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Argolis, Greece, Site Effect Study for the HERACLES Project (Nov. 2012 – Jun. 2013) - Report

Scientific Technical Report STR17/07 – Data
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Argolis, Greece, Site Effect Study for the HERACLES Project (Nov. 2012 – Jun. 2013) - Report

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Abstract
Engineering seismological models (incl. ground amplification and topographic effects) of key structures in Tiryns and Midea, Greece, will be used to test the hypothesis of seismogenic causes of the decline of the Mycenaean settlements in the 12th century BC.

Related Datasets

- DOI of datasets described in this report: http://doi.org/10.5880/GIPP.201211.1 (recommended for citation, see below)

Coordinates: 37.60°N, 22.81°E

Keywords: Archaeoseismology, Argolis, Geophysics, Site Effects

1. Introduction

Together with Mycenae, Midea, and Argos, Tiryns is one of the most important places of Mycenaean culture. Tiryns is located on the Argolis plain on the Peloponnesus peninsula in Greece. It is famous for its Cyclopean walls (right) of the fortification made from local limestone blocks, some masses exceeding 10^4 kg. Tiryns is well known from Greece mythology and thought to be the birth place of HERACLES which gave the name to the Project[1]. Since 1999 it belongs to the UNESCO world heritage. Tiryns excavation history spans more than 100 years and started in 1884 with the work of Heinrich Schliemann). During the 20th century, parts of the fortifications were restored, in particular, the western side, which faces the main road from Argos to Nafplion (Figure 1). In the 1970s the archaeologist K. Kilian conjectured that several destructive earthquakes caused (at least in parts) the decline of the Mycenaean culture at the end of the 12th century B.C.E. Damaged buildings and structures in the Tiryns ruins formed the nucleus of the hypothesis. The neighboring palace of Midea, 7 km east of Tiryns, also shows evidence of damage, possibly of a seismogenic nature.

In archaeoseismological field campaigns in 2012 and 2013, we gathered geophysical data for an engineering seismological model of the Tiryns site and structures, including P- and S-wave refraction tomography on twelve profiles, ambient noise single station and array measurements and a gravity survey. For a nine months period temporary stations were deployed to record local seismicity particularly to study site effects by the standard spectral ratio method. This report gives the essentials about the temporary station network.

2. Data Acquisition

2.1 Experiment design and schedule

A temporary network of ten stations was installed in September 2012 and operated until June 2013 (Figure 1). One station had to be moved in March 2013. Table 1 gives the project station codes and station locations. Seven stations were installed in and around the Mycenaean citadel of Tiryns and three at the Midea citadel (Figure 1). The station with the project code HE01 was placed on hard rock (Figure 2) and later used as the reference station for spectral ratio calculations (Hinzen et al., 2016).

Figure 1: The labeled red circles show the station locations of the temporal deployment in Tiryns (left) and Midea (right) in a GoogleEarth® view. Station labels are those from Table 1.

Table 1: Project station codes and station locations (from Hinzen et al., 2016).

Table 1
Project Station Code and Location of 11 Temporary Stations at Tiryns and Midea Operating between October 2012 and June 2013

Station Code	Latitude (°)	Longitude (°)	Elevation (m)	Location
HE01	37.5997	22.7998	35.8	Tiryns west wall/bedrock (reference station)
HE02	37.6011	22.8000	35.3	Tiryns north of citadel/sediment
HE03	37.5999	22.7997	34.9	Tiryns Unterburg/bedrock
HE04	37.5984	22.8005	34.6	Tiryns Oberburg/anthropogenic structures on bedrock
HE05	37.6014	22.8059	34.3	East of Tiryns/sediment
HE06	37.5981	22.8006	33.9	Tiryns South Gallery/anthropogenic structures on bedrock
HE07	37.5990	22.8011	33.7	Tiryns east of citadel/shallow sediments
HE08o	37.6576	22.8433	146.0	Midea northeast of hill/sediment
HE08	37.6461	22.8392	128.0	Midea southwest of hill/chapel on bedrock
HE09	37.6511	22.8434	230.0	Midea slope of hill/bedrock
HE10	37.6494	22.8423	257.0	Midea summit/bedrock

2.3 Instrumentation

The ten stations were equipped with MARK L-4C-3D sensors with 1.0 s nominal eigenfrequency, and acquisition was made with Earth Data PR6-24 field recorders (EDL; Fig. 2). All passive experiment data during the project were acquired with a sampling rate of 200 samples per second. Table 2 shows the project station code, EDL recorder numbers and the GIPP seismometer numbers. Sensors were oriented with a compass with uncertainties of up to +/- 5°.

For some stations a mains power supply could be used (Table 2), the other stations were operated with 80W solar panels. Table 2 shows the recorder and seismometer numbers together with the station codes and the power supply.

Figure 2: Setting of station HE01 at the Tiryns citadel on hard rock in a drainage channel of the Cyclopean fortification wall. (Photos K.-G. Hinzen)

For some stations a mains power supply could be used (Table 2), the other stations were operated with 80W solar panels. Table 2 shows the recorder and seismometer numbers together with the station codes and the power supply.

