Seismicity, earthquake and strong motion records of Kermanshah earthquake M 7.3, Iran

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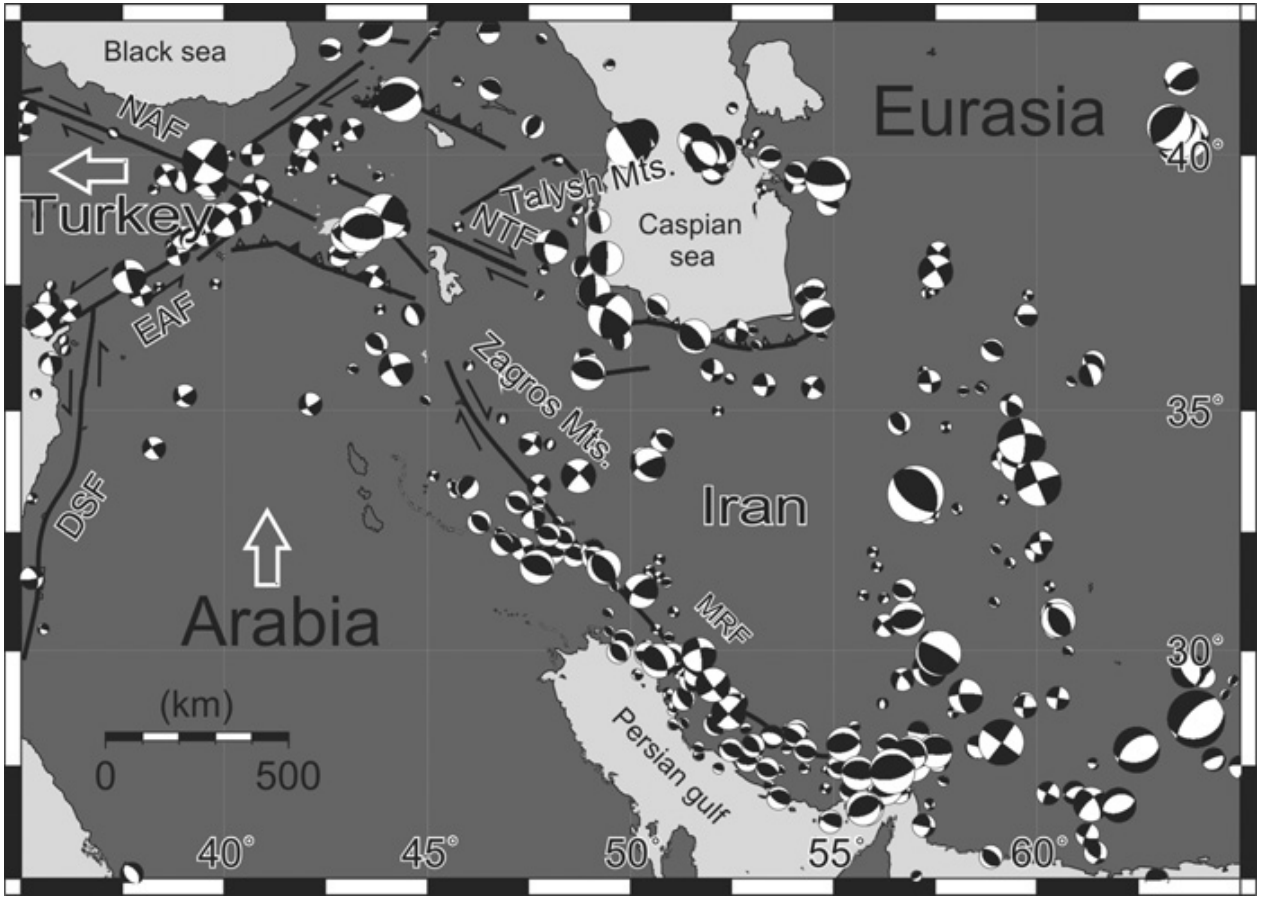
Seismic activities in Iran

- Interaction of Arabia and Eurasia plates
- The study area is located on Zagros thrust belt.



