POTENZIAMENTO ASSE FERROVIARIO MONACO - VERONA

LINEA DI ACCESSO SUD

FORTEZZA - VERONA

LOTTO 3 - CIRCONVALLAZIONE DI TRENTO E ROVERETO

Progetto PRELIMINARE

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Indagini geofisiche

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PROVINCIA AUTONOMA DI TRENTO

PROGETTO SPECIALE COORDINAMENTO ATTIVITA' PER LA FERROVIA DEL BRENNERO E PER LO SVILUPPO DELL'INTERMODALITA'

RFI

DIREZIONE MANUTENZIONE

DIREZIONE COMPARTIMENTALE INFRASTRUTTURA VERONA

1 – Premessa

Al fine di acquisire le prime informazioni di carattere geologico, idrogeologico e geotecnico lungo il tracciato preliminare della linea ferroviaria del Brennero (circonvallazione Trento – Rovereto), è stata effettuata una indagine geofisica, e geognostica su alcuni tratti valutati maggiormente significativi ai fini progettuali.

In particolare i siti/tratti indagati sono:
- area "ex scalo Filzi" a Trento in cui il tracciato preliminare inizia il percorso in galleria;
- tratto Doss di San Rocco – Mattarello, in cui il tracciato in galleria si sviluppa in prossimità/corrispondenza di un probabile accumulo di frana;
- attraversamento rio Cavallo, in cui è da valutare lo sviluppo in profondità della forra rocciosa;
- area di Serravalle, in cui è prevista l'uscita Sud del tratto in galleria.

In considerazione del carattere preliminare di questa fase d'indagine, le metodologie d'indagine prescelte sono state quelle che consentissero una acquisizione rapida e estesa di dati geognostici utili a definire il modello geologico delle aree/tratti attraversati.
Per questo oltre alla realizzazione di due sondaggi meccanici appositamente realizzati ed al reperimento di dati pregressi, le metodologie geofisiche utilizzate sono state quella ReMi e H/V.

I dati d'indagine diretti sono stati utilizzati per tarare e validare i dati geofisici acquisiti.

1.1 – indagini H/V - ReMi

L'analisi del rapporto spettrale delle componenti verticale e orizzontale del moto, proposta a partire dagli anni '70, è riconosciuta come efficace nel fornire stime attendibili della frequenza di risonanza del sottosuolo.
Essa viene effettuata dall'analisi dei microtremori presenti in ogni sito che, in corrispondenza di contrasti di impedenza sufficientemente elevati tra livelli distinti di terreno mostrano dei picchi nei fattori di amplificazione tra le componenti orizzontali e verticali del moto.
E' agevole determinare a quale frequenza di vibrazione si collochi il picco e tale frequenza (frequenza fondamentale di risonanza) può essere messa in relazione con la velocità di propagazione delle onde SH (V_{s1}) e con lo spessore del mezzo in cui esse si propagano (H) dalla seguente relazione:

$$f_r = \frac{V_{s1}}{4H}$$

Si osserva così come conoscendo il valore della frequenza di risonanza è possibile ricavare la profondità dell'interfaccia a partire dalla velocità delle onde S o viceversa.

Operativamente la misura H/V viene effettuata tramite un apposito strumento (tromino) e software (Grilla) che consente di ottenere le variazioni di ampiezza dei rapporti spettrali.
L'indagine ReMi si basa sulla possibilità che, a partire da una trasformata bidimensionale (p-f) *slowness(1/Velocità)-frequenza* della registrazione di un rumore di fondo (*microtremor*) si possa separare le onde di Rayleigh (onde di superficie) da altri tipi di onde che compongono il sismogramma rendendo possibile il riconoscimento delle vere velocità di fase dalle velocità apparenti.

2 – Scalo Filzi

Al fine di acquisire le prime informazioni di carattere geologico, idrogeologico e geotecnico nell'area presso l'ex scalo Filzi a Trento, in cui è prevista la realizzazione del nuovo tracciato ferroviario, è stata effettuata una analisi dei dati stratigrafici disponibili e condotta una specifica indagine geofisica.

La prima finalità di questa fase d'indagine è stata l'individuazione della morfologia sepolta del substrato roccioso per poter valutare con maggiore dettaglio le problematiche geologiche, idrogeologiche e geotecniche connesse alla realizzazione di un tracciato ferroviario sotterraneo che dovrà attraversare il contatto litologico tra depositi alluvionali di fondovalle e substrato roccioso.

Nella figura seguente è riportata l'ubicazione dell'area indagata.

fig. 1 - Ubicazione area d'indagine

In questa fase d'indagine sono stati raccolti i dati stratigrafici disponibili nel catasto sondaggi del Servizio Geologico e sono state effettuate specifiche indagini geofisiche (indagini ReMi e H/V) con la specifica finalità di individuare l'andamento della morfologia sepolta.

2.1 – Analisi dati stratigrafici

Nella figura seguente sono riportate le ubicazioni dei sondaggi meccanici presenti nel catasto sondaggi del Servizio Geologico e, tra esse, sono evidenziate quelle che hanno raggiunto il substrato.
L'icona a fianco riporta la profondità a cui si colloca la discontinuità tra deposito sciolto e substrato roccioso.
Si osserva come i dati disponibili siano scarsi e sicuramente insufficienti per poter definire in maniera esaustiva l'andamento della morfologia sepolta.

