Central Italy Earthquakes of 2016

Dr. Michael L. Blanpied
USGS Earthquake Hazards Program
mblanpied@usgs.gov

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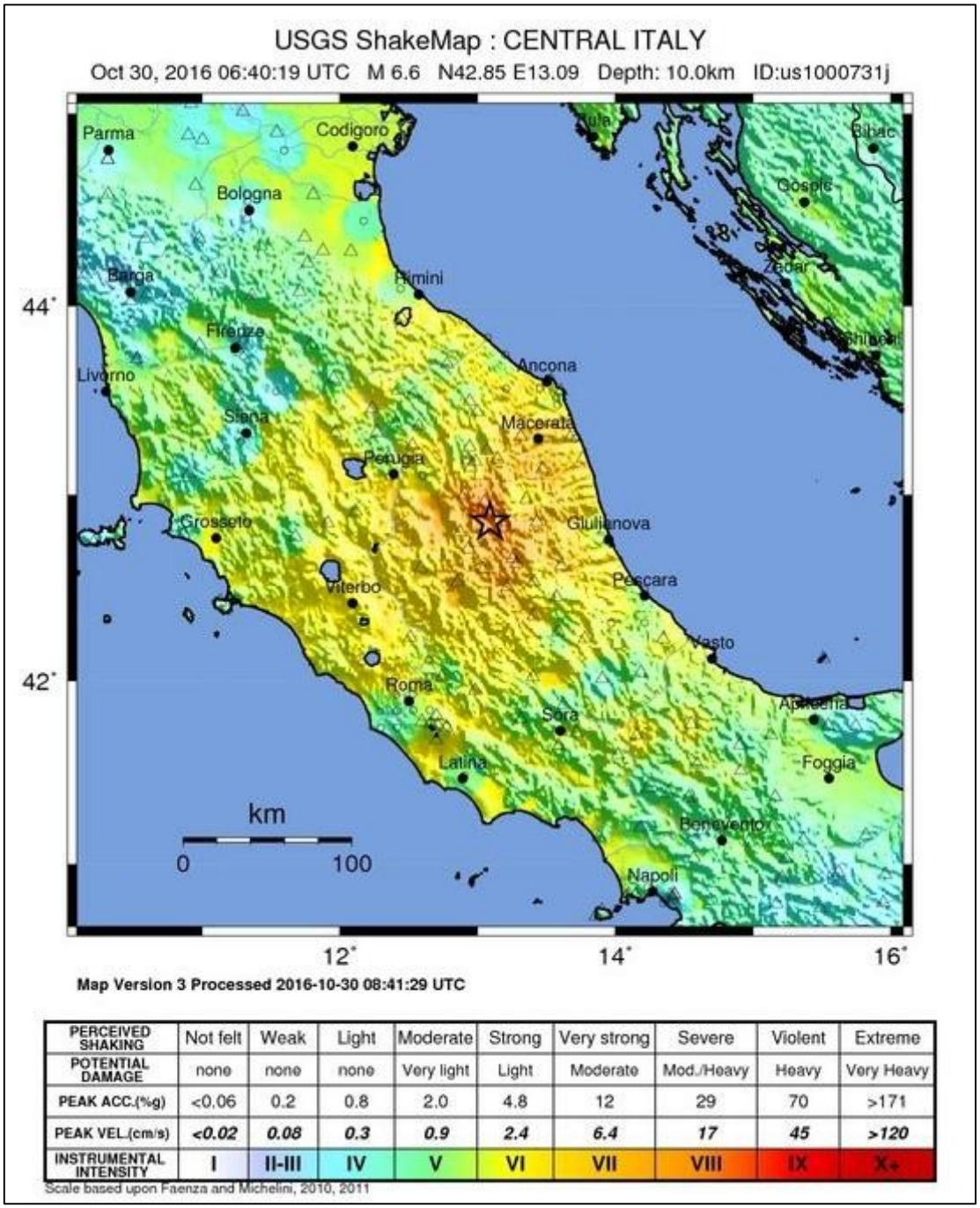
NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM

2016 Central Italy Earthquakes

- Sequence of earthquakes began in August, 2016.
- August 24 M6.2 killed ~300, severe damage to Amatrice.
- Vigorous aftershock sequence.
- October 26 M6.1 and October 30 M6.6 caused further widespread damage.
- Aftershocks continue.
- Faulting involves extensional slip on known faults of the central Apennines.
- Earthquakes are striking a high-hazard area with long history of damaging earthquakes.