Seismicity and Earthquake

- The event occurred in Zagros seismotectonic zone and shook western regions of Iran;

- Zagros zone formed in the foreland of collision between the Arabian Plate and the Eurasian Plate;

- This event with Mw 7.3 (GCMT) was the biggest earthquake in the Zagros zone (depth ~ 24 km);

- Mechanism solution shows a thrust fault with a dip angle of 10 degree;

- After instrumental era (1900 to 2017), two earthquakes with magnitudes 5.1 and 5.4 have been recorded;

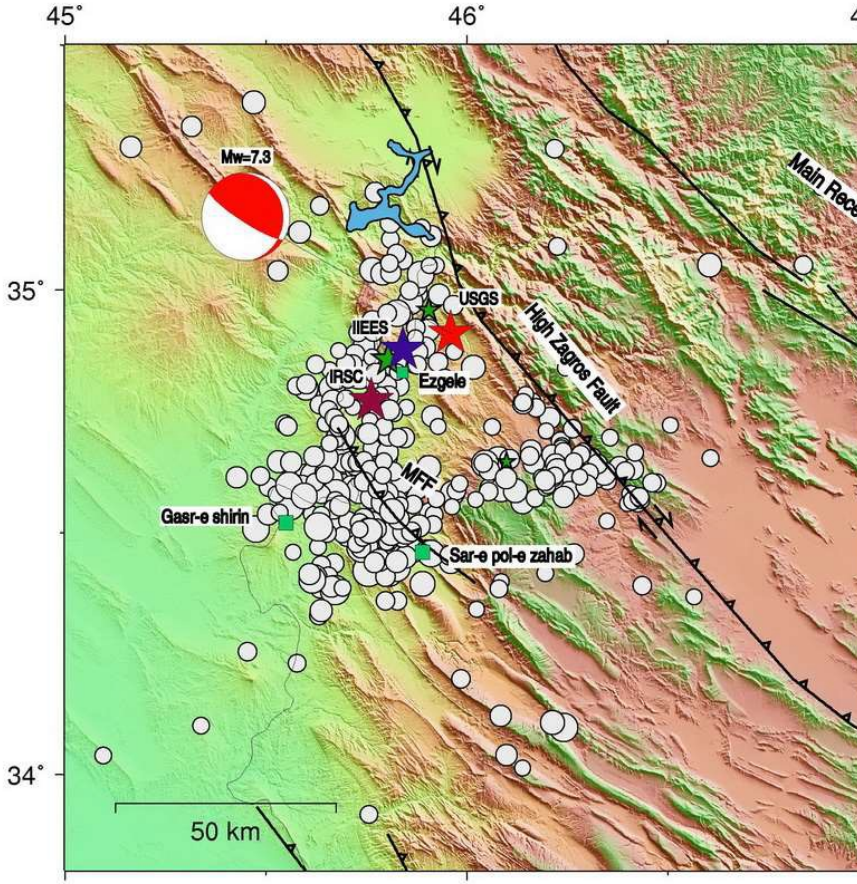
Seismicity and Earthquake

- One foreshock with magnitude of 4.3 reported an half hour before the main shock;
- As of 11 January 2018, there have been 598 aftershocks in magnitude range of 2.5 to 5.4;
- Wide distribution of aftershocks confirms low fault dip angle and a thrust mechanism

