Studio preliminare della risposta sismica locale presso il sito di Castelleone (CR): analisi del rumore sismico ambientale tramite configurazioni ad array e singola stazione

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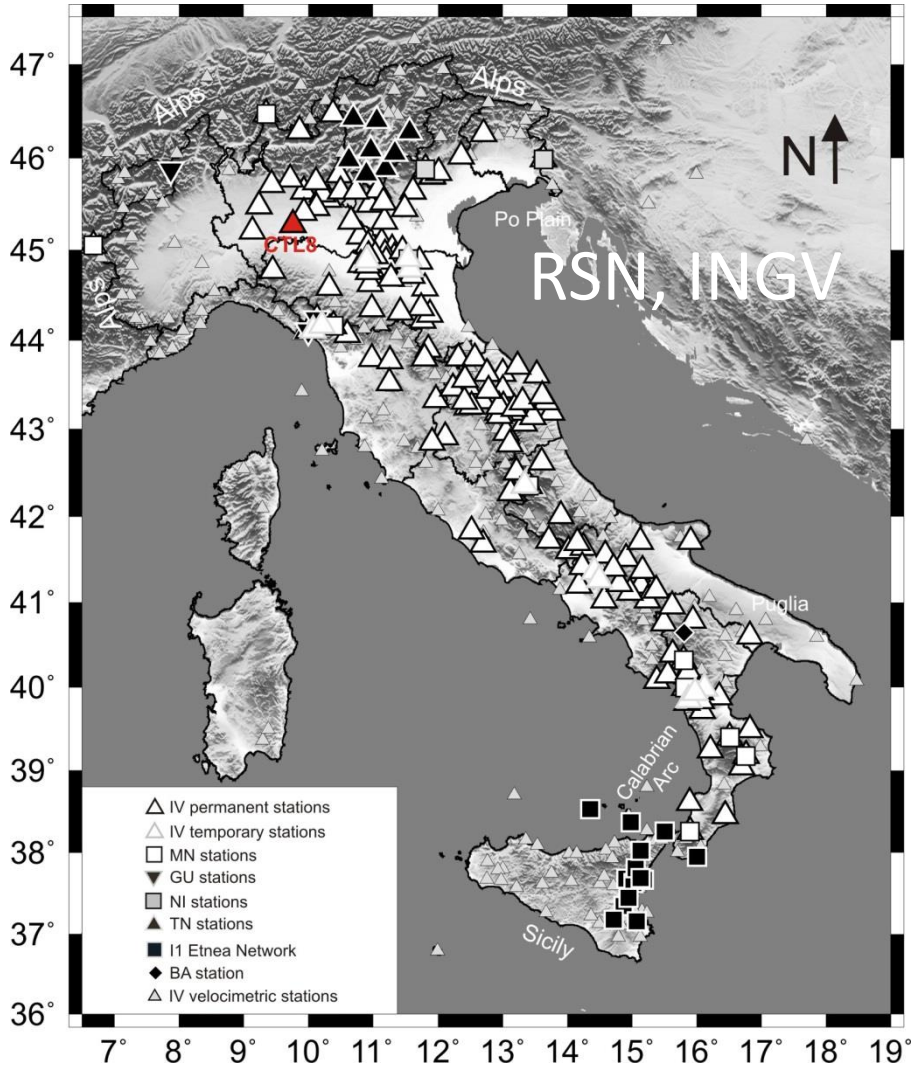
Scopo del lavoro

- definizione classe di sito EC8
- determinazione bedrock di normativa e geologico
- stima modello di velocità 1D
- relazione con i risultati H/V
- conseguenze sul PSHA



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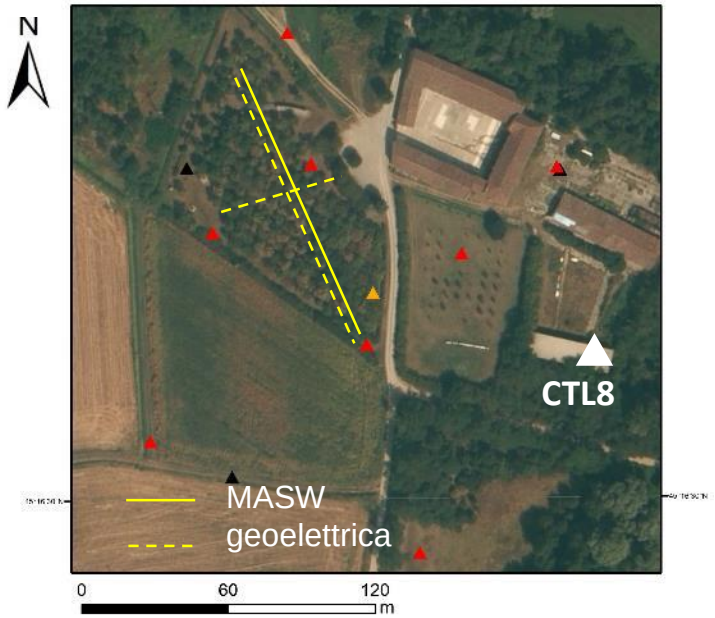
Indagini eseguite:

Sismica attiva:

- MASW
- sismica a rifrazione
- indagine geoelettrica

CLASSE C, Vs_{30}=253 m/s

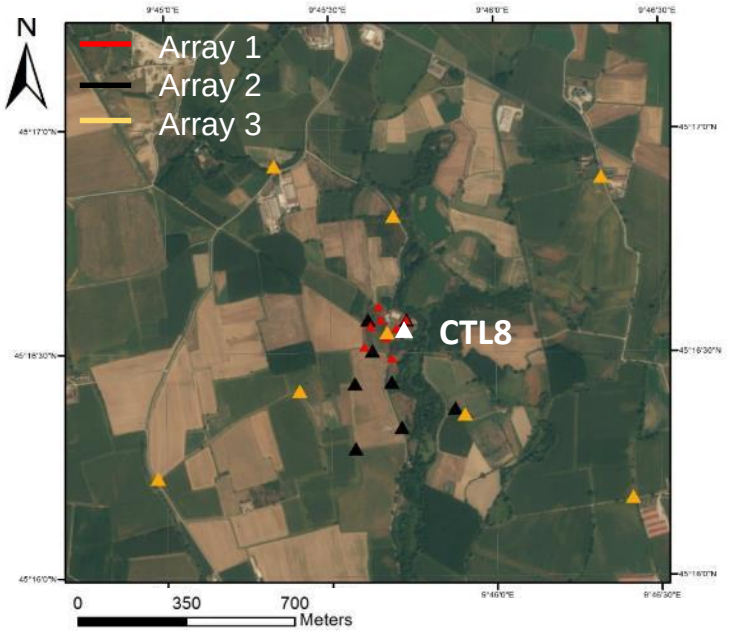


Sismica passiva:

- analisi H/V
- array sismici

- Velocimetro Lennartz 5s (8)
  - Acquisitore Reftek-130, 24 bit
  - Frequenza campionamento : 100 Hz
  - Durata registrazione : 2h

- Velocimetro Trillium 40s (1)
  - Acquisitore Gaia2, 24 bit
  - Frequenza campionamento : 100 Hz
  - Durata registrazione : 2 gg



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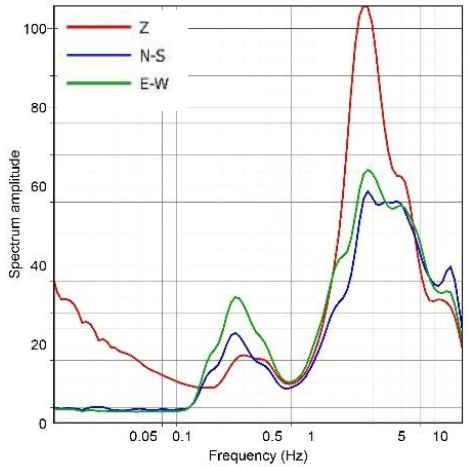
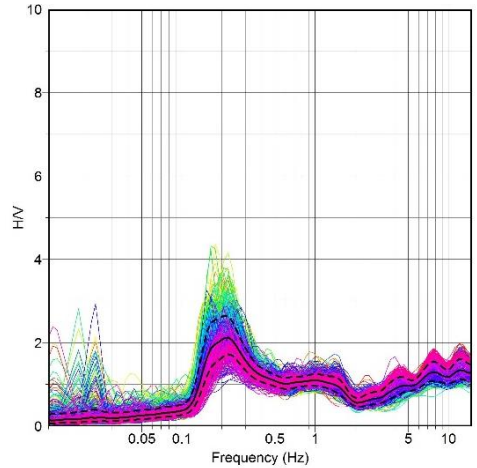
Analisi H/V da noise alla stazione CTL8

