

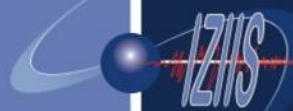
Institute of Earthquake Engineering and  
Engineering Seismology  
University 'Ss. Cyril and Methodius', R. of Macedonia

NATO SiP 983054 Project

**HARMONIZATION OF SEISMIC  
HAZARD MAPS FOR THE WESTERN  
BALKAN COUNTRIES**

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**Professor**

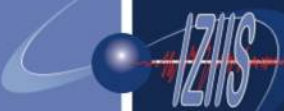


## GROUND MOTION MODELS - States

- **GMM are empirical relationship between ground motion parameters and parameter of the earthquakes and local soil that have influence to the intensity of the ground motion.**
- **Based on the analysis and synthesis of the published ground motion models in the region, Europe and World**
- **States are:**
  - - Large number of GMM based on local, regional and combined data banks of occurred strong earthquakes.
  - Different definition of magnitude and its size.
  - Different definition of distance and its size.
  - Different classification of the local soil condition at the strong motion instrument sites.
  - With Involve or not involve the type of the fault mechanism of the earthquakes
  - Different mathematical models as an GMM
  - Single or double regression analysis as a method for their determination

## Influence of the GMM on Results of PSHA

- **This situation with the GMM's will last for a long period of time due to the fact that time of instrumental recording of earthquakes compared to the time period of their occurrence on the Earth is very small and imposes application of alternative GMM's in the PSHA for the purpose of scattering the error from the only one GMM upon the results from PSHA that are applicable in practice.**



## **CERTAIN INITIAL CRITERIA FOR THE SELECTION OF GMM s**

- **GMM's should be defined on databanks that include regional data.**
- **The application of alternative GMM's from Europe and World must be based on comparison with recorded regional data from occurred earthquakes.**
- **The main banks in the counties of the WB could contained relevant data that are necessary for the using of the alternative GMM's, as for example, defined shortest distances from the location to the vertical projection of the fault upon the surface, documentation on types of faults in all the countries in the WB involved in this project.**
- **The software tools to be used in the analyses of PSHA in this project should be able to accept different mathematical models of GMM's.**

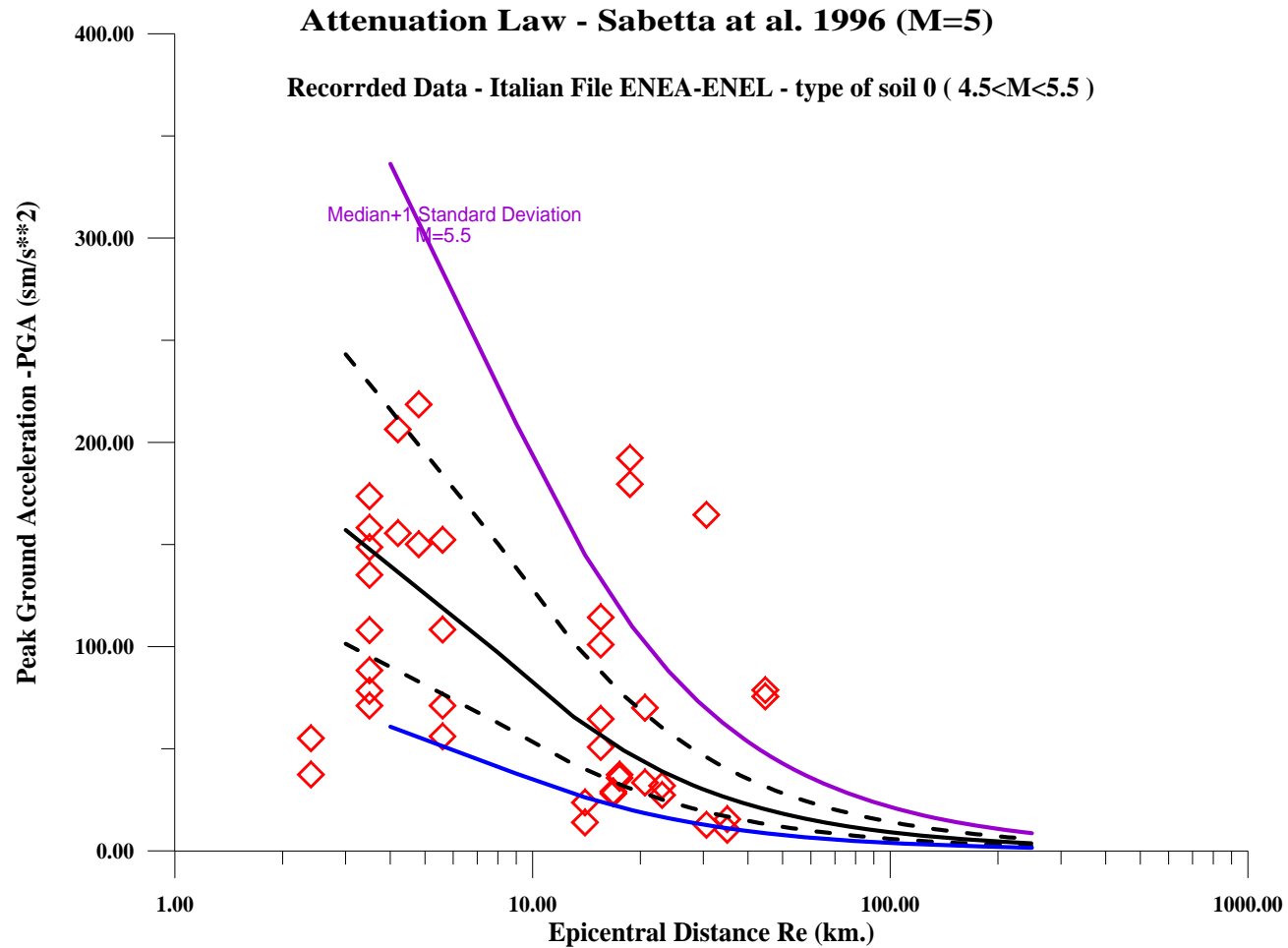
## A Wider Selection of Alternative GMMs

- **ALL regional Attenuation laws** that satisfy previous criteria for selection.
- **Ambrasseys et al. (1996)** defined on the basis of the European Bank of Strong Motion Data.
- **Sabetta & Pugliese (1996)** developed based on the Italian strong motion data bank.
- **Ambrasseys et al (2005)** defined on the basis of the European data bank and with a mathematical model that includes the effect of the type of fault at the focus.
- **Idriss (1993, 2002, 2007)** defined based on data bank from the USA enriched with other more important records from the entire World.
- **Sadigh et al. (1993).**
- **Boor & Atkinson (2007).**

## A Final Selection of Alternative GMM's

- Which of these GMM's shall be applied as alternative in final PSGA depends on possibility that they be directly applied in the software programme that are used for PSHA and the procurement of the local data banks with data necessary for the application of these GMM's.
- It's important to note that the software programme to be used must also take into consideration the scattering of the data around the median values of the GMM's, i.e. to include also the SD by which they have been defined.

