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STRUCTURAL CONCEPT (PLAY) TO REDUCE WELL TARGETING RISK: RANTAU DEDAP CASE STUDY

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ABSTRACT

One of the biggest exploration risks to proving geothermal reserves is well bore targeting. Based on the strain structural pattern in the Rantau Dedap prospect an oblique convergent strike-slip faulting model was developed. The structure model shows that a dilatational fault system has formed as a result of dextral movement along Sumatra (Semangko) Fault System.
Since subsurface permeability data is still limited, the surface structure data plays an important role in well targeting. Surface manifestations can reduce permeability risk for well targeting at the early exploration stage. Surface manifestations can confirm structure "play" model and prioritize faults for well targeting.
After the conceptual has been constructed, combining all available information, the model compared to MEQ and other available subsurface data. MEQ shear wave splitting was used to confirm the major targets to reduce well targeting risk.
Fault intersections and major strike slip faults could create zones of high fractures density, which are the best location for fluid flow particularly in a dilatational fault system. The distribution of geothermal manifestations is controlled by strike slip faults and their associated fractures particularly in NE-SW, NW-SE and N-S trends.
Integration of the fault mapping results, structural interpretation, surface manifestations and MEQ shear wave splitting data allow faults or structures to be prioritized for well targeting. NE-SW, NW-SE and N-S extensional faults associated with fumaroles and hot springs are prioritized faults. NE-SW, NW-SE and N-S extensional faults which are not associated with surface manifestations are considered secondary targets.

Keywords: Sumatra Fault, surface manifestations, permeability, well targeting, shear wave splitting.

1. INTRODUCTION

1.1 Location

The Rantau Dedap geothermal field is located in the Muara Enim Regency, about 215 km west of Palembang, the capital city of South Sumatra Province. The geothermal field is located SE of Mt. Dempo, an active volcano. The Rantau Dedap prospect area is located close to the intersection of two large geologic structures, the Semendo Caldera and the Great Sumatera Fault (GSF) System, hosting numerous volcanic centers (**Figure 1**).

1.2 Background

Well targeting is one of the biggest critical issues for exploration. Since subsurface permeability data is generally very limited prior to drilling, there is a need to maximize the utilization of surface data to predict subsurface permeability.
The development of a conceptual structure model is important to determine major drilling targets. Surface manifestations can support a structure "play" model and prioritize fault targets.
After the conceptual model has been constructed, combining all available information, the model can be check by MEQ and other available subsurface data. MEQ shear wave splitting was used to confirm major targets to lower well targeting risk.

2. GEOLOGY OVERVIEW

The regional geology of the Rantau Dedap area is shown in the geological map of Rantau Dedap (LIPI, 2008) (**Figure 2**). The geology of the study area is dominated by dextral slip movement of the Great Sumatra Fault (Semangko Fault), and Late Quaternary volcanism. The volcanic rocks consist of lava, volcanic breccia, and tuff.

3. GEOLOGY STRUCTURES

The critical step in identifying structure geology is to start by interpreting detailed remote sensing data. The lineaments interpreted from remote sensing analysis show dominant directions of NE-SW, NW-SE and N-S. Some of the lineament morphology shows slightly curving geometry, suggesting a possible normal fault system with dip direction dominantly to the west (**Figure 3**). Field checking is essential to confirm the fault movements by measuring field data such as fault breccias or slickensides. The structural geology in the study area has been mapped by LIPI (2008) and LAPI-ITB (2011) using combined remote sensing data and evidence from field mapping. Two models that fit the structure in Rantau Dedap are defined by morphological appearence. These are a terminated strike-slip model (model A) and a caldera model (model B) (**Figure 4**). The study concludes that the Rantau Dedap area is related to strike-slip deformation of Great Sumatra Fault (GSF) system as part of restraining bend in strike-slip system.

4. SURFACE DATA

The Rantau Dedap geothermal field is characterized by the occurrence of fumaroles and hot springs. Fumaroles are located in the south and in high elevation areas, while hot springs are located in the north and in lower elevation areas (**Figure 5**). Surface manifestations and hydrology can confirm a "best fit" structural play. Referring to the hydrology, model A appears to be the "best fit". Four key manifestations related to the geothermal system include fumaroles 1, 2, 3 and 4. Surface manifestations appear to be related to location of permeability in the area. In Rantau Dedap, manifestations are commonly associated with major faults. The occurrence of manifestations may indicate that the fault is permeable and provides a conduit for thermal fluid to flow from subsurface to the surface, similar to other volcanic arc geothermal systems, with upflow occurred along highland and discharge to hot springs in the lowlands in the lower topography area. Combination of hydrology and surface manifestation can confirm structure "play".