2016 Central Italy Earthquakes

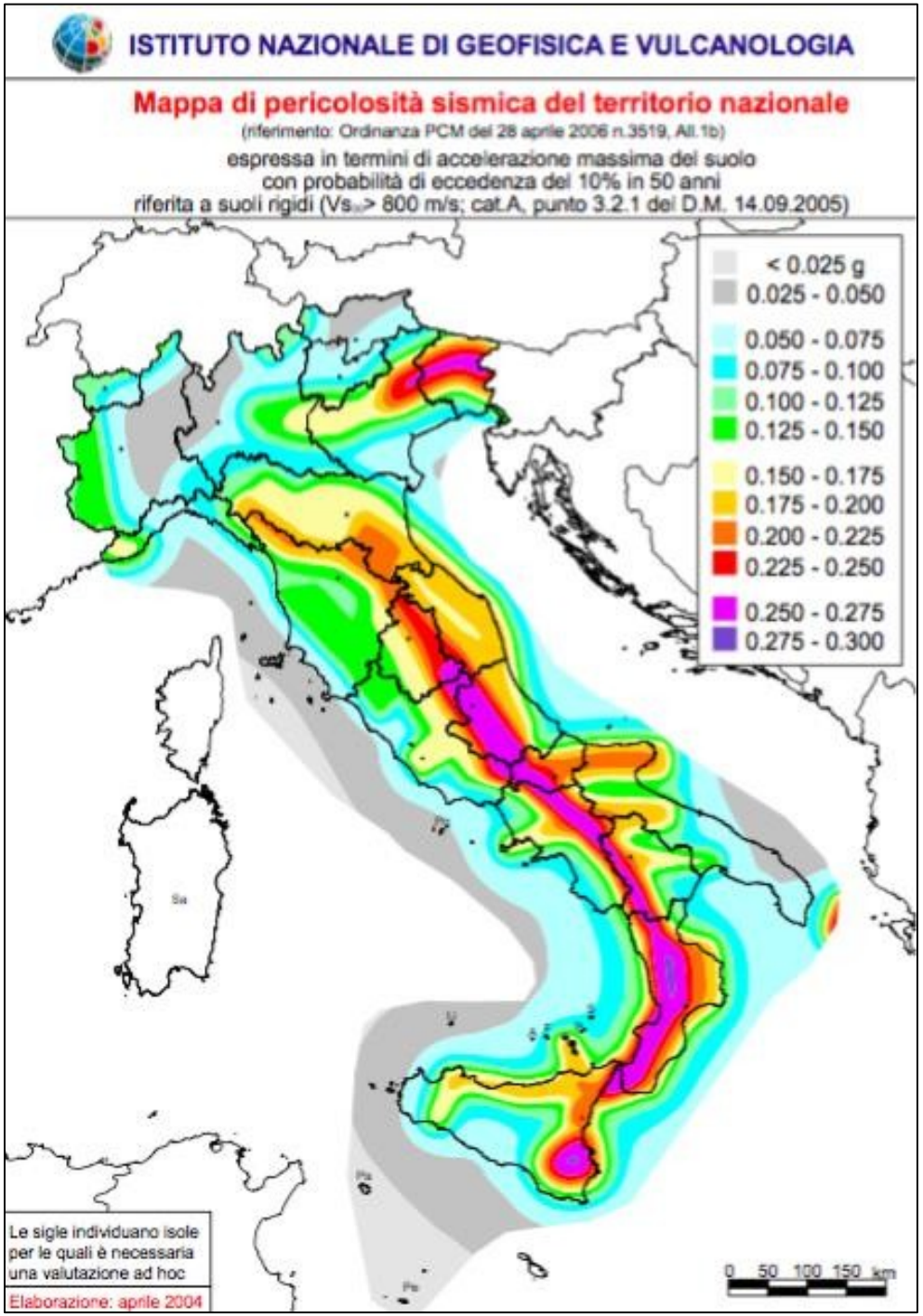
Image frame from YouTube video

2016 Central Italy Earthquakes

- Earthquakes have caused severe damage to unreinforced masonry structures, including many dating from ~1200 to ~1970.
- New and retrofitted structures have generally fared well.
- Following the deadly M6.2 earthquake of August 24, residents have avoided damaged structures and “red zones”, and have temporarily abandoned weak structures following larger earthquakes.

Italy's seismic hazard map

- Probabilistic seismic hazard map updated in 2006.
- Provides basis for seismic provisions in Italy's building code.
- Densely populated country has innumerable vulnerable structures, many with historic significance.



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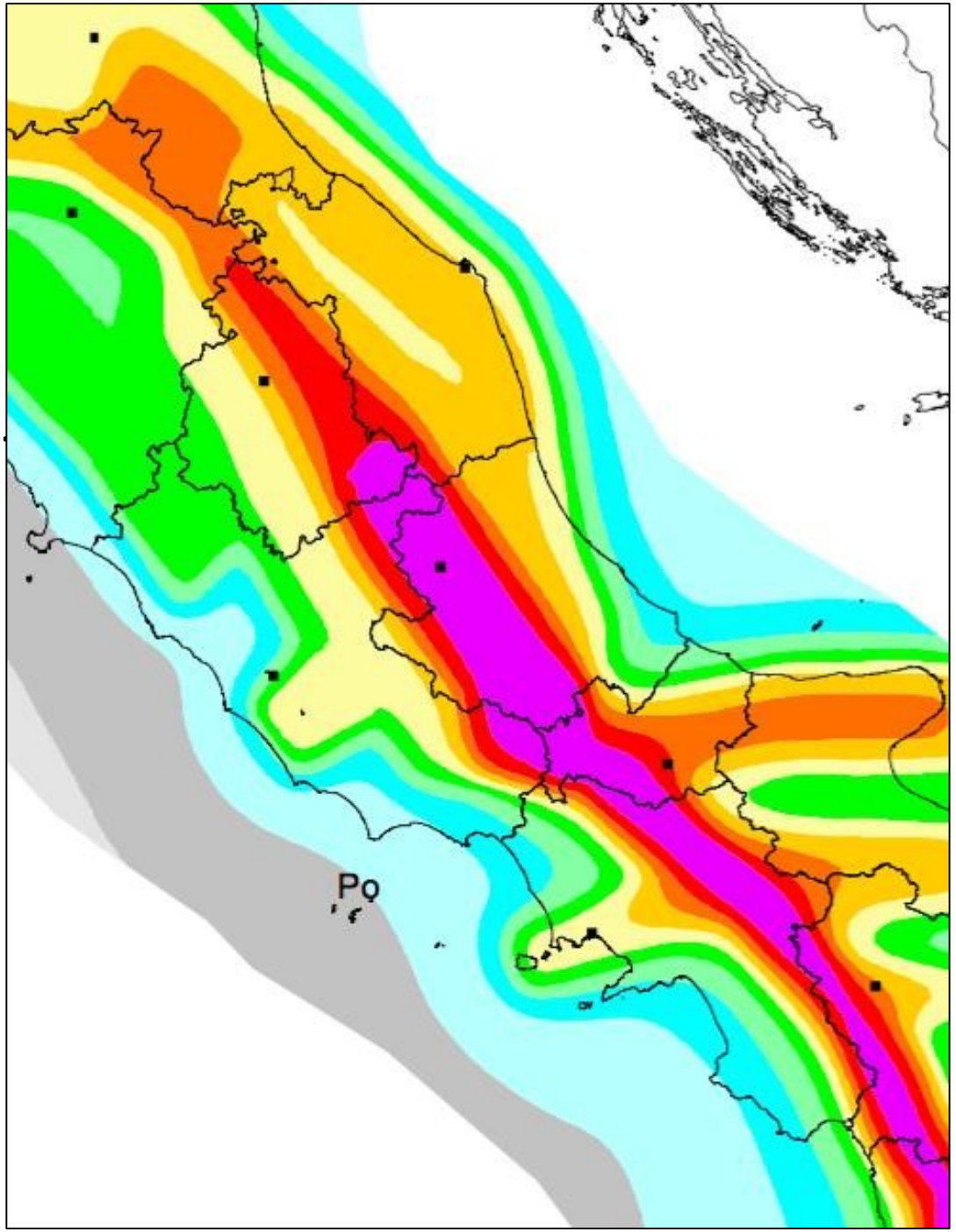
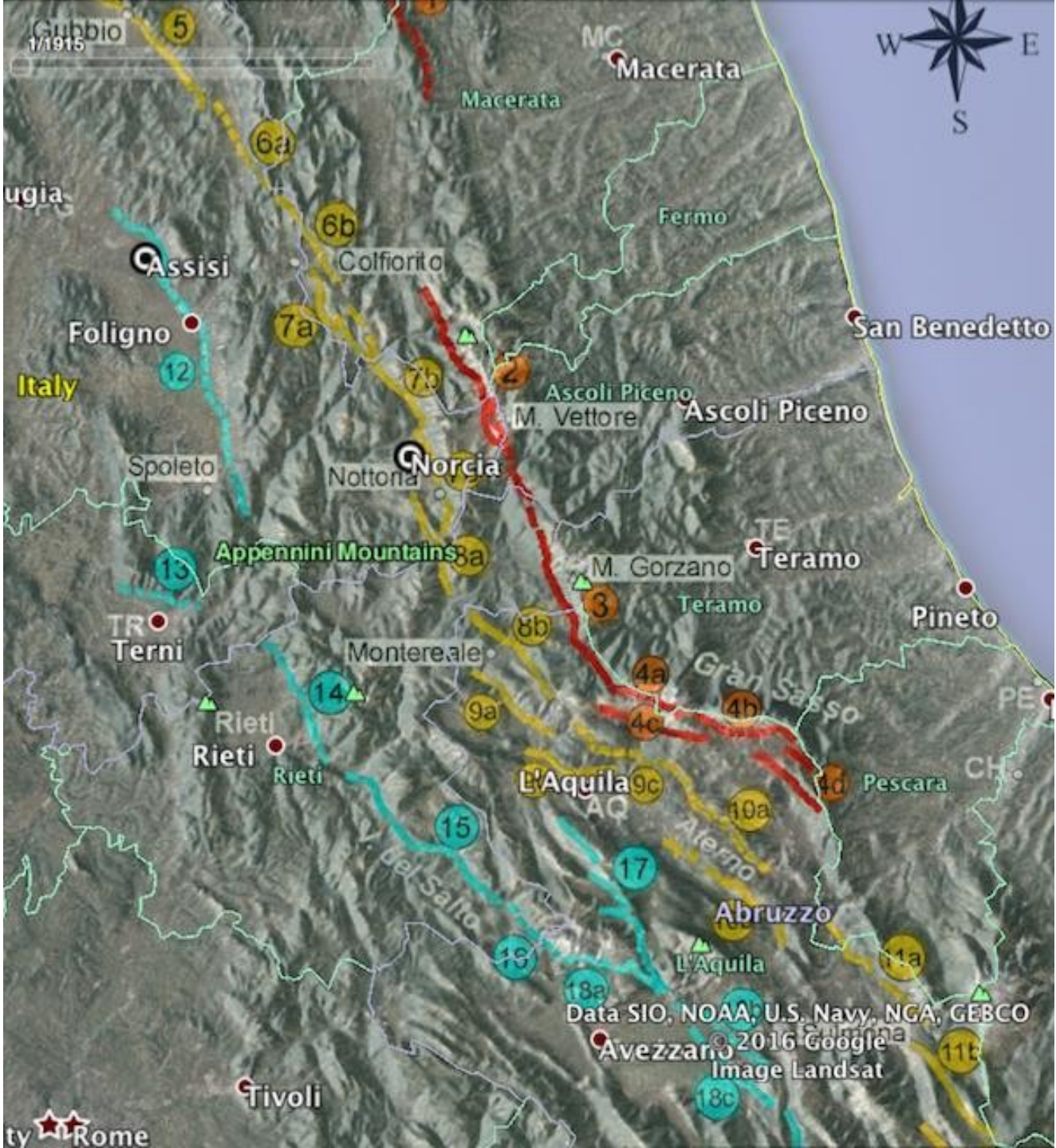