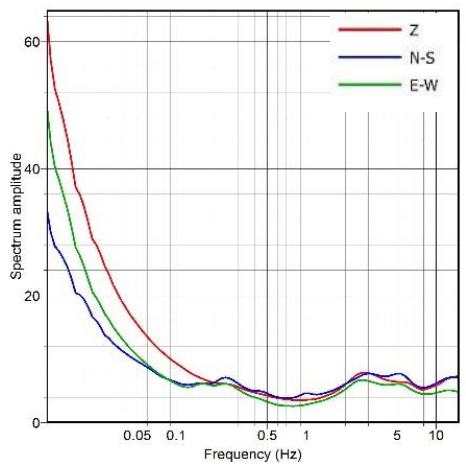
sensori permanenti

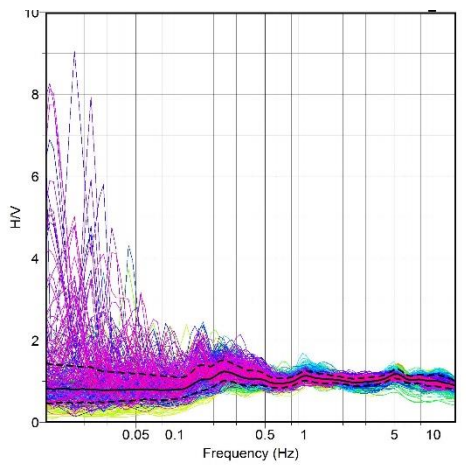
Malin Bore-Hole 2s





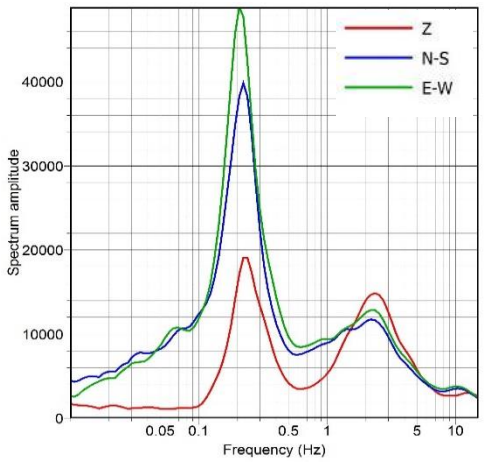
Episensor

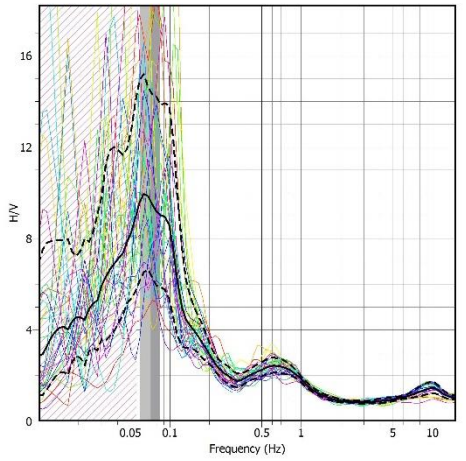




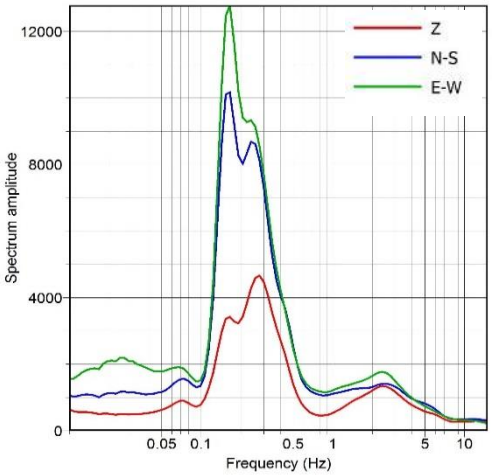
misure temporanee (03-04/11/2015)

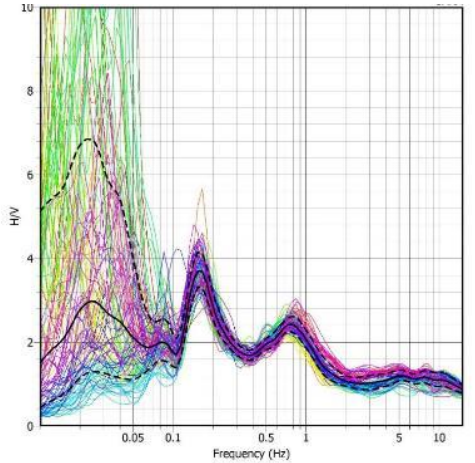
Lennartz 5s





Trillium 40s





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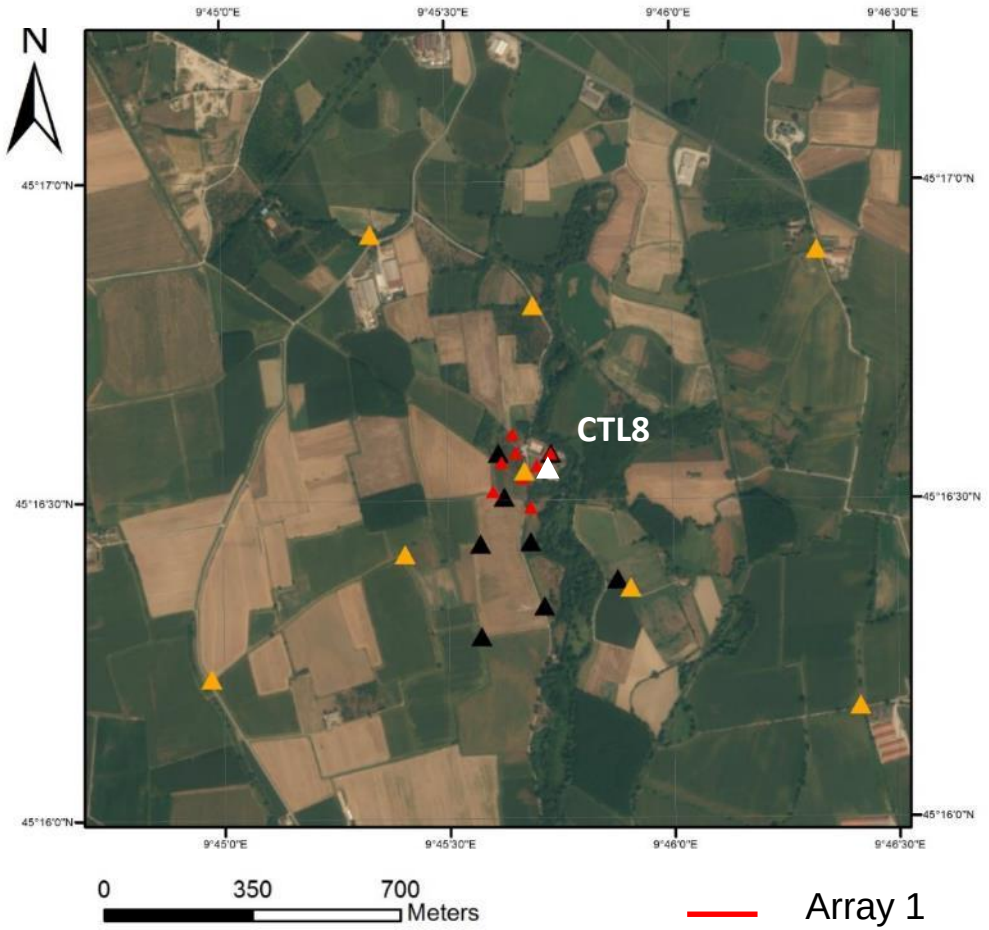
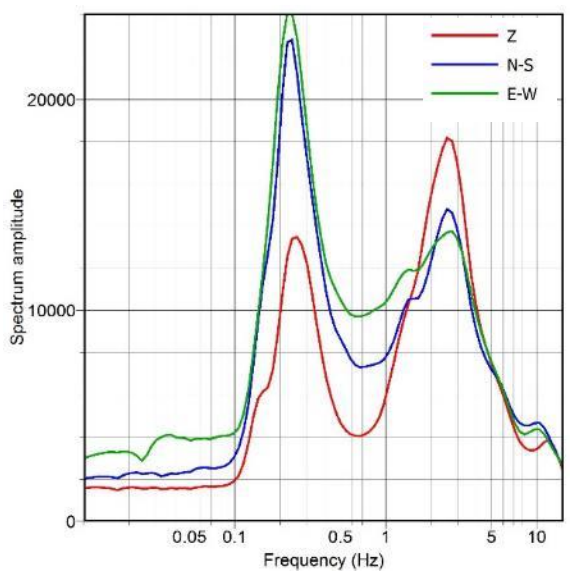
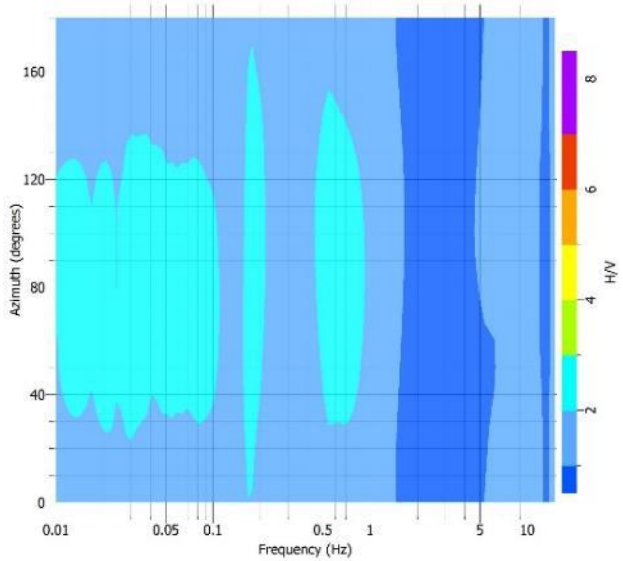
Analisi H/V da noise alle stazioni degli array

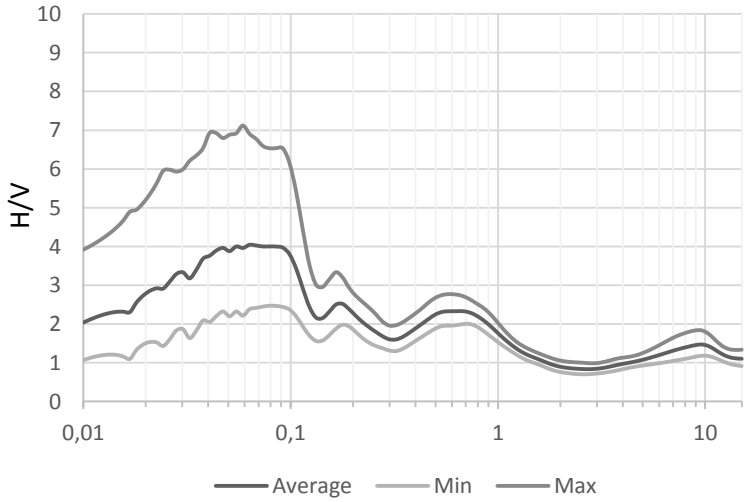


Array 1
Array 2
Array 3

Array 1: *dmin* **50 m**, *dmax* **200 m**
Array 2: *dmin* **150 m**, *dmax* **600 m**
Array 3: *dmin* **400 m**, *dmax* **2.000 m**







