmann −Wood limit. The changes in P−wave velocity with respect to CO2 saturation are significant different from the results of a previous experiment performed for a relatively higher permeability sandstone, which shows a relationship that is close to Gassmann−Hill limit during CO2 drainage. The difference can be explained by the development of very small and dispersive CO2 patches and relatively well mixing of CO2 and brine in the rock.

S6-2 Fluid flow simulations for the safety injection of carbon dioxide in Gundih CCS site, Indonesia

○Kyosuke Onishi[1] Duc Tam Nguyen[1] Hikari Fujii[1] Takeshi Tsuji[2] Masami Hato[3]
Toru Takahashi[4] Toshifumi Matsuoka[4] Mohammad Rachmat Sule[5] Wawan Gunawan A. Kadir[5]
[1]Akita University [2]Kyushu University [3]Waseda University [4]Fukada Geological Institute [5]ITB

The numerical CO2 flow simulation was used to evaluate the safety injection in Gundih CCS site. The narrow range reservoir model with detailed grids was prepared. Simulation results show that the injected CO2 moves to the northwest direction along with the anticline axis and the migration of CO2 will stop after about 100 years. Injected CO2 will also not move to the location of two faults. The fluctuations of total weight of mobile, trapped and dissolved CO2 in reservoir are also analyzed and the ratio of mobile CO2 increases in the condition of high volume of total injection.

S6-3 Pilot study carbon capture and storage (CCS) in Indonesia: planning for the CCS pilot facilities at Gundih field

○C.B. Rasrendra[1] H.B.A Suprapto[1] H. Prabowo[2] D. Sasongko[3] R. G. Dewi[1]
L. Mucharam[1] B. Marbun[1] A. Indarto[1]
[1]Institut Teknologi Bandung [2]UTC Pertamina [3]Pertamina EP

A pilot surface facility for CCS activities in Gundih area, Indonesia is designed to facilitate for the preparation, transportation and injection of 30 ton CO2/day. CO2 will be taken from a Central Processing Plant (CPP) Gundih, while the injection well is located about 22 km from the CPP. Two possible tapping points, as well as three technical options are studied for feasibility. Outlet of Sulphur Recovery Unit is identified as preferred capturing CO2 stream for economical reason. A systematic evaluation is perfomed to evaluate suitable option for transporting and injecting CO2 within this project. Two strategies for CO2 transporation, namely by trucking or piping and two method of CO2 injection either by compression or pumping are explored throughly. The option for liquefying CO2, transporting it to injection site by means of trucking, and injecting it in supercritical condition by means of pumping is preferred for economical and practical reason.

S6-4 Simulation of time lapse seismic for CO2-injection monitoring: preliminary result

○Rachmat Sule[1] Ariesty Asikin[1] Awali Priyono[1] Takeshi Tsuji[2] Sigit Raharjo[3]
[1]ITB [2]Kyushu University [3]UTC Pertamina

Simulation of time lapse seismic is conducted in the frame work of carbon storage pilot project that will be carried out in the Gundih Field and surrounding areas, Indonesia. The purpose of conducting this study is to find out whether the results of time lapse seismic simulation could detect the presence of CO2 in the determined CO2 reservoir, since the amount of CO2 that will be injected is only 20,000 tonnes within 2 years. The CO2−injection will is planned to be started from December 2016 or beginning of 2017 at the latest. This experiments is carried out as justification whether this approach could show significant seismic anomalies between before and after CO2−injection. At this stage, the method is tested by using synthetic geological model that assume maximum amount of CO2 could be injected, so that it filled all of the capacity of the reservoirs. The geological model itself was developed based on the results of seismic inversion, in which the physical properties inside the model were distributed from seismic and logs data. Two injection scenarios were proposed by utilizing two different reservoirs in order to see the effectiveness of the injection as well as the resulting seismic response. The results of this study will be a reference to the next step, i.e. reservoir simulation by using the obtained models.

S6-5 Geological characteristic and fault stability of the Gundih CCS pilot project at Central Java, Indonesia

○Benyamin Sapiie[1] Harya Danio[1] Awali Priyono[1] Ariesty Ratna Asikin[1] Djedi S Widarto[2]
Eko Widianto[3] Takeshi Tsuji[4]
[1]Institut Teknologi Bandung [2]UTC PERTAMINA [3]Trisakti University [4]Kyushu University

Gundih CCS pilot project is located within the Gundih gas field operated by PERTAMINA at Central Java, Indonesia. Geologically, this field is part of East Java Basin, which is well known as prolific hydrocarbon basin in South East Asia region. Gundih field and surrounding area is a gas field, which has been in production since the end of 2013. CO2 content, which is generated directly from this field, is 21% of the produced gas. Government of Indonesia is highly committed in reducing CO2 emissions. Therefore, flaring CO2 to the atmosphere is not an option anymore. CCS by injection to depleted oil and gas reservoir known as geological storage will be the best choice. The main objectives of CCS pilot study is to understand subsurface reservoir behavior and best monitoring technology. To achieve the best storage location as well as injection scenario detail evaluation including geology, geophysics and geomechanics need to done to avoid reservoir or top seal failures, which can cause environmental disaster. There are two possible reservoir candidates, which can be used for injecting CO2 in the Gundih field and surrounding area. Shallow (～1000 m) reservoir sequence consists of medium to thick quartz sandstone of Miocene Ngrayong Formation. The deeper (～2000 m) reservoir sequence consists mainly of carbonate units of Kujung Formation. Traps are mostly structures consist of fault−bounded anticline forming 4−way or 3−way dip closures. Fault−seal analysis suggesting most faults are sealing using SGR (20%). Geomechanics indicate strike−slip stress condition where Shmax>Shmin>Sv and most reservoir are in hydrostatic pressure condition. Overall, site evaluation results suggest that shallow reservoir target which is Ngrayong Formation is more suitable, stable and economic for conducting CCS pilot study.

S6-6 Time-domain electromagnetic (TDEM) baseline survey for CCS in Gundih area, Central Java, Indonesia

○Wahyu Srigutomo[1] Warsa Warsa[1] M. Rachmat Sule[1] Akira Saito[2] Keiko Nakayama[2]
Masami Hato[2] Trimadona Trimadona[1] Donny Prasetyo[1] Djedi S. Widarto[3]
[1]Bandung Institute of Tech. [2]Waseda University [3]Pertamina UTC

In August 2014, a grounded wire time−domain electromagnetic (TDEM) survey using high sensitivity MI (magneto−impedance) sensor were conducted for the first time in Gundih area, Central Java, Indonesia. The survey is aimed at providing information of baseline resistivity structure for carbon capture and storage (CCS) pilot project in the area. Using short transmitter−receiver offset and high current injection, high S/N and good quality data were obtained at 66 stations near the proposed CO2 injection site. The recorded data are the transient decay of vertical component of magnetic field, expressed in nT. The data were selectively stacked before inversion. The preliminary results of the inverted resistivity model indicate the presence of low resistivity layer below 800 m depth which can be associated with the Ngrayong formation as the targeted reservoir of CO2 injection.

