Geothermal Modelling of Variscan EGS in Granitic and Metamorphic Rocks

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1. Introduction and Motivation

With the ambition to achieve European Union (EU)'s energy directive, that is 20% final energy consumption from renewable sources by 2020 then upscaled to 30% by 2030, all EU countries have adopted their national energy action plans to include more projects on low carbon thermal and electrical power generation technologies. One sustainable way to achieve this target can be the utilization of geothermal resources. Up to now, hydrothermal systems have restricted the widespread use of geothermal resources, since they are only available at the geological conditions that allow a heat transfer medium circulating from deep hot zones to surface. Nowadays with the developments of the last two decades, Enhanced Geothermal Systems (EGS) promise the dissemination of geothermal resources in spite of decreasing knowledge of geology at greater depths and increasing drilling depths.

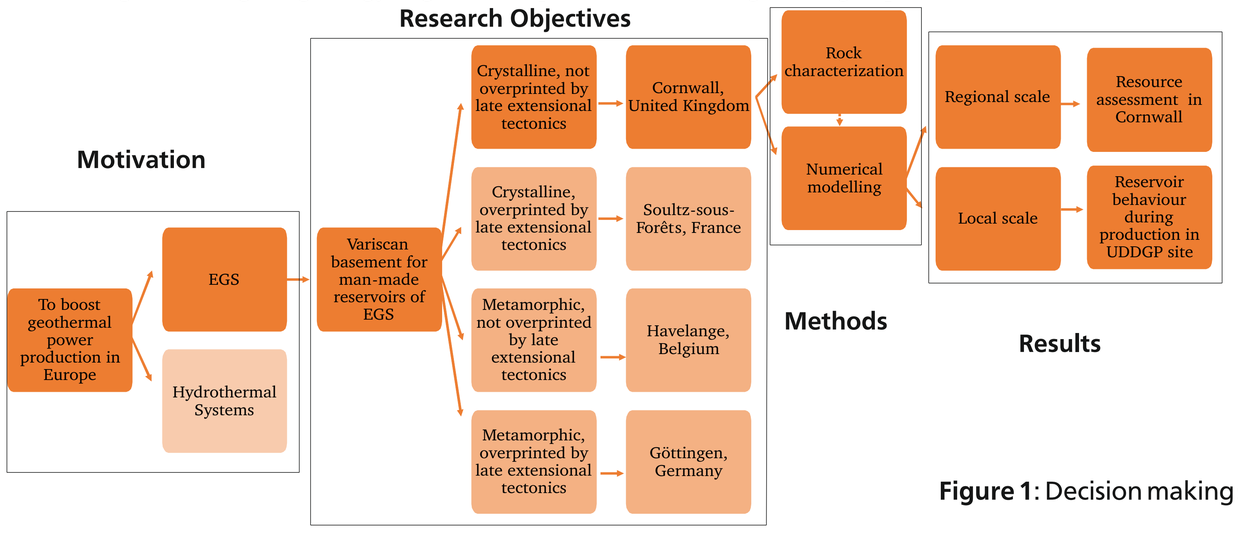

Figure 1: Decision making steps behind the project.

2. Aim

This study, as a part of the EU funded project MEET Multidisciplinary and multi-context demonstration of EGS exploration and Exploitation Techniques and potentials, aims to minimize the uncertainity in geology at greater depths by providing high quality datasets measured on both field analogues and drill-core samples of potential reservoir rocks, complemented by numerical models to predict reservoir parameters' behaviour during production and to minimize the drilling costs by focusing on the sites that already have certain infrastructure. Soultz-sous-Forêts, France (for Variscan crystalline basement overprinted by post-variscan extensional faults), Cornwall, United Kingdom (for Variscan base.ment not overprinted by late extensional faults), Göttingen, Germany (for Variscan metamorphic successions overprinted by younger extensional tectonics) and Havelange, Belgium (for Variscan metamorphic successions not overprinted by younger extensional tectonics) will be studied as four representative sites of EU Variscan basement. Focus of the PhD study area is Variscan crystalline basement, not overprinted by late extensional tectonics outcropped as Carnmenellis granite in SW England.