Selected Cities Exposed

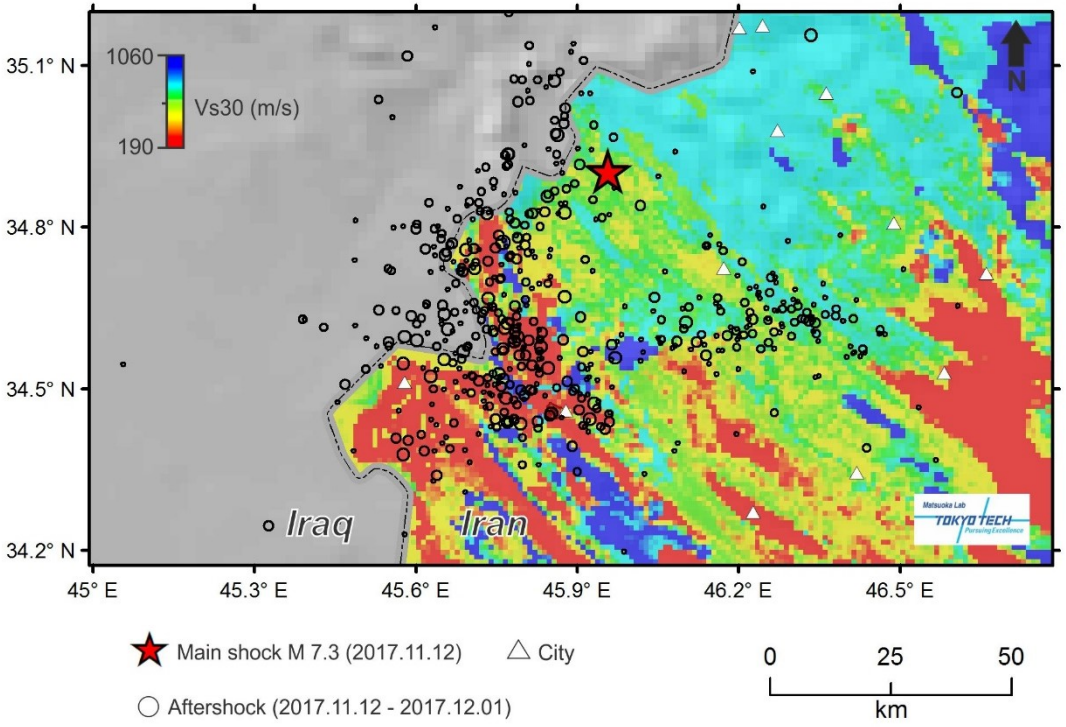
MMI	City	Pop.
VIII	Derbendixan	<1 k
VIII	Tazehabad	<1 k
VII	Halabjah	57 k
VII	Seyid Sadiq	<1 k
VII	Qasr-e Shirin	<1 k
VII	Halabjah al Jadidah	<1 k
V	Erbil	933 k
V	Baghdad	7,216 k
V	Tabriz	1,425 k
IV	Mosul	1,740 k
III	Qom	900 k

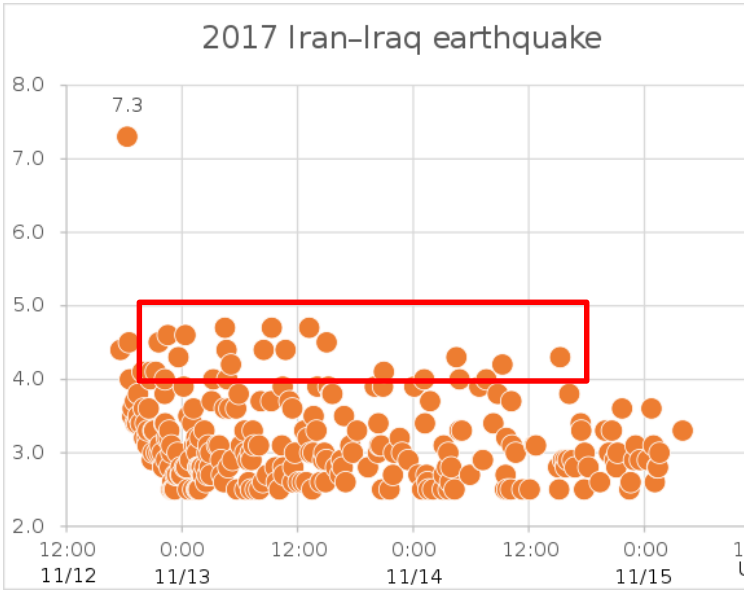
From GeoNames Database of Cities with 1,000 or more residents (k = x1,000)



Aftershocks overlaid on Vs30 map

- Vs30 proxy map of Iran together with location of the main shock, aftershocks and cities. Apparently, majority of the affected cities near the epicenter are located in soft soils with rather low Vs30.
- There are more than 10 aftershocks larger than 4.0 within a few days after the main shock.





Historical earthquakes

- According to the historical earthquake catalogue of Iran gathered by Ambraseys and Melville, the region had been experienced at least two earthquakes in 958 and 1150 AD.

