



Project co-financed by the European Union European Regional Development

...Towards Seismic Hazard Curves...

Collaboration with; UoM, UniCT, INGV

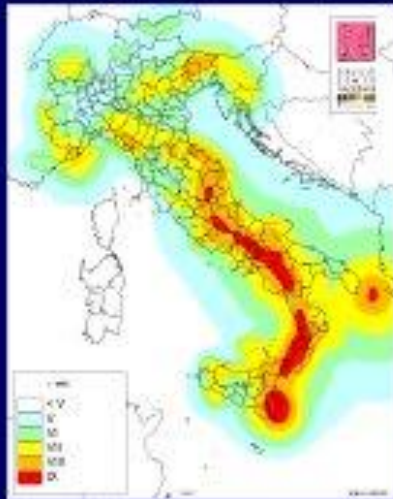


P.O Italia-Malta 2007-2013 progetto SIMIT (Codice B1-2.19/11):
Costituzione di un sistema integrato di protezione civile transfrontaliero italo-maltese

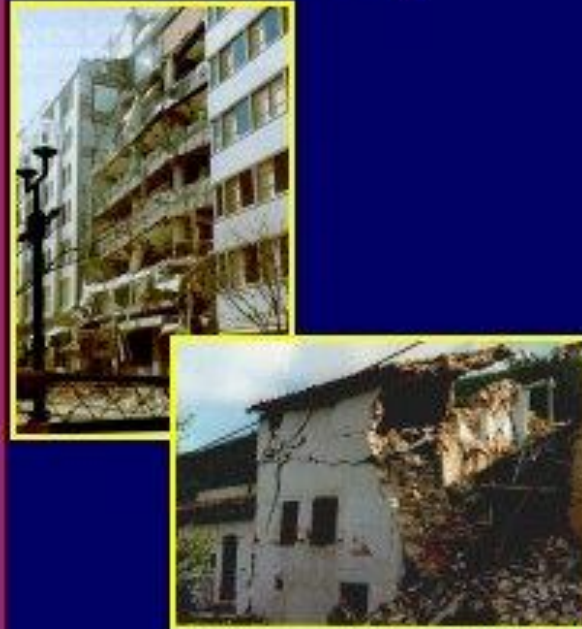


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Hazard



Vulnerability



Exposure





Earthquake
Emergency
Phase

t ~ seconds

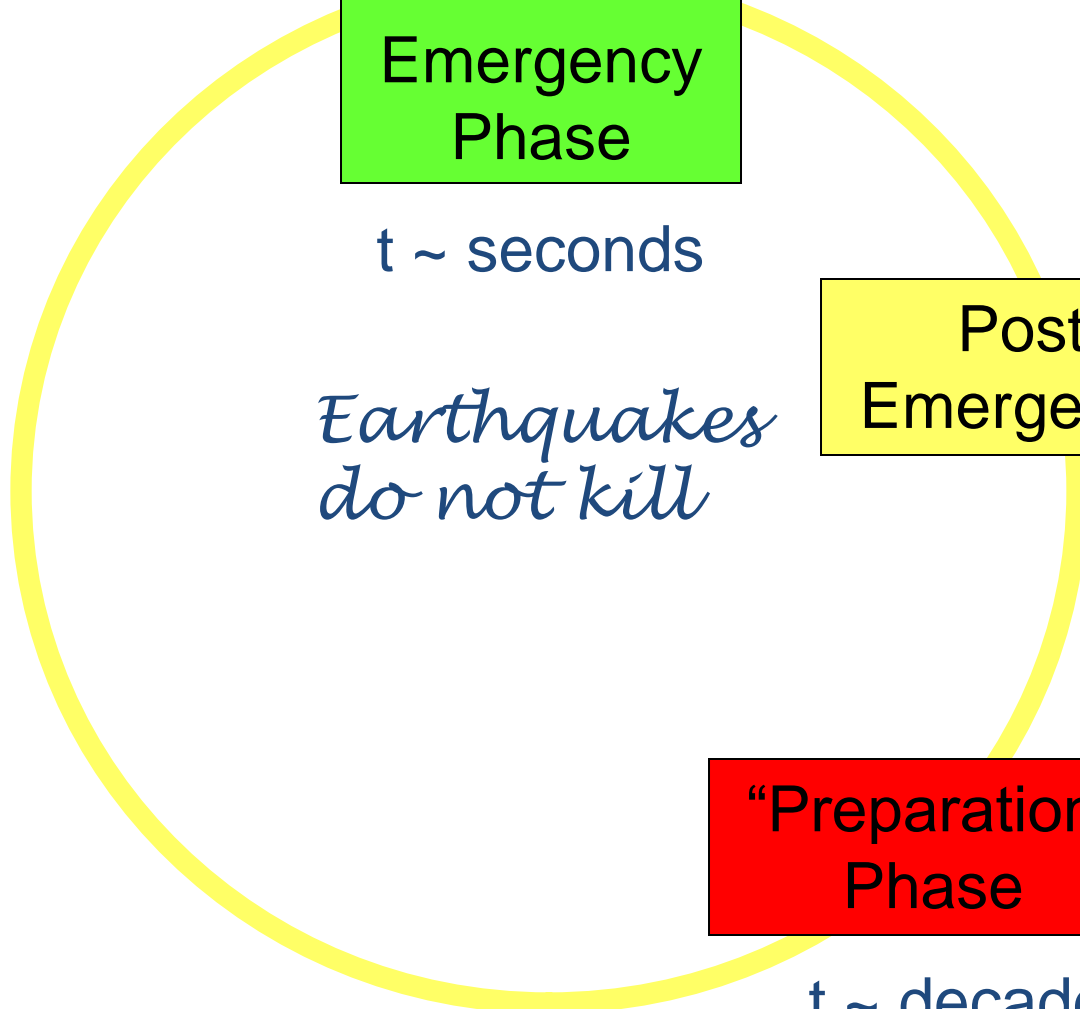
Post
Emergency

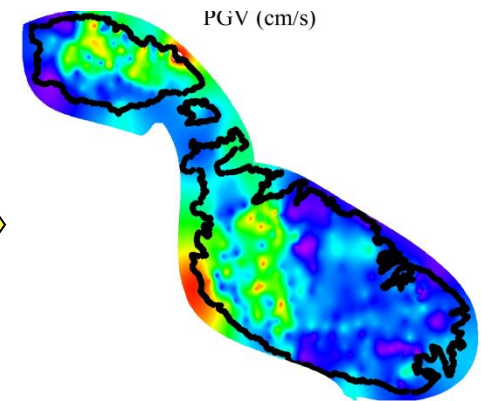
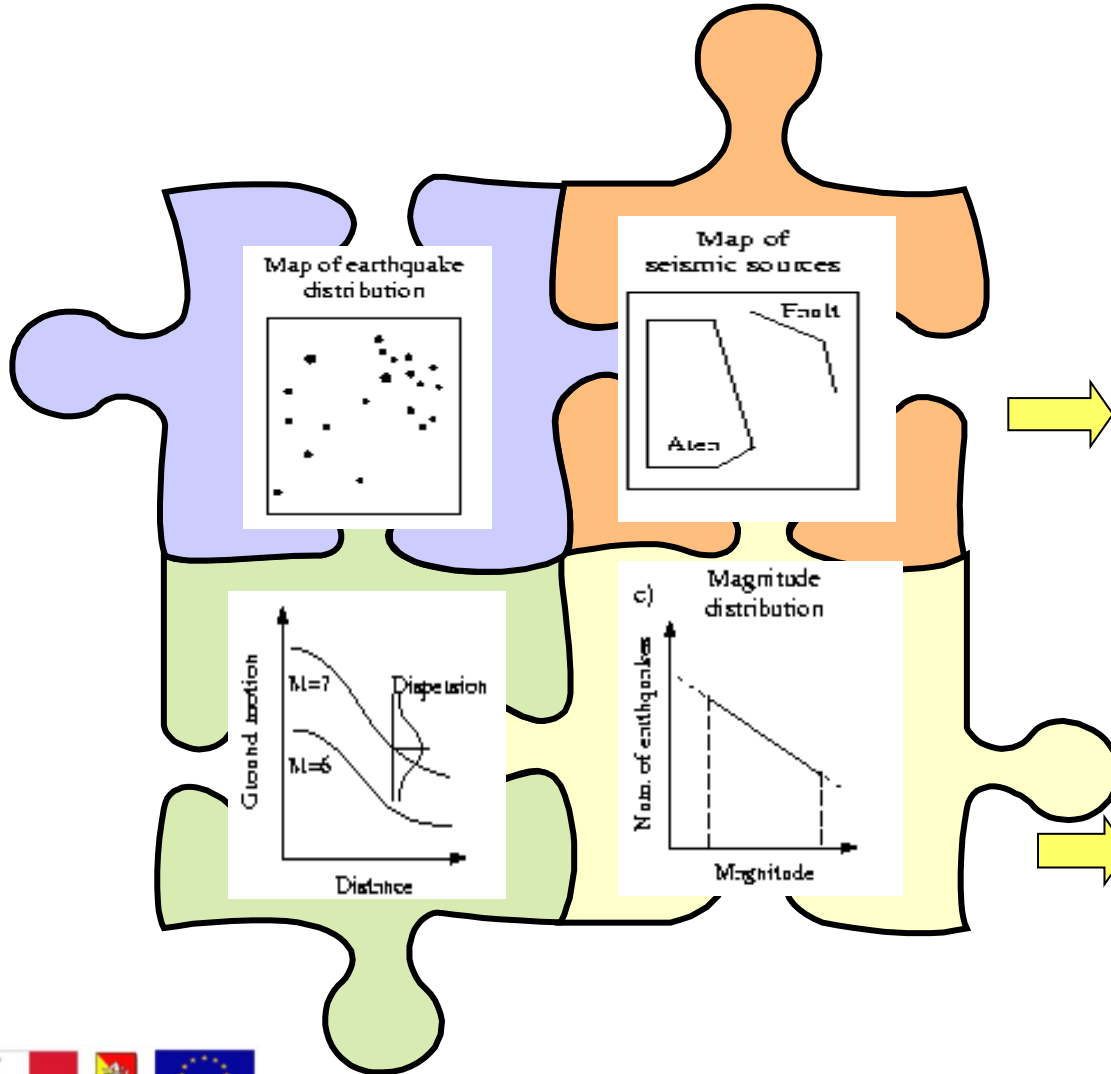
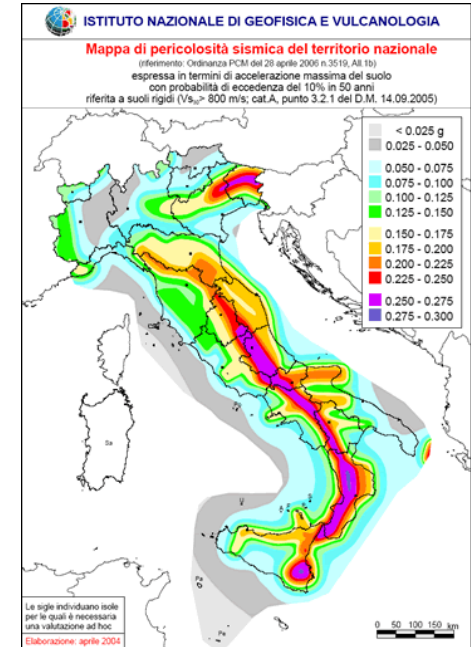
t ~ months

