

## PRELIMINARY REPORT ON DAMAGE AT CEPHALONIA ISLAND IN COLLABORATION WITH GEER ASSOCIATION

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The preliminary inspection of part of the damaged areas in the island of Cephalonia was performed by Prof. George Athanasopoulos of the University of Patras and Kiki Dimitriadi of Geoengineer.org on February 5<sup>th</sup> 2014, i.e., two days after the earthquake event. The following brief report concerns mainly the ports of Argostoli and Lixouri and some structures in Lixouri. Access to Lixouri was possible only through the ferry boat from Argostoli, because portions of the regional road that connects Argostoli with Lixouri were closed and there was high risk of rockfalls. For that reason, local authorities prohibited the mobility of privately owned cars on the day of our inspection. Note that the two main earthquake events recorded on Cephalonia (on Jan 26<sup>th</sup> and Feb 3<sup>rd</sup>) have caused damage primarily at the Lixouri peninsula with reportedly low damage in the eastern area of the island. This will need to be verified, by subsequent teams.

At the port of Argostoli, (**Picture 1 - 3**) sand boils and relatively narrow surface cracks, are observed, in the order of 5-10 centimeters, due to liquefaction and liquefaction induced lateral spread. Horizontal displacements increased from the landside to the waterfront of the port reaching half a meter in total in some locations. Vertical offset is estimated to be around 10cm.

The port of Lixouri (**Picture 4 – 8**) is significantly damaged with extensive cracks due to liquefaction induced lateral spread. According to our measurements displacements reached 55cm in the parallel to the waterfront direction and 35cm in the vertical direction. Vertical offset was measured around 20cm. In other locations of the port, horizontal displacement reached roughly 80cm. Liquefaction and lateral spread phenomena are observed mainly in the older part of the port, which consists of poorly compacted fill material, according to local engineers. The jetty (made of rip-rap) at the entrance of the port did not appear to have been significantly affected by the earthquake (**Picture 8**).

Evidence of liquefaction is observed along the coastline of the town of Lixouri, in the form of liquefaction sand boils (**Picture 9 – 11**) with diameter in the order of 50 cm. A few meters away from the particular location, the liquefied material has been ejected through the soil cracks and is now exposed on the soil surface (**Picture 12**).

It is important to note that the observed displacements at both ports are the sum of deformation caused by at least the two major events. Measurements performed on 28-30 January 2013 (i.e., two-three days after the January 26<sup>th</sup> event) made by the University of Patras Geotechnical Engineering Laboratory (Panagiotis Pelekis, Vasilis Vlachakis, Anastasios Batilas) indicated that the displacements

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were no larger than 30 cm. Thus, separating the two events will be key. The strong motion station positioned in the port of Argostoli by the Geotechnical Laboratory of the University of Patras following the first earthquake has recorded the February 3<sup>rd</sup> earthquake event (with approximate PGA of 0.42g), and will be key in analyzing this case history. There was pronounced liquefaction around the position of the ground motion station (see also **Picture 2**).

Additionally, along the coastline of the town, Hotel Summery has undergone some damage. We were not able to inspect the interior of the building, however important evidence regarding the directionality and intensity of the motion are provided in **Picture 13**. Evidence on the direction and intensity of the seismic motion are also provided in **Picture 14** taken at the church of Pantokrator, opposite to the City Hall of Lixouri. These issues need to be explored further.

Cases of non-damage include the old school of Lixouri, designed by Prof. Moraitis of NTUA, which has survived the even more devastating seismic activity of 1953 as well as newly built construction, with the exception of classic “soft storey” failures of one-storey building with pilotis as presented in **Picture 15**.

Based on our very brief presence on the island, damage was not concentrated in a specific area, apart of course from the two ports.

According to locals at Lixouri, significant damages have been reported at the *workers’ housing complex* at Lixouri as well as at the villages of: *Mantzavinata, Xi* (especially at the resort Cephalonia Palace located in the area), *Agios Georgios*, and possibly *Havriata*, all located south of Lixouri. Damages have also been reported at the areas of *Agios Dimitrios* and *Livadi*, north of Lixouri.

The above locations are also pinned below and the corresponding file has also been uploaded at the Information Hub:

<http://www.mygeoworld.info/file/view/66736/google-earth-file-vers3-with-geologic-map-ground-motion-station-locations-amp-damage-locations>

### **Things to keep in mind:**

Access to the island is possible only through the port of Poros, located in the South East part of the island. From there, Argostoli is located 40 km to the west and it takes about one hour drive to get there. To get to Lixouri you can either:

- (i) take the ferry boat from Argostoli, which should not take more than 30min. Ferry boats leave Argostoli every hour (starting from the half of the hour, i.e. 10:30 – 11:30 – 12:30 etc) and Lixouri at the exact hour (i.e. 10:00 – 11:00 – 12:00). **However, significant delays are reported and it is highly suggested that you do not rely on the formal schedule.**

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- (ii) take the local road from Argostoli. The particular road network is highly damaged and was closed for civilians as of Feb. 5<sup>th</sup>. The distance from Argostoli is roughly 40km and under normal circumstances should take you 45 – 50mins.

Generally, the local roads are narrow and winding with many heavy vehicles transferring supplies from the port of Poros to wherever it is possible and safe, on the island, therefore **be careful with the estimated driving times!**

Approximately 300 photos have been uploaded on the Information Hub and are available here:

<http://www.mygeoworld.info/photos/album/66643/photos-from-the-second-earthquake-in-cephalonia>



**Picture 1:** Port of Argostoli\_1



Picture 2: Port of Argostoli\_2



Picture 3: Port of Argostoli\_3



Picture 4: Port of Lixouri\_1.



Picture 5: Port of Lixouri\_2.



**Picture 6:** Port of Lixouri\_3.



**Picture 7:** Port of Lixouri\_4.



**Picture 8:** Port of Lixouri, entrance.



**Picture 9:** Liquafaction craters\_1 (Lixouri).



**Picture 10:** Liquefaction craters\_2 (Lixouri).



**Picture 11:** Liquefaction craters\_3 (Lixouri).



**Picture 12:** Indications of liquefaction (Corner of Laskaratou & Skarlatou, Lixouri).



**Picture 13:** Summery Hotel\_1 (Lixouri).



Picture 14: Church of Pantokrator.



Picture 15: Example of Soft-storey failure