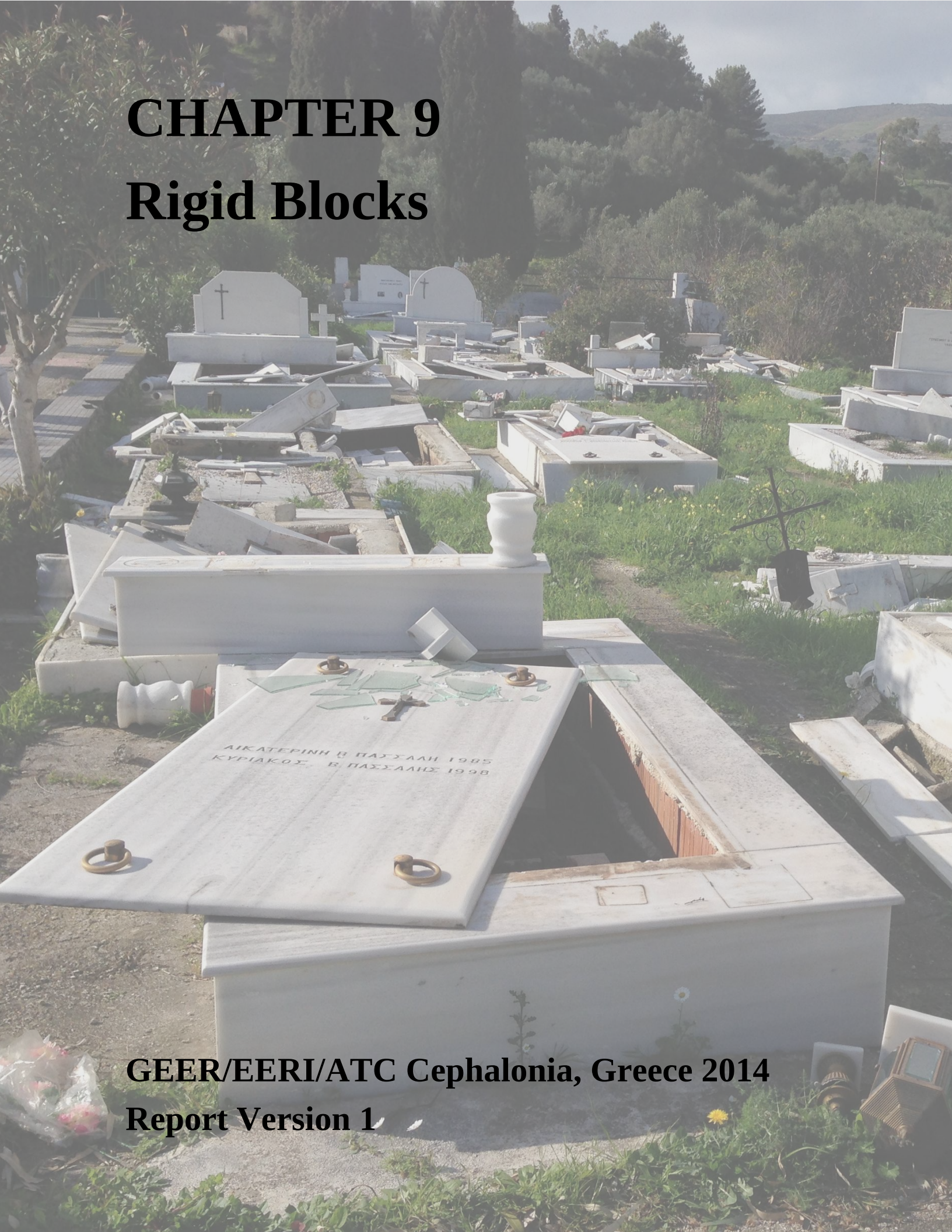
CHAPTER 9
Rigid Blocks



GEER/EERI/ATC Cephalonia, Greece 2014

Report Version 1

9.1 Overview and Key Observations

INTRODUCTION

One of the defining characteristic of the 1st and 2nd main earthquake events was the very extensive damage observed in nearly all 18 cemeteries of the Paliki peninsula and 9 additional cemeteries in the island, whose locations are shown in Fig. 9.1.1.

This damage, of unprecedented magnitude in the earthquake history of Greece, was in stark contrast with the overall excellent performance of the building stock in the same most-severely-shaken region. Thus, it attracted the attention of most reconnaissance teams, including AUTH, DUTH, HUA, ITSAK, NTUA, UMI, UPatras, UTH, and practitioners MRCE and Diatonos Mechaniki. This Chapter presents a synthesis of the findings of all teams involved.

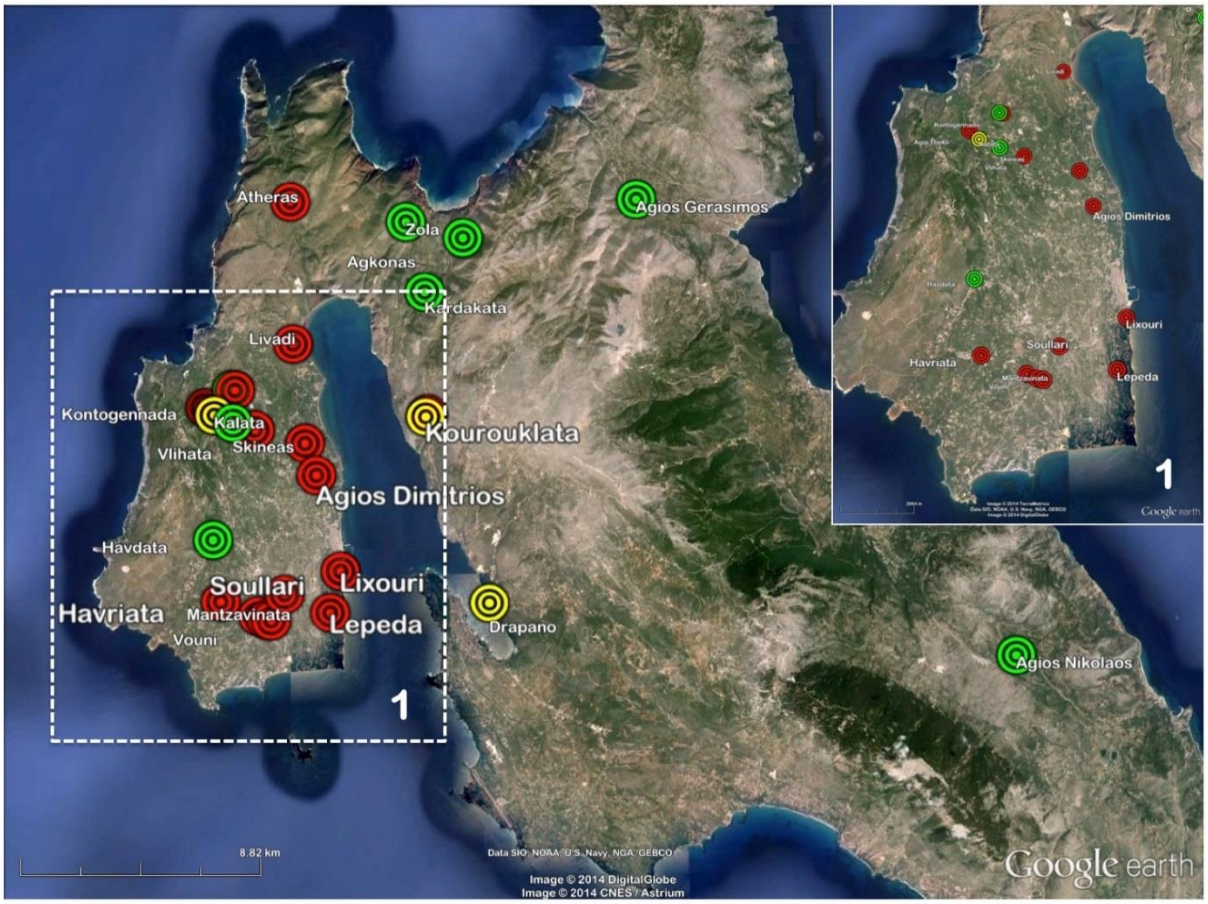


Figure 9.1.1 Locations of 27 cemeteries inspected during reconnaissance.

