GEOCAP
Geothermal Capacity Building Program Indonesia - Netherlands

Date: 17 December 2015

Work package 2.05 Hydrofracturing and acidizing: -Data analysis and selection criteria for the Wayang Windu site

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Document number: GEOCAP/2015/REP/institution/WP2.05/hydrofracturing

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1 WAYANG WINDU AREA

1.1 BRIEF DESCRIPTION

The volcanic area of Wayang Windu is named after the two mounts Wayang and Windu. An operating geothermal power plant owned by Star Energy is located in the area. The field is considered as a transition between a vapour dominated and liquid dominated system. Two of the centres are associated with the Malabar andesitic volcano while the other two with the smaller aligned volcanoes Wayang and Windu. The site is located approximately 35 Km south from Bandung, West Java. It belongs to a bigger geothermal cluster where also Tangkumban Perahu, Darajat, Papandayan and Kamojang belong.

The most evident surface manifestations in the Wayang Windu field occur close to the two volcanic edifices of Wayang and Windu. Impressive fumaroles, steaming, altered ground and hydrothermal alteration characterize the area.

Structurally the area is located in a collapse sector where the peak of mount Wayang represents the rest of a much larger and wider volcanic complex (Bogie et al., 2008).

The surface manifestations, i.e. springs, have temperature ranging from 25 up to 66 ºC. Their chemistry is unique due to the almost complete absence of Cl (Sudarman et al., 1986).

1.2 MOTIVATION OF THE SITE SELECTION

The presence of an existing plant, the accessible field with available good infrastructure and the constructive discussion with the operator Star Energy make this site a suitable one where to focus our studies, PhD work and geomechanical experiments. An additional GEOCAP PhD project (WP 2.04) will analyse and interpret seismic data of the Wayang Windu area so that the results of both theses will provide a broad understanding of the reservoir 's subsurface and rock properties.

Initially it was planned to have two days of fieldwork in October 2015 in order to sample rocks for the geomechanics experiments to be performed in Delft in the Wayang Windu area. However, an official permission by the company owning the field is needed. For this and other purposes there was a scheduled meeting in Jakarta before the fieldwork, which was cancelled upon short notice. In order to be able to go to the field and collected the foreseen samples Tangkumban Perahu has been chosen as alternative. This field belongs to the same cluster but there is no official permission requirement to access the area.

GEOCAP and the members of the WP 2.05 hydraulic fracturing and acidizing are in contact with Star Energy among others to obtain the permission to sample and access the Wayang Windu field in the near future. We are currently discussing a collaboration of GEOCAP with Star Energy on hydro-fracturing, which research, data

and sampling is shared and how to shape a non-disclosure agreement. The research within WP 2.05 will benefit from the collaboration with Star Energy and the results of the research (modelling, experimental) can then be validated to a real case geothermal operation.

The PhD research that focusses on the experimental part of hydrofracturing (PhD at TU Delft) plans to use a variety of volcanic samples representative for the rock types present in Indonesia to determine the geomechanical and fracturing response of these rocks. In contrast to the other research in WP2.05 and WP2.02 the experimental project is not solely dependent on a cooperation with industry partners for data and sample exchange. The use of samples from the Wajang Windu field is preferred, but not essential. For the success of the research project it is important that we have a wide variety of rock types/wide variety of rock properties in order to determine the different response to fracturing of the different material. With the use of different samples, prediction of fracturing behaviour can be made that can then be generally applied in modelling of fracturing or in hydrofracturing jobs in geothermal fields. For this we need volcanic samples with e.g. varying porosities, varying grain sizes and composition. The samples can originate from various geothermal fields in Indonesia (we have established contacts with different geothermal companies in Indonesia), from outcrops at different places in Indonesia and even from volcanic samples in similar subduction/volcanic environments in other countries in the world (e.g. Iceland, Italy etc.). This year, we have started selection of samples to be used in the fracturing experiment by collection volcanic blocks from outcrops near Bandung (Indonesia).

2 FIELD ACTIVITIES 2015

2.1 ROCK SAMPLE DESCRIPTION

Big andesitic rock samples with different porosity have been sampled at Domas Crater in Tangkumban Perahu (Fig.1). Fresh and altered rocks such as basalt, porous lava and pumice have also been collected.

Fig. 1: Domas crater and outcrop. Photos courtesy of TNO (Francesco Pizzocollo).

Additional basalts have been sampled in Gunung Lembang, in the city of Lembang (Fig. 2). All the samples will be shipped soon to Delft where the experiments are planned.

Fig. 2: outcrop at Gunung Lembang. Here basalts have been sampled. Photos courtesy of TNO (Francesco Pizzocollo).