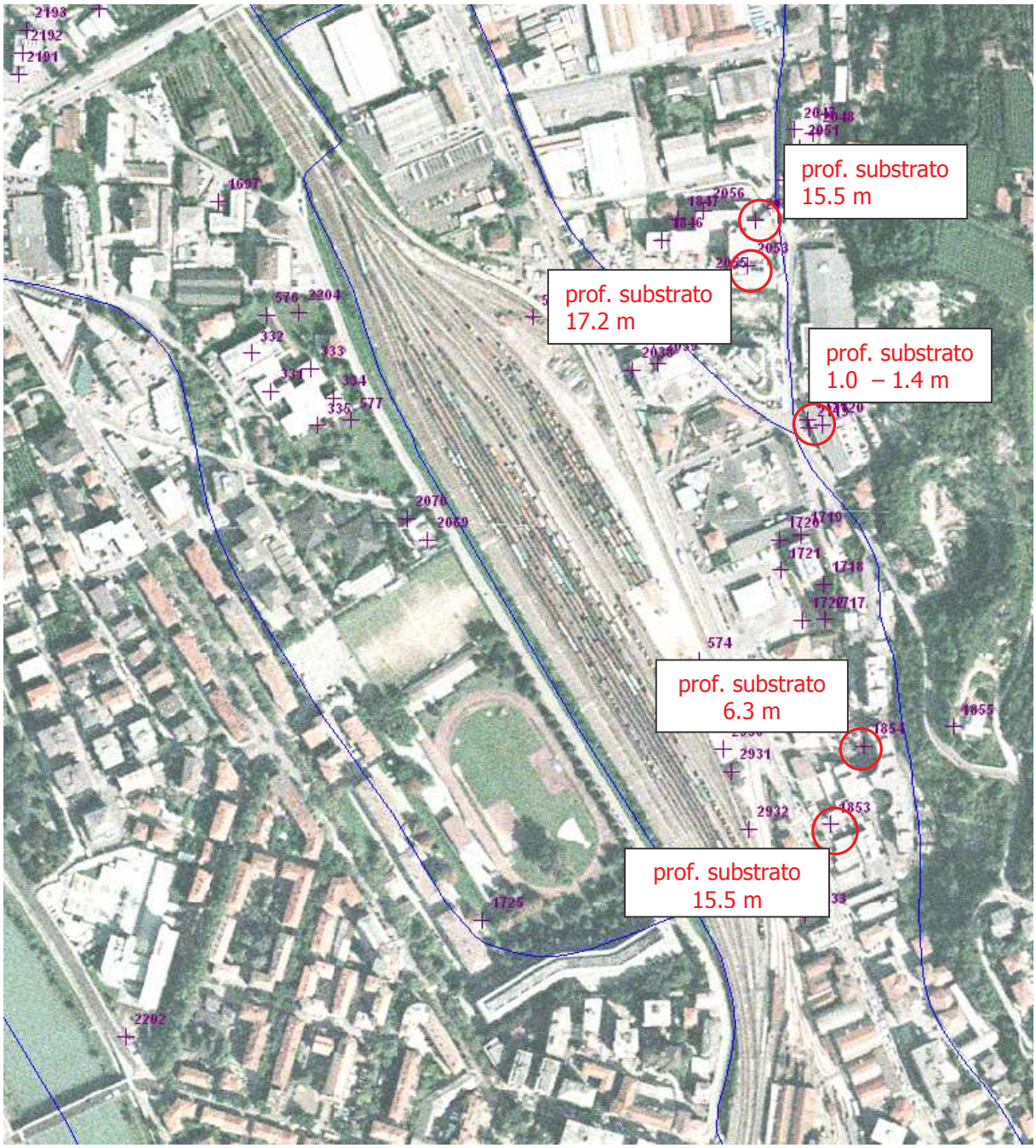


fig. 2 – sondaggi meccanici del Catasto Sondaggi P.A.T.

Per questo motivo, è stata condotta una indagine geofisica finalizzata a fornire le necessarie indicazioni relativamente alla profondità del substrato roccioso nell'area d'intervento.

A tale scopo sono stai realizzate 3 indagini ReMi e 14 indagini HVSR la cui ubicazione è riportata nella figura seguente.

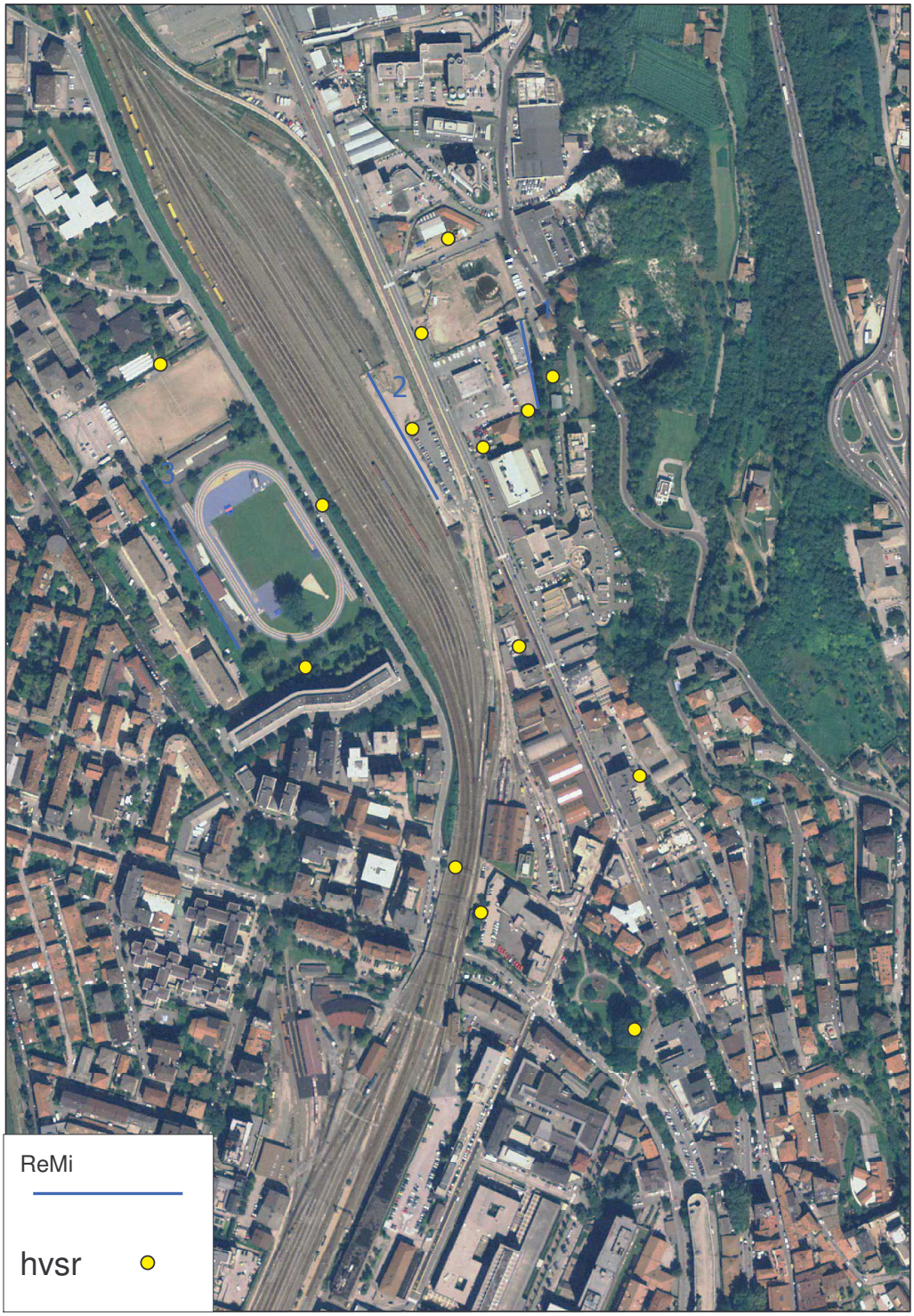


fig. 3 - Ubicazione indagini HVSR e ReMi

La scelta delle tipologie d'indagine nasce dal contesto altamente urbanizzato in cui si deve operare; infatti la presenza di elevati disturbi ambientali sia

meccanici che elettromagnetici, oltre alla quasi totale assenza di superfici non asfaltate o edificate rende assai difficoltose, se non impossibili, l'effettuazione delle usuali indagini geofisiche, come ad esempio sismica a rifrazione, che ben si presterebbe per gli scopi dello studio.
Pertanto si è scelto di operare con delle metodologie non usuali, ma già ampiamente sperimentate che sfruttano il cosiddetto "rumore ambientale" come elemento d'indagine.
Nello specifico si è scelto di realizzare delle indagini ReMi al fine di determinare la velocità delle onda di taglio dei depositi alluvionali e delle indagini H/V che consentono, a partire dal valore di Vs, di ottenere una stima dello spessore dei depositi sciolti

2.2 - Risultati ottenuti

Nella figura seguente è riportata l'ubicazione delle indagini HVSR eseguite, il valore della frequenza fondamentale individuata per l'intero deposito superficiale (e quindi indicativa del limite litologico tra substrato e alluvioni) e il counturing dei valori di frequenza.
I valori di frequenza determinati sono compresi tra un minimo di circa 1 Hz (campo Coni) ed un massimo di circa 5.5 Hz (area prossima al versante roccioso); l'andamento del counturing individua un modello sostanzialmente uniforme e omogeneo che risulta concorde con quanto ci si può attendere nel contesto esaminato.