TYPES OF DAMAGE AND CONTROLLING PARAMETERS

Description of typical tomb blocks and ornamental features are described in the next section of this chapter. The ground deformation German satellite TerraSAR interferometry data from the 2nd event presented in Section 7.3 can provide insight in understanding the

heavy damage in cemeteries, particularly on the thrust component of the predominantly strike-slip fault rupture. A maximum ground deformation of 12 cm occurred near the middle NS axis of the Paliki peninsula, while on the eastern coast (where Lixouri is located), the movements reached 7 cm in the opposite direction as shown on Fig. 7.3.2. Keeping this information in mind, we have classified repeated patterns of damage in five major categories listed below, along with representative figures.

1. Toppling of slender marble plates that had been serving as monuments (headstones) – Figs. 9.1.2 and 9.1.3;
2. Sliding and rotation of heavy marble blocks on their pedestals – Figs. 9.1.4 to 9.1.8;
3. Sliding and rotation of multi-block monuments on several interfaces along their height and in different directions – Figs. 9.1.9 and 9.1.10;
4. Combination of 1 and 3 with multi-block monuments: sliding and rotation on one interface and toppling of the top block – Figs. 9.1.11 and 9.1.12;
5. Breaking of covering tomb slabs, usually along a line perpendicular to their long side and rather rarely (and unexpectedly) along a line parallel to the long side – Figs. 9.1.13 and 14.

The parameters influencing the behavior of such rigid blocks relate to the geometry of the block and the nature of their seismic excitation. A partial list of the parameters includes:

- Block slenderness, indicated by the ratio, h/b
- Block weight, W
- Frictional capacity of interfaces, measured through the coefficient of friction, μ, but also dependent on the presence (or not) of gluing or grout material
- Peak Ground Acceleration , A or PGA, and velocity-step ΔV
- Dominant earthquake frequency,
- Detailed sequence of pulses of the seismic excitation
- Intensity of 2nd (horizontal) and 3rd (vertical) components of the ground acceleration, and even the time-dependent phasing between the various components.

Evidently, the problem of rocking and toppling on a rigid base indeed is chaotic, to the point that back analyses to estimate the ground shaking that has produced a certain displacement or rotation is a futile exercise. Almost as chaotic is the problem of sliding.

Main factors which affect the shaking-related parameters above are the source mechanism and the rupture propagation effects (i.e., forward or backward directivity), and certainly the prevailing soil conditions, since the cemeteries are invariably constructed on soil and not in rock. The variation of the extent of damage from place to place is indicative of differences in these seismological and geotechnical conditions which affect the ground shaking.

SPATIAL DISTRIBUTION OF DAMAGE

The extent of the damage in investigated cemeteries is a clear evidence of the tremendous intensity of the motion — in fact of all three components of motion. This is compatible with strong motions that were recorded in Lixouri and Chavriata (PGAs on the order of 0.6 g to 0.7 g, peak velocities as high as 120 cm/s in Lixouri).

Interestingly, many cemeteries were built on higher ground, often on a hill, as the characteristic example would be the Chavriata cemetery. It is reasonable therefore to expect that topographic amplification has possibly contributed to the intensity of ground motions.

In Section 9.3, the extent of damage in all cemeteries is correlated tentatively with the distance from the fault. The significant scatter, especially substantial differences in the level of damage observed among adjacent cemeteries, indicates the important contribution of all above mentioned factors on the observed performances listed above (related to both geometry-material of the blocks and their seismic excitation).

Figure 9.1.2. Overturning of the headstone in Lixouri cemetery taken on 2/9/14 by NTUA team (GPS coordinates: 38.192586, 20.438769).

Figure 9.1.3. Toppling of marble head-cross in Lixouri cemetery taken on 2/9/14 by NTUA team (GPS coordinates: 38.255833, 20.421111).

Figure 9.1.4. Displacement and rotation of a marble vase, responding as a rigid body at Livadi cemetery taken on 2/8/14 by NTUA team (GPS coordinates: 38.255555, 20.421111).

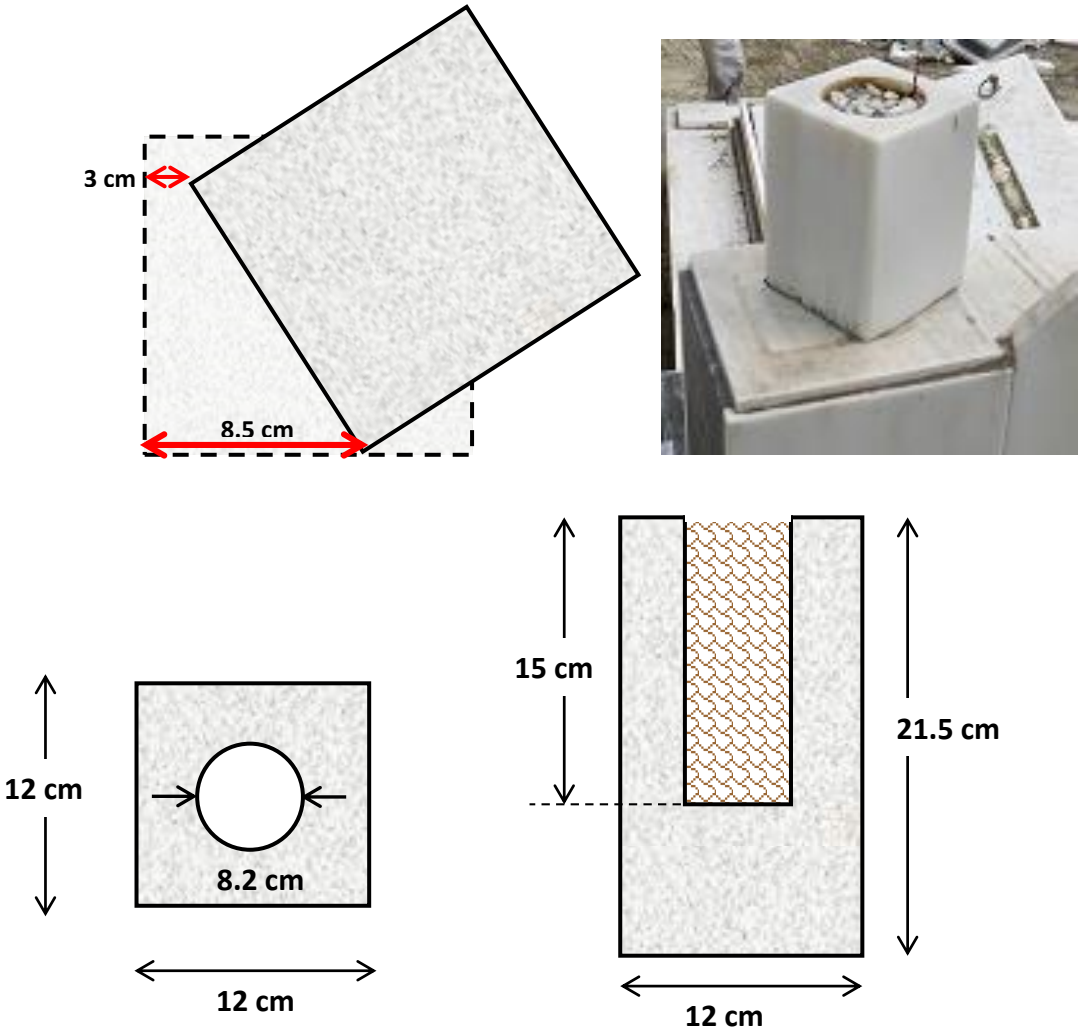


Figure 9.1.5. (a) A case of "double-rotation" in the Livadi cemetery: first rotates the massive headstone structure and then the marble vase. (b) Sketch of the dimensions and displacements of the slender marble artifact (GPS coordinates: 38.255833, 20.421111; NTUA team, 2/8/14).

