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A geodetic monitoring of the Soultz-sous-Forêts and Rittershoffen geothermal sites

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ABSTRACT

The geothermal site of Soultz-sous-Forêts began as a research site for deep geothermal production in the 80s and is converted to an electrical power plant in 2008. A second power plant, ECOGI, is in development near the village of Rittershoffen located at 7 km from Soultz-sous-Forêts. Both deep geothermal sites benefit of the natural circulation of geothermal water in deep altered granites. Seismic and aseismic slips were observed on the Soultz-sous-Forêts power plant. Therefore, we establish a long-term geodetic monitoring of the geothermal sites of Soultz-sous-Forêts and Rittershoffen in order to better understand the process involved in geothermal energy. The geothermal field will be monitor at the different periods of its evolution: in the natural state of the site, during the drilling period, during stimulation and during the production period.

The monitoring strategy combines two spatial geodesy methods: global Navigation Satellite System (GNSS) and Synthetic Aperture Radar Interferometry (InSAR). We present here the results of our monitoring in the natural state of the geothermal sites (2012-2014) and during the drilling phase of ECOGI site (2012 and 2014). We present also the result of the processing of the archive of ERS observation from 1992 to 2010 (drilling and production period for the Soultz-sous-Forêts power plant).

1. GNSS MONITORING

1.1 Location of the GNSS network

In 2013, we developed a continuous GNSS network in the vicinity of the two geothermal sites. Two stations are located on the Soultz-sous-Forêts platform (GPK1 and GPK2), one on the Rittershoffen platform (ECOG) and tree in the vicinity of Rittershoffen (figure 1). We process the data using double difference with a local network of continuous GNSS stations.

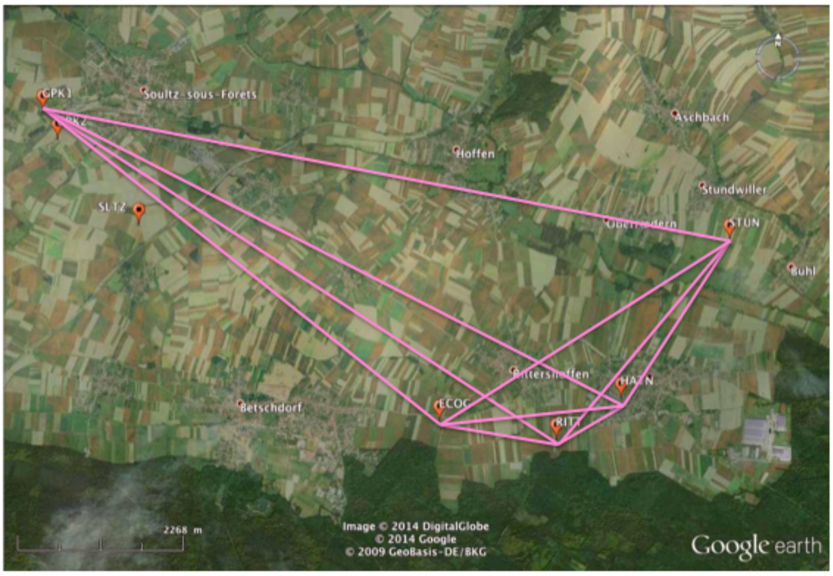

Figure 1: Location of the continuous GNSS stations (red symbols) and their corresponding baselines (pink lines).

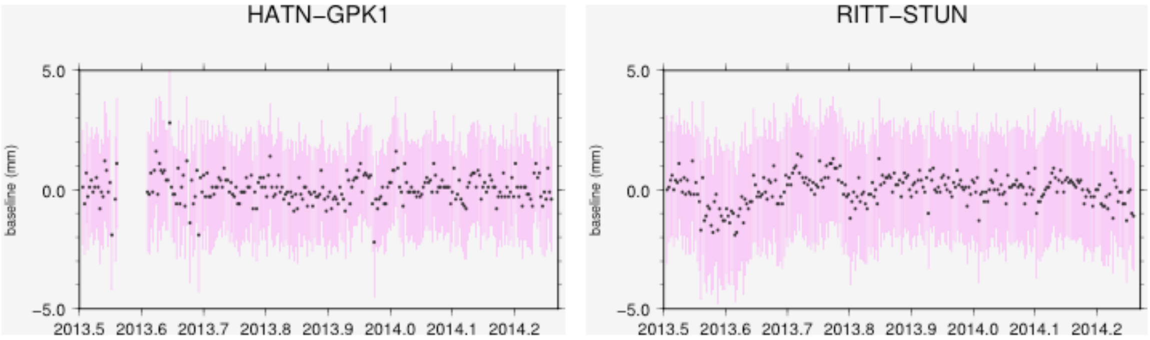

Figure 2: Examples of baseline length variations (mm) between July 2013 and March 2014

1.2 vertical experiment

In order to test the ability of GNSS to measure the vertical motion, we do a controlled vertical experiment of a GNSS antenna. The antenna is moved from 0.5 mm to the vertical every week. The modelled results of mean motion speed is then of 26 mm/year. We processed the data by double-difference.

The result within 137 days of displacement gives a trend of 25.1 mm/year with an rms of 3.2 mm and a total displacement of 9.4 mm whereas the controlled vertical displacement is 9.5 mm (figure 3).

The GPS experiment shows that a vertical deformation > 5 mm is detected by GPS. Considering that the GPS is more sensitive on the horizontal components, the detection threshold will be less on the horizontal components. The surface deformation monitoring will be able to detect surface displacements at a millimeter order.

Figure 3: Examples of baseline length variations (mm) between July 2013 and March 2014

2. INSAR MONITORING

The Synthetic aperture radar (SAR) images are provided by the German TerraSAR-X satellite since 2012. They are processed by Interferometry (InSAR) and persistent scatterers (PSI) method. The results will give information about surface deformation over a large area at millimetre order in the satellite direction that is close to vertical.

We also processed the archive images of ERS satellite (1992-2010) corresponding to the period of drilling, stimulation and production period of the Soultz-sous-Forêts site.

3. CONCLUSION

During the production period, the aim of the geodesy monitoring is to provide constrains on the dynamic behavior of a geothermal reservoir at the relevant space and time scales. The geodesy monitoring will also be a good indicator in case of damages and therefore it will help for the acceptability of the power plant. The results will be an input for reservoir modeling and give information about possible fault reactivation, induced seismicity and slow deformation.