2.2 WATER SAMPLES DESCRIPTION

Two surface manifestations have been sampled in the Domas crater. The samples DOM1 and DOM2 (Fig. 3) are respectively 44 and 88ºC warm and quite acidic with a pH of 1.5-2. The bicarbonate test failed twice once in the field and later on in the hotel. Their chemistry justifies the bicarbonate test as they are characterized by a very high sulphate concentration (1689 and 1733 mg/L) and low chlorine (49.5 and 87 mg/L). The major anion and cation have been analysed at the technical university of Berlin, Germany.

Fig. 3: hot spring DOM2.

Based on their chemistry the springs can be classified as steamed heated waters (see Fig. 4). Stable isotope (^{2}H and ^{18}O) measurements have been discussed and are planned between TU Delft and IF technology.

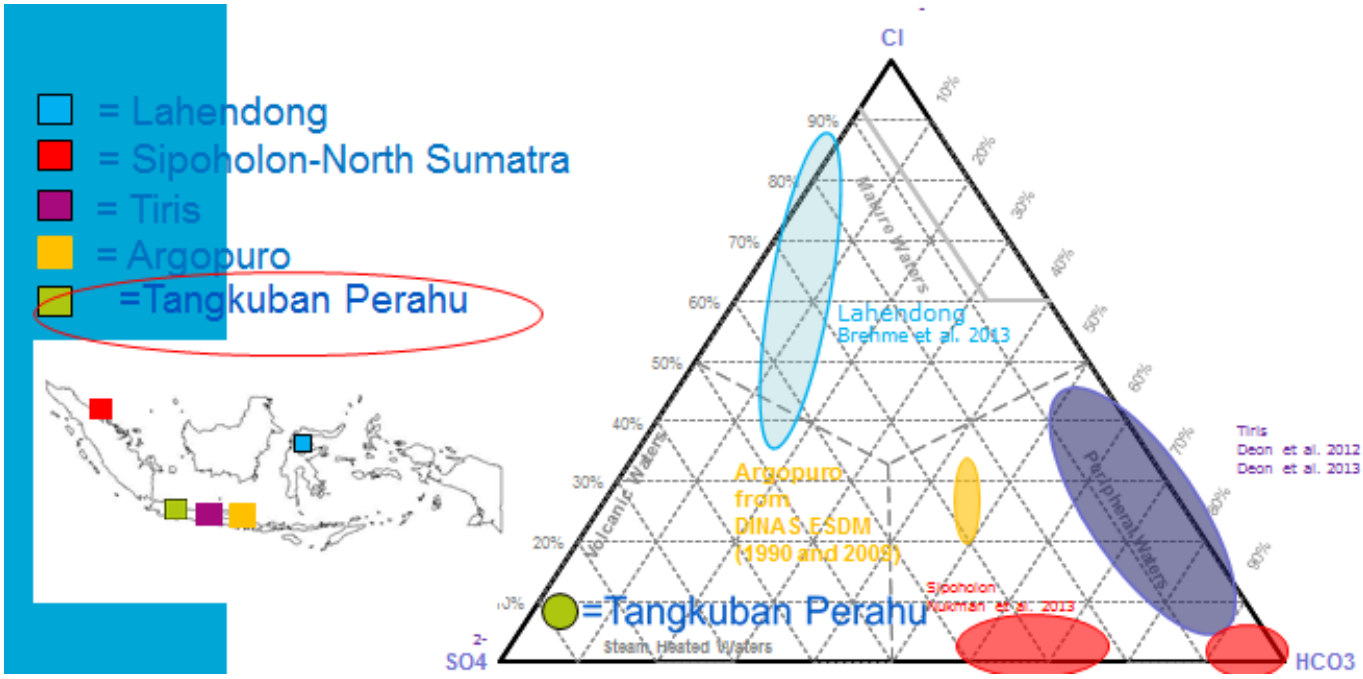

Fig. 4: Giggenbach ternary plot where the Domas crater water samples are shown. As comparison other springs from different geothermal fields in Indonesia are shown.

3 CONCLUSIONS

The hydrofracturing research within WP2.05 has established contact with the geothermal company Star Energy exploiting the Wajang Windu geothermal area. The Wajang Windu geothermal area is one of the main geothermal areas of Indonesia. Currently the GEOCAP partners (IF Technology, TNO, TUD and ITB) within WP2.05 are discussing the details of the cooperation with Star Energy on data and sample exchange for modelling and laboratory work and the details on confidentiality etc. of the data used. This anticipated collaboration will ensure the research of WP2.05 can be validated against real field data from a currently operational geothermal site in Indonesia. Furthermore in 2015, we have collected some first rock samples and analysed hot-spring water geochemistry at a volcano near Bandung to initiate the PhD research within WP2.05.