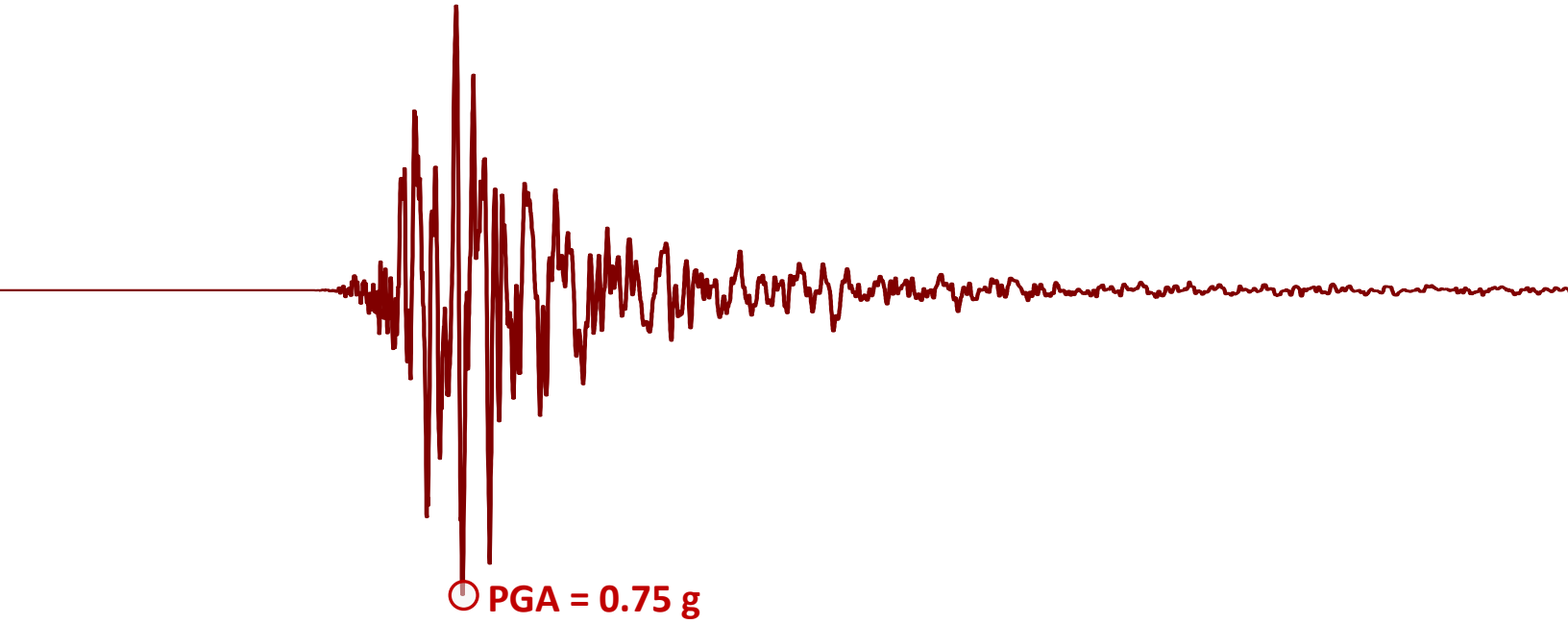
CHAPTER 7

Seismological and Strong Motion Aspects



GEER/EERI/ATC Cephalonia, Greece 2014

Report Version 1

7 Seismological and Strong Motion Aspects

INTRODUCTION

This chapter presents preliminary principal seismological and strong motion aspects of the1st mainshock event in Cephalonia that occurred on January 26th, 2014 with moment magnitude M_w of 6.1 and with epicenter off the southwest coast of the island. Seismological information on the 2nd M_w = 6.0 mainshock event of February 3rd, 2014, with epicenter around the Lixouri area, will be provided in the next version of this report, with only selected available data included in Section 2 of this Chapter. Digital data of both mainshocks recorded by the EPPO-ITSAK and NOA-IG stations were made available to our team and are accessible at the web links:

itsak.gr/news/news/65 (EPPO-ITSAK)

gein.noa.gr/data/kefalonia/LXRB_20140126_135543_unc.dat (1st event, NOA-IG)
gein.noa.gr/data/kefalonia/SMHA_20140126_135543_unc.dat (1st event, NOA-IG)

gein.noa.gr/data/kefalonia/ARGA_20140203_030844_unc.dat (2nd event, NOA-IG)
gein.noa.gr/data/kefalonia/SMHA_20140203_030844_unc.dat (2nd event, NOA-IG)

At present there is uncertainty as to the geometry of the ruptured area that generated the two events, including the possibility of having a pair of closely-spaced parallel dextral strike-slip faults with a trust component that ruptured in a sequence, whose aftershocks are difficult to separate. Some indication of this possibility comes from the remote sensing interferometry presented in Section 3 of this Chapter. In addition, since the seismographic network is almost exclusively located on the east of the island, some uncertainty exists as to the location of the epicenters. These issues will be addressed in future versions of this report.

7.1 First Main Event of January 26, 2014

On Sunday January 26, 2014, 13:55 GMT (15:55 local time) a strong earthquake with magnitude M 6.1 (HVR) occurred at the southwestern coasts of Cephalonia, about 9 km southwest of the Lixouri town. According to the Seismological Center of the Aristotle University of Thessaloniki (AUTH), it was a shallow crustal event with epicenter 38.161N, 20.340E and depth 10 km (geophysics.geo.auth.gr). At 18:45 GMT (20:45 local time) a strong aftershock with magnitude M 5.5 followed the mainshock.

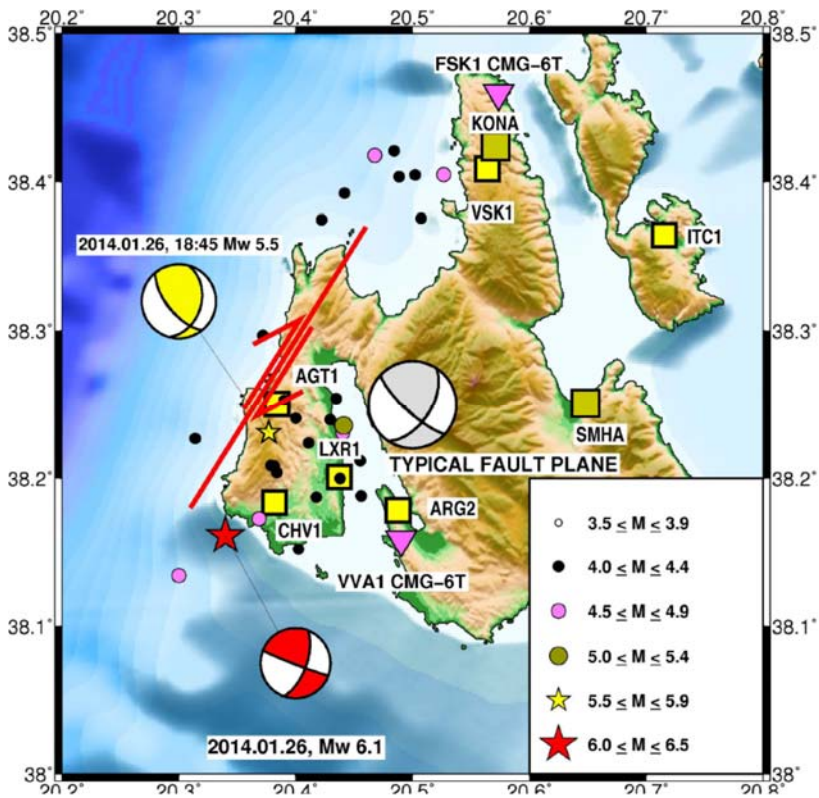


Figure 7.1.1 Epicenters of 1/26/14 1st mainshock (M_w6.1, red star), aftershock (M_w5.5, yellow star) and 48-hour aftershocks (M ≥4.0) (source: Geophysical Laboratory, AUTH). Instruments: EPPO-ITSAK accelerographs (yellow squares); seismographs (pink triangles). NOA-IG accelerographs (green squares) and permanent station VLS (green triangle). Focal mechanisms (source: Columbia University) and preliminary seismic fault (by Dr. Papaioannou, ITSAK) shown in red line.

The strike slip Cephalonia Transform Fault (CTF) (Scordilis et al., 1985) was related to the focal mechanisms of both the mainshock (13:55 GMT) and aftershock (18:45 GMT) events. CTF is a dextral strike-slip fault with a thrust component (Papazachos and Papazachou 1997, 2003) shown as the grey focal mechanism on Fig. 7.1.1. In the same figure, mainshock and aftershock epicenters are shown with red and pink star, respectively. Focal mechanisms of the two events were determined by Columbia University (www.globalcmt.org).

From the aftershock distribution during the first two days following the mainshock, a fault rupture length of about 18 km was established, corresponding to a moment magnitude M_w of 6.1. The aftershock distribution of about 48 hours after the mainshock is shown also shown on Fig. 7.1.1.

The ground shaking was strongly felt in Cephalonia and the neighboring Ionian islands of Ithaki, Lefkada and Zakynthos. The overall felt area, shown on the macroseismic intensity map of Figure 7.1.2, included a large part of continental Greece, south Italy and Albania (source: European Mediterranean Seismological Centre, EMSC; emsc-csem.org).

