



**ADRC Study visit to Kumamoto and
ADRC Steering Committee
Kumamoto, Japan 2016**



**THE SPITAK EARTHQUAKE
07.12.1988**

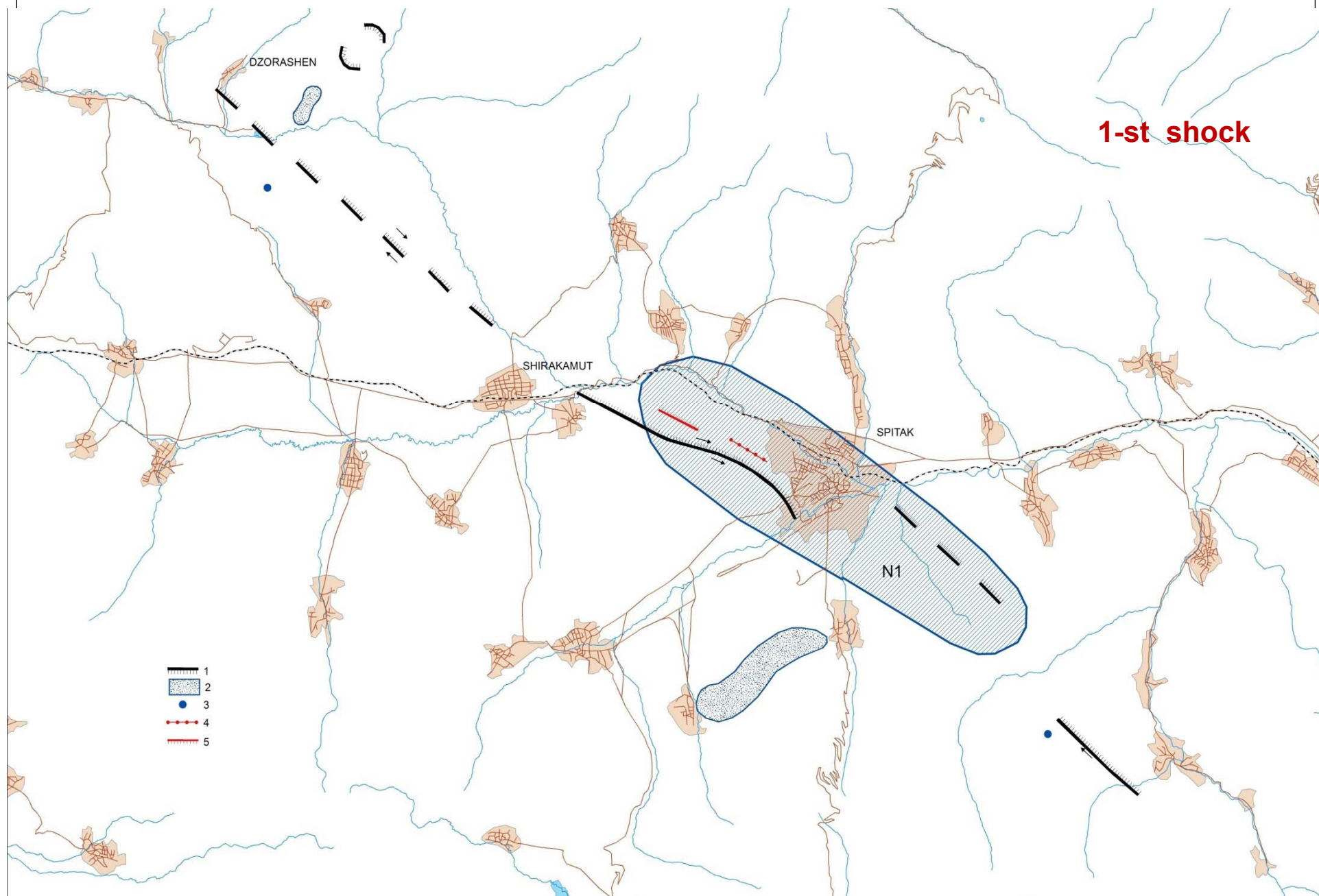
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SEISMOLOGICAL PARAMETERS

