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Summary of the geothermal survey well WD-1a penetrating to the brittle-plastic boundary in the Kakkonda geothermal field

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The summary of the geothermal survey well ”WD-1a” penetrating the brittle-plastic transition in the Kakkonda geothermal field of NE Japan is necessary to discuss the thermal energy extraction from the region deeper than the brittle-plastic transition. The WD-1a was drilled by the New Energy and Industrial Technology Development Organization (NEDO) as part of the ”Deep-seated Geothermal Resources Survey” project. It was 3729 m deep and the temperature at the bottom of the hole was estimated to be more than 500 ?C (Ikeuchi et al., 1996; Kato et al., 1996). This borehole penetrated the Quaternary and Tertiary volcanic rocks and the pre-Tertiary sedimentary rocks, and encountered the Kakkonda granite at 2860 m depth (Kato et al., 1996). The Kakkonda granite continues to the bottom of the hole. K-Ar ages of biotite and hornblende from the Kakkonda granite range from 0.068 to 0.21 Ma and 0.08 to 0.34 Ma, respectively (Kanisawa et al., 1994).

From the viewpoint of the brittle-plastic transition, the boundaries of hydrothermal convection and conduction zones (Ikeuchi et al., 1996), seismic and aseismic zones (Tosha et al., 1995), and low and high resistivity zones related to fracture distribution (Kato et al., 1996) are present at a depth of about 3 km. These lines of evidence suggest that the WD-1a penetrates the brittle-plastic transition (Muraoka, 1997). The geothermal reservoir with fractures is developed in the region above 3 km depth and lower than 350 oC (Kato et al., 1996), while few deformation features are recognized below 3 km depth and higher than 350 oC. The drill core of WD-1a collected from 2936 to 2937 m includes the miarolitic cavities in the granite. The three-dimensional shape measurement of these cavities using the X-ray CT (Ohtani et al., 2000) and the ellipsoid fitting indicate that the minor axes of ellipsoids are preferred to E-W direction. This suggests that the cavities show the N-S shortening due to the effect of regional stress (Ohtani et al., 2001).

From the viewpoint of the thermal energy extraction, the Kakkonda geothermal field consists of shallow hydrothermal convection zone, contact metamorphic aureole, deep hydrothermal convection zone, and plastic zone toward the deeper part, and the hydrothermal convection for the conventional flash power generation is not occurred in the plastic zone (Muraoka et al., 1998). Therefore, the thermal energy extraction from the plastic zone needs new technology development such as EGS (Enhanced Geothermal Systems).

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