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Temporary passive seismic data acquired at Rittershoffen geothermal field Alsace, France, 2013-2014 (TOPASE) - Report

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Abstract

This report describes the passive seismic data acquired by the TOPASE network deployed over Rittershoffen geothermal field (Alsace, France). The monitoring period extends from March 2013 to November 2014, which includes the stimulation of the first well of the doublet, the drilling of the second well and well tests. These data were acquired using 31 Earth Data Loggers PR6-24 and MARK-SERCEL L-4C-3D 1 Hz seismometers of the Geophysical Instrument Pool Potsdam (GIPP), which were provided to the KIT-AGW-Geothermal research division.

Coordinates: 47.92° N / 9.25° E

Keywords: geothermics, enhanced geothermal system, Rittershoffen, Upper Rhine Graben, induced seismicity

1. Introduction

In Rittershoffen (Alsace, France), a deep geothermal well doublet was developed between 2012 and 2016, the year it was inaugurated (Baujard et al., 2014a; Baujard et al., 2014b; Baujard et al., 2017). Currently, the plant provides industrial heat to dry starch in a bio-refinery located 15 km away.

During the development of the enhanced geothermal system, passive seismic monitoring took place (Gaucher et al., 2013; Maurer et al., 2013; Maurer et al., 2015). The network was composed of permanent stations (12) and temporary stations (31). The temporary stations were provided by the GIPP and the associated data description is the bulk of this report.

The main objectives of the so-called TOPASE project, which is associated with the dense passive seismic monitoring network were:

1. to provide monitoring of the induced seismicity occurring during the field development operations (well stimulation, well drilling, well tests) (Lengliné et al., 2017; Maurer et al., 2015),
2. to perform ambient noise tomography of the site (Lehuteur et al., 2015; Lehuteur et al., 2016),
3. and to attempt drill-bit tomography.

The first two objectives were reached and led to several publications.

2. Data Acquisition

2.1 Experiment design and schedule

The temporary seismic network consisted of 31 stations deployed around the drilling pad of Rittershoffen geothermal plant, between March 2013 and November 2014. This period includes the stimulation of the first well GRT-1, the drilling of the second well GRT-2 and circulation tests. These stations were deployed in three different phases due to permitting and tool availability. Figure 1 shows a map of the location of all stations. Figure 2 shows a typical set-up of a temporary seismic station. In Figure 3, a schematic of the different components is shown.

The seismometers were buried between 50 and 100 cm depth. No cement plate was used at the bottom of the hole, the seismometer was simply levelled, oriented and then coupled to the ground and covered with the excavated soil; in half cases, the latter consisted of sand. The orientation of the North component of the seismometer was made using a manual compass.

