JBBP (Japan Beyond-Brittle Project)

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

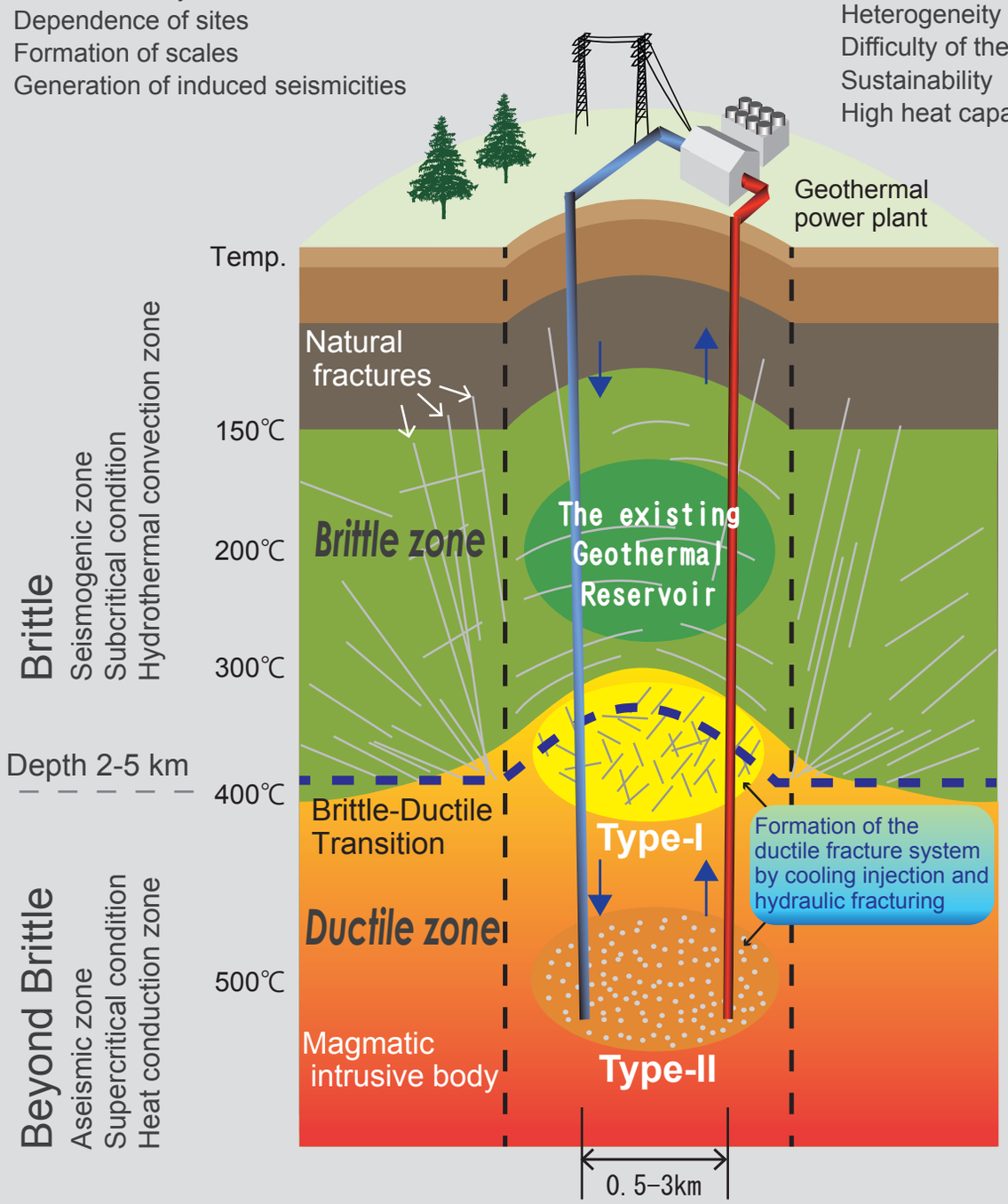
The objective of the JBBP is to demonstrate engineered geothermal energy extraction from an earth sciences perspective through scientific understanding of various phenomena in the brittle-ductile transition and engineering development.

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



Commercial Geothermal Reservoir

Temp. 200～300 ℃
Depth 1000～2000 m

JBBP Type-I Reservoir

Connection between artificial fractures and existing deep-seated reservoir
Temp. 350～400 ℃
Depth ～3000 m

Type-II Reservoir

Isolated artificial fracture network in the ductile rocks
Temp. ～500 ℃
Depth ～4000 m

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 ("Onesen," 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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