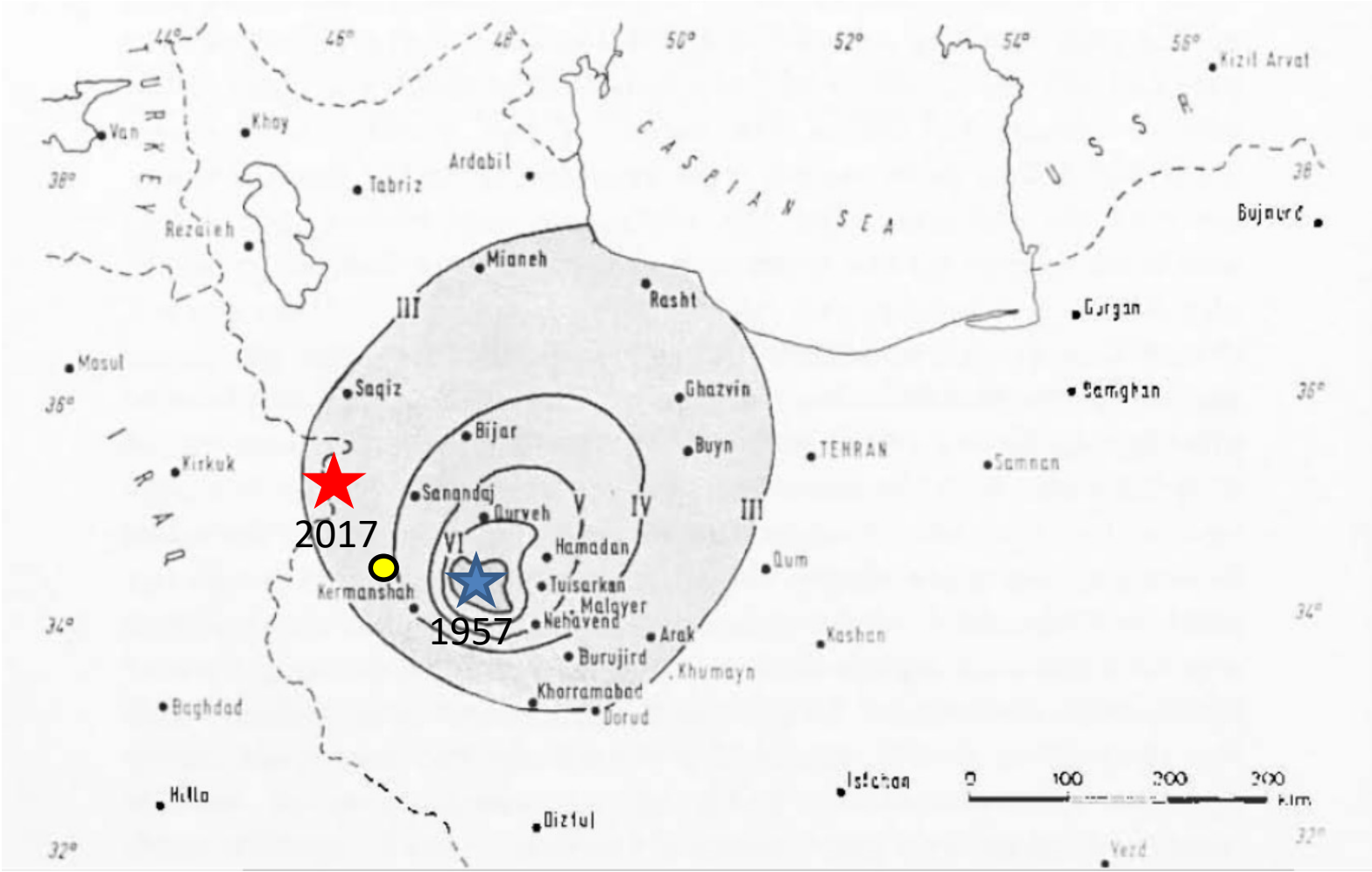
- In addition, one major event in this region is Farsinaj earthquake of 13 December 1957, Ms7.1 which was calculated from 17 stations.

- This earthquake caused heavy damages within an area of 2800 square kilometers in which 1119 people were killed and 900 injured and 15000 left homeless.