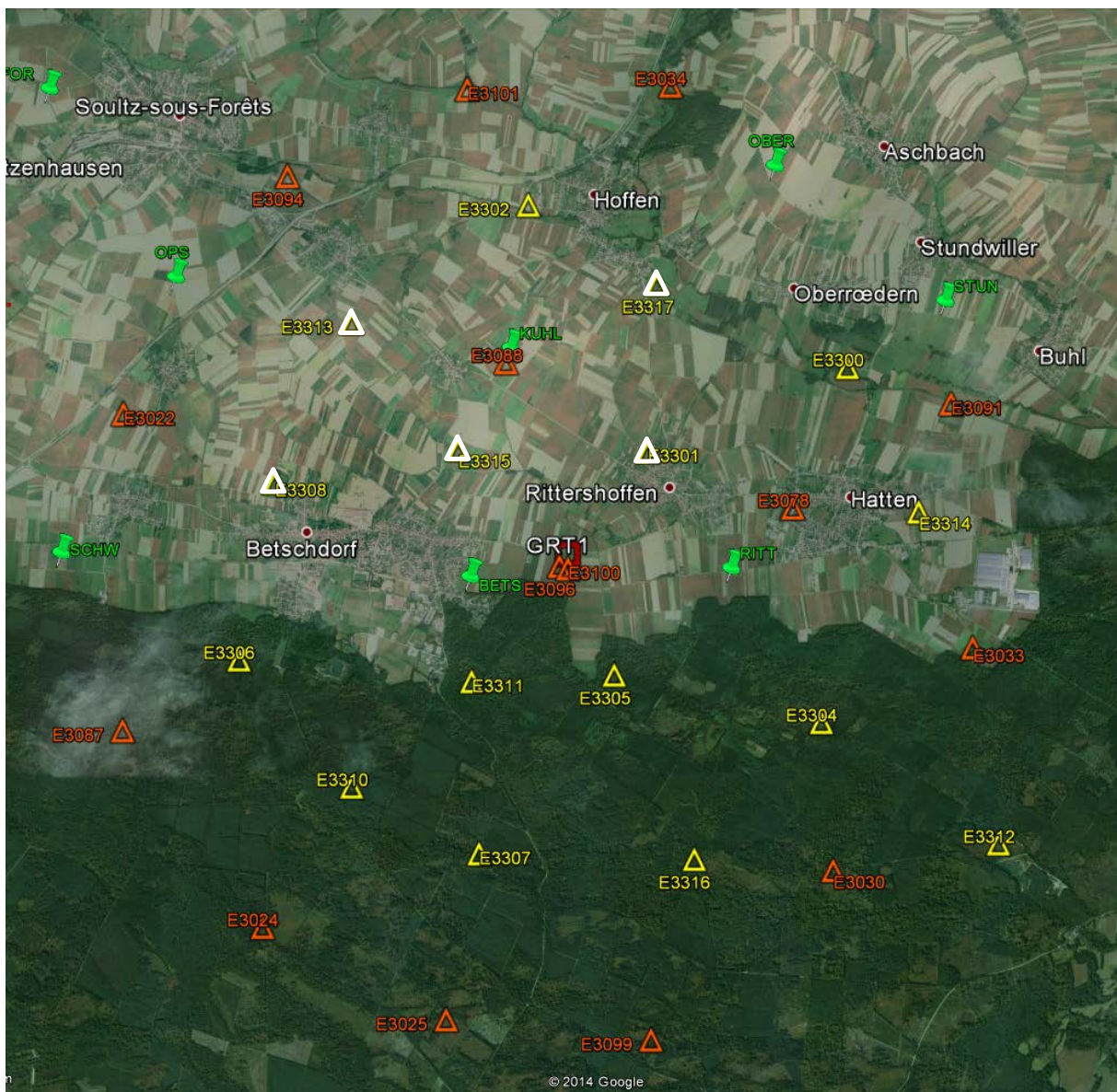


Figure 1: Location of the 31 seismic stations of the TOPASE network (triangles). The white, yellow and red triangles show the stations installed in June 2013, July 2013 and March 2014 respectively. (The green pins show the location of permanent stations).



Figure 2: Typical in-field deployment.

