New ICDP project proposal: Post-drilling assessment and experiments in the St1 Deep Heat Reservoir, Finland (DEEP EGS)

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The ongoing climate change and energy crisis have confronted societies with urgent challenges of finding energy resources, which should be renewable and sustainable. There is a quest for low-enthalpy energy especially for space heating in typical continental areas, including Precambrian shields. Enhanced Geothermal Systems (EGS) provide an option to utilize low-enthalpy geothermal energy practically everywhere. Low geothermal gradients and large lithospheric stresses complicate application of EGS at depths of several km. There are considerable challenges and knowledge gaps related to hydraulic stimulation, induced seismicity, and hydraulic properties of fractured heterogeneous media. Shedding light on these factors will aid developing a more efficient and economically viable EGS technology and improve its societal acceptance. Numerous EGS projects have encountered problems in achieving sufficient and sustainable flow rates for economic operation of EGS as well as controlling induced seismicity.

The world's deepest Enhanced Geothermal System (EGS) project was carried out by the company St1 in Espoo, Finland, 2014 - 2022. The project comprised drilling two deep wells to >6 km depths, and carrying out hydraulic stimulation and monitoring of induced seismicity with downhole seismic arrays and satellite stations. The St1 drill site in Otaniemi, Espoo, is a world-class site, where superdeep wells are accessible in an urban area. Seismological, structural, hydraulic, geothermal and microbiological research has been already done providing in-depth background knowledge (Kwiatek et al., 2019; Purkamo et al., 2020; Heikkinen et al., 2021; Kukkonen et al., 2023). The St1 deep holes provide a unique possibility to establish a deep borehole observatory and geothermal laboratory offering unprecedented possibilities for research in induced seismicity, geothermics, hydraulic properties, deep fluids and gas as well as deep biosphere, helping to understand the behavior of crystalline bedrock at extreme depth.

Our aim is to apply the boreholes and data sets for a thorough analysis of the crystalline bedrock conditions at 5 – 6 km depth, solving problems related to developing EGS in crystalline rock as well as basic research questions. We expect that the project will provide novel and indispensable data for planning new EGS projects.

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