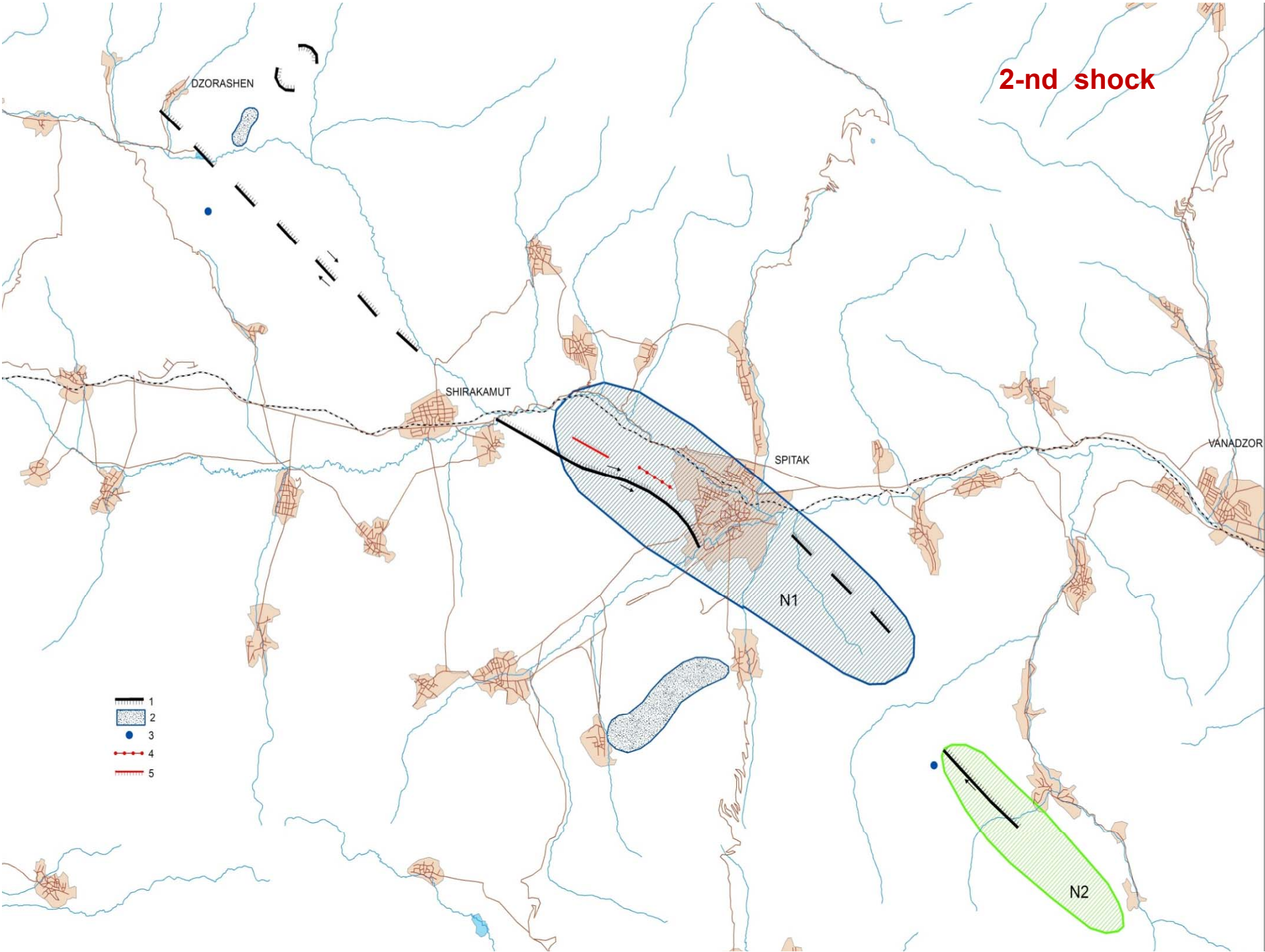
- Time – 7 of December 1988, at 11.41 by local time
- Location of the epicenter – close by Spitak city ($\varphi = 40,9$; $\lambda = 44,2^\circ$)
- Magnitude- M-7,0 (according to different estimations 6.9-7.1)
- Intensity in the epicenter-9-10 intensity by MSK-64 scale
- Sizes of epicenter zone - $10 \times 60 \text{ km}^2$
- Depth of the hypocenter – about 10km (according to different data 2,5-15km)
- Duration of the main event -35-45 sec.
- Characteristics of seismic fault : the total length -37km, the maximal vertical amplitude-2,5m, and the horizontal amplitude -1,5m, type thrust- slide, the angle of incidence of the zone of the fault – 60° - 80°
- The most important dislocations: two faults – lengths about 10-11km, revealed on the surface (between the Spitak city and the village Gekhasar, near the village Alavar), seismic –gravitational formation near the village Dzorashen, on the right side of the river Getik.
- Character of the main event –multiple, in minimum consisting of 3 shocks, these 3 shocks are more separating and happened with 5 sec. and 14 sec. time intervals