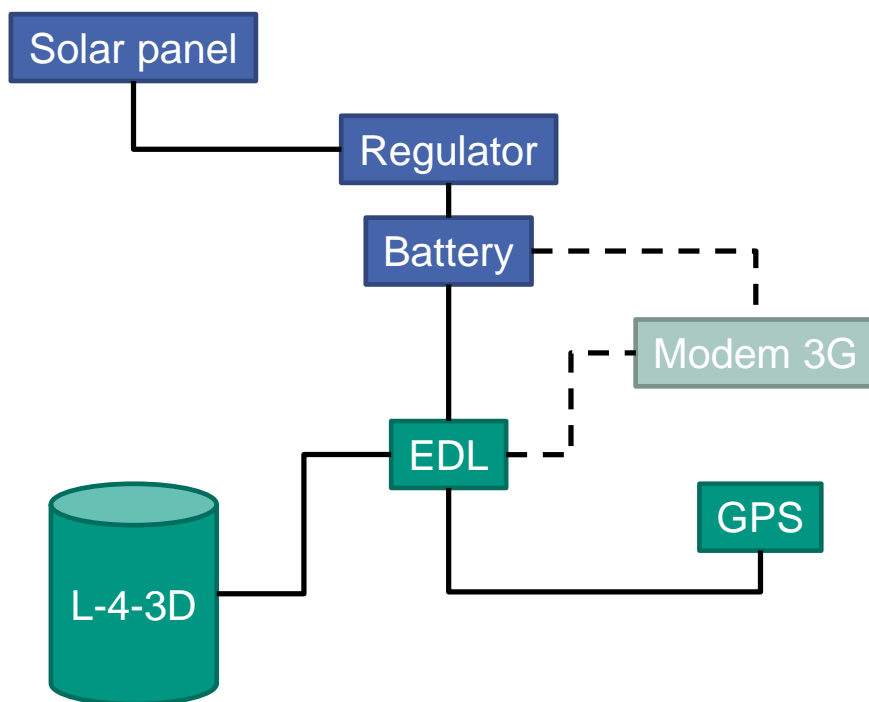


Figure 3: Schematic of a seismic station.

2.2 Geometry / Location

Table 1 gives the location of all stations as well as their recording period. The positioning was obtained using a Garmin GPS, which provided better location accuracies (especially in altitude) than the EDL internal GPS. Positioning uncertainties are of the order of ± 3 m. The station name corresponds to the EDL data logger ID.

Table 1: Position of the 31 seismic stations and their corresponding deployment period. The “Acc.” column gives the accuracy of the station location in m.

| Name | Latitude (°) | Longitude (°) | Altitude (m) | Acc. (\pm m) | Working period (dd/mm/yy) |
|-------|--------------|---------------|--------------|-----------------|---------------------------|
| E3022 | 48.90989 | 7.87614 | 182 | 3 | 25/03/14 – 22/10/14 |
| E3024 | 48.86239 | 7.89575 | 156 | 5 | 12/03/14 – 12/11/14 |
| E3025 | 48.85383 | 7.92157 | 140 | 5 | 12/03/14 – 12/11/14 |
| E3030 | 48.86765 | 7.97601 | 136 | 3 | 13/03/14 – 12/11/14 |
| E3033 | 48.88828 | 7.99569 | 134 | 3 | 25/03/14 – 12/11/14 |
| E3034 | 48.94036 | 7.95313 | 150 | 3 | 13/03/14 – 12/11/14 |
| E3078 | 48.90124 | 7.97032 | 161 | 5 | 25/03/14 – 13/11/14 |
| E3087 | 48.88058 | 7.87603 | 160 | 3 | 12/03/14 – 12/11/14 |
| E3088 | 48.91468 | 7.92996 | 185 | 6 | 27/03/14 – 12/11/14 |
| E3091 | 48.9109 | 7.99267 | 129 | 6 | 13/03/14 – 13/11/14 |
| E3094 | 48.93197 | 7.89912 | 152 | 3 | 13/03/14 – 12/11/14 |
| E3096 | 48.89584 | 7.93749 | 153 | 3 | 27/03/14 – 12/11/14 |
| E3099 | 48.85197 | 7.95038 | 137 | 4 | 12/03/14 – 12/11/14 |
| E3100 | 48.89561 | 7.93868 | 153 | 6 | 13/03/14 – 12/11/14 |
| E3101 | 48.94006 | 7.92446 | 148 | 3 | 27/03/14 – 12/11/14 |
| E3300 | 48.91429 | 7.97807 | 129 | 3 | 03/07/13 – 13/11/14 |
| E3301 | 48.90645 | 7.94989 | 172 | 3 | 19/06/13 – 12/11/14 |
| E3302 | 48.92932 | 7.93307 | 145 | 3 | 03/07/13 – 12/11/14 |
| E3304 | 48.88137 | 7.97436 | 131 | 3 | 19/07/13 – 12/11/14 |
| E3305 | 48.88576 | 7.9452 | 149 | 3 | 18/07/13 – 12/11/14 |
| E3306 | 48.88715 | 7.8924 | 154 | 3 | 12/07/13 – 12/11/14 |
| E3307 | 48.8692 | 7.92618 | 139 | 3 | 12/07/13 – 12/11/14 |
| E3308 | 48.90361 | 7.89742 | 174 | 6 | 24/06/13 – 12/11/14 |
| E3310 | 48.87538 | 7.90825 | 147 | 3 | 12/07/13 – 12/11/14 |
| E3311 | 48.88515 | 7.92513 | 159 | 3 | 18/07/13 – 12/11/14 |
| E3312 | 48.87011 | 7.99928 | 128 | 3 | 19/07/13 – 12/11/14 |
| E3313 | 48.91835 | 7.90827 | 182 | 3 | 20/06/13 – 12/11/14 |
| E3314 | 48.90087 | 7.98808 | 147 | 3 | 03/07/13 – 13/11/14 |
| E3315 | 48.90664 | 7.92323 | 175 | 3 | 20/06/13 – 13/11/14 |
| E3316 | 48.86869 | 7.95647 | 132 | 3 | 19/07/13 – 12/11/14 |
| E3317 | 48.92203 | 7.95124 | 144 | 3 | 19/06/13 – 12/11/14 |