November 20, 2015

Ito Hall

Session -7 Imaging/Interpretation Case Studies (2)

S7-1 Optimization of imaging the marine seismic data including CCS expected area: a case study offshore Korea

○ Taeyoun Kim[1] Seonghyung Jang[2]
[1]UST [2]KIGAM

The purpose of this study is to address a process issue for multiple suppression with surface−related multiple elimination (SRME) and Radon filtering and to increase the signal−to−noise ratio by using common reflector surface (CRS) stacking on seismic data from the eastern continental margin of Korea. To remove free surface multiples, SRME and Radon filtering are applied to attenuate the interbed multiples. Results obtained using synthetic data and field data show that the combination of SRME and Radon filtering is effective for suppressing free−surface multiples and peg−leg multiples. Applying CRS stacking to seismic data in which multiples have been eliminated increases the signal−to−noise ratio for the area examined, which is being considered for carbon dioxide capture and storage (CCS).

S7-2 Interpretation of electrical resistivity tomography monitoring data of the Boguchan hydroelectric power plant rockfill dam

○ Evgeny Zerkal
Lomonosov Moscow State University

In order to locate seepage zones in rockfill dam of Boguchan hydroelectric power plant (HPP) and to control the technical condition of rockfill dam during the filling of the reservoir electrical resistivity tomography (ERT) four monitoring cycles was carried out. For an assessment of the three−dimensional (3D) effects connected with a 3D structure of dam, and estimation of true resistivity of dam elements mathematical modelling was performed for models with changing of properties and geometry in several directions. Modelling showed that generally, geoelectric sections obtained by 2D inversion of field data don't represent true geoelectric properties of the studied object due to distortion of 2D ERT data by the 3D dam structure, significant contrast in resistivity of dam constructional elements leads to a strong distortion of geoelectric sections: the artifacts, caused by work of the inversion algorithm, occurs. The analysis of monitoring data in respect of the performed modelling allowed to exclude the presence of a seepage in the dam body.

S7-3 A case study of soil type identification for levee structure by electric survey with unified cone field test

○ Mamoru Mimura[1] Yoshinori Iwasaki[2] Koichi Nakagawa[3] Akira Jomori[4]
Mitsugu Yoshimura[5] Masaaki Fujiwara[2] Masanori Uno[1]
[1]Kyoto Univ. [2]Geo Research Inst. [3]Osaka City Univ. [4]Neo Science [5]Soil & Rock Eng.

It has been recognized that electrical survey for river levee is useful to identify different soils of the embankment based upon obtained electrical resistance of the ground. However, the relationship between electrical resistance and soil type is not uniquely determined. The resistance depends upon several factors of not only types of soils but also resistance of water and other factors. In this study, we are developing a method to obtain geotechnical modeling of river levee section by electric survey with unified cone penetration test. This is a part of progress report of the second year of total three year project and presents fundamental results of the relationship between electricity and soil types that were carried out in the field experiments as well as by laboratory tests. Electric logging and unified cone field test were conducted at levees of Kiso River and Yura River. Soil types were obtained by unified cone and compared with electric resistances. Clay shows generally less than 100ohm m and sand and gravel larger than 1000ohm m. Intermediate soil shows rather much wider range from 100 to a few 1000ohm m. Laboratory tests show that the electric resistance depends upon degree of saturation of the soil. Since the relationship between soil type and electric resistance depends upon site conditions, calibration needs to be obtained to induce soil model from electric resistance.

S7-4 Application of fine-tuned interval velocity model In Rengasdengklok, West Java, Indonesia

○ Tania Meidiana Mochamad Razi
Pertamina EP Asset 3

Seismic data is recorded in time domain section, while generally depth domain section is more required for interpretation. Conversion of seismic data from time to depth domain is one of the most important parts in routine of seismic data interpretation. Conversion of structure maps from time to depth domain would ensure that the anomalous founded in seismic section is appropriate to the actual features. In this study, we applied a fine−tuned interval velocity method using the data of geology and geophysics (RMS velocity, intervals velocity, and average velocity). First, we have to correct the interval velocity. Corrected value of control point resulted from the calibration between checkshot and sonic logs data (correction factor), aims to correct the interval velocity that has been generated from the Dix formula. After the deployment control point using geostatistical mapping, the interval velocity is converted to average velocity. The average velocity is used to perform the optimum result of structures map within time to depth conversion. During the processing data, we calibrated data with sonic log and checkshot. Results of depth structure map using sonic log has a small error and it can indicate the presence of a closure in accordance with the seismic section. KEY WORDS: Conversion, RMS velocity, interval velocity.

S7-5 Fracture imaging of a sabo dam by a debris flow by means of GPR and high-resolution seismic survey

○Hiroshi Kisanuki[1] Kunio Aoike[2] Hideki Saito[2] Tomio Inazaki[1] Takeshi Shimizu[1]
Hiroaki Izumiyama[1] Naoki Fujimura[1]
[1]PWRI [2]OYO

Detailed geophysical survey was conducted on the rear face of a sabo dam, which was damaged by a huge debris flow on July 9, 2014. The survey consisted of GPR and high−resolution seismic measurements for imaging internal fractures, along with photogrammetric image analysis for delineating surface displacements. A 10 m wide and 15 m high area on the face was covered with parallel lines at 20 cm intervals to map 3D subsurface fracture distribution using GPR. A single line was set at the bottom of the face for high−resolution seismic survey. Piezoelectric type accelerometers were pasted on the surface at 20 cm intervals and manual hit using rock hammer was employed for generating high−frequency signals. As a result, GPR could successfully imaged fractures at the shallow depth up to 1 m, and high−resolution seismic survey detected dipping fractures extending into the deeper portion of the body up to 8m. In addition, photogrammetric analysis clearly mapped blocked deformation. Combined interpretation of geophysical survey results with the photogrammetric analysis was helpful to interpret the dislocation process of the dam body. GPR and high−resolution seismic survey results also demonstrated their applicability for the delineation of internal fracture in large concrete structures.