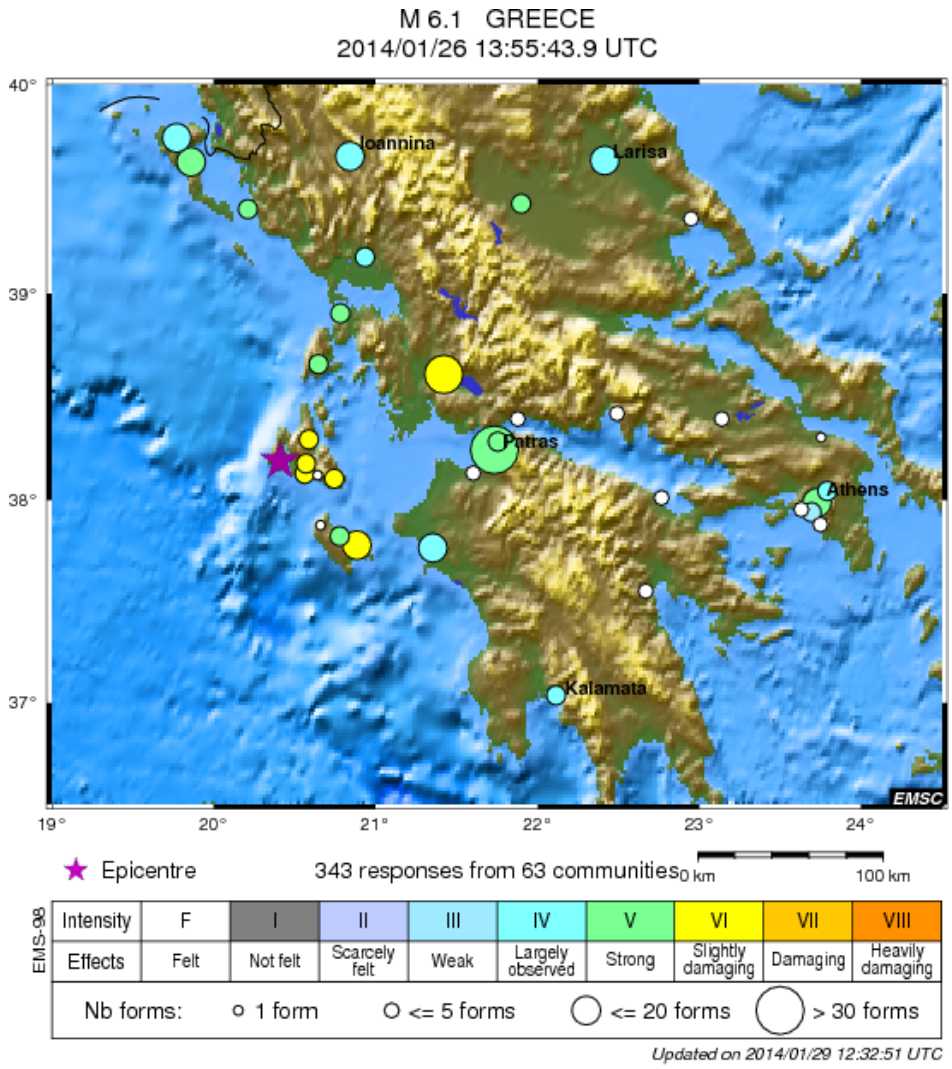


Figure 7.1.2. Observed macroseismic intensities of the 1st mainshock event of 1/26/14 (EMSC, 2014).

INSTRUMENTATION AND STATION NETWORK

During the past three years, EPPO-ITSAK (Institute of Engineering Seismology and Earthquake Engineering) and NOA-IG (National Observatory of Athens Geodynamic Institute) have installed a dense network of continuous recording broadband accelerographs of high resolution (24bits), with absolute GPS time throughout Greece. These instruments are supported by existing accelerographs of previous generations (12-16bits digitizers). Recordings of the network are transferred in real time at the central computing units of the two institutions.

On the day following the 1st event, scientific and technical staff of EPPO-ITSAK installed additional accelerographs and seismographs in Cephalonia to record potential future earthquakes on natural and built environment (EPPO-ITSAK, 2014). Collaboratively, additional instruments were installed by the Geotechnical Engineering Laboratory of UPATRAS. The permanent strong motion stations (digital instruments) on the Cephalonia and Ithaki Regional Unity were installed and run by EPPO-ITSAK, NOA-IG and UPATRAS. The geographical distribution of the accelerographs of the three institutes are shown on Fig. 7.1.3.

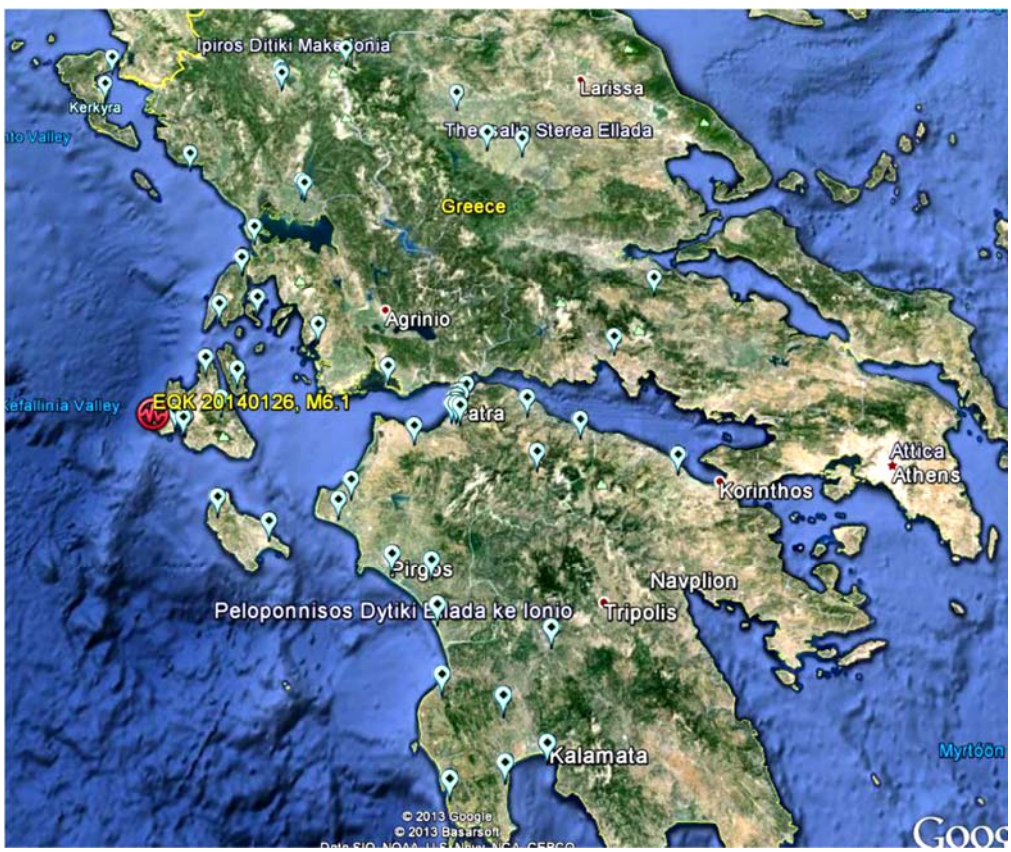


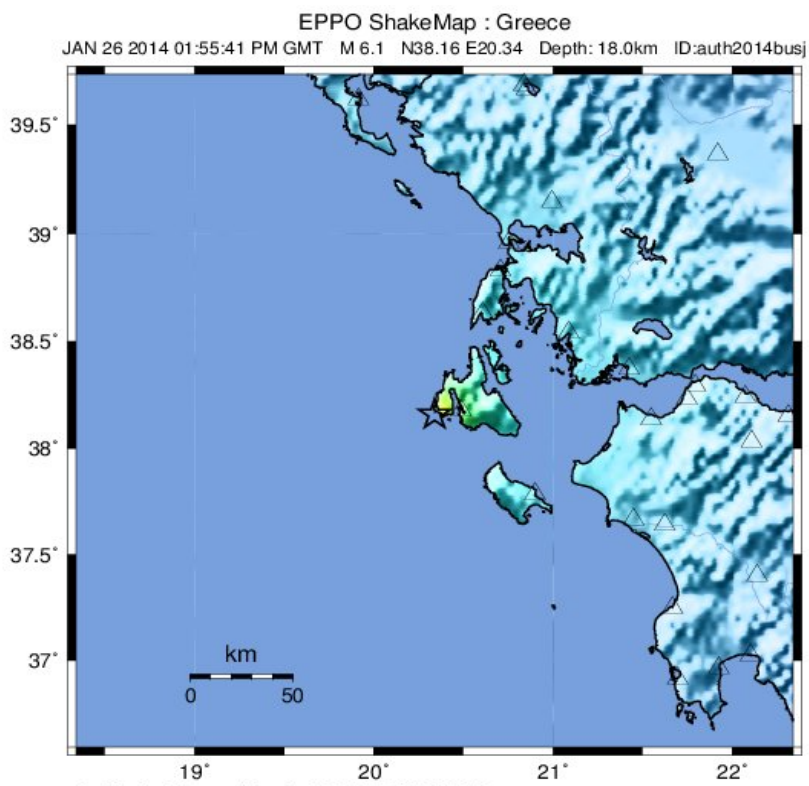
Figure 7.1.3. Permanent accelerographic stations installed by EPPO-ITSAK, NOA-IG and UPATRAS at epicentral distances up to 200 km. The epicenter of the 1st event is shown in red.

Most of these instruments are of continuous mode that provide information on the seismic source properties of the mainshock and its aftershocks. This continuous information is significant as it can be used for ground motion prediction in the near field and site effects studies. Some of the instruments are of trigger mode, but their resolutions are very high providing high quality strong motion data.

Table 7.1.1 lists the installed and triggered accelerographic instruments within an epicentral distance of 200 km as a result of the 1st mainshock event, including station location, geographical coordinates, and owner (EPPO-ITSAK, NOA-IG, UPATRAS). The epicentral and hypocentral distances, orientation of N/L, E/T and Z/V components (azimuth from N) and corresponding PGA values.

STRONG GROUND MOTION RECORDINGS

In less than 10 minutes after the earthquake, preliminary shakemaps became publically available with distribution of instrumental intensity, Peak Ground Acceleration (PGA) and Velocity (PGV) (portal.ingeoclouds.eu/sitools/client-user/Shakemaps/project-index.html).



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	<0.02	0.1	1.4	4.7	9.6	20	41	86	>178
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2011)

Figure 7.1.4. Shakemaps for the 1st mainshock event of M_w 6.1 in Cephalonia.

Table 7.1.1. Accelerographic stations and ground motion parameters within epicentral distances of 200 km from 1st event (1/26/14, M_w6.1). Station location, code, owner, geographical coordinates, epicentral and hypocentral distances, azimuth and PGA (cm/s^2) for N/L, E/T, Z/V components.

