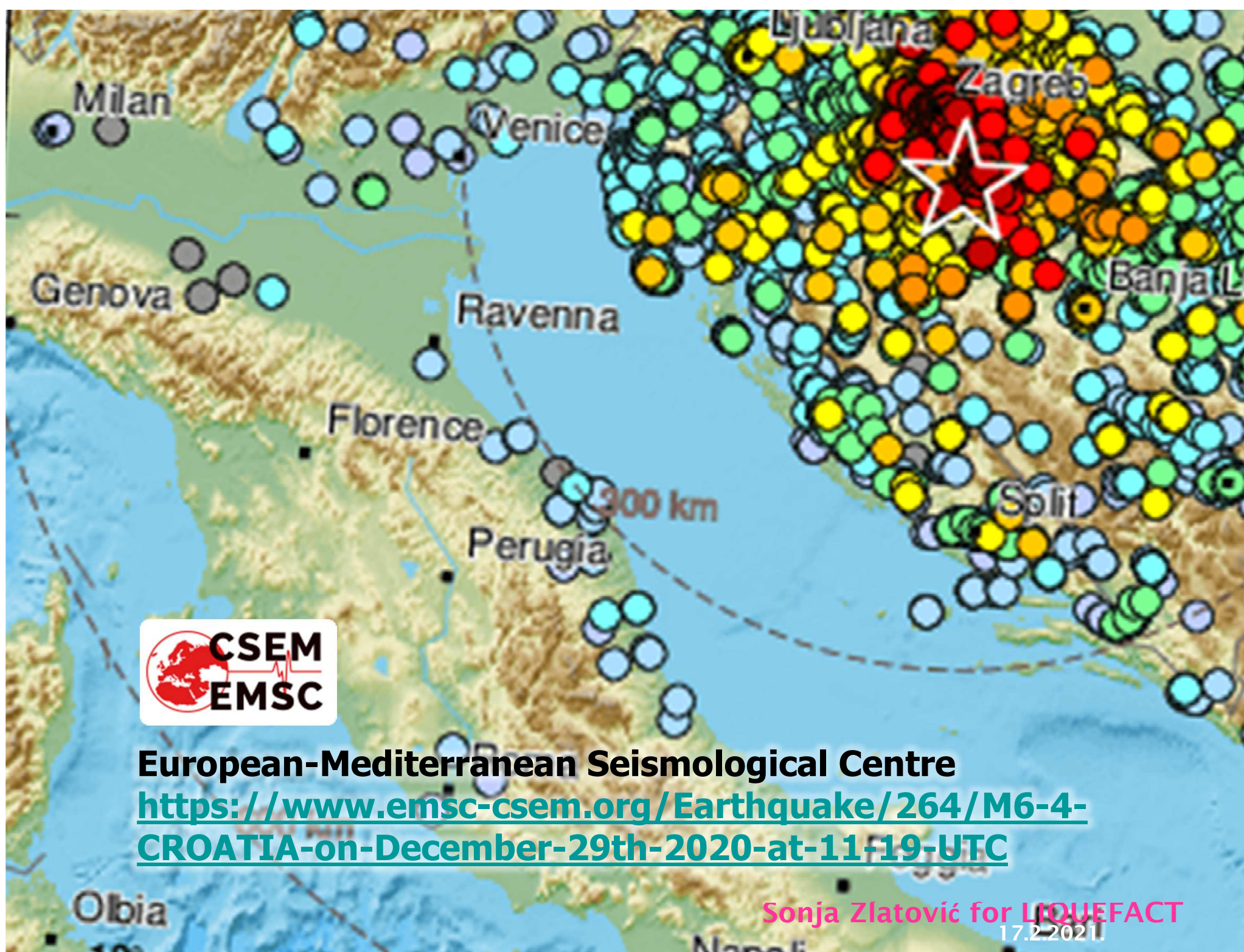




**Liquefaction  
in  
Petrinja  
earthquake  
M6.4  
29.12.2020.**

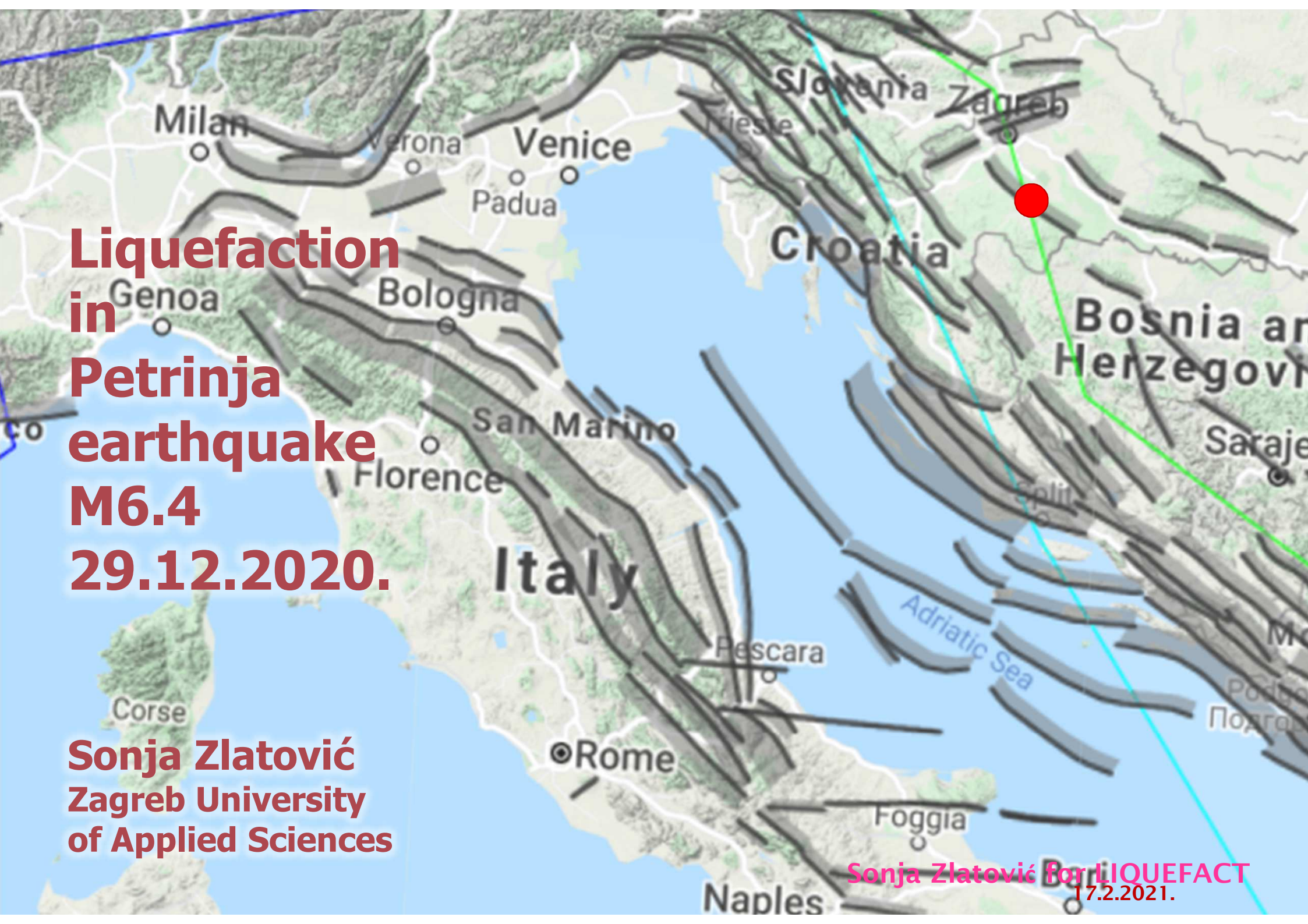
17.2.2021.

**Sonja Zlatović**  
Zagreb University  
of Applied Sciences



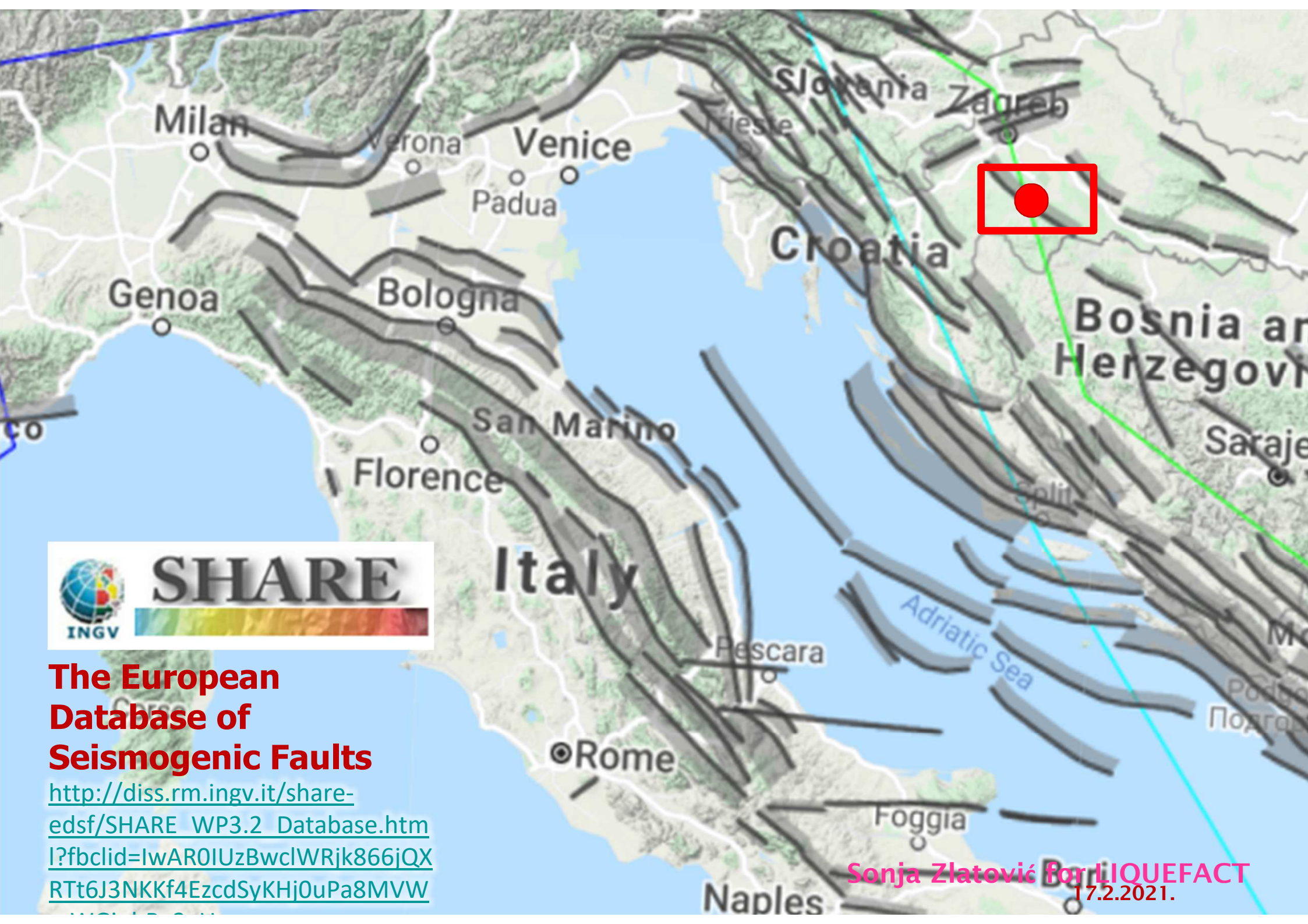
**European-Mediterranean Seismological Centre**  
<https://www.emsc-csem.org/Earthquake/264/M6-4-CROATIA-on-December-29th-2020-at-11-19-UTC>

Sonja Zlatović for LIQUEFACT  
17.2.2021.

