

*6-th National Conference on Earthquake Engineering, 2-nd  
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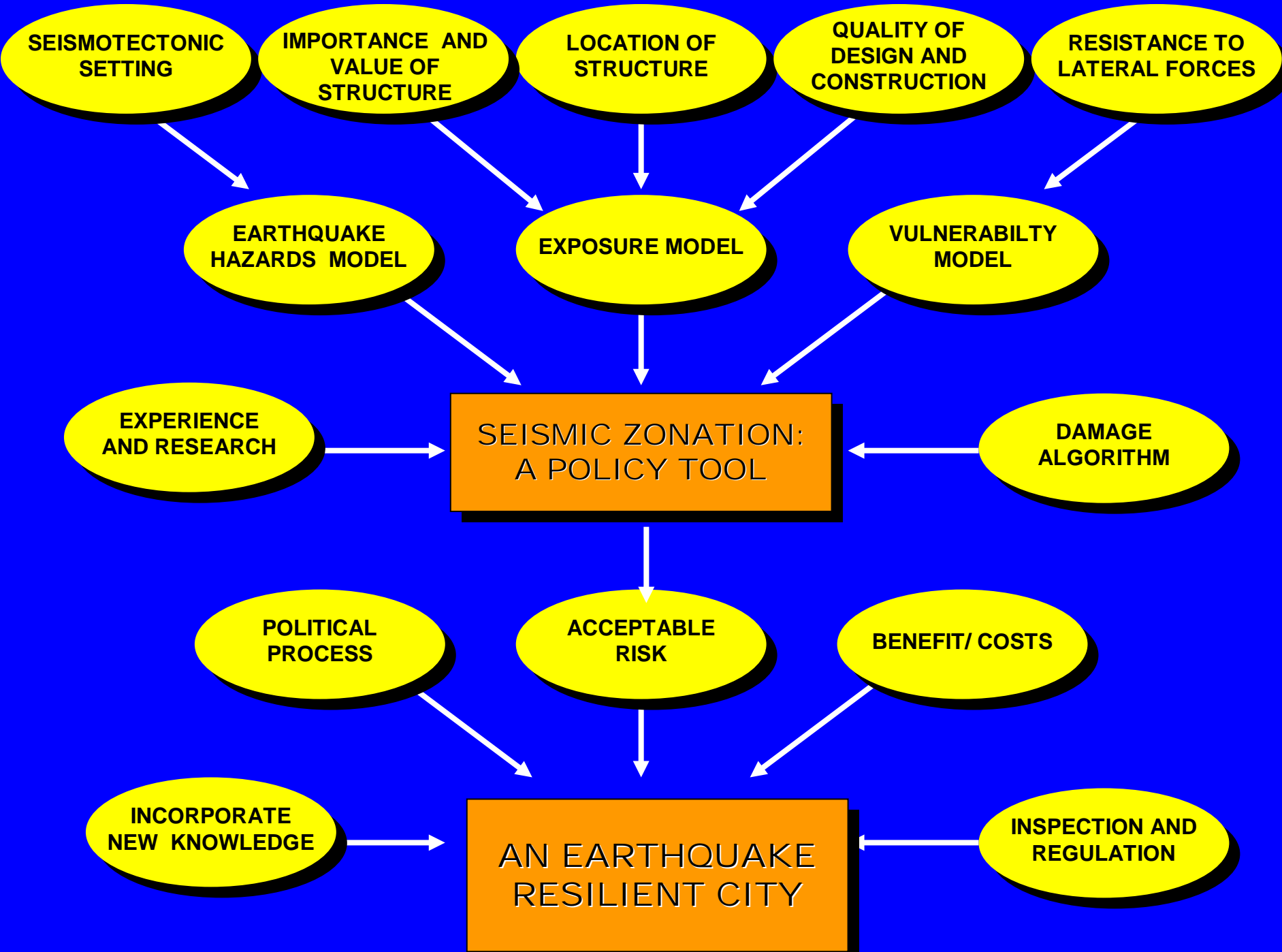
*Historical earthquakes:  
new intensity data points using  
complementary data from churches and  
monasteries*

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*Dr. Carmen Ortanza Cioflan*

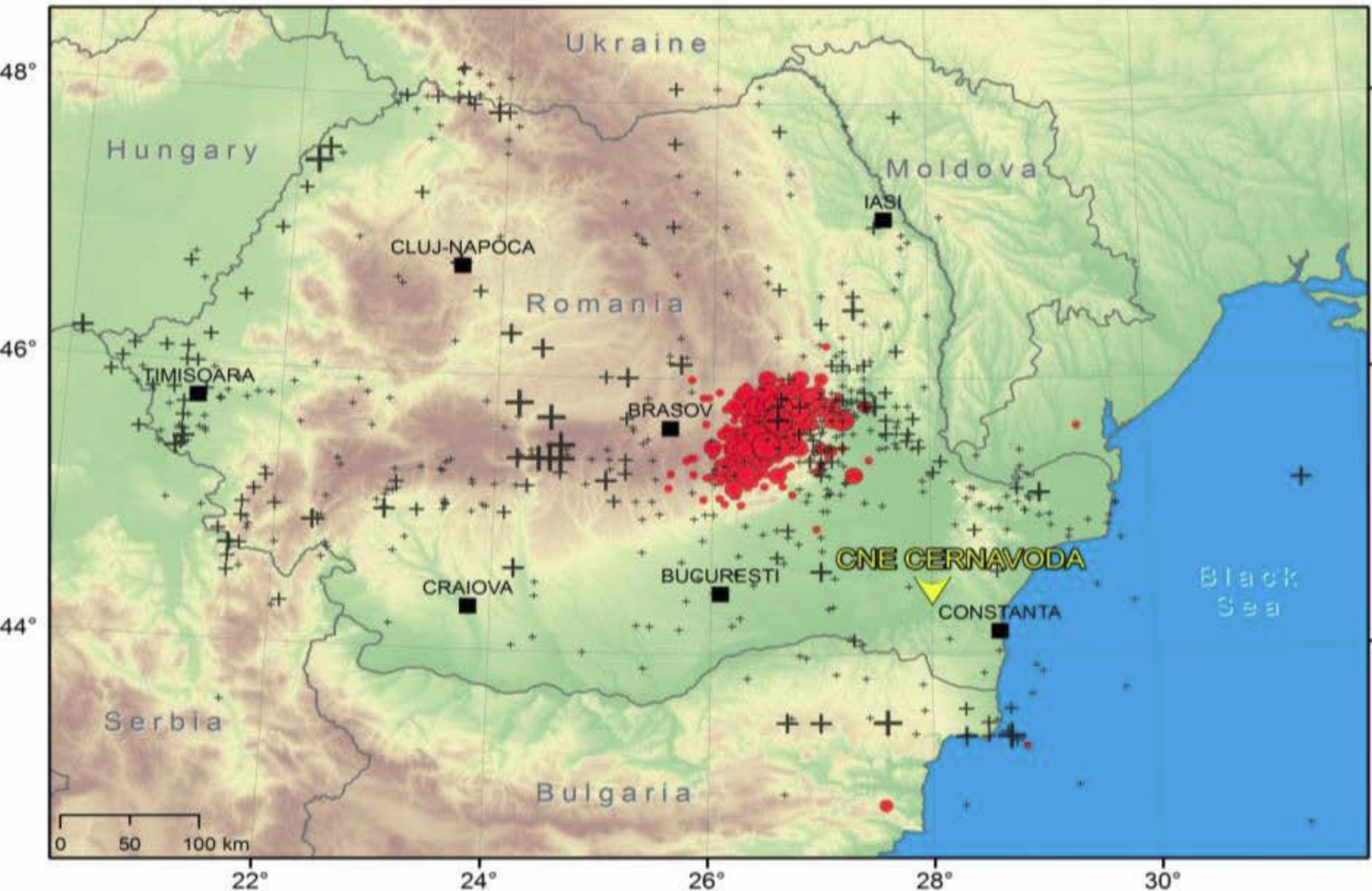
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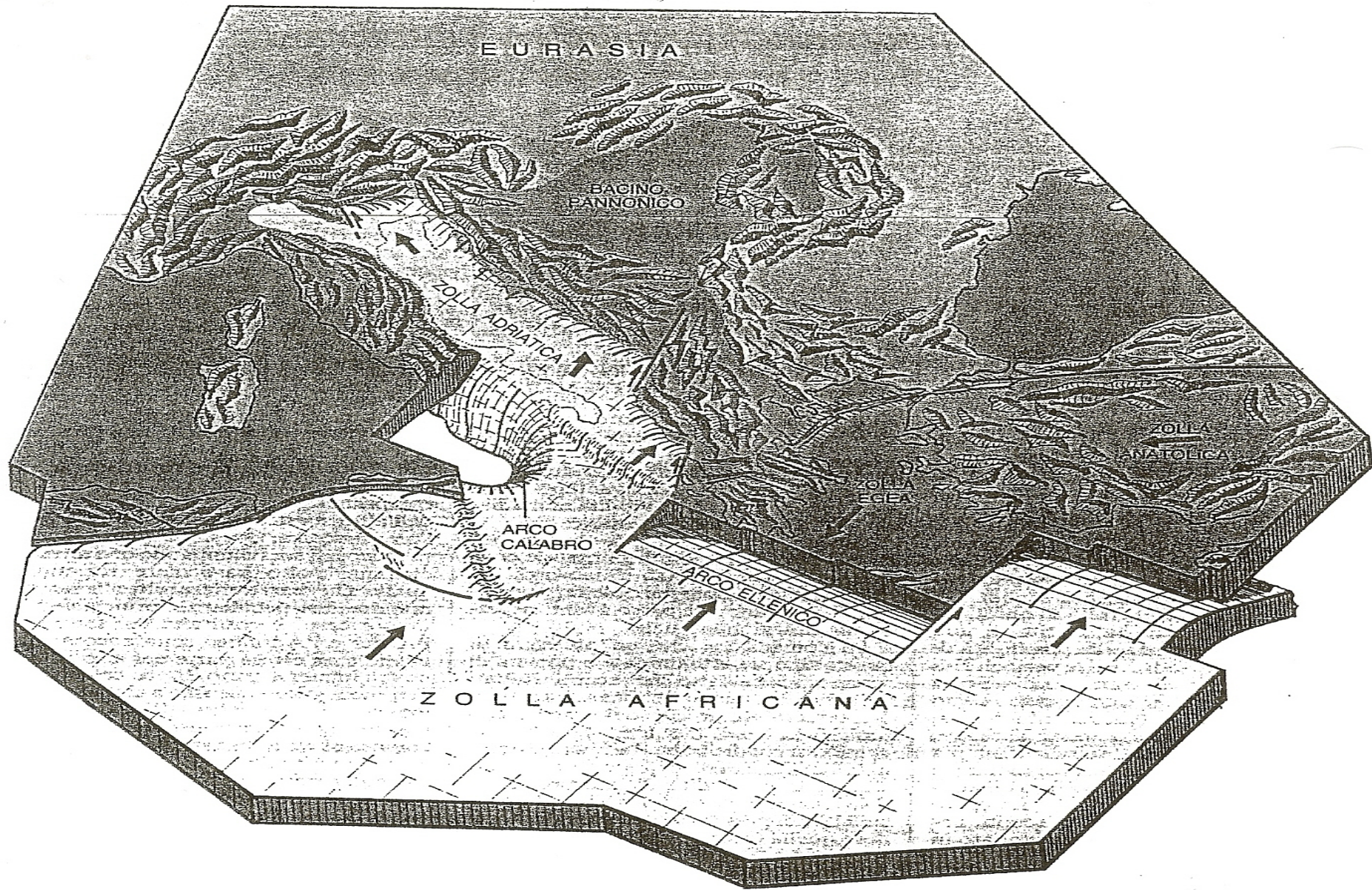