STATION LOCATION	CODE	ORGANIZ OWNER	LAT (deg)	LON (deg)	EPIC. D (km)	HYPC. D (km)	AZIM N_L	PGA N_L	AZIM E_T	PGA E_T	AZIM Z	PGA Z
Aigio - Gen. Nosokomeio	AIG2	EPPO ITSAK	38.242	22.072	152	153	0°	2.34	90°	2.39	Z-V	1.47
Akrata	AKR1		38.154	22.313	173	173	0°	2.21	90°	2.68	Z-V	1.41
Arxaia Olympia	AOL1		37.643	21.625	127	128	0°	4.36	90°	6.38	Z-V	3.02
Argostoli	ARG2		38.178	20.488	13	22	0°	349	90°	424	Z-V	324
Vasilikades Cephallonia	VSK1		38.412	20.562	34	39	0°	95.0	90°	79.6	Z-V	55.1
Arta	ART2		39.148	20.994	124	125	0°	3.46	90°	4.24	Z-V	3.24
Astakos	AST1		38.542	21.09	78	80	0°	15.44	90°	25.54	Z-V	20.0
Ithaki	ITC1		38.365	20.716	40	44	0°	56.54	90°	60.44	Z-V	37.6
Ioannina	IOA2		39.664	20.852	173	174	0°	3.58	90°	4.47	Z-V	2.90
Ioannina	IOA3		39.684	20.838	175	176	0°	3.62	90°	5.13	Z-V	1.85
Kato Axaia	KAC1		38.138	21.548	106	107	0°	11.24	90°	15.36	Z-V	5.52
Kalamata	KAL3		37.025	22.103	200	201	0°	2.42	90°	2.30	Z-V	1.19
Karditsa	KAR2		39.366	21.92	192	193	0°	4.33	90°	4.60	Z-V	1.19
Kalavryta	KLV1		38.033	22.108	155	156	0°	3.75	90°	4.90	Z-V	1.79
Kerkyra	KRK1		39.618	19.916	166	167	0°	8.33	90°	6.05	Z-V	2.84
Kyparisia	KYP2		37.25	21.667	154	156	0°	1.92	90°	2.54	Z-V	0.97
Lefkada	LEF2		38.83	20.708	81	83	0°	26.46	90°	23.18	Z-V	16.2
Megalopolis	MGP1		37.402	22.138	179	180	0°	2.85	90°	3.08	Z-V	1.64
Mesologi	MSL1		38.373	21.424	98	99	0°	26.53	90°	17.75	Z-V	6.36
Patra - Nosk. Ag. Andreas	PAT4		38.234	21.748	123	125	0°	7.53	90°	11.00	Z-V	5.44
Rio - Geniko Nosokomeio	PAT5		38.296	21.795	128	129	0°	5.50	90°	5.41	Z-V	3.38
Petalidi	PET1		36.964	21.926	193	194	0°	2.55	90°	2.04	Z-V	0.79
Preveza	PRE2		38.958	20.755	96	97	0°	15.78	90°	16.10	Z-V	7.18
Pylos	PYL1		36.914	21.695	183	184	0°	0.48	90°	0.84	Z-V	0.40
Pyrgos	PYR2		37.667	21.451	112	113	0°	5.55	90°	5.15	Z-V	3.13
Vasiliki Lefkadas	VAS2		38.63	20.608	57	60	0°	80.01	90°	86.17	Z-V	61.4
OTE Zakynthou	ZAK2		37.788	20.9	64	67	0°	49.39	90°	49.31	Z-V	19.6
Reginne	RGG1		38.719	22.709	215	216	0°	3.28	90°	2.85	Z-V	2.30

Table 7.1.1. (continued)

STATION LOCATION	CODE	ORGANIZ OWNER	LAT (deg)	LON (deg)	EPIC. D (km)	HYPC. D (km)	AZIM N_L	PGA N_L	AZIM E_T	PGA E_T	AZIM Z	PGA Z
Lefkada	LEF1	EPPO ITSAK	38.826	20.702	80	82	70°	32.08	250°	40.66	Z-V	22.1
Vartholomio	Var2		37.864	21.208	83	85	270°	18.51	0°	13.44	Z-V	7.12
Lixouri Town Hall	LXRB	NOA-IG	38.201	20.437	10	20	180°	561.60	270°	425.00	Z-V	562
Sami Town Hall	SMHA		38.251	20.648	29	34	220°	269.16	310°	238.67	Z-V	183
Volimes	VLMS		37.877	20.663	42	46	0°	51.48	90°	99.50	Z-V	30.0
Meganissi Town Hall	MGNA		38.656	20.791	68	70	340°	27.04	70°	28.84	Z-V	6.06
Lefkada OTE	LEFA		38.833	20.704	81	83	140°	54.07	230°	39.73	Z-V	23.0
Lechaina Town Hall	LCHA		37.937	21.264	85	86	0°	18.99	90°	19.58	Z-V	7.14
Rio Town Hall	RIOA		38.296	21.791	128	129	100°	5.20	190°	5.93	Z-V	3.37
Arta Town Hall	ARTB		39.157	20.979	124	125	200°	8.08	290°	9.49	Z-V	4.14
Parga Town Hall	PRGA		39.286	20.402	125	127	240°	23.79	330°	26.53	Z-V	3.97
Zacharo Town Hall	ZARA		37.487	21.649	137	138	150°	3.77	240°	4.09	Z-V	2.16
Ioannina	JANA		39.656	20.849	172	173	0°	2.22	90°	3.86	Z-V	1.76
Ithomi	ITMA		37.179	21.925	177	178	0°	1.13	90°	1.34	Z-V	0.78
Kassiopi Town Hall	KASA		39.746	19.935	180	181	310°	2.22	40°	2.66	Z-V	1.42
Delfoi Town Hall	DLFA		38.478	22.496	191	192	230°	1.09	320°	0.96	Z-V	0.64
Metsovo Town Hall	MTVA		39.77	21.183	193	194	200°	2.64	290°	3.15	Z-V	1.85
Trikala Town Hall	TRKA		39.553	21.766	198	199	110°	2.99	200°	3.88	Z-V	1.82
Sofdes Town Hall	SOFA		39.337	22.097	201	202	320°	5.81	50°	5.88	Z-V	2.34
Kiato Town Hall	KIAA		38.014	22.75	212	212	40°	3.59	130°	3.80	Z-V	2.05
City of Patras	VA-1	UPATRAS	38.233	21.74	123	124	350°	10.10	80°	10.60	Z-V	5.40
	UP-1		38.269	21.748	124	125	0°	7.31	90°	6.54	Z-V	3.96
	UP-2		38.259	21.767	125	126	0°	8.71	90°	9.26	Z-V	6.20
	UP-3		38.249	21.748	123	125	0°	6.75	90°	9.45	Z-V	3.43
	UP-4		38.221	21.721	121	122	0°	16.29	90°	17.17	Z-V	5.52
	UP-5		38.22	21.743	123	124	0°	6.99	90°	7.79	Z-V	3.72
	UP-6		38.214	21.761	124	126	0°	5.26	90°	6.02	Z-V	2.34
	UP-7		38.249	21.735	122	124	0°	12.46	90°	11.87	Z-V	5.25
	UP-8		38.235	21.747	123	125	0°	8.55	90°	11.18	Z-V	5.88

Strong ground motion preliminary reports were quickly published on the web (itsak.gr/news). Acceleration time histories and corresponding response spectra for 5% structural damping are presented on Figs 7.1.5 to 7.1.7. Calculations were made with SMA (Kinemetrics, 1999) and ART (Guralp Systems, 2009) and ViewWare for accelerograms processing (Kashima, 2005). Some key observations are discussed in this section and summarized in Table 7.1.2.

Table 7.1.2. Highest PGA values and their components recorded during the 1st event at stations ARG2, VSK1, LXRB, SMHA at epicentral distances of 13, 34, 10, 29 km, respectively.

STATION LOCATION	CODE	ORGANIZATION OWNER	EPICENTAL DISTANCE (km)	max PGA (g)	COMPONENT
Argostoli	ARG2	EPPO-ITSAK	13	0.43	E(T)
Vasilikades	VSK1	EPPO-ITSAK	34	0.10	N(L)
Lixouri Town Hall	LXRB	NOA-IG	10	0.57	V(Z)
Sami Town Hall	SMHA	NOA-IG	29	0.27	N(L)

Argostoli Recording (ARG2): The highest PGA amplitude recorded was 424 cm/s^2 (0.43 g) in the horizontal E direction. High SA values exceeding 1,000 cm/s^2 (1 g), were generated for short periods of T < 0.3 s. In addition, relatively high SA values greater than >500 cm/s^2 (0.51 g) for periods up to 0.7 s were apparent in the NS component (Fig. 7.1.5).

Vasilikades Recording (VSK1): The SA values from the VSK1 station were up to four times lower than those of ARG2 as was the highest PGA at 0.1 g. The overall spectral shape was also different particularly for structural periods T > 0.5 s. The strong ground motion bracketed duration, for ground accelerations > 0.1 g, was about 9 s in both horizontal components and 6 s in the vertical (Fig. 7.1.6).

Lixouri Town Hall Recording (LXRB): At LXRB station, the highest PGA recorded was 562 cm/s^2 (0.57 g) in the vertical direction, perhaps due to close proximity to the epicenter, compatible with observed roof-tiles displacements discussed in Chapter 11. SA reached 2,000 cm/s^2 (~ 2 g) for short periods between 0.05 and 0.08 s in the vertical direction. For the horizontal components, PGA amplitudes were 531 and 425 cm/s^2 (0.54 and 0.43 g), while SAs reached 1,300 cm/s^2 (1.3 g) for periods between 0.5 and 1.0 s (Figs. 7.1.7, 8).

Sami Town Hall Recording (SMHA): Located 20 km from the epicenter, the SMHA station, recorded PGAs up to 239, 269, 183 cm/s^2 (0.24, 0.27, 0.17g) for L,T,Z components, respectively. The maximum SA was calculated at 1,000 cm/s^2 (~ 1g) at 0.3 s in the lateral direction and 600 cm/s^2 (0.61 g) at 0.1 s in the vertical direction (Figs. 7.1.9 and 7.1.10).