A map of the Adriatic region, including parts of Italy, Croatia, Slovenia, and Bosnia and Herzegovina. Major cities like Milan, Venice, Padua, Bologna, Florence, Rome, Naples, and Zagreb are labeled. A red dot marks the location of the Petrinja earthquake in Croatia. A green line runs from Zagreb to the red dot, and a cyan line runs from the red dot towards the bottom right. The Adriatic Sea is labeled in blue. Dark grey lines represent geological features or faults.

# **Liquefaction in Petrinja earthquake M6.4 29.12.2020.**

**Sonja Zlatović**  
Zagreb University  
of Applied Sciences



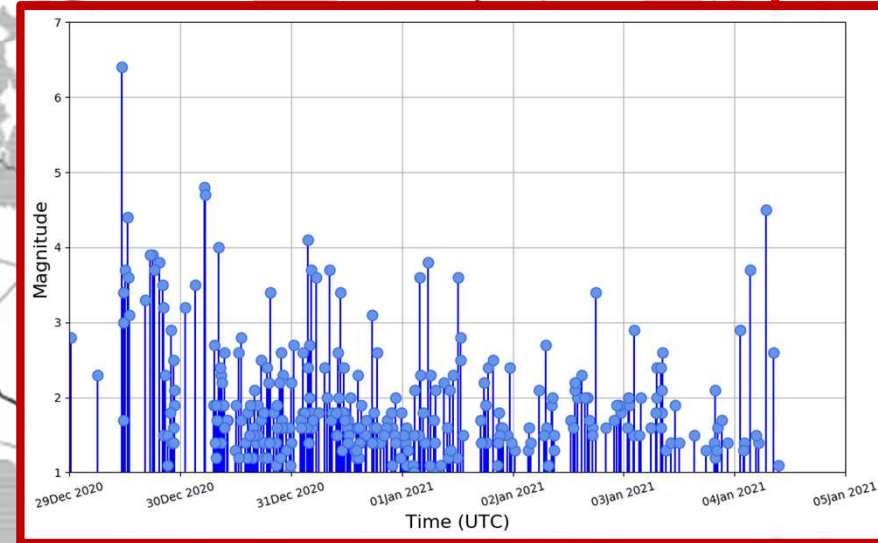
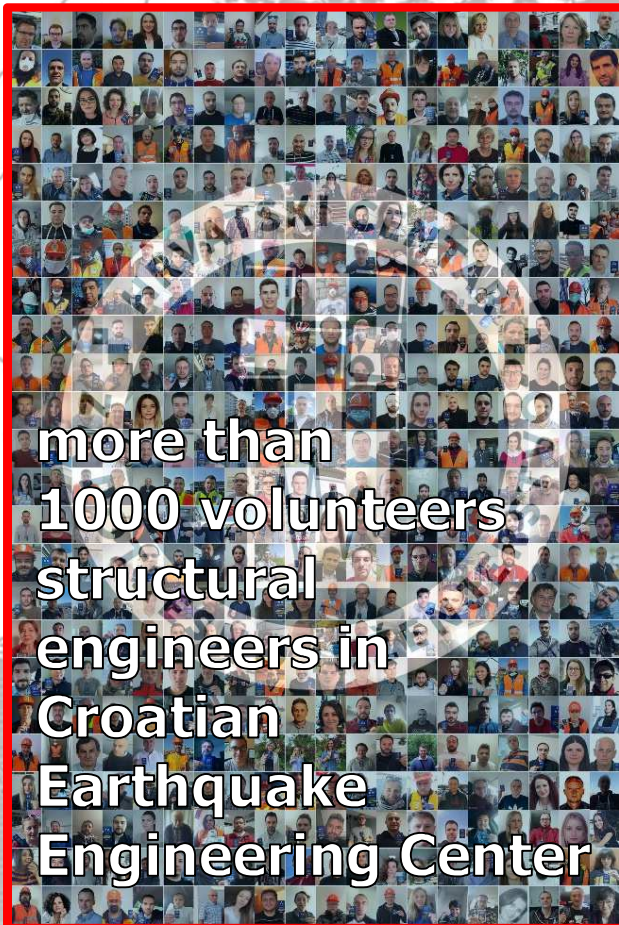
## The European Database of Seismogenic Faults

[http://diss.rm.ingv.it/share-edsf/SHARE\\_WP3.2\\_Database.htm](http://diss.rm.ingv.it/share-edsf/SHARE_WP3.2_Database.htm)  
[I?fbclid=IwAR0IUzBwclWRjk866jQXRTt6J3NKKf4EzcdSyKHj0uPa8MVW](http://diss.rm.ingv.it/share-edsf/SHARE_WP3.2_Database.htm?fbclid=IwAR0IUzBwclWRjk866jQXRTt6J3NKKf4EzcdSyKHj0uPa8MVW)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

Petrinja 29.12.2020.

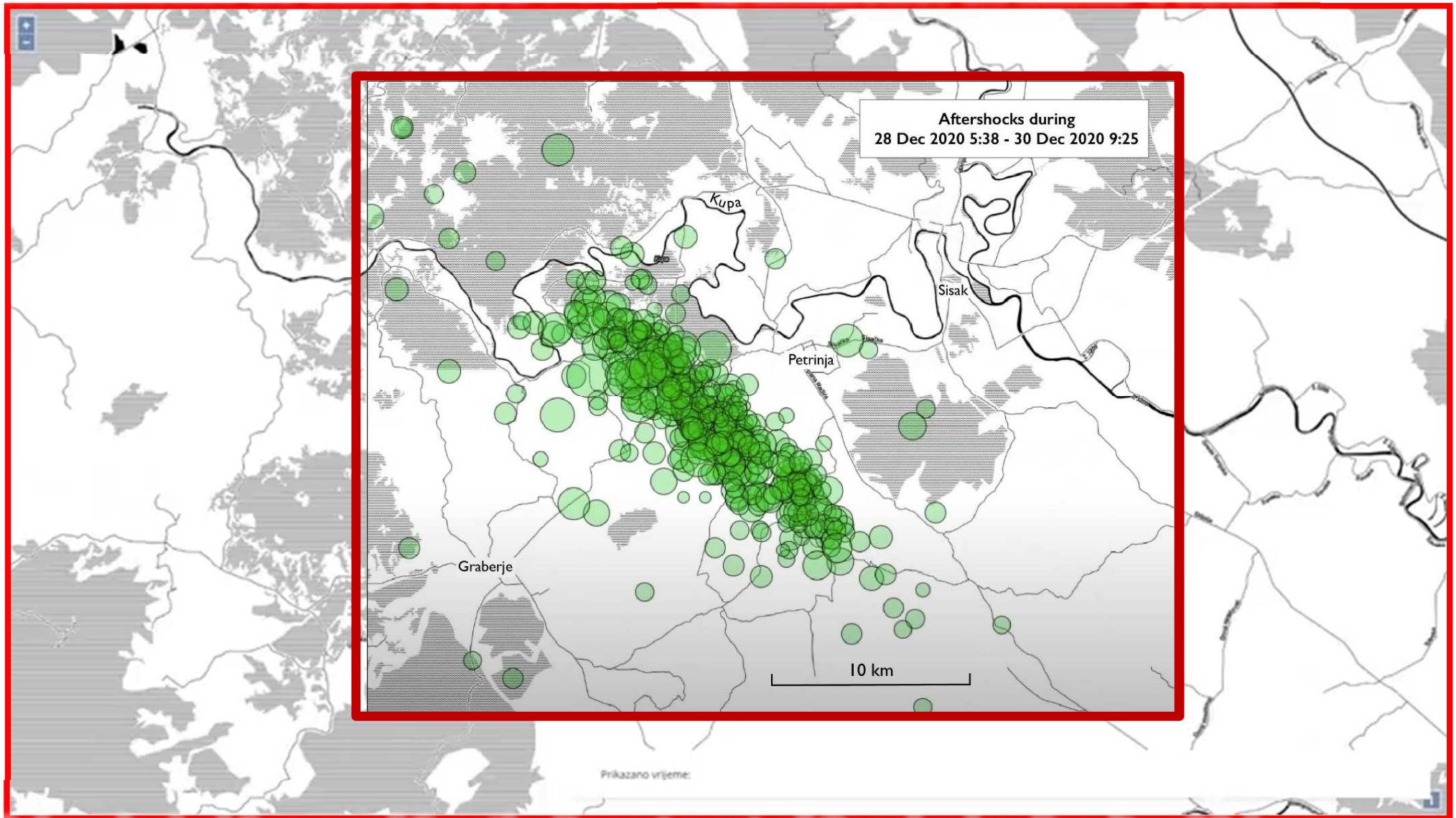
28.12.2020. at 6:28 M5.0 >>> 29.12.2020. at 12:19 M6.2



Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.youtube.com/watch?v=OSvZhrpIVng&feature=emb\\_logo](https://www.youtube.com/watch?v=OSvZhrpIVng&feature=emb_logo)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