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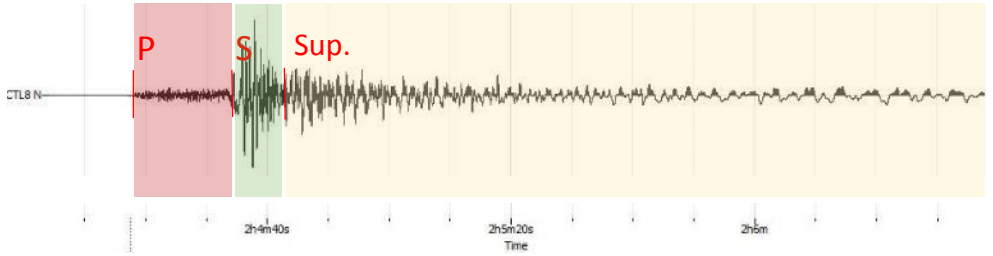
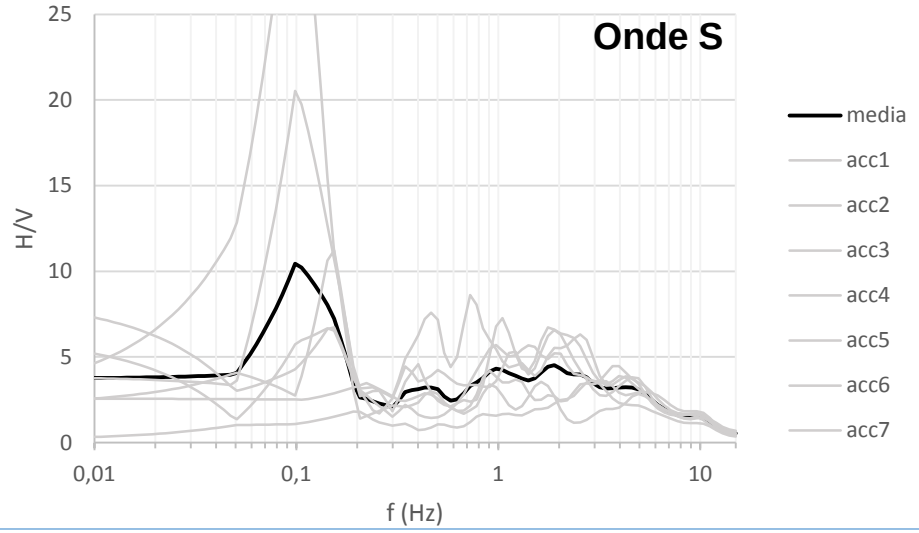
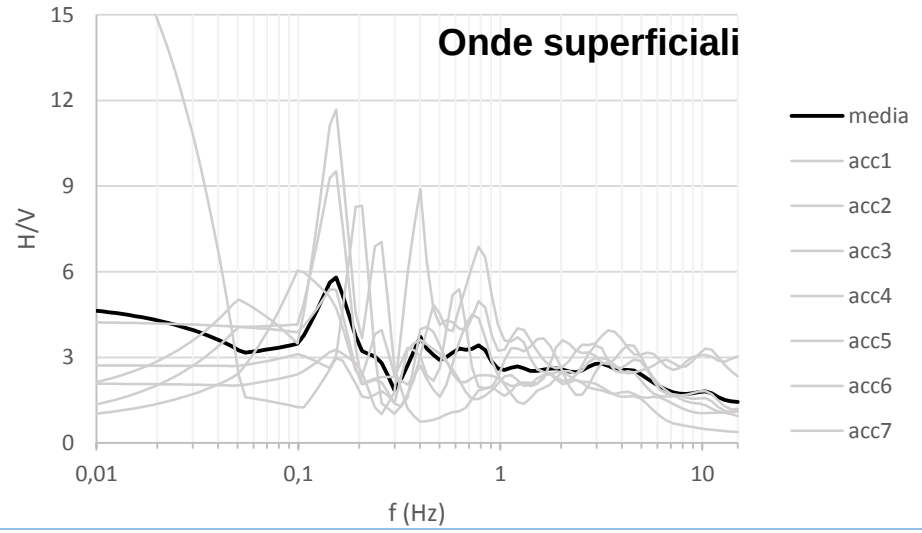
Analisi H/V da terremoti

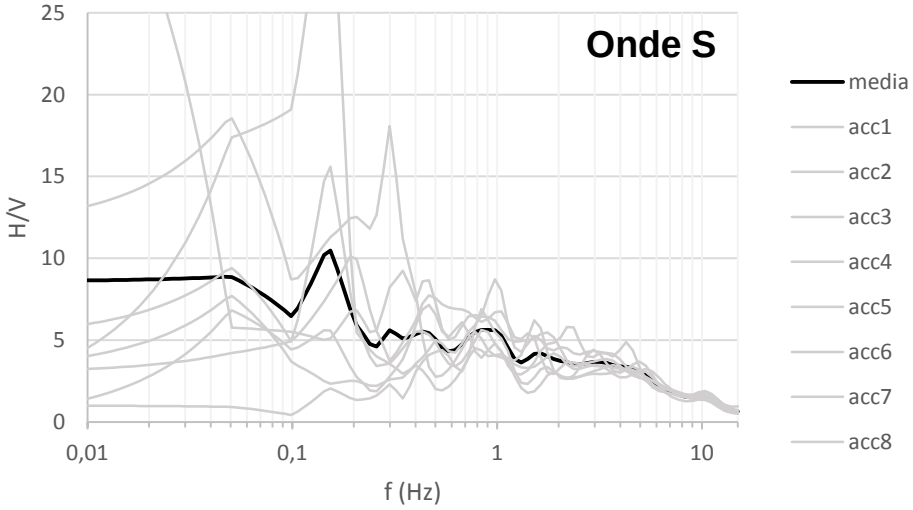


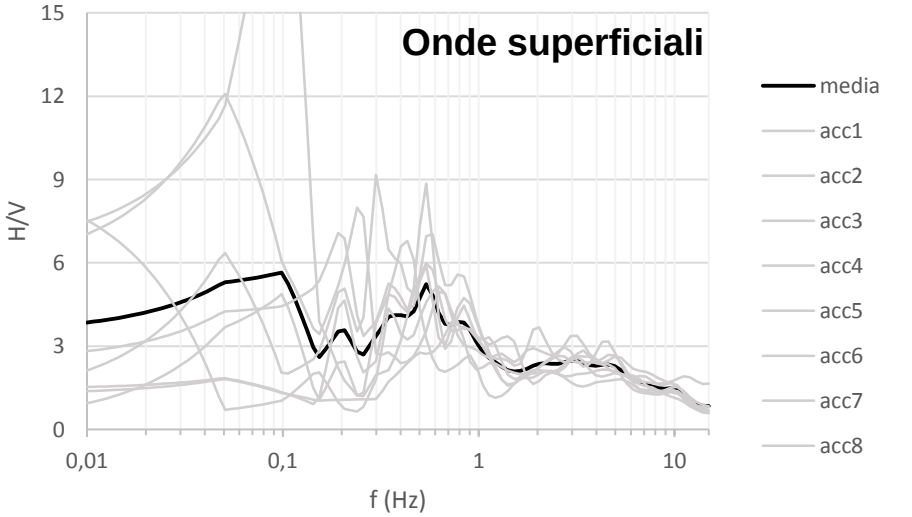
EMILIA 2012
5≤ M_L <6





EMILIA 2012
4≤ M_L ≤ 4.5





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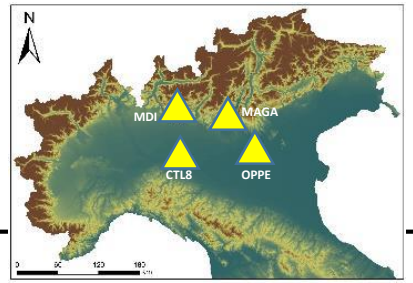
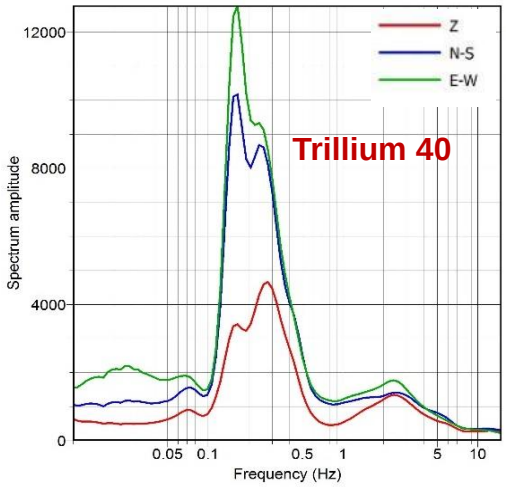
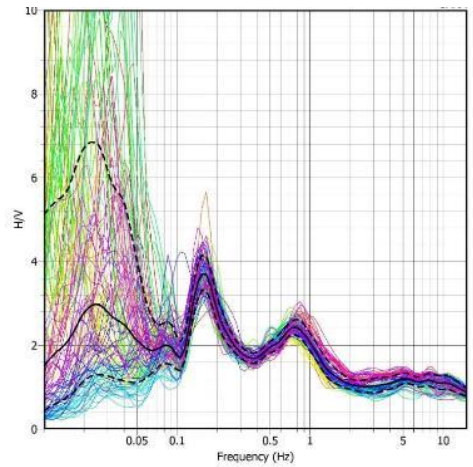
Verifica dei risultati