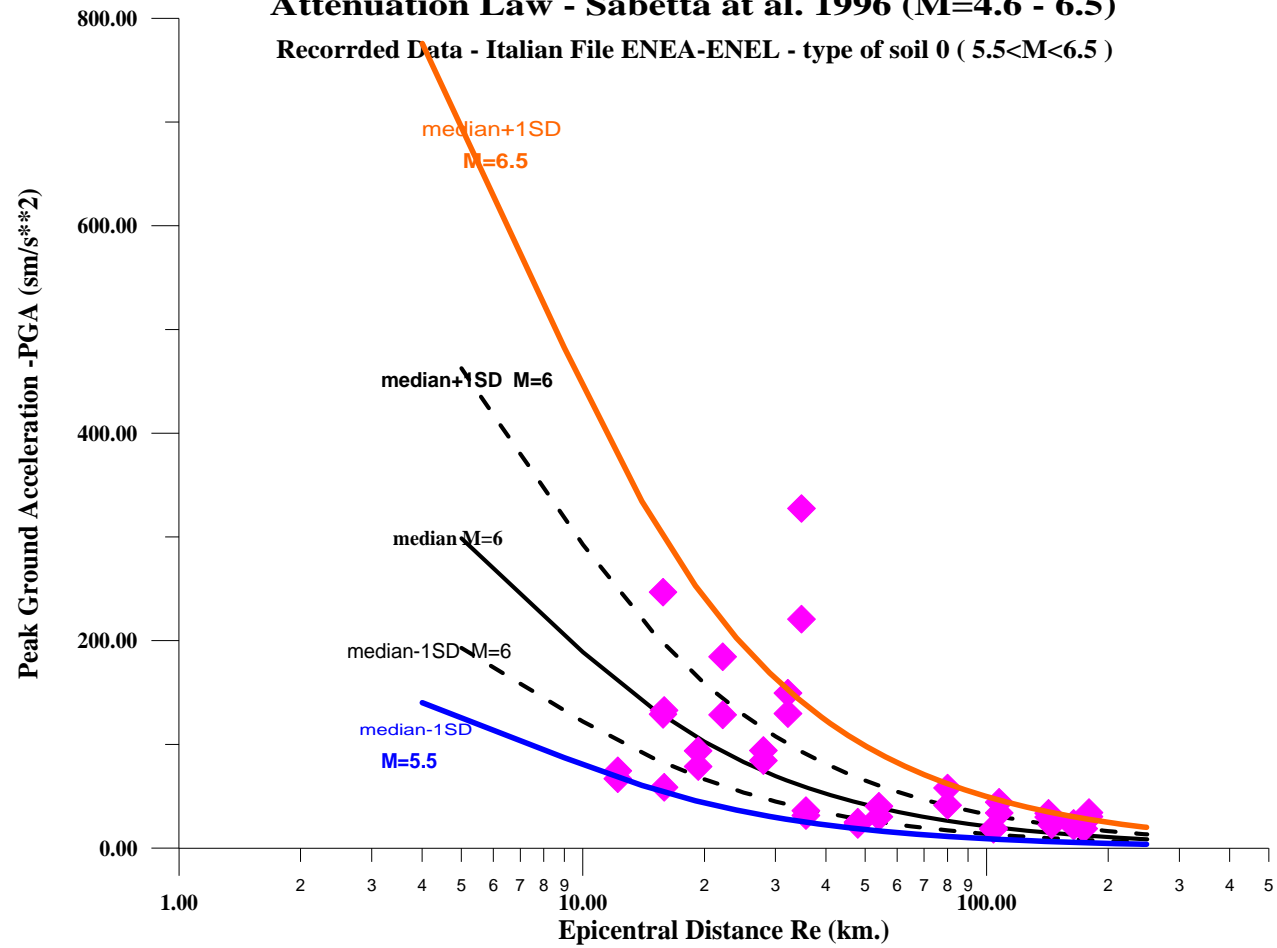
# RESULTS OF THE COMPARISONS MADE





### Attenuation Law - Sabetta et al. 1996 (M=4.6 - 6.5)

Recorded Data - Italian File ENEA-ENEL - type of soil 0 (5.5 < M < 6.5)