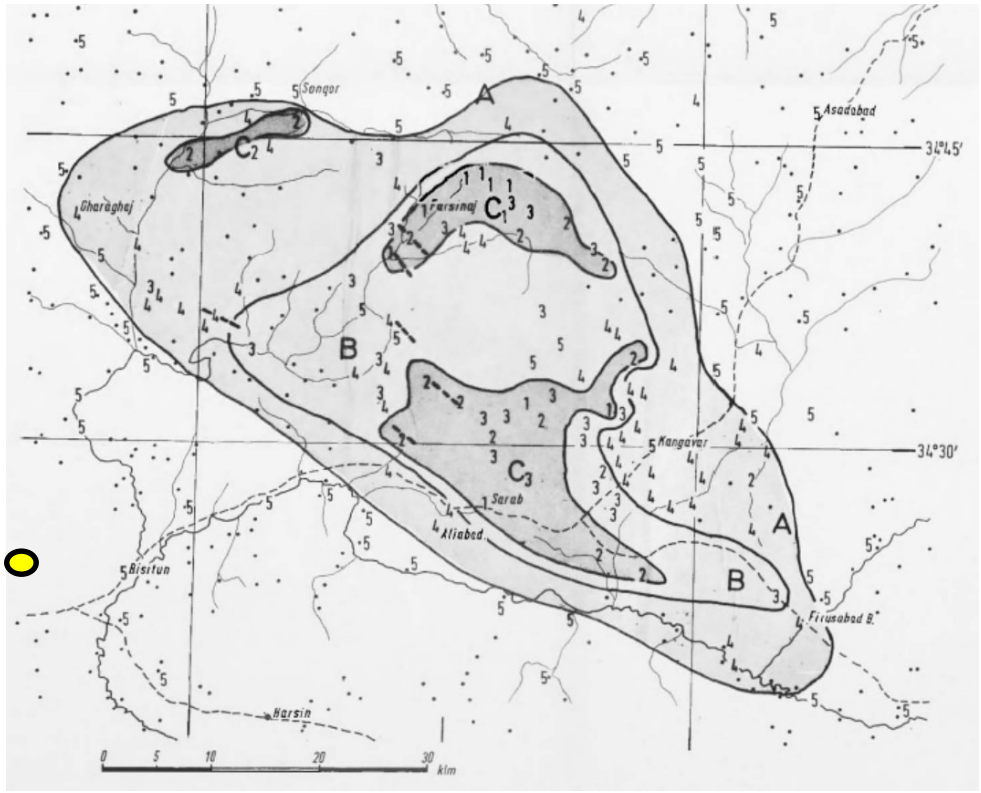
- The Farsinaj earthquake ruined more than 5000 house (abode materials) units out of 9000 existed house in the Kermanshah region.

Historical earthquakes

- Focal depth of the Farsinaj earthquake was 35 km, in the border of Kermanshah and Kurdistan provinces.
- The affected area lies between 1500 and 2500 meters above sea level



Historical earthquakes



- Damage map. Numerals show location of the affected villages and degree of damage. 100% of adobe buildings destroyed or damaged beyond repair. Dots indicate sites not damaged or uninhabited at time (Ambraseys and Melville).
- Dashed line indicate location and approximate extent of ground deformation. Thin dashed line are the roads.