La morfologia sotterranea sembra individuare due "speroni" prominenti (area "ex Motel Agip" e area "Fornaci") con un avvallamento tra essi.

In allegato sono presentati i diagrammi di elaborazione di ciascuna indagine realizzata unitamente alla loro ubicazione.

Sono state effettuate 3 indagini ReMi finalizzate alla determinazione del valore di Vs dei depositi alluvionali, valore necessario per effettuare una stima dello spessore della copertura detritica.
I profili di velocità Vs sono presenti in allegato.

I tre profili di velocità evidenziano tutti la presenza di una discontinuità che può essere interpretata come l'interfaccia deposito alluvionale/substrato roccioso anche se, i valori di Vs ottenuti per il substrato sono molto bassi.
Il fatto che però tutti e tre siano molto simili (350 ÷ 450 m/s circa)e che il campo di valori rientri comunque all'interno del campo di variabilità ricavabile su base bibliografica, fa ritenere, in prima analisi corrette le estrapolazioni effettuate.

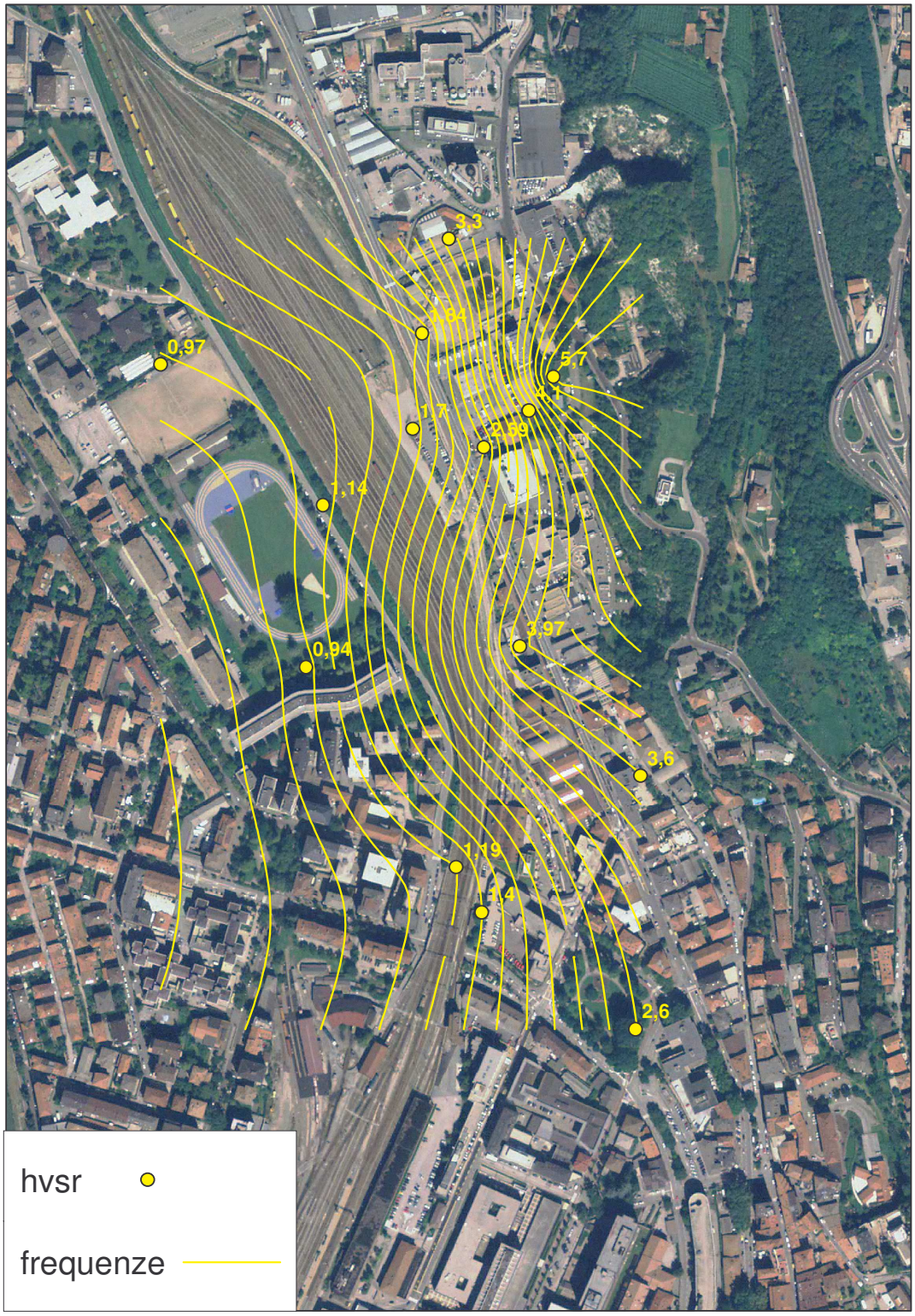


fig. 4 – andamento frequenze di risonanza

Nella tabella seguente sono riportati i valori di profondità a cui si colloca il presunto substrato e il valore di Vs ricavato (come media) dei depositi alluvionali soprastanti.

prova	prof. substrato (m)	Vs depositi sciolti (m/s)
ReMi 1	**20**	**295**
ReMi 2	**30**	**200**
ReMi 3	**55**	**208**

Anche in questo caso i valori sono tra loro congruenti ed evidenziano, in accordo al modello geologico dell'area un maggiore addensamento, oppure una composizione granulometrica più grossolana, nell'area che si colloca più prossimale al versante roccioso rispetto a quella posta verso il centro della valle.

2.3 – Confronto tra dati acquisiti

Sulla base dei valori di frequenza ricavati dalle indagini H/V ed i valori di Vs dedotti dalle indagini ReMi, è stata effettuata una stima degli spessori in corrispondenza di ogni punto d'indagine H/V.

Nella tabella seguente sono riportati oltre al numero identificativo dell'indagine (vedi l'ubicazione in allegato) il valore di frequenza, il valore di velocità (Vs) utilizzato (per la sua scelta si è fatto riferimento alle indagini ReMi più prossime) ed il valore dello spessore ricavato.

prova n°	f_r (Hz)	Vs (m/s)	h (m)
0	3,3	295	22,5
1	3,6	295	20,5
2	2,6	200	19,5
3	1,7	200	29,5
4	0,94	208	55
5	0,97	208	53
6	1,84	200	27
7	5,7	295	13
8	1,4	208	37
9	1,19	208	44
10	1,14	208	45
11	4,1	295	18
12	2,59	200	19,5
13	3,97	295	18,5

Sulla base di questi valori è stata elaborata la cartografia illustrante l'andamento della morfologia sepolta (isobate) riportata nella figura seguente.