“Preparation”
Phase

t ~ decades

*Earthquakes
do not kill*







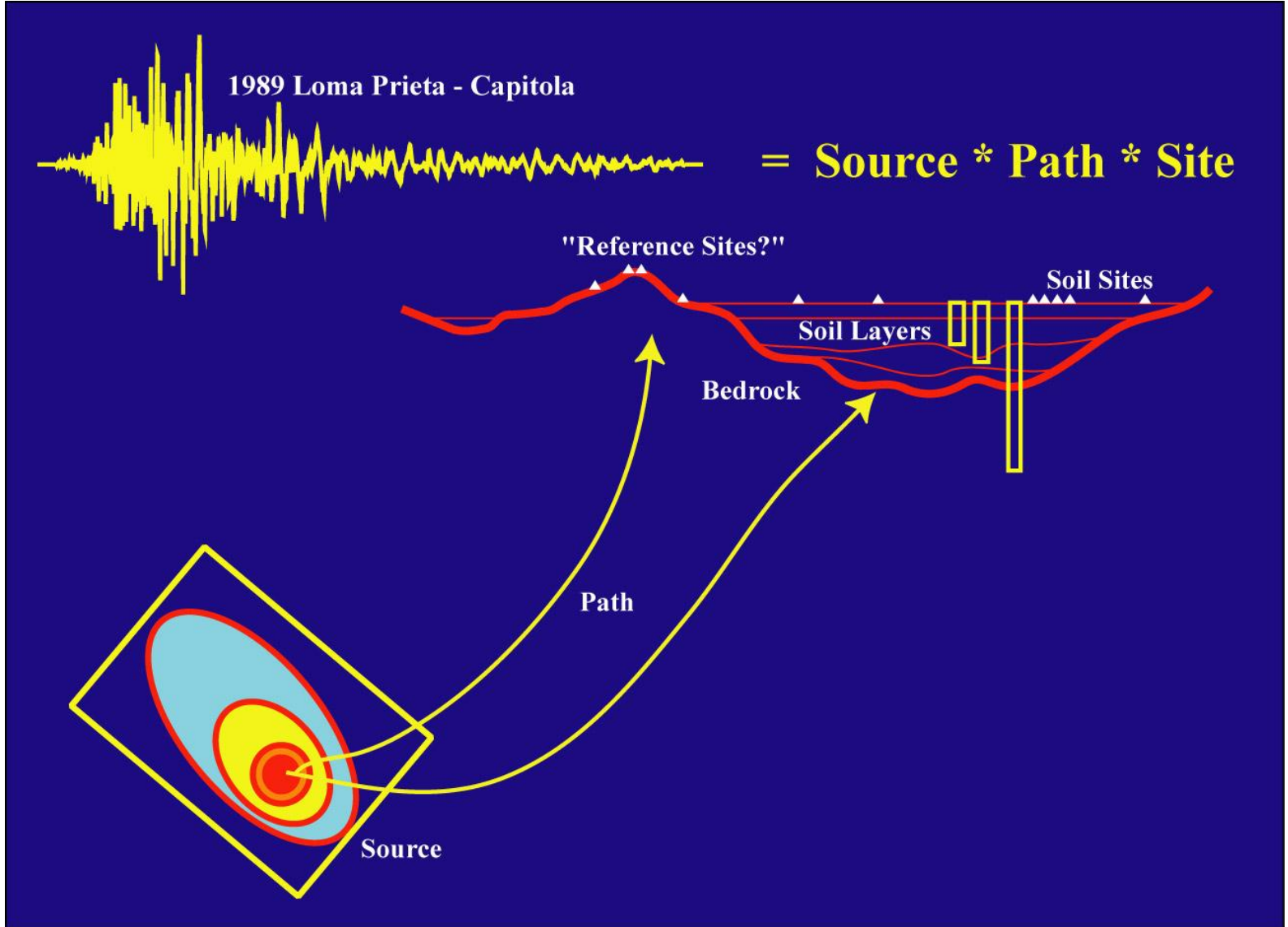
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- ITALY (**Eastern Alps**, Malagnini et al, 2002; **Apennines**, Malagnini et al, 2000, **Eastern Sicily**, Scognamiglio et al., 2001, **Western Alps**, Morasca et al., 2003)
- CENTRAL EUROPE (Malagnini et al, 2000)
- SWITZERLAND (Bay et al, 2002)
- TURKEY (**Erzincan region**, Akinci et al, 2002; **Marmara region**, Akinci et al, 2004, **Western Anatolia**, Akinci et al., 2013)
- USA (**CALIFORNIA, BASIN AND RANGE**, Malagnini et al. 2010)
- TAIWAN (D'Amico et al., 2012)





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The regional propagation term

$$D(r, r_{ref}, f) = \log[g(r)] - \log[g(r_{ref})] - \frac{\pi f(r - r_{ref})}{\beta Q(f)}$$

$$g(r) \sim \begin{cases} r^{-x1} \\ r^{-x2} \end{cases}$$

$$\begin{aligned} 1 < r < d1 \\ r > d2 \end{aligned} \quad \gamma(f) = Q_0 \left(\frac{f}{f_{ref}} \right)^\eta$$

Attenuation: It is due to the anelastic absorption and scattering. It is lose of energy due to the friction of the materials, temperature and inhomogeneity in the path

Geometrical Spreading:

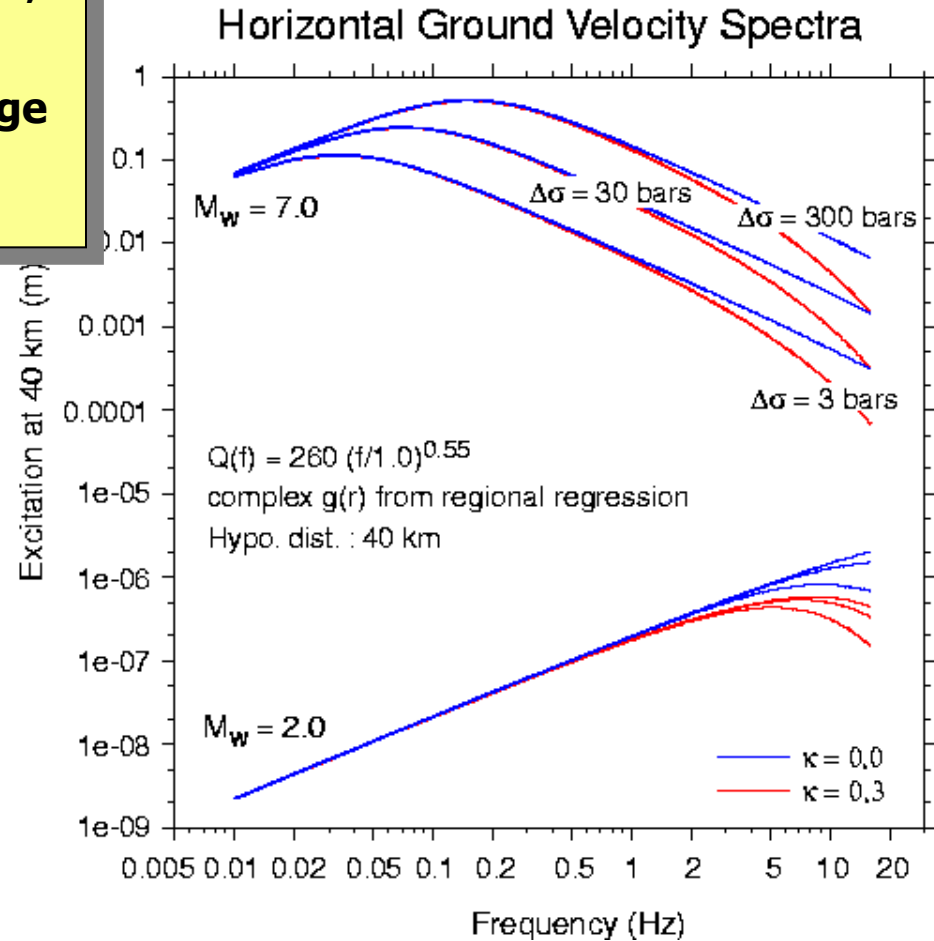
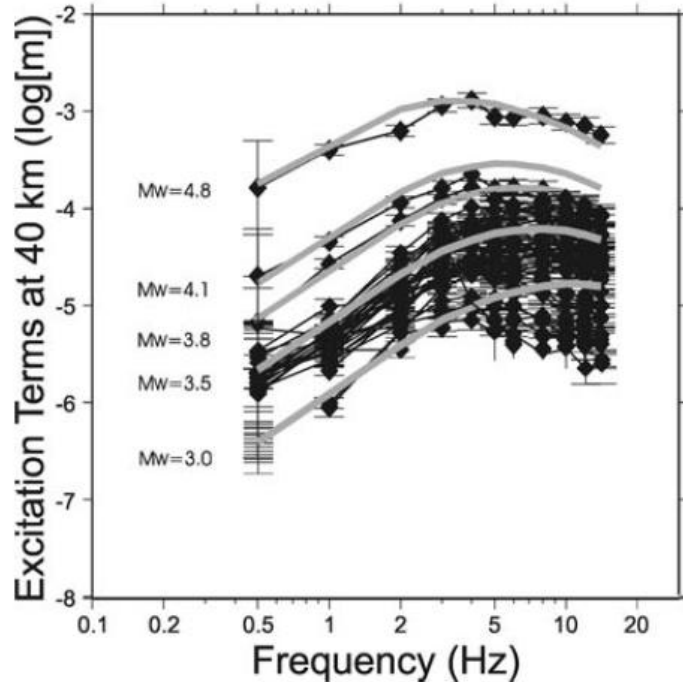
Propagation of a spherical wave front in an homogeneous and isotropic space (principle of conservation of energy)





Small events are insensitive to $\Delta\sigma$ in the frequency band of our interest, and can be used to calibrate κ_0 .

Spectra of radiated energy of large earthquakes must be used to calibrate the stress parameter.





SUMMARY

Region	Q_0	n	κ (sec) (distance-independent network average)	$\Delta\sigma$ (MPa) (Brune stress drop of largest events)	r_{max}
Central-Southern Apennines	130	0.10	0.00- 0.04	20	400
Eastern Alps	260	0.55	0.045	60	200
Western Alps	310	0.20	0.015	20	160
Eastern Sicily	360	0.50	0.03	40	70



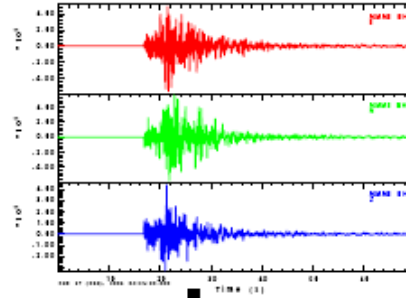
CAP & SLUMT methods

D'Amico et al. (2010, 2013)

Herrmann (2008)

1) Select velocity model.