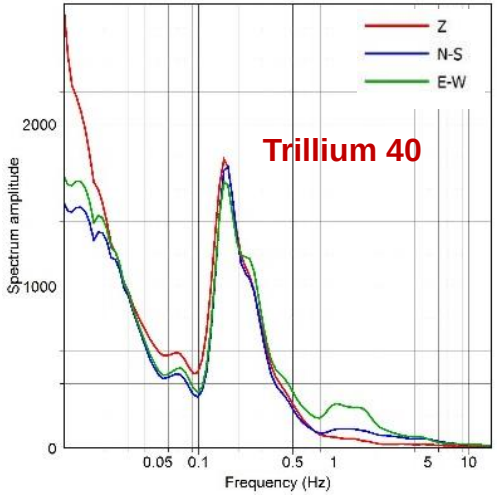


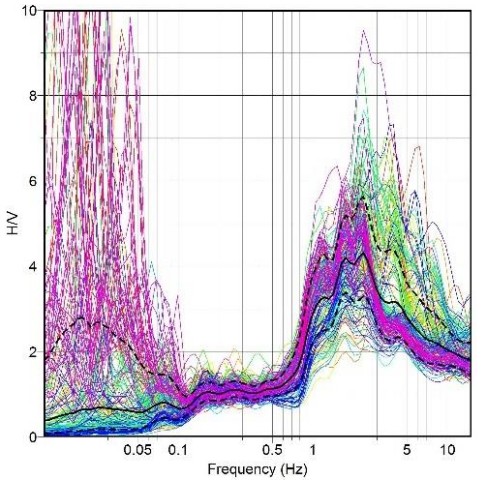
CTL8



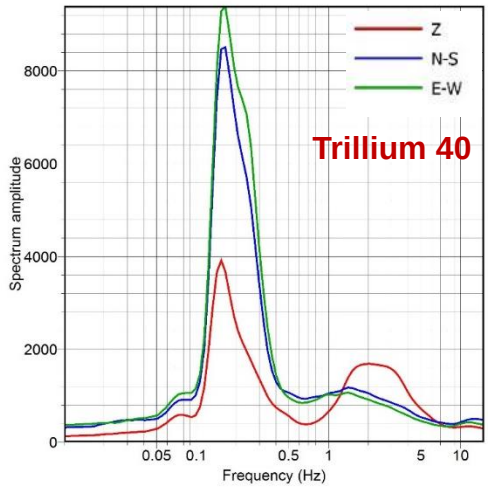


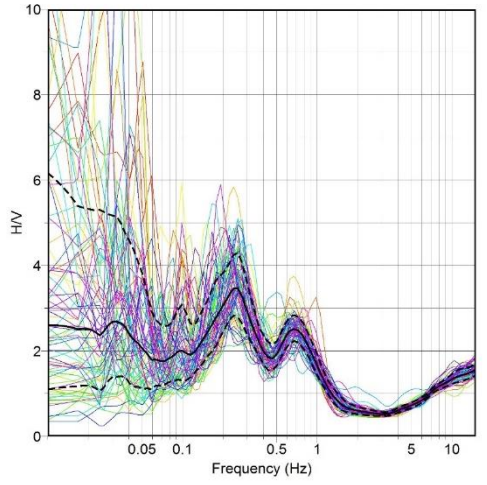
MAGA



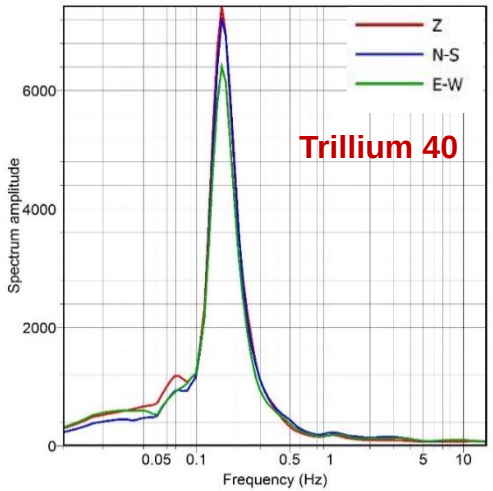


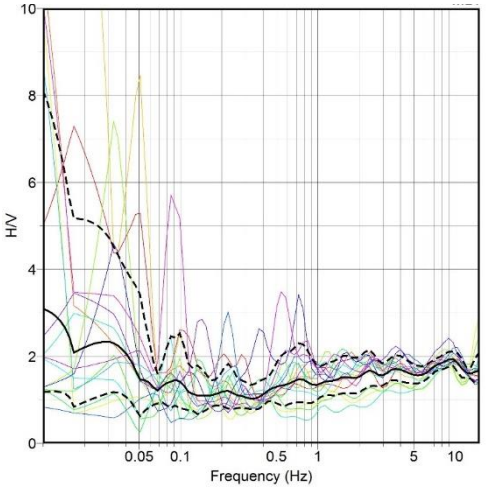
OPPE





MDI





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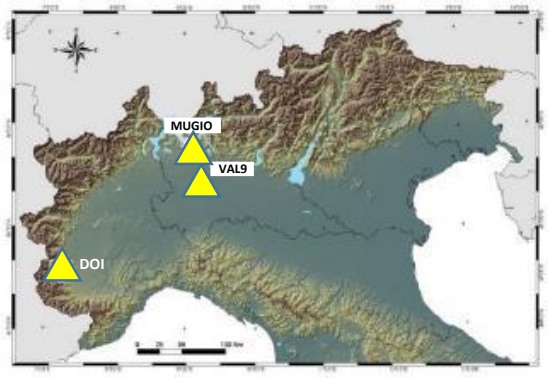
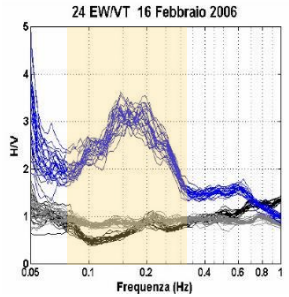
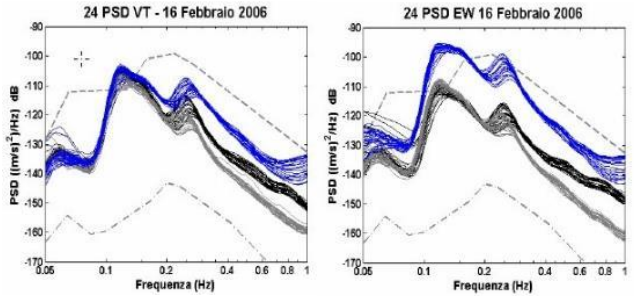
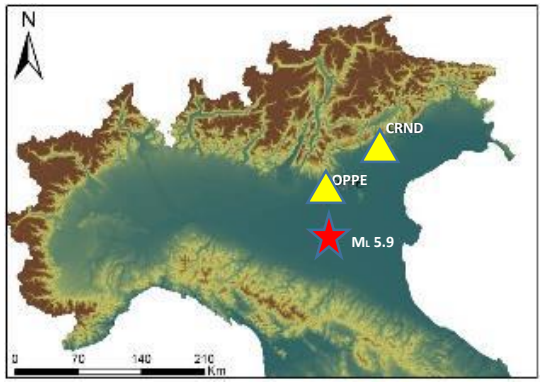
Esempi da letteratura in Pianura Padana