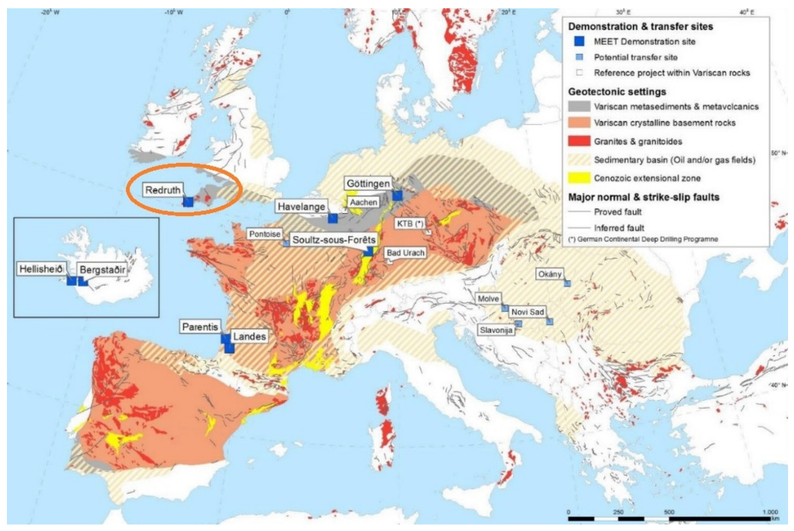

Figure 2: Map of different geotectonic settings at MEET demonstration sites with major faults, study area (as Redruth in Cornwall) is highlighted with a orange color frame (modified from Trullenque et al. 2018)

3. Methodology

The methodology employed involves comprehensive rock characterization and integration of this laboratory dataset (thermal conductivity, thermal diffusity, density, porosity, matrix permeability, uniaxial compressive strength, tensile strength, shear strength, cohesion, angle of friction, Biot-Willis and Skempton coefficients and storage coefficient) with archive data sets (porosity-permeability data, hydraulic test data, temperature measurements, world stress map data) and derivational datasets (specific heat capacity, rock mass permeability, transmissibility) to set up geothermal models as thermo-hydraulic subsurface temperature model. First field trip is planned for Spring 2019 in SW England to sample Carnmenellis granite outcrops.