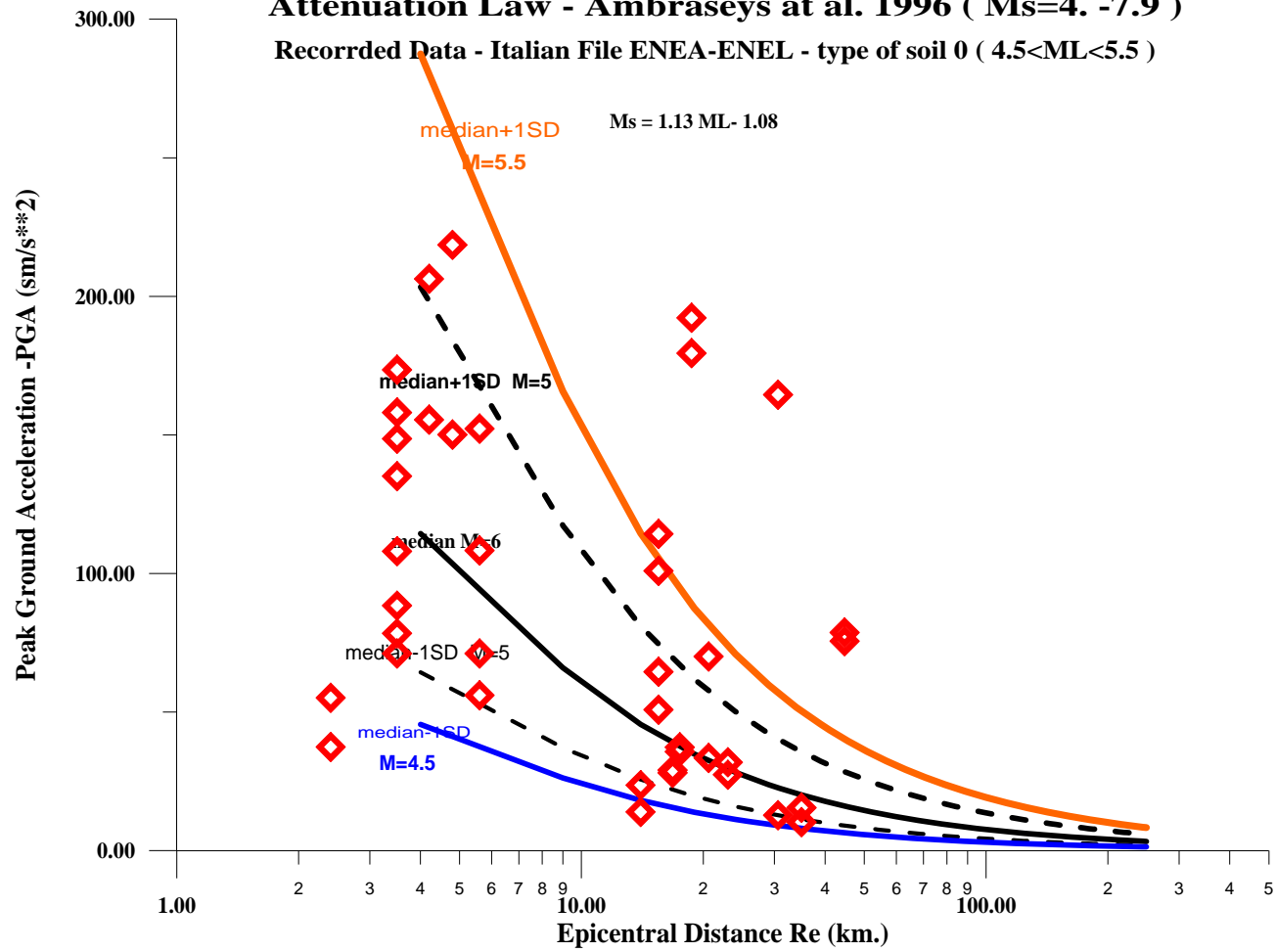






### Attenuation Law - Ambraseys et al. 1996 ( $M_s=4. -7.9$ )

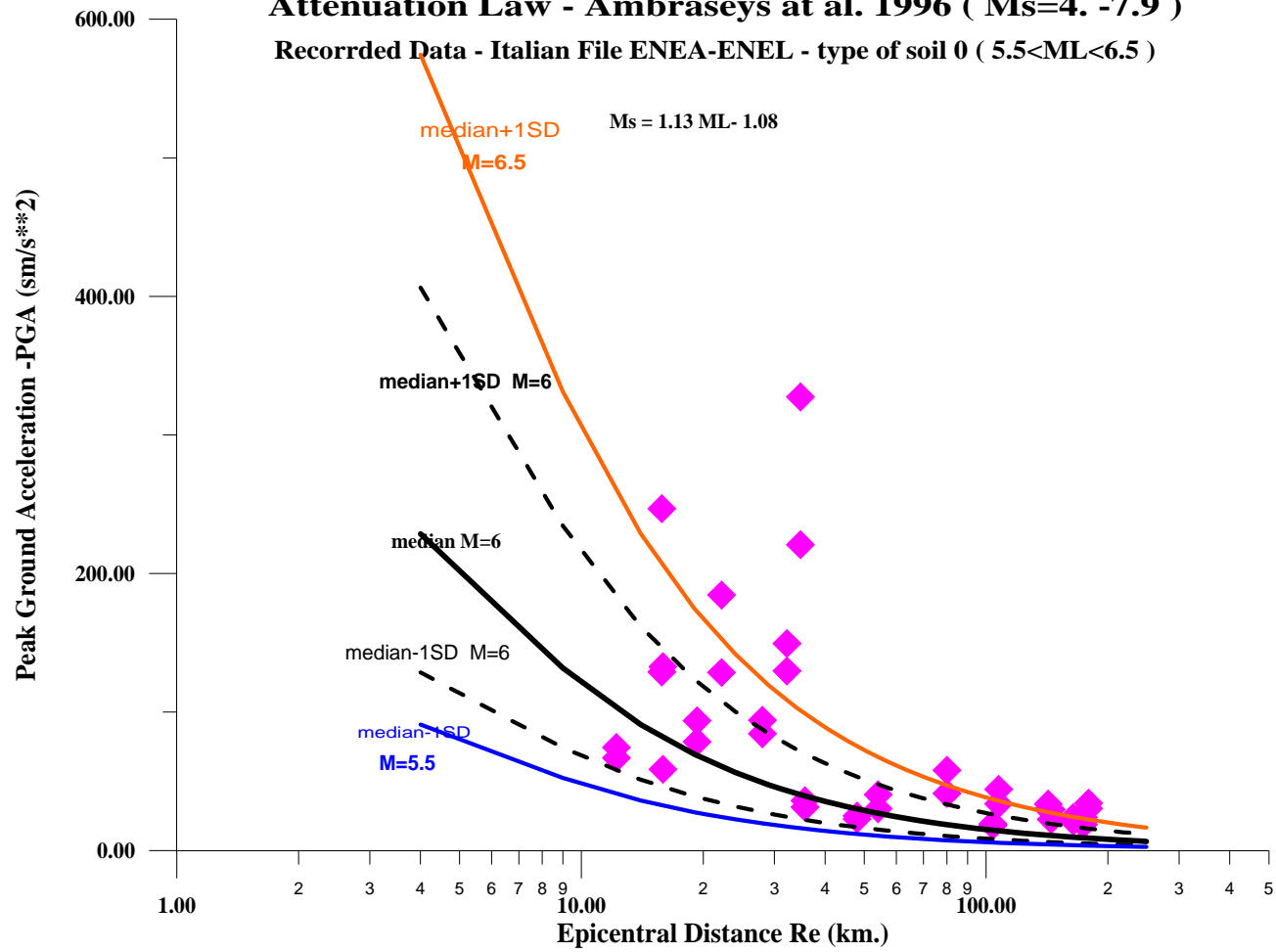
Recorded Data - Italian File ENEA-ENEL - type of soil 0 (  $4.5 < M_L < 5.5$  )