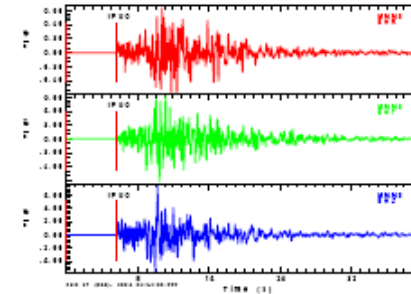
2) Compute Green's functions



+

Perform quality control and Correct for the instrumental response

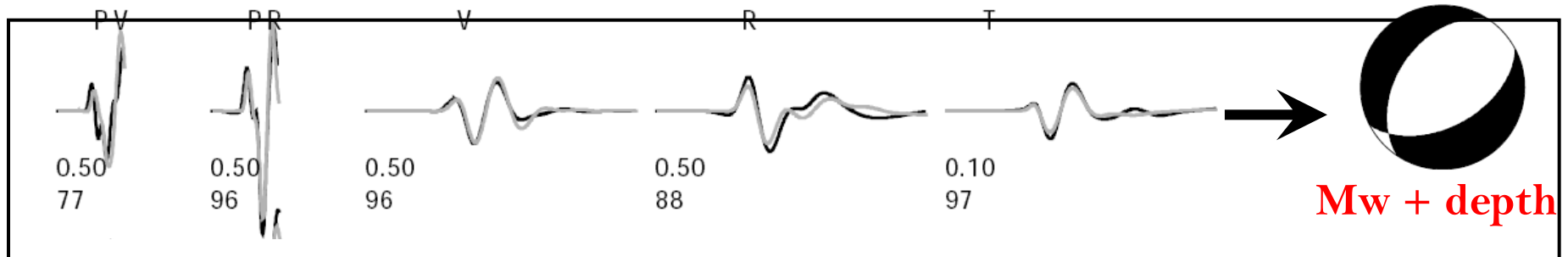
Review picking and Rotate



GF for a distance from 5 to 500km and a depth range from 5 to 60km with a spacing of 2km.

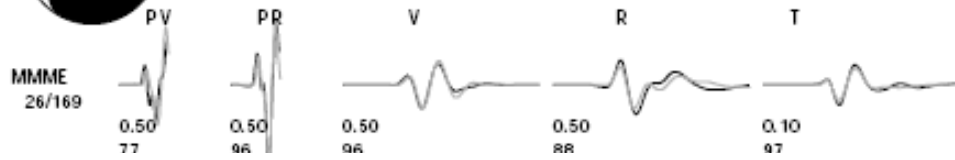
Grid-search over:

