**JBBP** (Japan Beyond-Brittle Project)

Scientific/technological challenges in investigating the feasibility of engineered geothermal development beyond the brittle-ductile transition

The objective of the JBBP is to demonstrate engineered geothermal energy extraction from an earth sciences perspective through scientific understanding of various phenomena in the brittle-ductile transition and engineering development.

**Commercial geothermal development in the brittle zone**

- Lower recovery rate due to lost circulation
- Dependence of sites
- Formation of scales
- Generation of induced seismicities

**Three factors of geothermal development**

- Fracture, Fluid, and Temperature
- Heterogeneity
- Difficulty of the precise exploration
- Sustainability
- High heat capacity

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The core team of the JBBP consists of researchers from national institutes and universities with a variety of scientific/engineering, backgrounds, and this team aims to conduct a drill of the “JBBP borehole” under the ICDP scheme.

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Why JBBP?

Problems in development of hydrothermal resources in Japan
- Relatively small capacity (10-20 MW, difficult to maintain sustainability)
- Complex geology (risks of “dry wells”)
- Possible impact on natural hot springs (“Onsen,” the most popular Japanese resort)
- Resources in natural reserves (national parks)
- Site dependency

Negative aspects of engineered geothermal systems (EGS) in Japan
- Difficulties in designing the system owing to localized geological settings
- Possible large induced EQs

Possible Advantages of the JBBP Reservoirs
- Simpler design/control of the reservoirs owing to homogeneous rock properties and stress states beyond the BDT
- Higher recovery rate of injected water
- Sustainable production by controlling flow rate and chemical contents of the liquid used for circulation
- Minor impact on shallow hydrothermal systems
- Large-scale power generation from widely distributed ductile zones at relatively shallow depth in the tectonic belt
- Universal design/development/control methodologies for ductile EGS reservoirs
- Lesser probability for induced/triggered earthquakes of damaging magnitudes

Scientific/Technological challenges in the JBBP
- Characterization of the rock mass beyond the BDT
  - WRI, thermal properties, behavior of pore water
- Rock mechanics
  - Stress state, fracture/reservoir creation process, numerical simulation
- Risk assessment of induced EQs
- Exploration and monitoring
  - Identification of the BDT, monitoring of the reservoirs
- Drilling, completion, and fracturing
  - Drill mud, cementing, casing, MWD/LWD, coring, zonal isolation
- Logging and monitoring tools

Contribution to HT Geothermal Projects and Earth Sciences in ICDP
- Obtaining a concurrent understanding of the nature of HT geothermal resources among HT geothermal projects
- Joint technology development
- Understanding of various phenomena in the Earth’s crust, including dehydration/degassing of magmas, global hydrogeology in the Earth’s crust, creation process of faults, occurrence of various types of earthquakes/tremors at the depth, and the processes in hydrothermal convection/conduction zones

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