Reconstructing geothermal geological models by combining recent geophysical, geochemical and geological studies in Tatun volcanoes area, Northern Taiwan

Jian-Cheng Lee[1], Chien-Chih Chen[2], Hideaki Hase[3], Hsin-Hua Huang[1], Cheng-Horng Lin[1], Shenrg-Rong Song[4], Yi-Chia Lu[2], En-Chao Yeh[5], Gong-Ruei Ho[1], Chuang-Hsiang Mu[1], Yu-Chang Chan[1], Li-Wei Kuo[2], Yue-Gau Chen[6], Sun-Lin Chung[1]

[1]Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan, jclee@earth.sinica.edu.tw
[2]Department of Earth Sciences National Central University, Chungli, Taiwan, chienchih.chen@g.ncu.edu.tw
[3]Geothermal and Energy Research & Development (GERD) Co., LTD., Tokyo, Japan, hase@gerd.co.jp
[4]Department of Geosciences, National Taiwan University, Taipei, Taiwan, srsong@ntu.edu.tw
[5]National Taiwan Normal University, Taipei, Taiwan, ecyeh@ntnu.edu.tw
[6]Centre of Environmental Change Research, Academia Sinica, Taipei, Taiwan, ygchen@gate.sinica.edu.tw

SUMMARY

In this study, we conduct a multi-disciplinary study, including geophysics, geochemistry, and geology, with help of tens of exploration wells, to reconstruct a geothermal geological model at the shallow 5 km, for a geothermal exploration project in the Tatun volcano area, northern Taiwan. Our reconstructed geological profiles show that the Tatun volcanoes have a ~1-2-km thick of lava flows, erupted on the frontal area of the 6-8-km-thick fold-and-thrust Miocene sedimentary rocks. The seismic velocity imaging indicates a likely magma reservoir of high anomaly of Vp beneath the Tatun at the depths of 8-15, with an estimated volume of ~250-300 km^3.

Incorporating the regional geology with the newly acquired magnetotelluric (MT) results, when it comes to geothermal reservoir, we found three horizontally-seated low-resistive layers at different depths, which we tend to interpret as possible “cap rocks”. The underlying high-resistive zones are interpreted as potential geothermal reservoirs: 1) near-surface reservoir at depth of <200 m beneath surface deposits; 2) main shallow reservoirs at the depth of 200-500 m (downhole temperature of 150-250°C), covered by low-resistive volcanic layers (possibly clay-rich altered rocks); 3) deeper reservoirs at the depth of ~ 1-1.5 km, seemingly in the uppermost basement of quartz-rich sandstone, underneath low-resistive lobs.

At least four high micro-seismicity zones with cylinder shape are interpreted as conduits of hot fluid derived from deep over-pressured zones, either along the frontal thrust of the Jinshan fault (at the depth of ~2 km), or the outer edge of the fluid saturated magma reservoir around 4-6 km depth, which is also of potential for “super hot geothermal” exploration.

Keywords: Geothermal Geological Model, Magnetotelluric survey, Tatun, Taiwan