

令和3年 研究成果報告 Research Achievements 2021

令和3年4月－令和4年3月

(April 2021-March 2022)



九州大学 大学院工学研究院 地球資源システム工学部門
カーボンニュートラル・エネルギー国際研究所
マルチスケール構造科学ユニット

辻研究室

Dept. Earth Resources Engineering, Faculty of Engineering
International Institute for Carbon-Neutral Energy Research, Kyushu University
Multiscale Science and Engineering for Energy and the Environment Thrust

辻研究室 メンバー (2022 年 1 月時点)

辻 健 Takeshi TSUJI (Professor)
池田 達紀 Tatsunori IKEDA (Assistant Professor)
西澤 修 Osamu Nishizawa (Researcher)
Fei JIANG* (WPI Visiting Assistant Professor)
Jihui JIA* (WPI Visiting Assistant Professor)

Chanmaly CHHUN (Post-doctoral Researcher)
Rezkiya Dewi ANDAJANI (Post-doctoral Researcher)
Shuhei Tsuji (Post-doctoral Researcher)

木村 陽子 (Yoko KIMURA) (Administrative Staff)
持田 貴子* (Takako MOCHIDA) (Technical Staff)

張 雨田 (Yutian ZHANG) 【D3】
Mohamed MOURAD 【D3】
Fahrudin 【D3; 10 月入学】
二宮 啓 (Hiro NIMIYA) 【D3; 10 月入学】
Bokani NTHABA 【D2】
Tarek Samir IMAM 【D2】

棕本 浩太 (Kota MUKUMOTO) 【D1】
Ahmad AHMAD 【D1】
Daulet BAKHTIYAR 【D1; 10 月入学】

荒巻 健 (Takeru ARAMAKI) 【M2】
繁 恒樹 (Koki SHIGE) 【M2】
松浦 稜祐 (Ryosuke MATSUURA) 【M2】
Natanael SUWANDI 【M2; 10 月入学】

内垣 友貴 (Tomoki UCHIGAKI) 【M1】
國増 貴明 (Takaaki KUNIMASU) 【M1】
折田 まりな (Marina ORITA) 【M1】
竹之内 秀斗 (Shuto TAKENOUCHI) 【M1】

中山 航平 (Kohei NAKAYAMA) 【B4】
坂上 雄士 (Yuji SAKAGAMI) 【B4】

SAMIM Khair Mohammad (research student)

* : I2CNER 所属 学年は 2022 年度 1 月現在

令和3年度 研究成果一覧

List of Research Achievements in FY2021

(1) 学会誌（査読あり） / Peer-Reviewed Journals

Chapman, Andrew, Elif Ertekin, Masanobu Kubota, Akihide Nagao, Kaila Bertsch, Arnaud Macadre, Toshihiro Tsuchiyama et al., Achieving a Carbon Neutral Future through Advanced Functional Materials and Technologies, *Bulletin of the Chemical Society of Japan*, 95, 73-103, doi: 10.1246/bcsj.20210323, 2022.

F. Jiang, H Liu, X Chen, T. Tsuji, A coupled LBM-DEM method for simulating the multiphase fluid-solid interaction problem, *Journal of Computational Physics*, 110963, doi: 10.1016/j.jcp.2022.110963, 2022.

K. Sawayama, T. Ikeda, T. Tsuji, F. Jiang, O. Nishizawa, Y. Fujimitsu, Elastic wave velocity changes due to the fracture aperture and density, and direct correlation with permeability: an energetic approach to mated rock fractures, *Journal of Geophysical Research: Solid Earth*, 127(2), e2021JB022639, doi: 10.1029/2021JB022639, 2022.

Y. Zhang, F. Jiang, T. Tsuji, Influence of pore space heterogeneity on mineral dissolution and permeability evolution investigated using lattice Boltzmann method, *Chemical Engineering Science*, doi: 10.1016/j.ces.2021.117048, 2022.

Y. Suwa, S. Ko, T. Obata, S. Nakagawa, R. Morishita, K. Sawayama, T. Tsuji, 機械学習による弾性波速度測定実験の自動解析技術, *IEICE Journal D*, D 105 (1), 52-59, doi: 10.14923/transinfj.2021SKP0001, 2022.