***BIGSEES Project: Bridging the gap between seismology and earthquake engineering from the seismicity of Romania towards refined implementation of seismic action of European Norm EN 1998-1 in earthquake resistant design of buildings (BIGSEES).***

- 1. National Institute for Seismology, Bucharest***
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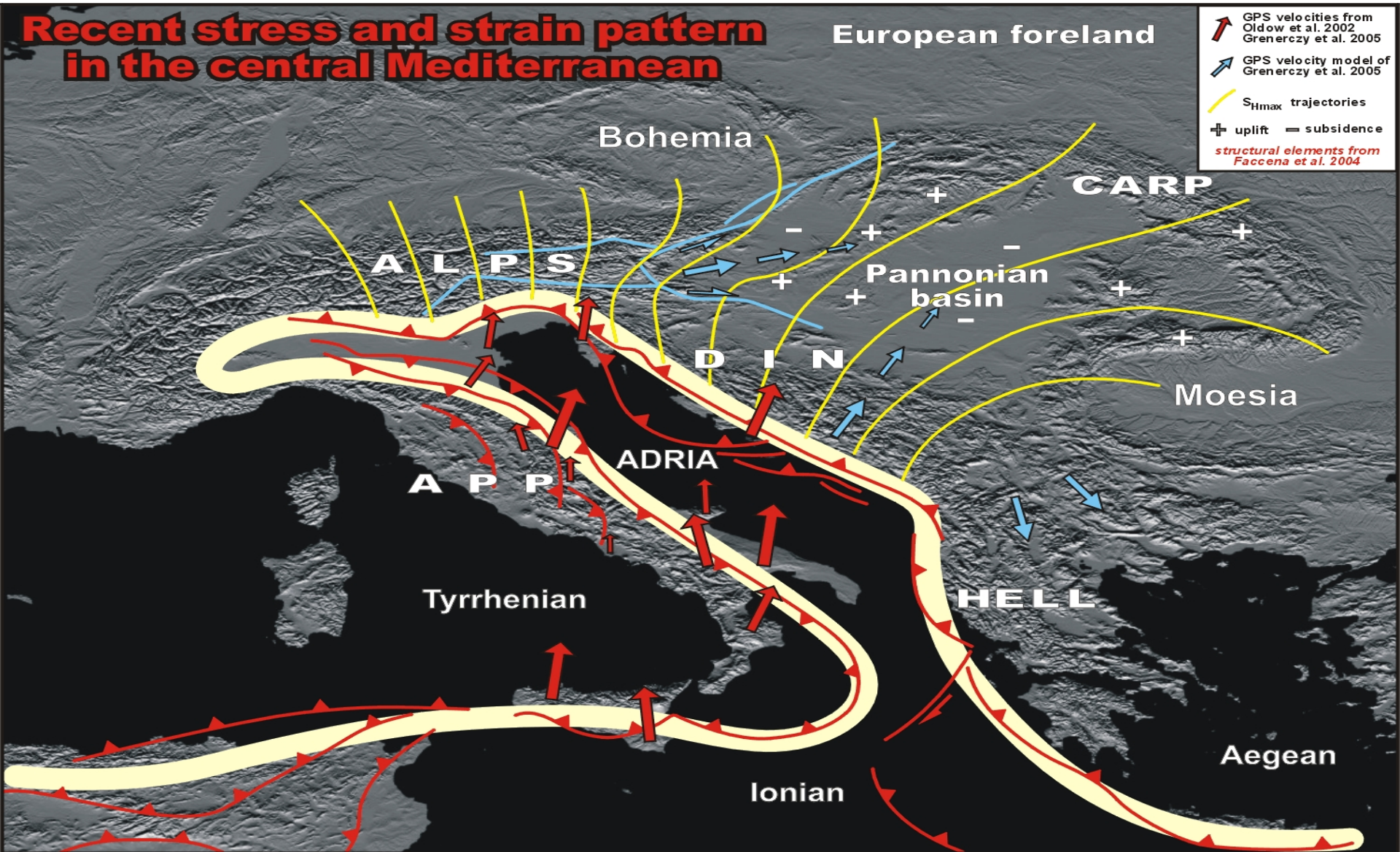