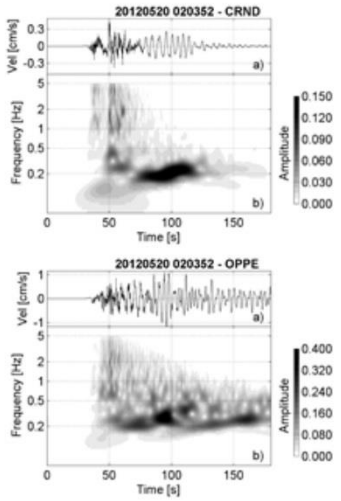


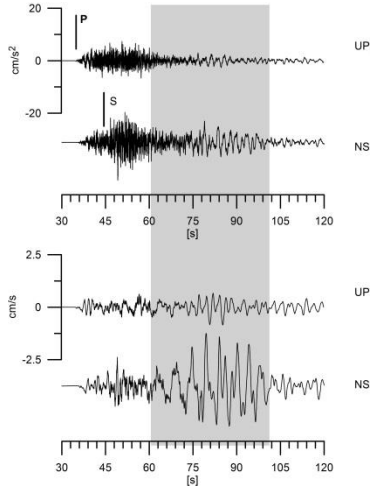




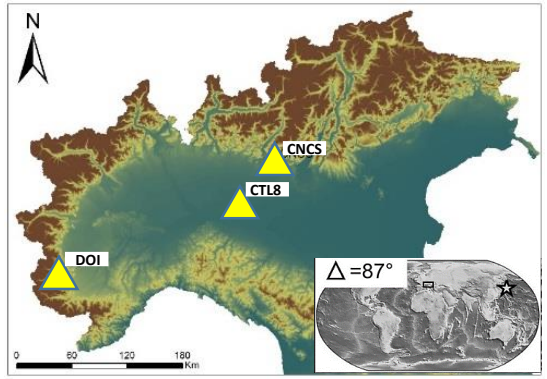
Marzorati PhD thesis, 2006

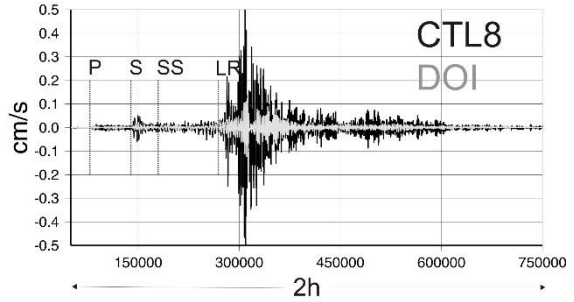


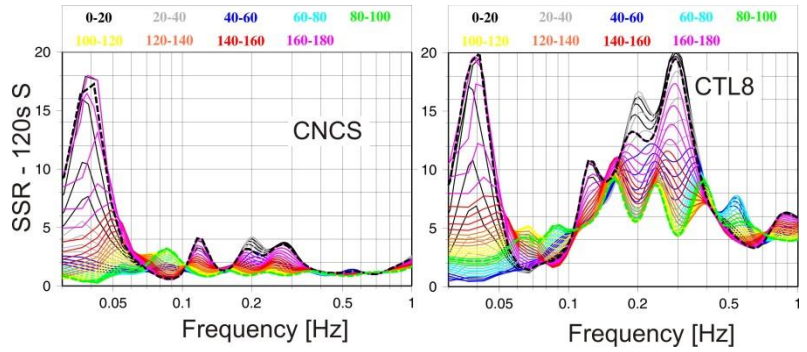




Luzi et al., 2013, SRL







Massa and Augliera 2014, BSSA

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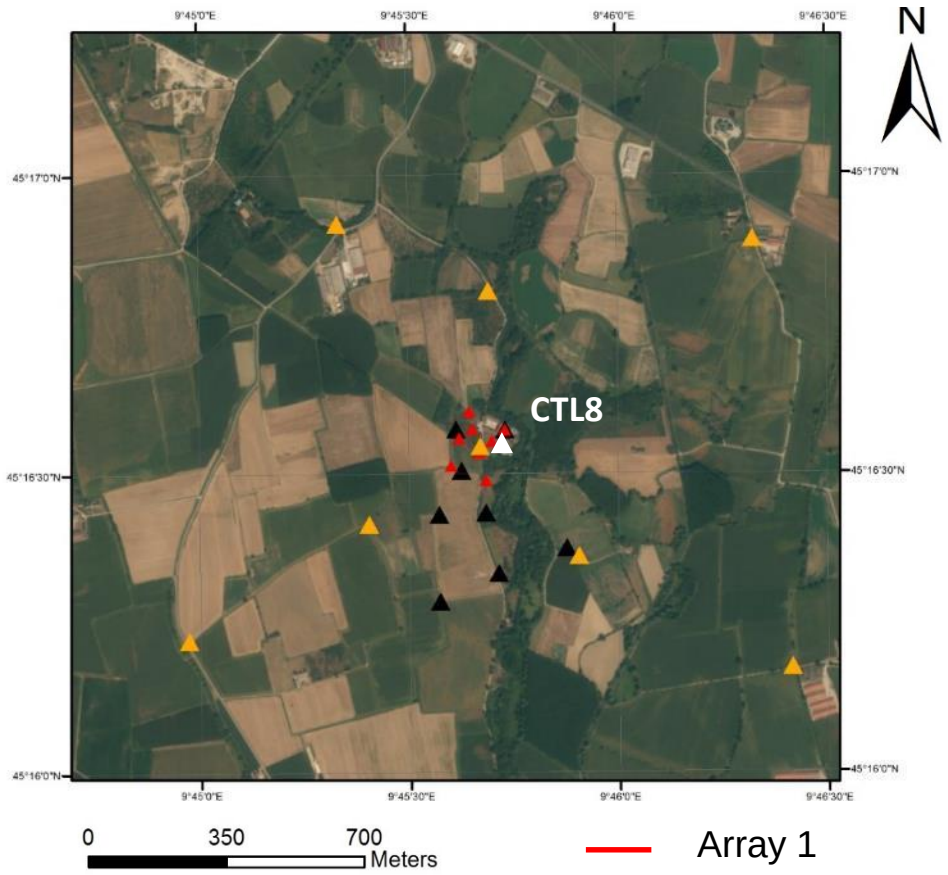
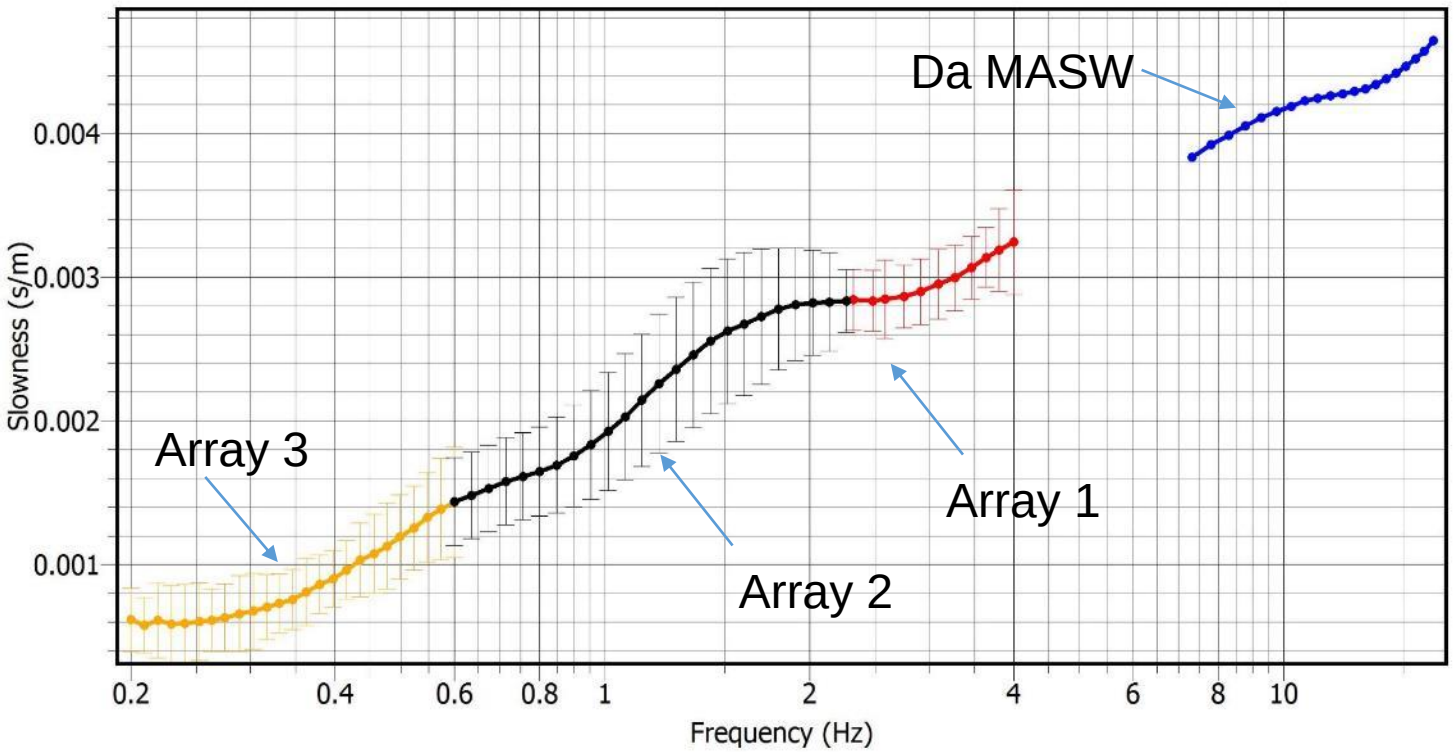
Analisi array sismici



Array 1: *dmin* **50 m**, *dmax* **200 m**
Array 2: *dmin* **150 m**, *dmax* **600 m**
Array 3: *dmin* **400 m**, *dmax* **2.000 m**



Software: Geopsy, spac2disp, max2curve (http://www.geopsy.org/).