Session -8 Mining Geophysics & MT methods

S8-1 Integration of downhole data sources with different resolution for improved boundary detection

○Katherine L Silversides Arman Melkumyan
University of Sydney

Ore deposits such as the banded iron formation hosted iron ore deposits located in the Hamersley Ranges of Western Australia require detailed knowledge of the location of important orebody boundaries for orebody modelling. These boundaries may require multiple data types to be processed simultaneously. In the typical Marra Mamba style deposit used in this paper, the alluvial to bedded boundary creates distinctive signatures in both the magnetic susceptibility logs and the downhole chemical assays. However, for each of these data types similar signatures can be observed at other locations in the drill holes. Therefore, a method of processing them together is required. This method must be capable of using data with different sampling resolutions, as magnetic susceptibility is sampled at 0.1m intervals and the assays at 2m intervals. This paper proposes a methodology that uses Gaussian Processes to probabilistically process both magnetic susceptibility and chemical assays to provide a combined boundary identification method. Processing the magnetic susceptibility and assays separately achieved accuracies of 73.9% and 90.9% respectively where the GP output was certain. However, the similarity of the signatures to other sections of logs caused this accuracy to decrease to 72.3% and 88.7% respectively where a certain signature was identified. The combined method used both data sets to obtain an improved accuracy of 93.5% in the certain holes and 94.0% for the certain signatures. Therefore the combined method is proposed as a viable method for automating boundary identification from disparate data sources.

S8-2 Scenario to optimize nickel laterite exploration using ERT with gradient configuration

○Sabrianto Aswad[1] Yudi Surawan[1] Muhammad Altin Massinai[1] Wanni[2]
[1]Hasanuddin University [2]Vale Indonesia Inc

Some researcher showed tramendeous result how ERT could identify zones or lateric deposits profile, more special in nickel laterite exploration. Mostly the results claim ERT data used as complementary technique from existing exploration data, which are drill core data or test pit. it means that ERT survey done after collecting drill core data or test pit. This ERT data then correlated with drill core data or test pit for geological interpretation on identify nickel laterite profile. In this research we go forward not only use ERT as complementary technigue but also the most important things used ERT become primary data in guidance for collecting drill core or test pit data. ERT images reveal nickel laterit deposit profile, which are limonite zone, saprolite zone and bed rock zone. This result will use as guidance to choice the position of drilling and how deep shoul be drilled. Configuration used in this researh was gradient configuration.

S8-3 Large fractures mapping around tunnels by detailed 3D seismic imaging

○Nicoleta Enescu Calin Cosma
Vibrometric Oy

RD&D activities for structure characterization ahead and around tunnels are ongoing, with focus on the safety assessment for engineering and mining applications. With hard rock nuclear waste repositories, brittle deformation zones and large fractures are considered to pose a potential risk for the mechanical integrity of the spent fuel disposal canisters. These are to be avoided in positioning of the deposition holes that will host the canisters, and they need to be identified during construction of the deposition tunnels and ultimately the deposition holes. Results from two high resolution seismic surveys carried out in ONKALO (Finland) and Aspo HRL (Sweden) are presented here, providing continuity information for several large fractures identified through geological mapping to cut the tunnels and/or boreholes. These were recognizable in transmission and reflection images produced from the seismic data sets. We show that reflection seismic surveys are relevant to the detailed characterization of crystalline bedrock. Relatively small−scale features, even single fractures, can demonstrably be detected. On the other hand, the detection of some distinctive features, even large−scale, can be uncertain if the survey layout is spatially constrained. Combinations of borehole and tunnel measurements using measuring arrays with diverse orientations helped reducing the location ambiguities and should be used in the future wherever possible.

S8-4 Accuracy evaluation of MT response calculated with particle method and higher-order particle method using the Taylor expansion

○Keiichi Ishizu Tadanori Goto
Kyoto University

The finite difference method and the finite element method are often used as a numerical calculation of the electromagnetic field below the surface for the forward and inverse problem of the MT method. However, using the finite difference method has a difficulty of including complicated shape in the model like the topography and underground heterogeneous structure. For overcoming the weak point, the particle method attracts attention of MT users recently. The particle method is a technique to make a model discretization with particles not aligned along lattice or mesh. In this study, we performed examination about the better setting of the influential radius to achieve the high accuracy when we use the particle method for the analysis of the electromagnetic field in the MT method. In our numerical results, the trend is obvious the smaller the calculation error of electric field is if the smaller the influential radius is. However, the accuracy decreases when a model consists of irregular arranged particles. The higher−order particle method using the Taylor expansion was developed to solve this problem in a model with irregularly particles. We applied the higher−order particle method in the analysis of the electromagnetic field in the MT method. The result shows that the higher−order particle method have better accuracy than the conventional particle method regardless of whether particles are distributed regularly or randomly.

Session -9 Rock Physics & Environmental and Engineering Application

S9-1 Three-Dimensional magnetic resonance sounding tomography

○Warsa Warsa Hendra Grandis Wahyudi W Parnadi
Institut Teknologi Bandung

Magnetic resonance sounding (MRS) method is based on magnetic resonance relaxation variation of the H (hydrogen) proton of water after the intrinsic spin magnetic moment excited and rotated from equilibrium state by electromagnetic (EM) wave. Initial amplitude of magnetization increase directly depends on the number of water molecule (H2O) in a volume unit and therefore is directly proportional to water content. The decay time is a relaxation time required by a proton returning initial condition which depends on pore size. This paper reports the development of three−dimensional MRS tomography using inverse modeling method more realistically. Forward modeling program is used to calculate the initial amplitude and decay time responses from a synthetic model of water content and decay time simulating some hydro−geological model in the field. Furthermore, 3 D inversion program accommodating Levenberg−Marquardt strategy has been developed to produce the distribution model of water content and decay time. The decay time as function of depth is linked to the pore size and there fore to hydraulic conductivity.

S9-2 A practical method of nation wide Vs30 mapping with 250m grids for developing countries by automated topographical classification and published data in Japan

○Sugio Imamura[1] Akihiro Furuta[2]
[1]CTGK ltd. [2]ORCG co.

A practical method for nationwide Vs30 mapping with 250m grid based on automated topographic classification is proposed. In the process of earthquake hazard map creation, how to implement ground amplification factor is one of the most important issue. For the nationwide mapping, engineering geomorphologic classification map is used for estimation of Vs30 (averaged S−wave velocity shallower than 30m) distribution. However in the case of developing countries, there is very few S−wave velocity data nor authorized engineering geomorphologic classification map. On the other hand, earthquake disaster management activity is more important for such developing countries and coming earthquake cannot wait until accumulation of S−wave velocity data nor completion of engineering geomorphologic classification map. On the bases of such condition in the developing countries, we have developed a practical method that needs only DEM (for example, SRTM) and standard GIS software (for example, ArcGIS). Automated Topographic Classification proposed by Iwahashi and Pike (2007) is employed instead of engineering geomorphologic classification. In order to assignment Vs30 to each topographic class, a conversion table is created by taking correlation between each topographic class and Vs30 data with 7.5−arc−second resolution downloaded from J−SHIS web site (Japan Seismic Hazard Information Station: www.j−shis.bosai.go.jp). The method is applied to Vs30 mapping of whole Indonesia with 250m grids to evaluate actual applicability and limitation.