5. SUBSURFACE DATA

Limited subsurface structural data are available during the exploration stage. Surface information must be maximized to reduce the risks of well targeting. Presently, the standard tool to identify subsurface permeability is MEQ shear wave splitting to confirm major structural targets (**Figure 6**)

6. DATA INTEGRATION

The Rantau Dedap prospect is located close to the intersection of two major structures; the Semendo Caldera and the Great Sumatera Fault System, hosting numerous volcanic centers, included Bukit Besar within the prospect area. The structural setting is associated with NE-SW, NW-SE and N-S fault trends, and circular features. These structures control the locations of all surfaces manifestations suggesting the permeability could be controlled by these structures as well. Surface data (such as fault and surface manifestation location) was correlated with subsurface data MEQ shear wave splitting data.

Based on the analysis, a good correlation was made between surface and subsurface data. For example, fault trends from surface align with MEQ shear wave splitting (SWS) (**Figure 7**).

7. WELL-TARGET RANKING

For well targeting, analysis of structure geology becomes very important for predicting subsurface permeable zones. The integration of structural data shows that the extensional structures (NE-

SW, NW-SE & N-S faults) correlate with the surface manifestations. The target ranking was made based upon the direction of the faults and correlation to manifestations;

- Ranking 1: has faults intersections (NE-SW, NW-SE & N-S) and has surface manifestations.
- Ranking 2: has single major fault (NE-SW) and has surface manifestations.

Ranking 1 is prioritized as drilling targets, located in the center of the Rantau Dedap area. They show potential for good permeability, with surface features (NE-SW NW-SE & N-S faults), surface manifestations, and SWS orientations. Ranking 2 is the secondary drilling target (**Figure 7**). To increase the confidence level of well-target ranking related to the permeability of these faults, we need to conduct an induced microearthquakes (MEQ) survey after drilling has started.

8. SUMMARY & DISCUSSION

The appearances of surface manifestations related with faults or fault zones in the Rantau Dedap area, especially faults with NE-SW, NW-SE and N-S direction suggests that the first well target should target the most permeable faults or fault intersections.

9.ACKNOWLEDGEMENTS

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10. REFERENCES

Geotechnology-LIPI & Supreme Energy, 2008, Geological Structure and Alteration at Rantau Dedap Geothermal Prospect Sumatra. Unpublished report.

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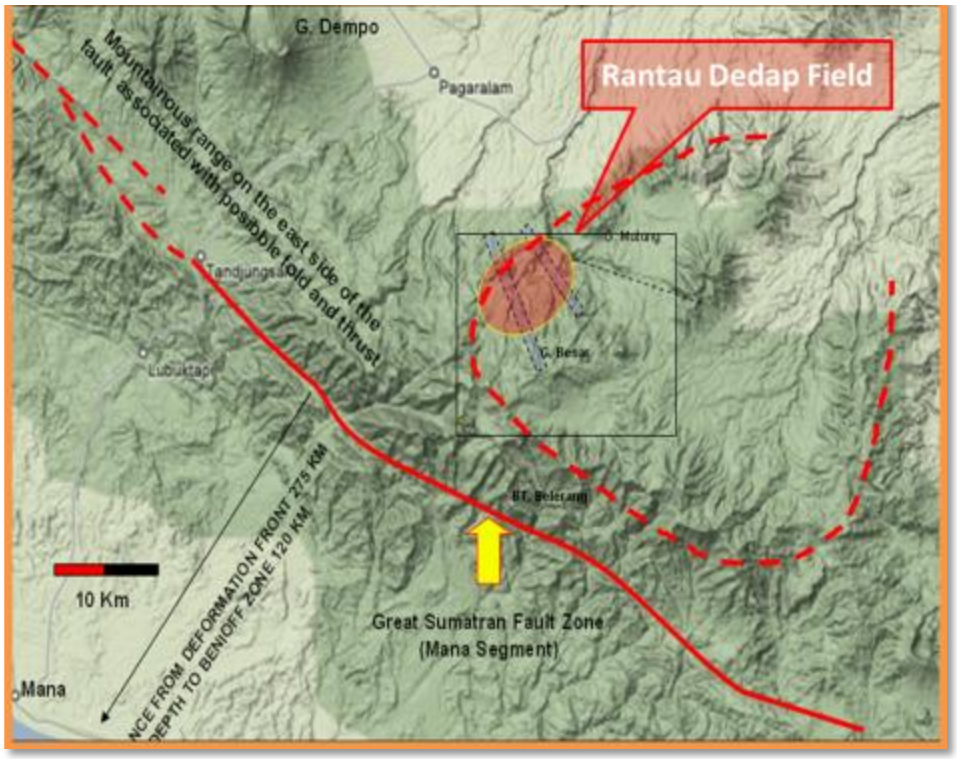