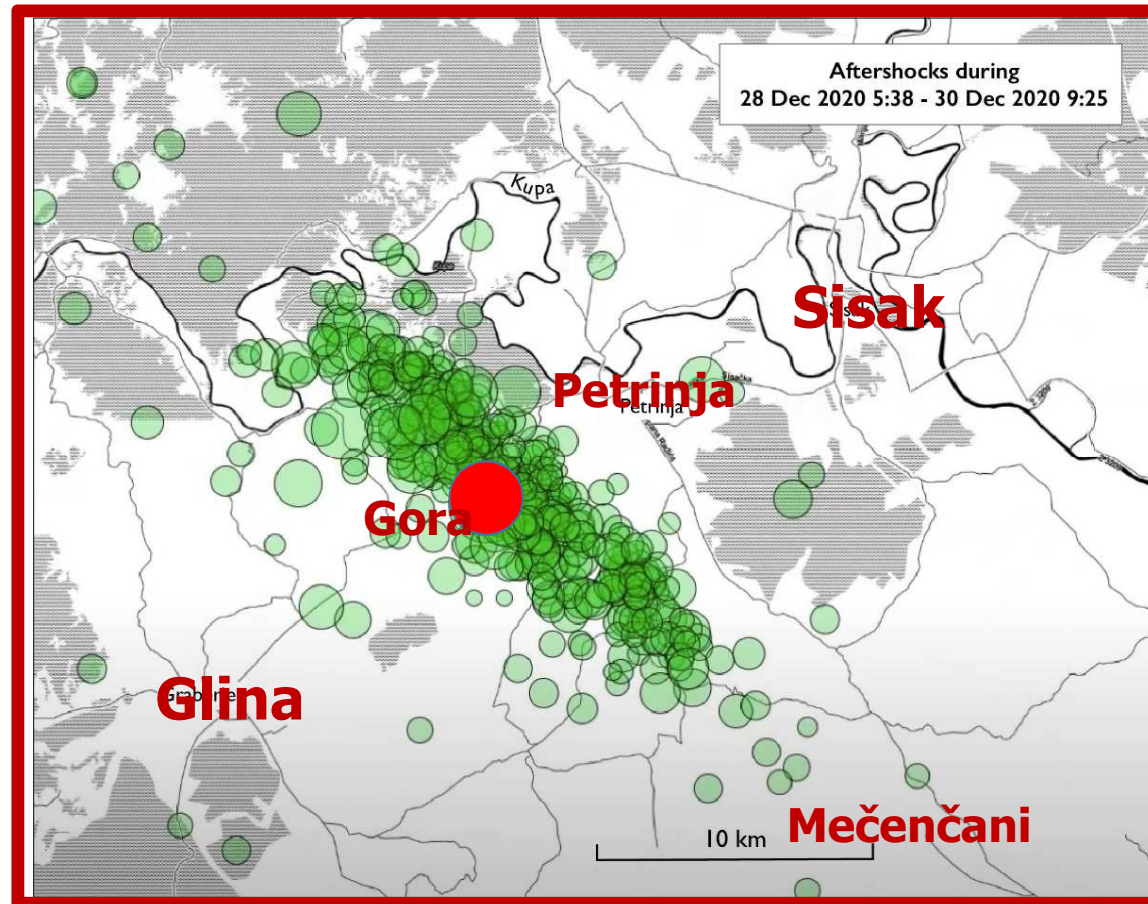
28.12.2020. at 6:28 M5.0 >>> 29.12.2020. at 12:19 M6.2



Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.youtube.com/watch?v=OSvZhrpIVng&feature=emb\\_logo](https://www.youtube.com/watch?v=OSvZhrpIVng&feature=emb_logo)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

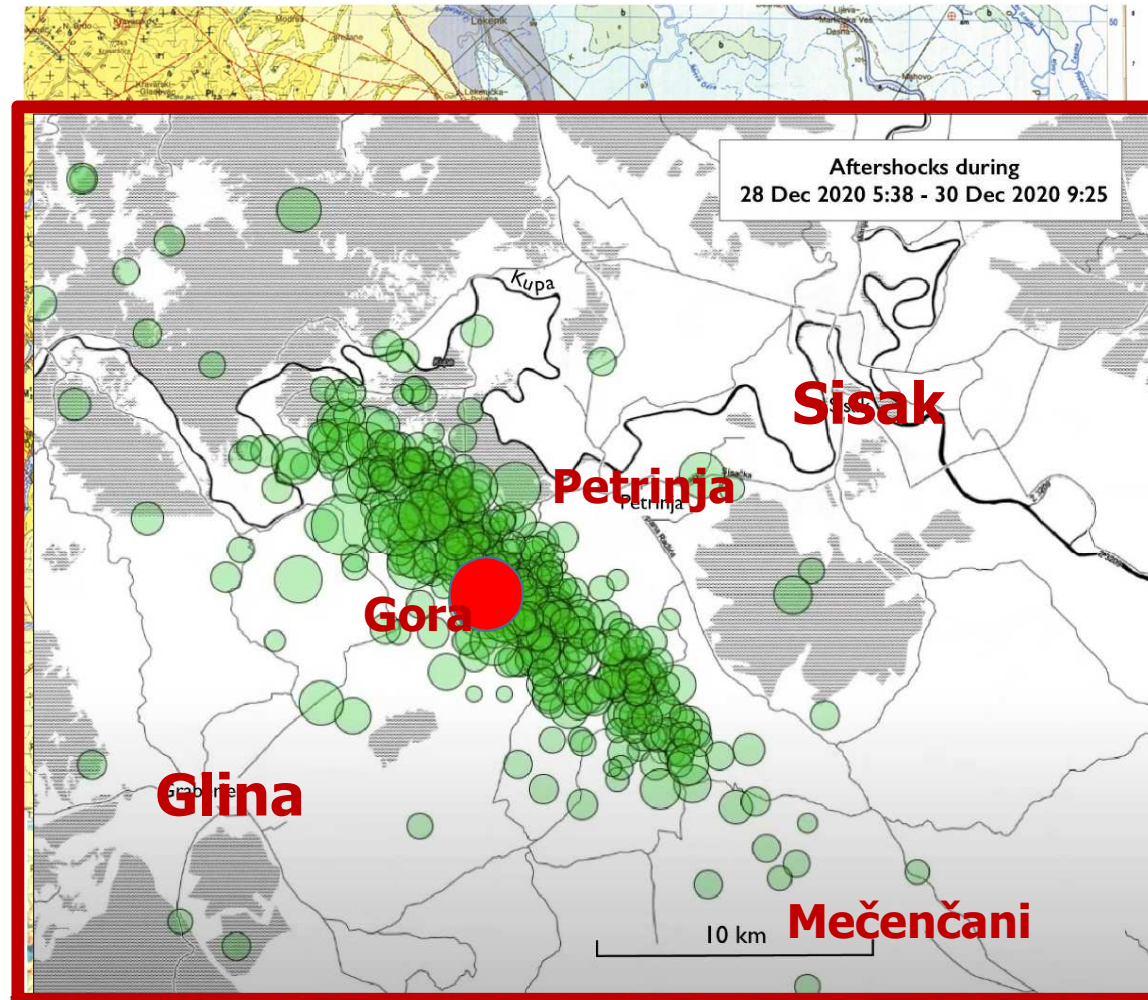
## Glina, Gora, Petrinja, Sisak



map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

## Glina, Gora, Petrinja, Sisak



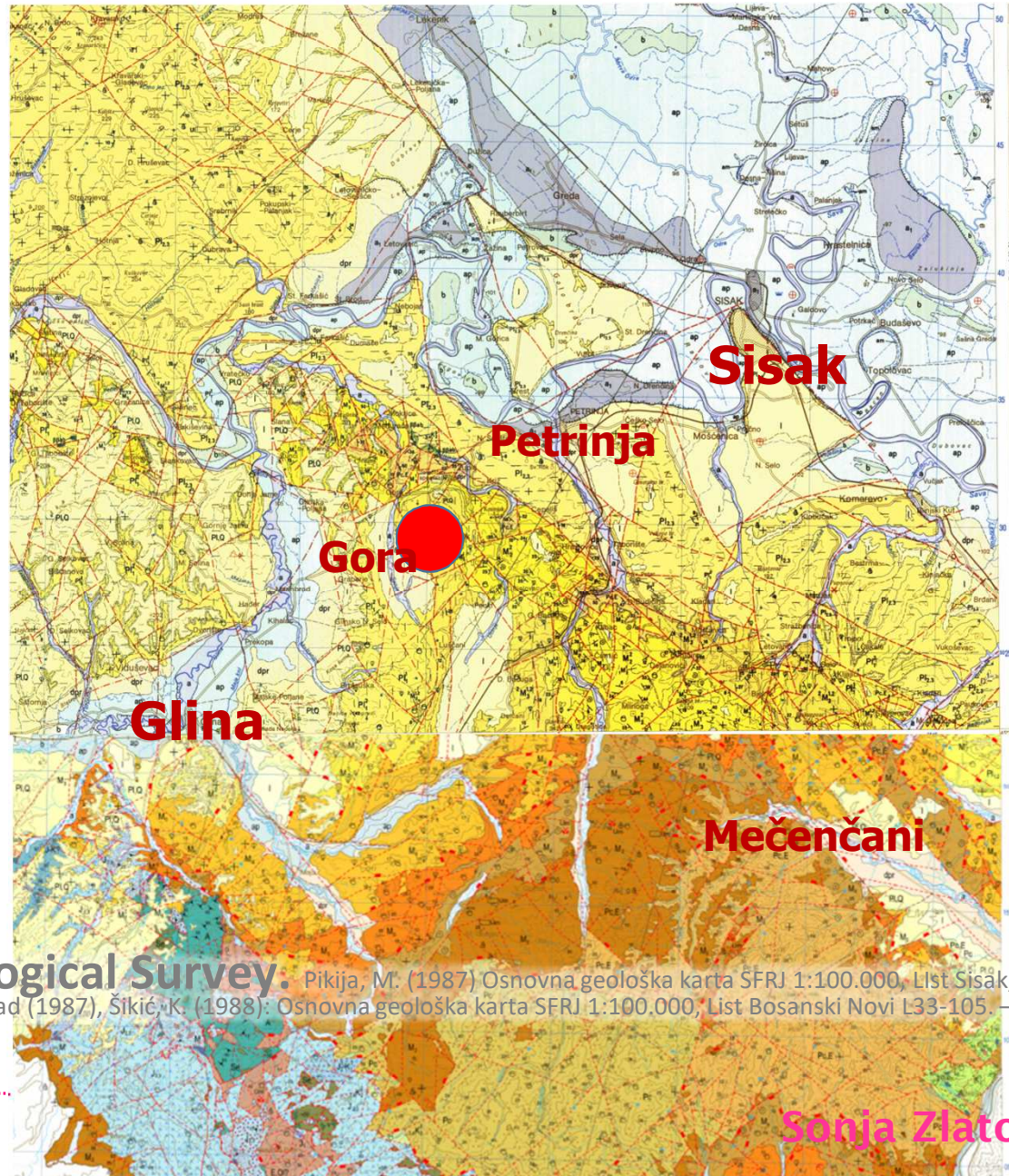
**maps:** Croatian Geological Survey. Pikija, M. (1987) Osnovna geološka karta SFRJ 1:100.000, List Sisak, L33-81. - Geološki zavod, Zagreb (1975-1986 Savezni geološki zavod, Beograd (1987), Šikić, K. (1988): Osnovna geološka karta SFRJ 1:100.000, List Bosanski Novi L33-105. – Fond stručne dokumentacije Instituta za geološka istraživanja, Zagreb

**map:** Seismological Survey of Croatia, Department of Geophysics, Faculty of Science, University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