M_w, Depth, Strike, Dip, Rake

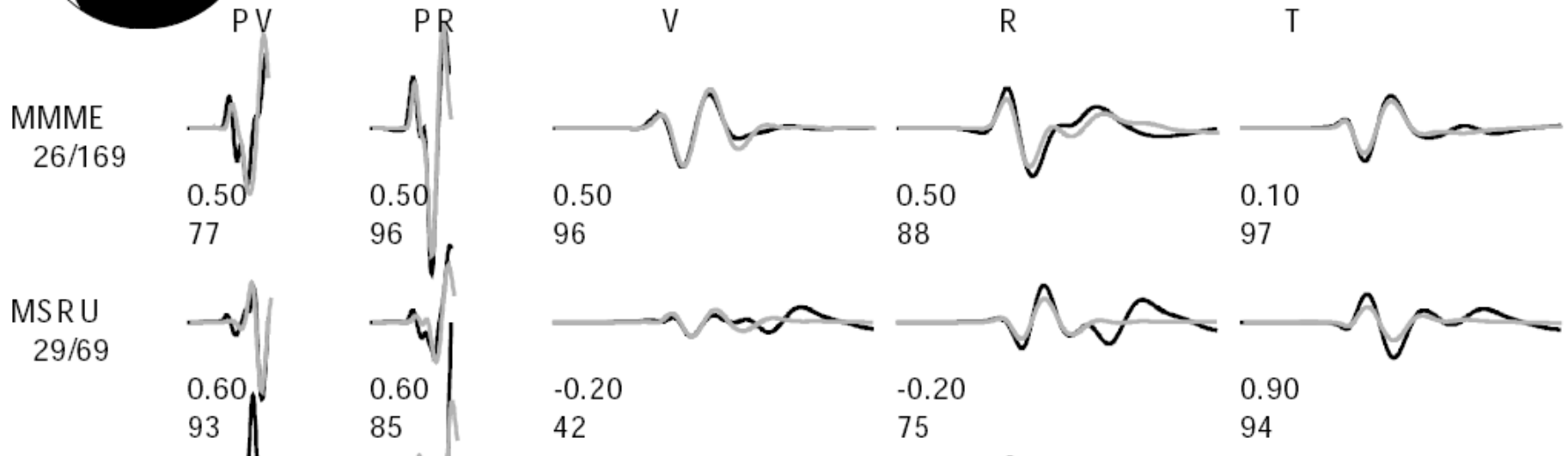




Event: 20060227a Model: VM1 FM: 62 50 -71 Mw: 4.1 rms: 6.276e-04

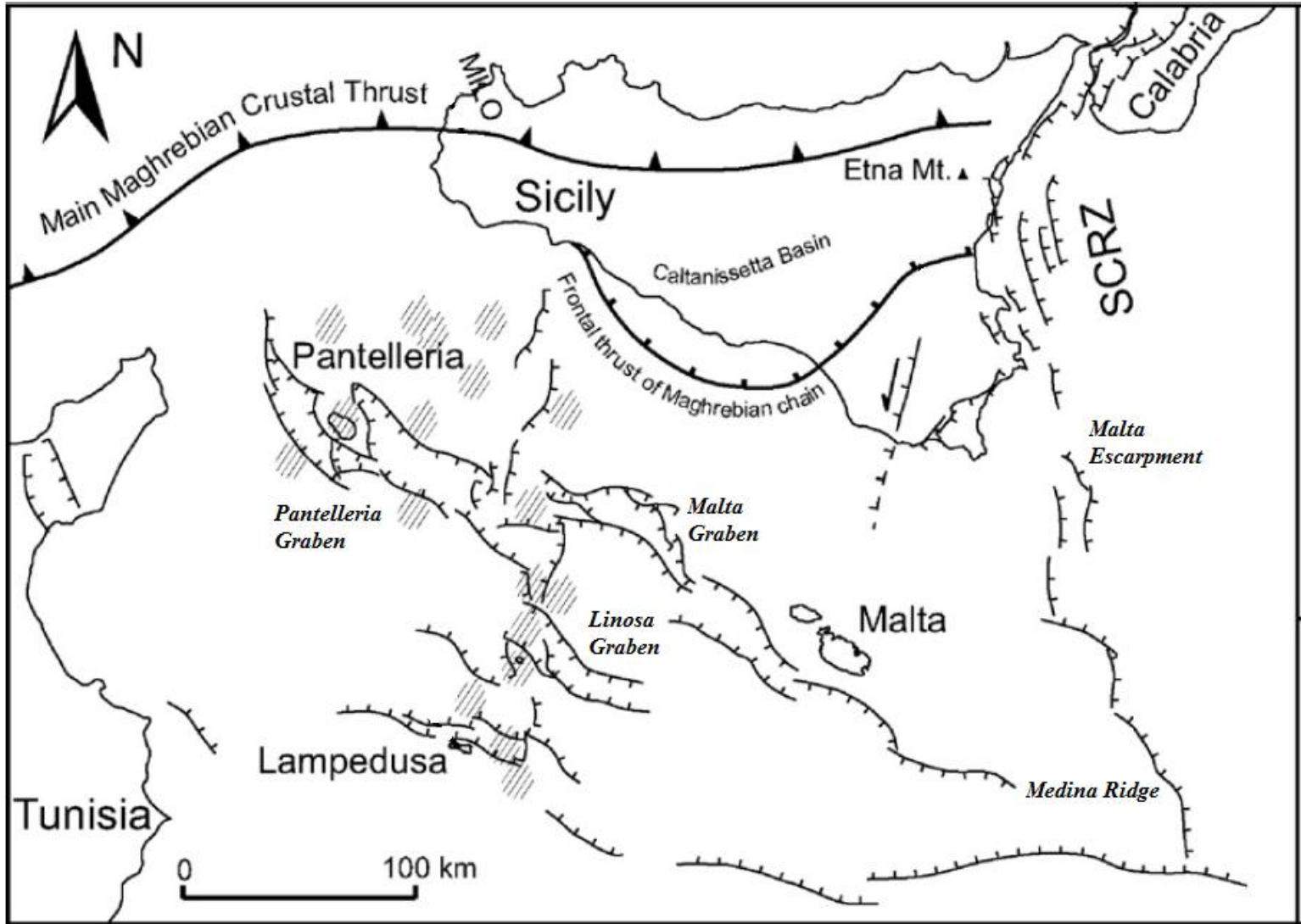


Event: 20060227a Model: VM1 FM: 62 50 -71 Mw: 4.1 rms: 6.276e-04





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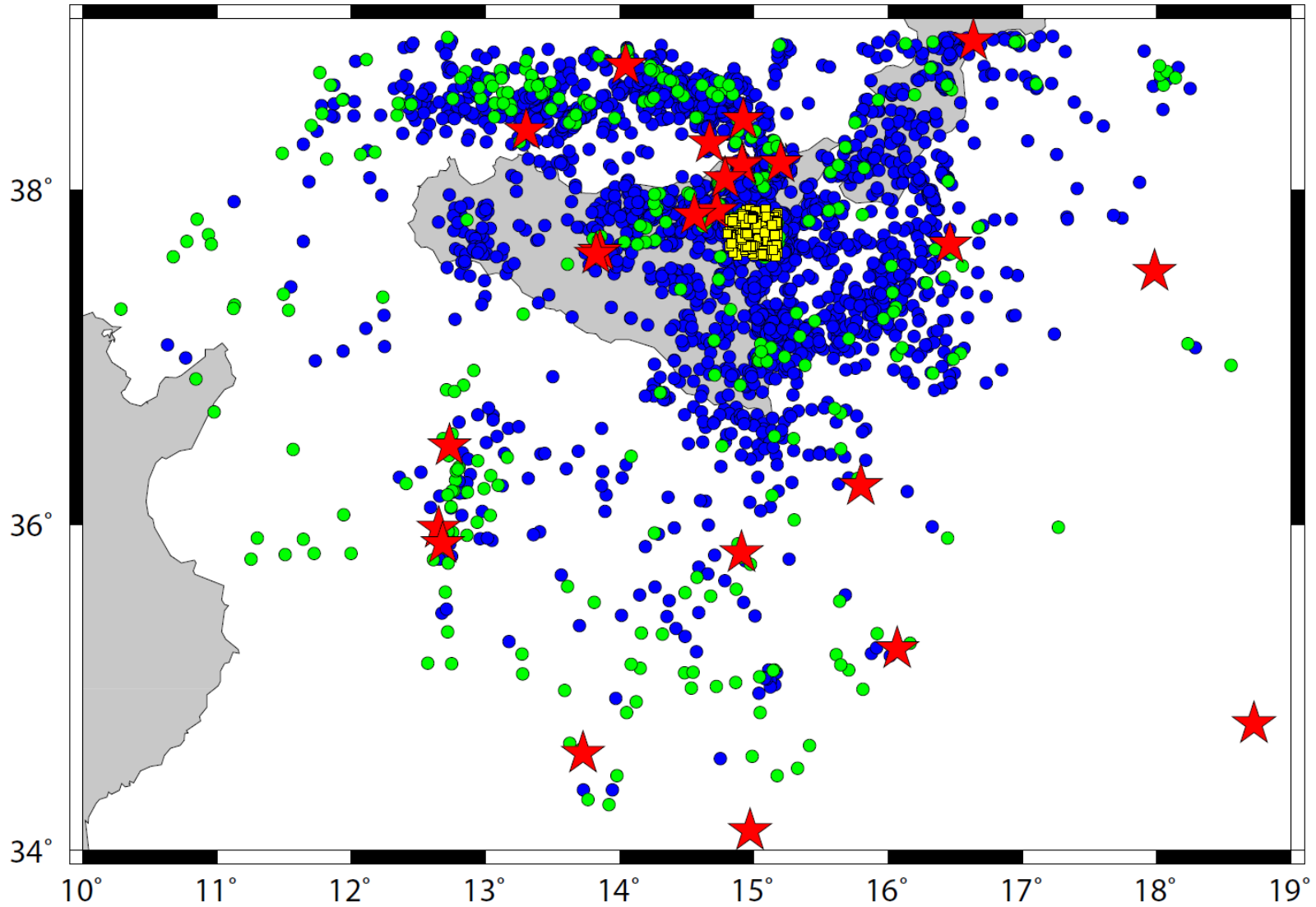


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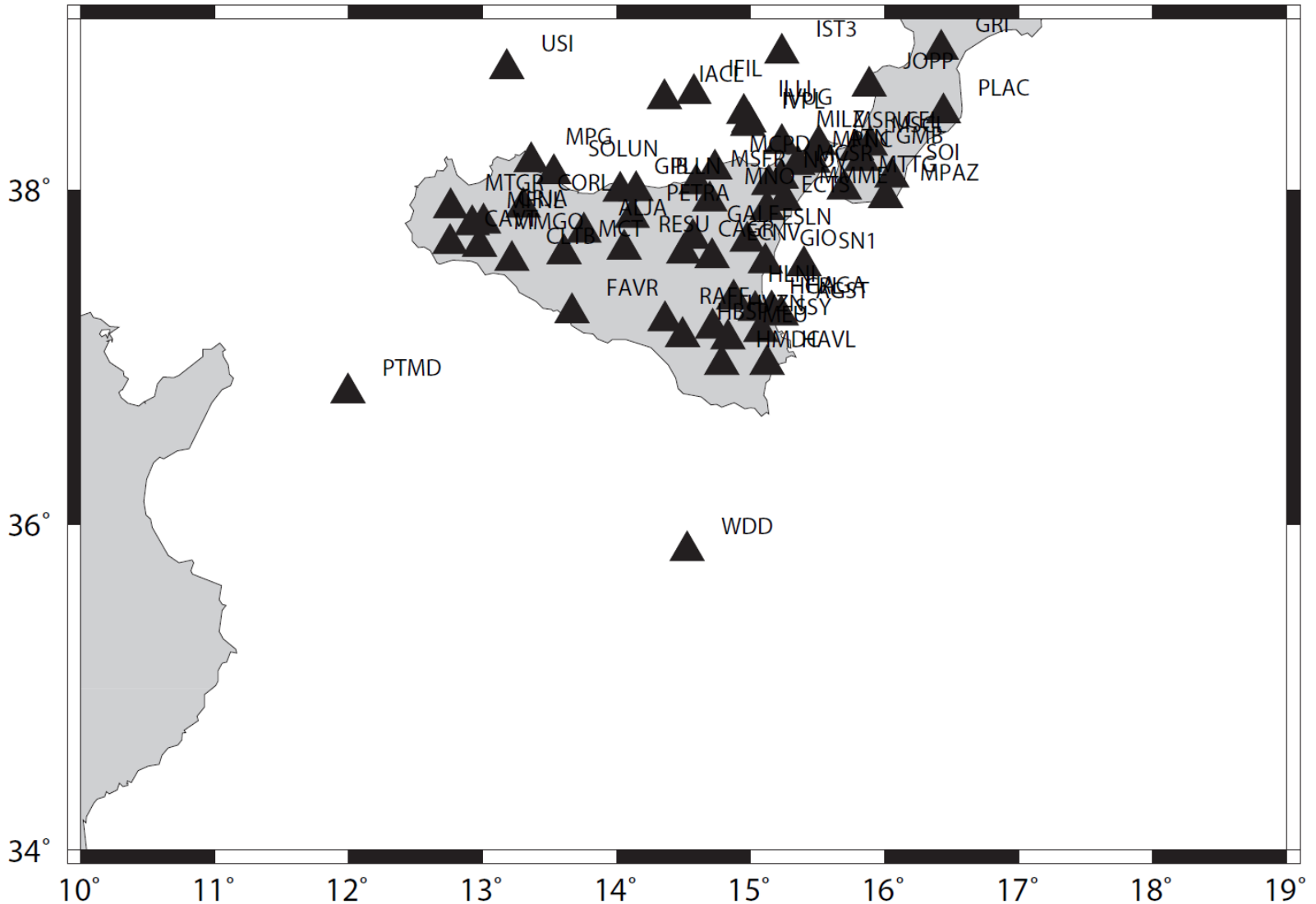
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Costituzione di un sistema integrato di protezione civile transfrontaliero italo-maltese



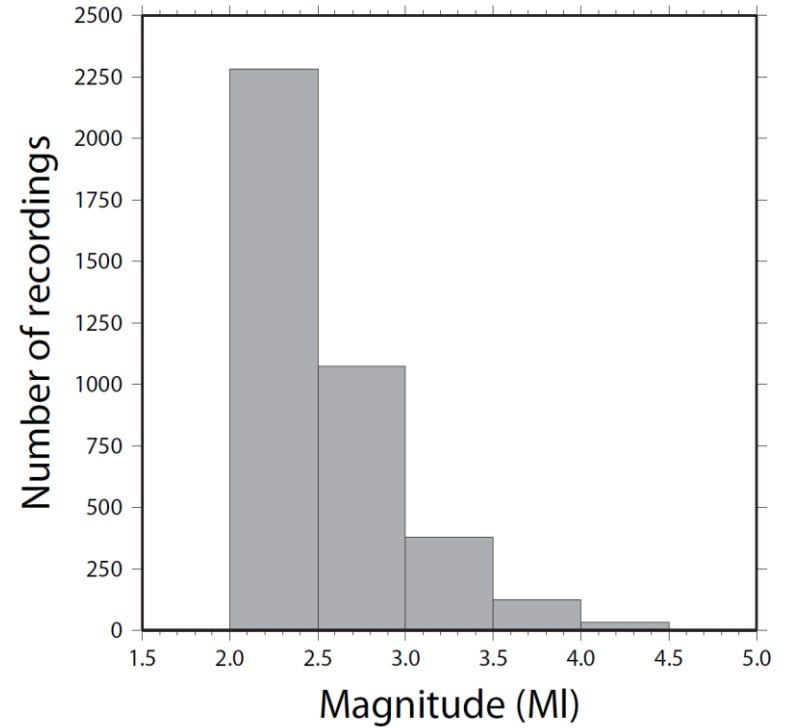
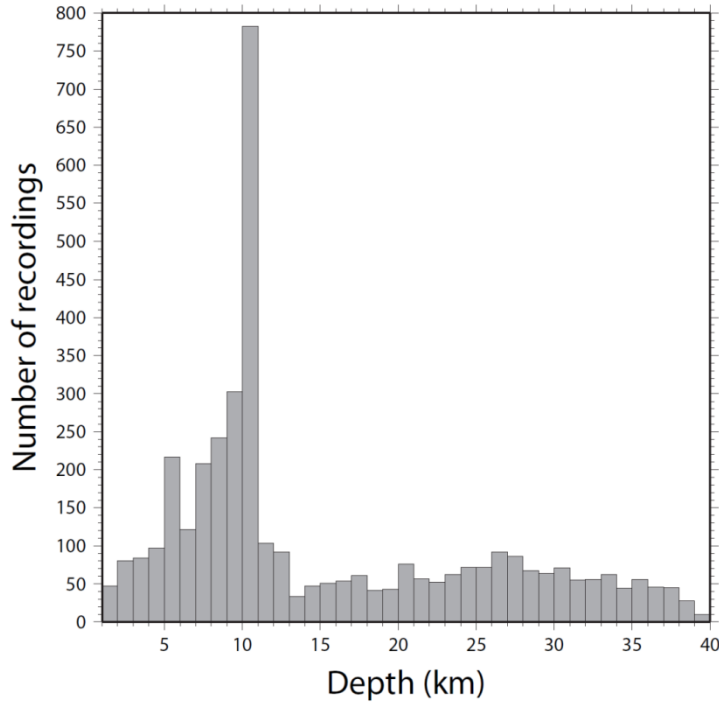