Figure 1. *Location of Rantau dedap geothermal prospect, located at SE of Mt. Dempo(LIPI 2008)*

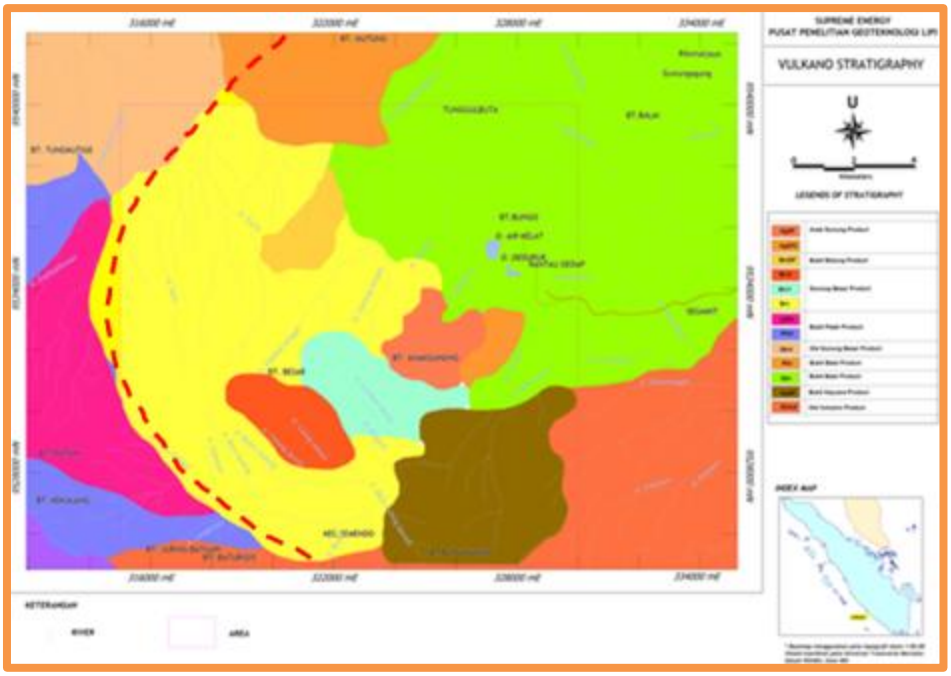

Figure 2. *Geology map of Rantau Dedap area (LIPI,2008)*

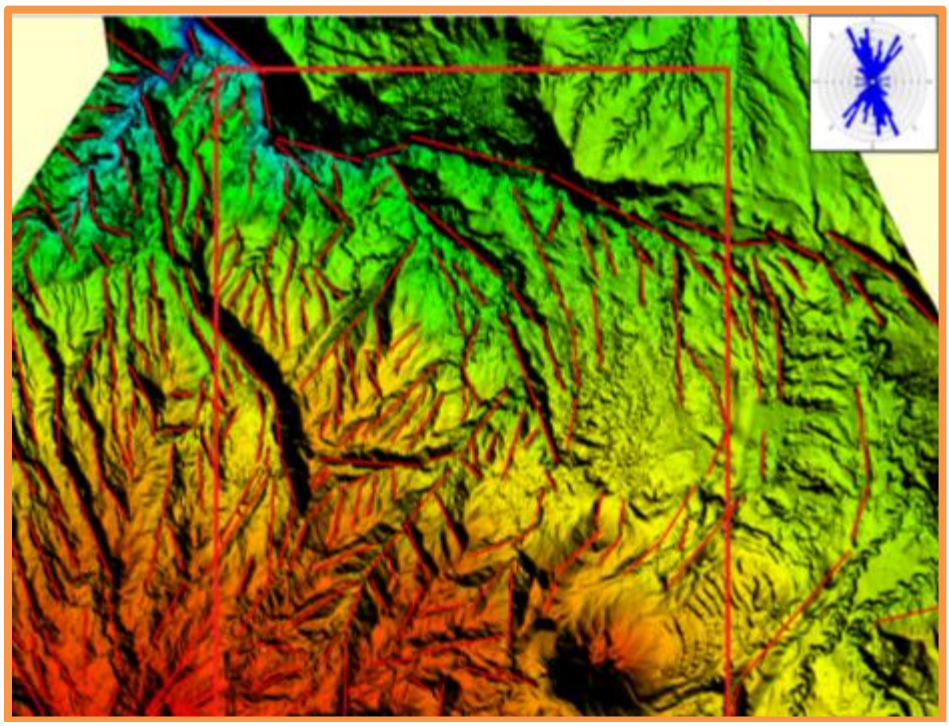

Figure 3. *Lineament map of Rantau Dedap area (LAPI,2011)*

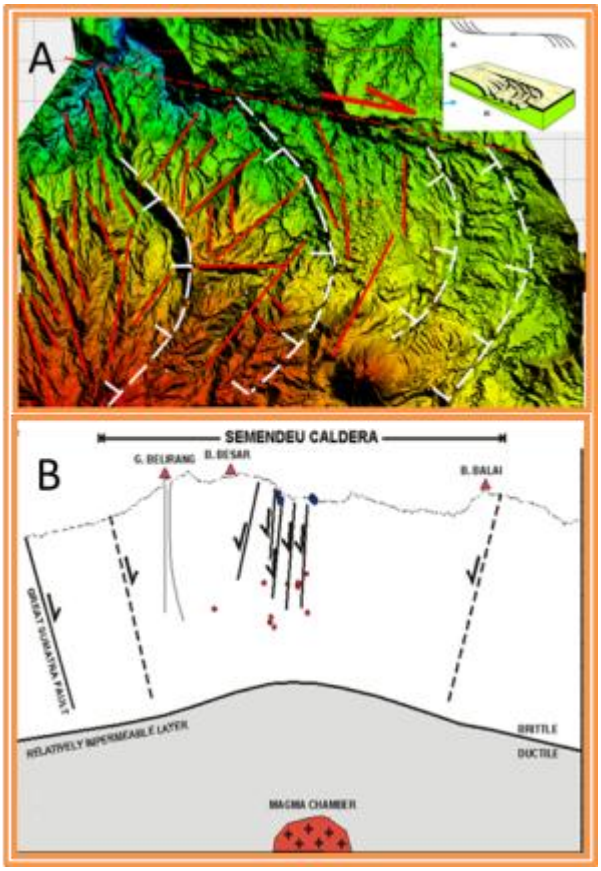

Figure 4. *Proposed model, terminated strike-slip model (model A) and Caldera model (model B)*

