Description to dataset “Seismic repeat survey acquired in the Mont Terri Underground Rock Laboratory (URL), Switzerland”

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Abstract
The dataset contains SEG-Y data of a 3D seismic in situ experiment in the Mont Terri URL, Switzerland. The data were acquired using a pneumatic impact source and 3-C geophones, installed in boreholes or on the tunnel wall. The data publication covers the raw data (individual hits per shot point) and the vertically stacked data stored in SEG-Y format. The survey geometry (source coordinates, receiver coordinates) is included.

Coordinates: 7.164784459° E / 47.378893610° N
Keywords: seismic data, seismic exploration, in situ experiment, impact source, Mont Terri URL, Opalinus Clay, iCross project

1. Introduction

The Mont Terri Underground Rock Laboratory (URL, Bossart et al. 2017), Switzerland, is located in the Opalinus Clay, which is a potential host rock for underground storage facilities. In the framework of the iCross project, several seismic investigations (SI-A experiment) were carried out in the galleries to characterize clay formations around the rock laboratory. The SI-A experiment comprises a 3D-pilot survey (Wawerzinek et al. 2022), a 3D-repeat survey and a 2D reflection seismic survey.
This data publication contains the seismic repeat survey aiming to provide a denser data set (more source points) to focus on the seismic characterization and imaging of the main fault.

2. Data Acquisition – Experiment, schedule, acquisition parameters

The 3D-seismic survey (Fig. 1) covered the shaly and carbonate-rich sandy facies of the Opalinus Clay (Bossart et al. 2017) and was carried out in September 2020. The dataset was acquired by using a pneumatic impact source (Giese et al. 2005) and at each source point (SP) five hits were carried out at the tunnel wall. In total, the dataset comprises 89 source points, more precisely 25 SPs from the pilot survey and 64 new SPs (Fig. 1 left).
The seismic data were recorded on 32 3-component (3-C) geophones using the DAQlink4 recording system, a sampling interval of 1/8 ms and a trace length of 500 ms. 23 3-component (3-C) geophones were deployed in 2 m deep boreholes (channels 1-72) and 8 3-C geophones were mounted on the tunnel wall (channels 73-96). The channels 13-15 are dead traces, since receiver 9 could not be installed during this survey. It was replaced with receiver 39 (channels 91-93).
The 3-C receivers (Fig. 1 right) installed in boreholes were vertically spread over two levels 2 m apart. The lower sensors were oriented horizontally (w/o inclination), while the upper sensors had an inclination of -40°. The individual components of the borehole receivers were oriented “vertically” (#1), parallel (#2) and perpendicular (#3) to the tunnel wall. Additional 3-C receivers were installed at the tunnel wall (w/o inclination) to close existing gaps. Their components were oriented parallel (#1), radial (#2) and vertically (#3) to the tunnel wall. The orientation of the individual components is listed in file /info/receiver_coordinates.txt.

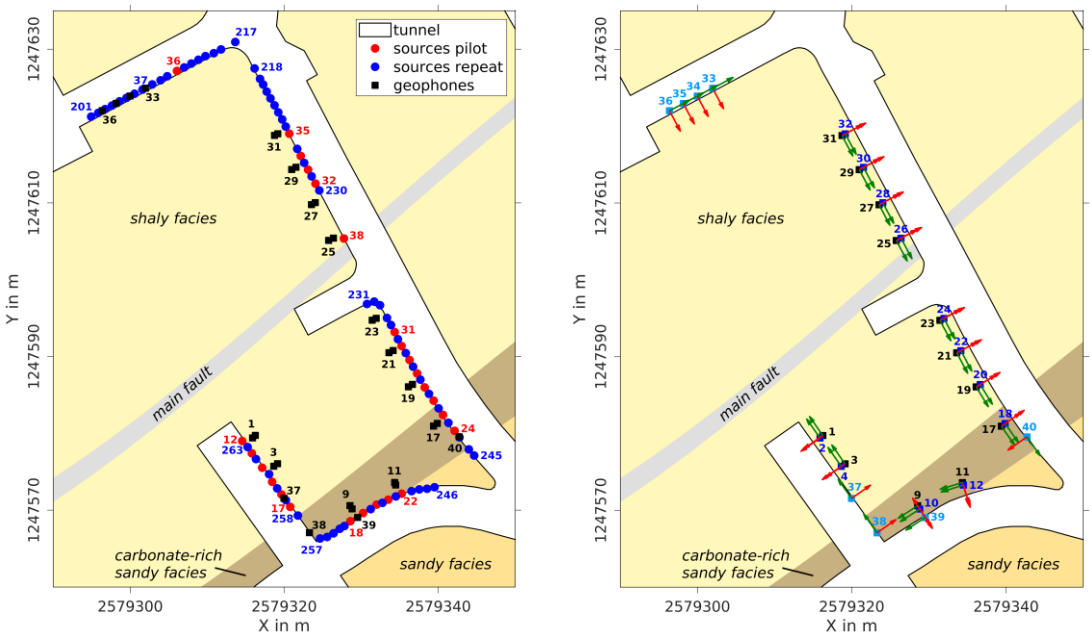

Figure 1: Left: Overview map of the study area showing the local geology (provided by the Mont Terri Project, swisstopo) and the source (blue & red dots) and receiver (black squares) locations with the corresponding numbering. Source locations from the previous pilot survey (Wawerzinek et al. 2022) were also acquired in this survey and are marked as red dots. Right: Location of the 3-C geophones and the corresponding orientation of the tunnel-radial (red arrows) and tunnel-parallel (green arrows) components. 3-C geophones were installed in 2 m deep boreholes w/o inclination at the lower level (black squares) and with an inclination of -40° at the higher level (dark blue squares); their vertical component points upwards. Complementary 3-C geophones (light blue squares) were installed on the tunnel wall and their vertical component points downwards.