S9-3 Estimation of s-wave velocity and attenuation anisotropy from sonic waveform logs in methane hydrate bearing sediments

○Jun Matsushima
Univ. of Tokyo

The presence of shear wave attenuation anisotropy in the hydrate bearing sediments can provide new information about the distribution of hydrates in the pore spaces. However, few measurements of attenuation anisotropy from sonic logging waveform data have been conducted. In this study, I have estimated shear attenuation anisotropy from upper and lower dipole waveforms based on the modified median frequency shift method. Although the median frequency shift method is considered to be effective and robust compared to the conventional spectral ratio method, the median frequency shift methods strongly depend on reference data under lower signal−to−noise ratios. The modified median frequency shift method does not depend on arbitrarily choosing a reference value and to quantify the uncertainties in attenuation estimation. This paper has demonstrated that the modified median frequency shift method provides more stable and reliable attenuation results. The final shear attenuation results from both upper and lower dipole data indicate that there is no significant shear wave attenuation anisotropy in methane hydrate bearing sediments. We also derive shear wave velocity anisotropy values by using Dispersive Slowness−Time Coherence (DSTC) method and compare them with those of shear wave attenuation anisotropy.

S9-4 Representation of the resistivity model using volume fraction of porous clay

○Chisato Konishi
OYO Corporation

A new representation of the resistivity model using volume fraction of the porous clay is presented to include unique features of clayey soil. Since porous clay is comprised of electrically conductive small materials and water saturated pore space, the increase of the porous clay contributes to the increase of porosity, saturation, and electrical conductivity of soils. The volume fraction of the porous clay is determined for a limited range of combinations of total porosity and solid clay fraction. The range enables us to include the clayey soils characteristics. A simulation result shows that the range of the combinations is consistent with actual data distribution observed in a large dataset and the response of the resistivity to porosity agrees with measured resistivity of artificial soil samples in a laboratory. This resistivity model will provide more realistic interpretations for shallow subsurface.

Poster Session
Exhibition Hall

Poster Session

P1 Experimental monitoring of CO2 drainage and brine imbibition in sandstone by complex electrical impedance and X-ray CT imaging

○Yi Zhang　Hyuck Park　Tamotsu Kiyama　Osamu Nishizawa　Ziqiu Xue
RITE

We report the results of an experiment conducted to monitor the processes of CO2 drainage and brine imbibition in Berea sandstone using the complex electrical impedance and X−ray CT imaging methods. The results suggest that the resistances corresponding to the bulk pore solution and surface conduction both become smaller in imbibition than in drainage, which suggests the conductive network of brine was in better connection during imbibition. Furthermore, the capacitance reduces largely since the commencement of CO 2 drainage whereas it keeps large values during imbibition. These differences are associated with different fluid distributions between drainage and imbibition as shown by CO2 maps calculated on the basis of X−ray CT images.

P2 Experimental stidy of two-phase fluid flow in the porous sandstone by P-wave velocity and electrical Impedance measurement

○Keigo Kitamura　Hiroyuki Honda　Sinnosuke Takaki　Yasuhiro Mitani
Kyushu University

Capillary number (Ca) is an important parameter to discuss the CO2 behavior in porous sandstone. Numerical and theoretical studies indicated the strong relationships between Ca and CO2 saturation. These relationships were also monitored by direct observation experiments by X−ray CT scanner. In this study, experimental investigation is conducted to discuss the relationships between Ca and non−wetting fluid flow by Compressional wave velocity (Vp) and electrical impedance (IP). We use the Berea sandstone (porosity: 18%) and the nitrogen (N2) for non−wetting phase fluid. Result of Vp measurement indicates clear Vp−reduction around 4% at 2.8×10−9 in Ca. There are no obvious Vp changes with increasing Ca. Subsequent water re−injection process (imbibition), Vp does not show large change under lower Ca flow (1.14×10−4 to 1.14×10−3). Over this Ca, Vp indicates increment around 3%. On the other hand, IP measurement indicates clear and continuous increment on the Cole−Cole plot diagram with increasing Ca of N2 in drainage process. In imbibition, IP also shows clear and continuous decrement on the Cole−Cole plot. These experimental results suggest that IP changes directly reflect the N2 saturation change than Vp. It also imply that we can monitor the saturation of reservoir precisely by both of Vp and IP.

P3 Repeat micro-gravity measurements using A10 absolute gravimeter for CO2 injection monitoring in Gundih gas field, Central Java, Indonesia

○Jun Nishijima[1] Yoichi Fukuda[2] Yayan Sofyan[3] Matomu Itakura[2] Eko Wahyudi[4] Toshifumi Matsuoka[2]
[1]Kyushu University [2]Kyoto University [3]University of Indonesia [4]Bandung Institute of Technology

The SATREPS project—Pilot Study for Carbon Sequestration and Monitoring in Gundih Area, Central Java Province, Indonesia—, which is funded by JICA and JST, are conducting a research and development of safety storage of CO2 in the subsurface and to establish monitoring technologies in the Gundih gas field, where natural gas production is just started. Repeat micro−gravity measurements by using A10 absolute gravimeter have been conducted since 2013 at 6 stations in order to reveal the background gravity changes before CO2 injection. The A10 gravimeter is a portable absolute gravimeter, and it can operate on a 12V DC battery. Therefore, we can use for the field survey such as CO2 injection well site. Two gravity stations were lost because the facilities and pipeline construction began after the measurement in 2013. Four more stations were added after the final candidate CO2 injection well (Jepon1) was decided in 2014. The accuracy of the measurements is less than 10 micro gal. It means that the noise level is very low and the ground condition of the stations is stable. Although the gravity data at KTB1 showed larger differences (32 micro gal). However, the other station gravity data were within 10 gal which is the nominal accuracy announced by the manufacturer.

P4 Application of microtremor exploration to shallow dipping layers under the assumption of horizontally stratified structure

○Kyosuke Okamoto[1] Seiji Tsuno[1] Naoyasu Iwata[1] Kimitoshi Sakai[1] Kohei Tanaka[1] Atsuhiro Usami[2] Kaoru Kobayashi[3] Masaya Hirabayashi[3]
[1]RTRI [2]RTRI (present at JCC) [3]JR-East

Shallow S−wave velocity structures are estimated from dispersion curves of phase velocity, H/V spectral ratios, etc., using microtremor exploration technique. However the estimation is originally based on the assumption that layers of media are horizontally stratified. So, if layers of media incline or are discontinued, the estimated structures have errors to some extent. In this study, we tested a procedure of microtremor exploration for a dipping structure and examined the influence of the horizontal stratification assumption on the estimated structure. The followings are brief description of our procedure. At first, we determined S−wave velocity structures apart from the dipping area as references using the SPatial Auto Correlation (SPAC) method. The corresponding fundamental peak frequency of Rayleigh wave ellipticity was also obtained. Using the information from the reference structures, the dipping structure was determined by the H/V spectral ratios which were obtained along the dipping structure under the assumption of the horizontal stratification. We found that the fundamental peak frequency shifts toward lower frequency smoothly as the structure becomes deeper. Using the determined structure, we numerically calculated influence range of the dip on the wave filed. As a result, it was revealed that the structure within one wavelength likely gives effect on the wave field and disturbs the H/V spectral ratios.