Figure 9.1.6. Rotation of a massive headstone in Chavriata (GPS coordinates: 38.183219, 20.389813). Photo taken by NTUA on 2/10/14.

Figure 9.1.7. Detailed views of the previous photo taken on 2/10/14 by NTUA team (GPS coordinates: 38.183219, 20.389813).

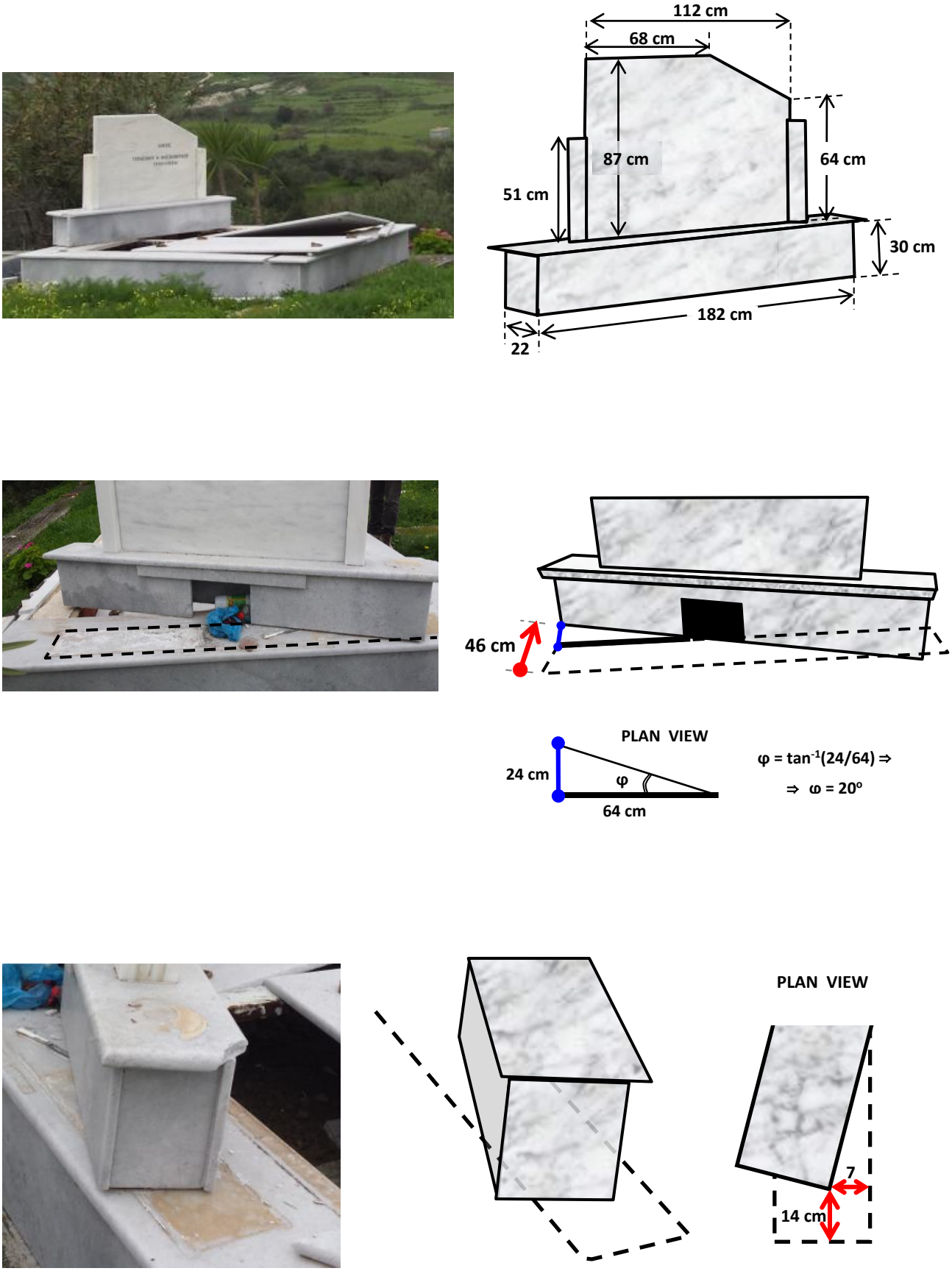


Figure 9.1.8. Sketch of the dimensions and displacement of rotated headstone.

Figure 9.1.9. Double rotation of the headstone and its base in opposite directions. The photo on the left is a plan view of the rotation at the base. Lixouri cemetery, dated 2/9/14 (GPS coordinates: 38.192561, 20.438797).

Figure 9.1.10. Detailed views of the rotational movement located at three different interfaces (shown with red rectangles and arrows). Rotations occurred in opposite directions. Lixouri photo taken on 2/9/14 by NTUA team (GPS coordinates: 38.192780, 20.438486).

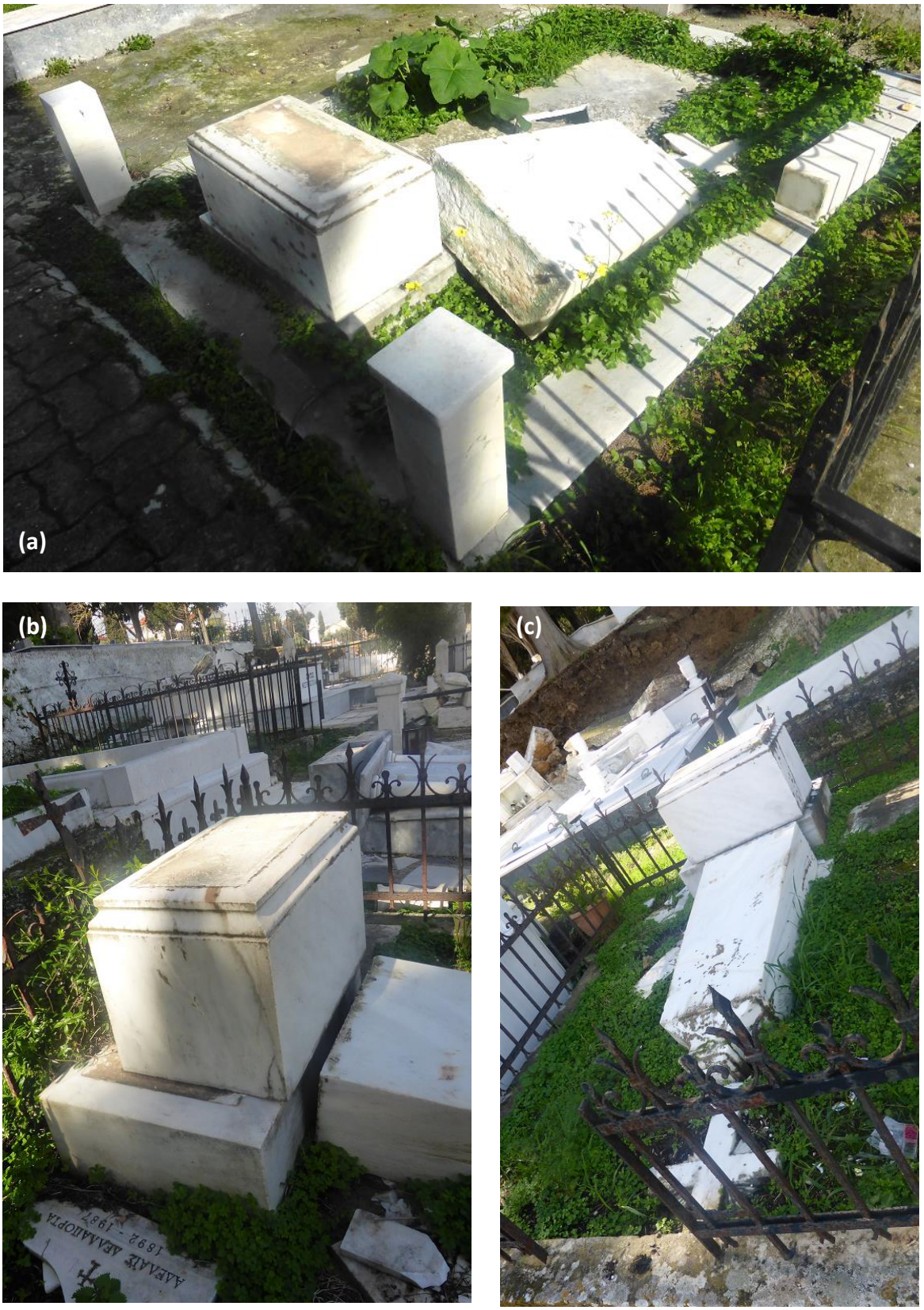


Figure 9.1.11. Detailed views of the rotated lower marble pedestal and toppling of the slender cross headstone. Lixouri cemetery, photo taken on 2/9/14 by NTUA team (GPS coordinates: 38.192436, 20.438666).