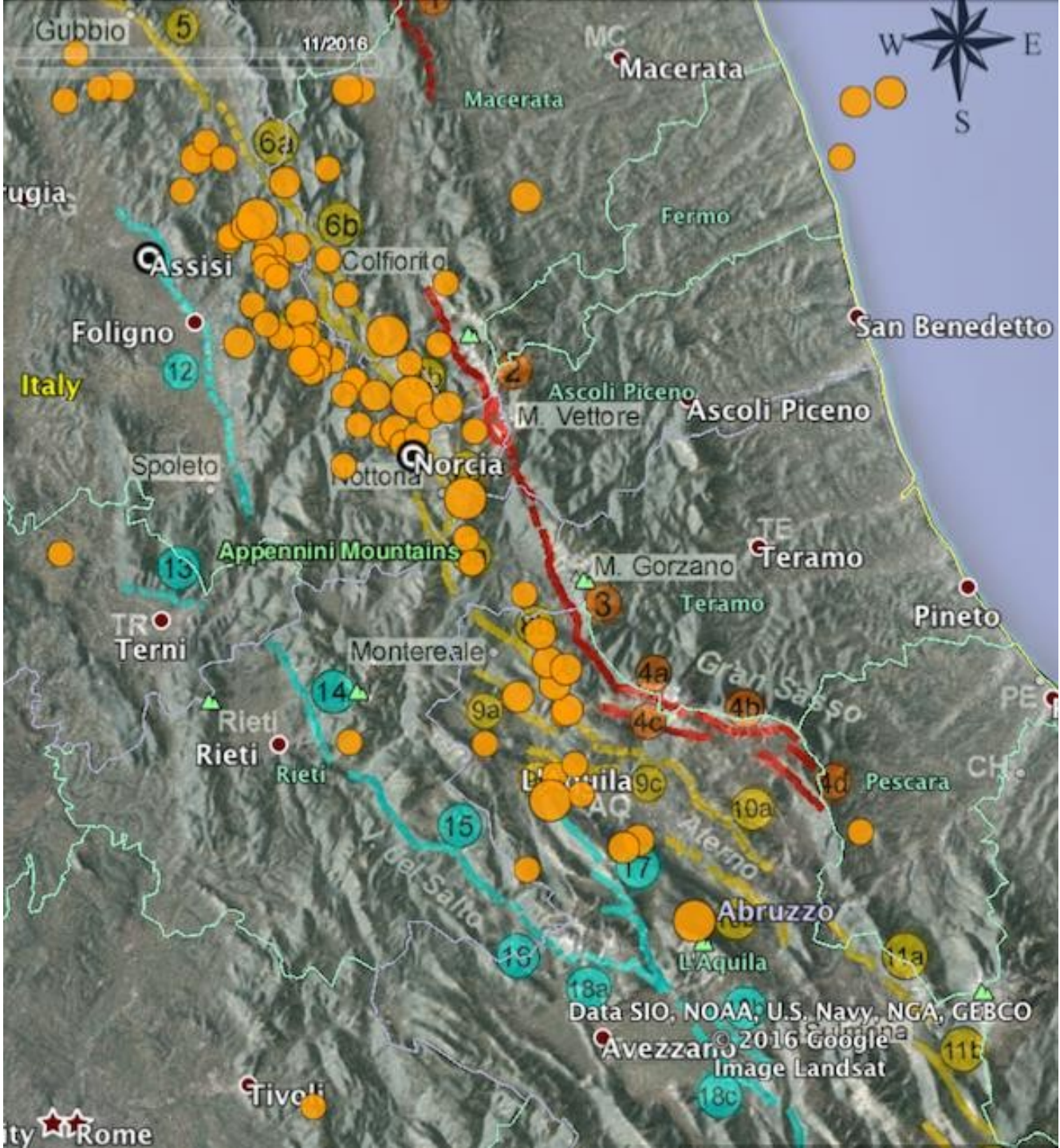
Central Italy earthquakes

- Colored lines show active faults of central Italy.
- Three sub-parallel belts of extensional faults follow the Apennines.
- Used in INGV seismic hazard model.