**Vrancea seismogenic area with large & deep earthquakes ( $M_w \leq 7.9$ )**

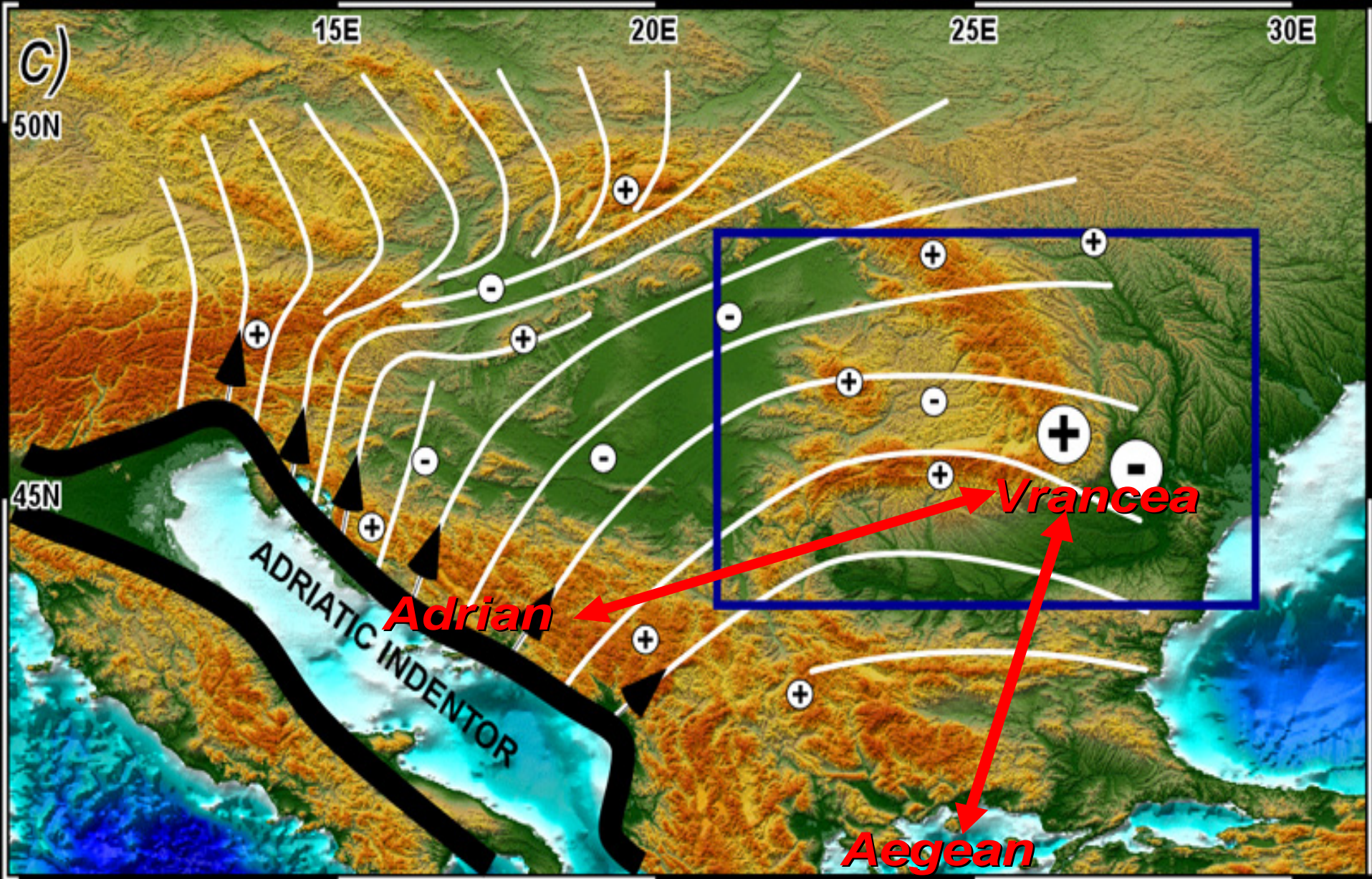


**Zolla Africana & Arco Calabria & Zolla Adriatica & Arco Ellenico[2].**

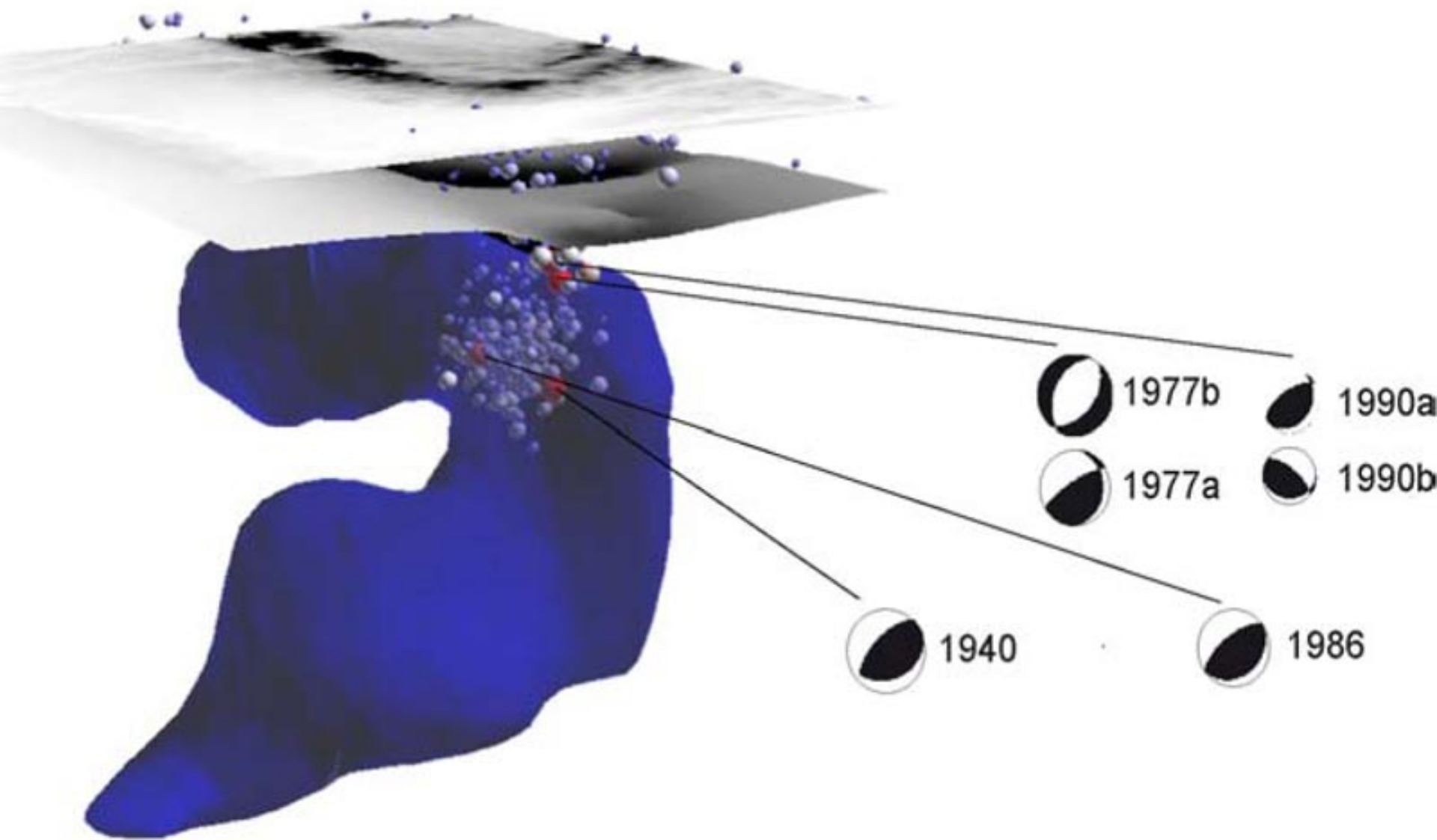
# Recent stress and strain pattern in the central Mediterranean



Recent stress and Strain Pattern in the Central Mediterranean[4]



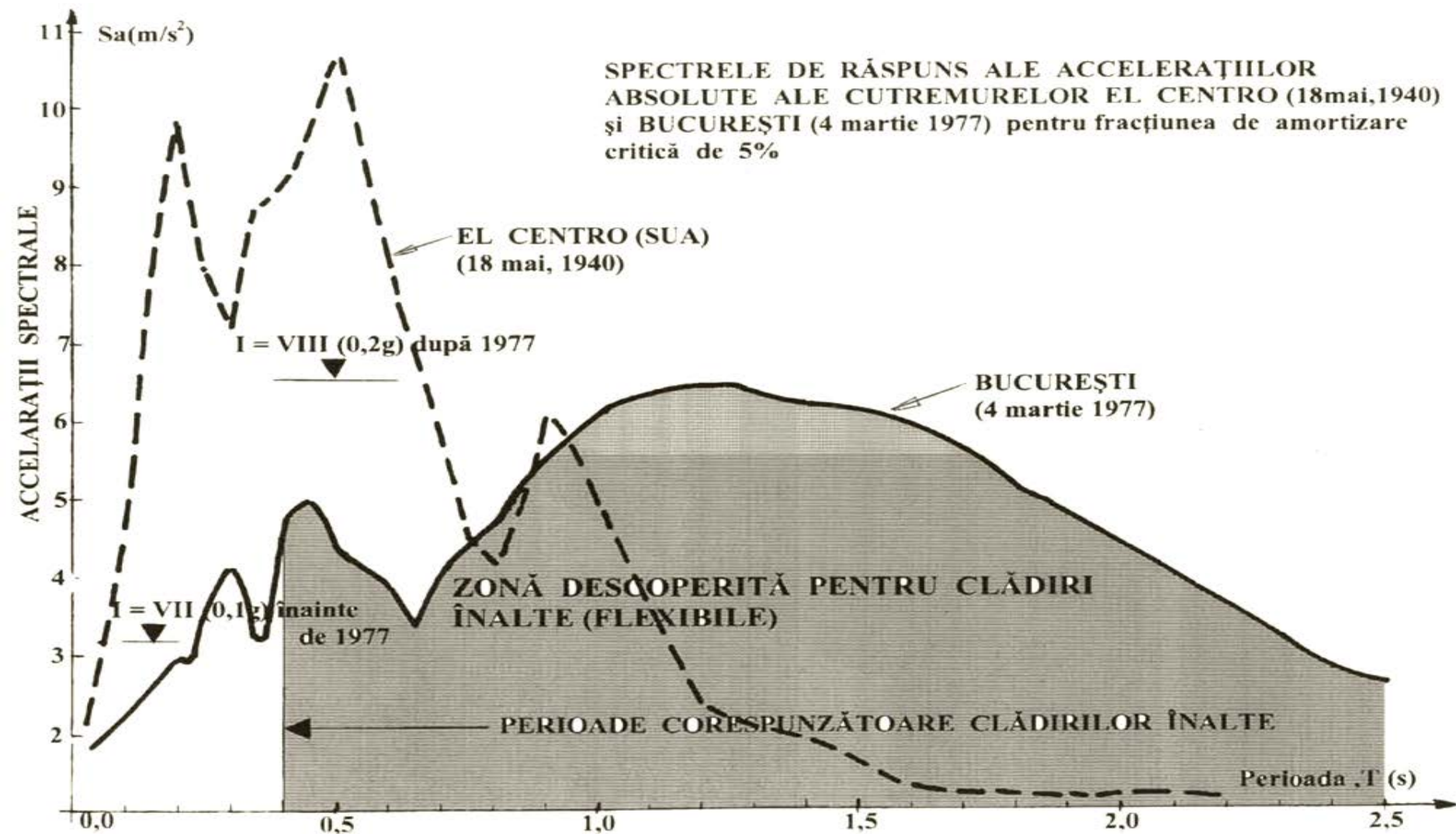
Strain transfer from the active Adriatic, Aegean and Vrancea deformation fronts through the ALCADI- Pannonian System [4]



