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aXis BAGUS Project News

The project obviously has been greatly affected by COVID-19 in its entire project term. The Kyoto University team hoped to visit the drilling site at Patuha at least once and to participate in the survey activities together with the ITB team and other Indonesian counterparts but the prevailing COVID-19 situation finally did not allow that to happen.

At a time, due to complicated government procedures in connection with the land permit etc. the commencement of the drilling survey was delayed much and it made the entire project team worried if the planned survey can be completed within the project term of March 2022. Fortunately, with concerted efforts of the ITB team and other Indonesian counterparts and of course the NewJec team, the drilling survey was able to produce the results of which the project can be proud.

Research Activity Progress

Following the TEM (Transient Electromagnetic) survey conducted in October 2020 by the ITB team at the two locations of TCH sites (TCH-A and TCH-B) which aimed to get the images of subsurface structures which may contribute to a permeability zone of hot steam flow, drilling operations have finally been carried out in collaboration between NewJEC, PT Petrotec Guna Perkasa and Center for Coal, Mineral, and Geothermal Resources (CMCGR).

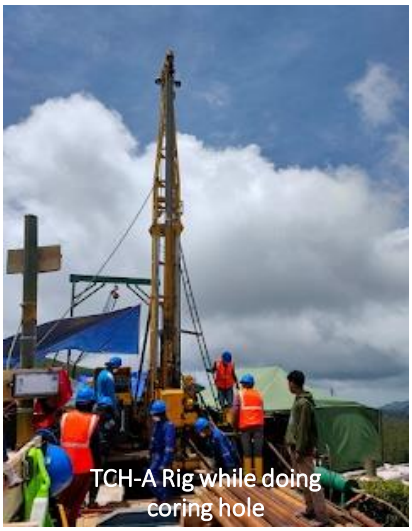
The wellpad preparation at TCH-A was carried out on 13th to 28th January 2022, followed by the mobilization of drilling equipment on February 2nd to 3rd, 2022. Drilling was started on February 19th, 2022 after waiting for all supporting equipment. Meanwhile, the wellpad preparation at TCH-B was carried out on February 8th to 26th, 2022. The mobilization of drilling equipment was carried out on March 2nd to 3rd, 2022 and is in the process of preparing supporting equipment before starting the drilling.

Samples drilled at TCH-A showed that up to 15.60 m depth, the type of overburden was soil, followed by andesite up to a depth of 32.50 m, and then tuff. In the depths 29.40 to 47.40 m there has been lost circulation which is probably caused by the presence of a fracture zones. Until March 5th, 2022 the drilling reached a total depth of 68.40 m out of the targeted 500 m. During the drilling, wellsite geologists from CMGCR were assisted by undergraduate and graduate students from ITB.

Preparation of drilling machine mobilization from CMCGR Office to TCH-A

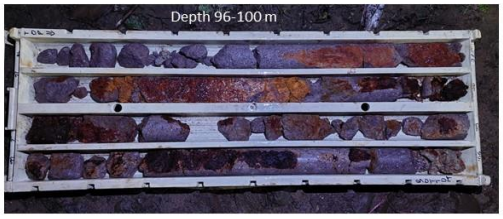
Wellpad preparation of TCH-A

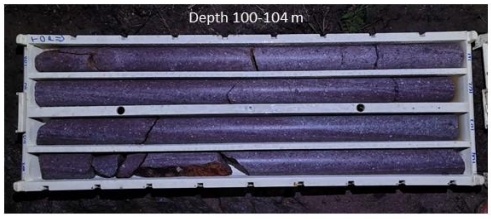
TCH-A Rig in elevation of 2243 m above sea level with Patengan Lake in the background

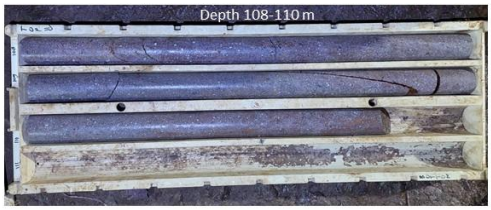


TCH-A Rig while doing coring hole

TCH-A: reach total depth 110 m on March 08, 2022 in early morning







Left: Location of TCH-B; right: preparing the mobilization of second drilling machine from CMCGR Office to location

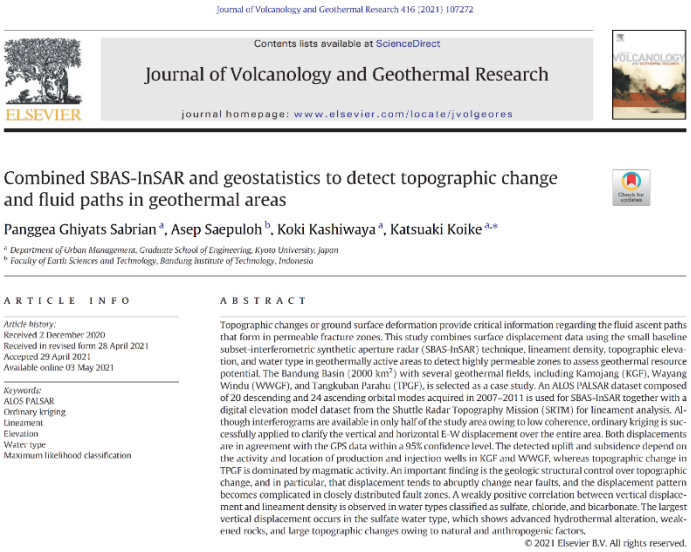
TCH-B: start for drilling (spud in) on March 08, 2022 at 01.45 am