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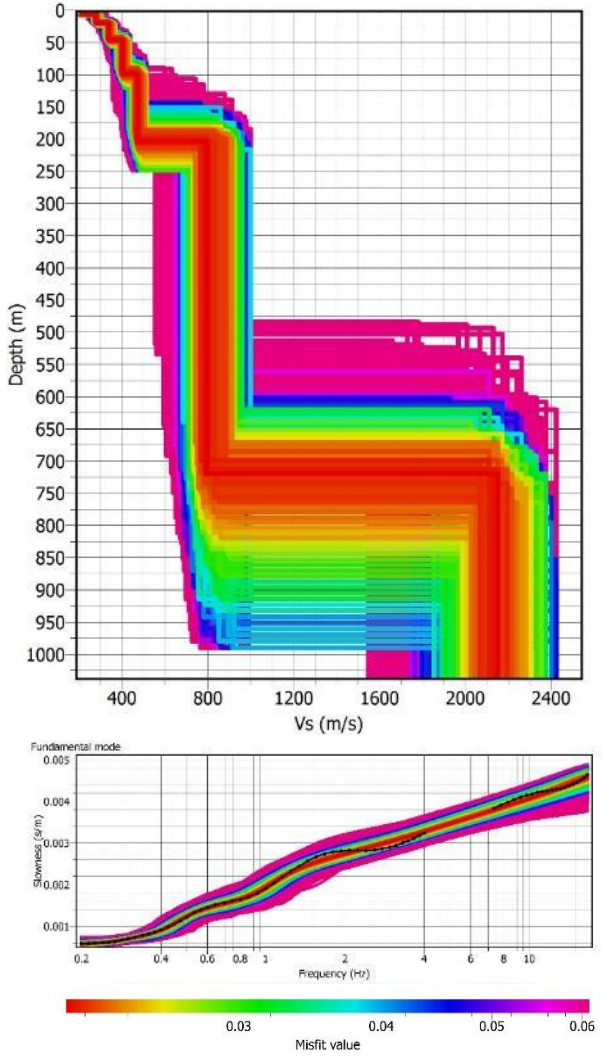
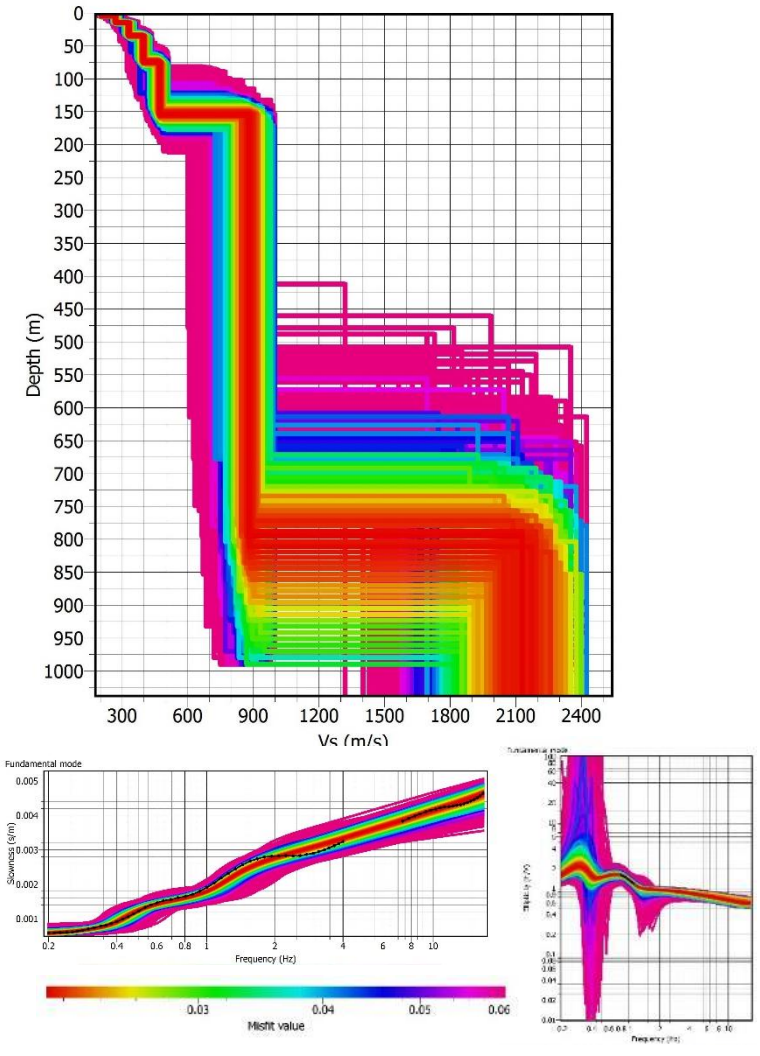
Modelli di velocità

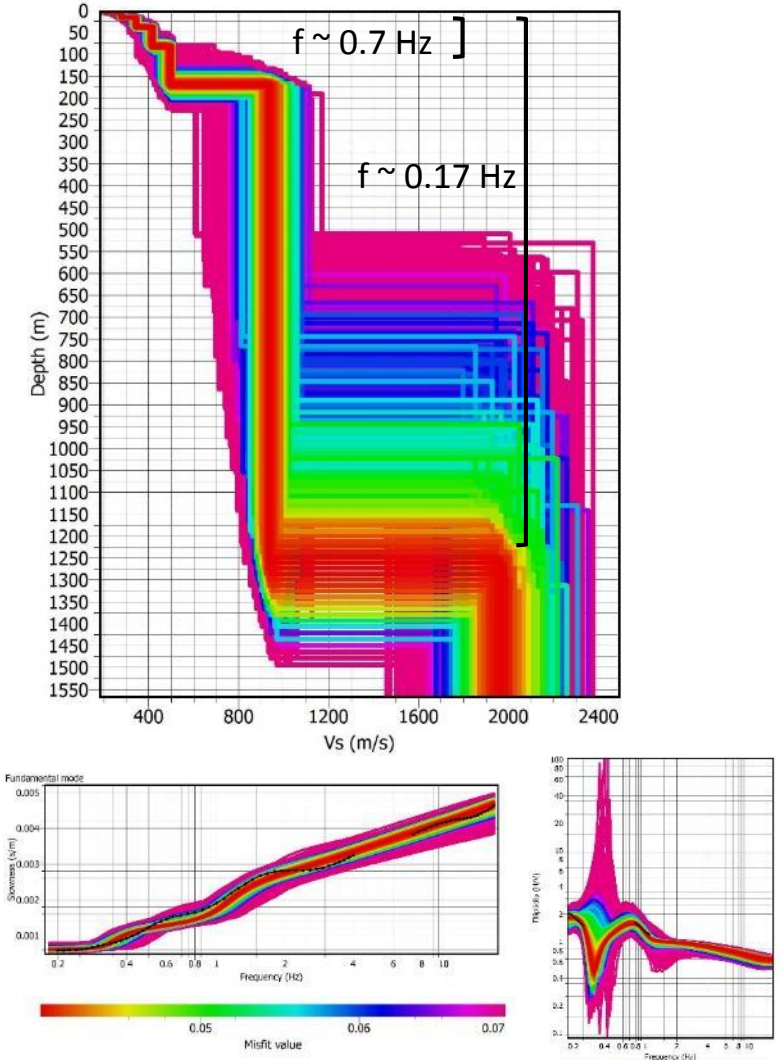
curve di dispersione



curve di dispersione ed ellitticità 0.7 Hz



curve di dispersione ed ellitticità 0.7 e 0.17 Hz



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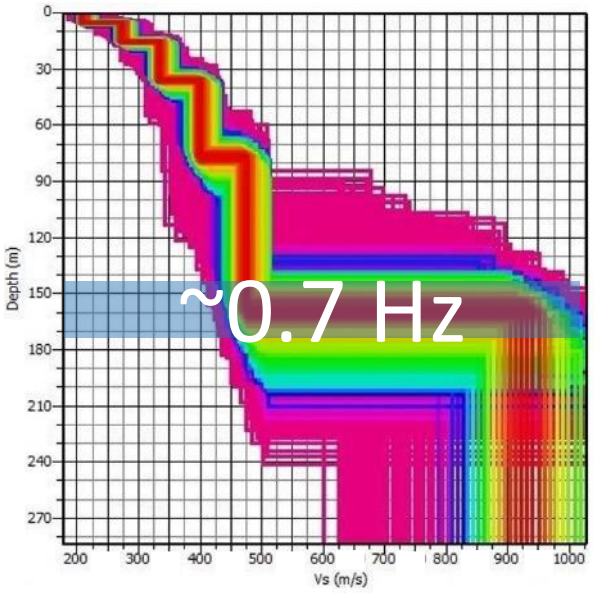
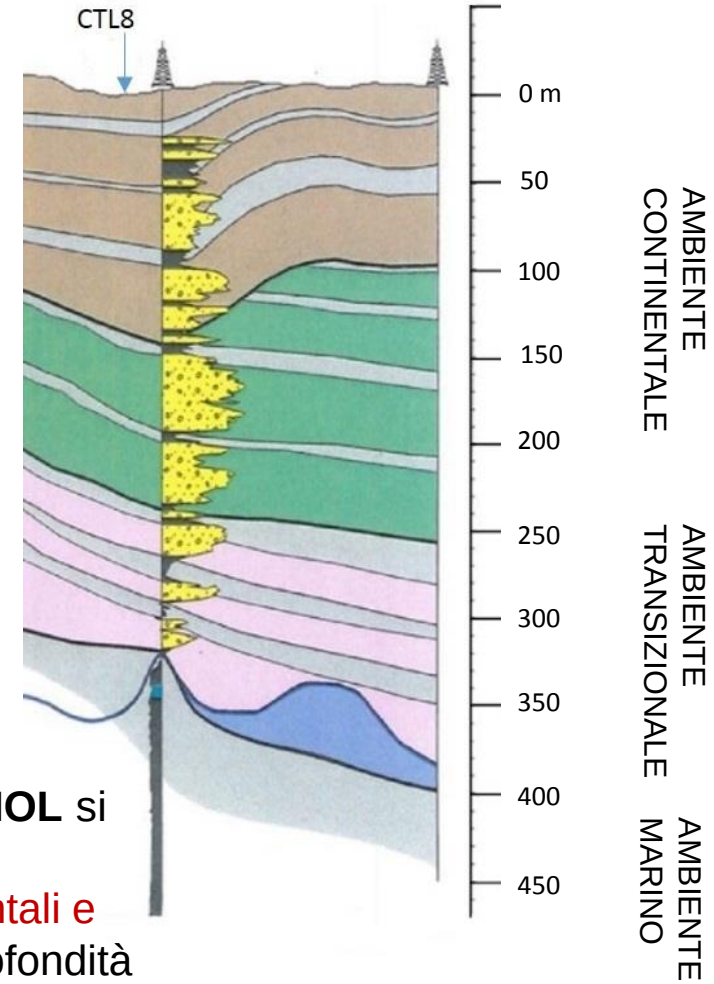
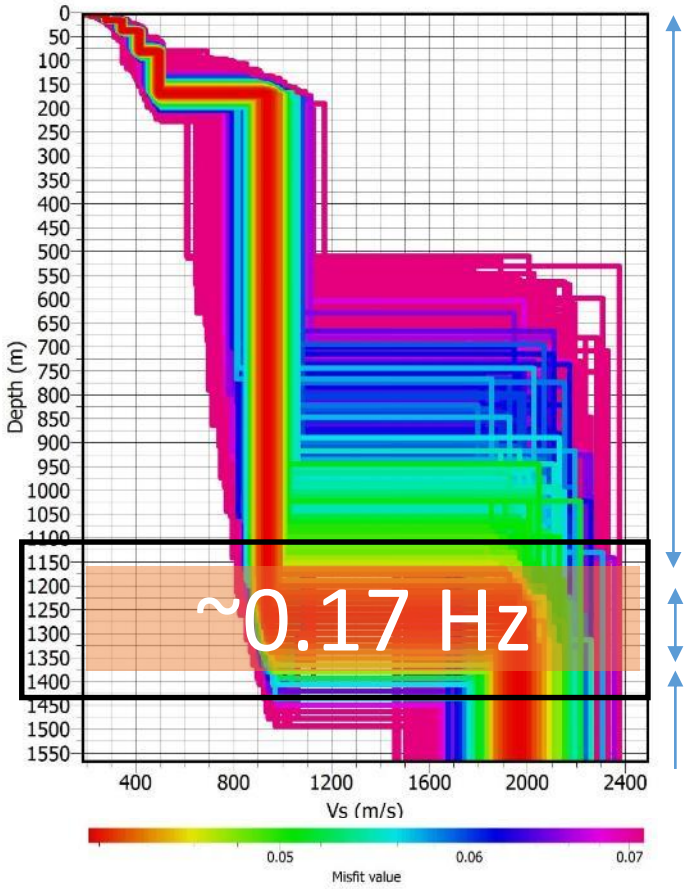
Correlazioni con la stratigrafia





Pozzo Soresina
(Carcano e Piccin, 2002)

Dal report del progetto **GEOMOL** si osserva una discontinuità tra i sedimenti Quaternari continentali e marini (tra QC1 e QM3), a profondità confrontabili con quelle ottenute dal modello 1D (**circa 160m**).