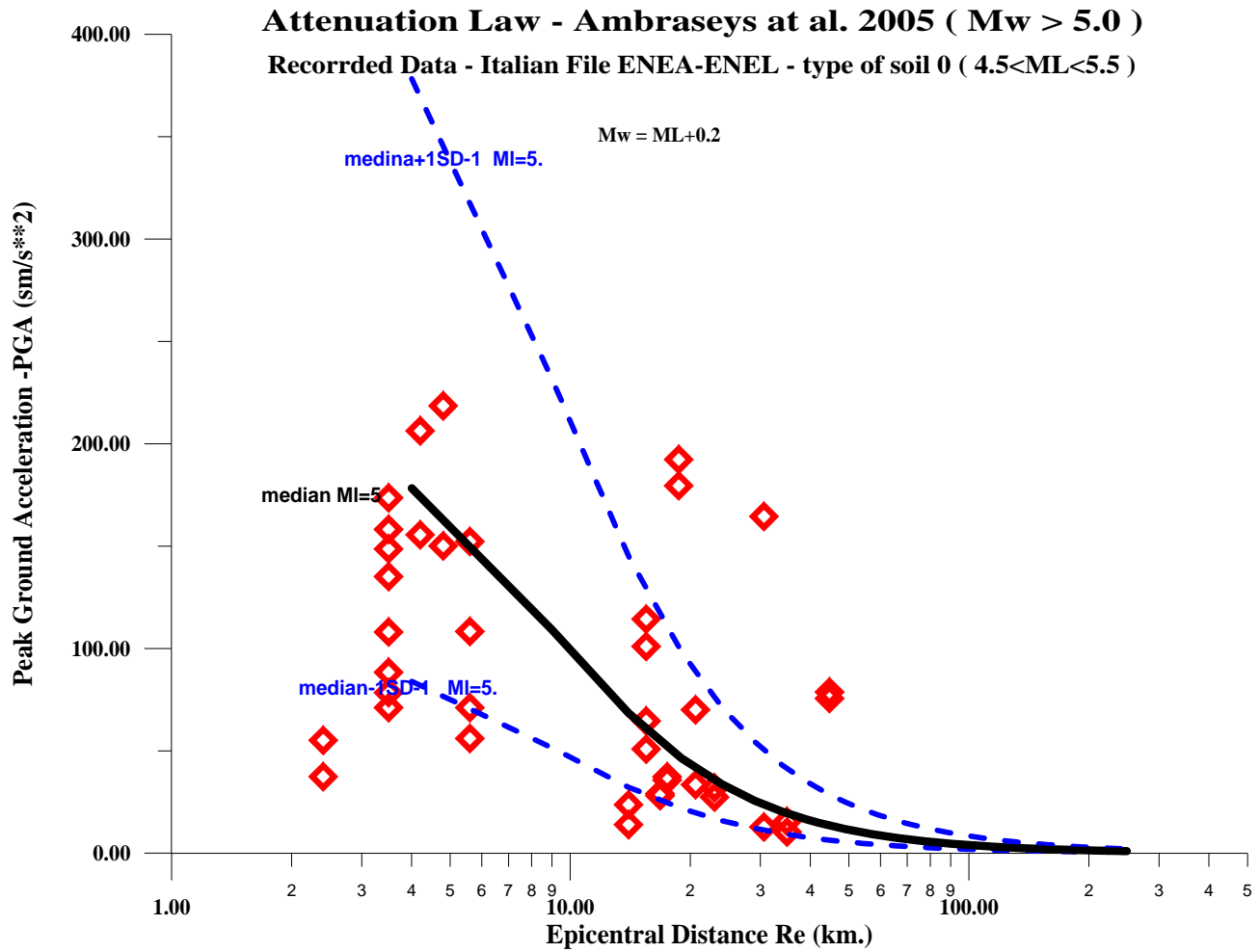


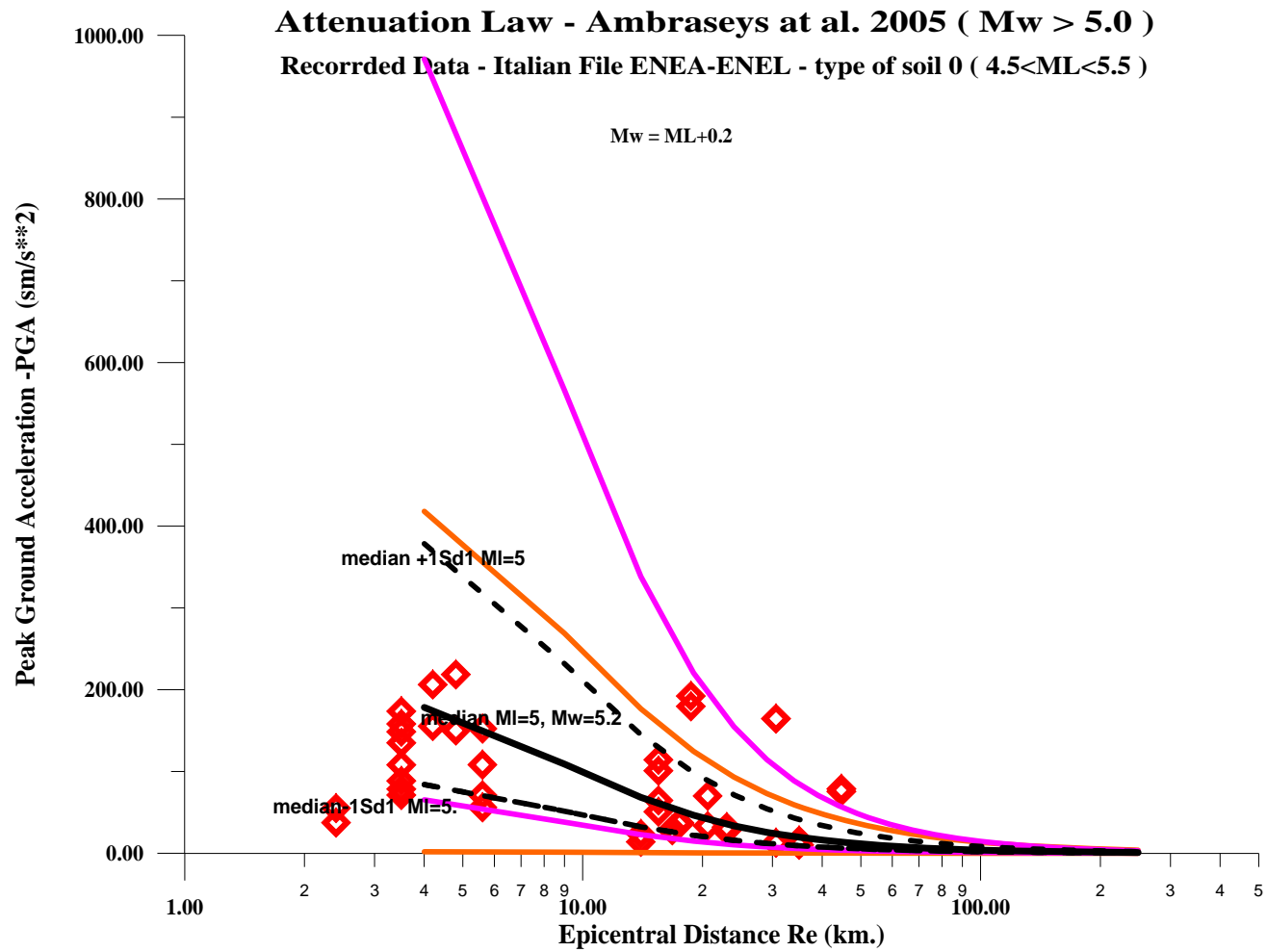


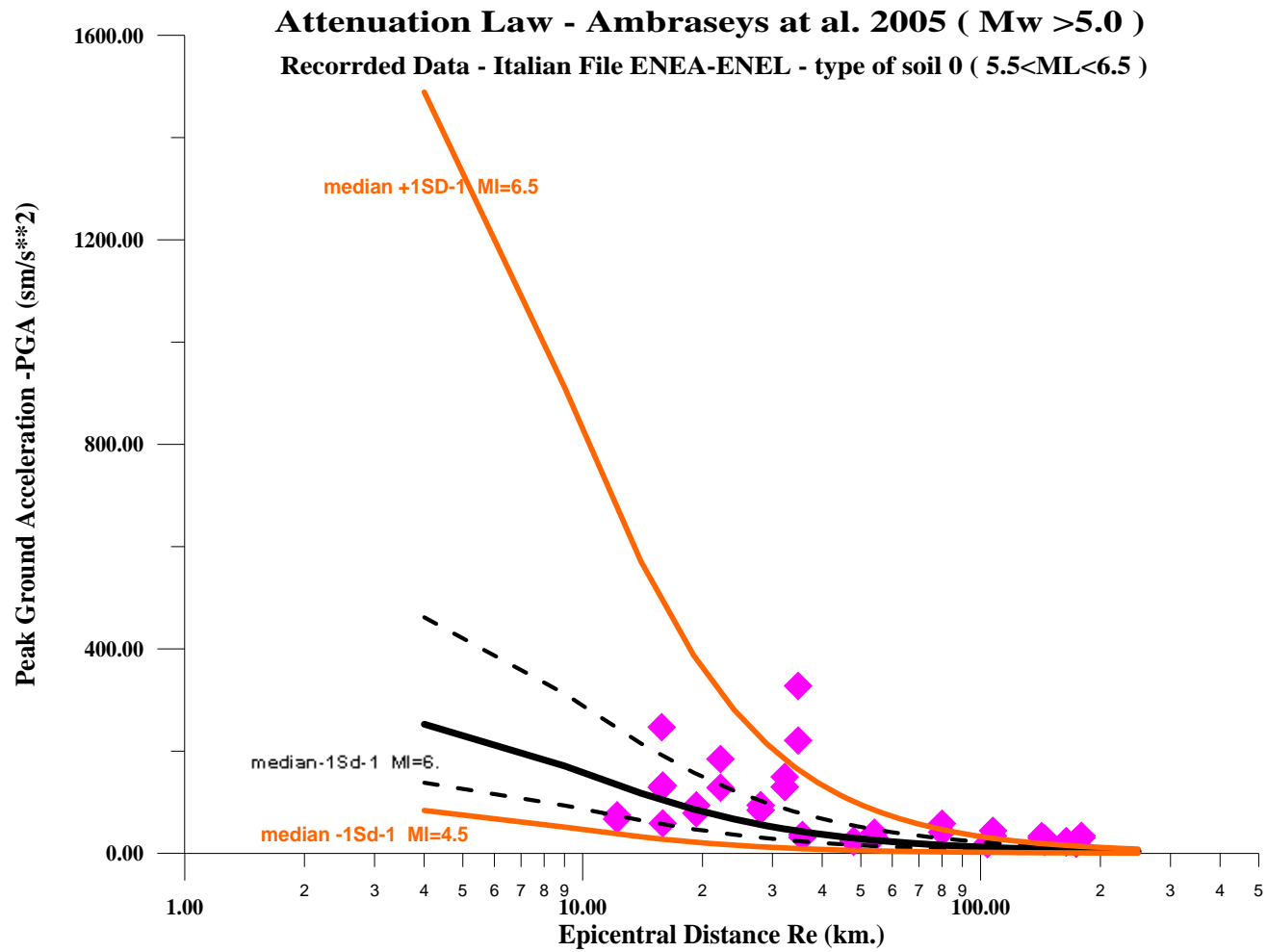
### Attenuation Law - Ambraseys et al. 1996 ( $M_s=4. -7.9$ )

Recorded Data - Italian File ENEA-ENEL - type of soil 0 (  $5.5 < M_L < 6.5$  )