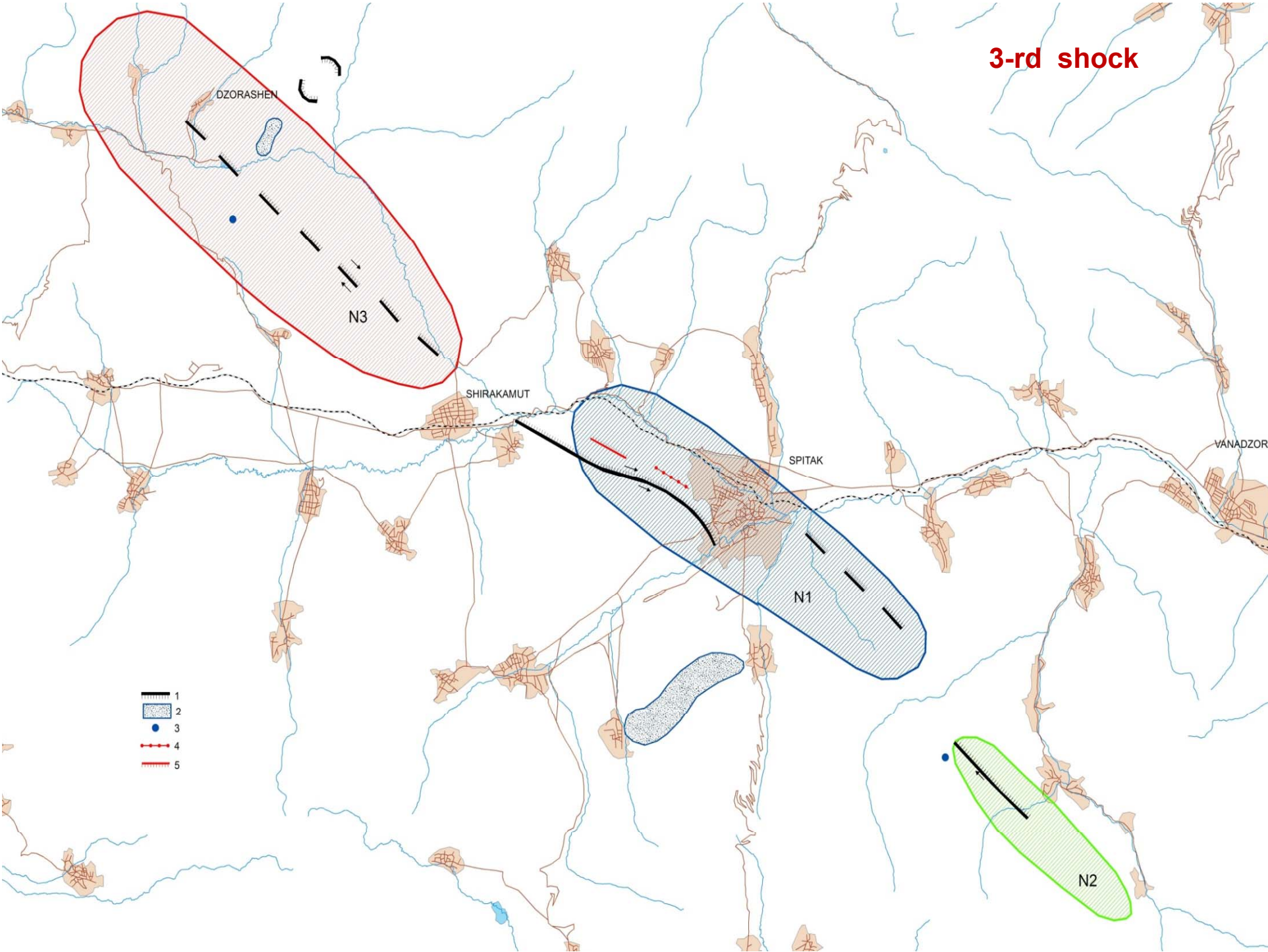
LOCATION OF DIFFERENT 3 SHOCKES OF THE MAIN EVENT OF SPITAK EARTHQUAKE OF 1988 DURING 35-45 sec