Central Italy earthquakes

- Map shows earthquakes M≥4.5 since 1915.
- Earthquakes up to M~6.7 have broken numerous segments of the yellow and red fault zones.
- Complex geological structure and youthful faults are thought to prevent the through-going rupture that would create M7+ quakes.



Central Italy Earthquakes

Monte Vettore and the Castellucio valley, east of Norcia

Photo by Michael Blanpied, 2016

Central Italy Earthquakes

- Fault offset from M6.6 October 30 earthquake.

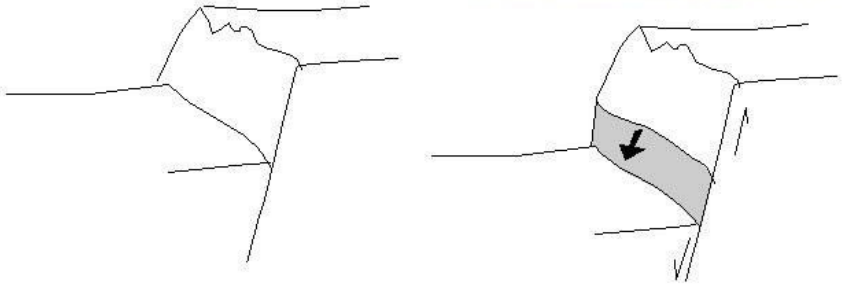


Photo by Francesca Cinti, INGV

Central Italy Earthquakes

- Dots are reports of impacts from earthquakes near Norcia since 1328.
- Active tectonic deformation causes slip on a complex network of faults (black lines).

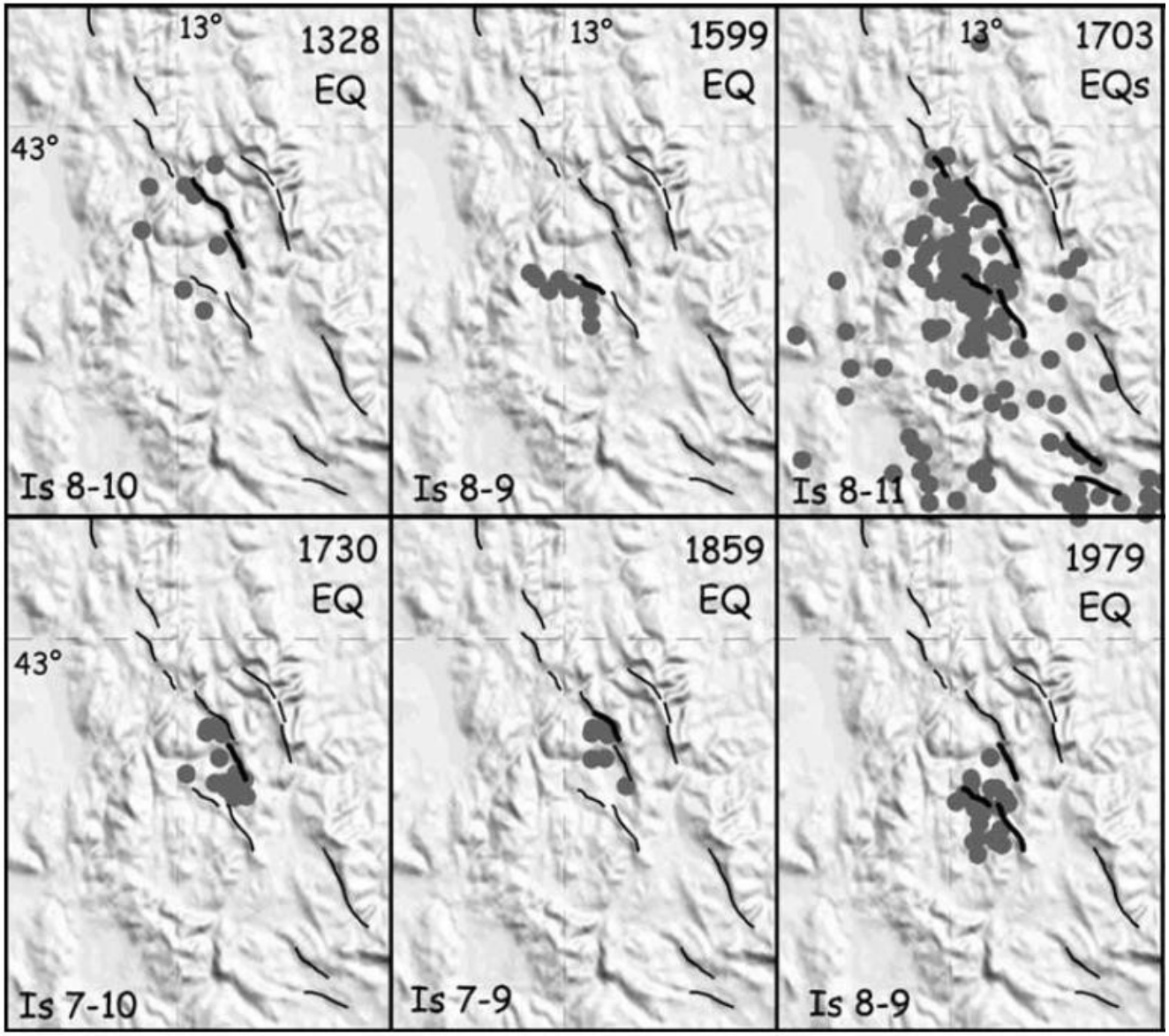
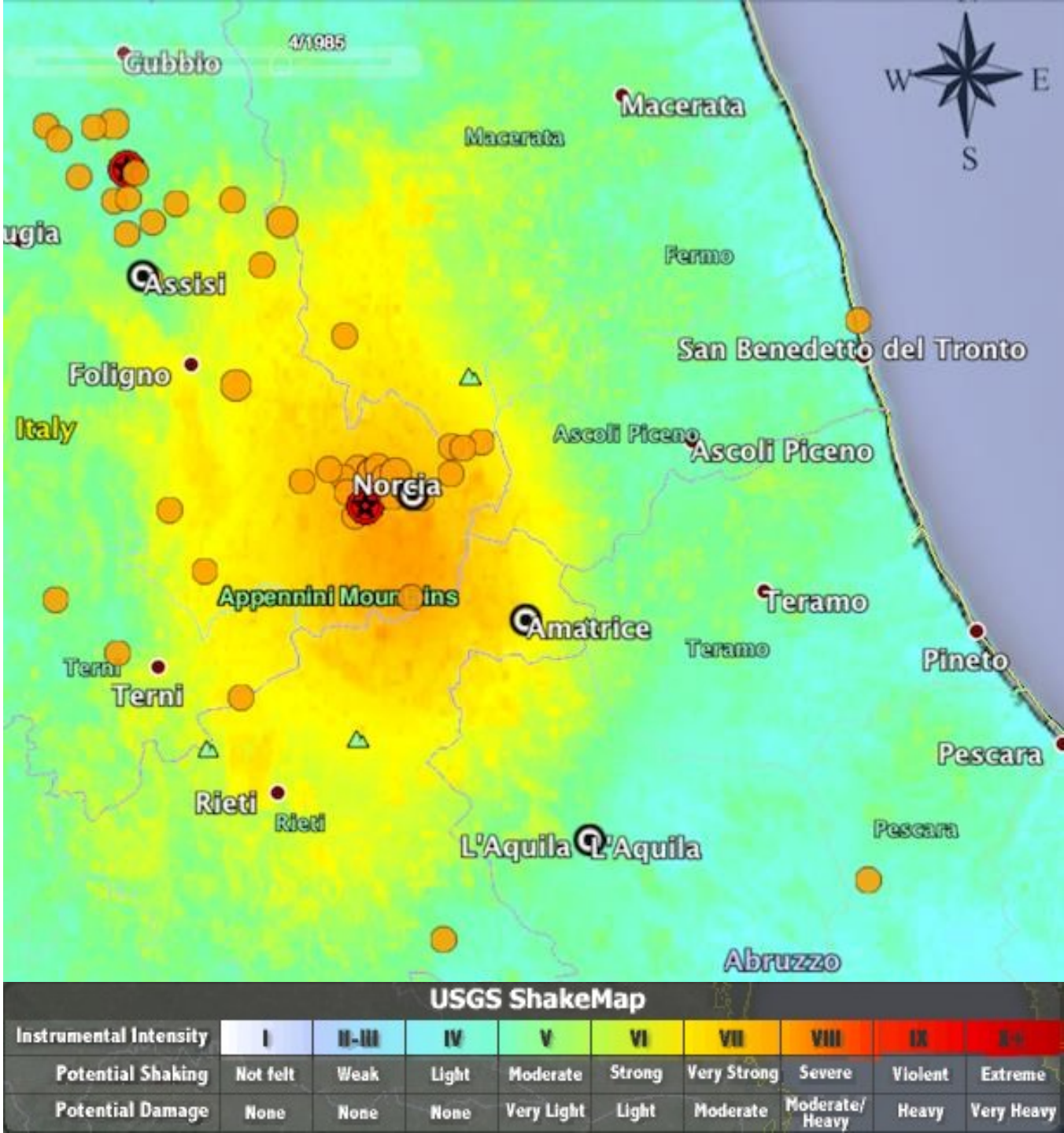