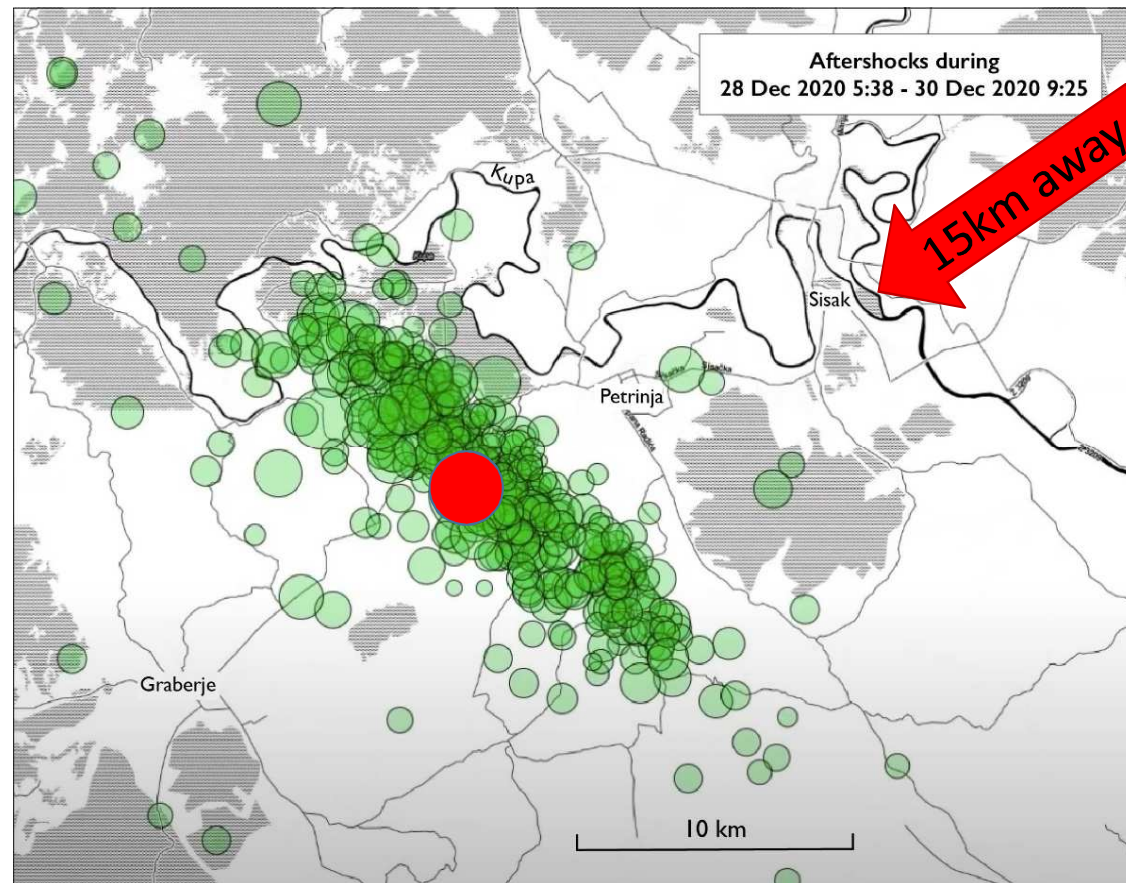
## Glina, Gora, Petrinja, Sisak, Mečenčani

meandering rivers  
fine sands  
silts  
clays  
gravels



**maps: Croatian Geological Survey.** Pikija, M. (1987) Osnovna geološka karta SFRJ 1:100.000, List Sisak, L33-81. - Geološki zavod, Zagreb (1975-1986 Savezni geološki zavod, Beograd (1987), Šikić, K. (1988): Osnovna geološka karta SFRJ 1:100.000, List Bosanski Novi L33-105. – Fond stručne dokumentacije Instituta za geološka istraživanja, Zagreb

**Sisak, Udruga KAS, Savska 66, 15 km away**



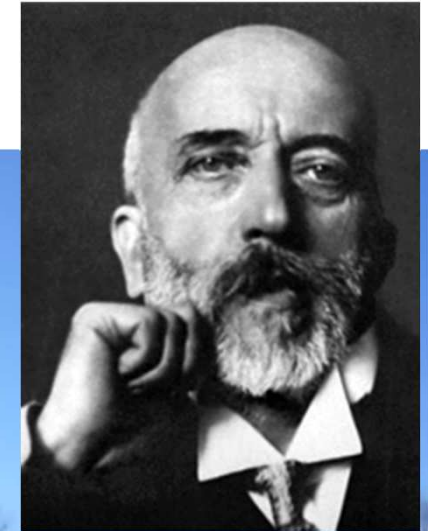
map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

Petrinja 29.12.2020.

**Sisak, Udruga KAS, Savska 66, 15 km away**

**Andrija Mohorovičić  
(1857-1936)**



**Video: Daniel Pavlić** [https://www.youtube.com/watch?v=hH3AHtYMEKE&feature=emb\\_logo](https://www.youtube.com/watch?v=hH3AHtYMEKE&feature=emb_logo)

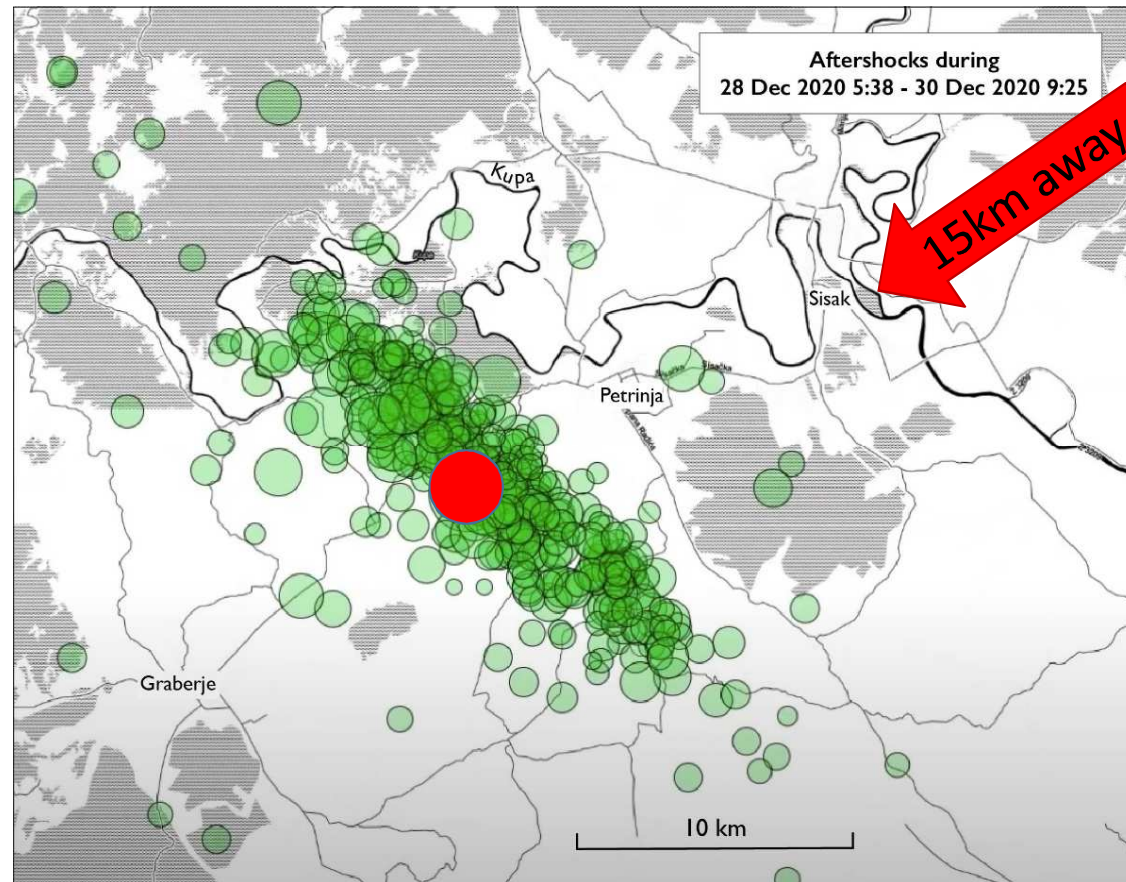
**Sonja Zlatović for LIQUEFACT**  
17.2.2021.

## In the fields



Courtesy of Croatian Waters – Hrvatske vode

## Levee along the Sava river, Galdovo, 15 km away



map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

**Levee along the Sava river, Galdovo, 15 km away**



**Sonja Zlatović for LIQUEFACT**  
17.2.2021.

## Levee along the Sava river, Galdovo, 15 km away

| DUBINA (m) | NADMORSKA VISINA (mm.m.) | PROMJER JEZGRE (mm) | PROMJER ZAŠTITNE KOLONE (mm) | PPV (m) | RPV (m) | SIMBOL   | INTERVAL (m) | GRUPA MATERIJALA | OPIS TLA                                                                                                                                                           |
|------------|--------------------------|---------------------|------------------------------|---------|---------|----------|--------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0,0        | 100,13                   |                     |                              |         |         |          | 0,10         |                  | Humus                                                                                                                                                              |
| 1,0        |                          |                     |                              |         |         |          |              |                  |                                                                                                                                                                    |
| 2,0        | 146                      |                     |                              |         |         | N(CL-CI) |              |                  | Tijelo nasipa - Glina niske i srednje plastičnosti, kruto plastične konzistencije, smeđe boje. U intervalima od 0,80 do 1,30 i 2,80 do 3,40 m glina je pjeskovita. |
| 3,0        | 98,09                    |                     |                              |         |         |          | 2,80         |                  |                                                                                                                                                                    |
| 3,0        | 97,59                    |                     |                              |         |         | N(CI)    | 3,30         |                  | Tijelo nasipa - Glina srednje plastičnosti, kruto plastične konzistencije, sa pijeskom, sive i smeđe boje.                                                         |
| 4,0        |                          |                     |                              |         |         | CL/SC    |              |                  | Pjeskovita glina niske plastičnosti, kruto plastične konzistencije do zaglinjeni pijesak, sive boje.                                                               |
| 4,0        | 96,69                    |                     |                              |         |         |          | 4,20         |                  |                                                                                                                                                                    |
| 5,0        | 95,99                    |                     |                              |         |         | CL       | 4,90         |                  | Glina niske plastičnosti, kruto plastične konzistencije, sive boje.                                                                                                |
| 5,0        |                          |                     |                              |         |         | CI       |              |                  | Glina srednje plastičnosti, kruto plastične konzistencije, sive boje.                                                                                              |
| 6,0        | 95,19                    | 131                 |                              | 5,5     |         |          | 5,70         |                  |                                                                                                                                                                    |
| 7,0        |                          |                     |                              |         |         | CH       |              |                  | Glina visoke plastičnosti, kruto plastične konzistencije, smeđe boje.                                                                                              |
| 8,0        | 93,29                    |                     |                              |         |         |          | 7,60         |                  |                                                                                                                                                                    |
| 8,0        | 92,59                    |                     |                              |         |         | CL/SC    | 8,30         |                  | Pjeskovita glina niske plastičnosti, meko plastične konzistencije do zaglinjeni pijesak, vrlo rastresit, smeđe boje, prošarane sivom.                              |
| 9,0        |                          | 116                 |                              |         |         |          |              |                  |                                                                                                                                                                    |
| 9,0        |                          |                     |                              |         |         | SC       |              |                  | Zaglinjeni pijesak, sitan do srednje krupan, srednje zbijen, smeđe i sive boje.                                                                                    |
| 10,0       | 90,89                    |                     |                              |         |         |          | 10,00        |                  |                                                                                                                                                                    |