A. Suzuki, M. Miyazawa, J. Minto, T. Tsuji, I. Obayashi, Y. Hiraoka, T. Ito, Flow estimation solely from image data through persistent homology analysis, *Scientific Reports*, 11, 17948, doi: 10.1038/s41598-021-97222-6, 2021.

I. Ando, Y. Mugita, K. Hirayama, S. Munetoh, M. Aramaki, F. Jiang, T. Tsuji, A. Takeuchi, M. Uesugi, Y. Ozaki, Elucidation of pore connection mechanism during ductile fracture of sintered pure iron by applying persistent homology to 4D images of pores: Role of open pore, *Materials Science and Engineering: A*, 828, 142112, doi: /10.1016/j.msea.2021.142112, 2021.

A.B. Ahmad, and T. Tsuji, Machine learning for automatic slump identification from 3D seismic data at convergent plate margins, *Marine and Petroleum Geology*, 133, 105290, 2021.

M. Mourad, T. Tsuji, T. Ikeda, K. Ishitsuka, S. Senna, K. Ide, Mapping aquifer atorage properties using S-Wave velocity and InSAR-derived surface displacement in the Kumamoto Area, Southwest Japan. *Remote Sensing*, 13(21), 4391, doi: 10.3390/rs13214391, 2021.

C. Chhun and T. Tsuji, Pore pressure and gas saturation distribution in the forearc basin of the Nankai subduction zone inferred from high-resolution V_p and V_s , *Petroleum Science and Engineering*, 205, 108911, doi: 10.1016/j.petrol.2021.108911, 2021.

T. Tsuji, M. Sorai, M. Shiga, S. Fujikawa, T. Kunitake, Geological storage of CO₂-N₂-O₂ mixtures produced by membrane-based direct air capture (DAC). *Greenhouse Gas Sci Technol*, 11: 610-618, doi: 10.1002/ghg.2099, 2021.

T. Tsuji, T. Ikeda, R. Matsuura, K. Mukumoto, F.L. Hutapea, T. Kimura, K. Yamaoka, M. Shinohara, Continuous monitoring system for safe managements of CO₂ storage and geothermal reservoirs, *Scientific Reports*, 11, 19120, doi: 10.1038/s41598-021-97881-5, 2021.

T. Hirose, Y. Hamada, W. Tanikawa, N. Kamiya, Y. Yamamoto, T. Tsuji, M. Kinoshita, V.B. Heuer, F. Inagaki, Y. Morono, Y. Kubo, High fluid-pressure patches beneath the décollement: A potential source of slow earthquakes in the Nankai Trough off Cape Muroto. *Journal of Geophysical Research: Solid Earth*, 126, e2021JB021831, doi: 10.1029/2021JB021831, 2021.

T. Ikeda, T. Tsuji, K. Konishi, H. Saito, Spatial autocorrelation method for reliable measurements of two-station dispersion curves in heterogeneous ambient noise wavefields, *Geophysical Journal International*, 226 (2), 1130-1147, doi: 10.1093/gji/ggab150, 2021.

A.B. Ahmad, and T. Tsuji, Traffic monitoring system based on deep learning and seismometer data, *Applied Sciences*, 11(10), 4590, doi: 10.3390/app111045902021, 2021.

K. Sawayama, T. Ishibashi, F. Jiang, T. Tsuji, O. Nishizawa, Y. Fujimitsu, Scale independent relationship between permeability and resistivity in mated fractures with natural rough surfaces, *Geothermics*, 94, 102065, doi: 10.1016/j.geothermics.2021.102065, 2021

K. Sawayama, T. Ishibashi, F. Jiang, T. Tsuji, Y. Fujimitsu, Relating Hydraulic-Electrical-Elastic Properties of Natural Rock Fractures at Elevated Stress and Associated Transient Changes of Fracture Flow, *Rock Mechanics and Rock Engineering*, 54(5), 2145–2164, doi:10.1007/s00603-021-02391-5, 2021.

H. Nimiya, T. Ikeda, T. Tsuji, Temporal changes in anthropogenic seismic noise levels associated with economic and leisure activities during the COVID-19 pandemic, *Scientific Reports*, 11, 20439, doi: 10.1038/s41598-021-00063-6, 2021.