Figure 9.1.12. Toppled headstone (top) and horizontal slippage of tomb panel (bottom). Chavriata cemetery photo taken on 2/11/14 by NTUA team (GPS coordinates: 38.183013, 20.389619).

Figure 9.1.13. Rotation of several grave ledgers at the same direction in Livadi (GPS coordinates: 38.255833, 20.421111). Photo taken on 2/8/14 by NTUA team.

Figure 9.1.14. Cracked marble panels, toppled artifacts and overturning headstones in Kourouklata (GPS coordinates: 38.242500, 20.474166]. Photo taken on 2/8/14 by NTUA team.

9.2 Detailed Reconnaissance

OBSERVATIONS IN CEMETERIES

Traditional Greek cemeteries feature above-ground tombs aligned in the east-west direction, all bearing crosses and most bearing photograph frames, flower vases and similar grave markings. This section summarizes the findings of detailed reconnaissance surveys on the rigid block response in cemeteries of Cephalonia (Fig. 9.2.1).

The information presented in this section was gathered through five field investigations during the period of January 27 to February 23, 2014. In total, 27 cemeteries were inspected: 18 of which are located in the Paliki peninsula and 9 on the main island. The 18 cemeteries of the Paliki peninsula inspected cover almost all cemeteries in the meioseismal area. The scope of reconnaissance studies was to document and identify possible damage patterns that might be caused by a combination of variety of factors including proximity to source, near-fault earthquake directivity, and local site effects. Note that this section does not address any hanging or foot wall effects, since the actual trace of the fault (or faults) is yet to be determined. The following Section 9.3 "Statistics of observed failures" summarizes key statistical observations for all cemeteries discussed in this section.

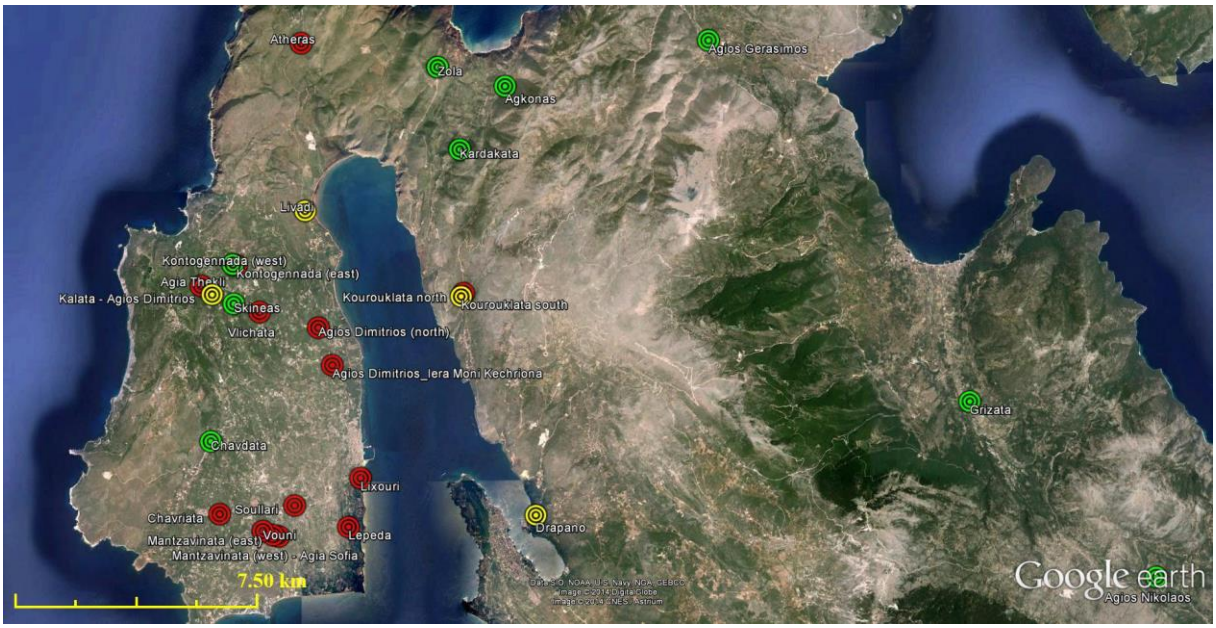


Figure 9.2.1. Reconnaissance of 27 cemeteries in Cephalonia. Colored dots indicate percentage of toppled tomb objects: red for more than 65%, yellow 30-65%, and green less than 30%.

The Vouni village cemetery is the only one where observations were made after both the 1st and 2nd events. After the 1st event, the Vouni village cemetery experienced severe damage (Fig. 9.2.2a). Following the 2nd event, objects that were still standing after the first event, eventually toppled, as shown on Fig. 9.2.2b.

Figure 9.2.2. Vouni village cemetery [GPS: 38.178456, 20.404778] toppled objects following the: (a) 1st event (on 1/28/14) and (b) 2nd event (taken on 2/20/14). Photos by ITSAK and DUTH teams.

The rest of cemeteries were assessed by the GEER reconnaissance teams only after the 2nd event. Therefore, safe conclusions cannot be drawn about the time of the observed damage in the majority of the cemeteries inspected. Local witnesses indicated that severe cemetery damage observed in the Paliki peninsula was induced by the 1st event and increased by following the 2nd event.

However, the investigators could not verify these statements in most of the cemeteries based on our observations solely without analytical studies. In fact, Fig. 9.2.2 contradicts this assertion, since minimal damage was caused by the 1st event, while most of the damage seems to have been inflicted by the 2nd event.

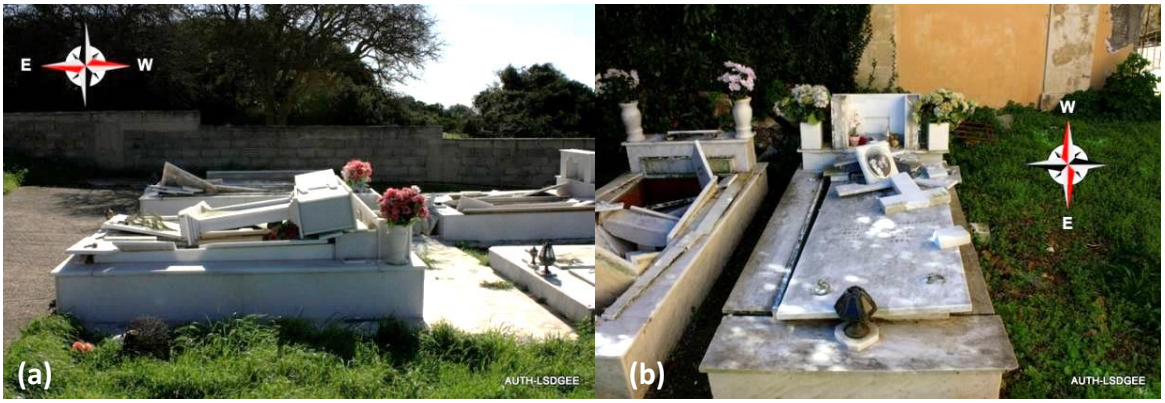


Figure 9.2.3. Objects toppled mainly towards the East: (a) Atheras [38.311280, 20.418498] and (b) Kontogennada East [GPS: 38.250936, 20.396137]. Photos by AUTH team on 2/11/14.