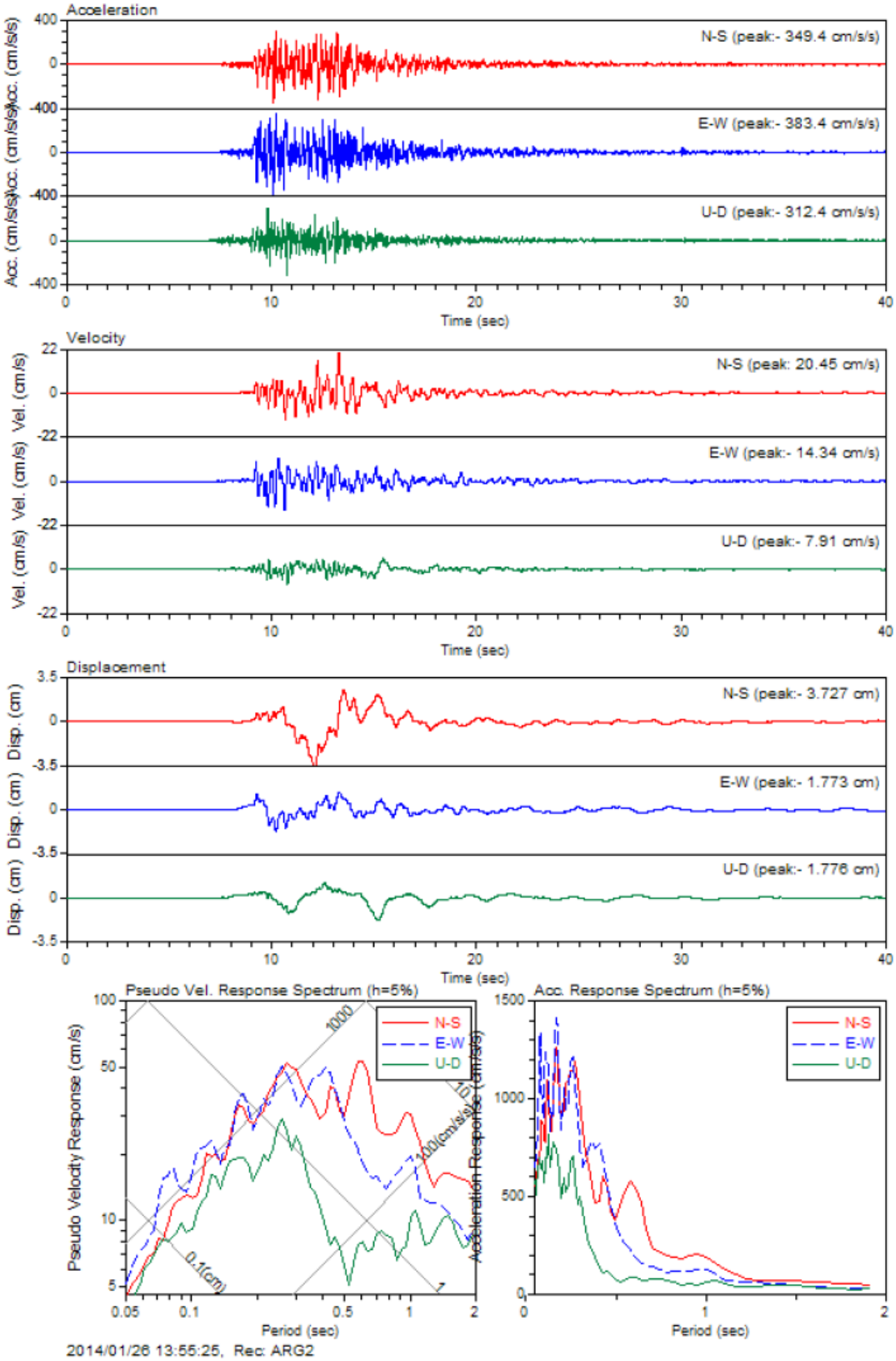


Figure 7.1.5. Acceleration, velocity and displacement time histories recorded at Argostoli (ARG2) station (top). Corresponding response spectra of pseudovelocity PSV and acceleration SA (bottom) for the 1st mainshock event of 1/26/14, 13:55 GMT (M_w6.1). Structural damping ξ = 5%.

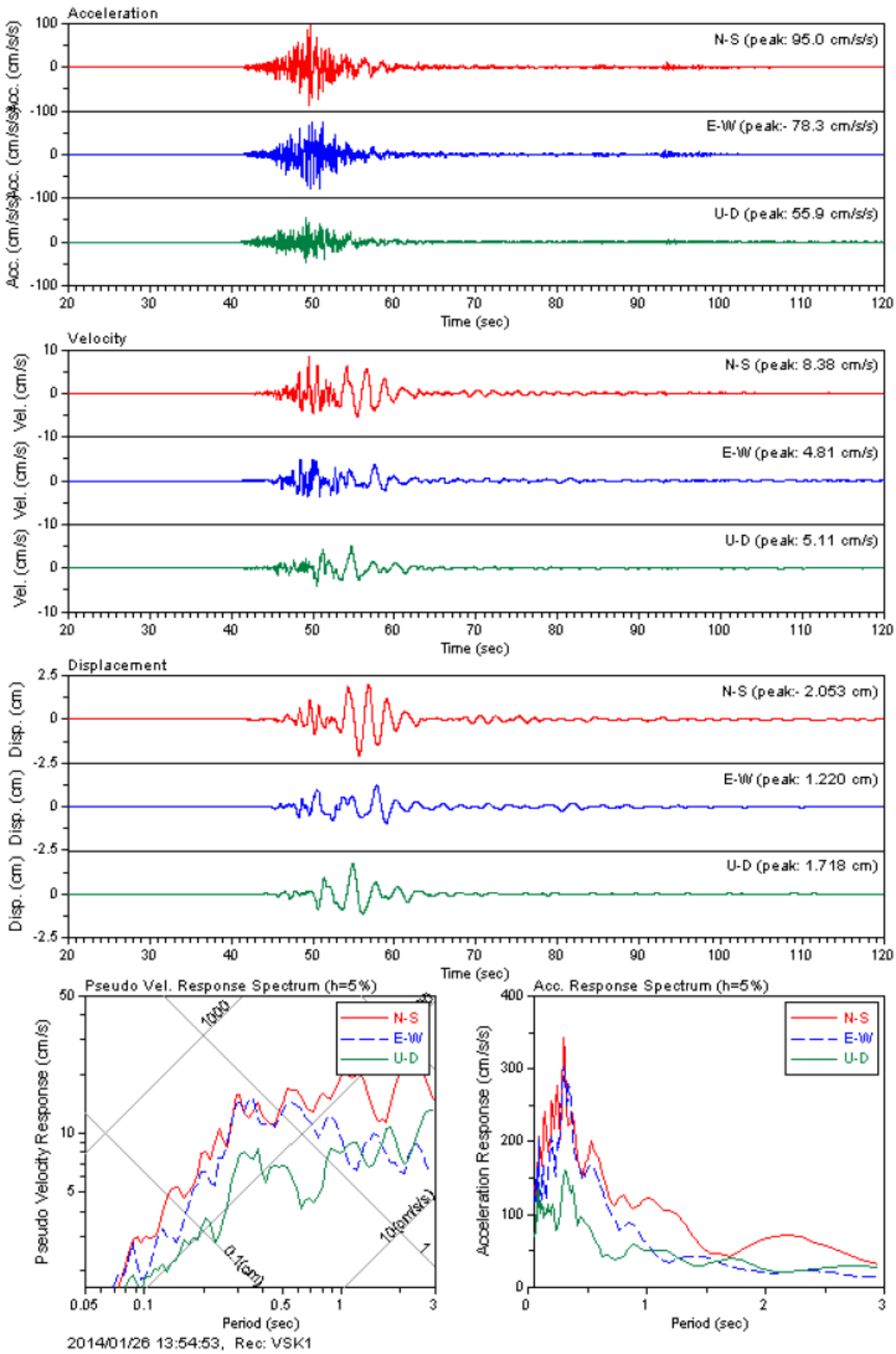


Figure 7.1.6. Acceleration, velocity and displacement time histories recorded at Vasilikades (VSK1) station (top). Corresponding response spectra of pseudovelocity PSV and acceleration SA (bottom) for the 1st mainshock event of 1/26/14, 13:55 GMT (M_w6.1). Structural damping ξ = 5%.

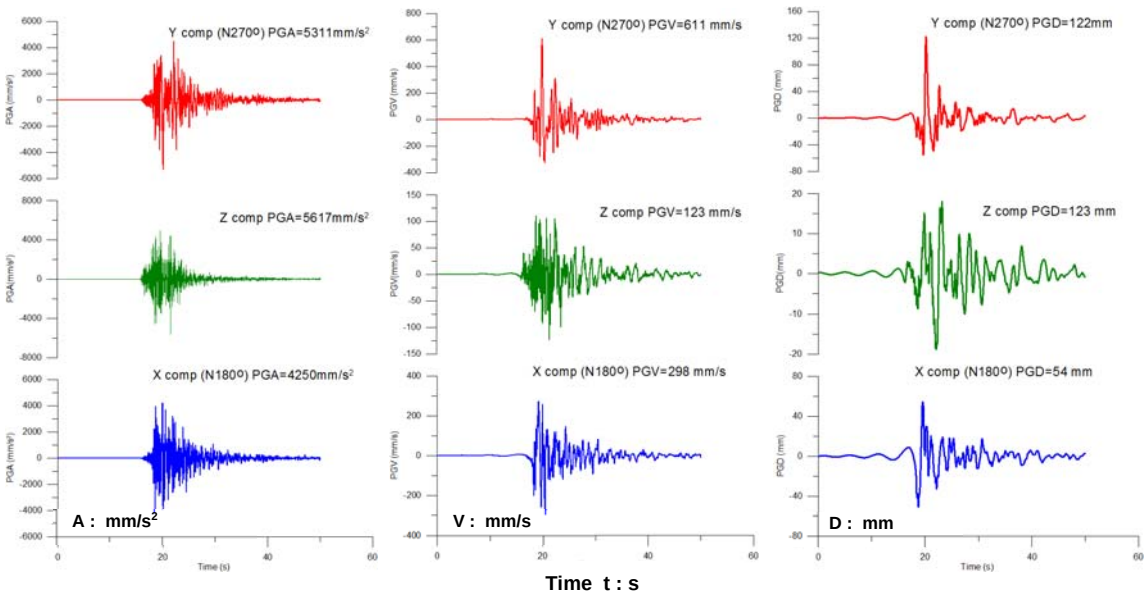


Figure 7.1.7. Lixouri (LXRB) station recordings of acceleration (left), velocity (middle) and displacement (right) time histories for the 1st mainshock event of 1/26/14, 13:55 GMT (M_w6.1).