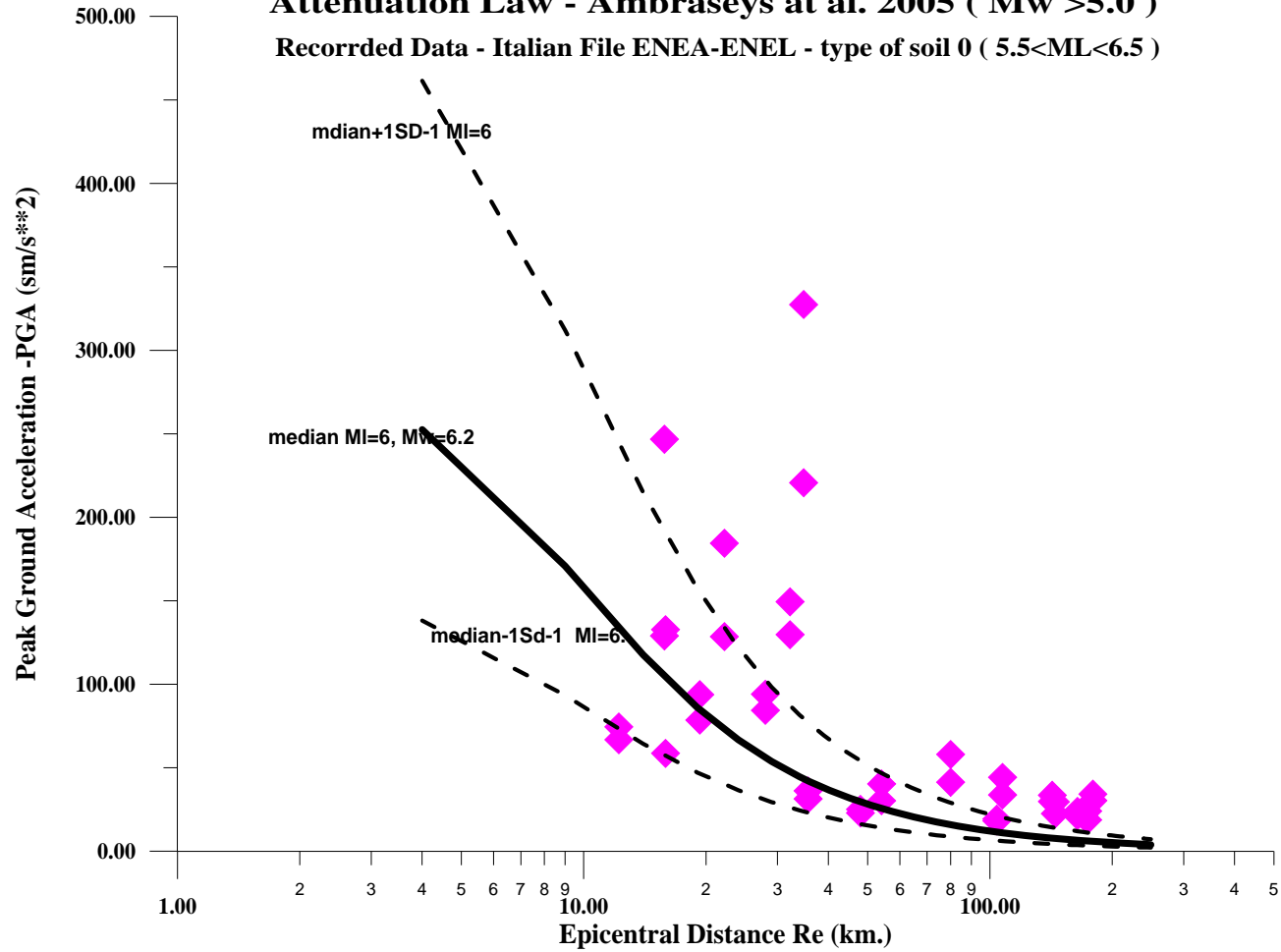


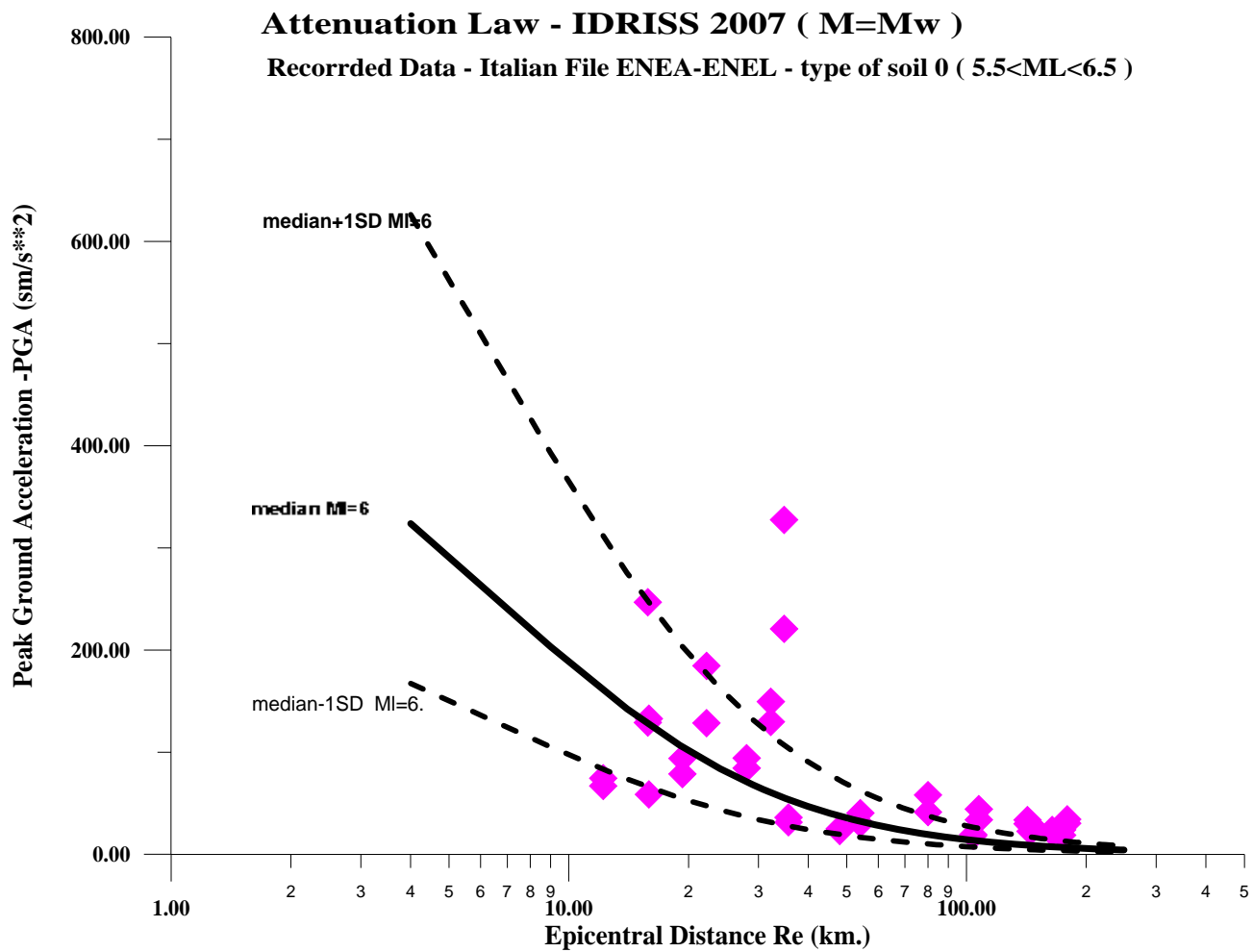


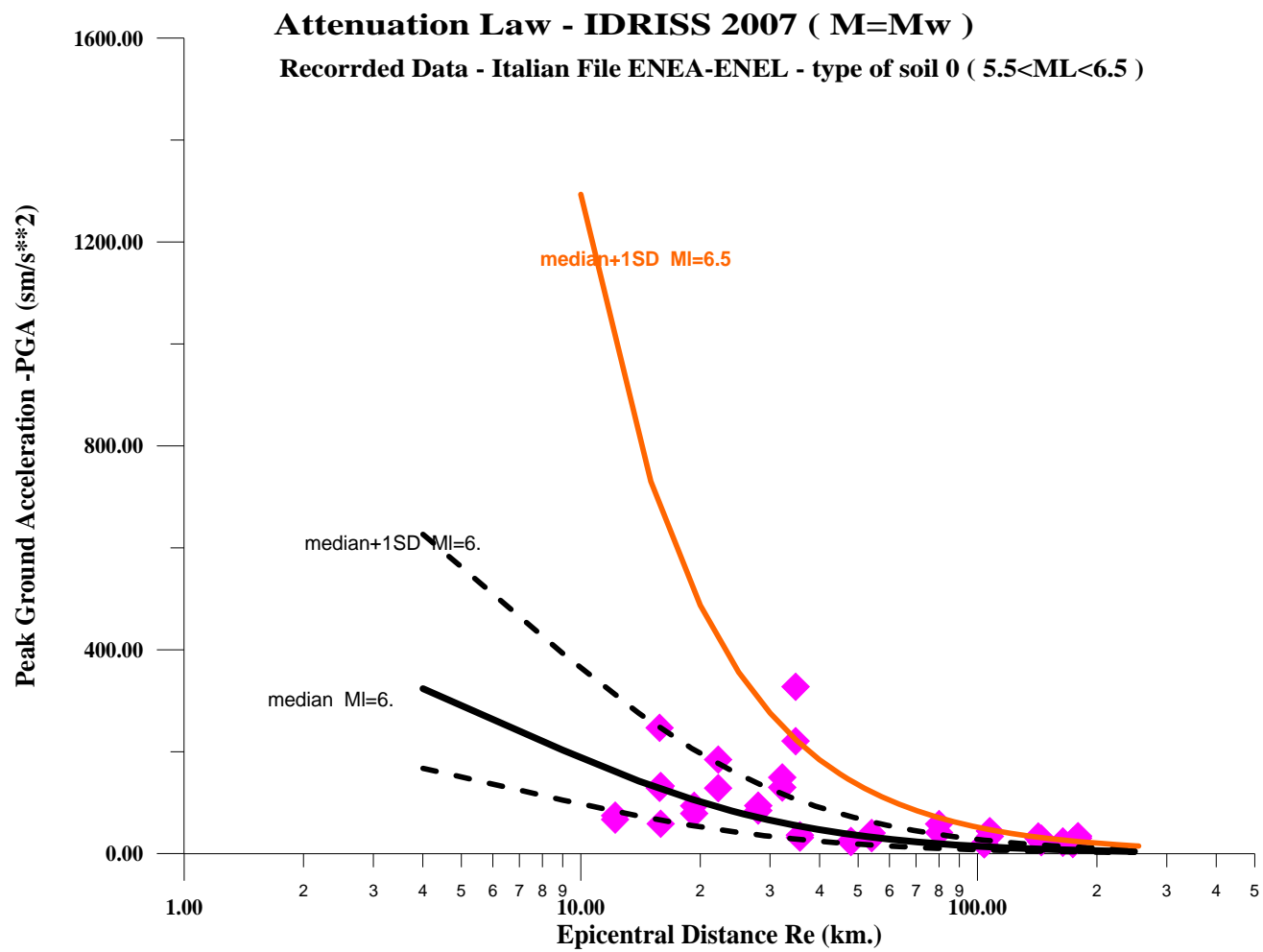


### Attenuation Law - Ambraseys et al. 2005 ( Mw >5.0 )

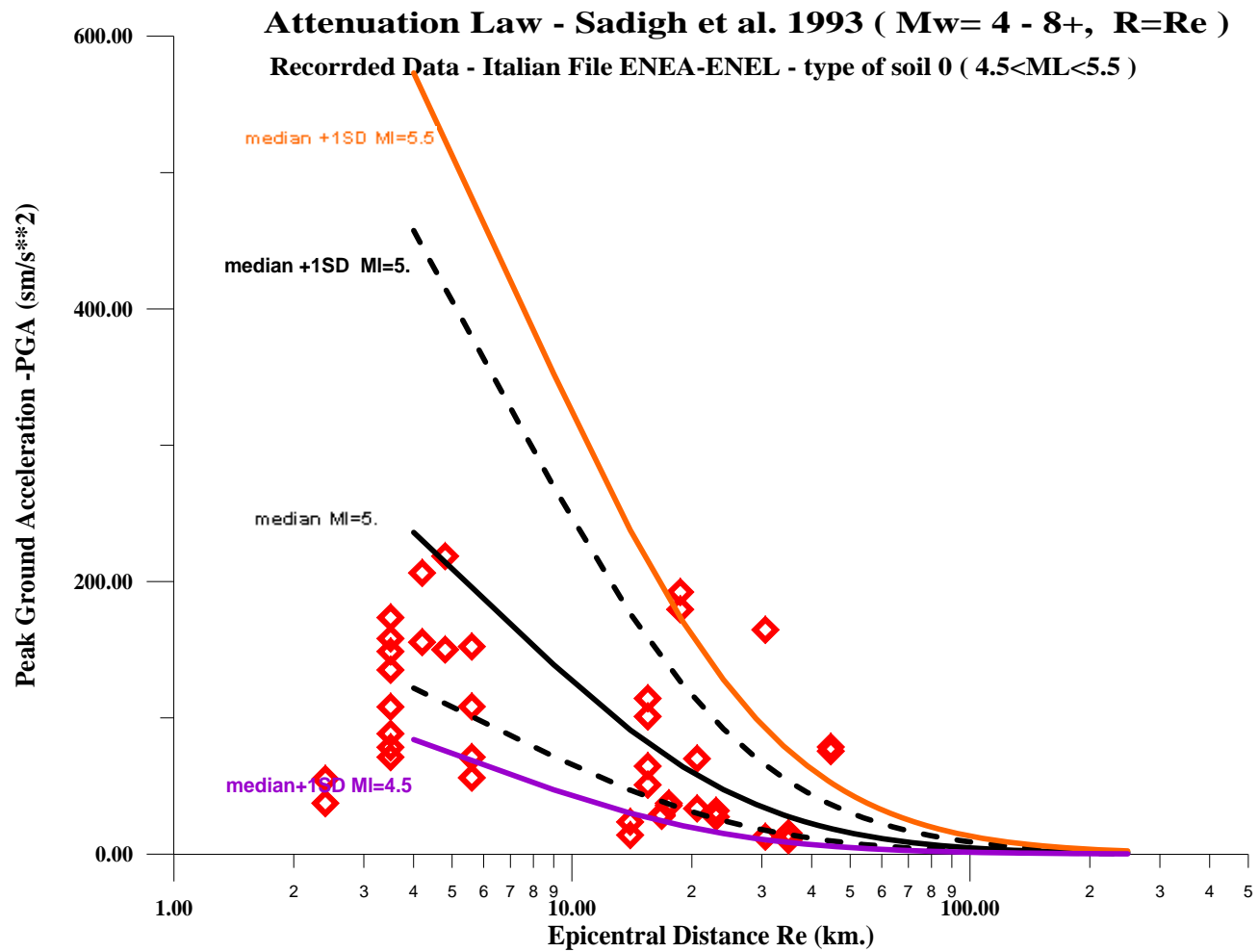
Recorded Data - Italian File ENEA-ENEL - type of soil 0 ( 5.5 < ML < 6.5 )