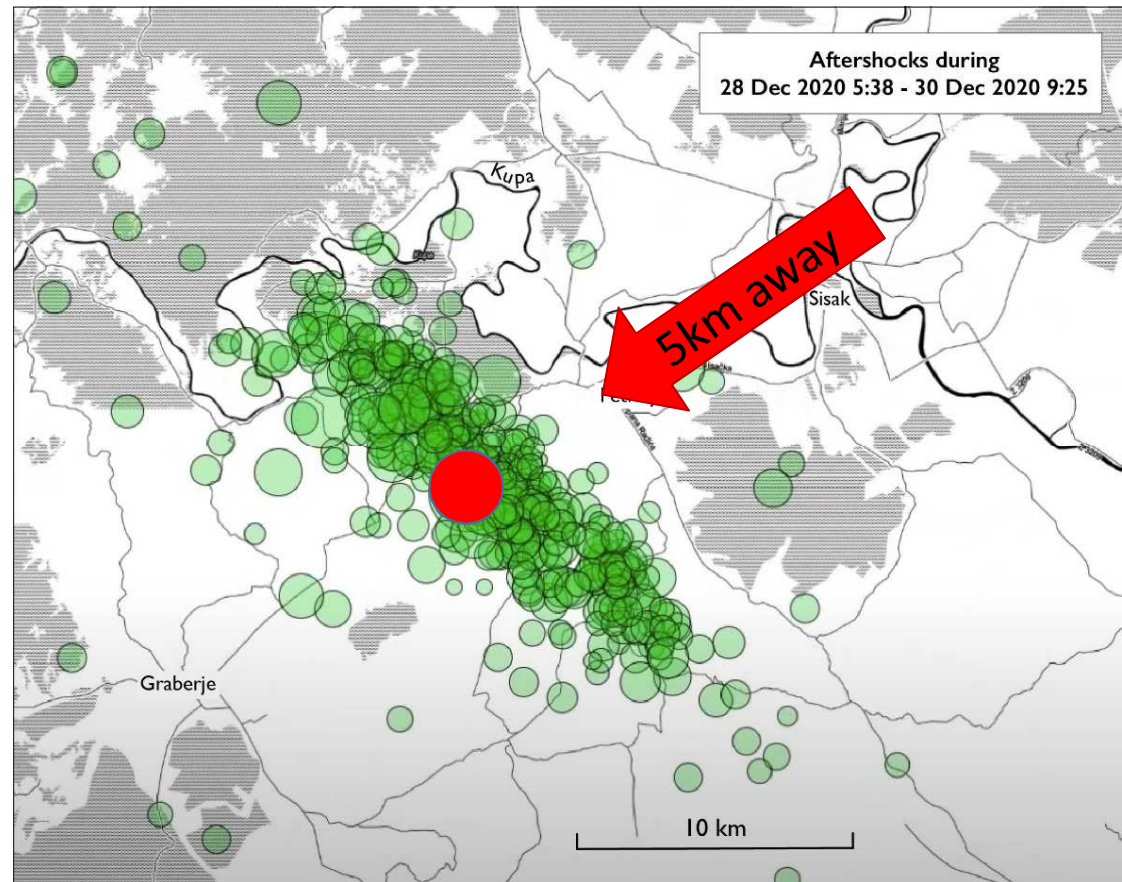
**8,3m sand with clay**

Courtesy of Croatian Waters.. Hrvatske vode... [www.voda.hr](http://www.voda.hr)

Sonja Zlatović for LIQUEFACT  
17.2.2021.



**Petrinja, Ulica Slavka Kolara 13, 5 km away**



map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

**Petrinja, Ulica Slavka Kolara 13, 5 km away**



Petrinja 29.12.2020.

Petrinja, Ulica Milana Makanca 10, 5 km away



Ulica Milana Makanca 14



Sonja Zlatović for LIQUEFACT  
17.2.2021.

**Petrinja 29.12.2020.**

**Petrinja, Ulica Milana Mikanca 14, 5 km away**



**Sonja Zlatović for LIQUEFACT**  
17.2.2021.

Petrinja, Ulica Milana Mikanca 13, 5 km away



**Petrinja, Ulica Milana Mikanca 11, 5 km away**



**DPM 30**

**rod diameter:  $\varnothing=20$  mm**

**tip diameter:  $\varnothing=35,6$  mm**

**tip surface:  $A=10,00$  cm<sup>2</sup>**

**mass:  $P = 30,0$  kg**

**height fall:  $h = 20$  cm**

**N: blows for 10 cm**



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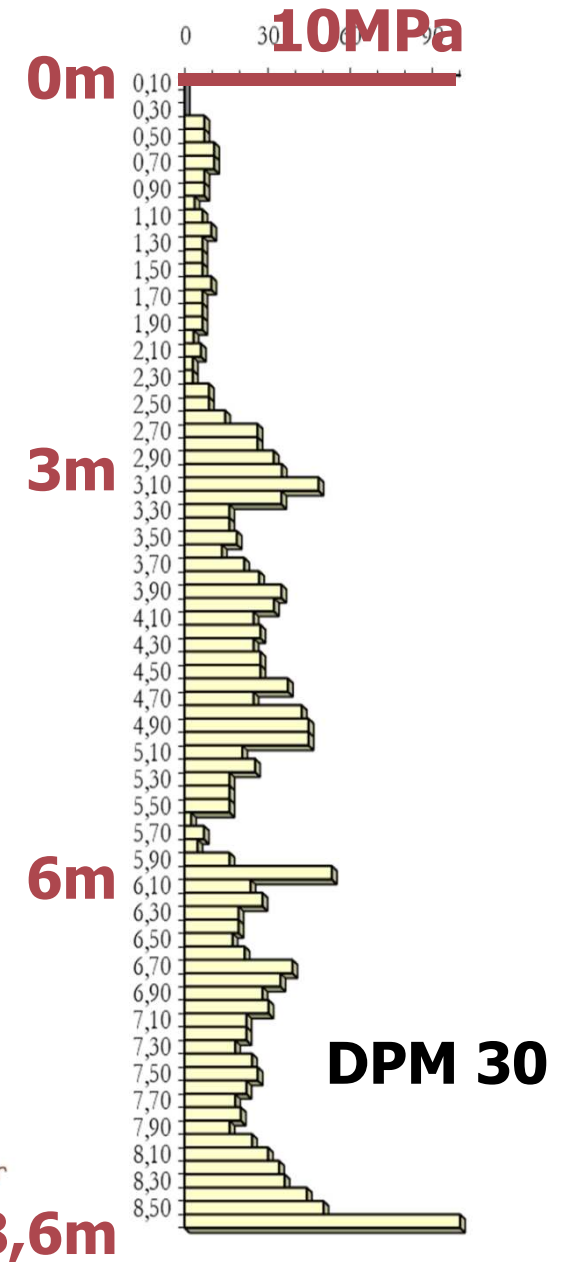
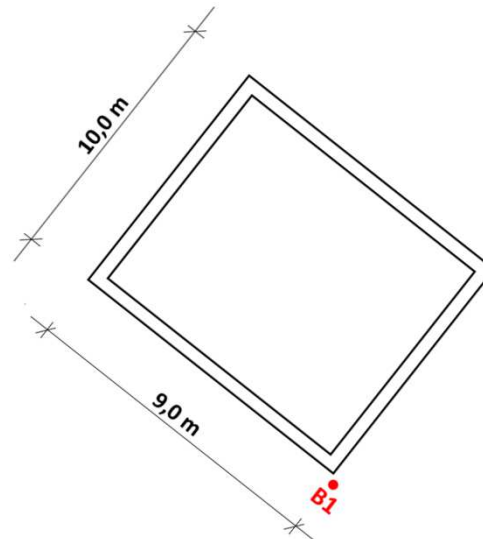
Mob +385 98 719 475

Fax +385 1 3377 006

[www.uretek.hr](http://www.uretek.hr) | [info@uretek.hr](mailto:info@uretek.hr)

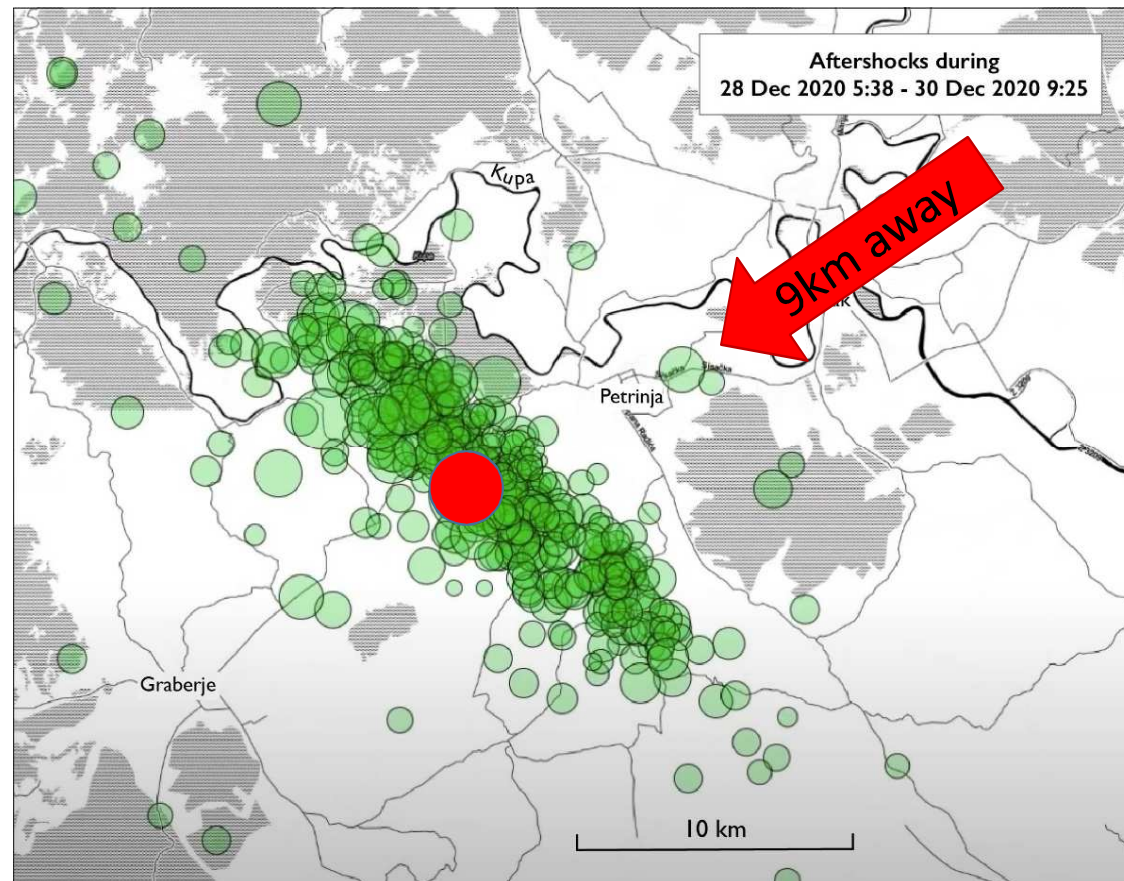
left video recorded by Tomo Zorčić, vlasnik kuće