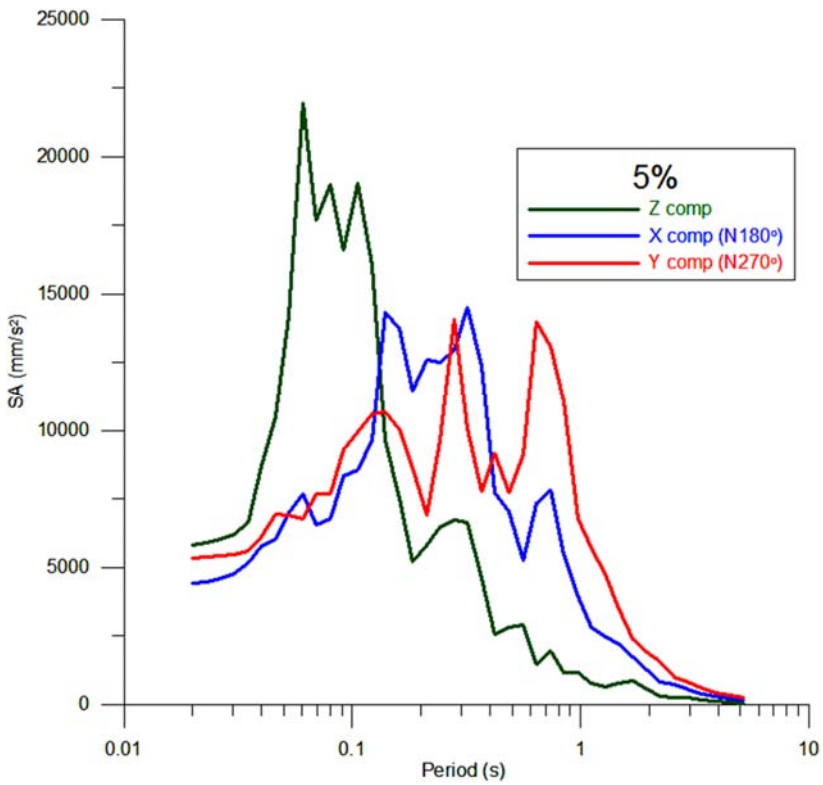


Figure 7.1.8. Acceleration response spectra from the Lixouri (LXRB) station recordings of Figure 7.1.7 (1st mainshock event of 1/26/14, 13:55 GMT, M_w6.1). Structural damping 5%.

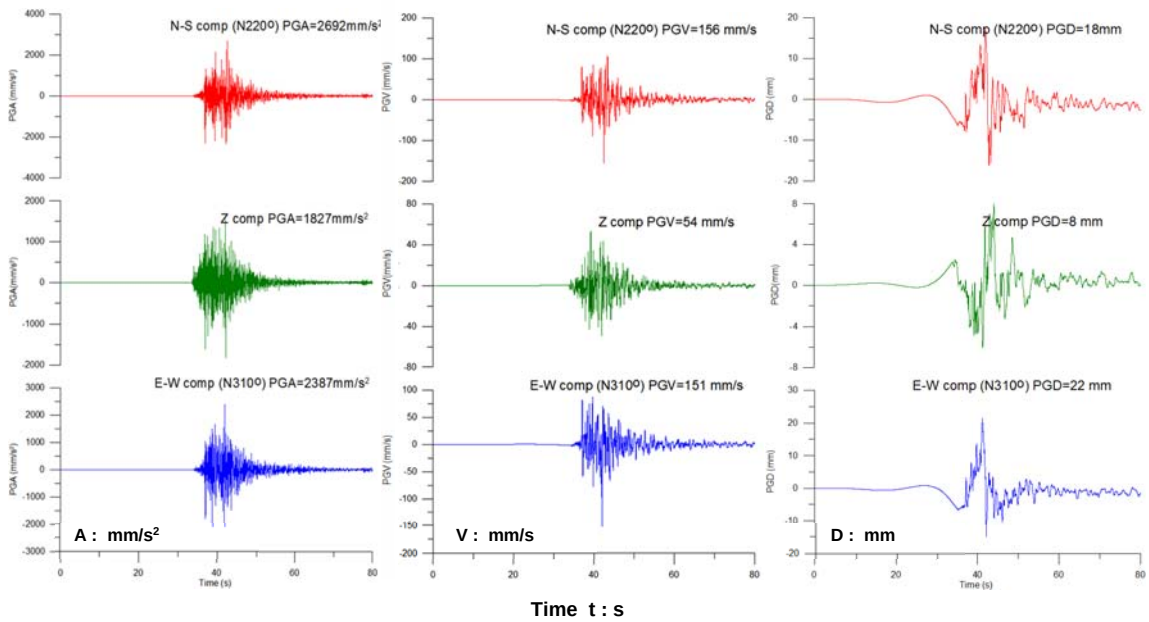


Figure 7.1.9. Sami Town Hall (SMHA) station recordings of acceleration (left), velocity (middle) and displacement (right) time histories for the 1st mainshock event of 1/26/14, 13:55 GMT (M_w6.1).

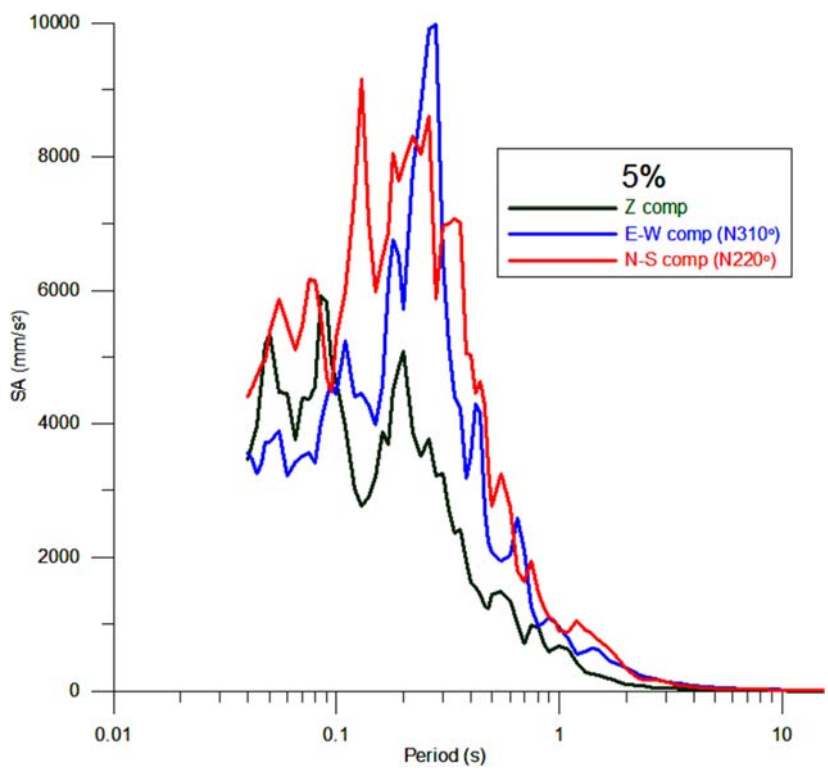


Figure 7.1.10. Acceleration response spectra from the Sami Town Hall (SMHA) station recordings of Figure 7.1.9 (1st mainshock event of 1/26/14, 13:55 GMT, M_w6.1). Structural damping 5%.

GROUND MOTION ATTENUTATION

Figure 7.1.11 presents plots of the horizontal Peak Ground Acceleration (PGA) of all strong motion recordings of the Greek stations as function of the stations distance from the epicenter of the 1st mainshock. In this version, all recorded PGA values are plotted for both horizontal components, regardless of the site conditions of the accelerographic stations. An update will follow in the next version when more details on the site conditions are available. The recorded PGA values are compared to calculated PGAs from the Ground Motion Predictive Equation (GMPE) proposed by Skarlatoudis et al. (2003) for Greece. Median and plus one standard deviation (σ) of the GMPE are shown in the same with blue lines.

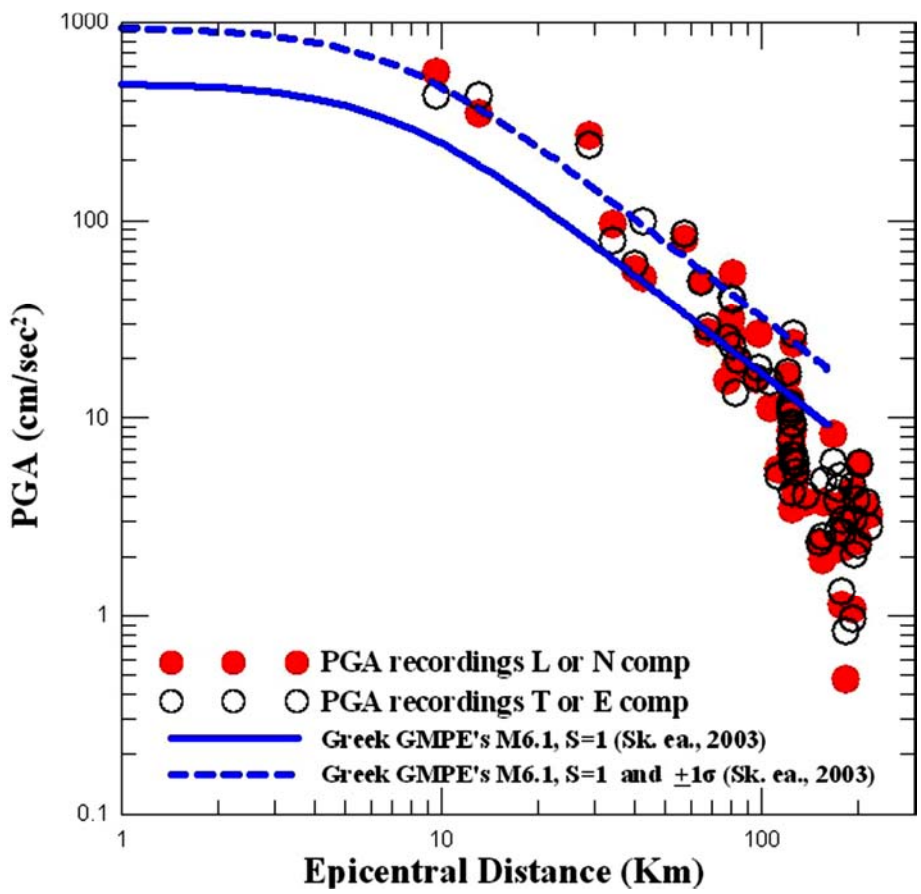


Figure 7.1.11. Peak Ground Acceleration (PGA) of the two horizontal components recorded by all stations in the Greek network from the 1st event versus epicentral distance. Blue lines show median and +one standard deviation (σ) of Ground Motion Predictive Equation (GMPE) for Greece by Skarlatoudis et al., (2003). Red circles are L(N) components and open circles are T(E) components.