0.0 m - 1.4 m: ground level to bottom of cellar hole
1.4 – 4.0 m: Oxidized Andesite

Other Research Activities

Some notable activities within the aXis BAGUS Project team are the acceptance of not one, but two papers. One paper, titled "Combined SBAS-InSAR and geostatistics to detect topographic change and fluid paths in geothermal areas" by Panggea Ghiyats Sabrian, published in a reputable geothermal journal, Journal of Volcanology and Geothermal Research, vol. 416, 107272.

Sabrian P. G., Saepuloh A., Kashiwaya K. and Koike K. (2021) Combined SBAS-InSAR and geostatistics to detect topographic change and fluid paths in geothermal areas. Journal of Volcanology and Geothermal Research, vol. 416, 107272, (https://doi.org/10.1016/j.jvolgeores.2021.107272)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Combined SBAS-InSAR and geostatistics to detect topographic change and fluid paths in geothermal areas

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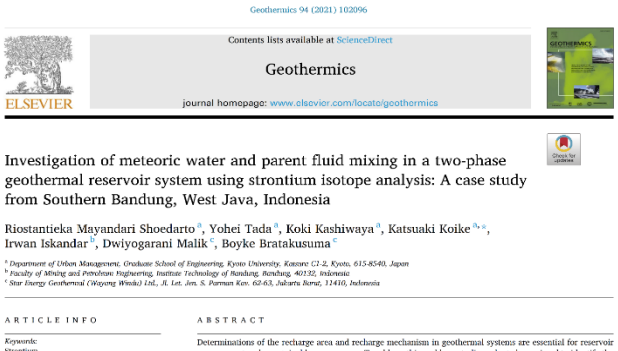
ABSTRACT

Topographic changes or ground surface deformation provide critical information regarding the fluid ascent paths that form in permeable fracture zones. This study combines surface displacement data using the small baseline subset-interferometric synthetic aperture radar (SBAS-InSAR) technique, lineament density, topographic elevation, and water type in geothermally active areas to detect highly permeable zones to assess geothermal resource potential. The Bandung Basin (2000 km²) with several geothermal fields, including Kamojang (KGF), Wayang Windu (WWGF), and Tangkuban Parahu (TPGF), is selected as a case study. An ALOS PALSAR dataset composed of 20 descending and 24 ascending orbital modes acquired in 2007–2011 is used for SBAS-InSAR together with a digital elevation model dataset from the Shuttle Radar Topography Mission (SRTM) for lineament analysis. Although interferograms are available in only half of the study area owing to low coherence, ordinary kriging is successfully applied to clarify the vertical and horizontal E-W displacement over the entire area. Both displacements are in agreement with the GPS data within a 95% confidence level. The detected uplift and subsidence depend on the activity and location of production and injection wells in KGF and WWGF, whereas topographic change in TPGF is dominated by magmatic activity. An important finding is the geologic structural control over topographic change, and in particular, that displacement tends to abruptly change near faults, and the displacement pattern becomes complicated in closely distributed fault zones. A weakly positive correlation between vertical displacement and lineament density is observed in water types classified as sulfate, chloride, and bicarbonate. The largest vertical displacement occurs in the sulfate water type, which shows advanced hydrothermal alteration, weakened rocks, and large topographic changes owing to natural and anthropogenic factors.

Mr. Panggea published this paper of a part of his PhD study related to the SATREPS and aXis BAGUS projects. Besides, he had been awarded Ph.D. degree (Engineering) from Kyoto University on March 24th, 2022. A Defense on his dissertation, entitled “Improvement of Differential Interferometric Synthetic Aperture Radar (D-InSAR) technique to accurate and overall displacement monitoring in geothermal fields for sustainable resource use”, February 22nd, 2022. Mr. Panggea will be an assistant professor at Department of Mining Engineering, Mulawarman University, Kalimantan. We hope his furthermore development in remote sensing applications to geothermal research.

The other paper, entitled "Investigation of meteoric water and parent fluid mixing in a two-phase geothermal reservoir system using strontium isotope analysis: a case study from Southern Bandung, West Java, Indonesia" by Riostantieka Mayandari who contributed to the SATREPS and aXis projects from the beginning, was published in Geothermics, a leading geothermal journal as well as JVGR. It was a part of her Ph.D. study and being her second paper published in Geothermics.