Figure from Galli et al., Tectonophysics, 2005

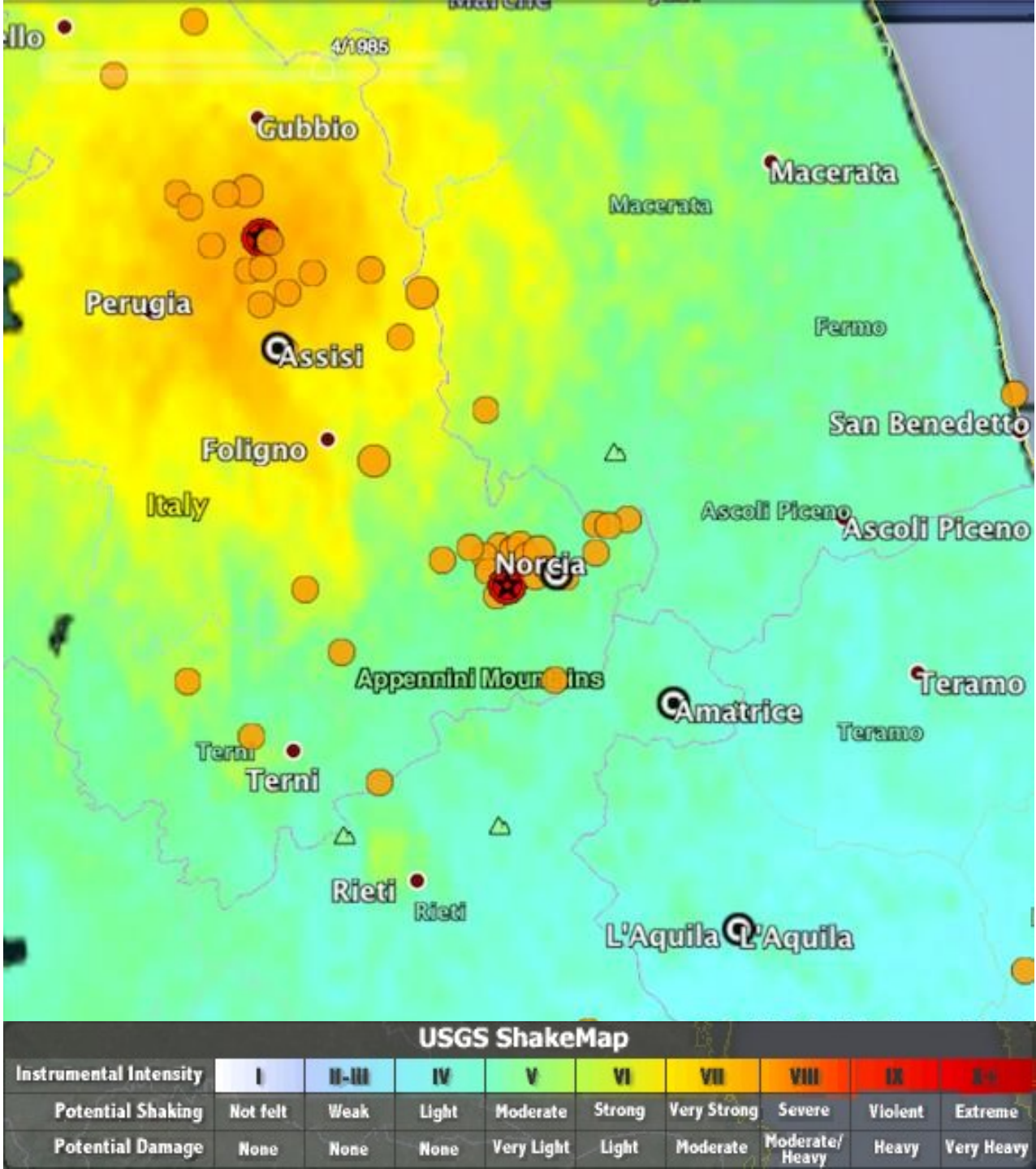
Central Italy earthquakes

- M5.9 Norcia earthquake of September 1979.
- Five deaths and extensive damage.