Figure 9. 2.4. Cases of tomb objects toppling to the West: (a) Vouni [GPS: 38.178455, 20.404778] and (b) Atheras [GPS: 38.311280,2 0.418498]. Photo by DUTH and AUTH teams on 2/11/14.

Notably, in most cemeteries inspected, the rigid objects (crosses, vases, markings) placed on the tombs generally oriented in the EW direction, persistently toppled towards the East (Fig. 9.2.3). In very few cases, crosses toppled towards the West (Fig. 9.2.4). This observation may suggest strong near-field effects, with a single or multiple pulses being responsible for the almost uniform direction of toppling. Analyses based on recorded ground motions is needed to confirm near-field effect assumption. However, analytical investigations in the literature reveal sensitivity of the direction of toppling to details of the rocking block geometry, restitution coefficient, and excitation waveform (assuming horizontal rocking plane), which make the possibility of unilateral topping hard to justify. No systematic effort has been conducted to establish if the rocking plane was indeed horizontal, or soil settlements caused an inclination in the direction of the grave (i.e., in East). Likewise, no variability of damage related to the grave construction method was established, since by inspection no major construction variations were identified among the total of ten funeral homes of the island by inspection.

The principal cause of tomb damage was object toppling on the grave marble slab, resulting in rupturing the latter. Other types of damage observed in tombs were slippage, vertical separation, and/or rotation of blocks and tombstones, without toppling. Marble blocks are displaced and rotated as seen in Fig. 9.2.5 at the cemetery of Chavriata [GPS: 38.183026, 20.389692]. Similar response was observed at the southern cemetery of Kourouklata, behind the church shown in Fig. 9.2.6 [GPS: 38.242544, 20.474056].

Figure 9.2.5. Rotation of a massive headstone, responding as a rigid body without toppling, at the Chavriata cemetery [GPS: 38.183219, 20.389813]. Photo by NTUA team on 2/10/14.

Another interesting case of marble block dislocation was observed in the Livadi cemetery [GPS: 38.255689, 20.421035]. Notice the practically identical type of sliding and rotation of two neighboring low rise marble block constructions (A and B) on Fig. 9.2.7(a). The detail in Fig. 9.2.7(b) is related to marble block construction B, which reads a displacement of 8.7 cm to the North, 8.1 cm to the East, and a counter-clockwise rotation of approximately 3.5^{o}. If these displacements were due to a single shaking, they could qualitatively indicate that ground motions at the Livadi cemetery had comparable intensities in both the NS and EW directions. Since reconnaissance was performed by the UTH team only after the 2nd event, this hypothesis cannot be confirmed. The observed damage could likely involve asymmetric friction under the blocks or even a torsional excitation component, and possible variations in cohesive/frictional resistance under the blocks, especially block A.

It is unclear whether the distance from source (fault trace and dip angle not precisely determined by seismologists yet) in the meioseismal area was as important as soil and topographic conditions. In the village of Skineas [GPS: 38.240479, 20.395151], 7% of tomb objects toppled, while the rest are still standing (Fig. 9.2.8a). In contrast, just 1 km away, at the village of Vlihata [GPS: 38.238268, 20.403932], more than 70% of objects

overturned (Fig. 9.2.8b). In general, object toppling was concentrated in the Paliki peninsula at a rate of about 2/3 (i.e., on average 67% of the objects toppled – see cemeteries observations 1 to 18 of Table 9.3.1, sorted from North to South). On the main island, observed toppling had an approximate rate of 1/5 (average of large dataset with variable distances from the source) and essentially zero at the east side of the island.

Figure 9.2.6. Headstone rotation without toppling at the south cemetery of Kourouklata [GPS: 38.242361, 20.474188]. Photos by NTUA team on 2/8/14.

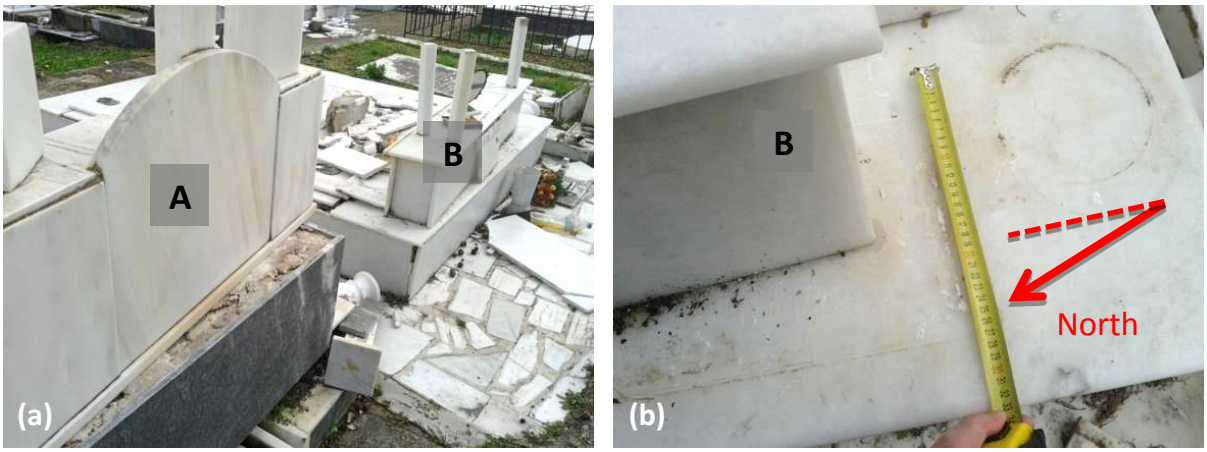


Figure 9.2.7. Livadi cemetery [GPS: 38.255689, 20.421035] after the 2nd event: (a) Displacement and rotation of two neighboring low rise marble block constructions (A and B) and (b) Detail of displacement and rotation of marble block construction B. Photos taken by UTH team on 2/8/14.

Figure 9.2.8. In (a) Skineas [GPS: 38.240479, 20.395151] a mere 7% of objects toppled; in 0.8 km east at (b) Vlichata [GPS: 38.238268, 20.403932] 71% of objects toppled. AUTH photos, 2/11/14.

Nevertheless, the extent of damage of the cemeteries investigated is a clear evidence of the tremendous intensity of the ground motion, probably in all three components. This is compatible with the strong motions that were recorded in Lixouri and Chavriata (PGAs of the order of 0.6 to 0.7g, peak velocities reaching 120 cm/s in Lixouri). Since many cemeteries were often built on hills, it is reasonable to expect that topographic amplification has contributed to the intensity of ground motion in many cases. Strong evidence supporting this assumption was found at Chavriata cemetery, where 87% of tombs toppled (Fig. 9.2.9).

Figure 9.2.9. View of total destruction view at Chavriata cemetery [GPS: 38.183013, 20.389619]: broken marble panels, toppled artifacts, overturned headstones. Photos by NTUA team on 2/10/14.

Cemeteries on the east side of Paliki peninsula were most severely damaged (Lepeda, [GPS: 38.17962, 20.434612], Lixouri, [GPS: 38.192880, 20.438620], Aghios Dimitrios, [GPS: 38.223752, 20.428779], Soullari, [GPS: 38.185414, 20.415757], and Chavriata, [GPS: 38.183026, 20.389692]). The toppling rates in these cemeteries were over 80%, which may be related to their proximity to the 2nd event fault (if its trace is indeed located offshore the eastern part or near the centerline of the peninsula.)

Figure 9.2.10. Two Kourouklata cemeteries [GPS: 38.243401, 20.474875] where: (a) 59% (north) and (b) 76% (south) of objects toppled. Photos by UPATRAS team on (a) 2/11/14 and (b) 2/8/14.