COMPARISON TO 1983 CEPHALONIA EARTHQUAKE

The most recent large event on the causative fault occurred on January 17th, 1983 with magnitude M 7.0. Despite its large magnitude, this event caused a macroseismic intensity I_{MM} = VI according the NOA Bulletin of Geodynamic Institute. A PGA of 0.17 g was recorded at an epicentral distance of 35 km from Argostoli (Theodoulidis et al., 2004). At the time, there was only a single recording instrument on the island.

Fig. 7.1.12 compares Spectral Accelerations (SA) recorded at that ground surface at Argostoli from the 1st event of 1/26/14 (M_w6.1) and the single record of 1/17/1983 (M 7.0). For periods shorter than 1.2 s, the 2014 SA values are higher than the corresponding 1983 SA values by a factor of 2 to 3. This difference could be attributed to the shorter hypocenter-to-station distance of the 2014 event.

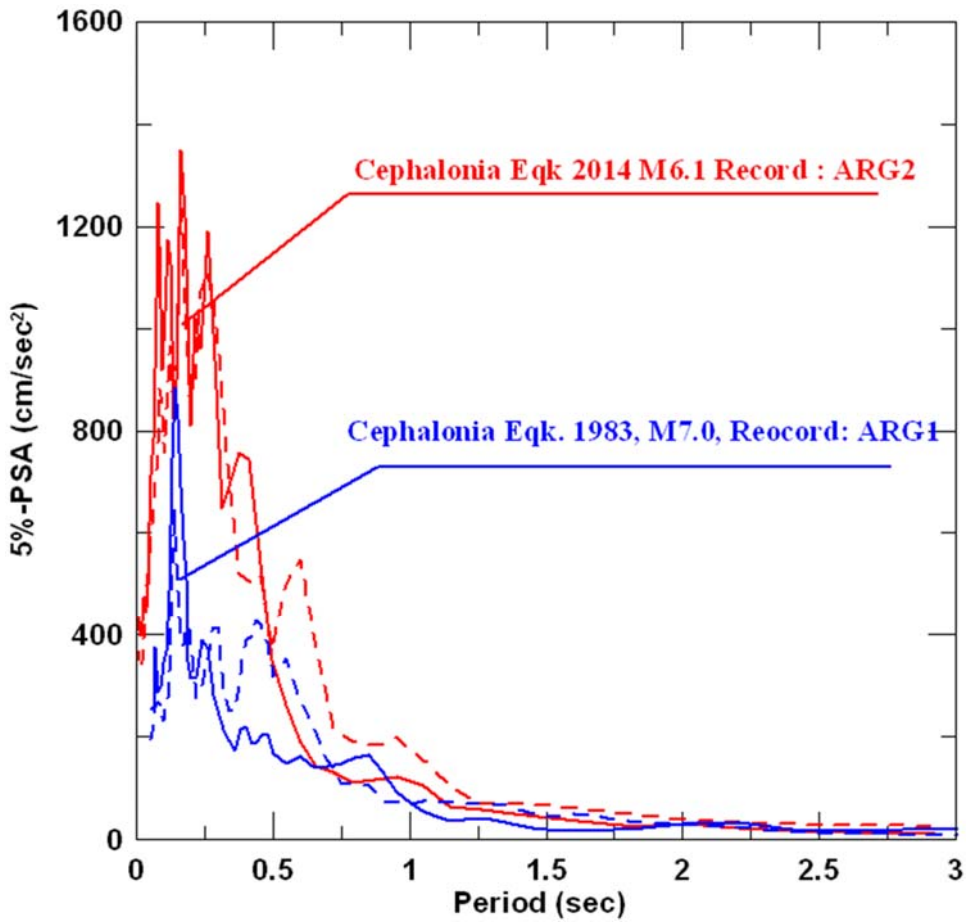


Figure 7.1.12. Acceleration response spectra of horizontal components of the 1st event of 1/26/14 (M_w 6.1) at the Argostoli station (in red) and the single record of 1/17/1983 (M 7.0) at a station located 35 km from Argostoli (in blue). Structural damping ξ = 5%.

7.2 Second Main Event of February 3, 2014

Seismological data and details of the 2nd mainshock event of February 3rd, 2014 (03:07 GMT) with $M_w = 6.0$ and epicenter around the Lixouri area, will follow in the next version.

In this version, Figures 7.2.1 through 7.2.3 (compiled by Prof. Pelekis, ASPETE) present acceleration time histories and corresponding response spectra and horizontal-to-vertical spectral ratios from recordings of the 2nd event by the UPATRAS Geotechnical Engineering Laboratory stations in Argostoli Port (38.180N, 20.490E), Fokata town (38.127N, 20.527E), and Cephalonia International Airport (38.119N, 20.506E).

Additional information from the EPPO-ITSAK recordings of the 2nd event are presented in the Site Effects section of the following Chapter.

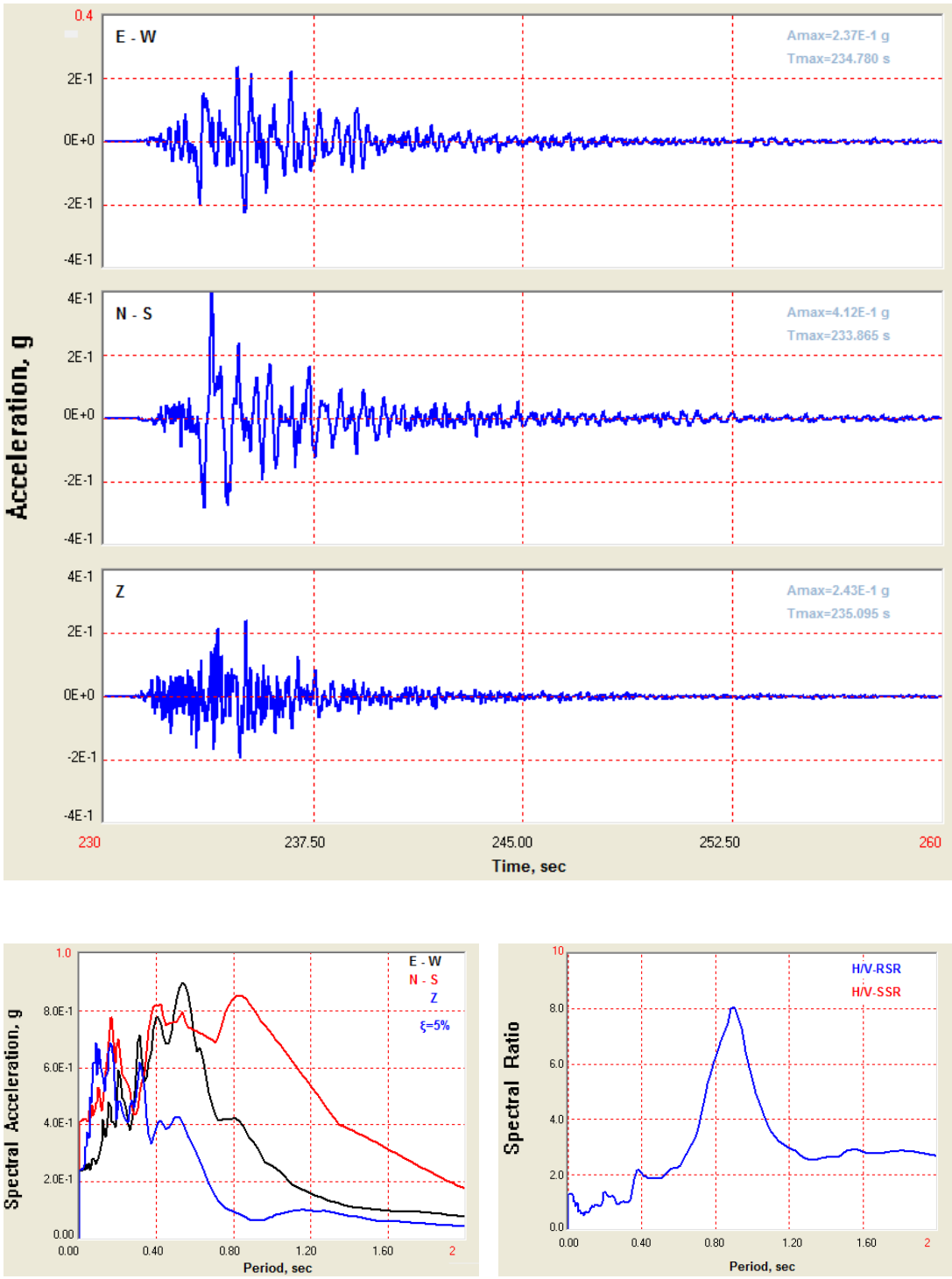


Figure 7.2.1. Acceleration time histories in the two horizontal (E-W, N-S) and vertical directions (Z) (top) and corresponding acceleration response spectra SA (bottom left) and SA Horizontal to Vertical ratios of (bottom right) recorded by the UPATRAS Argostoli Port (38.180N, 20.490E) station during the 2nd mainshock event of 2/3/14, 03:07 GMT (M_w6.0). Plots compiled by Prof. Pelekis of ASPETE. Structural damping ξ = 5%.