**Topography and Moho layer and the isosurface of the 2.2% p-wave velocity anomaly of the Vrancea area from the seismic tomography work [6]**

A major part of the information for determining the design basis earthquakes is a *complete set of historical earthquake data*. Therefore it is necessary that the available historical records be collected, extending as far back in time as possible. Most of these historical records will naturally be of descriptive nature, including such information as the number of houses damaged or destroyed, the behavior of population etc. But from such information a measure of the intensity scale value of each earthquake in modern *macroseismic intensity scale values* may be determined.

In estimating intensity scale values for historical earthquakes, account should be taken of the fact that information obtained from *old chronicles , from churches, monasteries and individuals* who may have experienced the event shows a tendency to exaggerate the importance of damage and other phenomena associated with earthquakes[8].



**Response spectra(5% damped): El Centro(USA,May 18,1940) and Bucharest, INCERC Seismic Station (March 4,1977) Bucharest, Romania ( $\zeta = 5\%$ )[6;8]**



**MONASTERY COZIA[9]**

**Cozia Monastery** on the Olt river valley at the base of the mountain Cozia, full of history, with the monastic community, was builded by **Mircea the Old**, in **1386**. The name of Cozia comes from the word *pecenego* – *cuman koz*, which means walnut trees. Toward the end of the 16th century, between 1583-1590, probably after the great earthquake of 24 November 1516 (MW= 7.5 and  $h = 150$  km (?)) and then after the other 2 earthquakes smaller, in 1543 and 1545 (MW =7.1 ;  $h=110$  km) produced many damages. Constantin Brancoveanu after the earthquake on 1701 restored the church painting and have serious place repair between 1706-1707 and rebuild the monastery. One of the saddest periods in the history of the monastery, was the one between 1879-1893 when the authorities have changed her in jail, thing that makes the Mihai Eminescu to write in an article on September 12, 1882, published by the newspaper The TIME : "Cozia, where is buried Mircea, the largest king of the Romanian Country, under which the country included Danube Delta and access to Black Sea..., a historical monument almost equal ages with the country...has become this ? **Jail** “ [9]



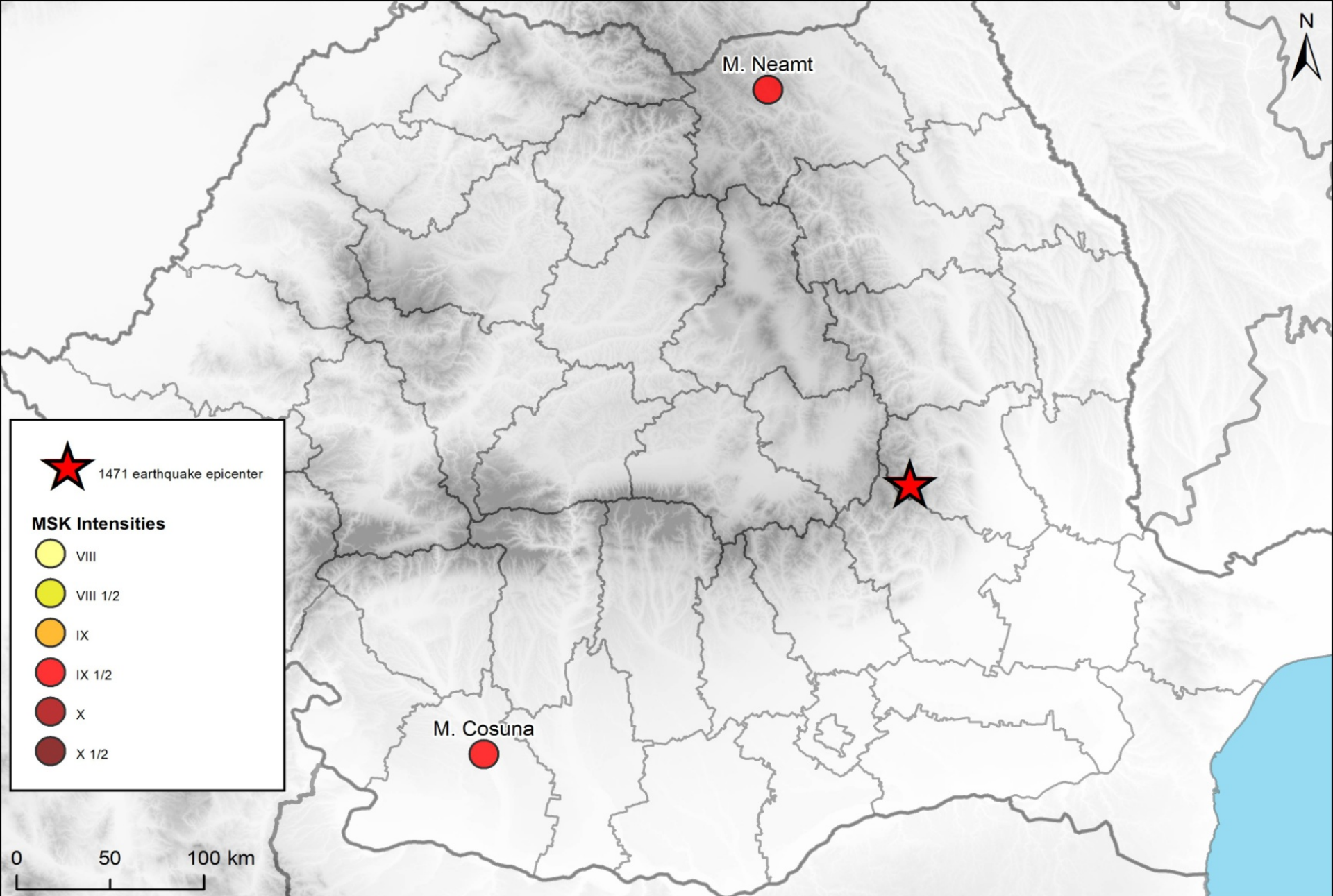
## Putna Monastery.

There are many data on the historical earthquakes. Many writers and journalists along time made *many descriptions on earthquake effects* on churches, monasteries etc. They come with important description elements after each large earthquakes. We do refer also to macroseismic intensity. After strong earthquake on 1620 ( $M_w=7.5$  ;  $h=150$  km), Vasile Lupu started Putna monastery restoration, in fact recovery it. The restoration of the Church at Putna Monastery "is finished" in the year **1662**. The year **1738** will bring a large earthquake ( $M_w=7.7$  ;  $h=130$  (?) km) ... seriously damaged the church, the walls of the enclosure and towers, of the four corners. Also, after the earthquake in **1802** ( $M_w=7.9$  and  $h=150$  km) many informations from Mihail Sadoveanu (Brothers Marten)...[ 9]