2-nd shock



3-rd shock



Characteristics of the zone of destruction

- Area of the zone of destruction- 10 000km², where about 1 million people lived
- Area of the zone of hard destructions (limited by the isoseismals of 8-10 intensity marks)-3000 km²
- Number of destructed cities-11
- Number of destructed villages-58
- Number of suffered cities -21
- Number of suffered villages-342
- Number of the people left without shelter from the zone of the earthquake were evacuated 120 000 people and the 75 000 of them beyond the bounds of Armenia

HUMAN LOSSES

- **The total number of victims- 25000 people**
- **Including in the cities:**
- **Gyumri -17000**
- **Vanadzor-1200**
- **Spitak- 4000**
- **Akhuryan- 500**
- **Stepanavan- 120**

OTHER STATISTICAL DATA

- **250 000 people were injured**
- **12 500 people were hospitalized**
- **514 000 homeless**
- **120 000 people were evacuated from the earthquake zone**

Material losses

Direct losses-about 14 billion US dollars

- Losses of dwelling space-9 million/m² (18% of the republic dwelling fund)
- 170 industrial enterprises with average productive capacity of 1,9 billion US dollars stopped their function
- 917 buildings of schools and other objects of national education for 20000 people, 250 objects of health care, 324 club- houses and cultural clubs, 2260objects of nourishment were put out of action or destructed
- The life-lines suffered hardly: 40km of railways, 80 km of electricity cables come out of action.
- More then 2300 from 8461 architectural and cultural monuments suffered (155 were ruined thoroughly, 984 seriously damaged , 1216 were half- ruined), at that the 179 architectural monuments were of international importance.