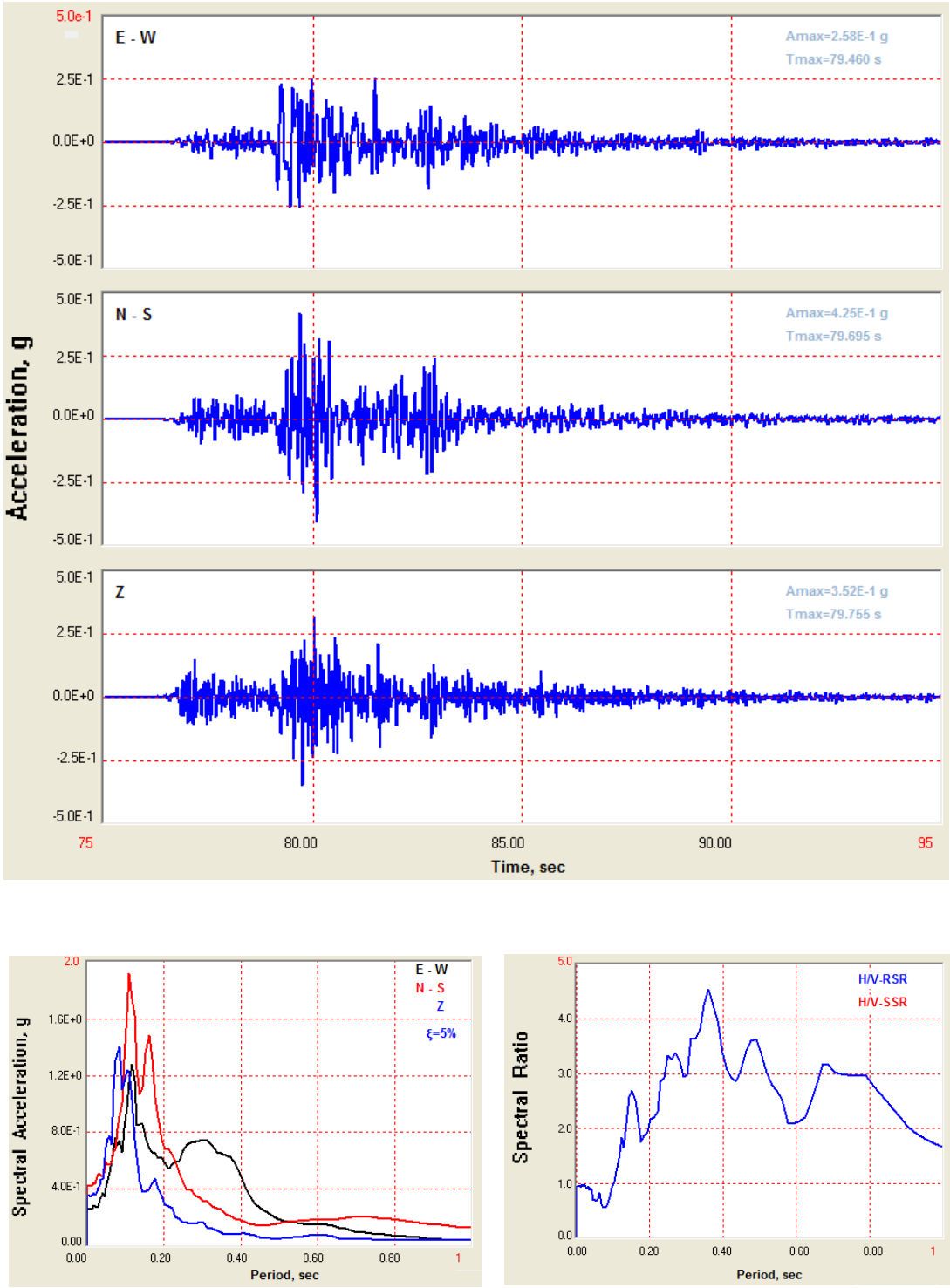


Figure 7.2.2. Acceleration time histories in the two horizontal (E-W, N-S) and vertical directions (Z) (top) and corresponding acceleration response spectra SA (bottom left) and SA Horizontal to Vertical ratios of (bottom right) recorded by the UPATRAS Fokata (38.127N, 20.527E) station during the 2nd mainshock event of 2/3/14, 03:07 GMT (M_w6.0). Plots compiled by Prof. Pelekis of ASPETE. Structural damping ξ = 5%.

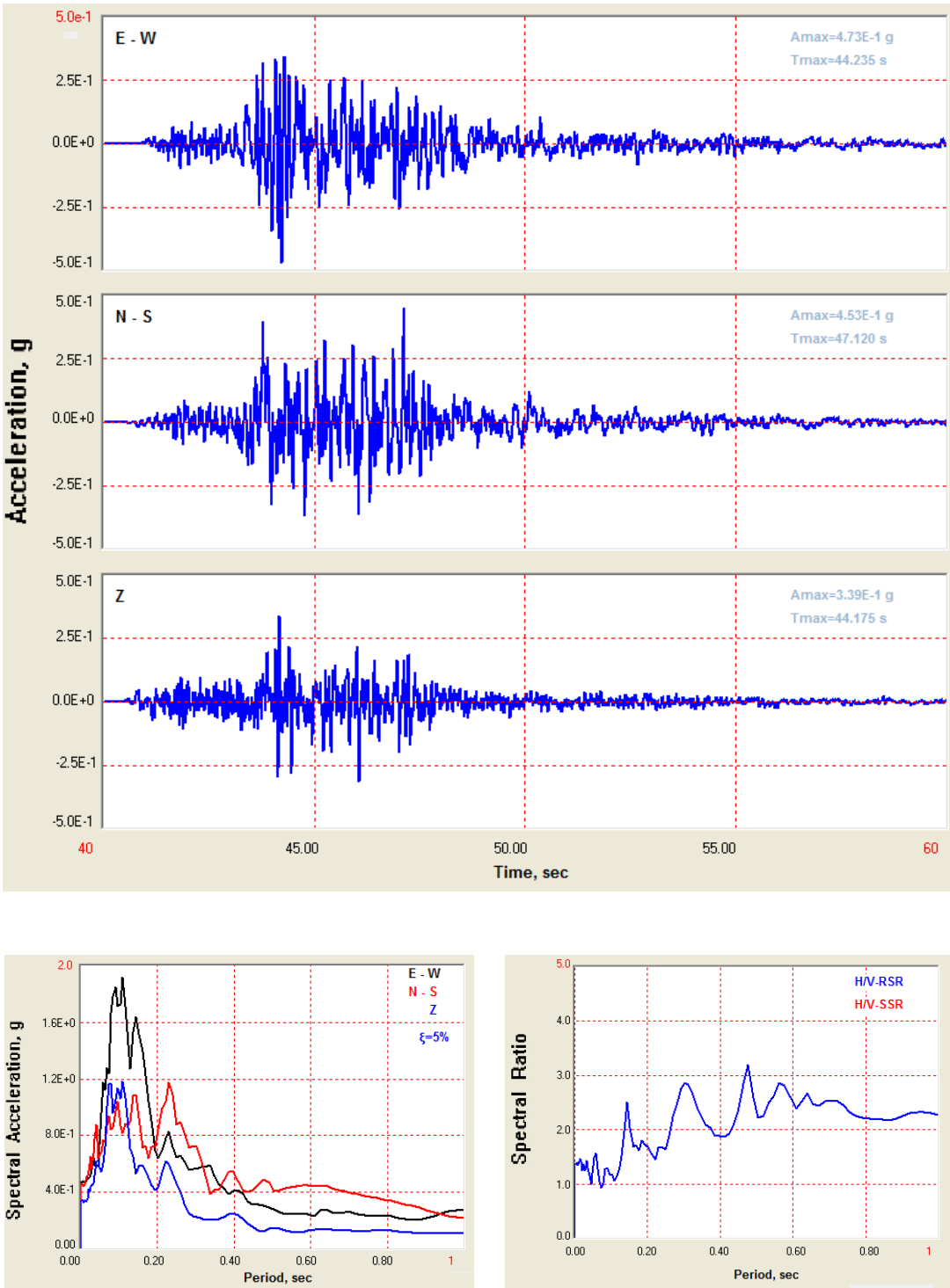


Figure 7.2.3. Acceleration time histories in the two horizontal (E-W, N-S) and vertical directions (Z) (top) and corresponding acceleration response spectra SA (bottom left) and SA Horizontal to Vertical ratios of (bottom right) recorded by the UPATRAS Airport (38.119N, 20.506E) station during the 2nd mainshock event of 2/3/14, 03:07 GMT (M_w6.0). Plots compiled by Prof. Pelekis of ASPETE. Structural damping ξ = 5%.

7.3 Remote Sensing Interferometry

The German satellite TerraSAR runs every eleven days over every area of the Earth at a distance of 700 km and can capture ground surface deformations using high resolution SAR Interferometry. When the 1st event took place on January 28th, 2014, TerraSAR was on its way from the South to the North Pole. Professor Parcharidis of the Geography Department of Harokopion University in Athens immediately notified the authorities and requested that an urgent signal is sent to the satellite for a panoramic picture of the island.

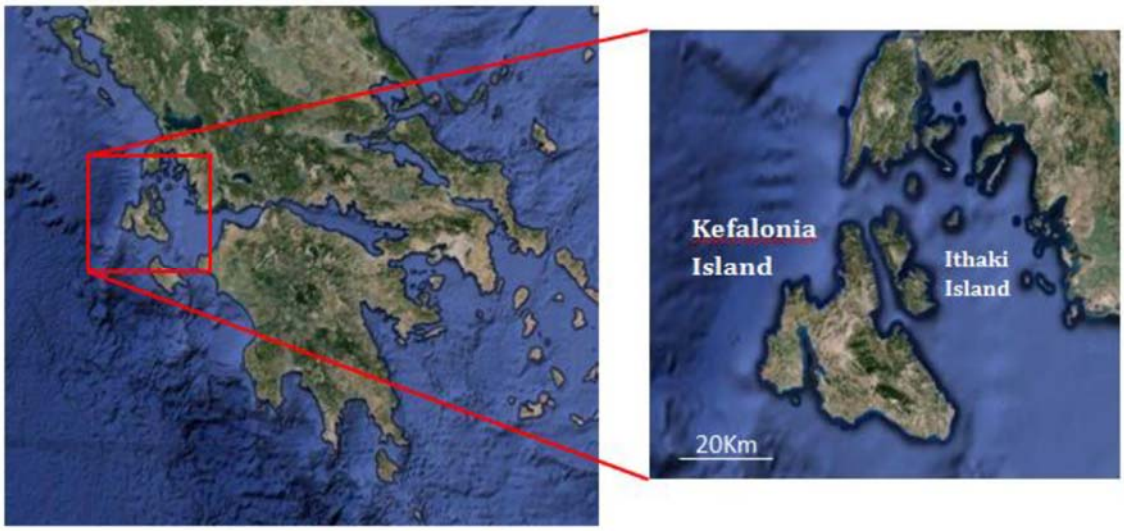


Figure 7.3.1. Study area captured by the German satellite TerraSAR after the 2nd event of 2/3/14.