Table 2: Station code, GIPP recorder and seismometer number and type of power supply

Code	Recorder	Seismometer	Power
HE_01	e3087	2933	Solar
HE_02	e3088	2934	Mains
HE_03	e3091	2937	Solar
HE_04	e3094	2938	Solar
HE_05	e3096	2939	Mains
HE_06	e3099	3037	Solar
HE_07	e3100	3038	Mains
HE_08(a)	e3101(a)	3039	Mains
HE_09	e3102	3041	Mains
HE_10	e3104	3042	Solar

3. Data Processing

Available data are raw data in MSEED format in files with durations of ~15 minutes. All metadata are in the accompanying EDL log files. The data on hand are in units of counts, not filtered and not resampled. The sensor constants, normalization factor, sensitivity, and poles and zeros are individual for each instrument and component (see www.gfz-potsdam.de/gipp → Instruments).

4. Data Description

Figure 3 gives an overview of the data completeness. Start of the timeline is Sep. 16. 2012 and unit is days. Due to bad weather conditions during the 2017/13 winter, the solar panel operated stations had numerous data losses during night time due to power failure.

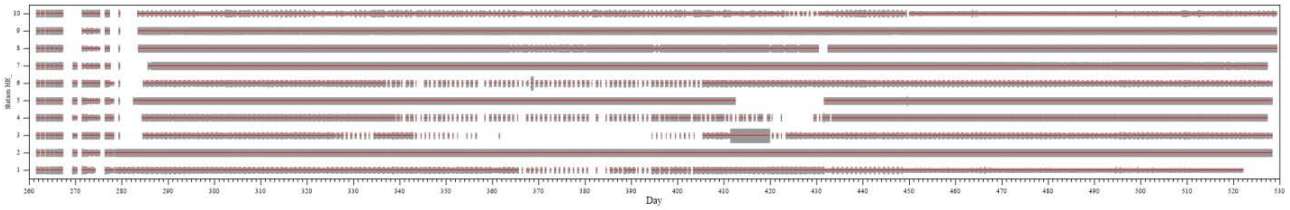

Figure 3: Overview ower the completeness of the recordings of temporary stations starting 16. Sep. 2012. X-axis is time (from September 2012 until June 2013); Y-axis is stations HE01 – HE10.

4.1 File format
All data are in MSEED format organized in files of ~15 minutes length in their original sample rate of 200 samples per second.

4.2 Data content and structure:
Data files are organized in directories with the following structure:

HE_XX / YYY

where **XX** is the station number 01 to 10 and **YYY** is the day of the year. Each day directory contains the MSEED files separate for each component with the file endings .PRI1, .PRI2, and .PRI3 and the file name indicating the start time and the log files .MSG as well as temperatures and voltages.

5. Data Quality/Accuracy
All stations were equipped with GPS clocks. The metadata on synchronization, temperatures, internal voltage etc. can be found in the EDL log files. Data are raw data without any corrections. Figure 4 shows a data example of a local earthquake.

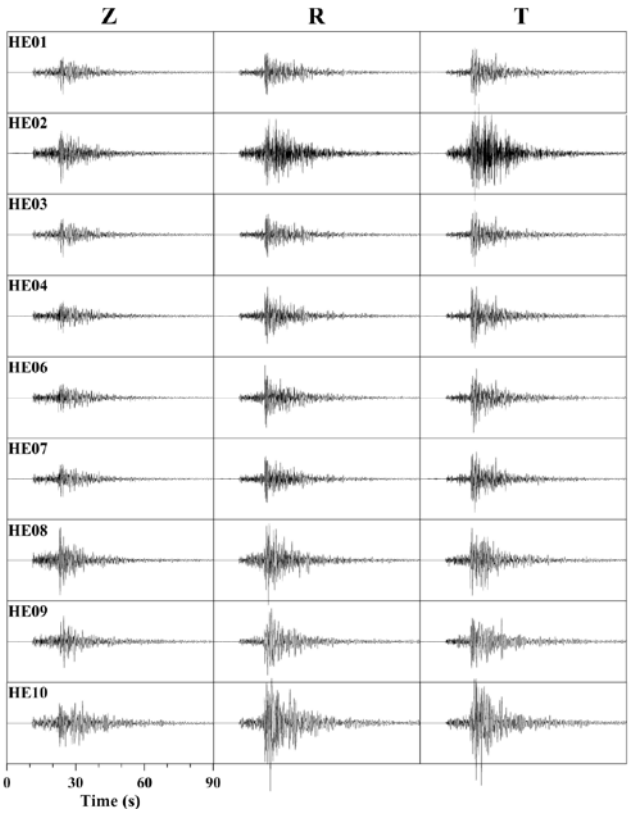

Figure 4: Data example with velocity proportional seismograms of a local ML 4.2 earthquake that occurred on 28 April 2013 in the Gulf of Corinth at an epicentral distance to Tiryns of 88 km. Components are rotated with respect to the backazimuth; vertical scale is ±1.0 mm/s for all boxes; temporary station code is shown in the upper left corner of the Z component.

6. Data Availability/Access

The data are archived at the GIPP Experiment and Data Archive where they will be made freely available for further use on January 1, 2018 under a “Creative Commons Attribution-ShareAlike 4.0 International License” (CC BY-SA 4.0).

When using these data, please cite the HERACLES dataset, and acknowledge the use of GIPP instruments. You can additionally cite this Scientific Technical Report STR, especially if referring to particular details explained therein.

Recommended citation for the data described in this publication is:

Hinzen, K.-G., Fleischer, C. (2017): Argolis Site Effect Study, Greece for the HERACLES Project (Nov. 2012 – Jun. 2013) - Datasets. GFZ Data Services.
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