Petrinja, Ulica Milana Mikanca 11, 5 km away



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## Nova Drenčina, 9 km away

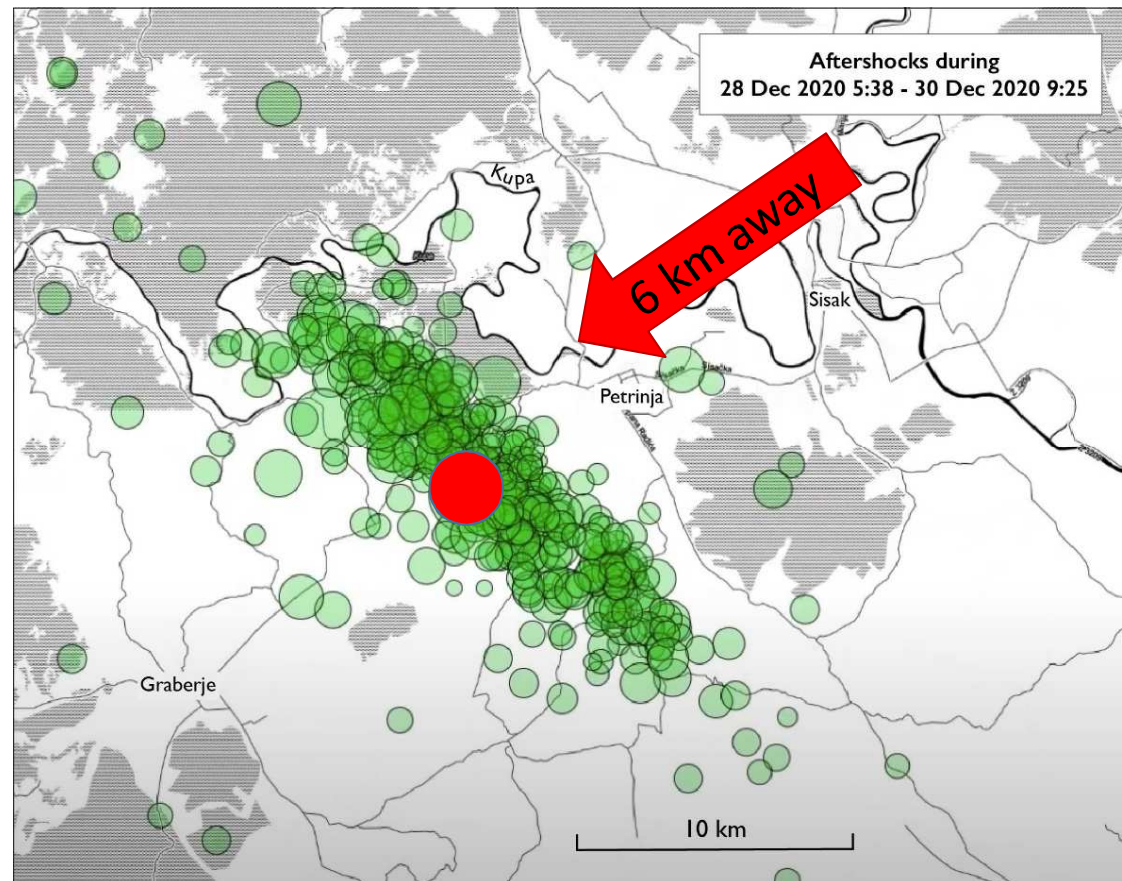


## Nova Drenčina, 9 km away



Sonja Zlatović for LIQUEFACT  
17.2.2021.

**Hađer, 8,5 km away**



map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

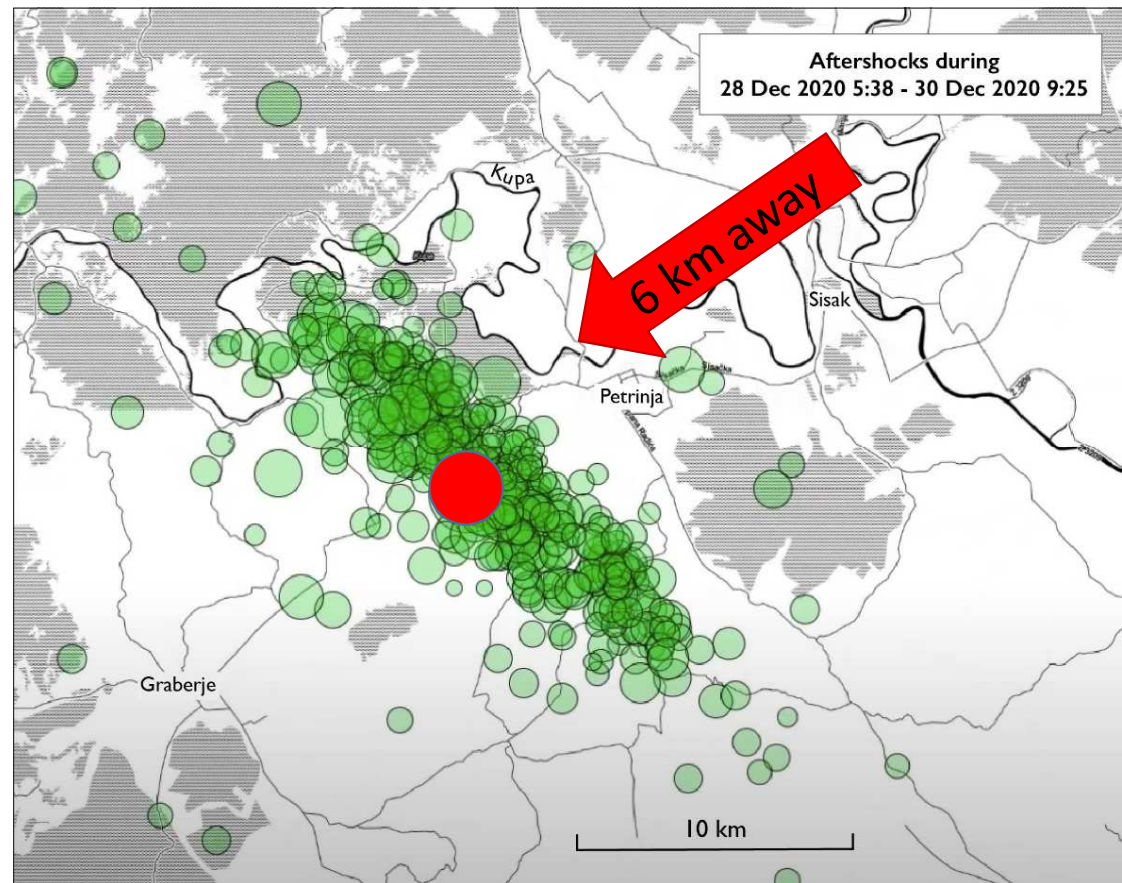
## Hađer, 8,5 km away

sliding  
very soft soil



Sonja Zlatović for LIQUEFACT  
17.2.2021.

## Brest Pokupski, 6 km away

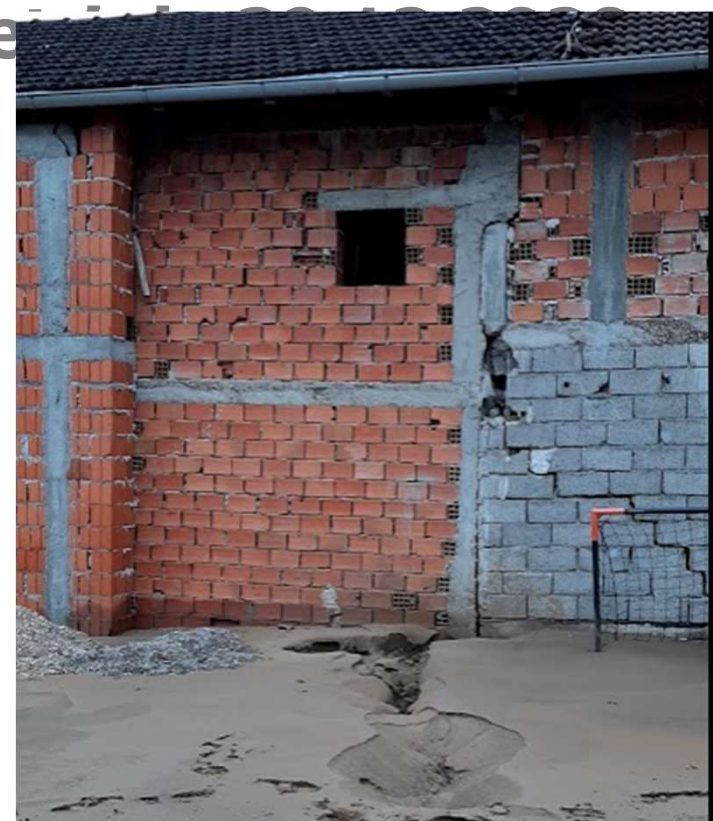
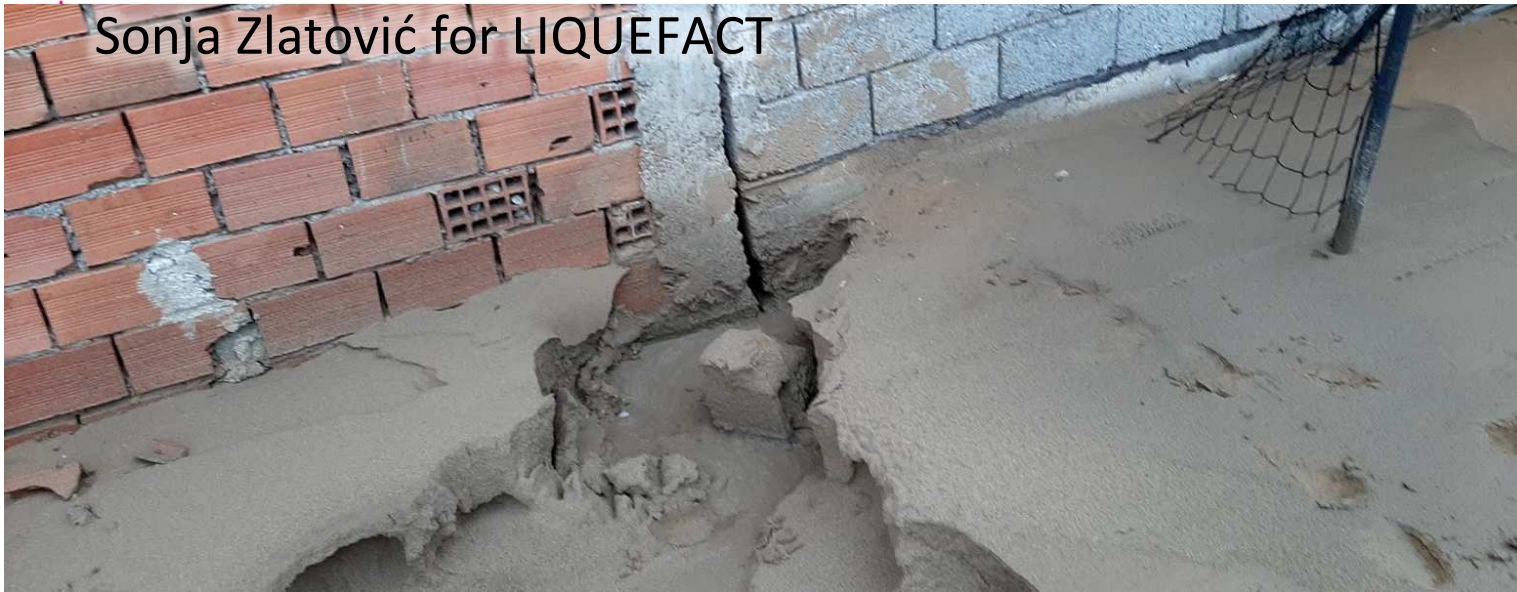