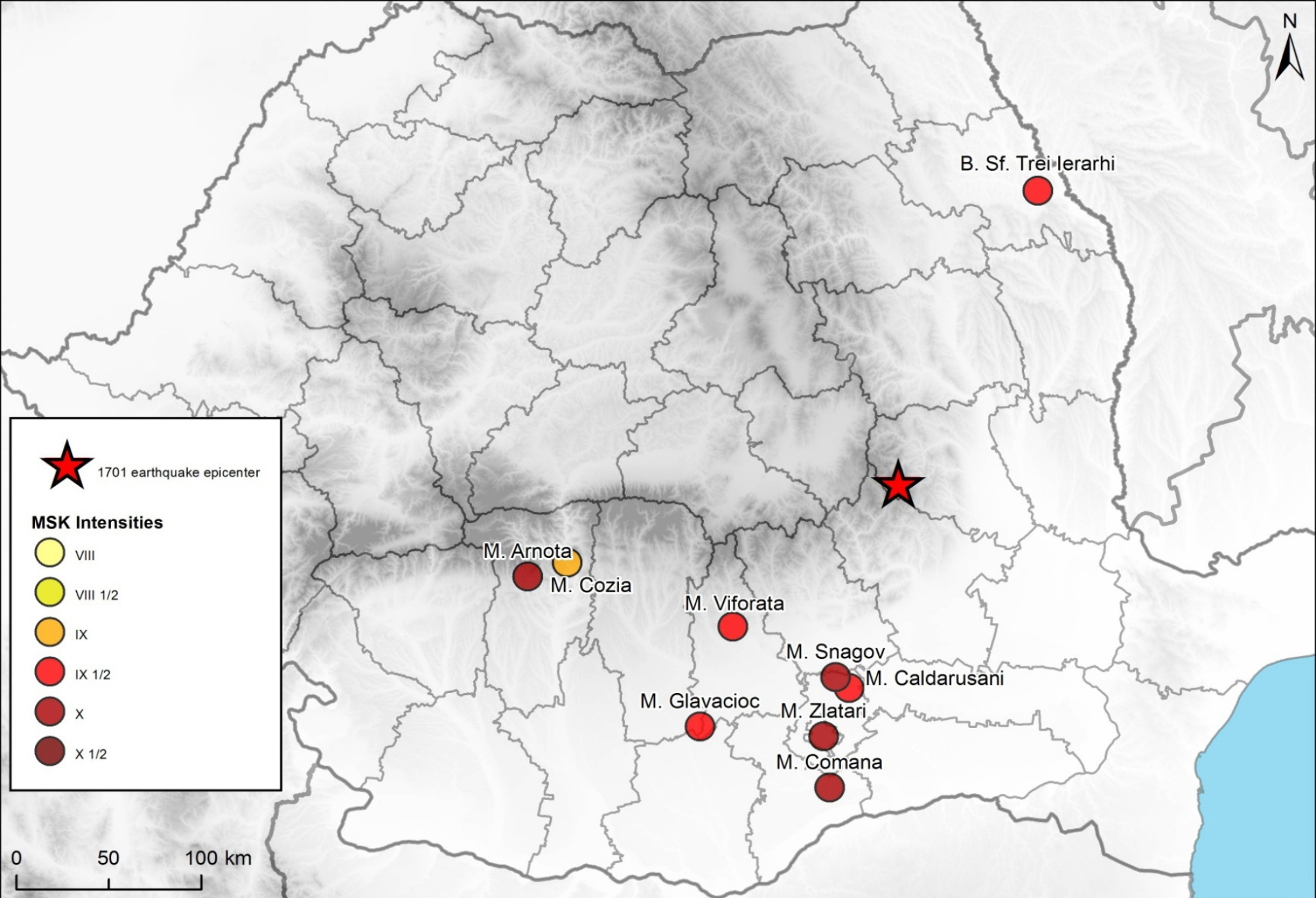




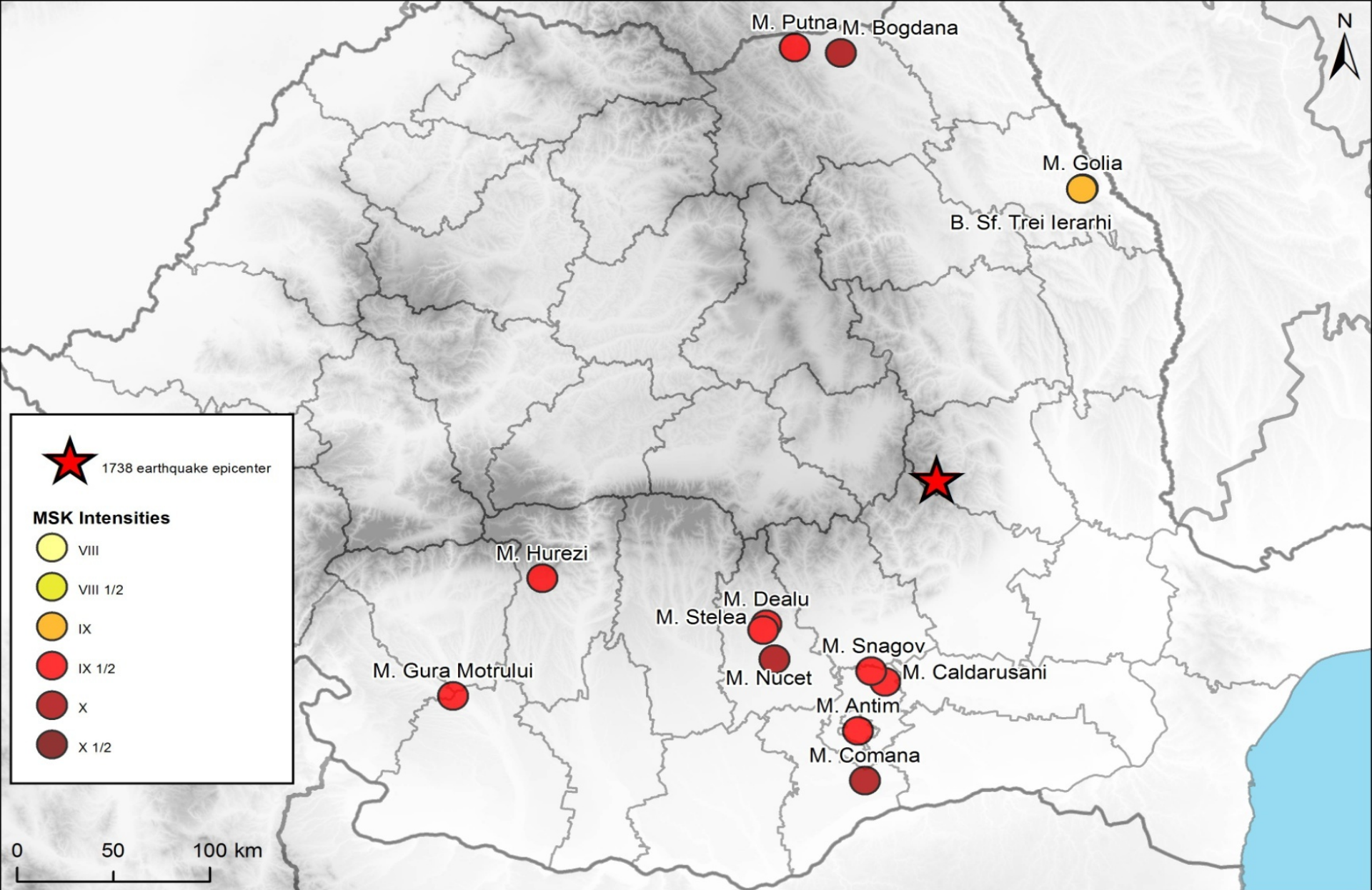
***PUTNA MONASTERY,  
"The Jerusalem of the Romanian nation" (M. Eminescu)[8;9]***