折田まりな, 池田達紀, 辻健, 月面探査に向けた地震アレイの小型化：アポロの微動データをを用いた可探深度の検討, 物理探査, 74, 79-91, doi: 10.3124/segj.74.79, 2021.

2) 研究発表 / Presentations

【 国際発表 】 (International)

AGU Fall Meeting 2021, 13-17 December 2021, New Orleans, LA

B. Nthaba, T. Ikeda, T. Tsuji, H. Nimiya, Y. Iio, Characterizing the crustal structure of the Kinki Area, Southwestern Japan using ambient noise surface waves tomography, *AGU Fall Meeting 2021*, 13-17 December 2021.

C. Chhun, T. Tsuji, T. Ikeda, S-wave velocity structure and temporal velocity change derived from ambient noise data in geothermal fields, the Great Rift Valley, Kenya, *AGU Fall Meeting 2021*, 13-17 December 2021.

N. Suwandi, F. Jiang, T. Tsuji. Investigation of viscosity ratio and capillary number influence on relative permeability in a two-phase flow system using Lattice Boltzmann method, *AGU Fall Meeting 2021*, 13-17 December 2021.

Y. Zhang, F. Jiang, T. Tsuji. Investigate the effect of pore structure heterogeneity on hydraulic and electrical conductivities evolution induced by mineral dissolution, *AGU Fall Meeting 2021*, 13-17 December 2021.

K. Sawayama, T. Ishibashi, F. Jiang, T. Tsuji. Relationship between permeability and resistivity explored via the numerical simulation of sheared fractures, *AGU Fall Meeting 2021*, 13-17 December 2021.

EGU General Assembly 2021, 19-30 April 2021

C. Chhun and T. Tsuji, Natural and artificial pore pressure variation for distinguishing earthquakes induced by CO₂ injection from natural earthquakes, *EGU General Assembly 2021*, 19-30 April 2021.

F. L. Hutapea, T. Tsuji, Katou, M., Asakawa, E., Shallow imaging of gas and hydrate using the deep-towed ACS data in Joetsu basin, Niigata, Japan, *EGU General Assembly 2021*, 19-30 April 2021.

R. D. Andajani, T. Tsuji, R. Snieder, T. Ikeda, Spatial evaluation of pore pressure variations related to rainfall from seismic velocity changes, *EGU General Assembly 2021*, 19-30 April 2021.

K. Mukumoto and T. Tsuji, S-wave velocity structure in the central Japan derived from adjoint tomography, *EGU General Assembly 2021*, 19-30 April 2021.

International Joint Workshop on Slow Earthquakes 2021

Fahrudin, C. Chhun, T. Tsuji, Tectonic tremors controlled by the shear zone thickness and strike-slip fault in Nankai Trough, Japan. *International Joint Workshop on Slow Earthquakes 2021*, Online, 14-16 September 2021.

International Symposium on Earth Science and Technology (CINEST) 2021, 26-27 November 2021, Kyushu University, Fukuoka

A. B. Ahmad and T. Tsuji, Seismic traffic footprint identification based on AI techniques, *International Symposium on Earth Science and Technology (CINEST) 2021*, Online, 25-26 November 2021.

B. Nthaba, T. Ikeda, T. Tsuji, H. Nimiya, Y. Iio, The use of high-resolution ambient noise surface wave tomography to map sedimentary and tectonic structures in the Kinki Area, Southwestern Japan, *International Symposium on Earth Science and Technology (CINEST) 2021*, 25-26 November 2021.

K. Shige, T. Tsuji, T. Ikeda, K. Sawayama, Estimation of elastic wave velocity in digital rocks: insight from feature extraction of pore structure using convolutional neural network, *International Symposium on Earth Science and Technology (CINEST) 2021*, 25-26 November 2021.

N. Suwandi, F. Jiang, T. Tsuji, Computational study for influence of viscosity ratio and capillary number on relative permeability value in a 2-phase flow system, *International Symposium on Earth Science and Technology (CINEST) 2021*, 25-26 November 2021.