At the main part of Paliki (e.g., at the village of Kourouklata [GPS: 38.243401, 20.474875], objects toppled at a rate of 76% and 59% at the two cemeteries (Fig. 9.2.10). Cemeteries on the east side of the island were not significantly affected. Overall, it is clear from our reconnaissance that adjacent cemeteries could exhibit markedly different responses. Figure 9.2.11 presents an overview the cemetery object toppling rates in Paliki peninsula.

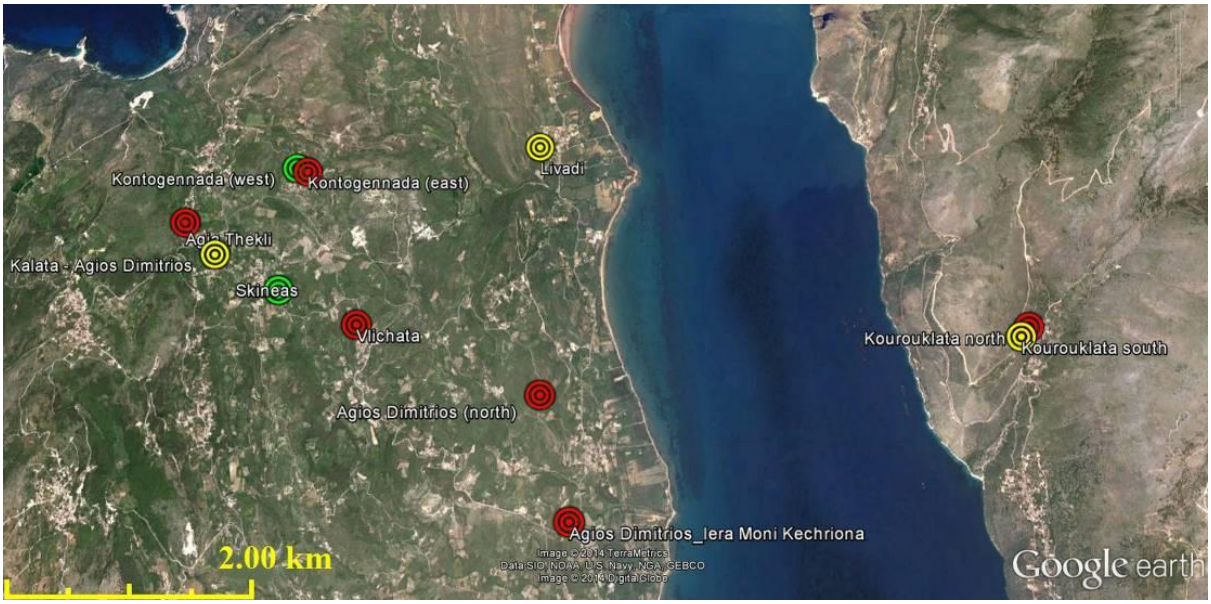


Figure 9.2.11. Cemetery reconnaissance at North Paliki peninsula. Red dots indicate object toppling rate greater than 65%, yellow from 30-65% and green with less than 30%. Observations indicated that adjacent cemeteries could exhibit markedly different response.

OTHER RIGID OBJECTS

This section presents representative observations of the seismic performance of rigid blocks or monuments besides cemeteries. Data provided in this section refer mainly to marble monuments and statues that suffered a rigid body motion (i.e., displacement and/or rotation), or even toppled after the 2nd event.

Two marble statues standing opposite to each other at the entrance of Lixouri City Hall were of particular interest (Fig. 9.2.12, 38°12'3.53"N, 20°26'14.92"E). Following the 1st event, the statue located north of the building entrance (Fig. 9.2.12b) displaced and slightly rotated towards the North without collapsing, since it was supported by the wall behind it. The trace of the original location of its base is visible, indicating an almost uniaxial displacement of approximately 40 cm. The top portion of the statue eventually toppled after the 2nd event towards the SE direction (Fig. 9.2.12c). A similar response was recorded (Fig. 9.2.12a) for the opposite standing statue (south of entrance), which also overturned in the same (SE) direction.

Another case of rotation of a marble statue was recorded close to Argostoli Customs building (Fig. 9.2.13, 38°10'47.94"N, 20°29'22.47"E), where a slight rotation towards the North was recorded. A similar response of a marble monument of Ilias Antipas is shown in Fig. 9.2.14 (38.18305°N, 20.50030°E), where a drum of the monument rotated without evidence of lateral displacement. Rigid-body lateral displacement followed by a slight rotation at different levels of a monument was observed near Lixouri (Fig. 9.2.15,

38°13’32.85’’N, 20°25’46.42’’E). Overturning and collapse of two marble drums was documented at Lixouri, including toppling off a war monument (Fig. 9.2.16, 38°11'51.7"N, 20°26'17.3"E) towards the S-SW direction. Two additional toppling cases of a massive Corinthian-type capital carrying a heavy top slab and a statue are shown in Figs. 9.2.17 and 9.2.18, respectively.

Figure 9.2.12. Two marble statues standing opposite to each other at the entrance of Lixouri City Hall (38°12'3.53"N, 20°26'14.92"E). (a) Overturned statue south of entrance recorded by UTH after 2nd event; (b) Displaced but still standing statue north of entrance after 1st event (ITSAK photo, 1/28/14); (c) Top of statue toppled after the 2nd event (Photo by ITSAK – AUTH-LSDGEE teams on 2/11/14).

Figure 9.2.13. Marble statue close to Argostoli Customs building (38°10'47.94"N, 20°29'22.47"E): Slight base rotation. Photo by ITSAK – AUTH-LSDGEE teams on 2/11/14.

Figure 9.2.14. Monument of Ilias Antipas mainly rotated (38.18305° N, 20.50030°E). The rectangular sketch shows rotated part at its base (in cm). Photo by UPATRAS teams on 2/8/14.