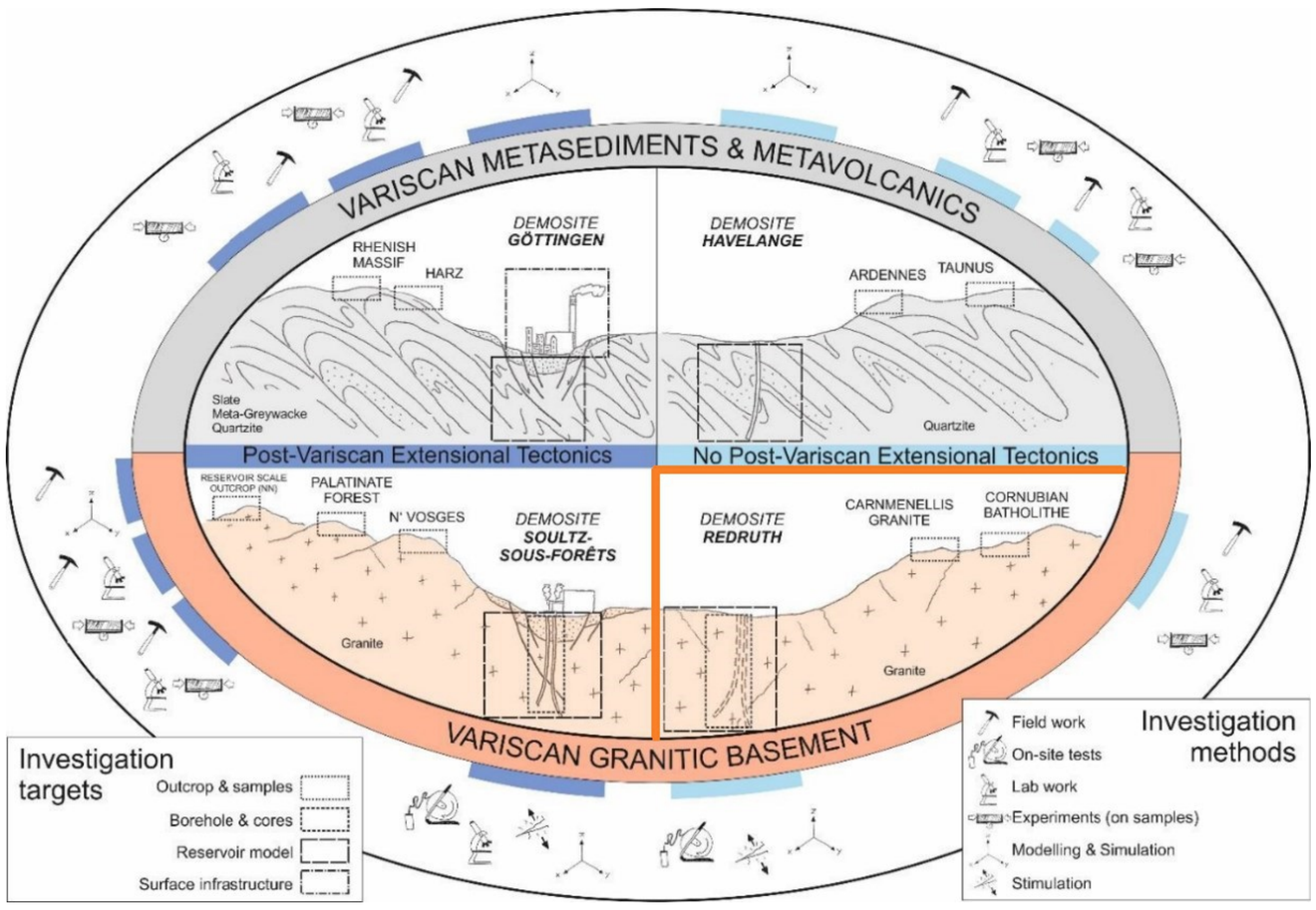

Figure 3: Investigation targets and methods within the project (modified from Trullenque et al. 2018)

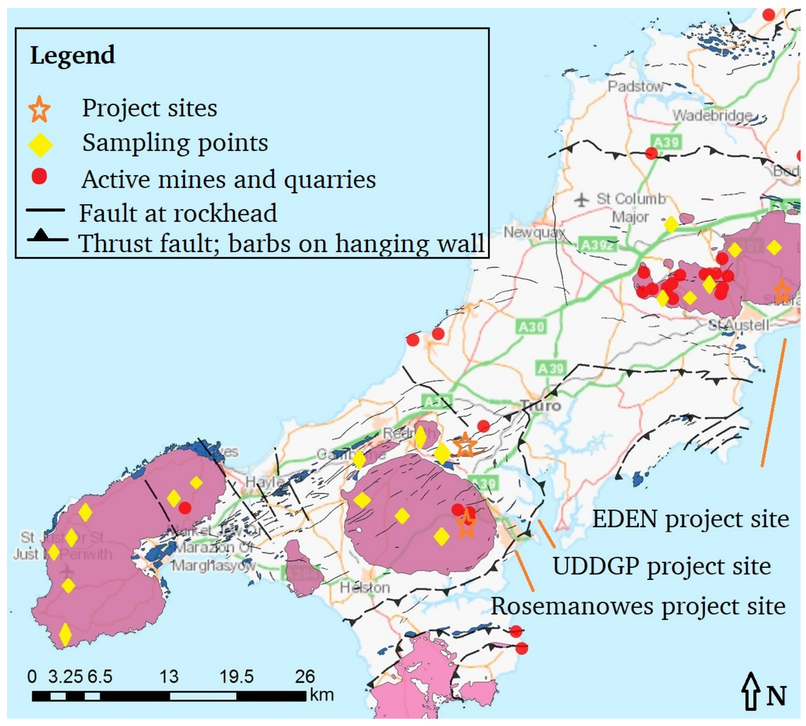

Figure 4: Map of Carnemenellis granite with the locations of EGS project sites, sampling points and active mines and quarries in SW England (modified from Geoindex onshore data sources by British Geological Survey)

4. Target Outputs

- Database of petrophysical and fluid physical properties and recommendations for model parametrization of Cornwall,
- Reservoir characterization of Cornwall,
- Static and dynamic geothermal models of Cornwall reservoir at regäonal scale and/or as conceptual models,
- Strategies and recommendations for stimulation operations for Cornwall reservoir, enhancing long-term sustainability of fractured rock system based on laboratory experiments and field-based characterisation,
- Chemical well treatment design for United Downs Deep Geothermal Power (UDDGP)-project,
- Regional scale numerical model of resource assessment in Cornwall,
- Local scale numerical model of reservoir behaviour during production at UDDGP project site.

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References

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