Preliminary results from interdisciplinary fault characterization in the Bedretto Underground Laboratory

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Engineered Geothermal Systems (EGS) are gaining increasing popularity as a source of renewable energy without significant CO₂ emissions. Fractured crystalline rock masses offer a promising environment for exploitation of geothermal energy. In such a setting, fractures and faults are the main conduits for fluid flow and heat transport. In-situ fracture permeabilities are usually too low at depths where rock mass temperatures are sufficiently high for geothermal energy production. Therefore, a suitable heat exchanger needs to be engineered by hydraulic stimulations. A proper in-situ characterization of the fracture geometry and hydro-mechanical properties is of primary importance for the design of the stimulation operations. This is often the most challenging task, since the majority of the fractures in the reservoir are usually inaccessible for direct characterization.

The Bedretto Underground Laboratory for Geosciences (BULG) provides a novel and unique environment to study EGS-related processes, such as seismo-hydro-mechanical fault zone response during hydraulic stimulation and subsequent fluid circulation experiments. The laboratory is hosted in an access tunnel from the Bedretto Valley in the Southern Swiss Alps to a railway tunnel from the Matterhorn-Gotthard-Bahn. The overburden of more than 1000 m above the BULG provides conditions that are approaching those of realistic EGS systems. For the rock mass characterization, three boreholes were drilled perpendicular to tunnel axis with lengths ranging from 190 m to 300 m.

We present first data sets from a variety of methodologies, ranging from hydrological tests to geophysical borehole- and remote-imaging. The complementary nature of these data sets allows us to construct a preliminary three dimensional geological model. Notably, the individual measurements yielded information over a multitude of scales, ranging from millimeter-scale core-log information to decameter scale low-frequency Ground Penetrating Radar measurements. Such
a wide range of scales is critical for the characterization of EGS reservoirs. The most prominent feature found is a large-scale fracture zone that extends across the entire investigation volume. This fracture zone will be the target for upcoming stimulation experiments.