2.3 Instrumentation

The seismometers are MARK-SERCEL L-4C-3D 1Hz (Geophysical Instrument Pool Potsdam, 2013).

The data loggers are EDL PR6-24 (Earth Data, 2004; Geophysical Instrument Pool Potsdam, 2013).

2.4 Acquisition parameters

All stations had the same acquisition configuration. The most important parameters are:

- Sampling rate: 300 sps
- File length: 4 minutes
- Gain: High
- Format: mini-seed
- Byte order: big endian

More details are given in the “recorder.ini” file, which is included in the database.

The geophone responses are provided in the “Geophon_PZ.zip” file, which is included in the database. The triplets of EDL – Geophone – Hard disk ID numbers are given in the file “EDL_and_GEOPHONES_numbers.pdf”, which is included in the database.

3. Data Processing

The provided data are raw data. No processing was performed.

4. Data Description

The data are provided as recorded by each EDL (Earth Data, 2004)

4.1 File format (s)

- Format: mini-SEED (IFDSN et al., 2012)
- Byte order: big endian

4.2 Data content and structure:

On the original disk provided by the KIT, several files exist:

- rawdata.tar: all raw files, for all stations, for the full recording period (except for the 3 stations and period below) generated by the EDL system
- e3301.2014.86-133.tar: raw files of station e3301 for the period Julian day 86 to 133 in 2014
- e3308.2014.86-133.tar: raw files of station e3308 for the period Julian day 86 to 133 in 2014
- e3315.2014.86-133.tar: raw files of station e3315 for the period Julian day 86 to 133 in 2014
- EDL_and_GEOPHONES_numbers.pdf: file giving the triplet of the EDL, Geophone and Hard disk ID numbers for each station
- Geophon_PZ.zip: zip file containing the response of each geophone as provided by the GIPP of GFZ.

The provided raw data are sorted as follows (once the tar files have been untarred):

- Year of acquisition
 - Station
 - Julian day
 - E*.pri*
 - E*. EDLTemp
 - E*. diskTemp
 - E*. battl
 - E*. battV1
 - E*. battV2
 - E*000000.gps
 - E*000000.gst
 - E*000000.msg
 - E*000000.pll¹

⁽¹⁾ Note that for several stations installed in June and July 2013, all files but the E*.pri* ones are unavailable at start of the monitoring period. However, since 10-Sep-2013 all files are available.

5. Data Quality/Accuracy

The data quality is provided in the numerous daily log files recorded by the data logger (see previous section) (Earth Data, 2004). However, as mentioned above, for several stations installed in June and July 2013, these log files are unavailable at start of the monitoring period. Since 10-Sep-2013 all files are available.

6. Data Availability/Access

Data are archived at the GIPP Experiment and Data Archive (GIPP) where they are freely available for further use under a “Creative Commons Attribution-ShareAlike 4.0 International Licence” (CC BY-SA 4.0). The data were restricted until 12 November 2018. When using the data, please cite the dataset below and acknowledge the use of GIPP instruments. You can additionally cite this Scientific Technical Report STR, especially if referring to specific details explained therein.

Recommended citation for data described in this publication:

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