THE MAIN REASONS OF LOW SEISMIC STABILITY OF MULTY FLAT AND COMMON BUILDINGS CONSTRUCTED BEFORE THE 1989

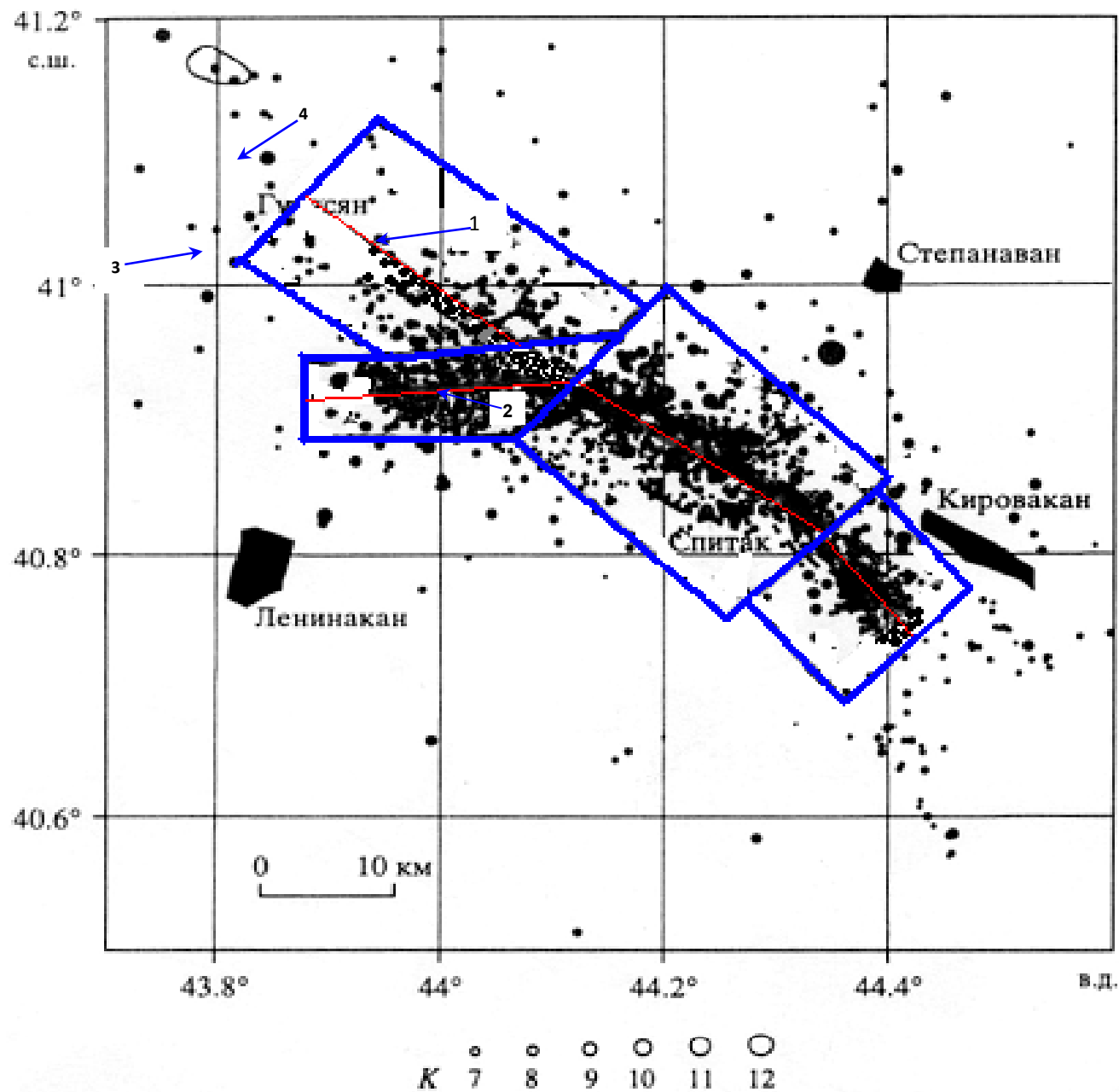
- **Design of buildings with lowered level of seismic hazard.**
- **The poor quality of construction.**
- **Unpermitted changes in the constructions of buildings, those increase the seismic vulnerability.**
- **Insufficient account of the all engineer- geological and seismic conditions of the construction surfaces.**
- **Design defects almost in the all types of buildings.**