M. Orita, T. Ikeda, T. Tsuji, K. Mukumoto, Estimating subsurface structure of Mars using ambient noise from InSight seismic data, *International Symposium on Earth Science and Technology (CINEST) 2021*, 25-26 November 2021

R. Matsuura, T. Tsuji, T. Ikeda, Subsurface reservoir monitoring system using continuous and controlled artificial seismic source, *International Symposium on Earth Science and Technology (CINEST) 2021*, 25-26 November 2021.

T. S. Imam, T. Ikeda, T. Tsuji, J. Uesugi, Y. Okaue, Imaging lithological boundary in the Hishikari mine area by using autocorrelation analysis of seismic data from mine explosions, *International Symposium on Earth Science and Technology (CINEST) 2021*, 25-26 November 2021.

Proceedings of the 14th SEGJ International Symposium, Tokyo, Japan

B. Nthaba, T. Ikeda, T. Tsuji, H. Nimiya, Y. Iio, Three-dimensional S-wave velocity structure of the Kinki Region, southwestern Japan with ambient seismic noise tomography using a dense seismic array. *Proc. of the 14th SEGJ International Symposium on Geophysics*, 2021, 18-21 October 2021.

M. Mourad, T. Tsuji, T. Ikeda, K. Ishitsuka, S. Senna, Mapping aquifer storage properties using S-wave velocity and InSAR measurements in the Kumamoto area, Japan. *Proc. of the 14th SEGJ International Symposium on Geophysics*, 2021, 18-21 October 2021.

K. Sawayama, T. Ishibashi, F. Jiang, T. Ikeda, T. Ishibashi, T. Tsuji, O. Nishizawa, Y. Fujimitsu, Digital rock physics revealing the relationships between permeability, resistivity and elastic wave velocity of rock fractures. *Proc. of the 14th SEGJ International Symposium on Geophysics*, 2021, 18-21 October 2021.

T. Ikeda, T. Tsuji, K. Konishi, H. Saito, Characterization and utilization of heterogeneous ambient noise field for imaging subsurface structure in the Itoshima Peninsula, Japan, *Proc. of the 14th SEGJ International Symposium on Geophysics*, 2021, 18-21 October 2021.

6th International Conference on Engineering Geophysics, Virtual, 25–28 October 2021

A. B. Ahmad, T. Tsuji, Saibi, and H., Belkacem, A. N., Vehicles detection based on their seismic surface waves using classification techniques, *in: Sixth International Conference on Engineering Geophysics*, Virtual, 25–28 October 2021. pp. 244–247. doi: 10.1190/iceg2021-063.1

Proceedings of World Geothermal Congress

K. Sawayama, F. Jiang, T. Ikeda, T. Ishibashi, T. Tsuji, Y. Fujimitsu, H. Asanuma, Estimation of permeability and water saturation from the resistivity and elastic wave velocity: Insight from laboratory experiment and digital fracture simulation, *Proceedings of World Geothermal Congress 2020+1*, 1–10, 2021.

1st International conference on Earth Resources and Geo-Environmental Technology (EraGET2022), Virtual, 18-19 February 2022

C. Chhun, T. Tsuji, and T. Ikeda, S-wave velocity structure derived from potential geothermal reservoirs in Kenyan Great Rift and Volcanism, *Proceedings of EraGET2022*, 18-19 February 2022.

【 国内発表 】 (Domestic)

第 144 回 物理探査学会 2021 年 6 月 9 日～11 日

池田達紀, 辻健, 小西 千里, 斎藤 秀樹, 糸島半島の不均質な微動場から抽出された表面波と実体波, 2021 年 6 月 10 日

竹之内秀斗, 椋本浩太, 辻健, 小平 秀一, 藤江 剛, 中村 恭之, 白石 和也, 反射法地震探査データの自動速度解析による熱流量の推定: 活断層の推定に向けた試み, 2021 年 6 月 9 日

國増貴明, 澤山和貴, 池田達紀, 辻健, デジタル岩石物理による月レゴリスシミュラントの氷含有率と弾性波速度の関係: 月の水資源探査に向けて, 2021 年 6 月 9 日