Historical earthquakes

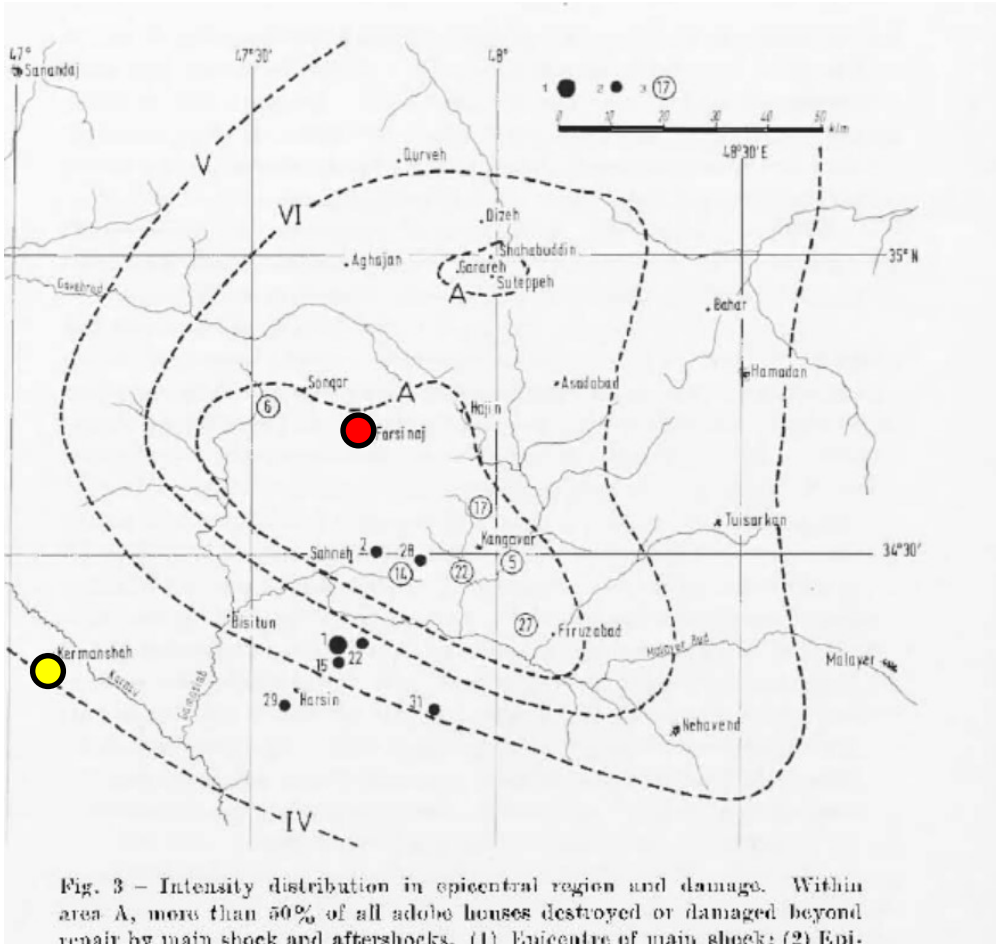


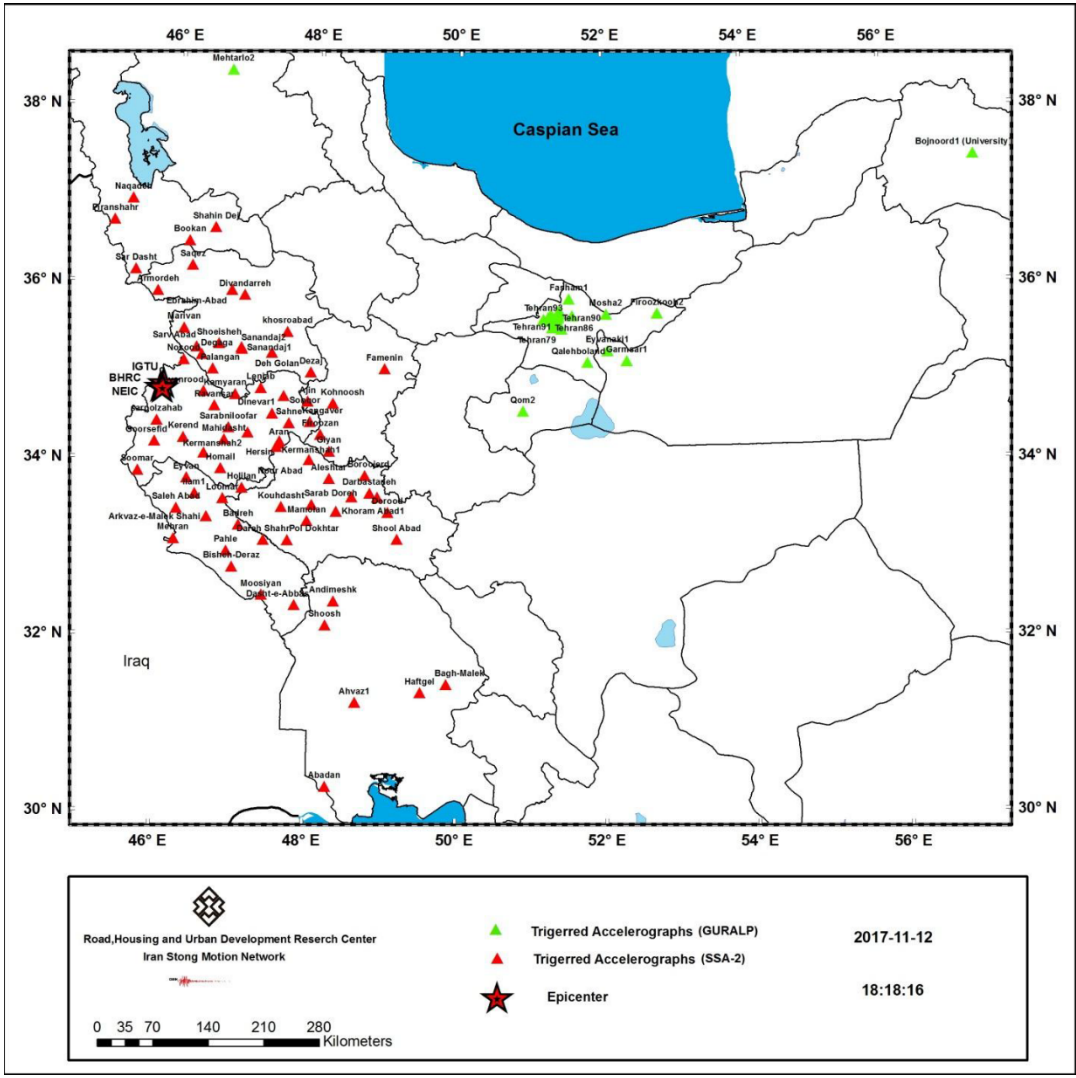
Fig. 3 – Intensity distribution in epicentral region and damage. Within area A, more than 50% of all adobe houses destroyed or damaged beyond repair by main shock and aftershocks. (1) Epicentre of main shocks; (2) Epi-