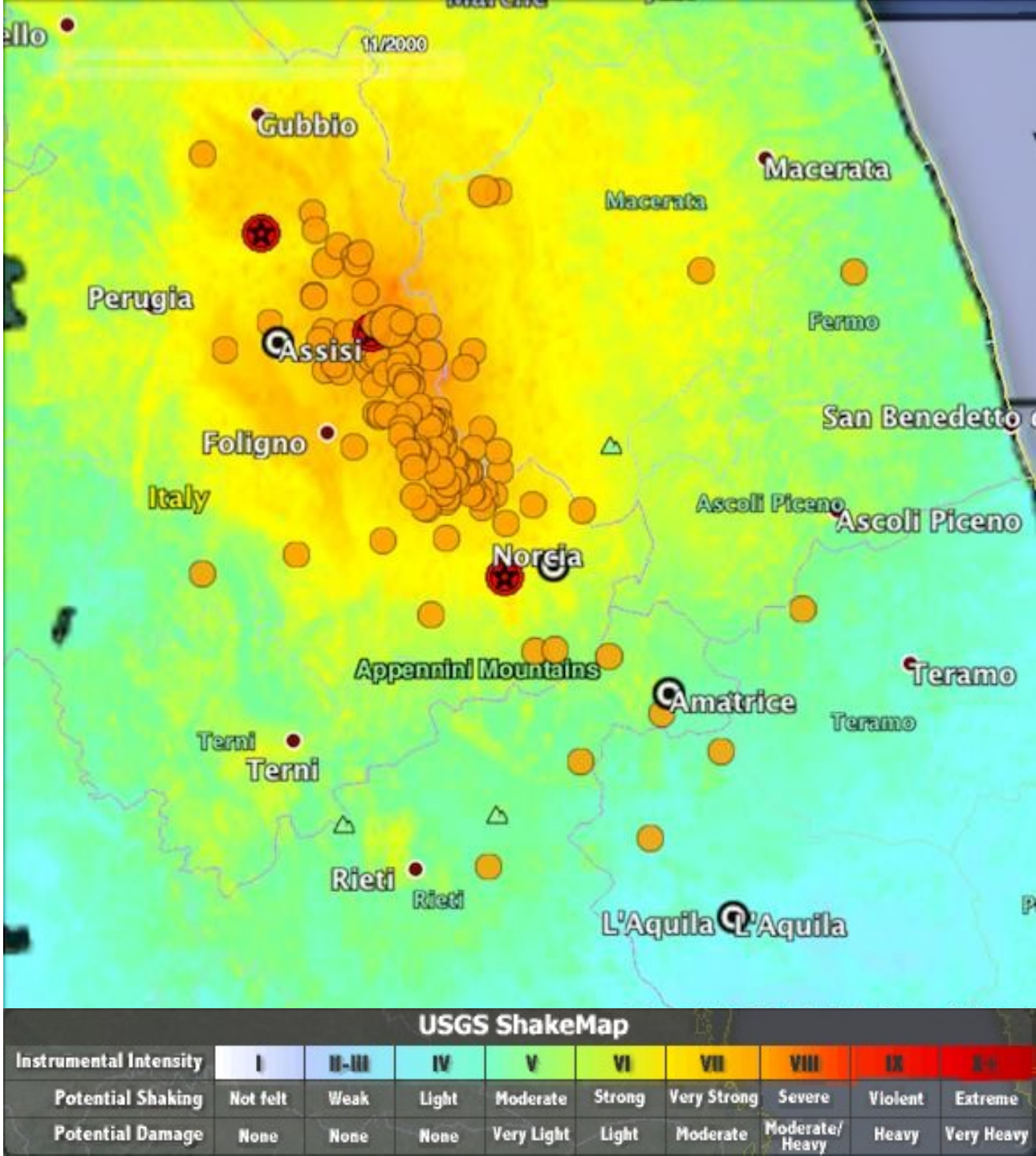
Central Italy earthquakes

- M5.7 earthquake of April 1984.
- Damage in Assisi, Norcia and Gubbio.
- Many injuries.