P5 Estimation of deep s-wave velocity structures from microtremor array measurements in Zeytinburnu and Tekirdag, Turkey

○Kosuke Chimoto[1] Ozlem Karagoz[1] Seckin Citak[2] Oguz Ozel[3] Hiroaki Yamanaka[1]
Ken Hatayama[4]
[1]Tokyo Tech [2]JAMSTEC [3]IU [4]NRIFD

The Marmara Sea region has a giant risk of the earthquake disaster expected to be occurred along the North Anatolian Fault zone. The site amplification of the sedimentary layers is known to has a significant contribution to the strong ground motion. We therefore need to estimate the S−wave velocity structures for the strong ground motion prediction in the Marmara Sea region. We performed microtrermor array explorations to estimate the deep S−wave velocity structure in Tekirdag, located in the western part of the Marmara Sea region, and Zeytinburnu, located in the west of Istanbul. The estimated phase velocities showed a variety in Tekirdag and Zeytinburnu. The inversion of the phase velocity revealed the S−wave velocity structures. The coastal site in Zeytinburnu has thick sedimentary layers compared with the inland sites in Zeytinburnu. In Tekirdag, the site at the center of Tekirdag has the deepest structures, while the sites far from the center exhibit the shallow and high velocity structure inferring the difference of the subsurface structures in Tekirdag province. The comparison of the horizontal−to−vertical spectral−ratio indicated that the S−wave velocity structure below 1000 m/s explains well on the dominant frequency of the site amplification, implying that our estimated S−wave velocity structure models are useful for the prediction of the strong ground motion in the region.

P6 Detailed spatial variation of short-period earthquake ground motion in the vicinity of Tachikawa-Fault

○Seiji Tsuno[1] Kosuke Chimoto[2] Koichiro Saguchi[2] Hiroaki Sato[3] Shinichi Matsushima[4]
Michiko Shigefuji[5] Nobuo Takai[5] Tatsuo Kanno[6] Hiroaki Yamanaka[2] Hiroshi Kawase[4]
[1]RTRI [2]Tokyo Tech. [3]CRIEPI [4]Kyoto Univ. [5]Hokkaido Univ. [6]Kyusyu Univ.

Inhomogeneity of shallow soil structure often causes earthquake damage and extreme large acceleration concentrated locally. To understand the phenomena for singular distribution of earthquake ground motions, therefore, we need to evaluate the spatial variation of short−period ground motion. We performed an earthquake observation at the site locating in Musashimuraya city, Tokyo. Several seismic stations were installed temporally within a linear array of about 650m crossing the Tachikawa−Fault. In this study, we evaluated the spatial variation of earthquake ground motion by applying spectral analyses to seismic data recorded during the Chiba−ken Hokuseibu earthquake. Moreover, we evaluated those characteristics quantitatively by the method of misfit criteria considering time−frequency analysis.

P7 Characteristics of seismic wave attenuation in rock with velocity fluctuation based on deep borehole array observation

○Hiroaki Sato[1] Naoki Nishizaka[2] Shunsuke Suzuki[2] Kozo Ohnishi[2] Yoshihiko Ishikawa[2] Shinichi Matsuzaki[2]
[1]CRIEPI [2]Shikoku Electric Power Co. Inc.

The 2000 m deep borehole array earthquake observation is conducted by Shikoku Electric Power Co. Inc., Japan. By using array observation records at deep borehole between GL −500 m and GL −2000 m, the seismic wave attenuation in deep underground is estimated to be Q=118 from the least−squared fitting of the spectral−ratio decay model of direct upgoing S wave. The result is consistent with the previous Q estimated from rock core samples (psammitc schist) deeper than GL −500 m at this borehole station. It is suggested that the seismic wave attenuation between GL −500 m and GL −2000 m is mainly caused by intrinsic absorption in rock, and that the additional attenuation effect by heterogeneity is very small. The heterogeneity strength at the borehole station is also investigated by using S wave logging data between GL −500 m and GL −2000 m. As a result, it is found that the standard deviation of 1D velocity fluctuation at this borehole station is smaller than the ones at the other near−surface rock sites (shallower than GL −500 m). Furthermore, it is demonstrated that the ka" and "kL" of heterogeneity at this borehole station is mapped to the area of equivalent homogeneous media in the ka−kL diagram (Aki and Richards).

P8 Use of multiple core lengths and travel times to calculate propagation velocity in laboratory measurements

○Kyosuke Onishi Kazushi Yoshizawa Hiroyuki Kosukegawa Hikari Fujii
Akita University

Using first arrival waveform of direct or reflective waves is an effective method to measure propagation velocity of a rock specimen in a pressure vessel. This study is examined for a measurement method setting transducers on external areas of a pressure vessel to improve accuracy of measuring velocity and amplitude of waves propagating through a rock specimen. Picking a first arrival time of a direct wave is difficult to keep accuracy and using the time of a first peak or a second node is applied to calculate intercept or delay times. Propagation velocity can be calculated from only a propagation wave passing through a rock sample, if the intercept or delay time is a known value. A cylindrical specimen and ultrasonic transducers are set in a special guide with four threaded rods and a load cell to keep same conditions between transducers and a rock specimen. This system can received a simple waveform to easily pick times with high accuracy. Velocities calculated from several peaks and nodes of waves shows different values but differences are only 0.1% in brasses and 0.3% in sandstones. Intercept or delay times shows large differences between brass cylinders and rock specimens, which shows that the intercept or delay time changes on different materials. This study also examined to record propagation waves with same amplitude. The precise control of load between transducers and a rock specimen can make small variations of amplitude.

P9 Borehole seismic data processing and interpretation using standalone Matlab application

○Mohammed Farfour Wang Jung Yoon
Chonnam University

Vertical seismic profile is vital tool in subsurface imaging and reservoir characterization. The technique allows geophysicist to infer critical information that cannot be obtained otherwise. MVSP is a Matlab application with user−friendly interface for VSP shot modeling, data processing and interpretation. The software deals with VSP data from loading and preprocessing stage to the final stage of corridor plotting and integration with well and seismic data. Several seismic and signal toolboxes are integrated and modified to suit and enrich the processing and display packages. We use the software to create a VSP synthetic data. The data is then processed using different available tools. Next, a real data is loaded and fully processed using the software. In order to value the software processing flow accuracy, the same data is processed using commercial software. Comparison of the processing results showed that the MVSP can process VSP data as efficiently as commercial software currently used in industry and provide similar high quality processed data.