map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

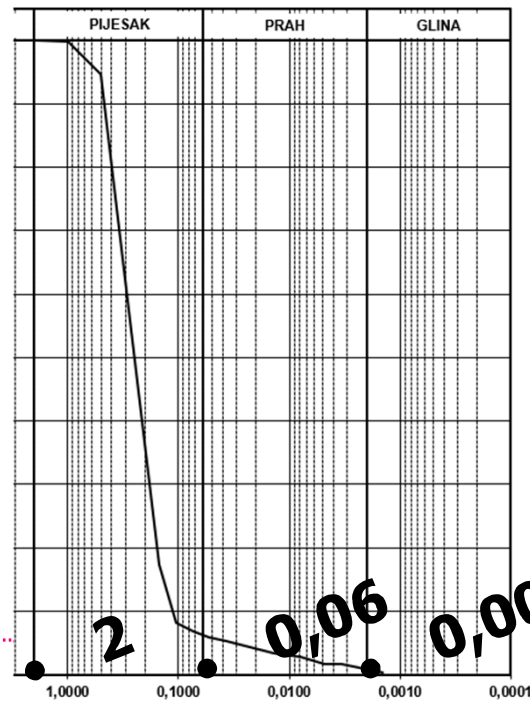
## Brest Pokupski, 6 km away

Sonja Zlatović for LIQUEFACT



Sonja Zlatović for LIQUEFACT  
17.2.2021.

Brest Pokupski, 6 km away



"GEO-LAB" d.o.o.  
za geomehanička ispitivanja  
Zagreb, Č. Truhelke 49, tel:3838797, fax:3838798

Sonja Zlatović for LIQUEFACT  
17.2.2021.

Petrinja 29.12.2020.

**Brest Pokupski, 6 km away**



Snimio Igor Gukov

Sonja Zlatović for LIQUEFACT  
17.2.2021.

Petrinja 29.12.2020.

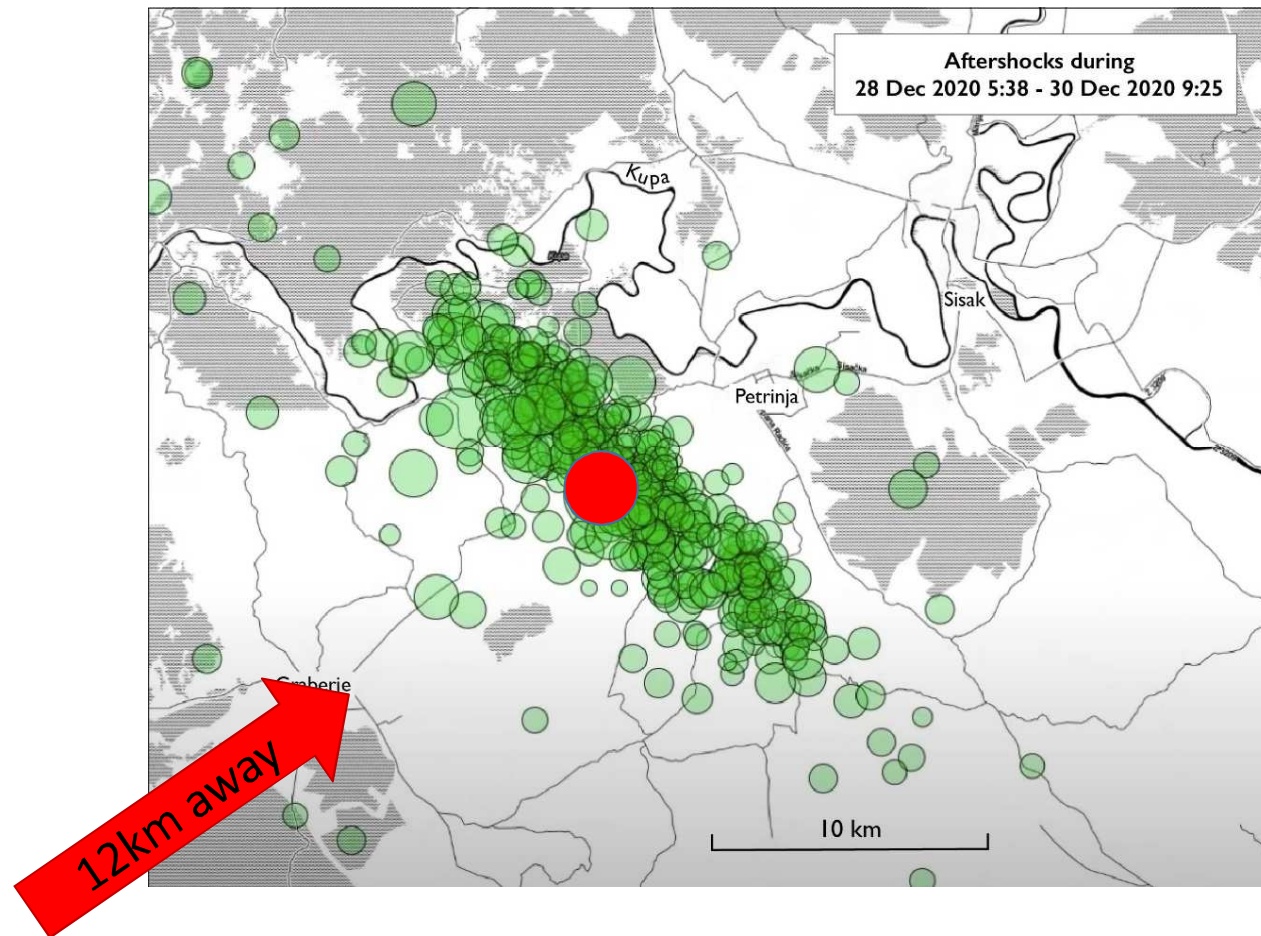
**Brest Pokupski, 6 km away**



Snimio Igor Gukov

Sonja Zlatović for LIQUEFACT  
17.2.2021.

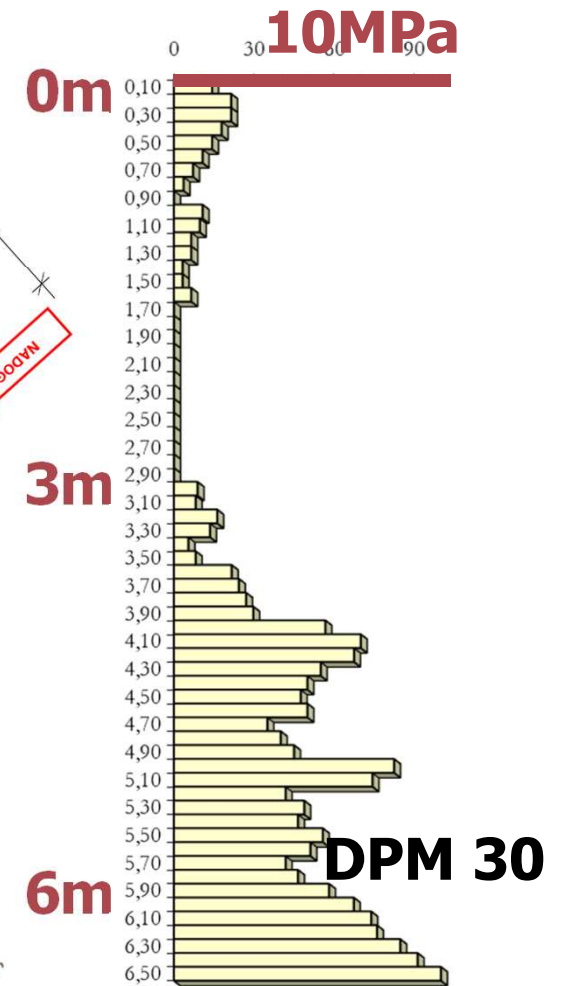
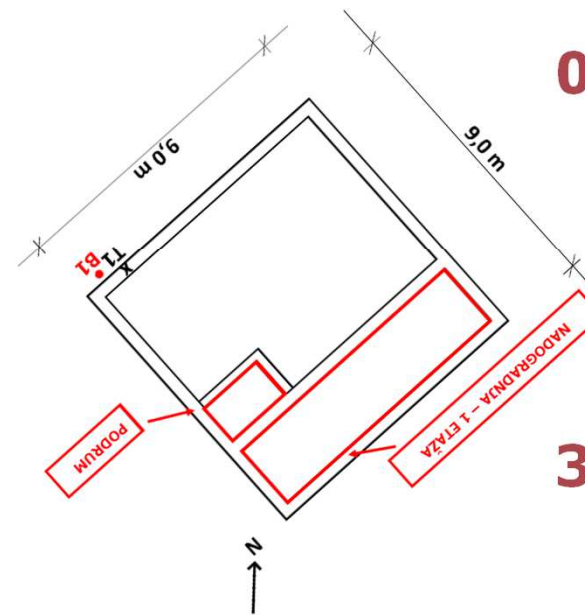
**Glina, Ul. 6 kolovoza 1995. br. 20, 12 km away**



map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

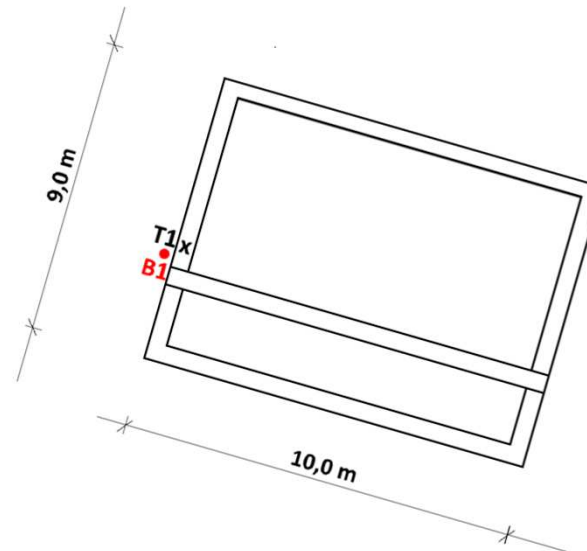
Sonja Zlatović for LIQUEFACT  
17.2.2021.