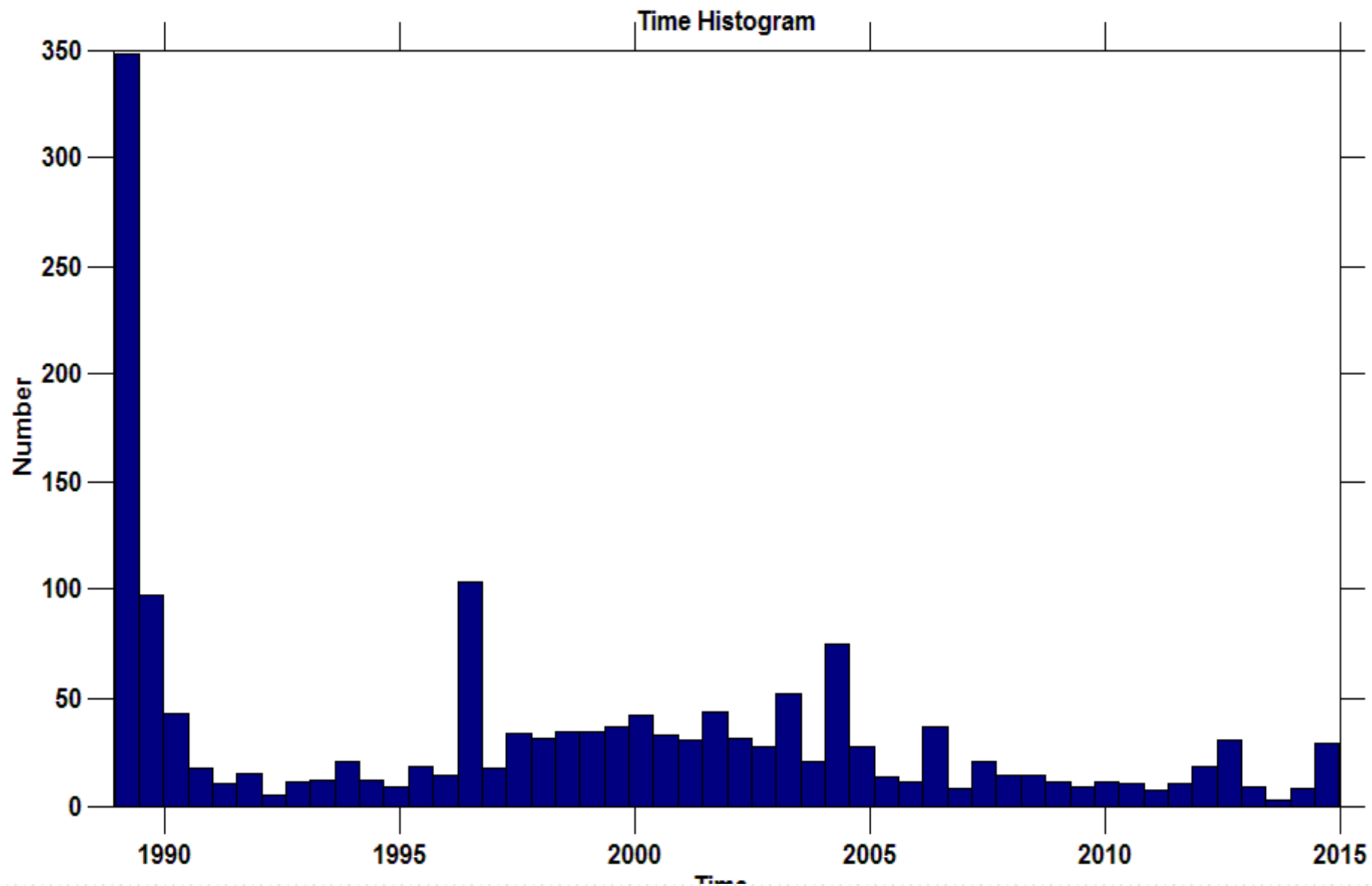




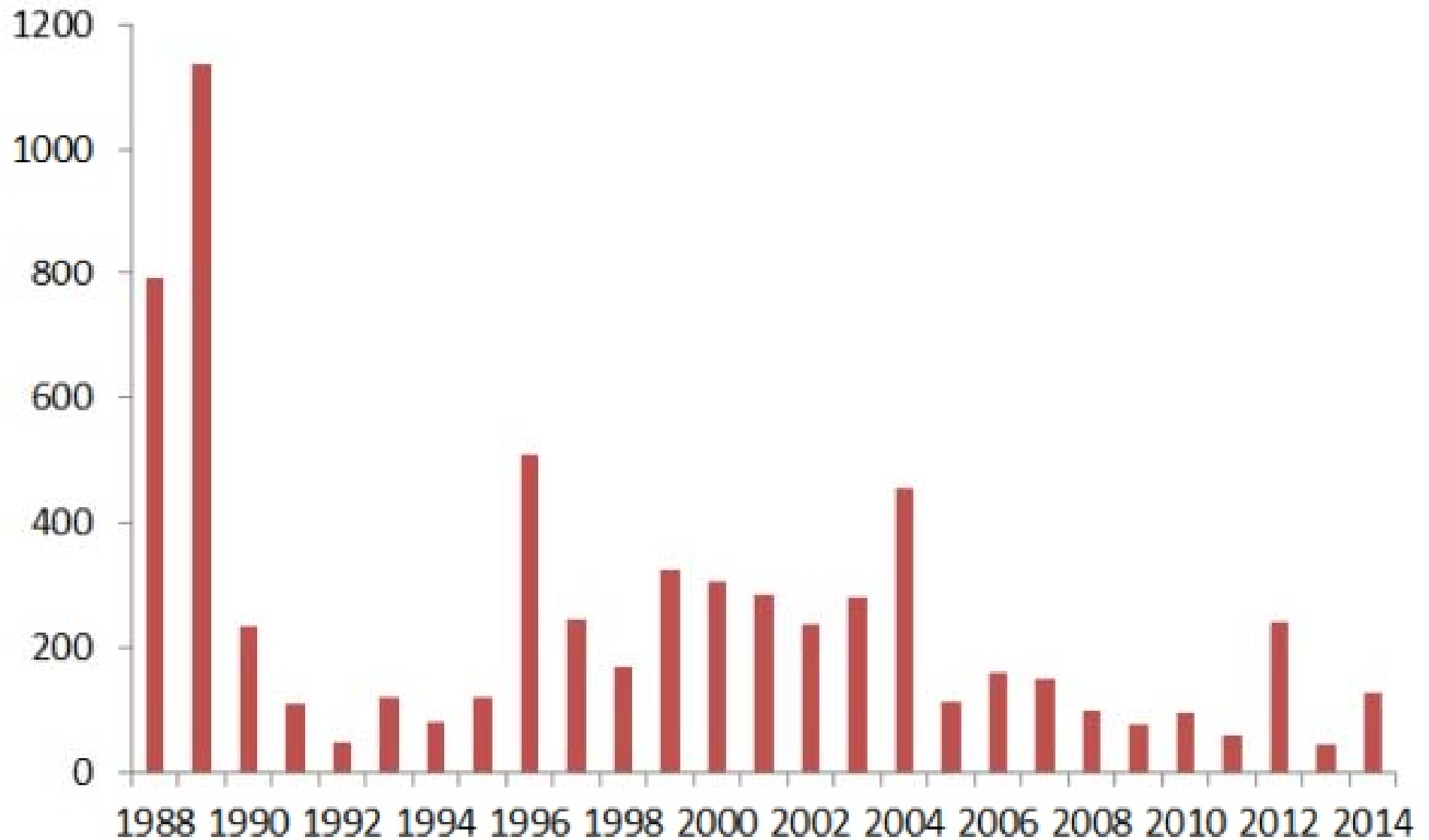




Zone of aftershocks of Spitak earthquake 1988 by Nazaretyan



Histogram of quantity Spitak earthquake 1988. during 1988-2015 $M > 2.5$



Histogram of aftershocks energy of Spitak earthquake 1988. during 1988-2015.with 10^5 Joule.

CONCLUSION

- The aftershock zone of the Spitak earthquake of 1988 is separated by various specialists into segments with different seismological characteristics.
- The aftershock activity is going on. The process is divided into highly active (1988-1991) and weakly active (from 1992 till now) periods.
- Within the period of 1996-2007 slight activation of the aftershock process is observed in all the segments, which is expressed in escalation of both the quantity of the aftershocks, and the released energy.
- Certainly, since 1996 the 4th segment demonstrates significant activity in the weakly active aftershock period with both the quantity of earthquakes and the energy. It should be noted that this segment corresponds to the most strong and intense shaking of the main event of the 1988 Spitak earthquake.
- Against the backdrop of the attenuation of aftershocks' amounts and their forces no certain pattern of strong aftershocks is observed. Only the well-known opinion on that the probability of relatively strong aftershocks is greater directly after the main event can be confirmed.
- Until 2016 the total released energy of the aftershocks of the 1988 Spitak earthquake is the small percentage of the energy released during the main event.
- The majority of the total aftershock energy (98%) was released during the active aftershock period (1988-1991).



Thank you for attention