P10 Tsunami waveform inversion using only observational sites at the vicinity of Tsunami source region: 2011 Tohoku-Oki Earthquake case

○Satoru Fujihara Mariko Korenaga Takahiro Tamiya Norihiko Hashimoto
CTC

For earthquake source inversion estimating slip distribution within a finite fault, the closer the obsevational sites are to the seismic source region, the more the amount of source information within a obsevational data becomes large. Generally, near−field tsunami wavefield can be computed very accurately by linear shallow water long wave theory at oceanic region where water depth is substantially large. On the other hand, as tsunami gets close to inland region, tsunami wavefiled gets nonlinear and complex. Thus, in carrying out tsunami waveform inversion, using the tsunami data observed far away from tsunami source region (and close to inland region) is not too ideal. However, there have been several tsunami source models of 2011 Tohoku −Oki earthquake, and they were generally constructed by using the dataset observed at both oceanic region and inland region. In this research, we show that tsunami waveform inversion using only observational sites near tsunami source region could estimate spatio−temporal distribution of coseismic displacement of 2011 Tohoku−Oki earthquake. Validation analysis by forward tsunami simulation show that the estimated tsunami source model of Tohoku−Oki Earthquake could reproduce tsunami innundation height at inland region fairly well.

P11 Parallel computation for speedup the computation time of direct determination of common-reflection-surface (CRS) attribute

○Fernando Lawrens
Institut Teknologi Bandung

Common Reflection Surface (CRS) stack method is seismic data stack processing method that using three parameters of seismic reflection wave attributes namely alpha, RNIP, and RN. There are two solution method to determine three parameters, namely the cascade solution method and the direct solution method. Zaky (2012) has proven that seismic stack result from direct method give better seismic image quality than cascade method. To produce a good seismic−section, it required a wide input values of CRS attribut, but wide range attribute will cause long time computation, so that why the implementation of the CRS−stack method is less popular in the industrial world. In this study, try to propose a solution to reduce computation time of CRS attribute search by using paralel computing. There are three possible ways to paralelize CRS attribute search, coherence search paralelization, sample time paralelization, and CDP data paralelization To make a good paralel algorithm needs two conditions, big granularity problem and no sharing attribute between processor. Paralel method that can provide with that condition is CDP data paralelization. This study uses an Intel i7 2600K processor that has 4 cores, it mean the ideal speedup accleration is 4 times. By maximizing techniques parallel algorithms and features hyperthreading, this research obtained 3.6 times speedup acceleration and optimization system value is 90%.

P12 IP effects on transient electromagnetic responses of deep-sea hydrothermal deposits

○Hangilro Jang　Wansoo Ha　Hee Joon Kim
Pukyong National University

In transient electromagnetic (TEM) measurements, secondary fields that contain information on conduc−tive targets such as hydrothermal mineral deposits in the seafloor can be measured in the absence of strong primary fields. A TEM system using a loop source is useful to the development of compact, autonomous instruments, which are well suited to submersible−based surveys. Since electrical conductivity of subseafloor materials can be frequency dependent, these induced polarization (IP) effects may affect the reliability of TEM data interpretation. In this paper, we investigate IP effects on TEM responses of deep−sea hydrothermal deposits with a thin sediment cover. Time−domain target signals are larger and appear earlier in horizontal magnetic fields than in vertical ones, although the vertical field has 2−3 times larger magnitude than the horizontal one. IP effects cause transient magnetic fields to enhance initially, to decay rapidly and then to reverse the polarity. The DC conductivity and IP chargeability in Cole−Cole parameters influences the time of sign reversal and the enhancement of the target response, simultaneously. The reversal time is almost invariant with the time constant while the target signal is almost invariant with the frequency exponent.

P13 3D inversion of gravity data using Cuckoo optimization algorithm

Reza Toushmalani[1] ○ Hakim Saibi[2]
[1]Islamic Azad University [2]Kyushu University

This paper describes a new inversion algorithm for 3D gravity data based on a new evolutionary optimization algorithm, inspired by the life history of the avian family of cuckoos. The newly developed method was applied to synthetic data to demonstrate its suitability and then applied to real data. Two case studies are presented: (1) salt dome case study from Charak region (Iran) and (2) Obama geothermal field (SW Japan). The results of the 3D gravity inversion of two sets of real field data, yield geologically plausible models with the estimated depths and shape that fit well with previous geoscientific studies.

P14 Geophysical exploration for skarn-type iron deposits in western Mongolia

Arvisbaatar Navaanchimed[1] ○ Tseedulam Khuut[2] Byambasuren Turtogtokh[2]
Munkhbaatar Sengee[2] Dugaraa Purev[2] Khosbayar Kh[3]
[1]NUM [2]MUST [3]Geomaster Engineering LLC

Most of the Mongolian iron ore deposits and occurrences are contact metasomatic skarn types. These small and medium deposits are structurally and lithologically controlled. The Taishir iron deposit is associated with Paleozoic granitic rocks and lies on the contact with Cambrian calcareous rock affected by metasomatic process. Other rocks in the area include, lower Cambrian limestone and sandstone, Cambrian granodiorite and granites forming part of an early Permian intrusive complex. The objective of geophysical surveys were done to identify ore bodies, marginal metasomatosis alteration zones and magnetite skarn bodies in the study area. The magnetic surveys were conducted with a 25m line spacing for detailed reconnaissance survey and 50m line spacing for the whole study area with a total of 1900 line kilometres collected. Gravity data were acquired at 200 m line spacing and station interval of 50m along 42 profiles with a total 104 line kilometres. Measurements of density and magnetic susceptibility confirmed the skarns to be the source of these anomalies. Skarn type iron mineralization in the Bor Nuur district was shown to coincide with distinct positive gravity and magnetic anomalies. Modelling of residual gravity and magnetic data allowed the geometry of the anomaly sources to be determined. Skarn bodies are estimated to be from 40 to 160 m thick and with a vertical plate geometry.

P15 Toward understanding focal mechanism of hydraulic fracturing induced earthquakes using constrained inversion: method and synthetic tests

Shuhei Iida ○Ahyi Kim
Yokohama City University

In this study, we extended double−couple constarained focal mechanism inversion code developed by Snoke (2003) to retrieve non−double couple component from hydraulic fracturing induced microearthquakes. We constrained the mechanism to be shear slip, tensile displacement, or combination of these mechanisms, since it is reasonable model for stimulation induced microseismicity. In addition, it has smaller model parameters to stabilize the inversion than that of full moment tensor case. Synthetic test is performed under the various condition and showed successful input model recovery.