Indeed, TerraSAR captured the ground surface deformation at Cephalonia Island during the period between January 28 and February 8, a period which included the 2nd event on February 3rd, 2014. The study area is shown in Figure 7.3.1 (Parcharidis, 2014). The data collected include an interferometric pair of SAR images acquired by the German TerraSAR-X (TSX): two repeat observations dated January 28 time 16:23:21 UTC and February 8 time 16:23:21 UTC, in fine-resolution single-polarization strip map mode ascending, strip_003R with an incidence angle range of 19°-23° at HH polarization. The TSX interferogram captured only the 2nd earthquake event of February 3rd. The resulting data was used to produce an interferogram using the GAMMA software.

The data were analyzed by the Geography Department of Harokopion University (HUA). Specifically, repeat-pass Interferometry was applied and the topographic phase was removed using a high resolution (~ 5 m) Digital Elevation Model (DEM) derived from airborne photogrammetry, with vertical accuracy better than 5 m. The flattened interferograms were filtered using an adaptive noise filter with a small window size and

unwrapped by means of Minimum Cost Flow (MCF) algorithm using the qualitative coherence (above 0.3) as a weight for the MCF solution. A baseline refinement was applied for removing residual phase ramps.

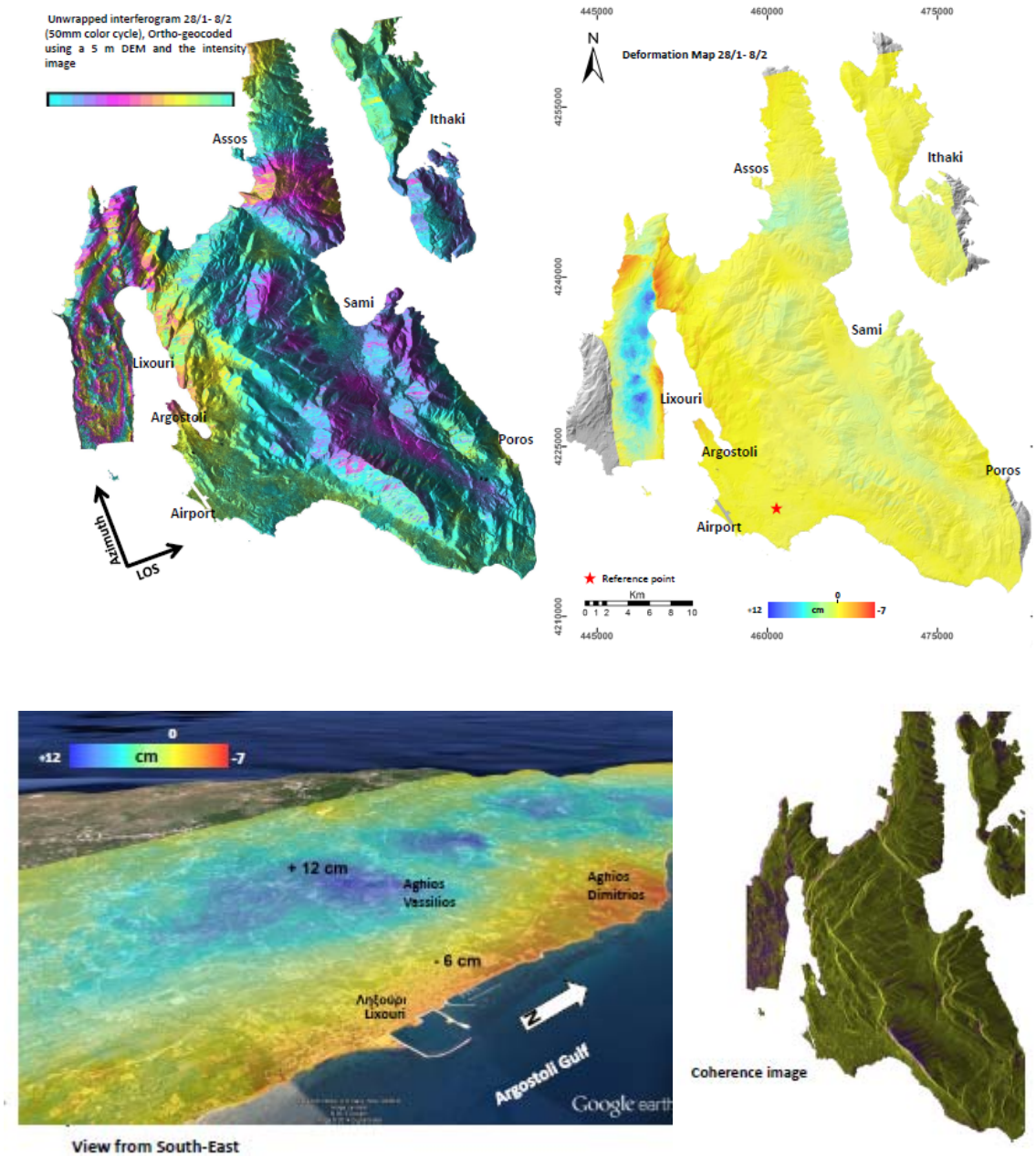


Figure 7.3.2. Interferogram from ground surface deformation measurements between January 28th and February 8th (modified from Parcharidis, 2014).

The TSX data are in the strip map high resolution mode allowing us to measure wide areas with a high spatial resolution of ~3 m. HUA produced an interferogram spanning eleven days from January 28 until February 8, 2014 (perpendicular baseline 108 m), sampling the co-seismic ground displacements of the February 3rd event in the ascending geometry. The multi-look factor applied to the interferogram is 5×5 m^2, which corresponds

to pixels of ~15×15 m^2 on the ground (Fig. 7.3.2). Note that the western most part of the Paliki peninsula area is not covered by the TerraSAR-X stripmap image product used for this study, that has a scene size 30 km width × 50 km length.

The interferogram exhibits a maximum motion of approximately 11 cm in the satellite Line of Sight (LoS) towards the satellite sensor, in the center-south of Paliki peninsula showing max deformation areas and a max LoS motion of about 7 cm away from the satellite at North and East of the peninsula close to Lixouri city (Briole et al., 2014).

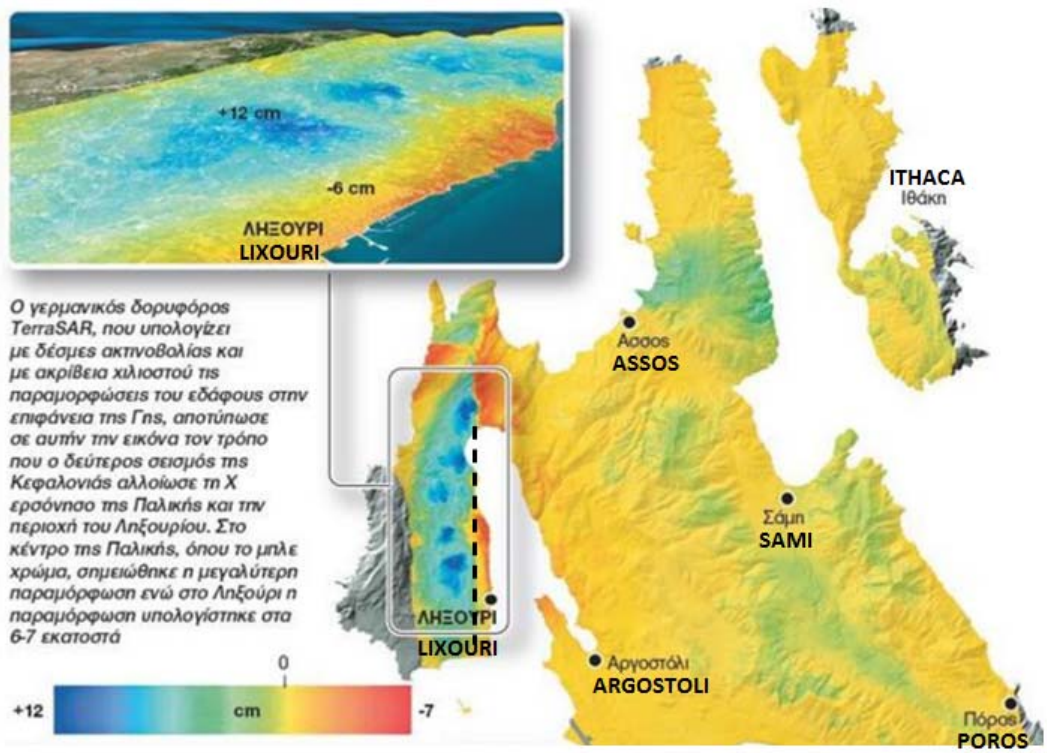


Figure 7.3.3. Interferometer map of Cephalonia after the 2nd event (modified from NEA, 2014).

The fault rupture was predominantly strike-slip (with some thrust component) and did not emerge on the ground surface. From the study of satellite data it was realized that maximum ground deformation occurred near the middle NS axis of the Paliki peninsula, with the ground surface moving southward by a maximum of 12 cm. On the eastern coast, Lixouri moved 6 cm in the opposite direction as did Aghios Dimitrios by 7 cm, both in the North direction, as shown on Fig. 7.3.3 (NEA, 2014).

Most of the observed damage to rigid blocks and particularly the extensive deformations and rotations in many cemeteries presented in great detail in Chapter 9 of this report, took place during the 2nd event of February 3rd. These observations are consistent with the assumption that the (blind) fault which triggered the 2nd event is located at the east side of Paliki as shown with the bold black dashed line in Fig. 7.3.3.