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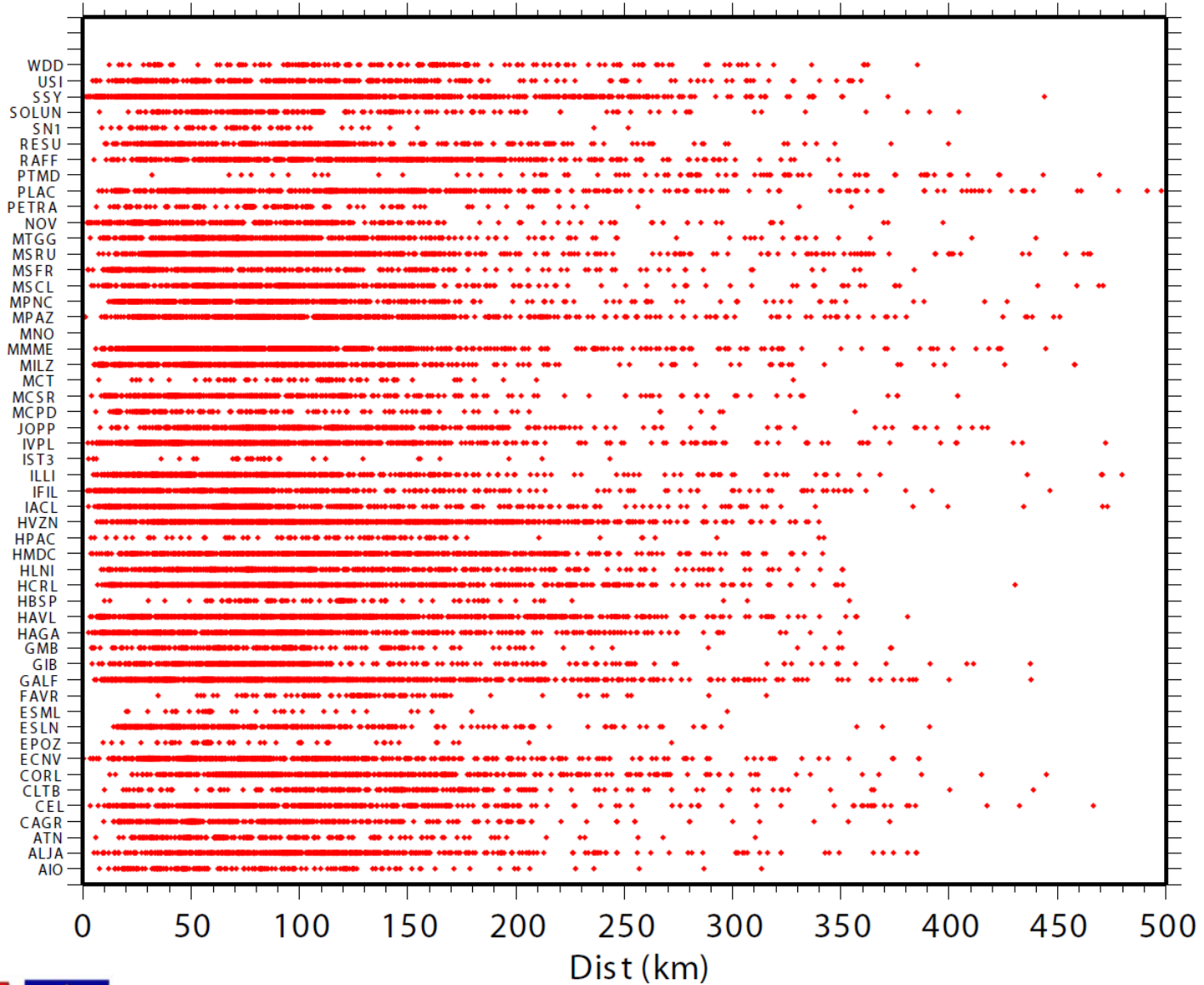


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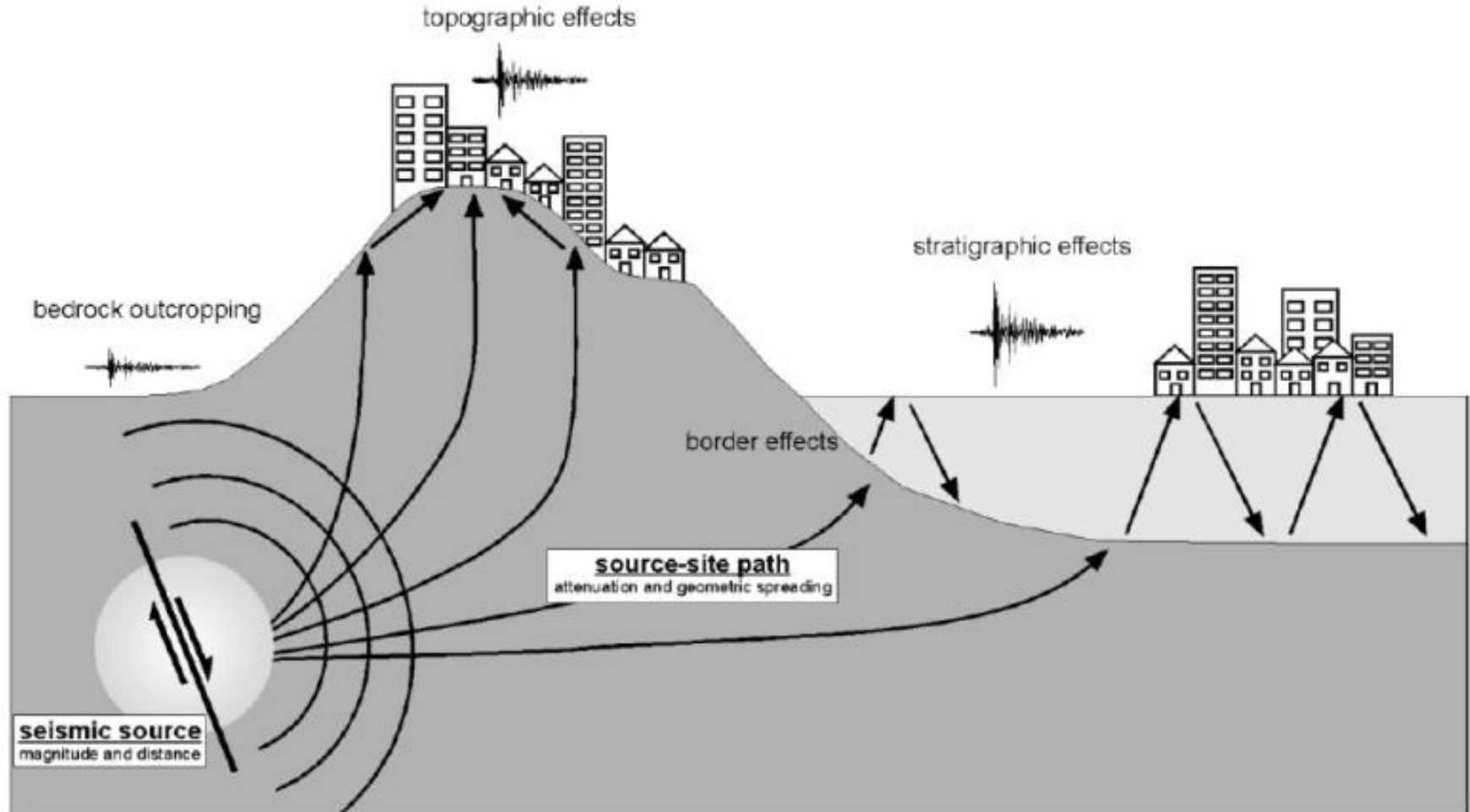
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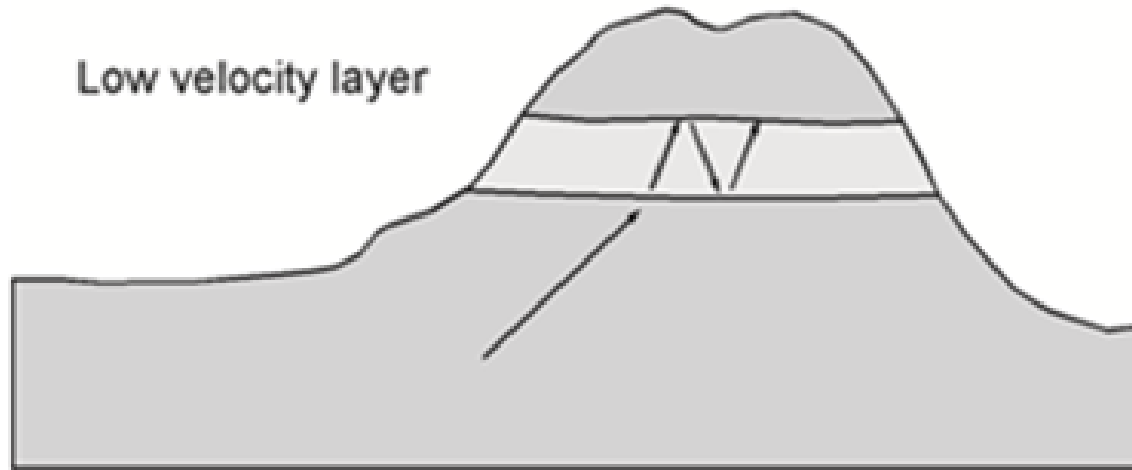
...INCLUDING SITE EFFECTS...