Quaternario: sabbie e ciottoli con argille

Pliocene: argille e sabbie

Miocene: marne

Pozzo Soresina
(Carcano e Piccin, 2002)

Dal report del progetto **GEOMOL** si osserva una discontinuità tra i sedimenti Pliocenici (argille con sabbie) e Miocenici (Marne), a profondità confrontabili con quella del pozzo Soresina (**circa 1300-1400m**).

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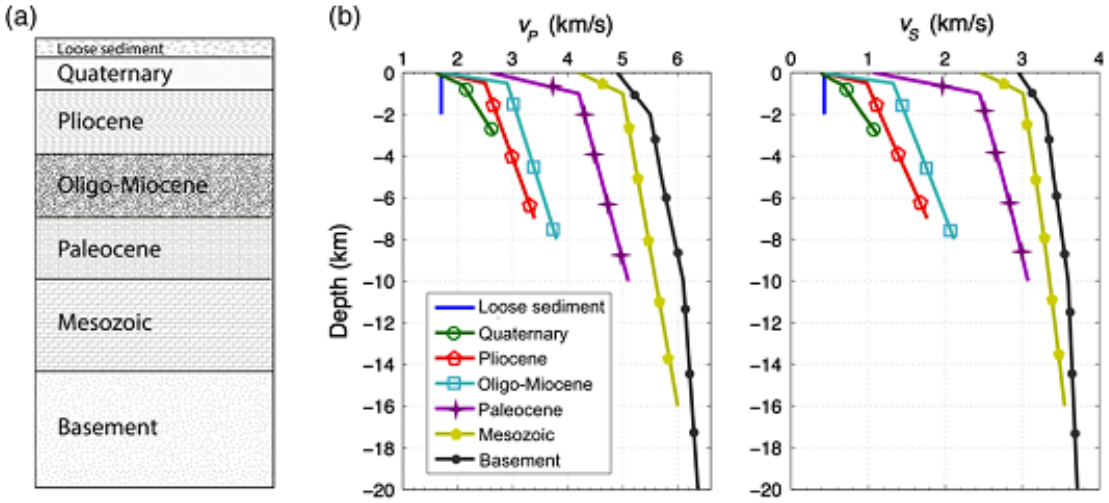
Validazioni del modello di Velocità

a) con modelli in letteratura della Pianura Padana



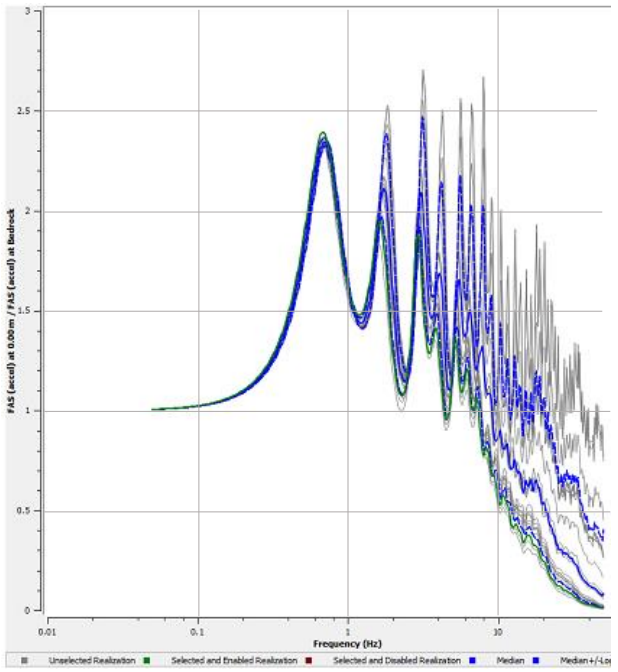
Molinari et al., 2015

Po Plain Model

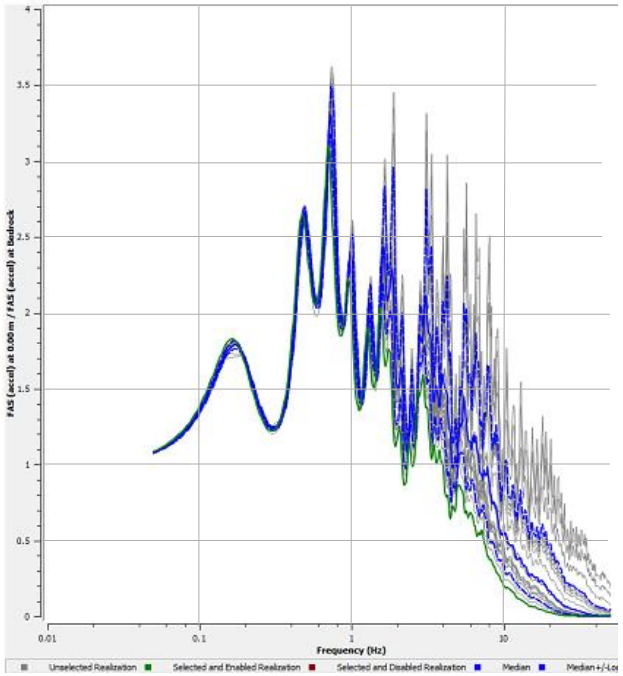
Depth Interval (km)	V_P (km/s)	V_S (km/s)	Density (g/cm^3)	Q_P	Q_S	Layer
(0.0–1.0)	1.500	0.60	1.60	40	20	Sediments
(1.0–2.0)	1.800	0.90	1.70	40	20	
(2.0–3.0)	2.160	1.20	1.70	80	40	
(3.0–3.5)	3.500	2.10	1.90	400	200	Consolidated Sediments
(3.5–4.0)	4.150	2.40	2.10	400	200	
(4.0–5.0)	4.750	2.75	2.75	400	200	
(5.0–6.0)	5.330	3.05	3.50	600	300	Upper Crust
(6.0–10.0)	5.880	3.40	3.85	600	300	
(10.0–20.0)	6.340	3.67	3.90	600	300	Middle Crust
(20.0–30.0)	6.800	3.93	3.90	1000	500	Lower Crust
Halfspace	7.700	4.41	3.95	1000	500	Upper Mantle

Vuan et al., 2011

b) calcolando la Transfer Function teorica



Bedrock 165m:
0.7 Hz e 1.9 Hz



Bedrock 1380m:
0.17 Hz, 0.46 Hz, 0.7 Hz, 1 Hz

Ellen M. Rathje; Albert Kottke (2010), "Strata," https://nees.org/resources/strata

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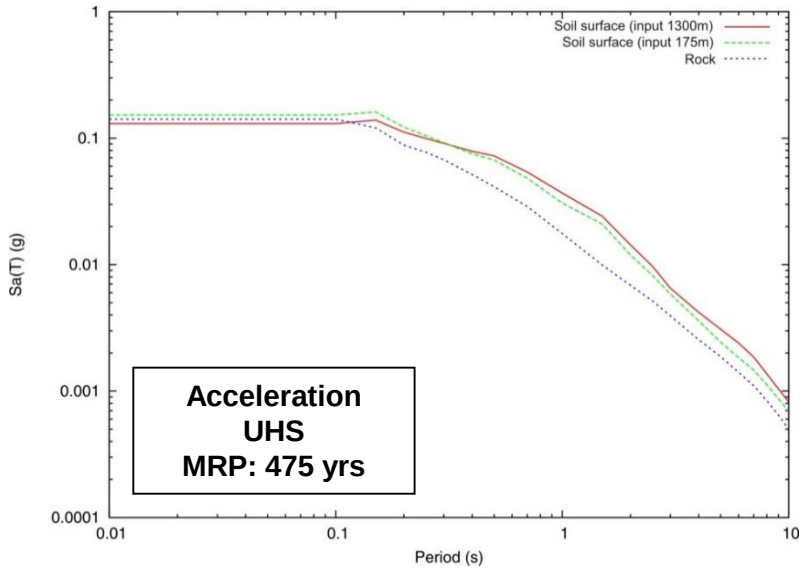
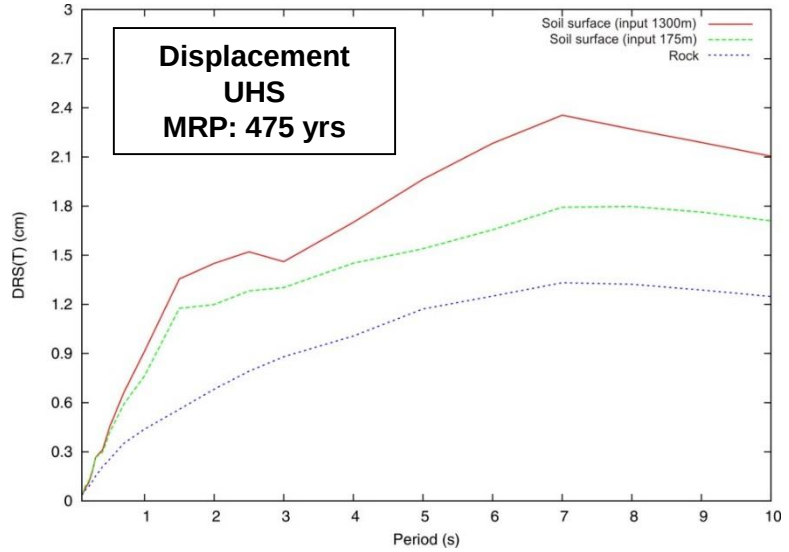
PSHA al sito : analisi preliminari

Metodo : Bazzurro and Cornell , 2004
GMPE : Cauzzi et al., 2014

In accelerazione …
aumentare la profondità del bedrock da 175 m a 1.300 m non ha condotto (come ipotizzabile) a differenze apprezzabili in termini di accelerazione spettrale a lunghi periodi.

