

地圏システムと構成物質の理解とその有効利用

Understanding of geosystems and geomaterials and their effective uses



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国際共同研究プロジェクト (SATREPS) を通じて、エルサルバドルの火山システムの特徴と地熱資源の実態を明らかにするために、詳細な地質調査と岩石試料の化学分析を行い、長石を対象とした新たな熱発光解析法の開発を進めた。また、エルサルバドルからの研修生を受け入れ、機器分析、シミュレーションなどの実践的内容の地熱スクールを実施した。地殻の流体-岩石反応についての研究において、加水膨張反応による岩石破壊のメカニズムを実験と数値シミュレーションにより明らかにするとともに、亀裂パターンと透水性の関係について明らかにした。また、南極やモンゴルのフィールドを対象とした研究では、鉱物脈や反応帯の組織解析と反応輸送モデリングにより、地殻や沈み込み帯における地震発生・鉱床形成との関連した短期間で変動する地殻流体流動の描像を明らかにした。さらに、超臨界地熱資源の開発に向けた基礎研究として、超臨界領域への溶存種の熱力学データの拡張を進めるとともに、海洋地殻の熱水系における開放系の変成作用、水の相変化に伴うシリカナノ粒子の形成・運搬挙動、流体の減圧に伴う破砕プロセスについてなど、超臨界・亜臨界状態における岩石-水相互作用の研究を進めている。

Through the SATREPS international collaborative research project, we carried out a geological survey of the volcanic system and geothermal resources in El Salvador and the chemical analysis of rock samples. We also developed the methodology for thermoluminescence analysis of feldspars. In addition, El Salvadorian students were provided with a geothermal training program that contained practical contents such as instrument analysis and simulations. In the studies on the fluid-rock reaction within crusts, reaction-induced fracturing during hydration of rocks was examined by laboratory experiments and numerical simulations. We also clarified the relationship between fracture pattern and crust permeability. In the field survey of Antarctica and Mongolia, we analyzed mineral veins and reaction zones using textural analyses and reactive-transport modeling, and we revealed the short-term crustal fluid flow related to earthquake generation and ore formation in the crust and subduction zone. Furthermore, to develop supercritical geothermal resources, we conducted various studies on water-rock interaction under sub- to supercritical conditions, including expansion of the thermodynamic data of dissolved species into the supercritical region, metamorphism in hydrothermal systems of the oceanic seafloor, the formation and transport silica nanoparticles, and rock-fracturing induced by fluid decompression.

現在進めている研究テーマ

- 超臨界地熱システムのナチュラルアナログ研究 (仙岩地域、モンゴル、金華山)
- 熱発光による地熱探査法の開発
- 延性地殻における減圧、水圧破砕実験
- 地殻と沈み込み帯の変成作用と流体流動 (モンゴル、南極、オマーン)
- シリカ析出と地震発生プロセス
- 反応に起因する岩石破壊に関する実験とモデリング
- 廃アルミニウムと温泉水を用いた水素発電システムの開発
- 機械学習と統計学的アプローチによる高次元地球化学データ解析

参加国際学会

16th International symposium on Water Dynamics, March 12-14, Sendai (Organized)・European Geosciences Union, General

Research topics

Natural analogue studies on supercritical geothermal systems/Geothermal exploration method by thermoluminescence/Experimental studies on hydrofracturing and decompression fracturing of ductile crust/Metamorphism and fluid flow within crust and subduction zone (Mongolia, Antarctica, Oman)/Silica precipitation and earthquakes/Experiments and modeling of reaction-induced fracturing of rocks/Hydrogen power generation system using waste aluminum and hot spring water/Statistical and machine-learning approaches on high-dimensional geochemical data analyses.

Participating in international conferences

16th International Symposium on Water Dynamics, March 12-14, Sendai (Organized)・European Geosciences Union, General Assembly, April 7-12, Vienna, Austria・International Geoscience and Remote Sensing Symposium, July 28-August 2, Yokohama・Geothermal Volcanology Workshop 2019,

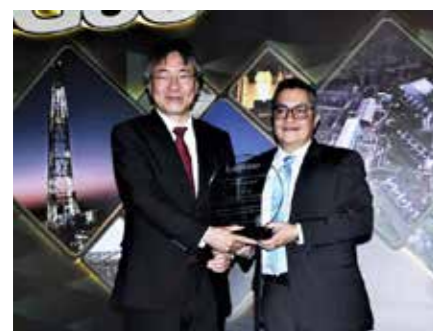


Fig.1 "Victor de Sola" award to Prof. Tsuchiya from LaGeo in El Salvador (October).

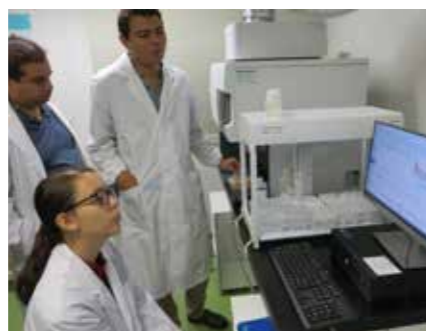


Fig.2 Training of solution analyses by ICP-OES in SATREPS geothermal school (Sendai, October).