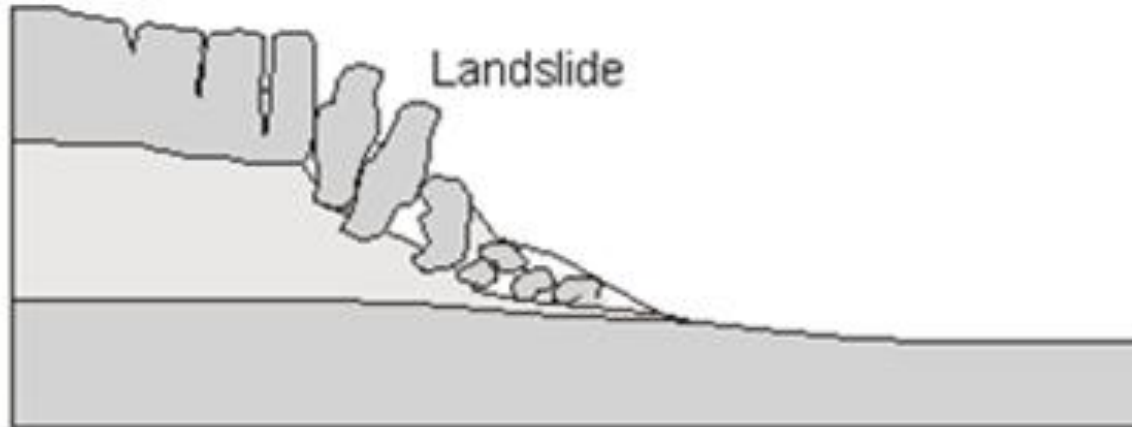


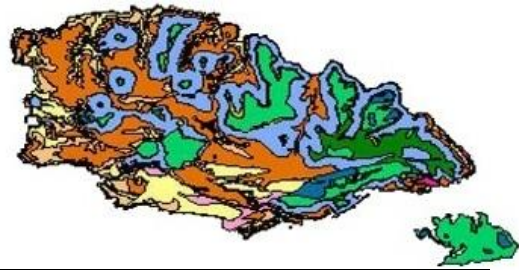


Low velocity layer



Landslide



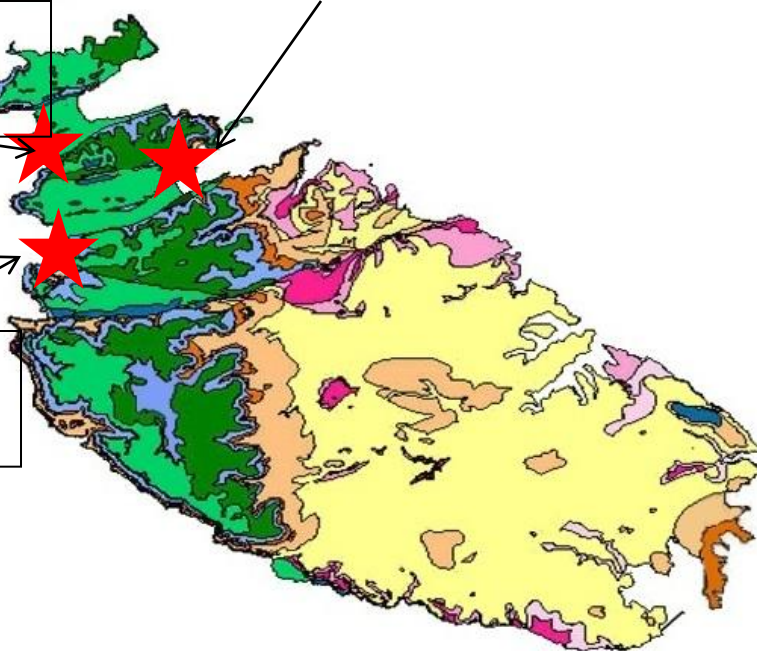
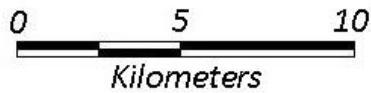
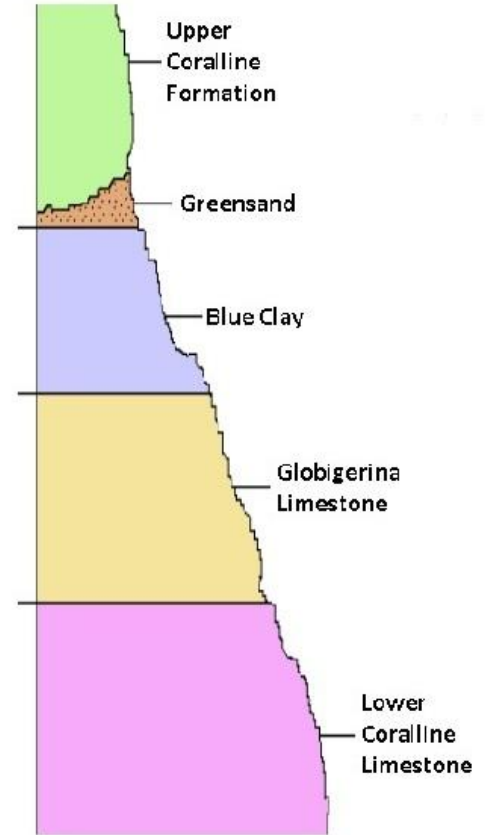


Xemxjia Bay
(Urban Area)

Anchor Bay
(Amusement Park Area)



Golden Bay
(Cultural Heritage Area)



Oligocene Lower Coralline Limestone

- Maghlaq Member
- Attard Member
- Xlendi Member
- Mara Member

Miocene Globigerina Limestone

- Lower Globigerina Limestone
- Middle Globigerina Limestone
- Upper Globigerina Limestone

Upper Miocene Upper Coralline Limestone

- Ghajn Melel Member
- Tal-Pitkali Member
- Marfa Member
- Gebel Imbak Member

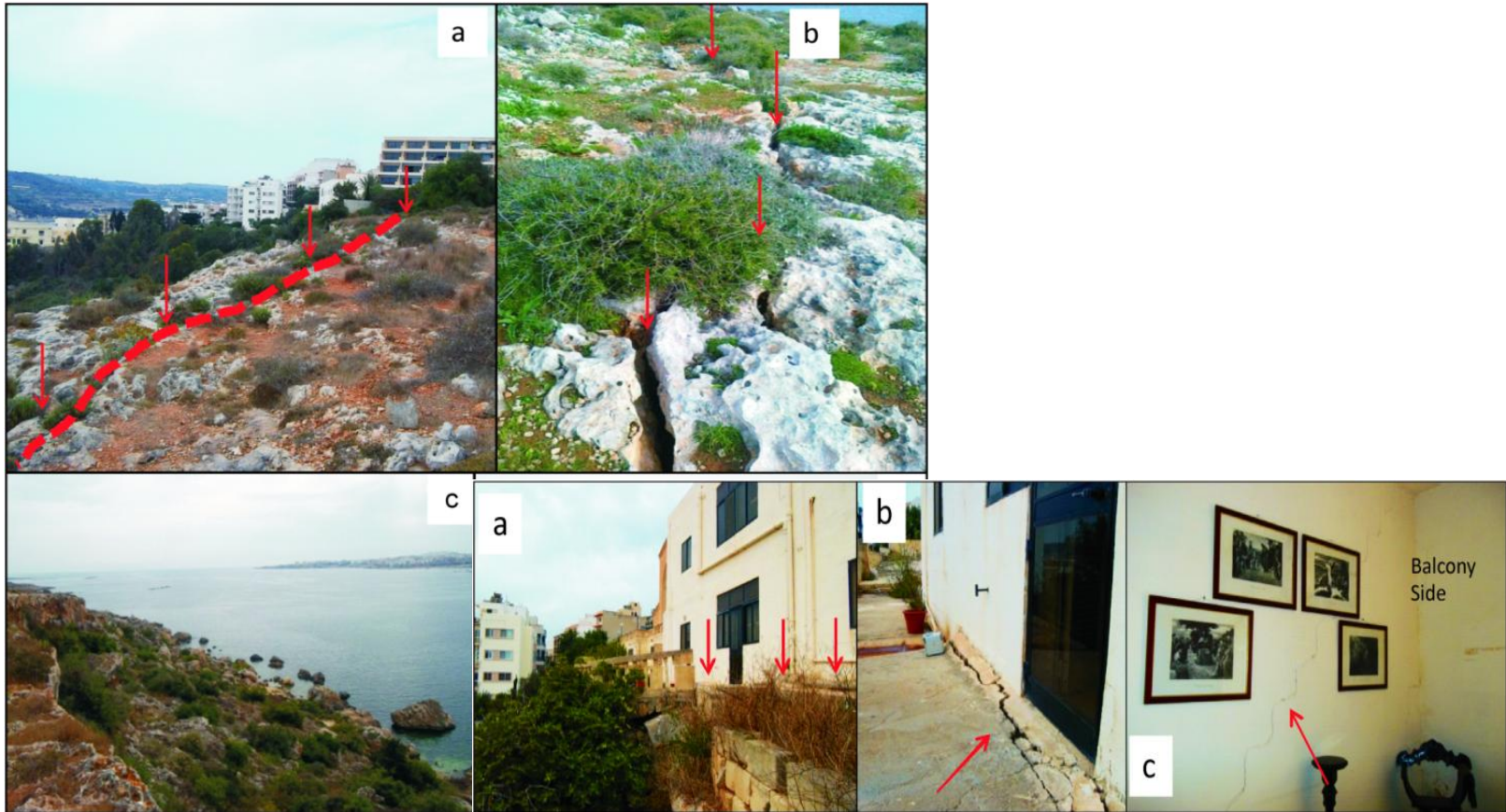
Miocene Blue clay

Miocene Greensands



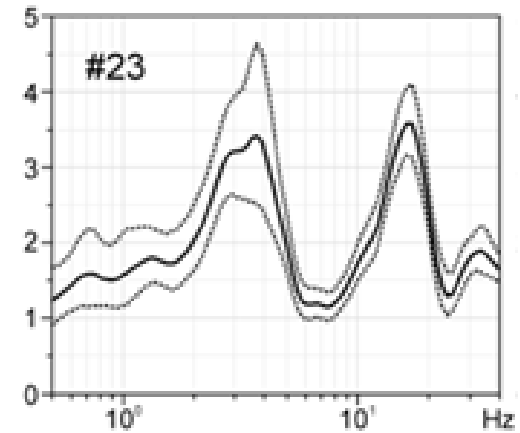
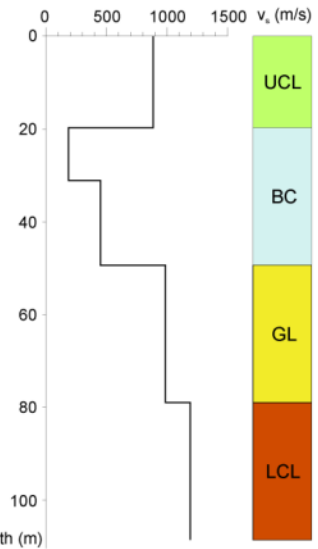
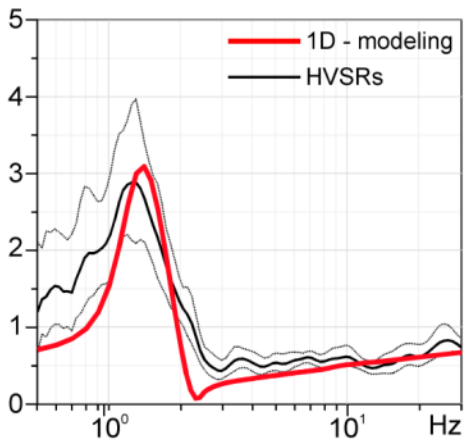
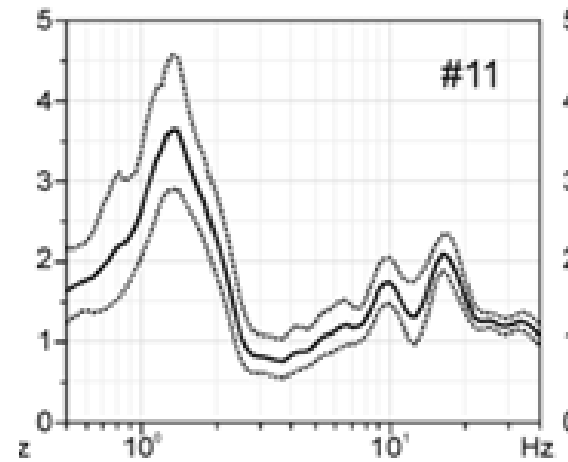
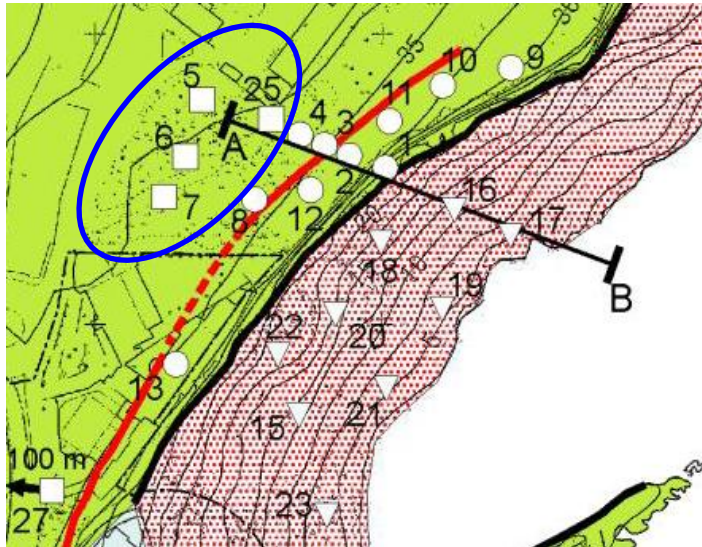