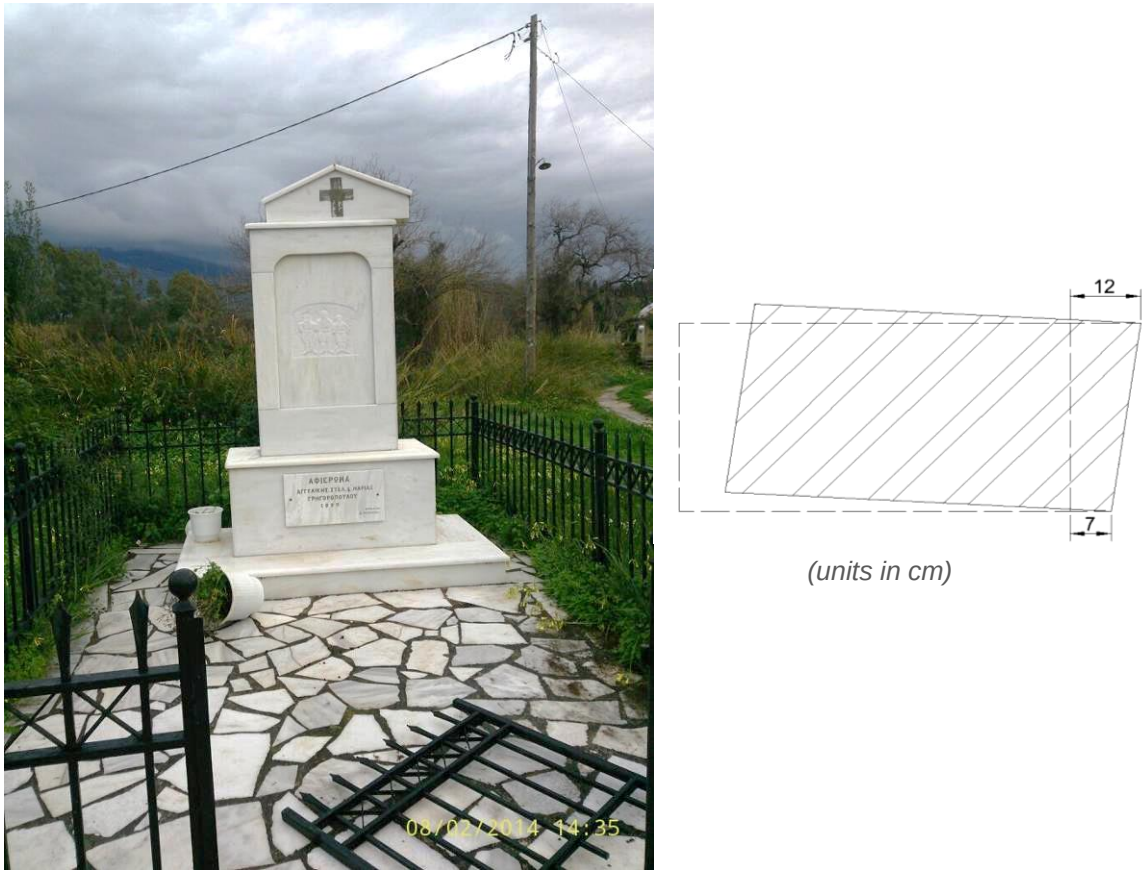


Figure 9.2.15. Marble monument near Lixouri (38°13'32.85''N, 20°25'46.42''E): Lateral displacement without significant rotation (dimensions in cm). Photo by UPATRAS team on 2/8/14.

Figure 9.2.16. Marble monument at Lixouri (38°11'51.7''N, 20°26'17.3''E). Dislocation and toppling of upper two marble blocks towards S-SW direction. Photo by LSDGEE-AUTH team on 2/11/14.

Figure 9.2.17. Overturning of massive Corinthian-type capital carrying a heavy top slab in Lixouri (GPS coordinates: 38.192713, 20.43]. Photo taken by NTUA team on 2/9/14.

Figure 9.2.18. The house across the street of the Public Library of Lixouri. No damage is noticed, but a statue overturned (marked with turquoise circle). Photo by NTUA team on 2/10/14.

Toppling and slight rotation of a rigid masonry hollow block was observed in a shoreline road house in Lixouri, adjacent to the local branch of the National Bank of Greece located (Fig. 9.2.19). These blocks, called “little churches of the souls,” are often seen in Greece in memory of deceased (usually at locations of car accidents).

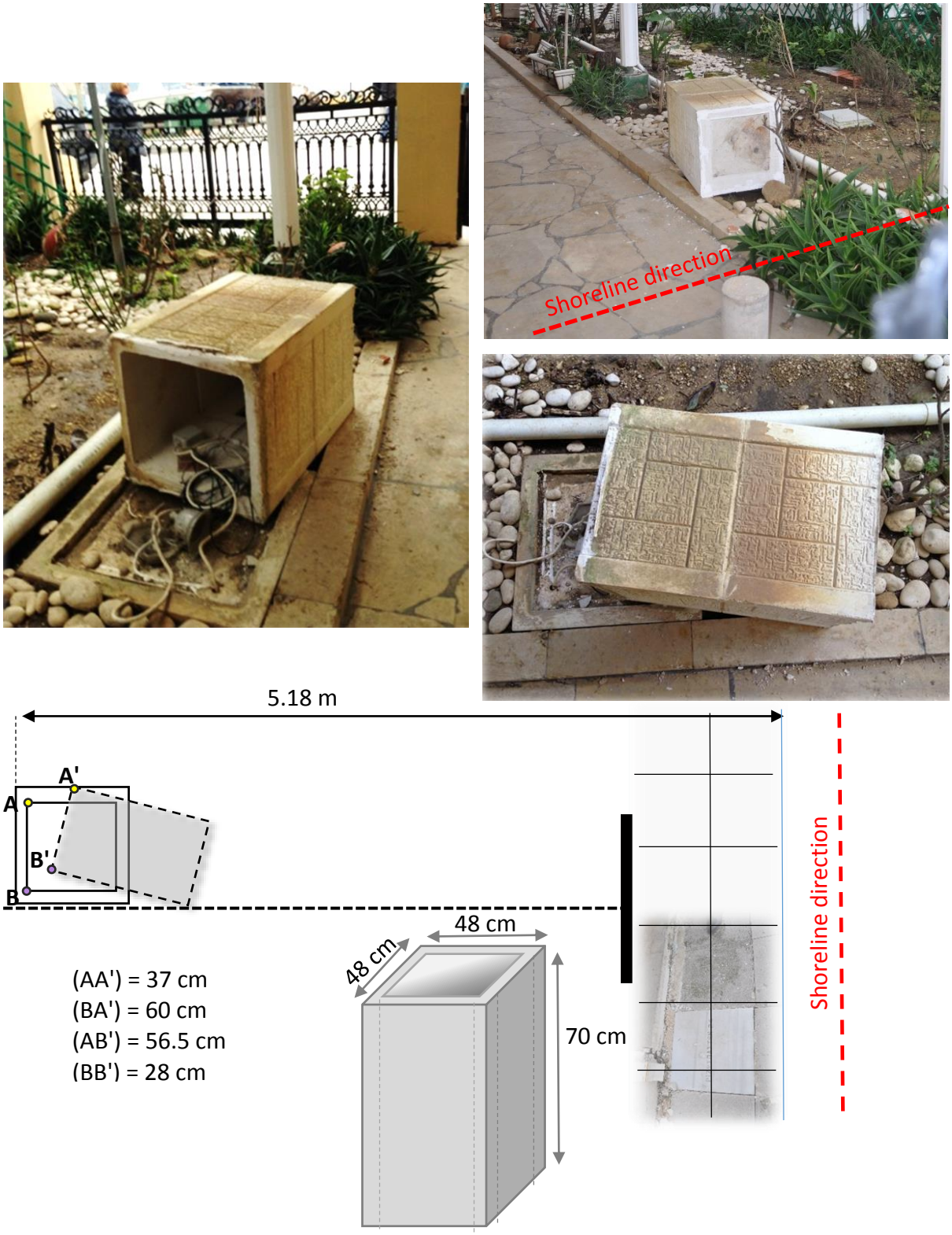


Figure 9.2.19. Toppling and rotation of rigid block at a shoreline road house next to Lixouri National Bank [38°12'9"N, 20°26'19.8"E]. Measurements by Diatonos Mechaniki; MRCE photos, 2/10/14.

9.3 Statistics of Observed Failures in Cemeteries

Table 9.3.1 summarizes statistics of toppling of objects resting on tombs from all cemeteries visited by the GEER reconnaissance teams, mainly after the 2nd event. For each cemetery, the following data are tabulated: (a) the percentage of toppled objects over total number of tombs (not accounting for other effects, such as sliding/rocking/uplift without toppling); (b) a rough estimate of the general geologic conditions of each cemetery; and (c) a rough estimate of the altitude. Cemeteries are highlighted according to toppling rate, in three categories, rated with respect to toppling percentage from minor (0-30%), to medium (30-65%) and to extensive (65-100%). These statistics are preliminary as the number of observations and toppling rates are being revised as more data become available and incorporated at this time.

Fig. 9.3.1 shows the toppling rate correlated with the (approximate) shortest distance from the hypothetical extension of the fault trace of the 2nd event, which runs almost in the NS direction, from immediately West of Atheras village [GPS: 38.311280,20.418498] to immediately East of the Soullari village [GPS: 38.185414,20.415757]. Our preliminary assumption is supported by the interferometry map of Section 7.3 and the tectonic setting of the area (insert of Fig. 9.3.1).