Glina, Ul. 6 kolovoza 1995. br. 20, 12 km away

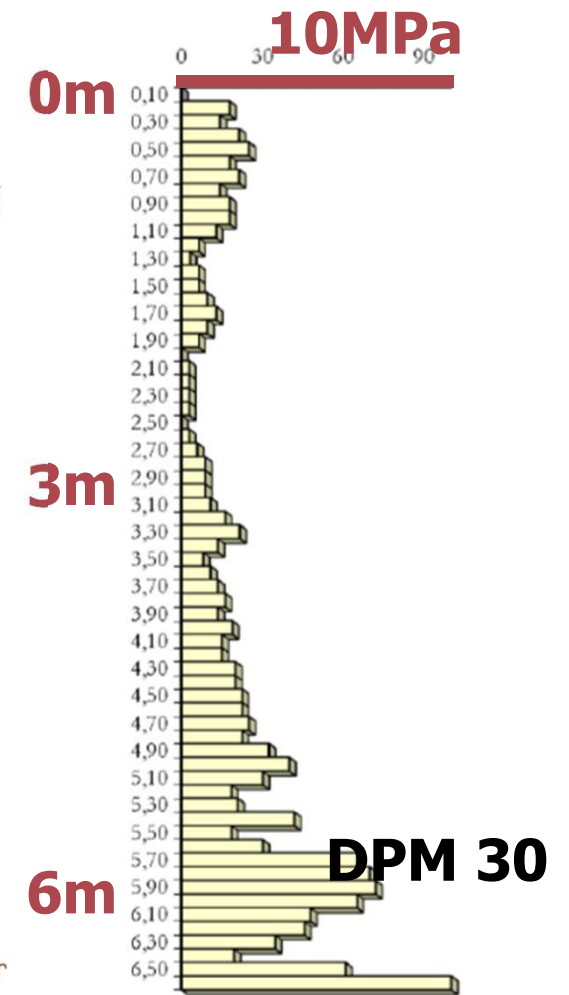


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[www.uretek.hr](http://www.uretek.hr) | [info@uretek.hr](mailto:info@uretek.hr)

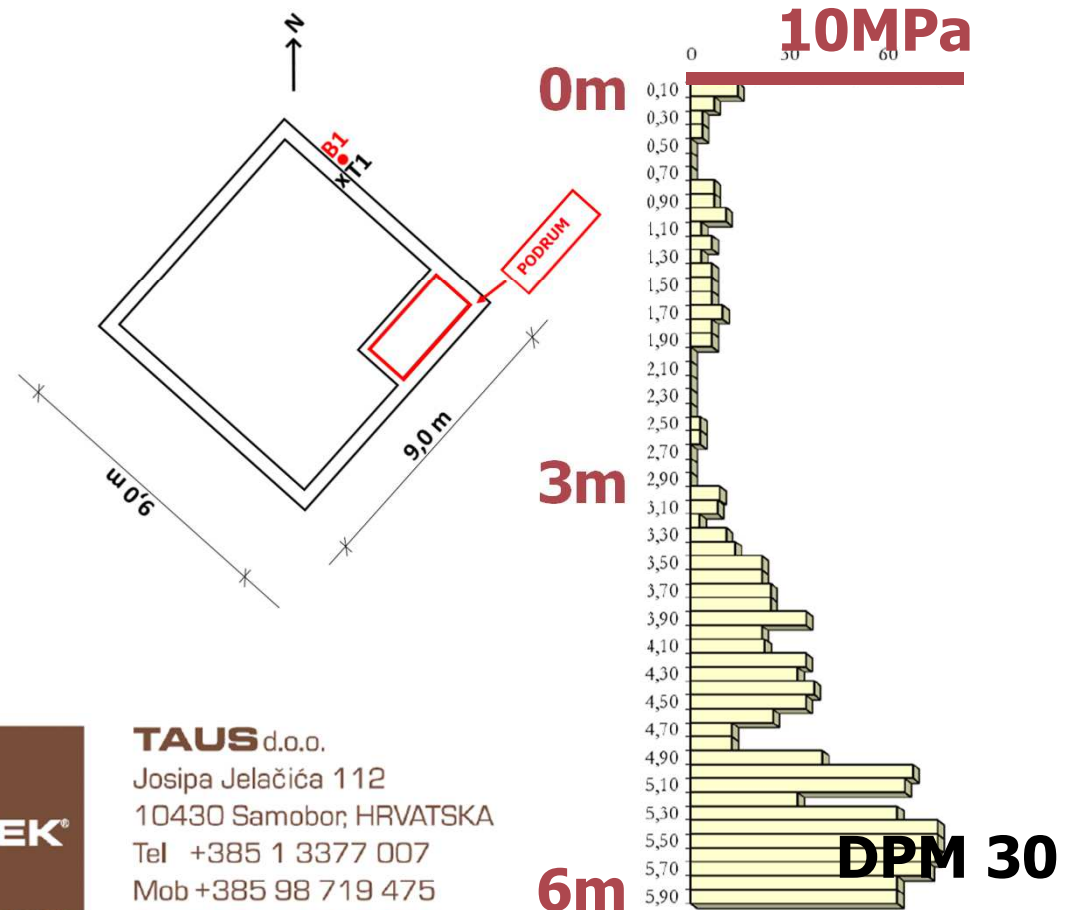
Glina, Ul. 6 kolovoza 1995. br. 35, 12 km away



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[www.uretek.hr](http://www.uretek.hr) | [info@uretek.hr](mailto:info@uretek.hr)

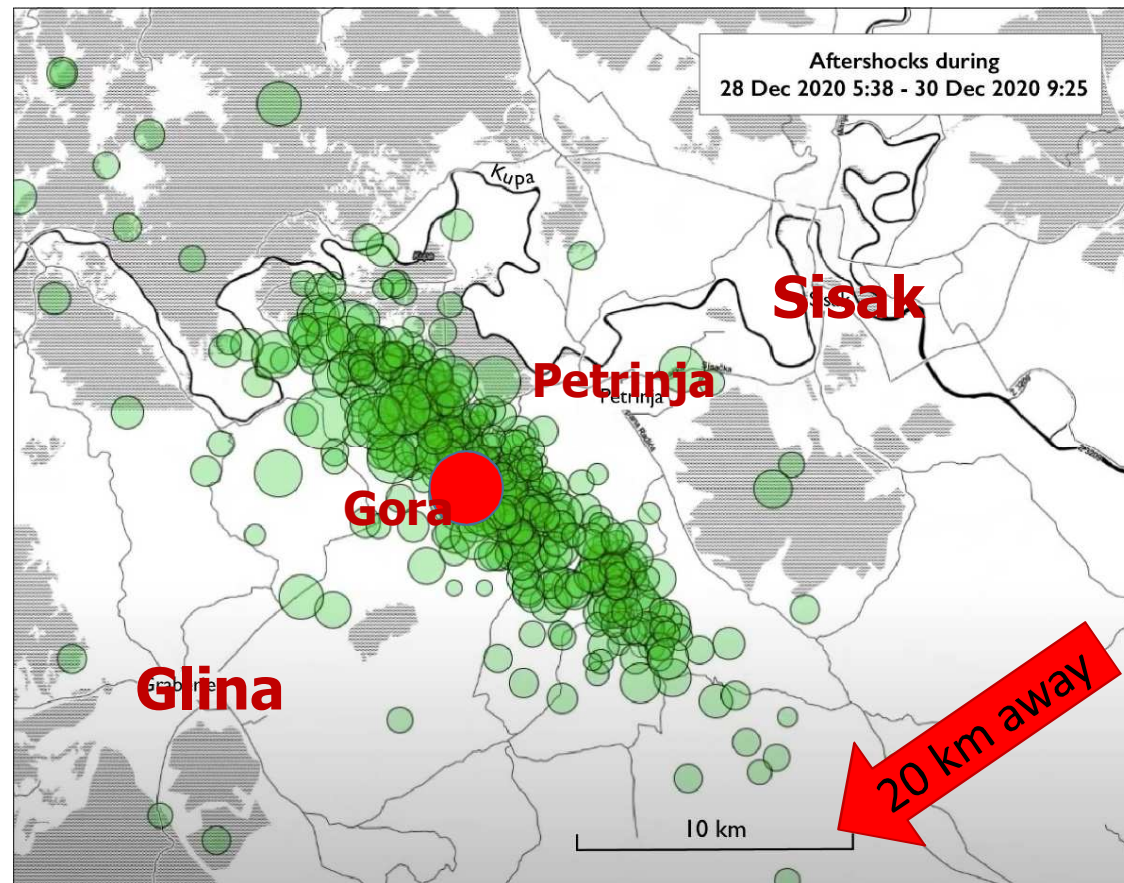


Glina, Ul. 6 kolovoza 1995. br. 25, 12 km away



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[www.uretek.hr](http://www.uretek.hr) | [info@uretek.hr](mailto:info@uretek.hr)

## Mečenčani



map: Seismological Survey of Croatia, Department of Geophysics, Faculty of Science,  
University of Zagreb [https://www.pmf.unizg.hr/geof/seizmoloska\\_sluzba/potresi\\_kod\\_petrinje?@=1m6am#news\\_118053](https://www.pmf.unizg.hr/geof/seizmoloska_sluzba/potresi_kod_petrinje?@=1m6am#news_118053)

Sonja Zlatović for LIQUEFACT  
17.2.2021.

**Petrinja 29.12.2020.**

**Mečenčani, 4.1.2021**



**Sonja Zlatović for LIQUEFACT**  
**17.2.2021.**

**Petrinja 29.12.2020.**

**Mečenčani, 15.2.2021., 20 km away**



**Sonja Zlatović for LIQUEFACT**  
17.2.2021.

**Petrinja 29.12.2020.**

**Mečenčani, 15.2.2021., 20 km away**



**Sonja Zlatović for LIQUEFACT**  
**17.2.2021.**

**more about the earthquake:  
preliminary report**

**DESIGNSAFE**



**<https://www.designsafe-ci.org/data/browser/public/designsafe.storage.published/PRJ-2959/#details-4541797621822058005-242ac118-0001-012>**

**soon:**

## **GEER REPORT**

**Ingrid Tomac, University of California San Diego**

**Sonja Zlatović, Zagreb University of Applied Sciences**

**Geotechnical Extreme Events Reconnaissance  
(GEER) Association**

**Petrinja 29.12.2020.**

**Kupa river near Petrinja**

**Thank you for your attention**



**Sonja Zlatović for LIQUEFACT**  
**17.2.2021.**