- Intensity distribution of Farsinaj earthquake. Within area A more than 50% of the adobe houses destroyed or damaged beyond repair.

Seismographs

- The motion has been recorded on 110 stations;

SSA-2 permanent instrument along with the temporary CMG5TD instrument (source: BHRC)



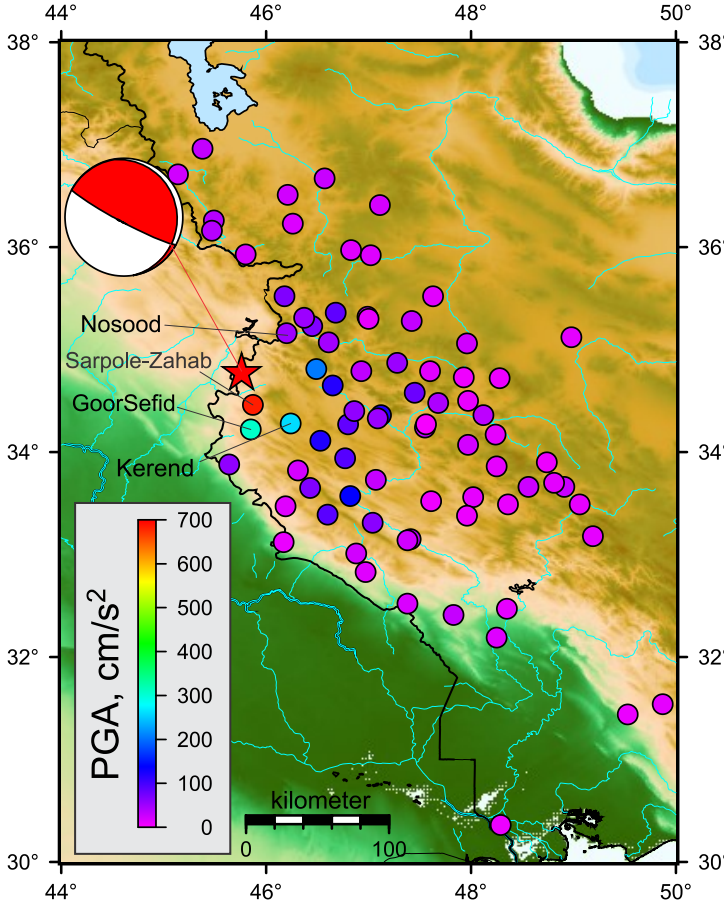
Seismographs

- The highest recorded PGA:
  Sarpole-Zahab station, epicentral distance= 39 km
  (L=681 gal, T= 562 gal, V=404gal);

- The second highest PGA:
  GooeSefid station, epicentral distance= 66 km
  (L=309 gal, T=277 gal, V= 233 gal);

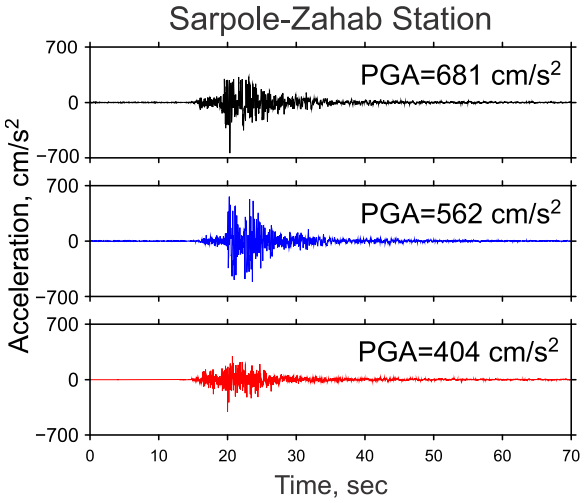
- The third highest PGA:
  Kerend station, epicentral distance= 66 km
  (L=195 gal, T= 261 gal, V=180 gal);