折田まりな, 池田達紀, 辻健, CCA 法での解析に基づく小型微動アレイ探査システムの月探査での活用に向けた検討, 2021 年 6 月 11 日

内垣友貴, 辻健, 鶴山 尚大, 金森 洋史, 氷が与えるレゴリスシミュラントの S 波速度への影響の検討, 2021 年 6 月 9 日

辻健, Fernando Lawrens-Hutapea, 池田達紀, 篠原雅尚, 山岡耕春, 木村恒久, 菊池竜之介, 土家輝光, 連続震源装置と DAS を用いた海域 CO2 貯留サイト連続モニタリングに向けた試み, 2021 年 6 月 9 日

第 145 回 物理探査学会 2021 年 11 月 24 日~26 日

國増貴明, 澤山和貴, 池田達紀, 辻健, デジタル岩石物理及び室内実験による月レゴリスシミュラントの氷含有率と S 波速度の関係, 2021 年 11 月 24 日

荒巻健, 池田達紀, 辻健, 山浦悠貴, 雑微動を用いた表面波トモグラフィによる地熱地域の 3 次元 S 波速度構造, 2021 年 11 月 24 日

椋本浩太, 辻健, 池田達紀, 上杉次郎, 佐々連鉱山における DAS を用いた地震波速度モニタリング, 2021 年 11 月 26 日

辻健, 木下順二, 池田達紀, 上杉次郎, イメージングとモニタリングを目的としたポータブル型アクティブ震源装置 (PASS) の開発, 2021 年 11 月 26 日

JpGU 2021

竹之内秀斗, 椋本浩太, 辻健, 小平秀一, 藤江 剛, 中村 恭之, 白石 和也, Estimation of the active faults from BSR-derived heat flow by automated velocity analysis in the Nankai Trough, Japan, 2021 年 6 月 5 日

折田まりな, 池田達紀, 辻健, 月などの地球外天体において簡易に地下構造を調べるためのシステム開発 ~CCA 法による地震アレイ探査の小型化~, 2021 年 6 月 4 日

澤山和貴, 西澤修, 池田達紀, 蔣飛, 辻健, 藤光康宏, デジタル岩石物理とエネルギー論的アプローチによる岩石亀裂の弾性波速度推定, 2021 年 6 月 5 日.

日本惑星科学会 2021 年秋季講演会, 2021 年 9 月 16 日~18 日, オンライン

折田まりな, 池田達紀, 辻健, 月面での小型な地震アレイ探査の有効性と可探深度の検討～
月における水資源探査や地盤調査に向けて～, 2021年9月18日

(3) 招待講演 / Invited Lectures

T. Tsuji, "Geophysical imaging and monitoring for resource exploration and CO₂ reduction"
EraGET2022, Cambodia (online), 18, February 2022.

T. Tsuji, "New CCS technologies, including DAC-captured low-purity CO₂", Global CCS Institute,
Online, 28 July 2021.

T. Tsuji, "Management of CO₂ in the Atmosphere and Ocean Using Solid Earth", 2021 Japan-
America Frontiers of Engineering Symposium (JAFOE), Online, 25 June 2021.

T. Tsuji, "Management of CO₂ in atmosphere and ocean, using the solid earth", The 2nd YU-
SDGs Cafe "Let's Think about Global Warming with Researchers as OUR Problem",
Yamagata University (Online), 31 May 2021

(4) 高校訪問事業（出前講義）

池田 達紀, 地球の内部構造を可視化して、資源探査や防災に貢献しよう, 愛光高等学校,
2021年10月26日(オンライン)

(5) 書籍・学術資料等 / Books and Academic articles

(6) 新聞 / Newspapers

(7) Web ニュースなど / Website News

南海トラフのスロー地震震源域近傍に高圧の間隙水帯を確認, 九州大学 HP, 2021年6月17
日

(8) 表彰 / Award

Bokani Nthaba, The 14th SEGJ International Symposium Outstanding Student Presentation Award

Kazuki Sawayama, The 14th SEGJ International Symposium Outstanding Student Presentation Award

R. Matsuura, T. Tsuji, T. Ikeda, Subsurface Reservoir Monitoring System using Continuous and Controlled Artificial Seismic Source, CINEST MITSUI MATSUSHIMA award for best presentation, November 2021.

内垣 友貴, 辻 健, 鶴山 尚大, 金森 洋史, 氷が与えるレゴリスシミュラントの S 波速度への影響の検討, 第 144 回 (2021 年度春季) 学術講演会 優秀発表賞 (口頭)