Si osserva come la morfologia del substrato che si ricava da questa elaborazione mostri, in termini generali, un andamento "gradinato"; in corrispondenza dell'attuale linea ferroviaria infatti, si rileva come aumenti l'acclività rispetto alla morfologia soprastante (che si raccorda con i versanti affioranti) e quella più profonda.

Al fine di valutare il grado di attendibilità di questa elaborazione, è stato condotto un confronto con i pochi dati diretti ricavabili dai sondaggi meccanici contenuti nel Catasto Sondaggi del Servizio Geologico.
In primo luogo non vanno considerati gli andamenti ai bordi della finestra di elaborazione poiché, nel processo utilizzato, non è stato inserito il substrato affiorante; per questo motivo le isobate si collocano anche al di sotto del versante roccioso.

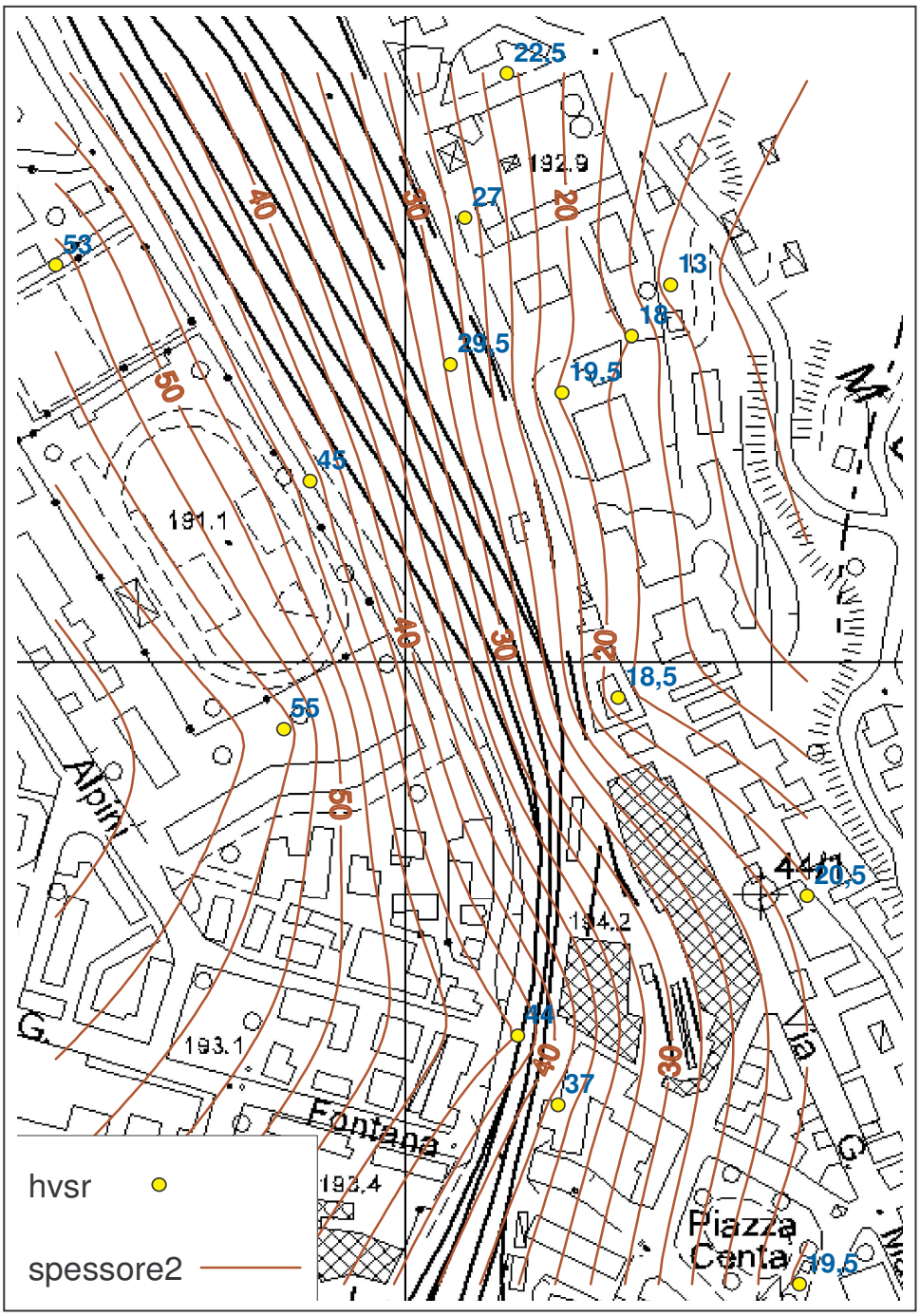


fig. 5 – andamento isobate substrato

Anche, nella parte rimanente, come è lecito aspettarsi non vi è totale coincidenza tra i dati desunti dai sondaggi geognostici e quelli dall'elaborazione geofisica; in particolare si osserva che:

- in corrispondenza del centro "Le Fornaci" (sondaggi 1854 e 1853) i dati sono quasi coincidenti sul primo sondaggio (prof. substrato 15.5 m – prof. geofisica 17.0 m) ma molto diversi sul secondo (prof. substrato 6.3 m – prof. geofisica 15.0 m);
- in corrispondenza della concessionaria di auto Renault (sondaggi 2118 ÷ 2120) i dati sono ancora più dissimili ((prof. substrato 1.2 m circa – prof. geofisica > 15 m);
- in corrispondenza dell'"ex Motel Agip" i sondaggi meccanici presentati non hanno raggiunto il substrato ma i dati sono stati comunque confrontati con l'elaborazione geofisica per validarla. Le isobate ricavate pongono il substrato in prossimità dell'edificio tra 16 m e 20 m circa mentre dei sei sondaggi realizzati 4 si sono arrestati a 15 m uno (n° 1719) a 19 m ed uno (n° 1721) a 24 m senza mai incontrare il substrato. I dati meccanici, in definitiva, pur non coincidendo, non smentiscono i dati geofisici anche se non possono confermarli.

Sulla base del confronto effettuato, è possibile affermare come l'indagine geofisica pur presentando ovvi limiti di precisione, ed in modo particolare avvicinandosi ai bordi (sia della finestra di elaborazione che morfologici) consenta con una buona approssimazione di ricostruire l'andamento morfologico del substrato.
Un maggior grado di precisione è sicuramente ottenibile infittendo i dati di misura e, contemporaneamente, realizzando ulteriori sondaggi meccanici di taratura.