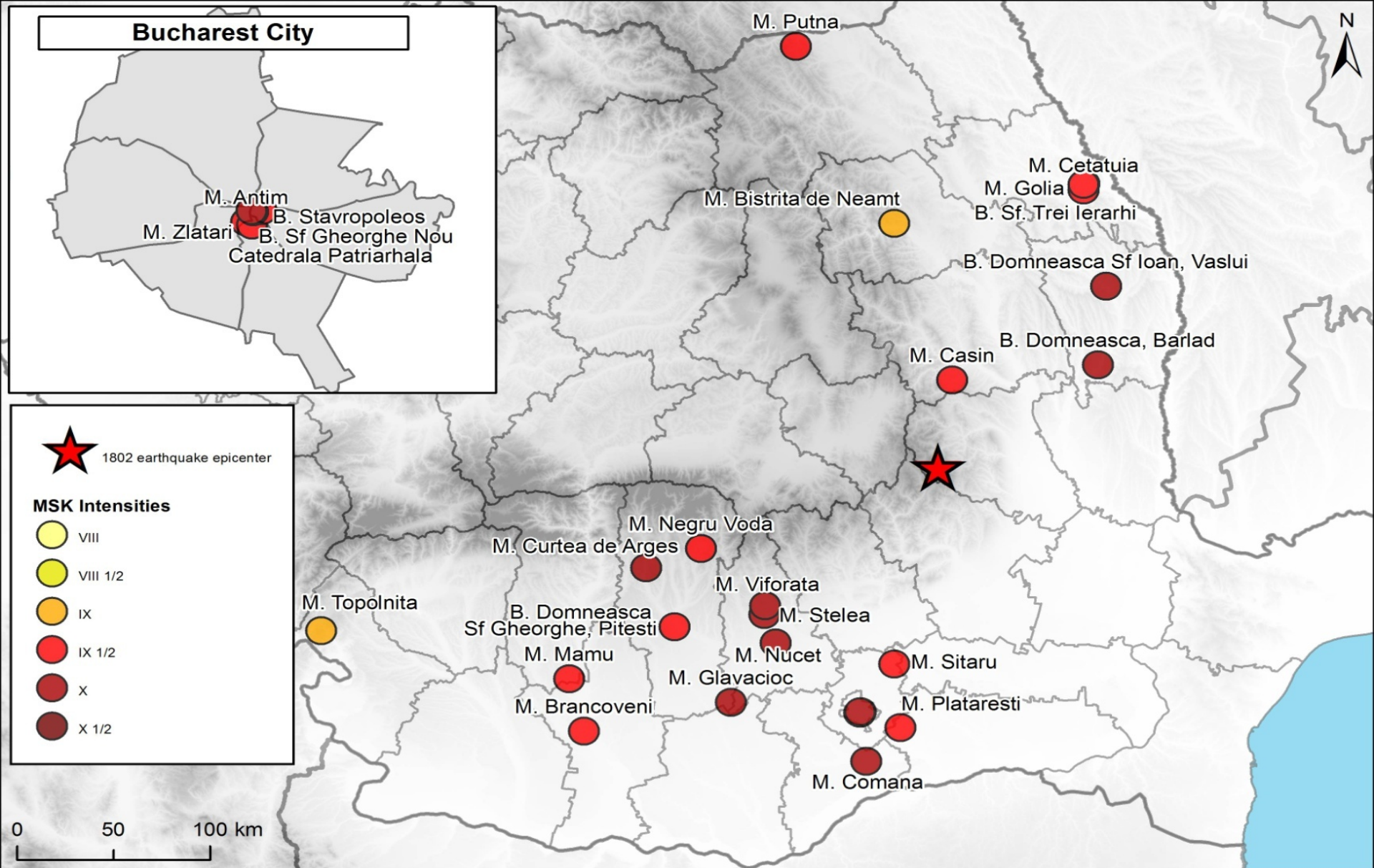
*Vrancea earthquake on August 29, 1471.  $M_W=7.5$ [9]*



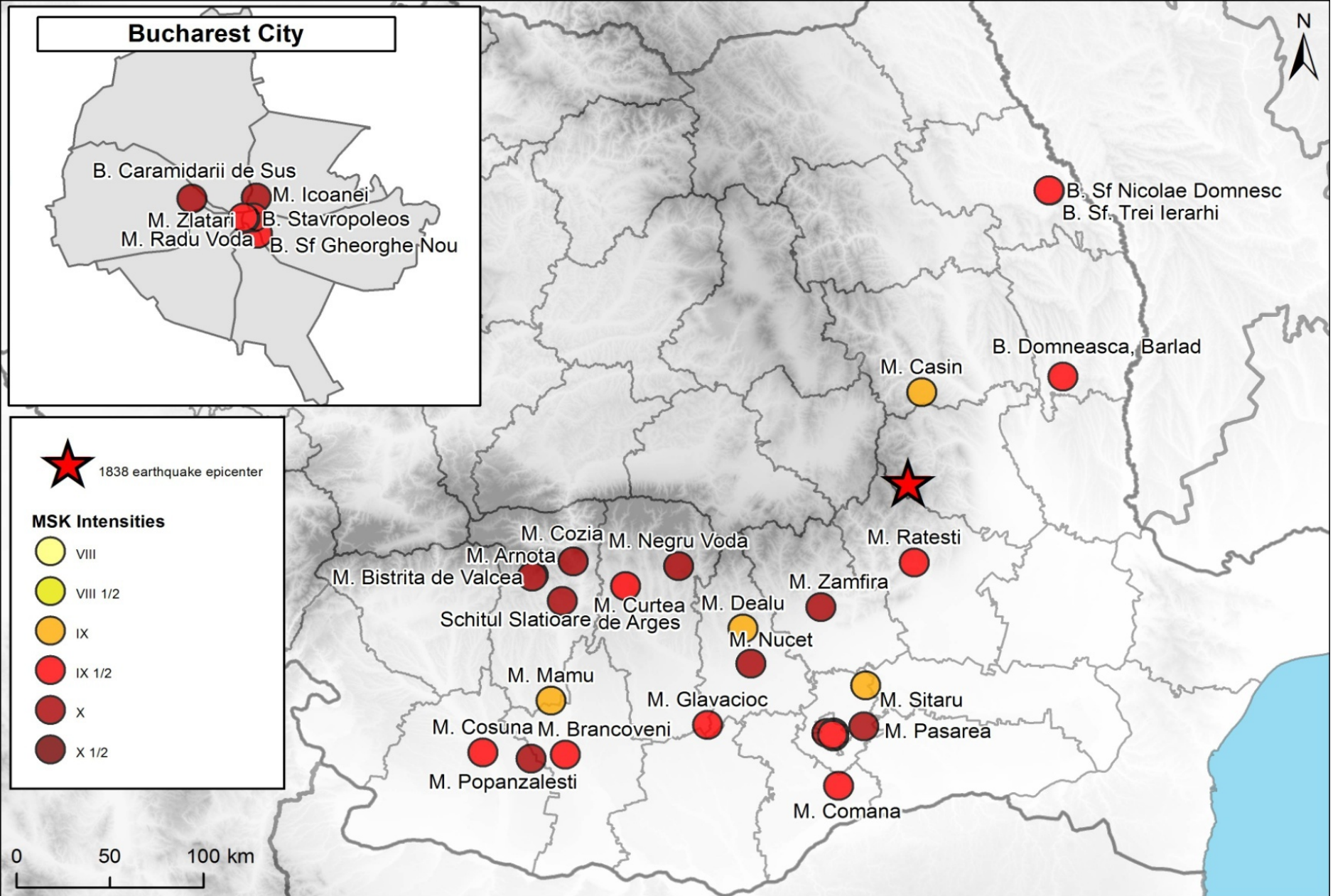
**Vrancea earthquake, June 12, 1701.  $M_W = 7.1$  (?) [9]**



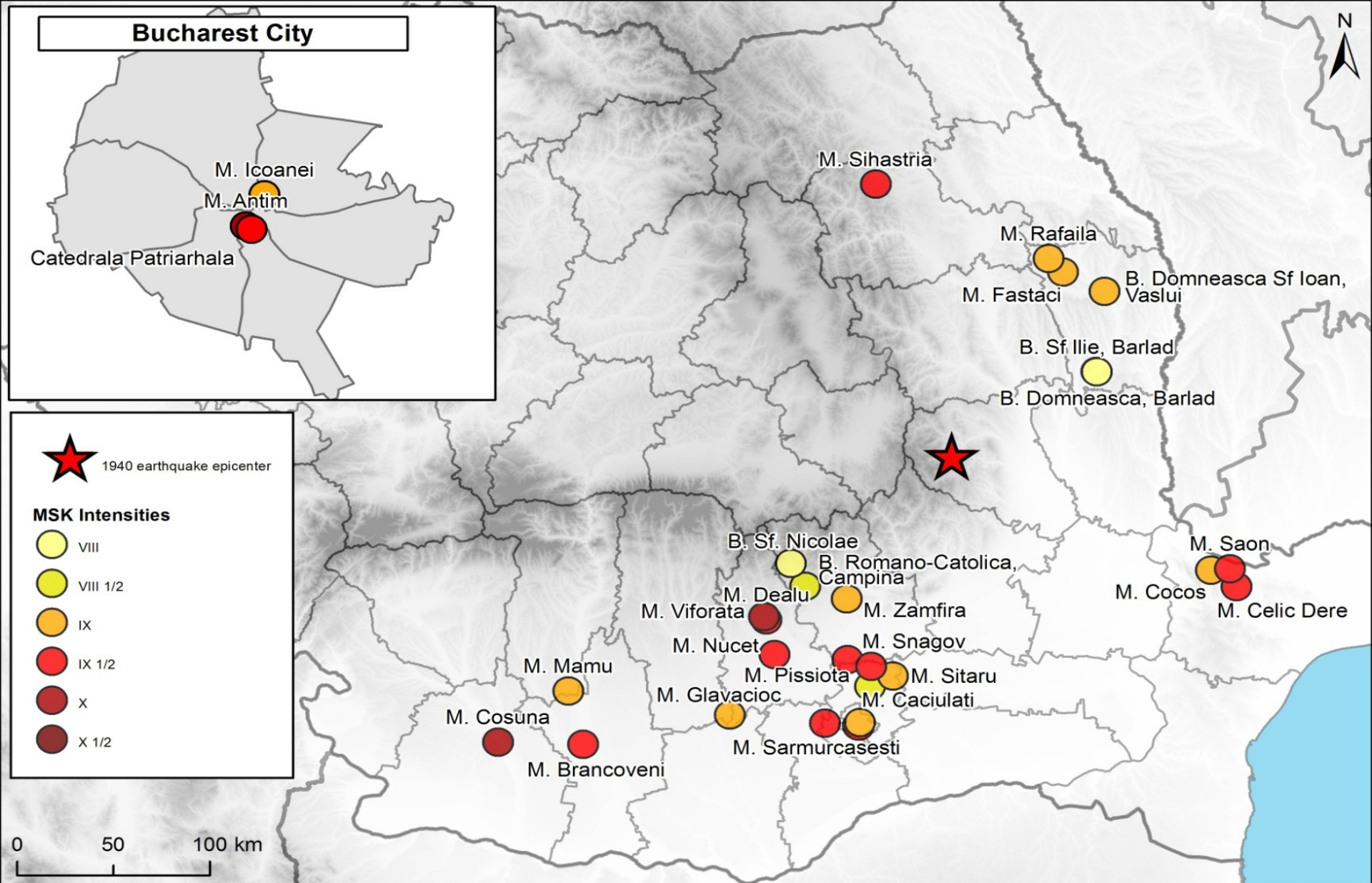
**Vrancea earthquake on June 11, 1738,  $M_W=7.7$ [9]**