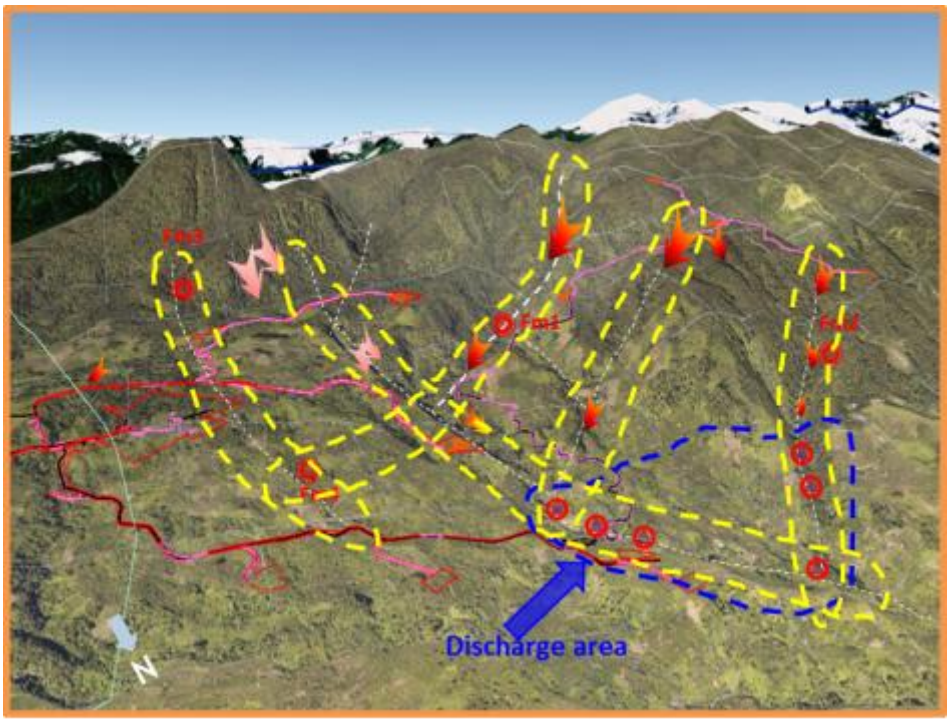

Figure 5. *Hydrology map combine with distribution of manifestation*

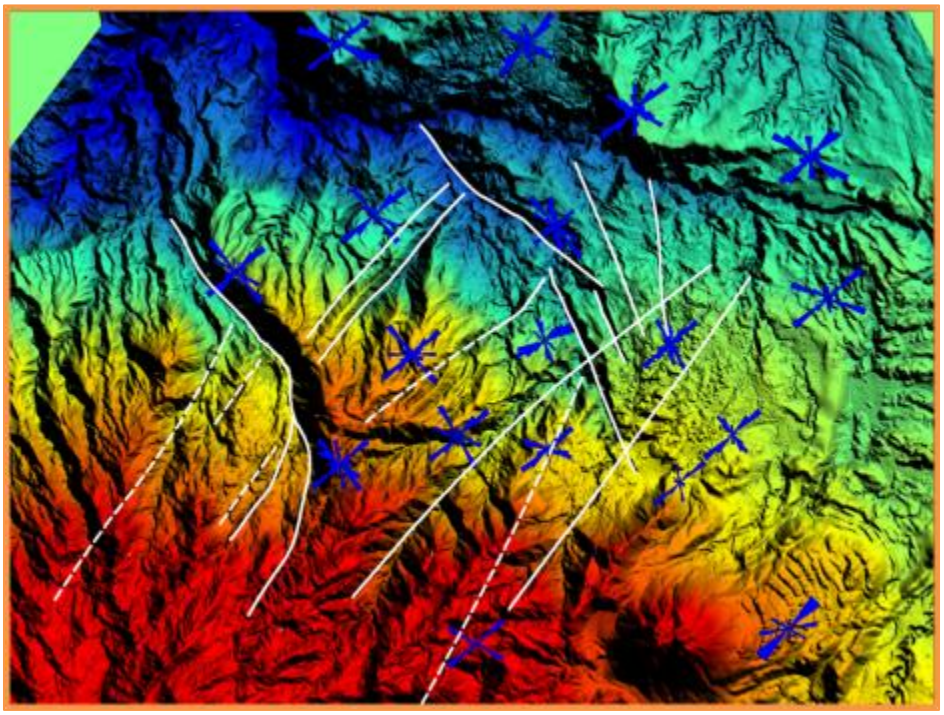

Figure 6. *Shear wave splitting map*