P16 Geological investigations using cosmic ray muons: a trial to detect fault at the Mizunami Underground Research Laboratory

○Eiji Sasao[1] Keiichi Suzuki[2] Nobuto Yamada[3] Koji Kuboshima[2]
[1]Japan Atomic Energy Agency [2]Kawasaki Geological Engin. [3]Nihonchikatansa

Investigations of a fault with thick, clay−altered damaged zone in granitic rock have been performed using cosmic ray muons. The investigation was performed at the Mizunami Underground Research Laboratory, located in Gifu Prefecture, central Japan. Geologically, the site investigated consists of an unconformable, overlying sedimentary sequence and basement granite. The unconformable contact is at the 170 meters below ground surface. A vertical fault with a thick, clay−altered damaged zone is present in the granite. The muon telescopes were settled at the 200 and 300 meters below ground level (G.L.) to estimate densities of granite and fault within it. Surface densities calculated based on Miyake's equation are 431 hg/cm2 (fault+sedimentary rock) at the G.L. −200 meters level, and 788 (granite+sedimentary rock) and 720 (fault+sedimentary rock) hg/cm2 at the G.L. −300 meters level. Densities of granite, fault and sedimentary rock are calculated to be 3.38, 2.88 and 1.99 g/cm3, respectively. Specific gravity of intact granite is measured as c.2.6. The calculated density is obviously higher than absolute value, though the reason of such difference is not clear at present. If the density of granite is assumed to be 2.6 g/cm3, then the re−calculated densities of fault and sedimentary rock are 2.2 and 1.5 g/cm3. This result indicates that cosmic ray muons have good potential to detect geological structure.

P17 Clarifying metal-enriched zones in landfills by Induced polarization measurement

○Ryuji Yokose[1] Takahiro Ito[1] Masahiro Kurokawa[1] Mutsuo Takeuchi[2]
Hirokazu Tanaka[3] Kazuo Kamura[1]
[1]Waseda University [2]Geo-vest Co. Ltd [3]FPIOPHES

In recent years, stable supply of mineral resources is one of the most important economic factors in Japan. Discarded electrical appliance and industrial waste contain various kinds of useful metal. However, they had been dumped into landfills without any good intermediate treatments until Home Appliance Recycling Law was enacted in 2000. Therefore, it is expected that metals are comparatively rich in such landfills. In addition, some metals are concentrated in particular zone and metal−enriched zone may be generated. Because rainwater permeates in landfill and dissolves soluble ions. We carried out electrical prospecting which employ resistivity and induced polarization in order to clarify the metal−enriched zone in landfills. In addition, we sampled drilled cores in landfill and analyzed them. On the other hand, we measured PFE values with the cores by sample holder and metal contents by ICP−MS. The relation between chargeability profile obtained around the drilled hole and the PFE values of core samples was examined. The following is the main results of this study. (1) There are close relations between the results of field measurements and laboratory experiments. Therefore, it can be judged that the results of field measurement are reasonable. (2) There is a good correlation between PFE values and iron contents. (3) IP measurements can identify the distribution of rare metal accompanying with iron. These results indicate that IP measurement is one of the useful methods to clarify the metal−enriched zone in landfills.

P18 Short-range ground deformation measurement by InSAR time-series analysis

○Shuichi Rokugawa Kosuke Nagakubo Takako Nakamura
Univ. of Tokyo

In this paper, we suggest a new technique for detecting the events of short time surface deformation by controlling the smoothing parameter of InSAR time−series inversion method. The previous method uses a constant and relatively large smoothing weight factor to stabilize the derived deformation profile. However in the new method, the smoothing parameters are categorized into two categories, lower and higher. Lower value is set to the time position where DInSAR value is relatively large. We applied the new technique to the Boso Peninsula, where it was reported that a slow−slip event occurred in 2007, and we investigated whether detection of this phenomenon is possible or not. The obtained time−series profiles were compared with the Global Positioning System (GPS) data. Our verification revealed that the incidence period of the slow slip could be detected by the new technique. Thus, it is clarified that the new technique is useful for identifying the period and range of short−range ground deformation.

P19 Detailed geophysical surveys on an embankment slope of a mountain road for slope stability assessment

○ Tomio Inazaki[1] Toshiyuki Kurahashi[2] Kei'ichiro Sakanishi[3] Sugio Imamura[4]
[1]PWRI [2]CERI [3]Mony [4]CTGK

Detailed geophysical surveys were carried out on an embankment slope of a mountain road situated in cold region, near Sapporo, Hokkaido. The surveys purposed to demonstrate the capability of near surface geophysics for the delineation of 2D structure along road embankments. 2D and 3D resistivity measurements, hybrid surface wave survey, portable dynamic cone penetrometer testing, and pore water pressure monitoring were adopted for the surveys. We conducted the field measurements twice before the snow season in 2013, and just after the snowmelt season in 2014 when the slope surface had been scraped and protected with caged riprap. No obvious change was observed in the resistivity profiles along a reference line set outside the stabilized slope zone. In contrast, the resistivities distinctively increased in the groundwater discharged zone. Surface wave survey clearly delineated the deepening of embankment thickness at the surface seepage zone in the slope. In conclusion, small−scale complex structure in the embankment, which might cause irregular distribution in the slope stability, was clearly identified by means of the detailed geophysical survey. In addition, it was demonstrated that periodic measurement was useful to evaluate the effect of slope stabilization work.

P20 Model tests on quality evaluation procedure for an unsaturation method for liquefaction countermeasures

○ Hiroshi Nakazawa[1] Koichi Nagao[2] Hisao Hayashi[3] Toshio Takagi[4] Kentaro Tabata[1]
[1]NIED [2]Advanced Const. Tech. Center [3]Geo-X Consultants Co. Ltd. [4]Fukken Co. Ltd.

The 2011 off the Pacific coast of Tohoku Earthquake caused many damages due to liquefaction in residential areas of the Kanto Plane. After the earthquake, several countermeasures against liquefaction have been developed energetically; one of these countermeasures is an unsaturation method. Some researchers from our research group have developed the microbubble water injection method for liquefaction countermeasures. During their developing process, there was no or few direct−confirmation technique of degree of saturation of a liquefaction layer in−situ, so it was difficult to quantitatively estimate effectiveness of liquefaction countermeasures. In this study, to develop estimation procedure of in−situ saturation degree for evaluation of an unsaturation method for liquefaction countermeasures, a series of tests on model ground under dry, saturated and unsaturated conditions were carried out. Generally, it is well known that liquefaction resistance increases with degree of saturation, while P−wave velocity of soil decreases. The proposed technique in this study is travel time tomography to obtain P−wave velocity distribution by ultilising dynamic cone penetration tests. The study suggests that application of this proposing technique has enough possibiltiy of estimating saturation degree.