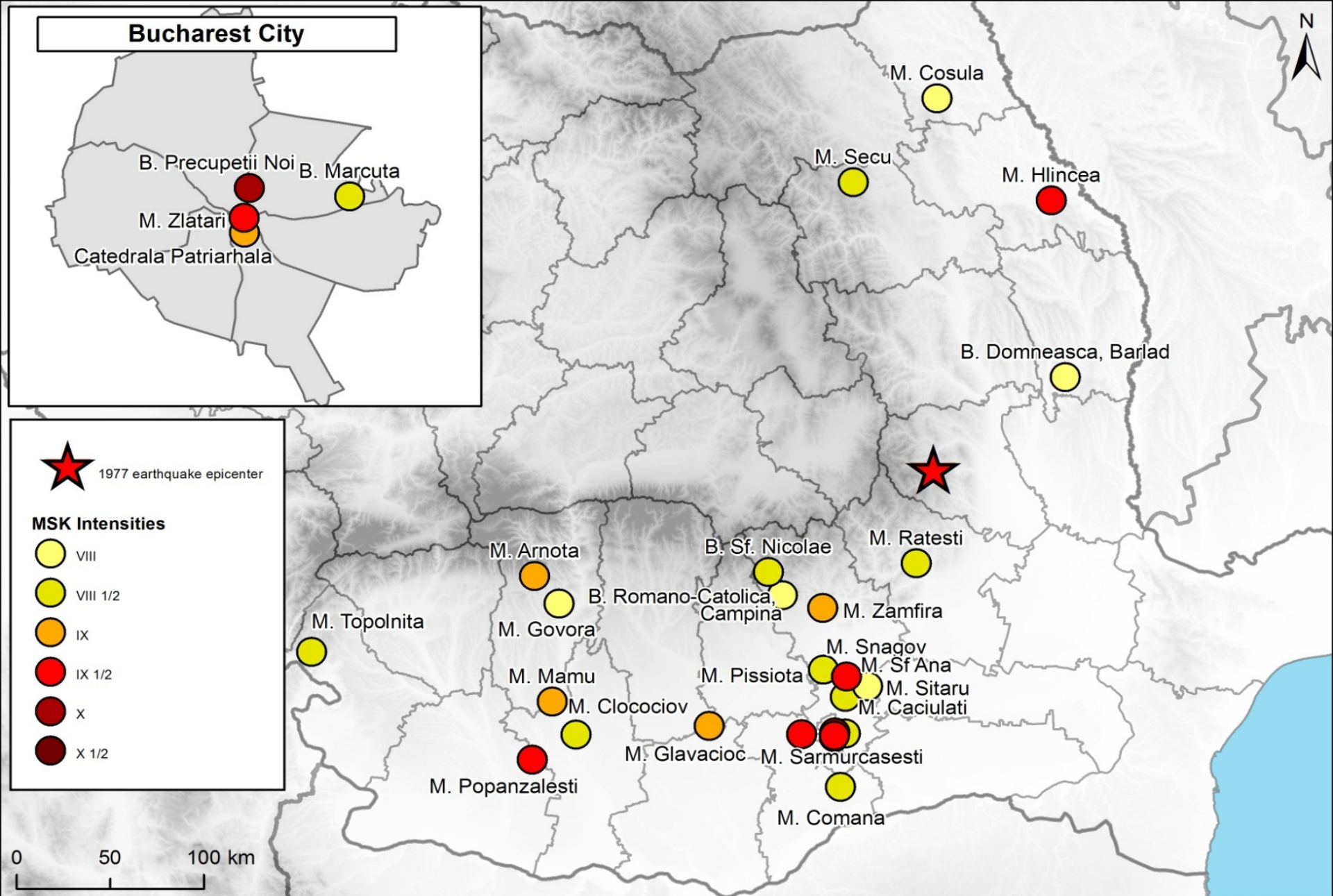
**Vrancea earthquake on October 26, 1802.  $M_W = 7.9$  [9]**



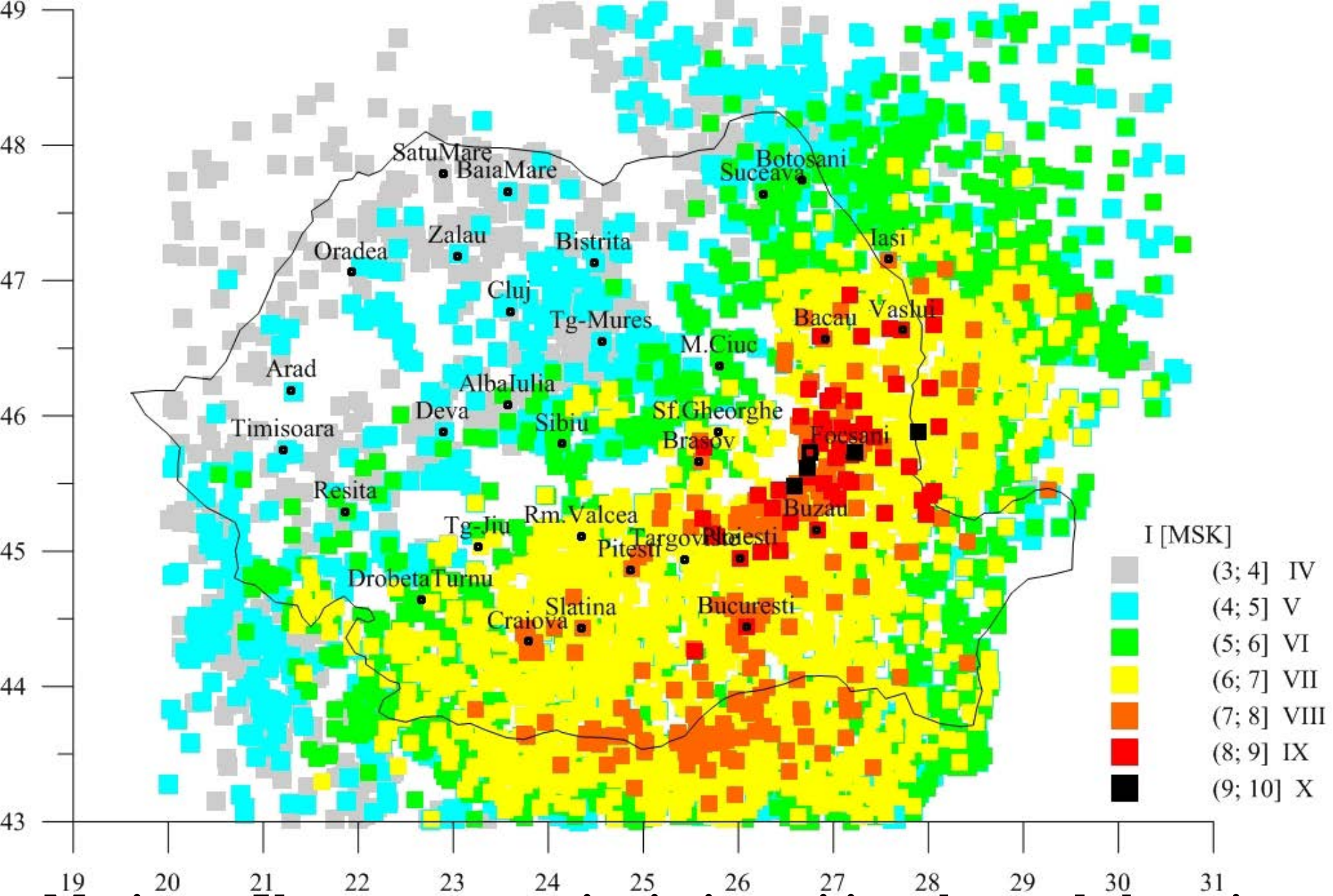
**Vrancea earthquake on January 23, 1838.  $M_W=7.5[9;11]$**