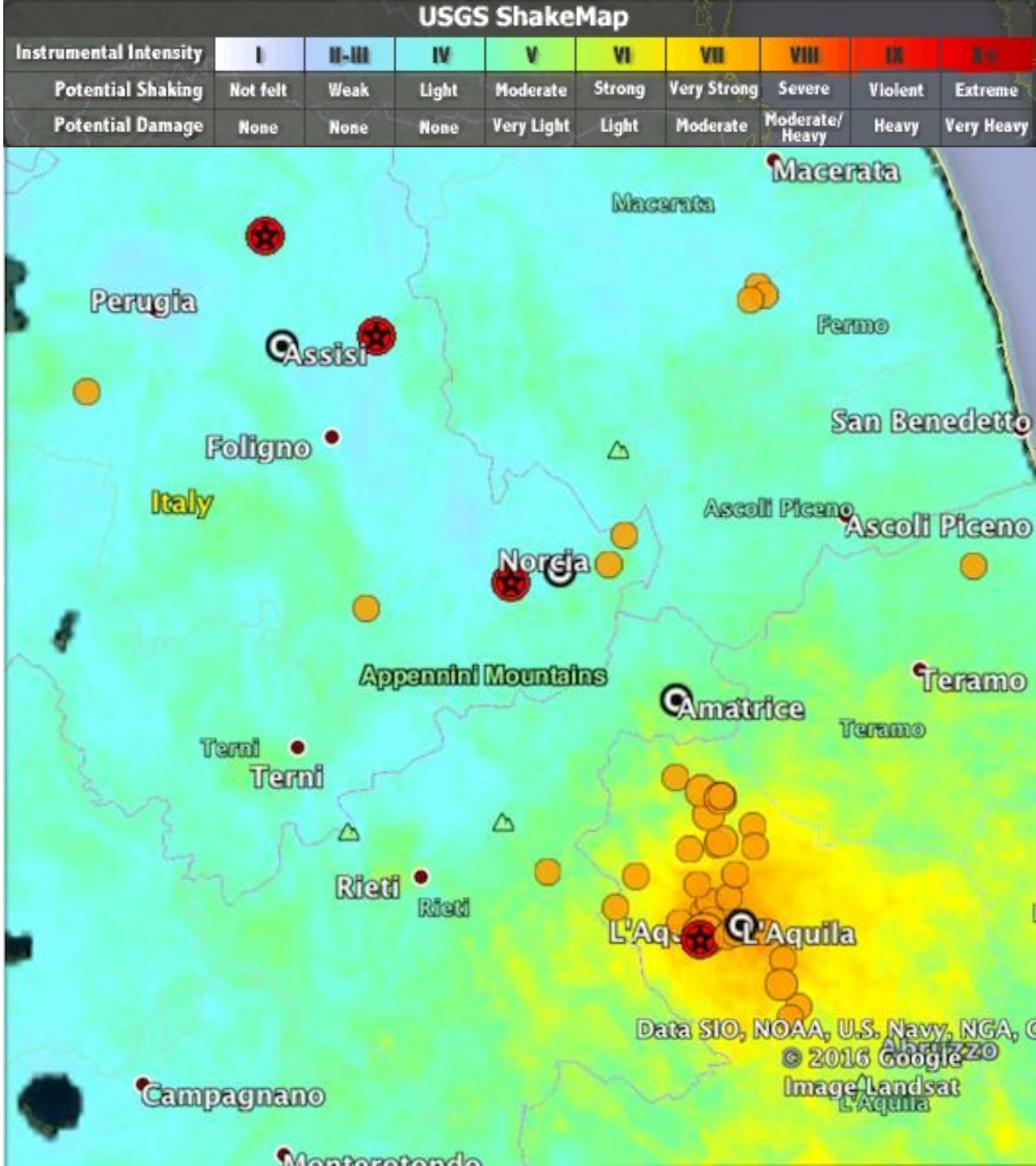
Central Italy earthquakes

- Many earthquakes in 1997, including M6.0 near Assisi.
- Caused ten deaths and widespread damage.
- Basilica of St. Francis was partially collapsed.



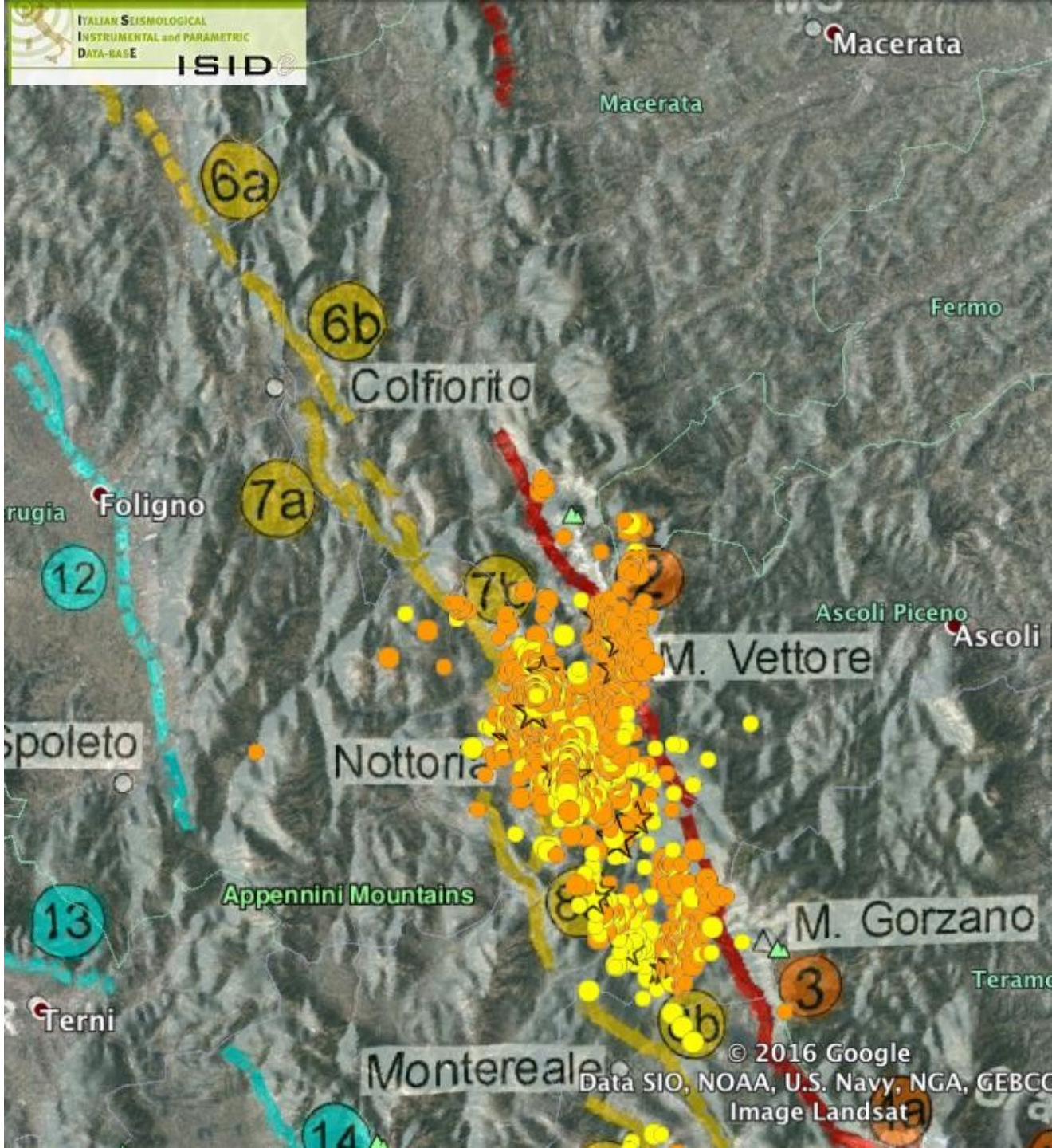
Central Italy earthquakes

- M6.3 L'Aquila earthquake.
- Caused ~300 deaths.
- Led to indictment of scientists of the Grand Risks Commission and an official from the Department of Civil Protection, for insufficient communication of earthquake risks.