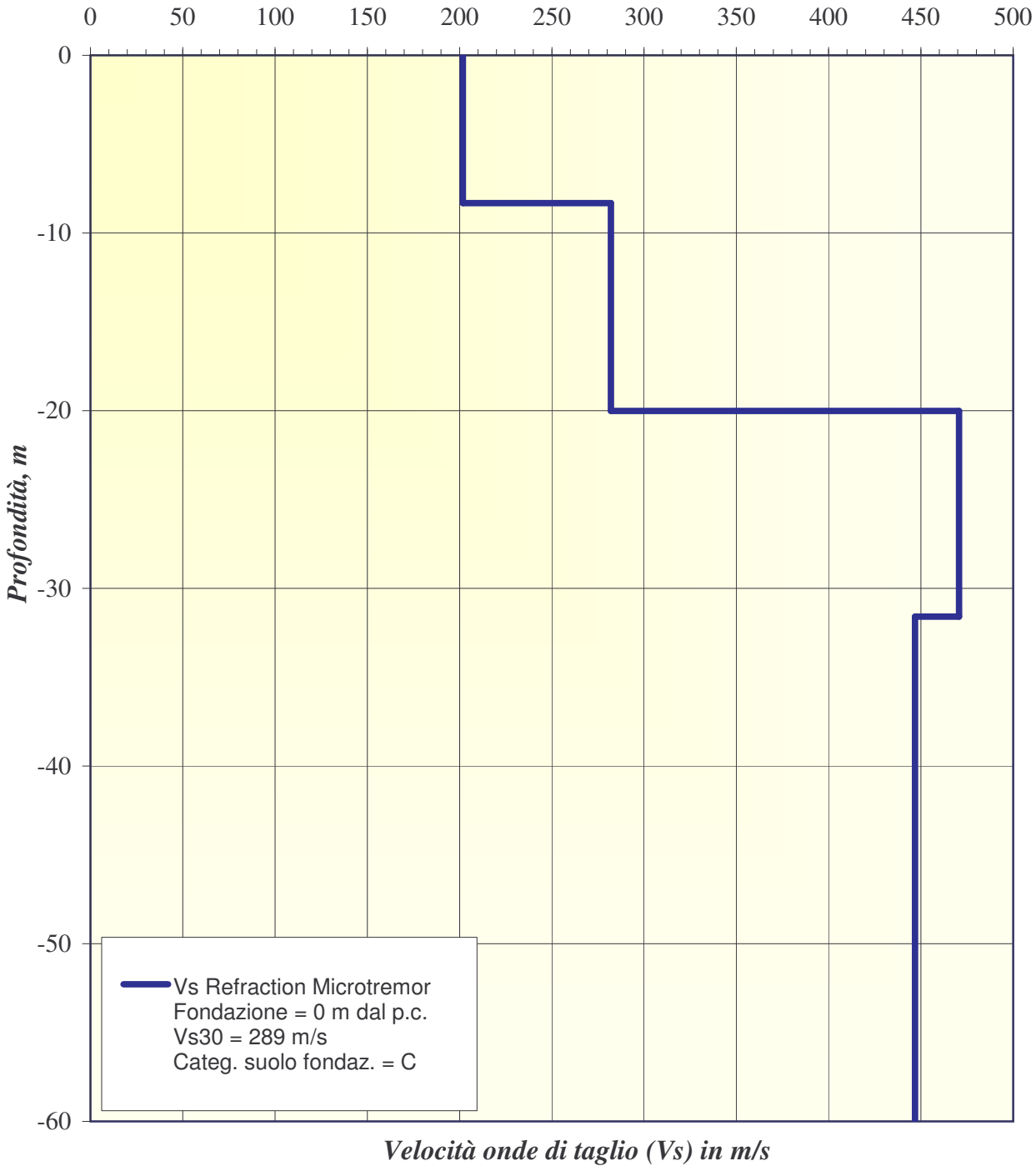
ALLEGATI

- profili di velocità ReMi

- elaborati indagini H/V

Scalo Filzi 1

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

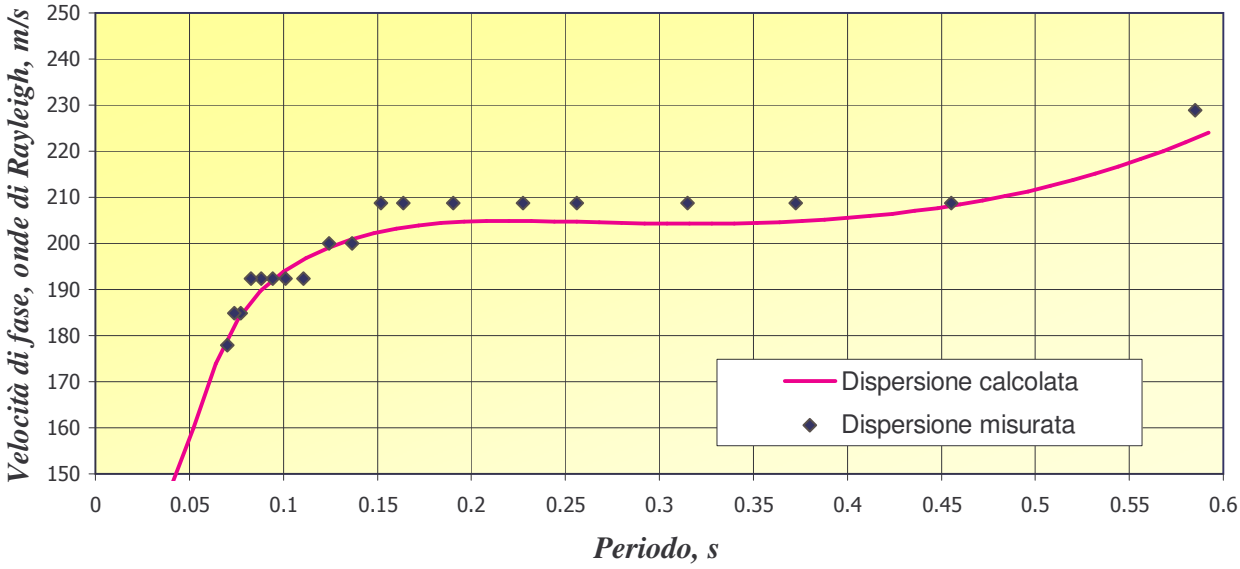
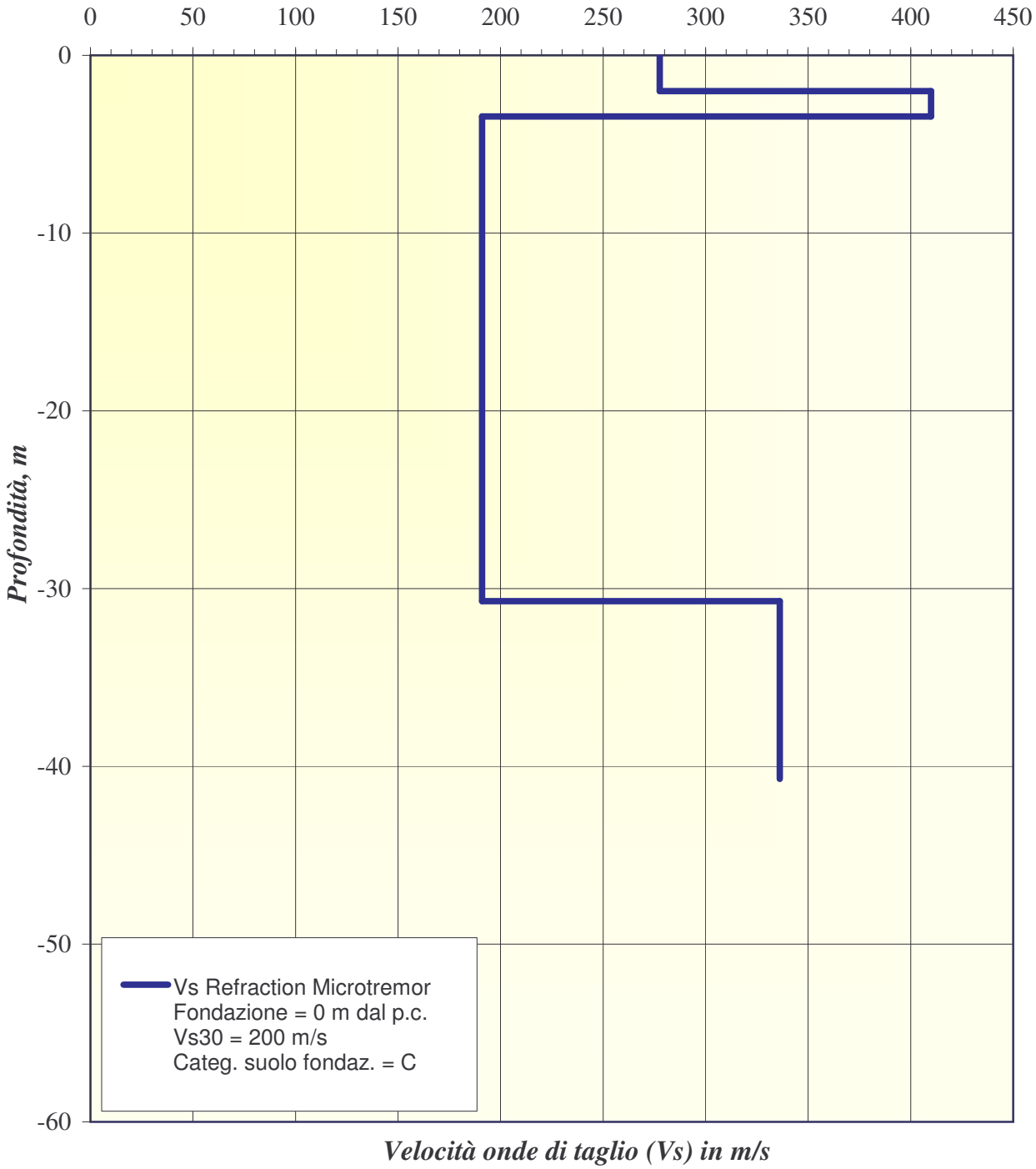