In spostamento …
al contrario si osservano differenze ~ 25%. Tale valore, non rilevante in siti a bassa pericolosità sismica, come Castelleone, potrebbe risultare significativa in prossimità di aree a pericolosità medio-alta con condizioni geologiche sfavorevoli.





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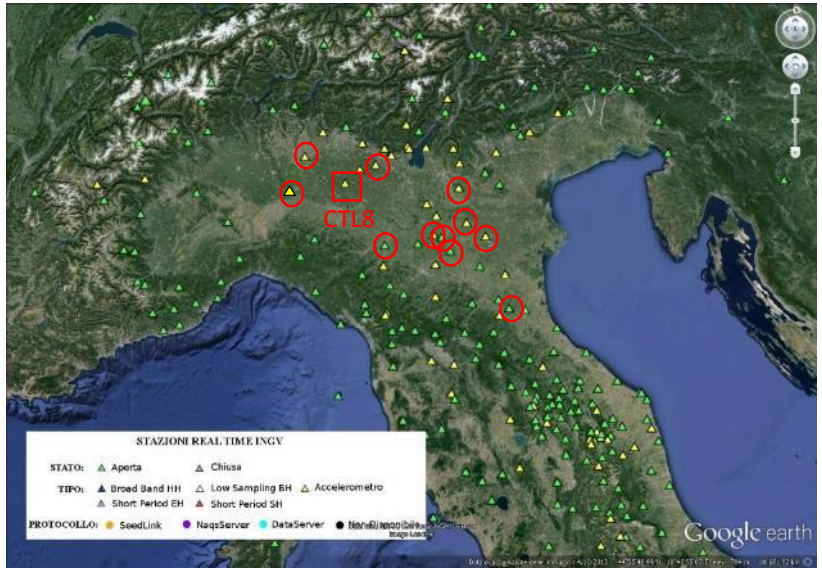
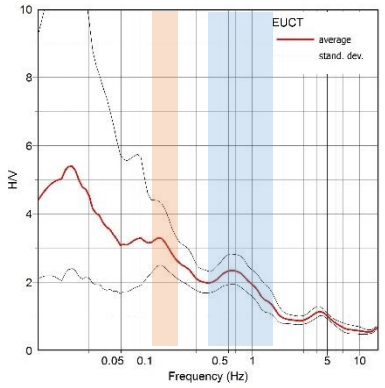
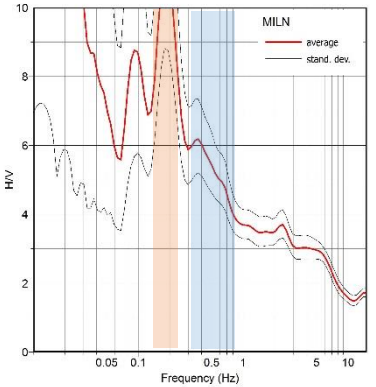
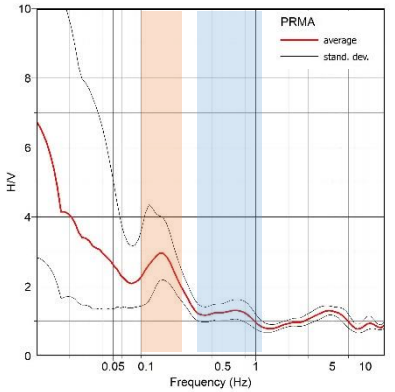
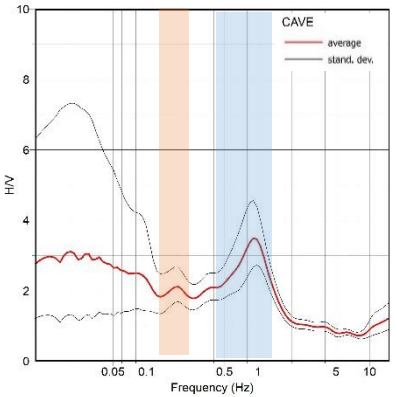
Possibile generalizzazione alla Pianura Padana

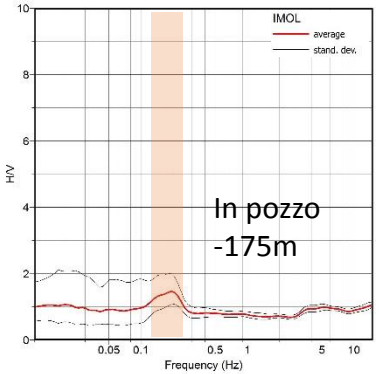


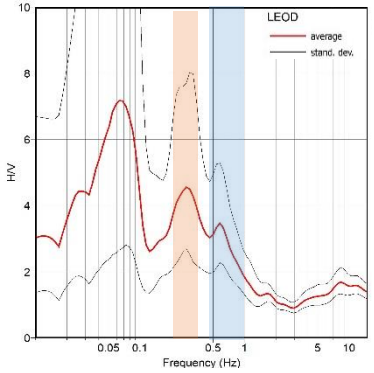


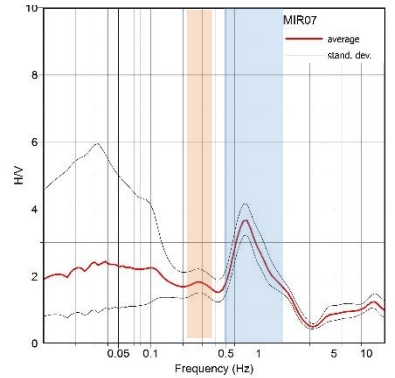


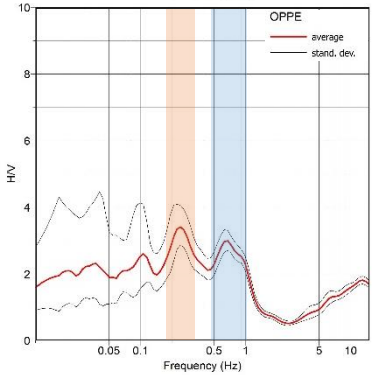


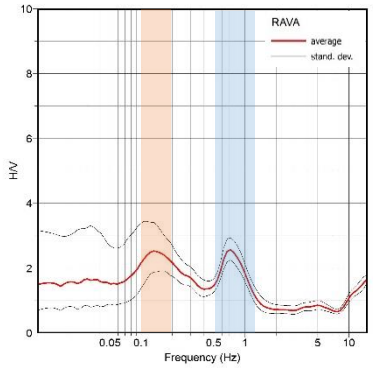


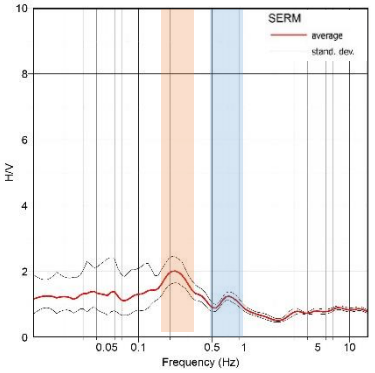


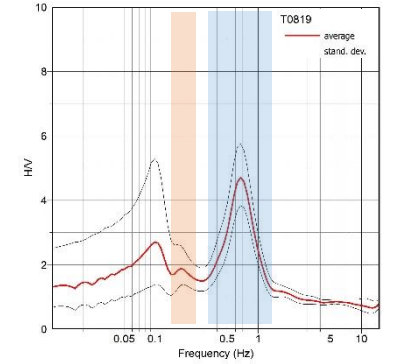


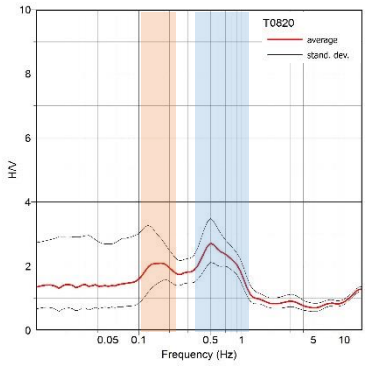












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Considerazioni finali

- Il sito in studio si collocata in **classe C** (NTC 2008)

- La profondità del **bedrock** come definito da **normativa** (Vs > 800 m/s) può essere ipotizzata a circa -150 m e mostra una buona correlazione con il picco H/V a circa 0.7 Hz

- In base ai dati di pozzo la profondità del possibile **bedrock geologico** si colloca a circa -1350 m, valore ben correlabile sia con il profilo di Vs sia con il picco H/V a circa 0.17 Hz

- Le conseguenze sul **PSHA** al sito sono apprezzabili esclusivamente in termini di spostamento :

  approfondire il bedrock da -150 m a circa -1.300 m conduce ad un aumento in termini di UHS in spostamento di poco superiore al **25% (MRP:475 anni),** % potenzialmente significativa in siti di pianura a pericolosità medio-alta

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Grazie per l'attenzione