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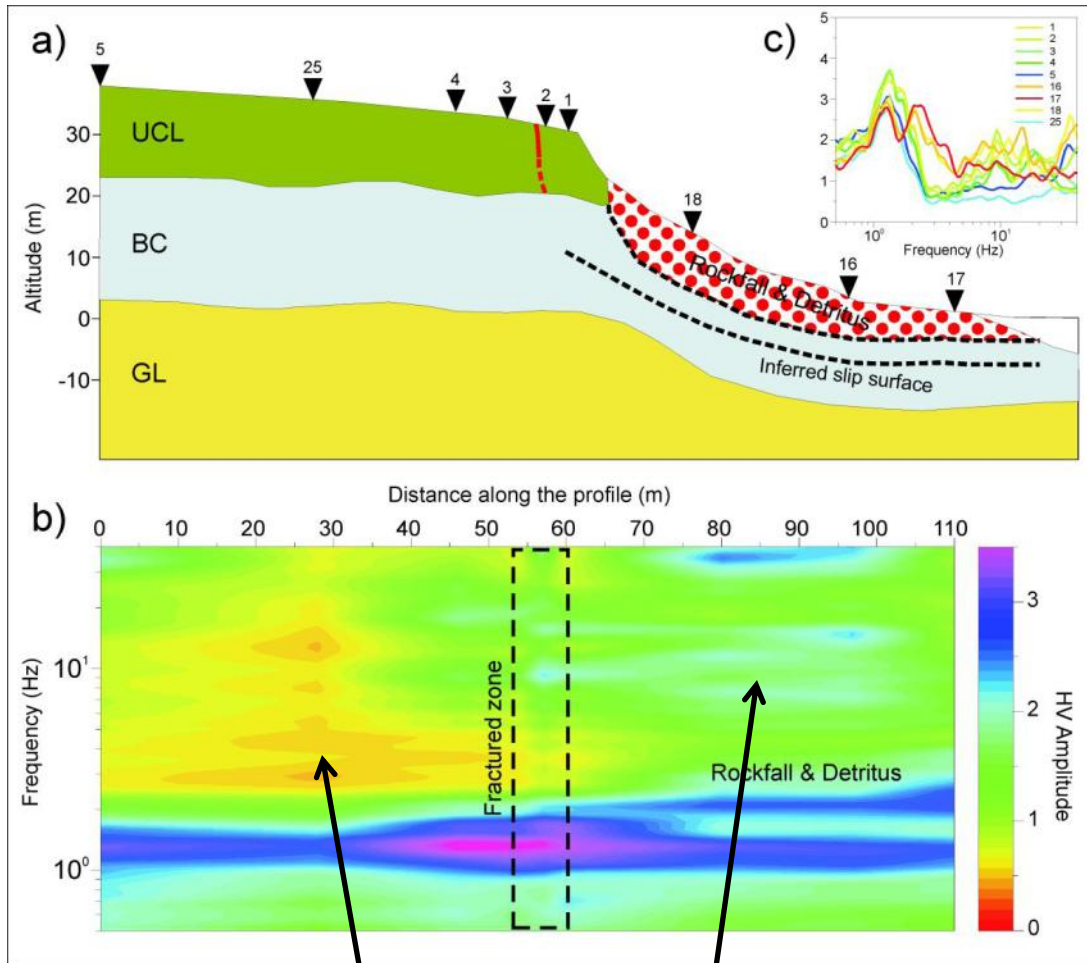


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-
-



H/V < 1 implies velocity inversion

Complex frequency response

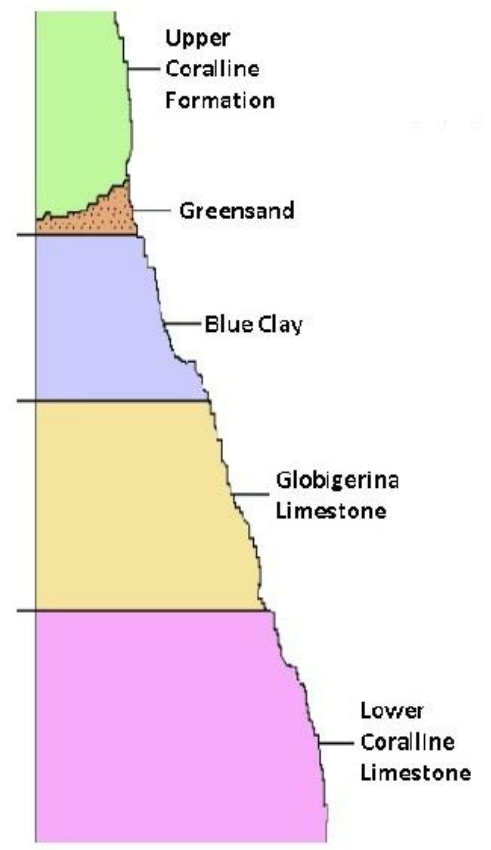
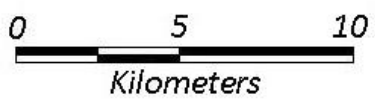
•
•



Xemxjia Bay
(Urban Area)

Anchor Bay
(Amusement Park Area)

Golden Bay
(Cultural Heritage Area)



- Oligocene Lower Coralline Limestone**
- Maghlaq Member
 - Attard Member
 - Xlendi Member
 - Mara Member

- Miocene Globigerina Limestone**
- Lower Globigerina Limestone
 - Middle Globigerina Limestone
 - Upper Globigerina Limestone

- Upper Miocene Upper Coralline Limestone**
- Ghajn Melel Member
 - Tal-Pitkali Member
 - Marfa Member
 - Gebel Imbak Member

- Miocene Blue clay**
- Miocene Greensands**



a)

Block A



Block B



Block C



Upper Coralline Limestone

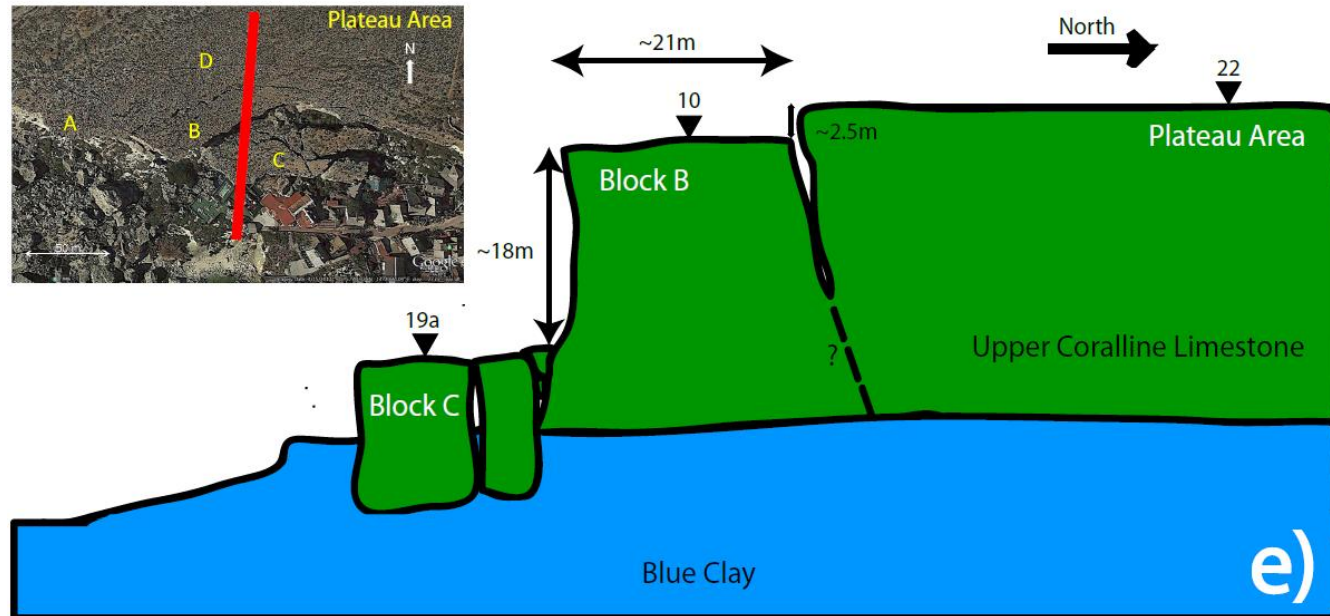
Blue Clay

Amusement Park

Anchor Bay

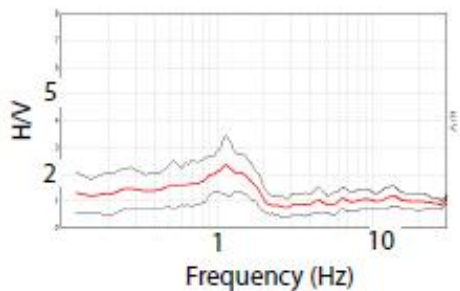


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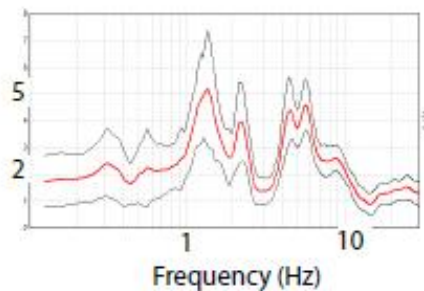


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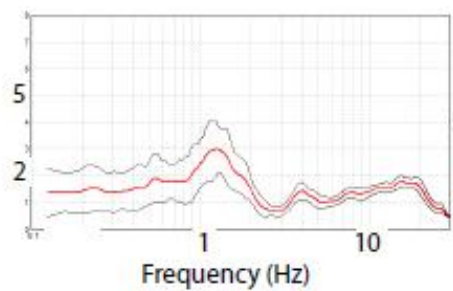
Site 22
(Stable Area)



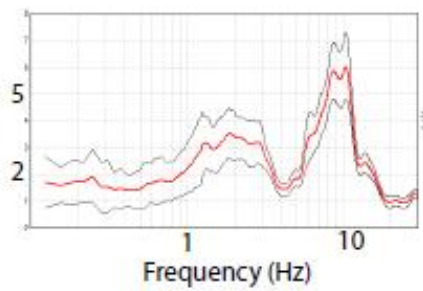
Site 1
(Block A)



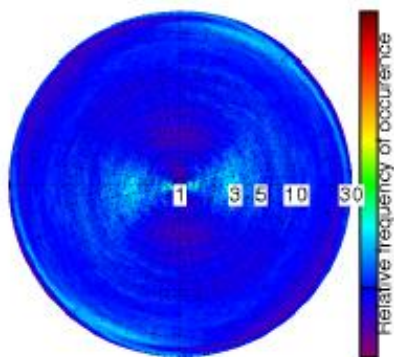
Site 10
(Block B)



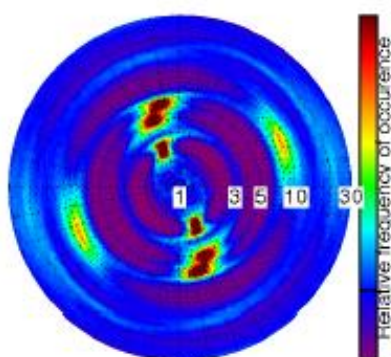
Site 19a
(Block c)