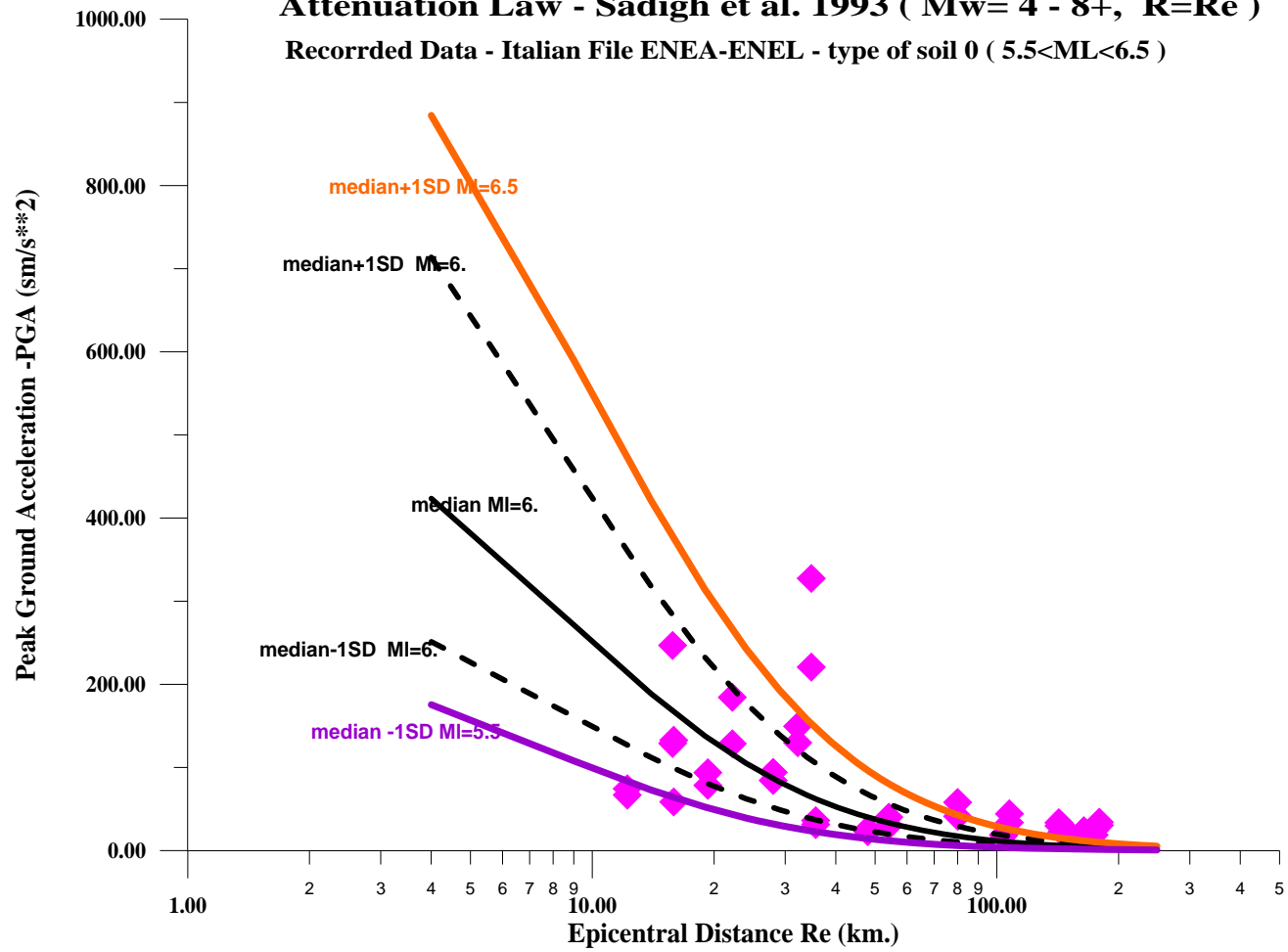


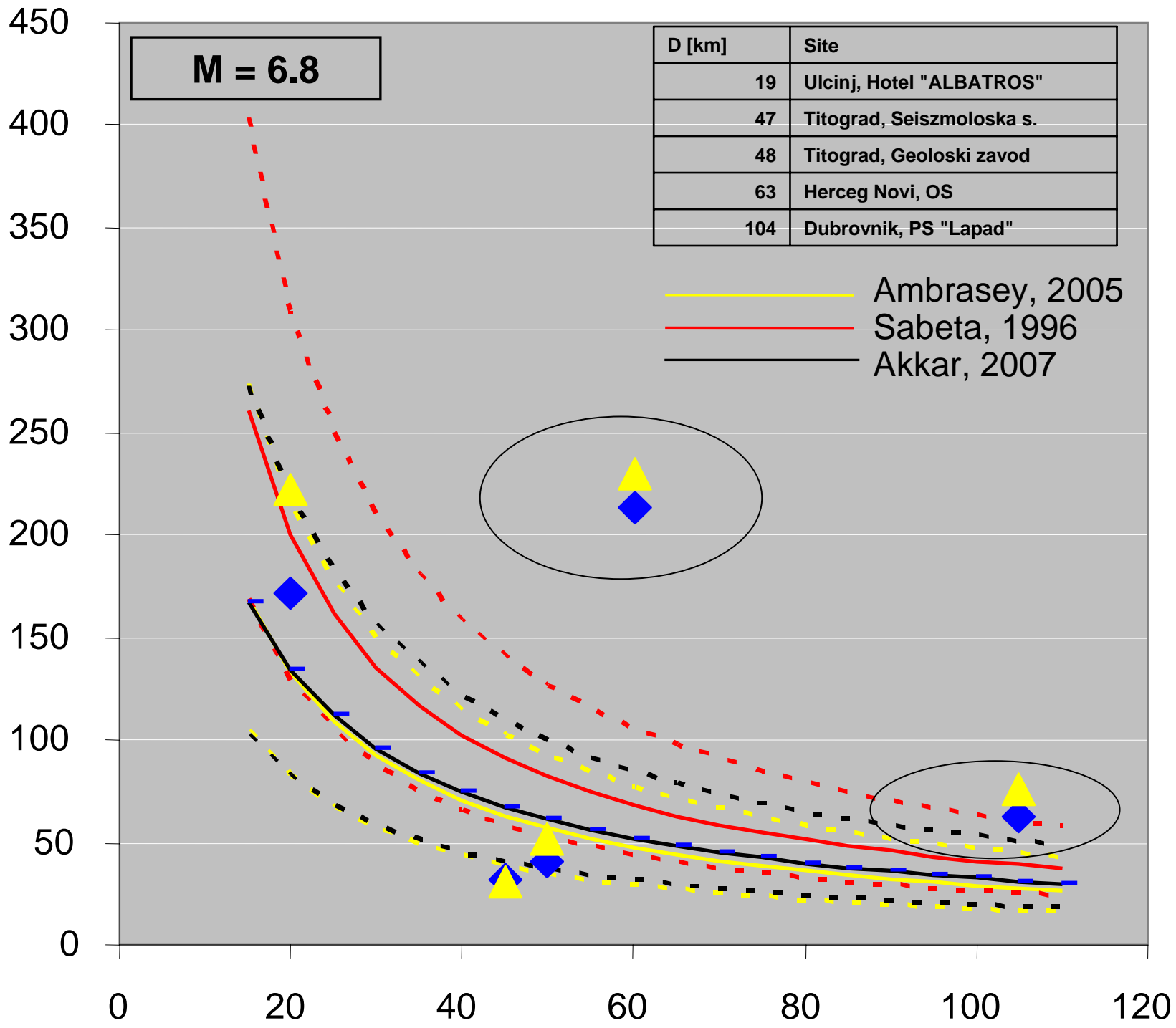




### Attenuation Law - Sadigh et al. 1993 ( Mw= 4 - 8+, R=Re )

Recorded Data - Italian File ENEA-ENEL - type of soil 0 ( 5.5<ML<6.5 )