Central Italy earthquakes

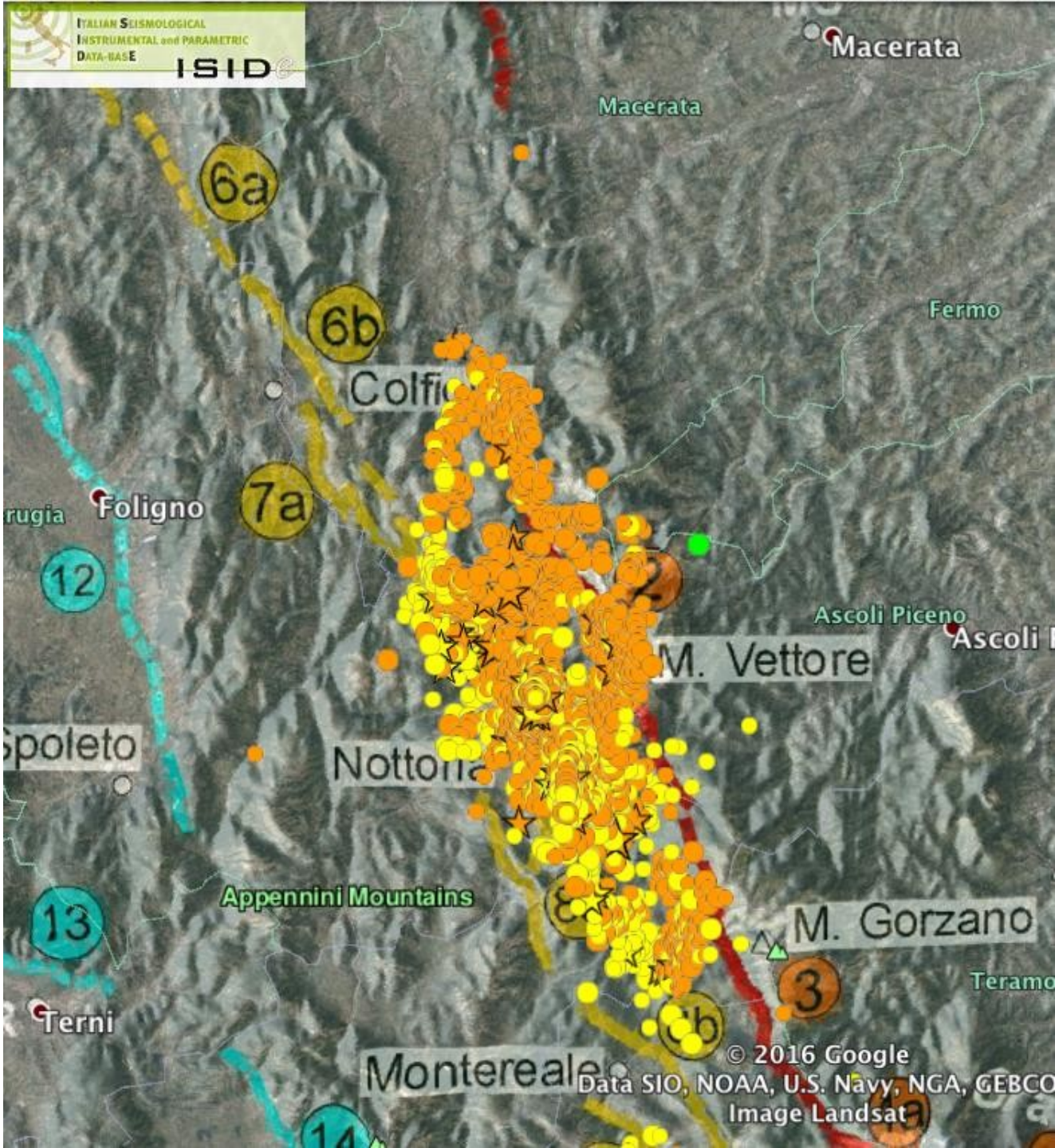
- Earthquakes of August 2016.
- Included M6.2 Amatrice earthquake, which caused ~300 deaths and widespread structural damage.
- Resulting from slip of Monte Vettore (red) fault segments.



Earthquake data from INGV

Central Italy earthquakes

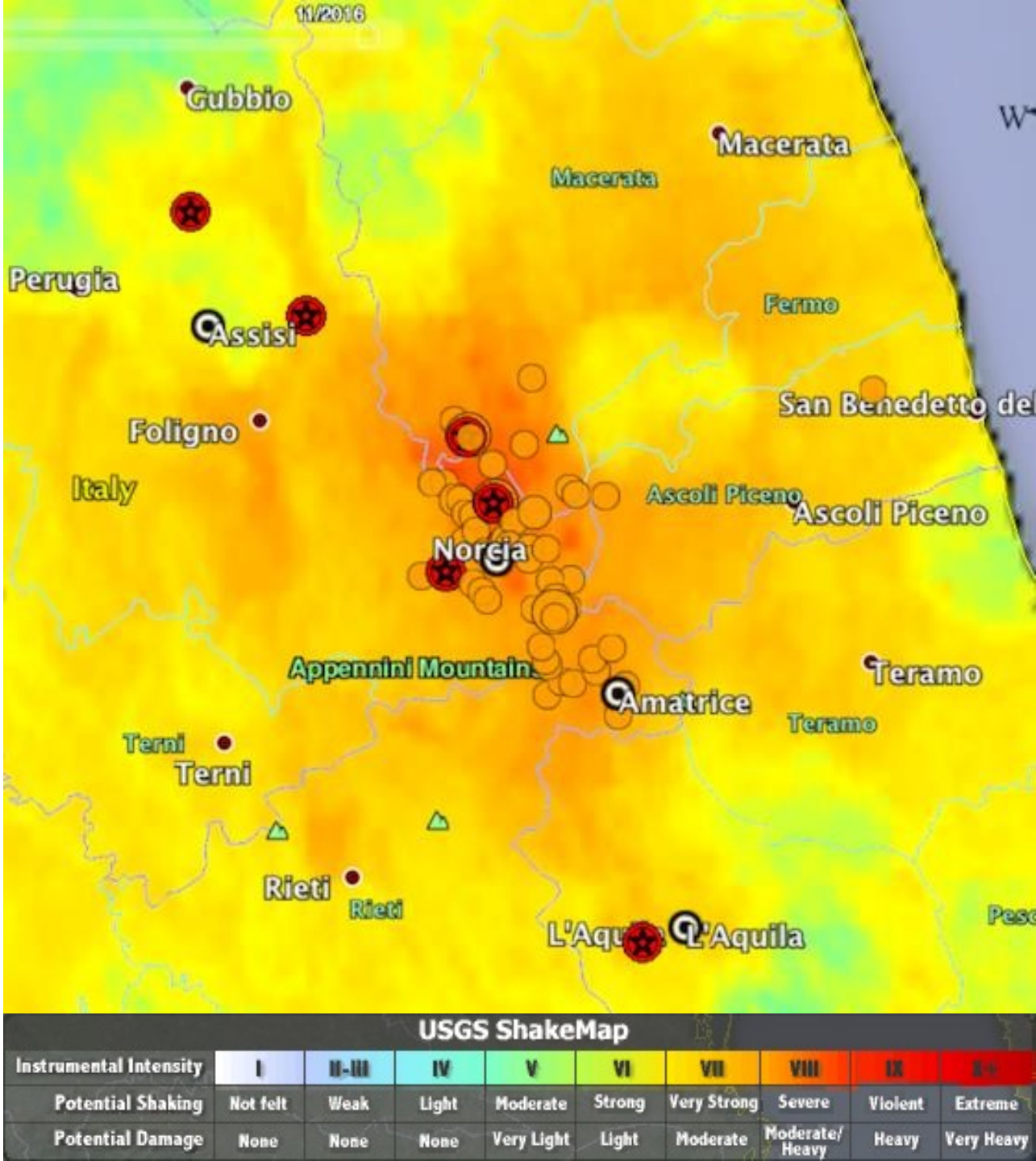
- Earthquakes of August through October 2016.
- October sequence included damaging earthquakes on October 26 and 30.
- Resulting from northward propagation of slip on Vettore-Bove (red) fault segments.



Earthquake data from INGV

Central Italy earthquakes

- USGS ShakeMap for M6.6 earthquake of October 30.
- Very strong to severe shaking over broad area. Widespread structural damage.
- No deaths and few injuries due to evacuations, cordons, and risk awareness from strong earthquakes in previous four days.



For more information:

http://earthquake.usgs.gov/

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