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Geological model of supercritical geothermal reservoir related to subduction system

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Following the Great East Japan Earthquake and the accident at the Fukushima Daiichi Nuclear power station on 3.11 (11th March) 2011, geothermal energy came to be considered one of the most promising sources of renewable energy for the future in Japan. The temperatures of geothermal fields operating in Japan range from 200 to 300 °C (average ∼250 °C), and the depths range from 1000 to 2000 m (average ∼1500 m). In conventional geothermal reservoirs, the mechanical behavior of the rocks is presumed to be brittle, and convection of the hydrothermal fluid through existing network is the main method of circulation in the reservoir. In order to minimize induced seismicity, a rock mass that is “beyond brittle” is one possible candidate, because the rock mechanics of “beyond brittle” material is one of plastic deformation rather than brittle failure.
Supercritical geothermal resources could be evaluated in terms of present volcanic activities, thermal structure, dimension of hydrothermal circulation, properties of fracture system, depth of heat source, depth of brittle factures zone, dimension of geothermal reservoir. On the basis of the GIS, potential of supercritical geothermal resources could be characterized into the following four categories. 1. Promising: surface manifestation d shallow high temperature, 2 Probability: high geothermal gradient, 3 Possibility: Aseismic zone which indicates an existence of melt, 4 Potential : low velocity zone which indicates magma input. Base on geophysical data for geothermal reservoirs, we have propose adequate tectonic model of development of the supercritical geothermal reservoirs.
To understand the geological model of a supercritical geothermal reservoir, granite–porphyry system, which had been formed in subduction zone, was investigated as a natural analog of the supercritical geothermal energy system. Quartz veins, hydrothermal breccia veins, and glassy veins are observed in a granitic body. The glassy veins formed at 500–550 °C under lithostatic pressures, and then pressures dropped drastically. The solubility of silica also dropped, resulting in formation of quartz veins under a hydrostatic pressure regime. Connections between the lithostatic and hydrostatic pressure regimes were key to the formation of the hydrothermal breccia veins, and the granite–porphyry system provides useful information for creation of fracture clouds in supercritical geothermal reservoirs.
A granite–porphyry system, associated with hydrothermal activity and mineralization, provides a suitable natural analog for studying a deep-seated geothermal reservoir where stockwork fracture systems are created in the presence of supercritical geothermal fluids. I describe fracture networks and their formation mechanisms using petrology and fluid inclusion studies in order to understand this “beyond brittle” supercritical geothermal reservoir, and a geological model for “Beyond Brittle” and “Supercritical” geothermal reservoir in the subduction zone were was revealed.