P21 A trial extraction of crustal deformation from seafloor hydraulic pressure gauges to estimate interplate coupling for subduction plate boundaries

○Keisuke Ariyoshi[1] Akira Nagano[1] Takuya Hasegawa[1] Motoyuki Kido[2] Ryoko Nakata[1]
Hiroyuki Matsumoto[1] Naoki Uchida[2] Toshihiro Igarashi[3]
[1]JAMSTEC [2]Tohoku Univ. [3]Tokyo Univ.

To estimate seismic plate coupling and crustal deformation near the trench such as Nankai Trough, we perform a trial simulation of earthquake, applying a rate− and state dependent friction law on the plate boundary and assuming a megathrust earthquake and slow earthquakes occurring in numerous small asperities. Our simulation suggests that the observed activity of the shallow slow earthquakes locally around the fault segmentation boundary between the source regions of the Tonankai and Nankai megathrust earthquakes may be due to weak coupling between the two segments, while quiescence of the shallow slow earthquake around the segmentation boundary between the Tonankai and Tokai megathrust earthquakes may indicate strong plate coupling between the two segments. To evaluate these characteristics quantitatively, we also estimate leveling change at seafloor due to shallow VLFE swarms. Since the levelling change is expected to be so local as to be incoherent, removal of the moving−averaged data from the data stacked by four nearby observation point in the same node may be useful to detect the short−term local levelling change. In the future, we have to extract the crustal deformation component by separating other components such as instrumental drift and oceanic changes in order to consider coherent change among the same science node.

P22 Using HeliFALCON airborne gravity gradiometer and HELITEM electromagnetic and magnetic data for geothermal exploration

○Jackie Hope[1] Jurriaan Feijth[1] Shane Mule[1] Satoshi Machida[2] Junichi Kuwamura[3]
[1]CGG [2]SRED [3]Fugro Japan

HeliFALCON airborne gravity gradiometer (AGG) and HELITEM electromagnetic (EM) and magnetic data were acquired in Kyushu, Japan to test the efficacy of the datasets for geothermal exploration. The AGG and magnetic data enabled mapping of structures across the two test areas while the EM data provided useful information about the distribution of hydrothermal alteration fluids. The data were acquired in mountainous areas, where helicopter geophysical surveys have an significant advantage as they can drape the terrain more closely.

P23 Reflection imaging of oceanic fine structure under strong ocean current in the Izu-Ogasawara region

○Mikiya Yamashita[1] Yoshio Fukao[1] Kanako Hasumi[2] Seiichi Miura[1] Shuichi Kodaira[1]
[1]JAMSTEC [2]Taisei Corporation

Recently, data of multi−channel seismic reflection (MCS) survey are known to be useful for physical oceanographic researches in recent years. This has opened up the new field of Seismic Oceanography. Many data of MCS surveys have already obtained everywhere in the world ocean. However, Seismic Oceanography still has uncertainty about the motion of oceanic currents due to the variation of the time order such as years, days and hours. This affects the real visualization of the oceanic fine structure. The reflection from the oceanic internal structure is excited by the strong ocean current such as Kuroshio Current and steep bathymetry. Although it is important to compare the oceanic fine structure about the survey direction under the strong oceanic current, there are few examples in the world. Japan Agency for Marine−Earth Science and Technology has been carried out many gridded MCS surveys in the Izu−Ogasawara region in order to evaluate the crustal structure for drilling beneath the seafloor. The Izu−Ogasawara region is known to be strong oceanic current from west to east. Our dense MCS profiles obtained in the Izu−Ogasawara region show the distinct difference about the survey direction for the Kuroshio Current. The results show the characteristics of the Doppler−like effect under the strong ocean current. In our profiles, clear reflectors are identified near the seafloor under the strong ocean current.Although many reflectors are appeared as flat, the deeper part of ocean is noisy when vessel direction is the same as ocean current at sea surface. In this study, we investigate the effect of the survey direction for vessel and ocean current by comparison using the qualities of dense MCS profiles.

P24 Spectrogram inversion for obtaining large-scale subsurface velocity structure

○Jiho Ha Wookeen Chung Sungryul Shin
Korea Maritime and Ocean Univ.

Although well−resolved subsurface velocity structures can be obtained by using waveform inversion method in time and frequency doamains, the results of inversion have suffered due to the lack of low−frequency components. To solve such an issue, various approaches have been presented to obtain a reasonable initial velocity model as large−scale with a long−wavelength velocity structure. In this study, a new full waveform inversion algorithm using the spectral decomposed signal from the spectrogram is proposed, for use in obtaining a long−wavelength velocity model. To examine feasibility of proposed inversion algorithm, we carried out the numerical test using a modified SEG/EAGE salt dome A−A line. We can obtain reasonable inverted velocity model with long−wavelength structures.

P25 Geophysics surveys in the Villa Antonini, Genzano (Roma)

○ Fabiola Ragagnin[1] Michele Di Filippo[1] Maria Di Nezza[2]
[1]Sapienza University of Rome [2]National Institute of Geophysics and Volcanology

During the excavation (2010−2011) in the residence of Antonini Emperor (probably, that it may be the property of Aurelio Fulvio and perhaps lived there the last of Antonini: Emperor Marcus Aurelius), they have been carried out the magnetic survey differential, GPR's relief and a electromagnetic survey (Slingram Method). The geophysics methods exploit the different physical characteristics of the rocks, sediments and structures present in the soil, physical characteristics such as density, electrical conductibility and the magnetic susceptibility (Di Filippo et al., 2005). As a function of such characteristics, it is chosen the geophysics method that it's more suitable; but it's more resolutive the integration of multiple geophysics methods. In the case that we have studied, keeping in mind the different level of resolution, relative to the methods used, they were discussed the following issues: characterization of the subsoil (differentiation of materials that incorporate the archeological structures and the others underlying layers), localization of archeological structures that it's present in the subsoil. Combining the most significant results, it is proposed a synthetic map, in which it is present the contribute of the methods used. the representation in a single map, it's only of the help for checking visually where there is the greater correspondence between magnetic anomaly, radar and conductibility (Di Filippo et al., 2006). The difficulty of reading the geophysic's signals it's abates when the prospecting's results were integrated and determine for the next archaeological excavations. From to All the three methods, horizontal magnetic's gradient, target GPR and Sligram's form of investigation, they had with how result the presence of a structure, with elliptical contour: the rapport between axis it's similarity at roman's amphitheater. The subsequent excavation (2012−2013), it has brought to light a small amphitheater, It is supposed to be the place where the Commodo, figure 1, (Roman emperor, member of the Antonine dynasty; He reigned 180−192, It is described by historians as bizarre and depraved), Marcus Aurelius's son, trained how gladiator.

MEMO