grafico slowness/frequenza

Scalo Filzi 2

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

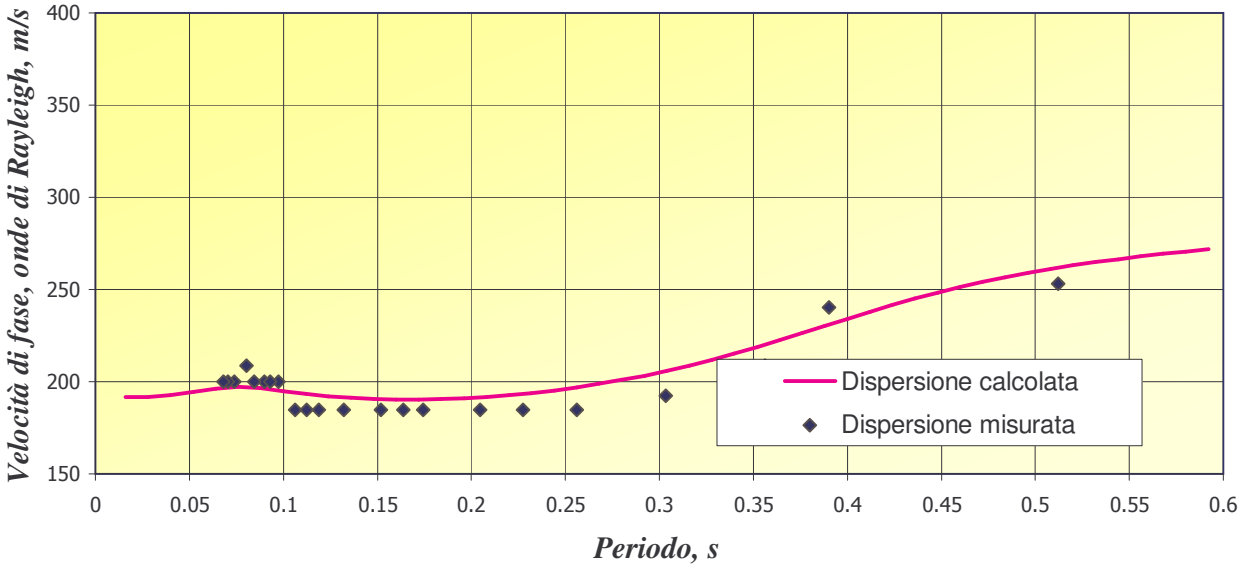
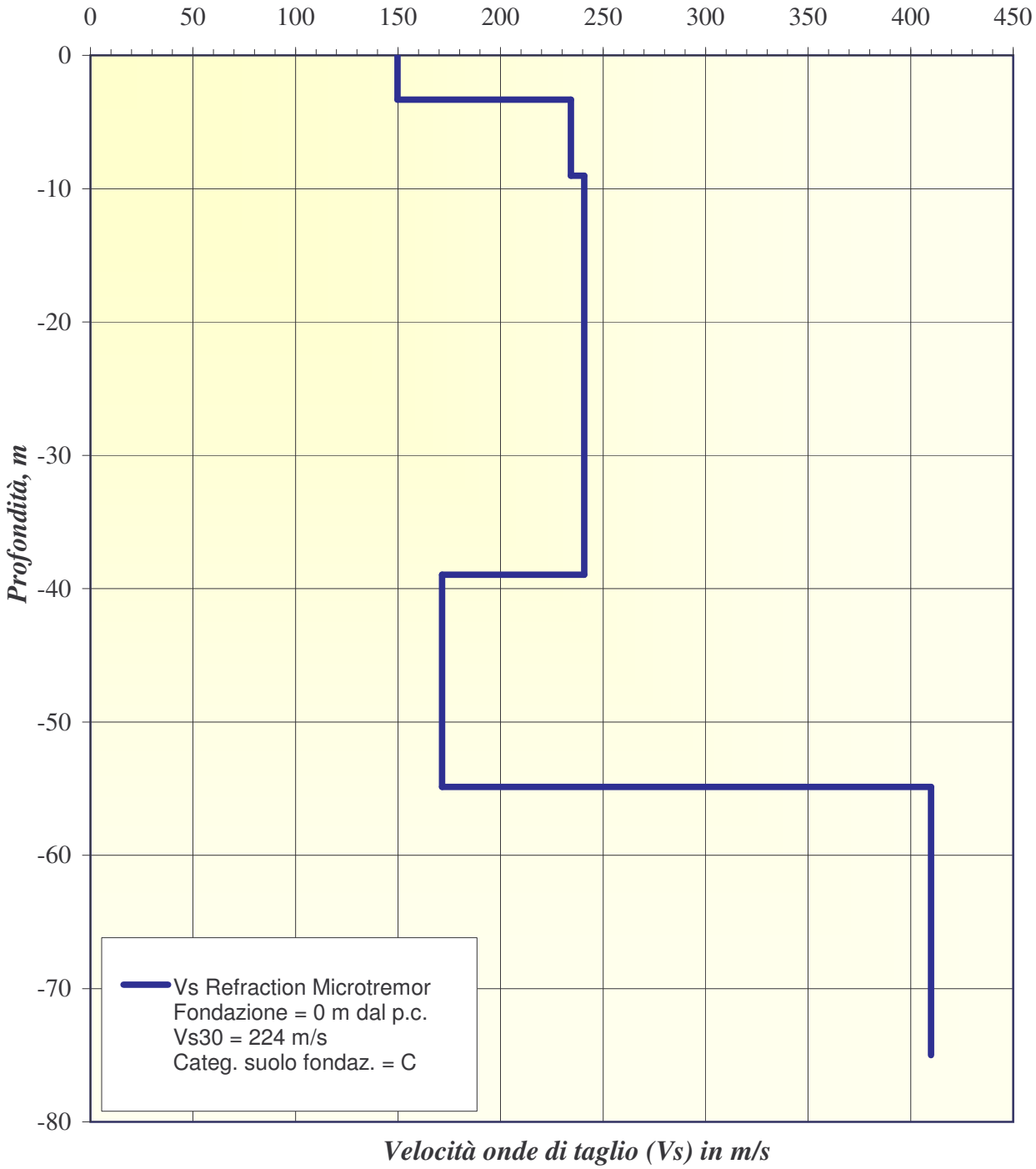