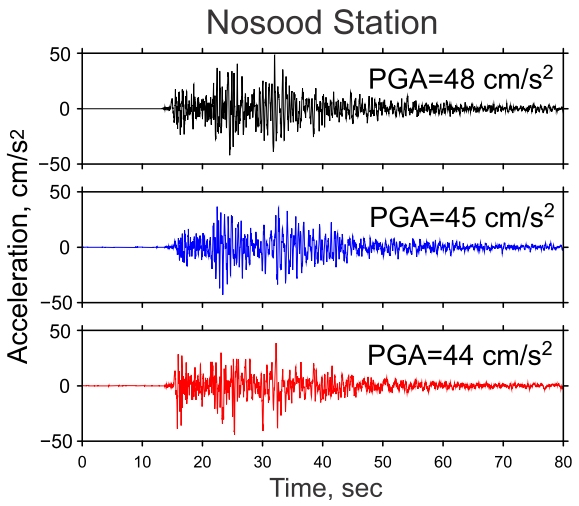
- Distribution of destructions is from epicenter to Sarpole-Zahab, GooreSefid and Kerend cities;



Seismographs

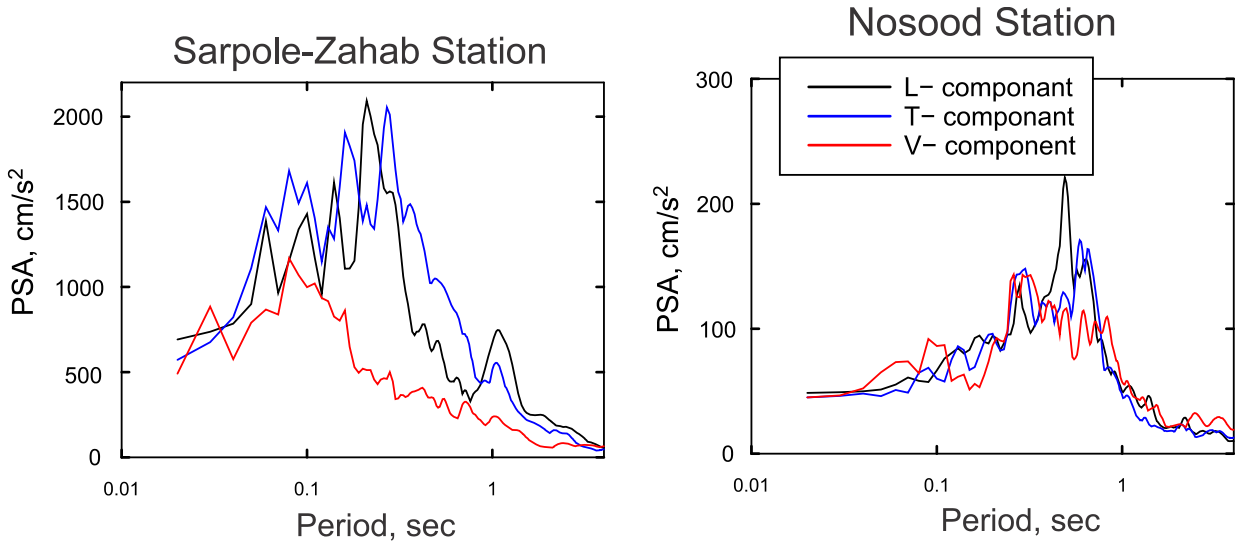
- Seismic waves were propagated from north to south; two isolated wave packets.
- Choosing Sarpole-Zahab (in the south) and Nosood (in the north) stations to investigate rupture directivity effect;
- Sarpole-Zahab station in forward direction:
  Epicentral distance: 39 km
  PGA; L=681 gal, T= 562 gal, V=404 gal
  Max. significant duration: 11 sec, major part of energy released in 11 seconds.
- Nosood station in backward direction:
  Epicentral distance: 47 km
  PGA; L=48 gal, T= 45 gal, V=44 gal
  Max. significant duration: 30 sec





Seismographs

- Pseudo spectral acceleration (PSA) plots show that the predominant ground shaking is with a period of 1sec or less;
- There are not many long-period components in the near-fault ground motions;
- This period range usually affects the 2 to 6 stories structures;
- Peak values of PSA at stations in the forward direction (Sarpole-Zahab) are much larger than those in the backward direction, showing a strong rupture directivity effect;



Thank you!