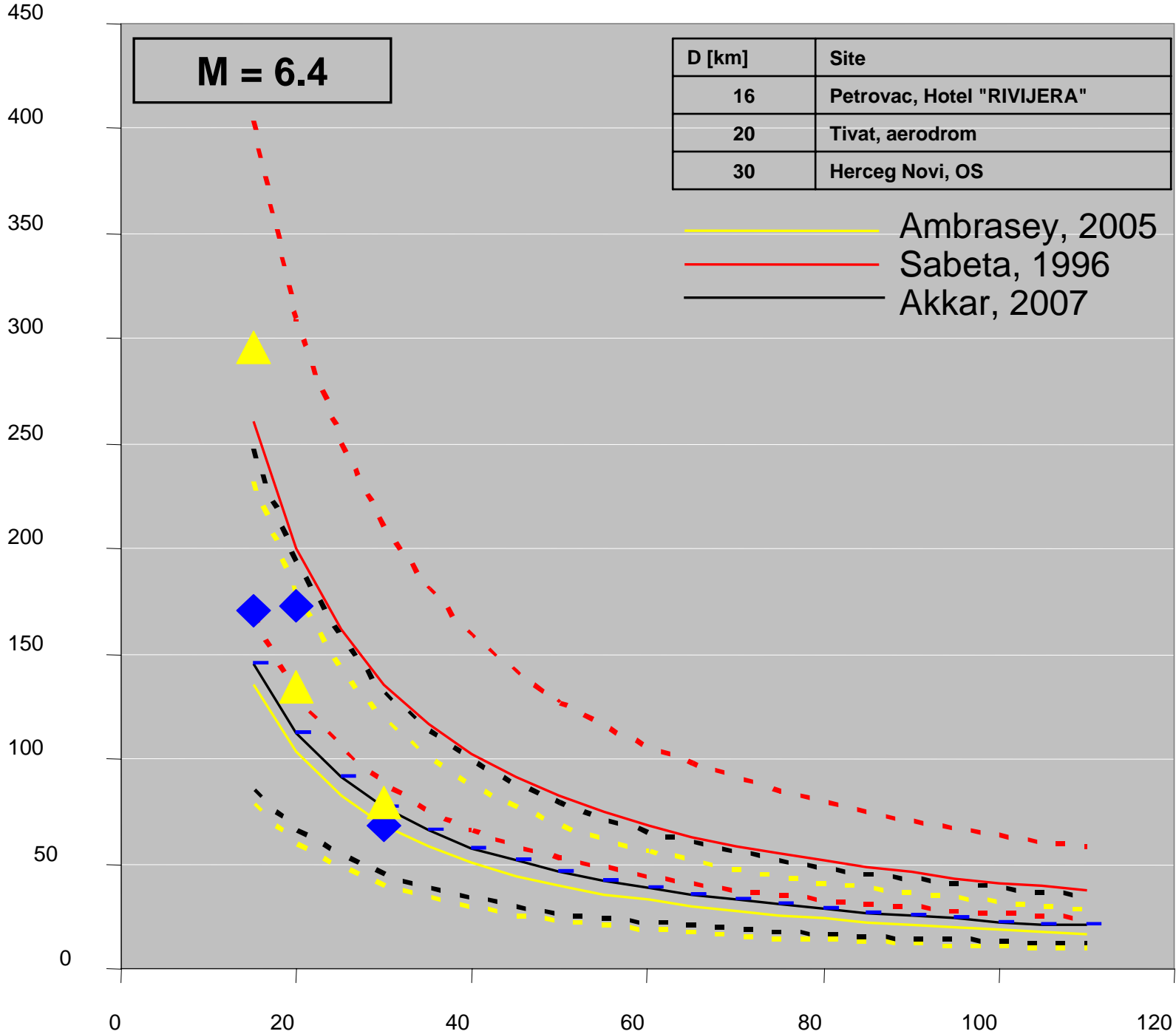




**M = 6.4**

D [km]	Site
16	Petrovac, Hotel "RIVIJERA"
20	Tivat, aerodrom
30	Herceg Novi, OS

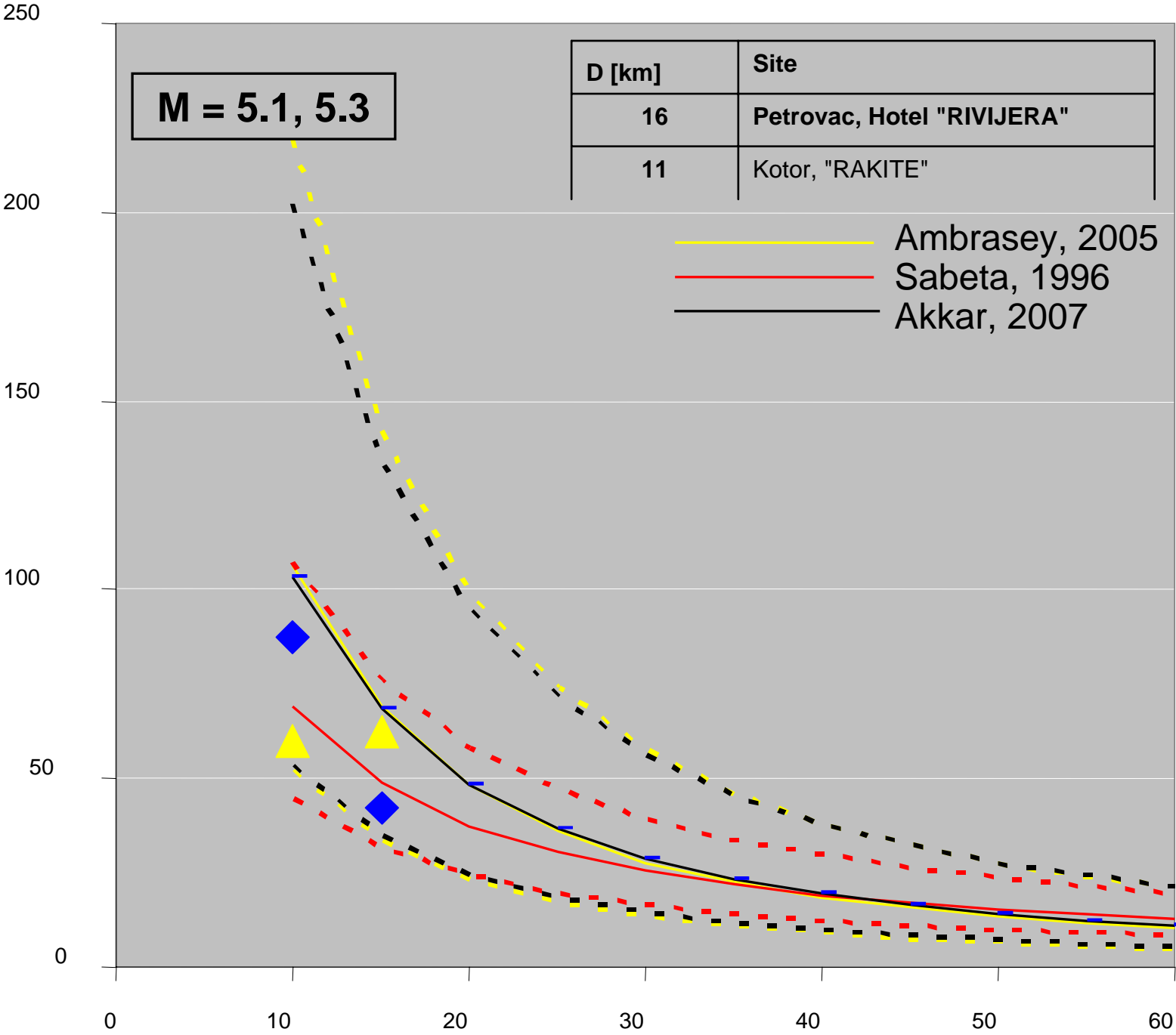
Ambrasey, 2005  
Sabetta, 1996  
Akkar, 2007



**M = 5.1, 5.3**

D [km]	Site
16	Petrovac, Hotel "RIVIJERA"
11	Kotor, "RAKITE"

Ambrasey, 2005  
Sabeta, 1996  
Akkar, 2007





**Thank you for your attention**