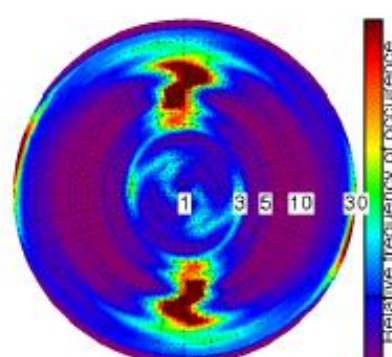
Strike vs. frequency



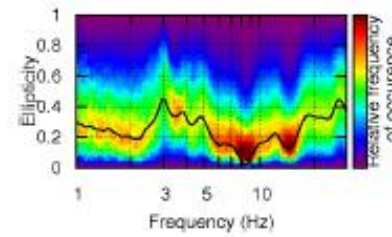
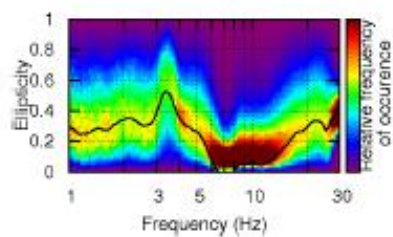
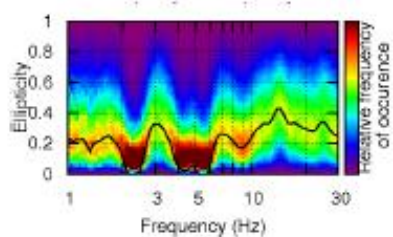
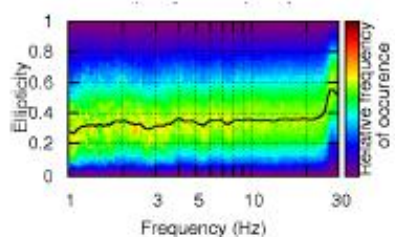
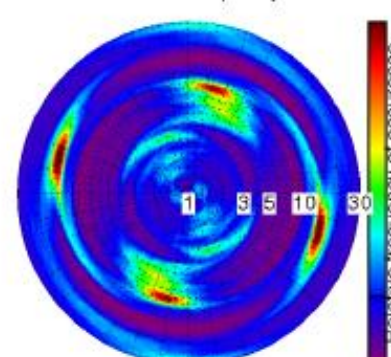
Strike vs. frequency



Strike vs. frequency

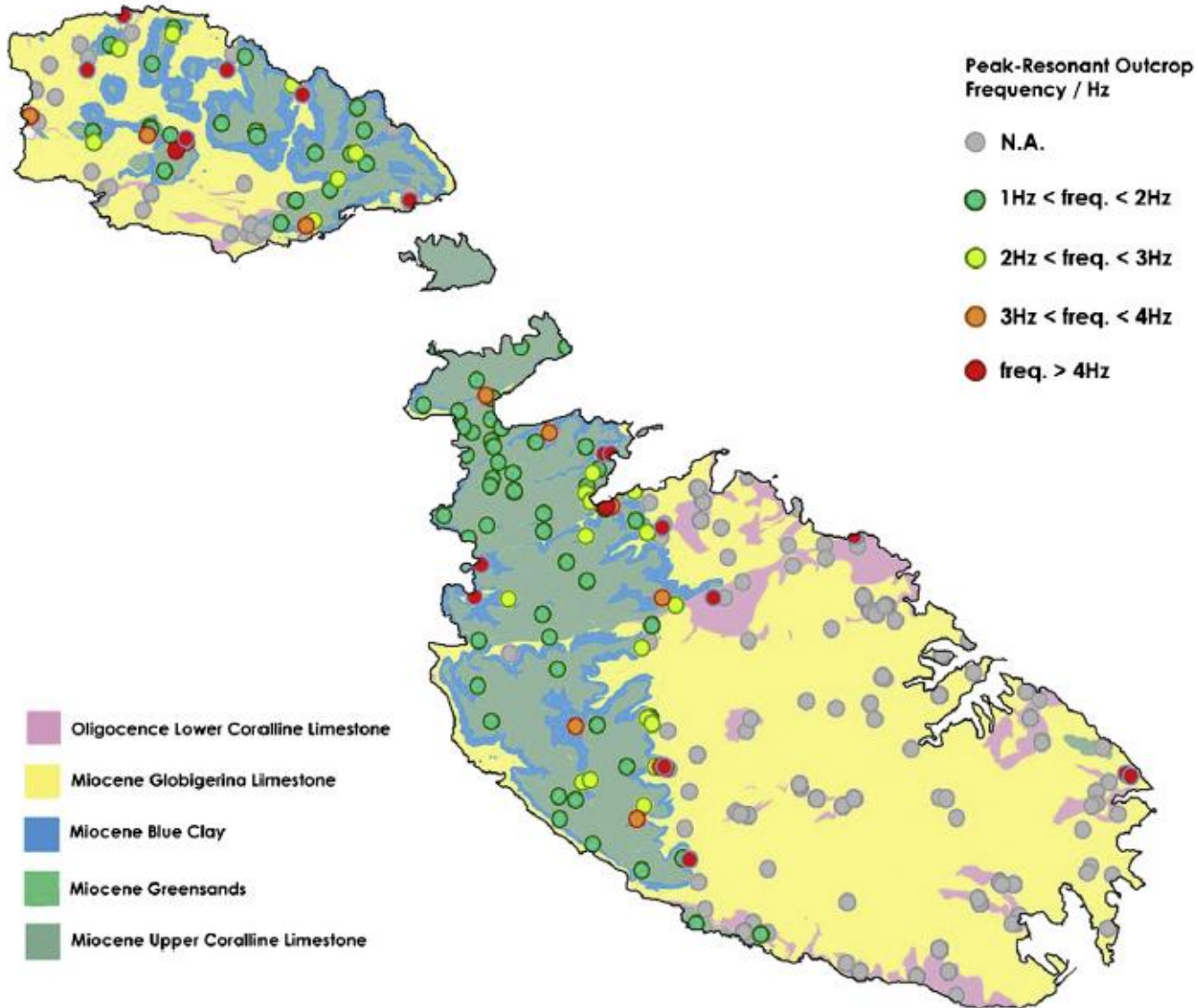


Strike vs. frequency



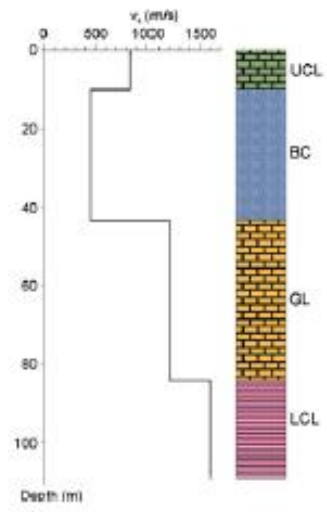
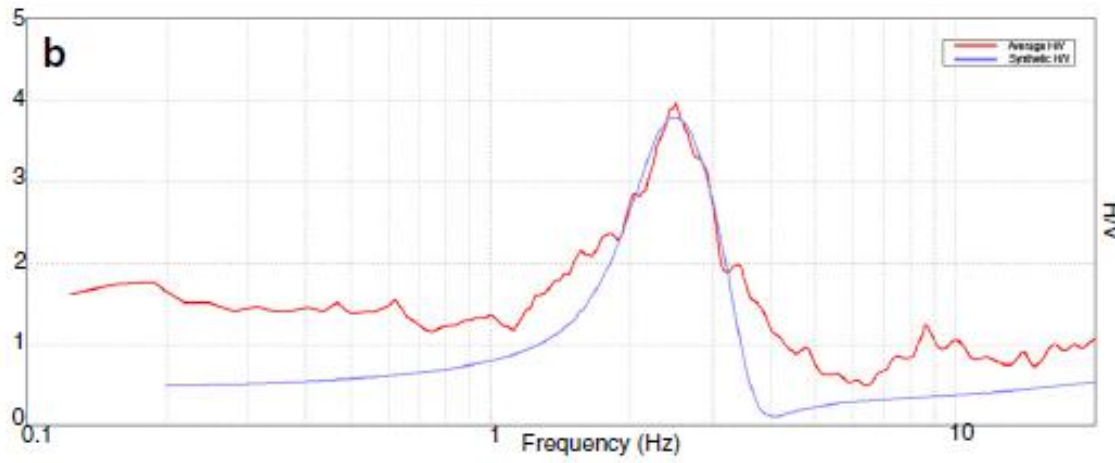
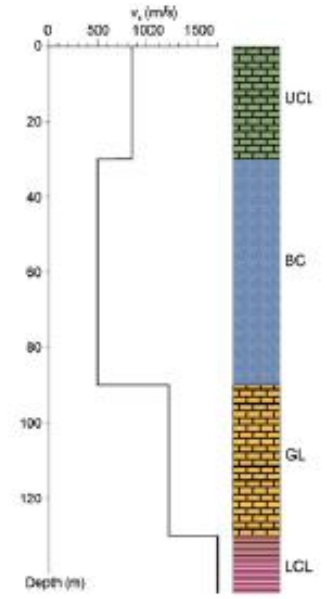
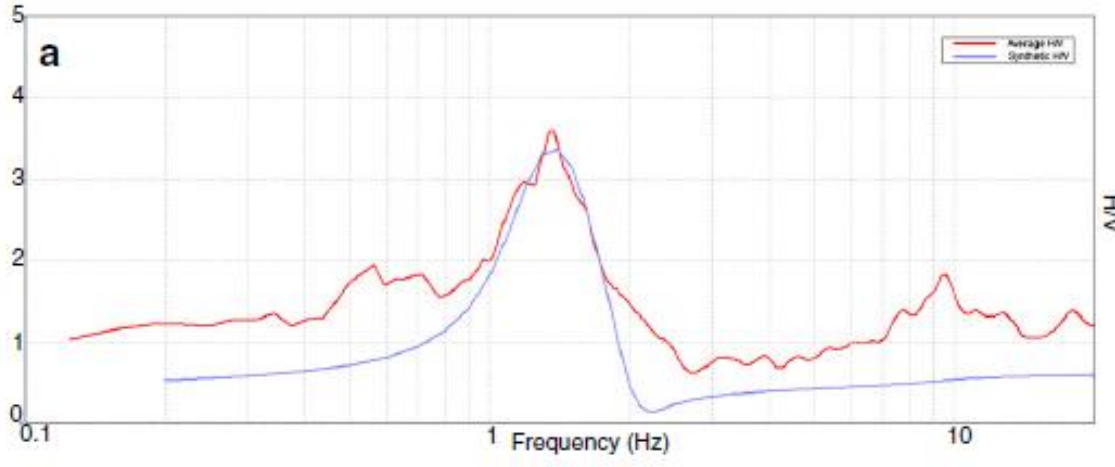


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CONCLUSIONS

- Regionalization shows substantial variations in the attenuation parameters, even within a relatively small country like Italy;
- Variations must be taken into account in order to produce reliable seismic hazard maps;
- Regional ground motion scaling can be properly defined by using the background seismicity;
- Site effects can be included in the computation of hazard curves and to study ad-hoc test sites





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