Nevertheless, the exact fault trace, and therefore the exact distance, is still unknown, and certainly we do not know the seismogenic fault of the 1st event, which also contributed at least to displacements and rotations of the monuments. Mechanisms of these events have not been fully understood either other than that they were both predominantly strike-slip with a thrust component, especially in the 2nd event. While interpreting statistics given in Fig. 9.3.1, one should be kept in mind that this is preliminary, indicating:

1. Four cemeteries (Aghios Dimitrios north & south, Lixouri and Lepeda) at the eastern coast of the Paliki peninsula exhibited the largest toppling rates, with average greater than 95%.
2. There was surprising low toppling rate at in the vicinity of the fault, at Kontogennada (west) and Skineas, 18% and 7% respectively.
3. Adjacent cemeteries presented significantly different toppling rates. In the two (western and eastern) cemeteries of Kontogennada, 18% and 69% toppling rate was witnessed, respectively. In Skineas the rate was 7% and in Vlichata, less than 1 km away, the rate was 71%. In both cases, the general geologic setting and altitude were roughly the same.
4. The correlation shows significant scatter, which is an indication of the many parameters that influence the performance of the rigid blocks.

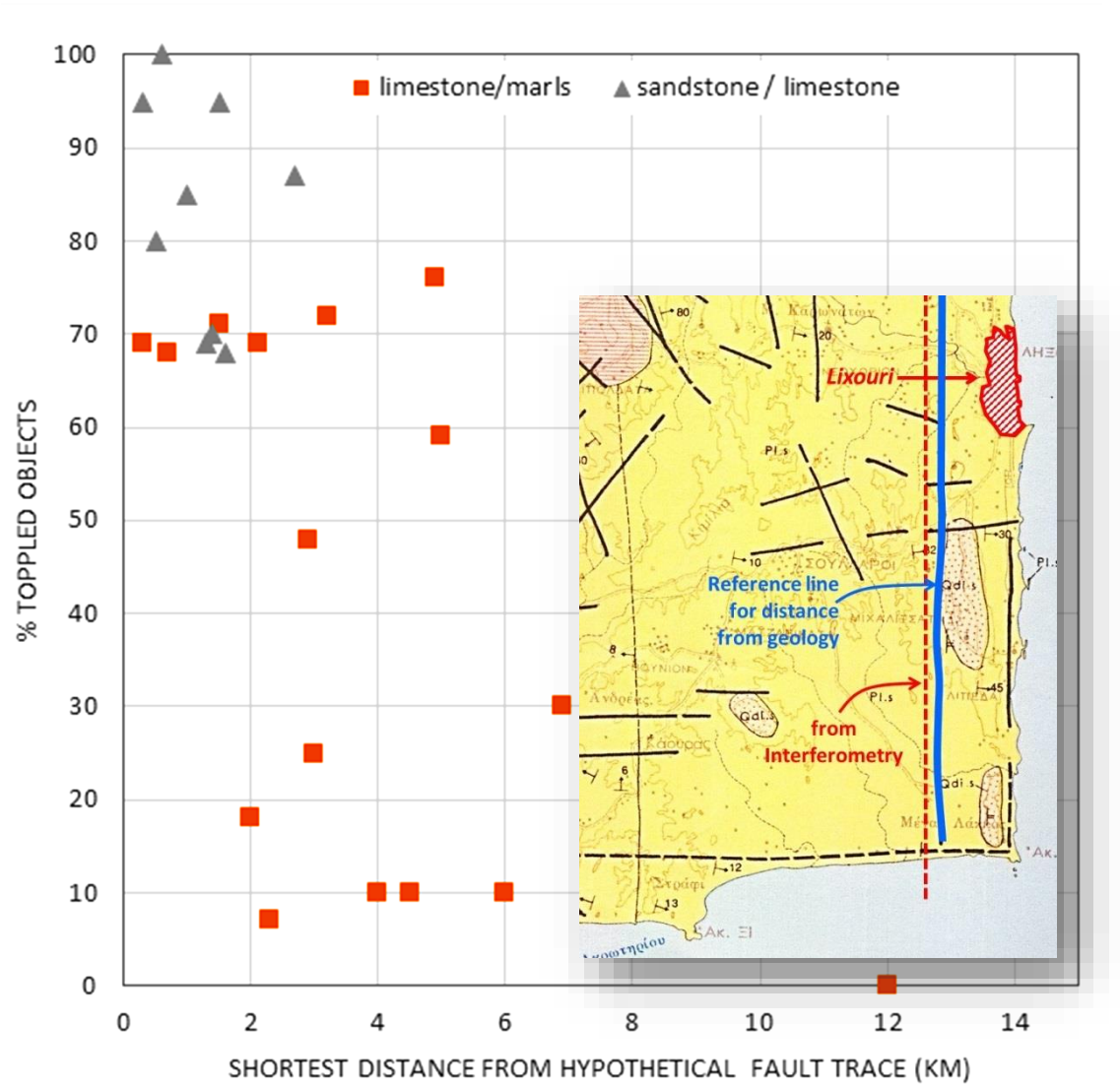


Figure 9.3.1. Correlation of damage in all cemeteries inspected to the shortest distance from the (hypothetical) trace on the surface of the seismogenic fault of the 2nd event. Insert: geologic ΙΓΜΕ map showing in blue the preliminary reference line used to calculate the distance to the cemeteries.

Table 9.3.1. Summary of statistics from cemeteries: Entries 1 through 17 are in Paliki peninsula (west part of Cephalonia), ordered from North to South. Entries 18 to 26 are on the main (east) part of the island. **Light red** indicates toppling rate over 65%; **light yellow** from 30-65%; and **light green** less than 30%. Generalized geologic setting: A = Conglomerate, sandstone and limestone and B = Conglomerate and brecciated limestone with marls.

Entry No.	Village / Cemetery Name	Total Tombs	Toppled Tombs	% Toppled	Generalized Geology	Altitude (m)	Geographic Coordinates
1	Atheras	73	50	68	limestone / marls	255	38.311280,20.418498
2	Livadi	42	29	69	limestone / marls	42	38.255689, 20.421035
3	Kontogennada (west)	45	8	18	limestone / marls	243	38.251145,20.394948
4	Kontogennada (east)	16	11	69	limestone / marls	253	38.250936,20.396137
5	Aghia Thekla	29	21	72	limestone / marls	255	38.245347,20.384113
6	Kalata / Aghios Dimitrios	46	22	48	limestone / marls	210	38.242973,20.387675
7	Skineas	67	5	7	limestone / marls	205	38.240479,20.395151
8	Vlichata	34	24	71	limestone / marls	175	38.238268,20.403932
9	Aghios Dimitrios (north)	-	-	95	sandstone / limestone	124	38.234006,20.424175
10	Aghios Dimitrios / I. Moni Kechriona	9	8	98	sandstone / limestone	44	38.224166, 20.428573
11	Havdata	200	50	25	limestone / marls	145	38.202990,20.387002
12	Lixouri	-	-	95	sandstone / limestone	6	38.192880,20.438620
13	Soullari	40	32	80	sandstone / limestone	50	38.185414,20.415757
14	Chavriata	110	96	87	sandstone / limestone	60	38.183026,20.389692
15	Vouni	50	34	68	sandstone / limestone	60	38.178455,20.404778
16	Mantzavinata (west) / Aghia Sofia	53	37	70	sandstone / limestone	62	38.177311,20.408334
17	Mantzavinata (east)	48	33	69	sandstone / limestone	53	38.176944,20.410314
18	Lepeda	-	-	85	sandstone / limestone	80	38.17962, 20.434612
19	Zola	-	-	10	limestone / marls	200	38.304909,20.465718
20	Makriotika / Aghios Gerasimos	20	0	0	limestone / marls	140	38.312289,20.559716
21	Agkonas	-	-	10	limestone / marls	280	38.299521,20.489215
22	Kardakata	-	-	10	limestone / marls	285	38.282360,20.473579
23	Kourouklata north	21	16	76	limestone / marls	255	38.243401,20.474875
24	Kourouklata south	61	36	59	limestone / marls	264	38.242544,20.474056
25	Grizata	56	0	0	limestone / marls	155	38.213876,20.650455
26	Drapano	-	-	30	limestone / marls	11	38.182783,20.499707
27	Aghios Nikolaos	100+	0	0	limestone / marls	312	38.166312,20.714258