Hydrothermal-heat source model for the Kakkonda field

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The geothermal system in the Kakkonda field has been summarized from the viewpoints of geothermal modeling. The results of surveys by NEDO were reviewed in terms of reservoir, thermal structure and hydrothermal structures based on the NEDO's reports of the project. The results by Geological Survey of Japan were divided into geological and geochemical modeling, geophysical modeling and developing history modeling, and were also reviewed in terms of reservoir, thermal structure and hydrothermal structures. These results were compared to each other and summarized on the table. The temperature decline model of the Kakkonda deep geothermal system was proposed based on the comparison with the Fournier model (1999).

Integrated model for the Kakkonda geothermal system was drawn based on the Kakkonda geothermal model related to Quaternary granite by Uchida et al. (1996), and thermal & hydraulic structural model by NEDO (1999) by comparison with the schematic subvolcanic hydrothermal model proposed by Fournier(1999). The schematic model by Fournier illustrates the transition from magmatic to epithermal conditions in a subvolcanic environment, and the boundary between hydrothermal convective and conductive zones is coincident with elastic-plastic boundary which is almost equivalent to 370-400 degree C isotherm. On the otherhand, the geothermal models proposed by Uchida et al. (1996) and NEDO (1999) illustrate the geothermal system not covered by volcanoes, and indicate that the boundary between hydrothermal convective and conductive zones is not coincident with elastic-plastic boundary. The former is correlated with 300-320 degree C isotherm inferred from cut-off depth of microseismicity, and the latter with 380 degree C inferred from kick-off point of temperature-depth profile. This means temperature has declined in the Kakkonda geothermal system, but the elastic-plastic boundary has not changed. It suggests temperature drop can not affect quickly on the elastic-plastic boundary. However, it should be further investigated which is more affective to the elastic-plastic boundary by temperature drop or pore pressure increase. The temperature decline in the Kakkonda field has been pointed out by comparison studies between formation temperature of contact aureole and present bore hole temperature (Sasaki et al., 1998, Takeno, et al., 2000). Temperature decline seems to be caused by cooling of Quaternary granite (Kakkonda granite), and/or quick erosion of 900 m on the surface inferred from barometric study by Muramatsu (1984). Pore pressure increase by the reinjected water has been clearly recognized by changes of cut-off depth and distribution of microseismicity.

Fournier (1999) proposed two schematic models for the transition from magmatic and epithermal conditions in a subvolcanic environment. One is the sealed model of elastic-plastic boundary against the underlying magmatic fluids, and the other is the episodic and temporary breaching model. In the case of the Kakkonda geothermal system, the leaked magmatic fluid has not been identified clearly in terms of fluids chemistry. However, the poly phase inclusions in quartz are identified not only in the Kakkonda granite, but also in lower Tertiary formations (Komatsu et al., 1998). This may suggest the possibility of magmatic fluids leakage through elastic-plastic boundary which is correlated to the 370-400 degree C isothermal zone. Leakage of magmatic fluids should be further investigated in terms of various factors.