grafico slowness/frequenza

Scalo Filzi 3

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

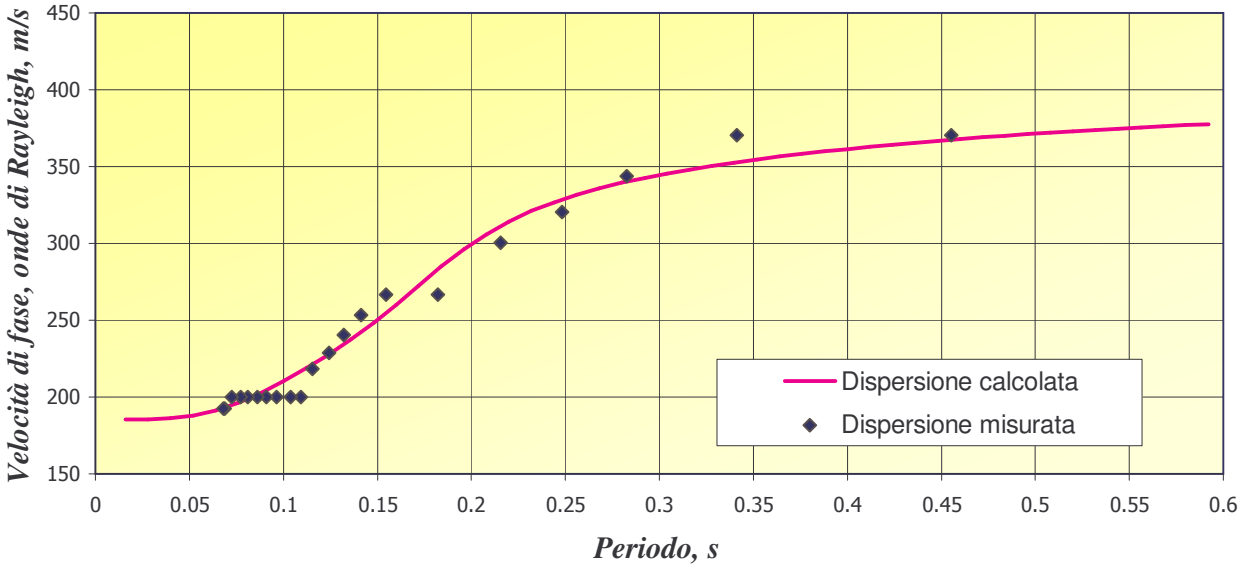


grafico slowness/frequenza


0
192.9
6
5
7
11
3
12
10
191.1
13
4
Alpini
444.1
194.2
9
193.1
8
Fontana
193.4
Piazza
Centa
2
hvsr