Shoedarto R. M., Tada Y., Kashiwaya K., Koike K., Iskandar I., Malik D. and Bratakusuma B. (2021) Investigation of meteoric water and parent fluid mixing in a two-phase geothermal reservoir system using strontium isotope analysis: a case study from Southern Bandung, West Java, Indonesia. Geothermics, vol. 94, 102096, (https://doi.org/10.1016/j.geothermics.2021.102096)


Geothermics 94 (2021) 102096

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Investigation of meteoric water and parent fluid mixing in a two-phase geothermal reservoir system using strontium isotope analysis: A case study from Southern Bandung, West Java, Indonesia

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ABSTRACT

Determinations of the recharge area and recharge mechanism in geothermal systems are essential for reservoir management and a sustainable resource use. To address this problem, studies aplenty have aimed to identify the recharge elevation using stable water isotopes, δ^2H and $\delta^{18}O$. Nevertheless, the physical and chemical processes involved in the generation of a reservoir fluid from a deeply infiltrated recharge flow remain poorly understood. This study aims to clarify this process using strontium (Sr) concentrations and isotope composition from water and well rock samples by selecting a geothermal field with a two-phase reservoir system in Southern Bandung, West Java, Indonesia. The water samples are characterized by variable Sr isotopic compositions ($^{87}Sr/^{86}Sr$) (0.70450–0.70725) and low Sr concentrations (0.01–0.72 ppm). The $^{87}Sr/^{86}Sr$ of the well rocks is also variable (0.70400–0.70827) with particularly high Sr concentrations (9.1–53 ppm). Three types of domain that are the combinations of the reservoir fluid mixing with groundwater are identified. The first two types are shallow and deep groundwater composed of 90 % meteoric water and 10 % upflow fluids with Sr concentration 0.01 to 0.11 ppm and the $^{87}Sr/^{86}Sr$ from 0.7055 to 0.70725. The shallow groundwater may possibly carry a $^{87}Sr/^{86}Sr$ anomaly (higher than $^{87}Sr/^{86}Sr$ of plagioclase: 0.7065) from the anthropogenic activities through the pathways created by the intersection of the NW-SE and NE-SW inferred regional faults in the west part of the field, hosted by the Wayang Windu Formation. The deep groundwater type is also a mixture of 10 % parent fluid hosted by the deeper aquifer rocks Malabar Formation, with lower strontium isotopes ratio than the first aquifer ($^{87}Sr/^{86}Sr$ 0.7045–0.7055). The third groundwater refers to the perched aquifer with mixture of 30 %–70 % parent fluid that has undergone condensation and mixing processes in Pangalengan Formation ($^{87}Sr/^{86}Sr$ 0.70452–0.7052). This groundwater is thought to be the source of mostly hot springs in the study area.

After continuing post-doctoral research at Kyoto University for one and half years, Ms. Riostantieka returned to Indonesia in December and is now a researcher at the National Research and Innovation Agency, Jakarta. She completed third paper about an application of Rare Earth Elements (REE) to fluids flow modeling in Wayang Windu, in which she was able to clarify in more detail the flow system by a combination of REE and previous outcomes of water and strontium isotopes. We believe her furthermore development in geochemical approach to geothermal research.

Other researchers progress worth noting are Brenda Ariesty Kusumasari, is now developing a multi-geothermometer method to estimate reservoir temperature more accurately, and will analyze mineralogical and chemical compositions and fluid inclusions of the Patuha drilling cores as well as Heru Berian Pratama and Mochamad Iqbal who passed the Ph.D. entrance examination and will enter the Ph.D. course. They will certainly contribute the next BAGUS project by numerical simulation of reservoir and power output with different generation systems (H.B.P.) and geothermal resource assessment through a combination of remote sensing, geophysical and geochemical data, and machine learning (M.I.).

Continuation of aXis BAGUS Project

As planned the aXis BAGUS Project successfully ended by the end of March 2022 and the project continues as "*Advanced joint research for detection of critical spot in reservoir enabling great promotion of geothermal power generation*". This is the post-aXis BAGUS project and will be funded by ***JSPS KAKENHI*** (Grants-in-Aid for Scientific Research) under the Japanese Ministry of Education, Culture, Sports, Science and Technology.

Following the essence of SATREPS-aXis BAGUS projects, this project aims to develop three new technologies that enable to

(1) specify the location of "Critical Spot",
(2) clarify and verify the ascent fluid paths from the Critical Spot, and
(3) predict electric power generation and its temporal change for sustainable resource use.

Critical Spot is a new concept for a specific location in a deep part of geothermal reservoir where the temperature and pressure of fluids are near the critical point of water (374 °C and 22.1 MPa), but permeable fractures for the fluid paths exist.

Detection of Critical Spots must increase the success ratio of deep drilling to reach the portions of large energy in deep reservoir, increase double or more the geothermal power generation by the advanced technology, and estimate accurately the ultimate possible power generation by geothermal resource over a country.

This project was adopted in the last October 2021 and will continue until the end of March 2026 for four and half years and Prof. Koike continues to serve as the project leader.