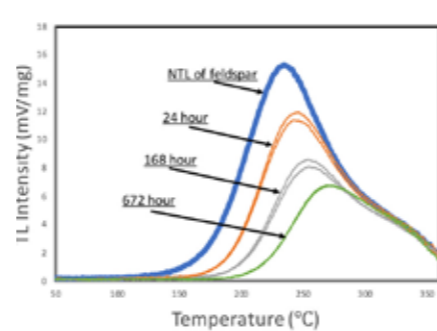


Fig.3 Grow curves of thermoluminescence of feldspar after heating at 125 °C.



准教授 岡本 敦 Associate Professor Atsushi Okamoto
助教 宇野 正起 Assistant Professor Masaaki Uno
助手 山岸 裕幸 Research Associate Hiroyuki Yamagishi
研究員 山崎 慎一 Researcher Shinichi yamasaki
研究員 山田 亮一 Researcher Ryoichi Yamada
日本学術振興会特別研究員 東野 文子 JSPS Research Fellowship for Young Scientist Researcher Fumiko Higashino
日本学術振興会特別研究員 永治 方敬 JSPS Research Fellowship for Young Scientist Researcher Takayoshi Nagaya

Assembly, April 7-12, Vienna, Austria・International Geoscience and Remote Sensing Symposium, July 28-August 2, Yokohama・Geothermal Volcanology Workshop 2019, September 5-9, Petropavlovsk-Kamchatsky, Russia・International Forum on Earth, Energy and Environment, November 11, Taiwan

研究プロジェクト・主な外部獲得資金

- [科研費補助金]
- 基盤研究 (B) (岡本)、挑戦的研究 (萌芽) (岡本)
- 若手研究 (宇野)、国際共同研究強化 (A) (岡本)
- 新学術領域公募研究 (宇野)
- [その他]
- SATREPS「地球規模課題対応国際科学技術協力プログラム」(土屋)、NEDO「超臨界地熱発電技術研究開発」プロジェクト (土屋、岡本)

教育・メディア報道など

- ・エルサルバドル大学へ地熱研究装置類一式を贈呈, Diario Co Latino(新聞), 2019.8.20
- ・毒水が新エネに変身、ドローンも車も動く!一, 日テレ NEWS24, 2019.9.20
- ・仙北・玉川温泉から水素燃料1日100リットルの確保目指す東北大と市が事業報告会一, 河北新報, 2019.12.4
- ・マグマ由来の流体による微小な割れ目網が地下水の流路に, 科学新聞, 2019.11.29

研究室の在学生

博士課程 10名 (インドネシア人4名、ロシア人1名、エルサルバドル人1名、モンゴル人1名)
修士課程 11名 (エルサルバドル人1名、モンゴル人1名)
学部生 9名 (インドネシア人1名)
研究室ホームページ <http://geo.kankyo.tohoku.ac.jp/gmel/>

September 5-9, Petropavlovsk-Kamchatsky, Russia・International Forum on Earth, Energy and Environment, November 11, Taiwan

Research projects, major externally acquired funds

[MEXT/JSPS KAKENHI]
Grant-in-Aid for Scientific Research (B) (Okamoto), Grant-in-Aid for Challenging Research (Okamoto); Grant-in-Aid for Young Scientists (Uno), Fund for the Promotion of Joint International Research (Okamoto), Grant-in-Aid for Scientific Research on Innovative area (B) (Uno)

[Others]
JST-JICA Science and Technology Research Partnership for Sustainable Development (SATREPS) (Tsuchiya), NEDO Research and Development of Supercritical Geothermal Power Generation Technology (Tsuchiya, Okamoto)

Education, media coverage

- ・Newspaper, *Deario Co Latino* (El Salvador), "Donation of a complete set of geothermal research equipment to the University of El Salvador"
- ・Nittere NEWS24 broadcasting, "Poison water turns into new energy, drone and car move," November, 20
- ・Newspaper, *Kahoku Shinpo*, "Hydrogen fuel from Semboku and Tamagawa Hot Springs Semboku City and Tohoku University aiming to secure 100 liters a day," December 4.
- ・Newspaper, *Kagaku Shinbun*, "Microfracture networks activated by magmatic fluids act as flow channels of ground water", November 29.

Lab members

Doctoral course: 10 students (4 Indonesian, 1 Russian, 1 El Salvadorian, 1 Mongolian)
Master's course: 11 students (1 El Salvadorian, 1 Mongolian)
Undergraduate students: 9 students (1 Indonesian)
Lab homepage: <http://geo.kankyo.tohoku.ac.jp/gmel/>

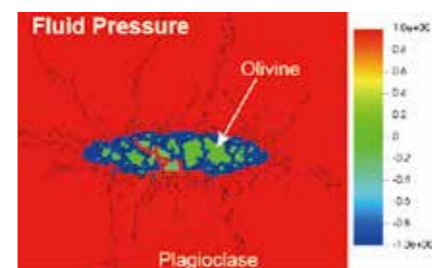


Fig.4 The numerical simulation on reaction-induced fracturing of oceanic crust during hydration.

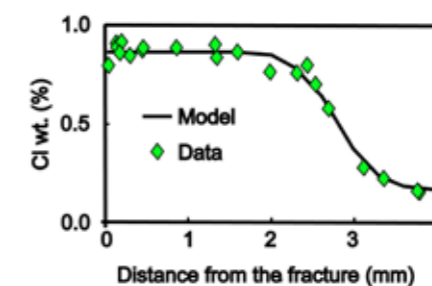


Fig.5 Cl-profiles in apatite around the reaction zone within the middle crust from Sor Rondane Mountains, East Antarctica.



Fig.6 Field survey to acid lake (pH = 0) at Ijen crator, east Java, Indonesia.