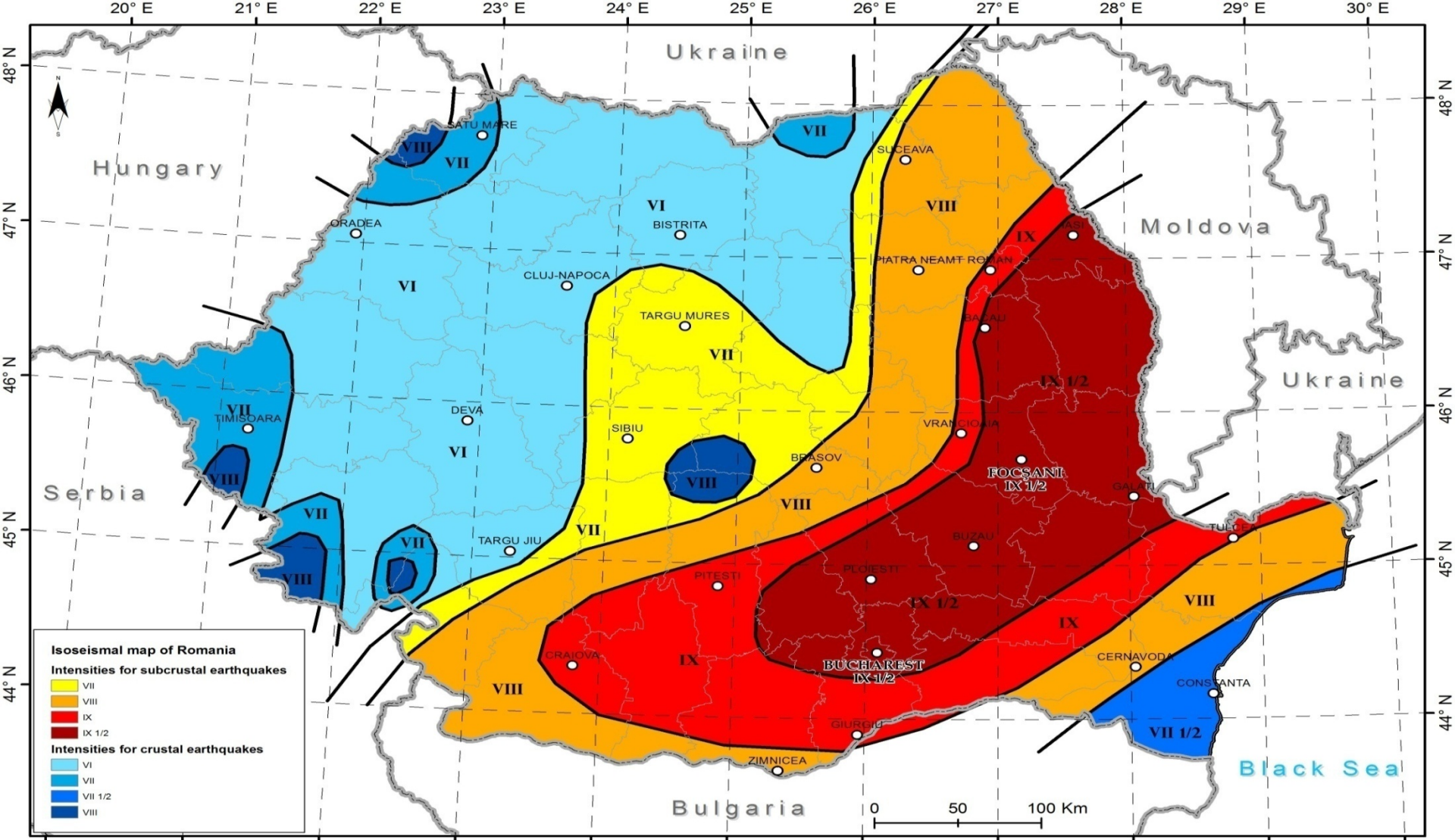
**Vrancea earthquake on November 10, 1940.  $M_W=7.7[9;11]$**



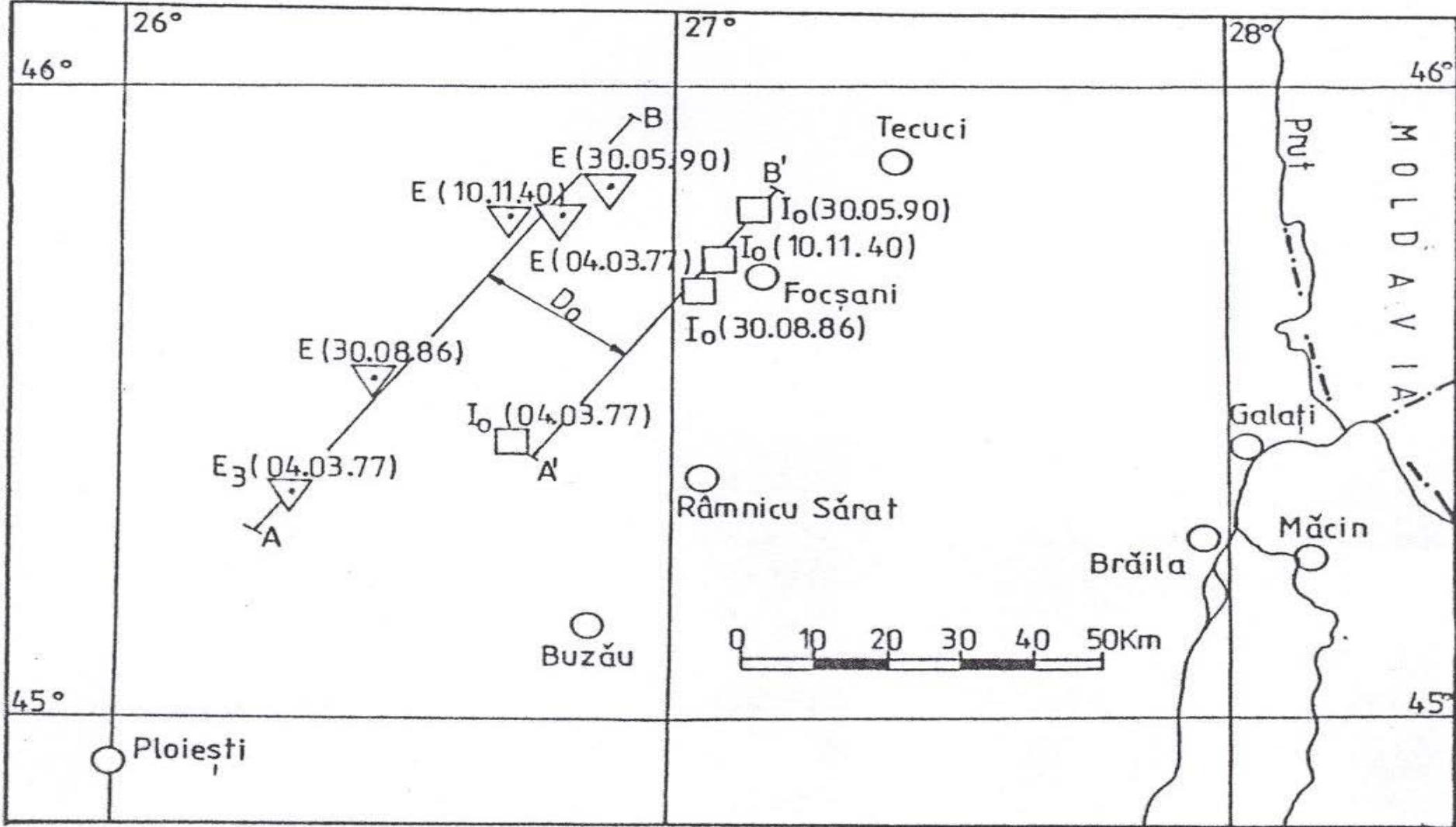
**Vrancea earthquake on March 4, 1977.  $M_W = 7.45[9;11]$**



**Maximum Vrancea macroseismic intensities observed along time  
(1471-2014)[8;9;11]**



*The isoseismal map of the maximum credible Vrancea earthquake or maximum probable Vrancea earthquake ( $M_W=7.9$ ), MM intensities. New intensity data points using complementary data from churches and monasteries, inclusively crustal earthquakes [8].*



**Epicenters E (line AB) & I<sub>0</sub> points(line A'B') at distance D<sub>0</sub> =23 km, corresponding to the four strong and major earthquakes ( $M_W \geq 6.9$ ) occurred in last 70 years: Nov. 10,1940 ( $M_W = 7.5$ ); March 4,1977 ( $M_W = 7.4$ ); August 30, 1986( $M_W = 7.1$ ) and May 30,1990( $M_W = 6.90$ )[8].**

*Project transformed the results of this methodological research on earthquake risk reduction into effective application, that is „**New Romanian Seismic Action**”, P100-1, 2013 for a refined implementation, in Romanian design practice, of seismic action as defined in EC- 8[13].*

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