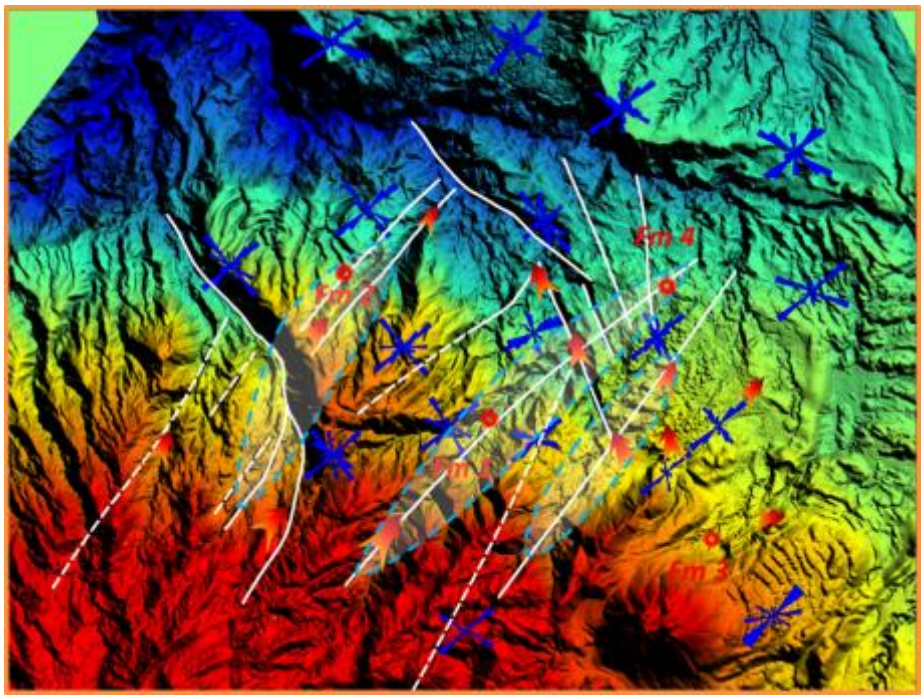

Figure 7. *Well-targeting of permeability zone based on intergrated data structure. Blue circle area is the most permeable and lowest risk target.*