3. Data Processing

The seismic data were recorded in SEG-Y format using the DAQlink acquisition system. The SEG-Y data were imported to ProMAX/SeisSpace (Landmark), the geometry was assigned, vertical stacking was applied and the data were exported as SEG-Y files.

The file impact_raw_data.sgy comprises the raw data (individual hits at each source point) and the file impact_preproc_data.sgy comprises the vertical stacked data. The header includes source point and receiver numbers as well as their corresponding coordinates.

4. Data Description

An overview of the directory structure and file inventory is listed in Table 1. The dataset is organized in two folders:

(1) The folder /segy contains the seismic data which was acquired with a pneumatic impact source (Giese et al. 2005). The data is stored in SEG-Y format (Barry et al. 1975) and the survey geometry is inserted in the SEG-Y header (Table 2) and includes shot point and receiver number and their corresponding coordinates.

(2) The folder /info comprises the survey geometry. The source and receiver coordinates are given as easting, northing and elevation above sea level using the local Swiss reference system CH1903+ (LV95) (https://www.swisstopo.admin.ch/en/knowledge-facts/surveying-geodesy/reference-systems/switzerland.html). The file formats are listed in Tables 3 & 4.

Table 1: Directory and file structure

Directory	Files	subdirectory	Content of subdirectory
/segy	impact_raw_data.sgy impact_preproc_data.sgy	-	3-C geophone data: raw and preprocessed (vertical stacking)
/info	source_coordinates.txt receiver_coordinates.txt	-	impact source point coordinates receiver coordinates

Table 2: SEG-Y header words set

SU header word[1]	SEGY header byte[2]	Length (byte)	Description	Value, if constant
fldr	9	4	Field record number	
tracf	13	4	Receiver channel number	
gelev	41	4	Receiver elevation (m)	
selev	45	4	Source elevation (m)	
scalel	69	2	Scale factor for elevation (negative scalar is used as divisor)	-10000
scalco	71	2	Scale factor for X and Y coordinates (negative scalar is used as divisor)	-100
sx	73	4	Source coordinate - X	
sy	77	4	Source coordinate - Y	
gx	81	4	Receiver coordinate - X	
gy	85	4	Receiver coordinate - Y	
ns	115	2	Number of samples in trace	4000
dt	117	2	Sample interval; in micro-seconds	125
unass	233	4	Source number	
unass	237	4	Receiver number	

Table 3: Format of the source coordinate file

Column	Column header	Units	Description
1	ID	-	Receiver number
2	east	m	Easting (swiss coordinate system)
3	north	m	Northing (swiss coordinate system)
4	elev	m	Elevation above sea level
5	ffid	-	Field record number

Table 4: Format of the receiver coordinate file. The azimuth is defined as horizontal angle measured clockwise from north: north (0°), east (90°), south (180°), and west (270°). The inclination is defined as the vertical angle measured from the horizontal (0°) upwards (positive) and downwards (negative). Nan values mean undefined angles, e.g. nan azimuth for exactly vertically oriented components.

Column	Column header	Units	Description
1	ID	-	Receiver number
2	east	m	Easting (swiss coordinate system)
3	north	m	Northing (swiss coordinate system)
4	elev	m	Elevation above sea level
5	ch1	-	Channel number of 1st component
6	ch2	-	Channel number of 2nd component
7	ch2	-	Channel number of 3rd component
8	az1	°	Azimuth of 1st component
9	in1	°	Inclination of 1st component
10	az2	°	Azimuth of 2nd component
11	in2	°	Inclination of 2nd component
12	az3	°	Azimuth of 3rd component
13	in3	°	Inclination of 3rd component

1 SU Seismic Un*x (Cohen & Stockwell, 2010)
2 SEG-Y (Hagelund & Levin, 2017)

5. Data Availability/Access

Data is archived at the *GIPP Experiment and Data Archive* where it is freely available for further use after the end of the embargo period on Month 12, 2023 under a “Creative Commons Attribution 4.0 International Licence” (CC-BY 4.0). When using the data, please give reference to this data publication. Recommended citation is:

> Wawerzinek, B., Esefelder, R., Giese, R., Jurczyk, A., Krawczyk, C.M., Krüger, K., Lüth, S. (2022): Seismic repeat survey acquired in the Mont Terri Underground Rock Laboratory (URL), Switzerland. GFZ Data Services. https://doi.org/10.5880/GIPP.202099.1

Acknowledgments

The collaborative research project iCross is funded by the German Ministry for Education and Research (BMBF, 02NUK053D), the Helmholtz Association and the GFZ. We are grateful for the technical support provided by Swisstopo, in particular by S. Schefer, D. Jaeggi and T. Theurillat. The field survey was carried by the authors, J. Mach and with support of the Helmholtz Innovation Lab "3D-Underground Seismics". We thank the Geophysical Instrument Pool Potsdam (GIPP) for providing the additional eight 3-C geophones to complement the survey layout. We also gratefully acknowledge the support of the SI-A experiment by the Nuclear Waste Management Organization (NWMO, Canada).

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