H/V n° 0

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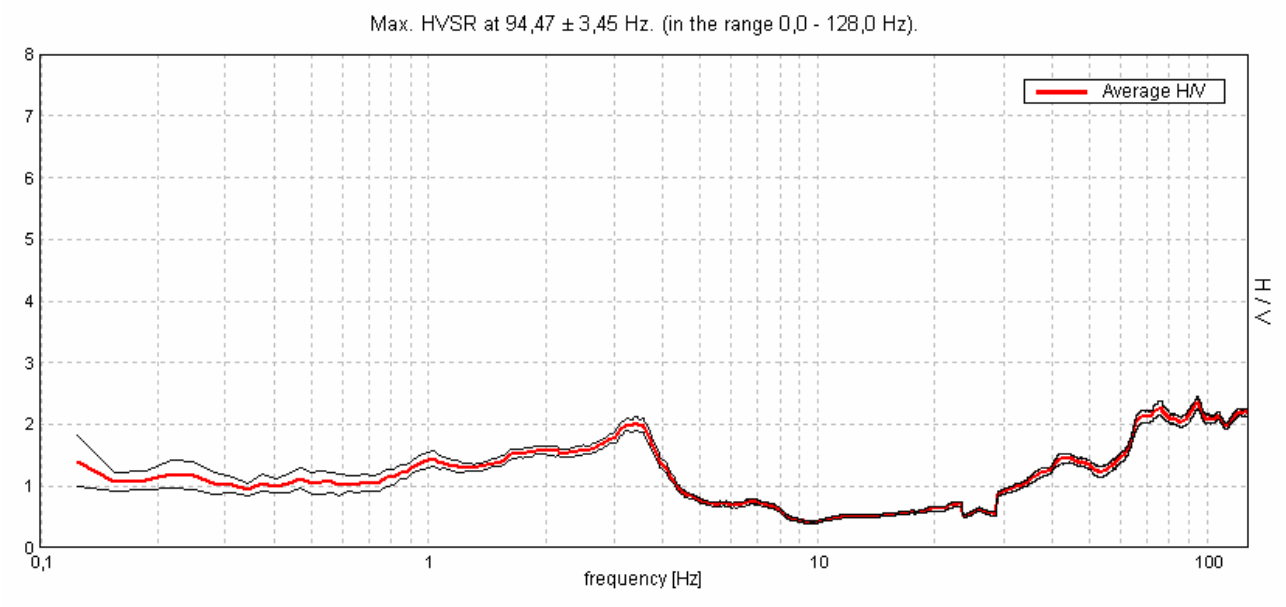
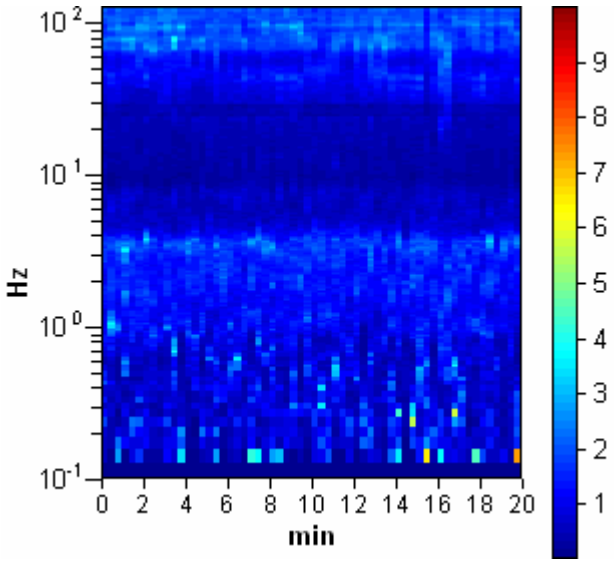
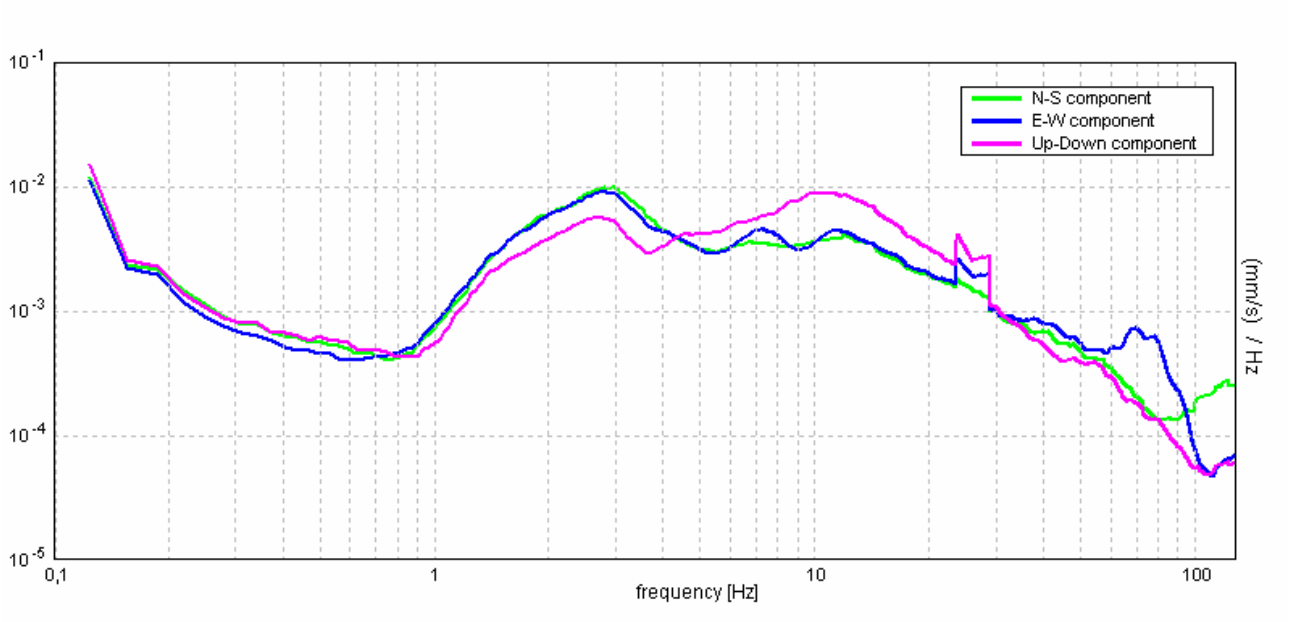
HORIZONTAL TO VERTICAL SPECTRAL RATIO



H/V TIME HISTORY



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 94,47 ± 3,45 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	94,47 > 0,50	OK	
$n_c(f_0) > 200$	113362,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 2586 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	36,406 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	2,35 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,01811| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	1,71107 < 4,72344	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0471 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n° 1

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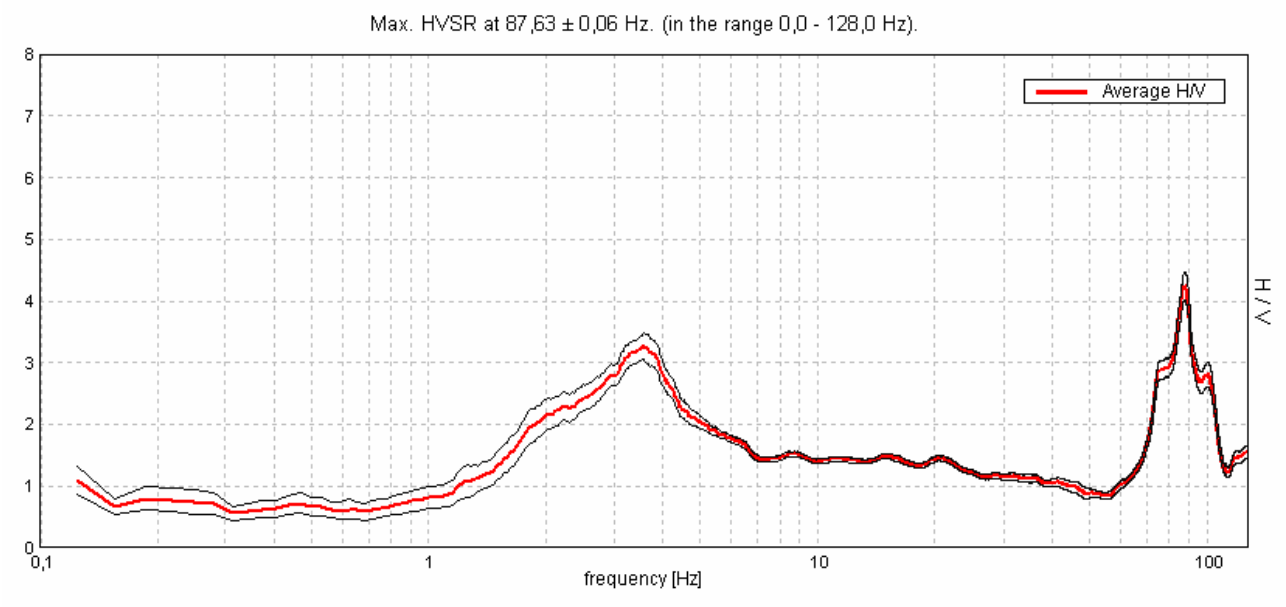
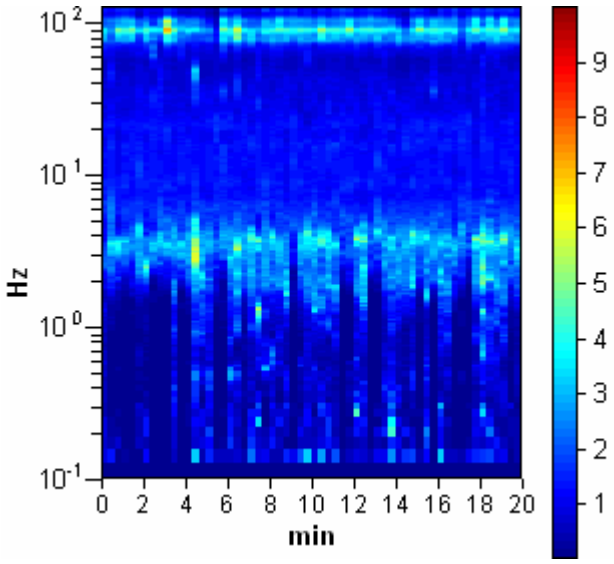
Smoothing: 10%

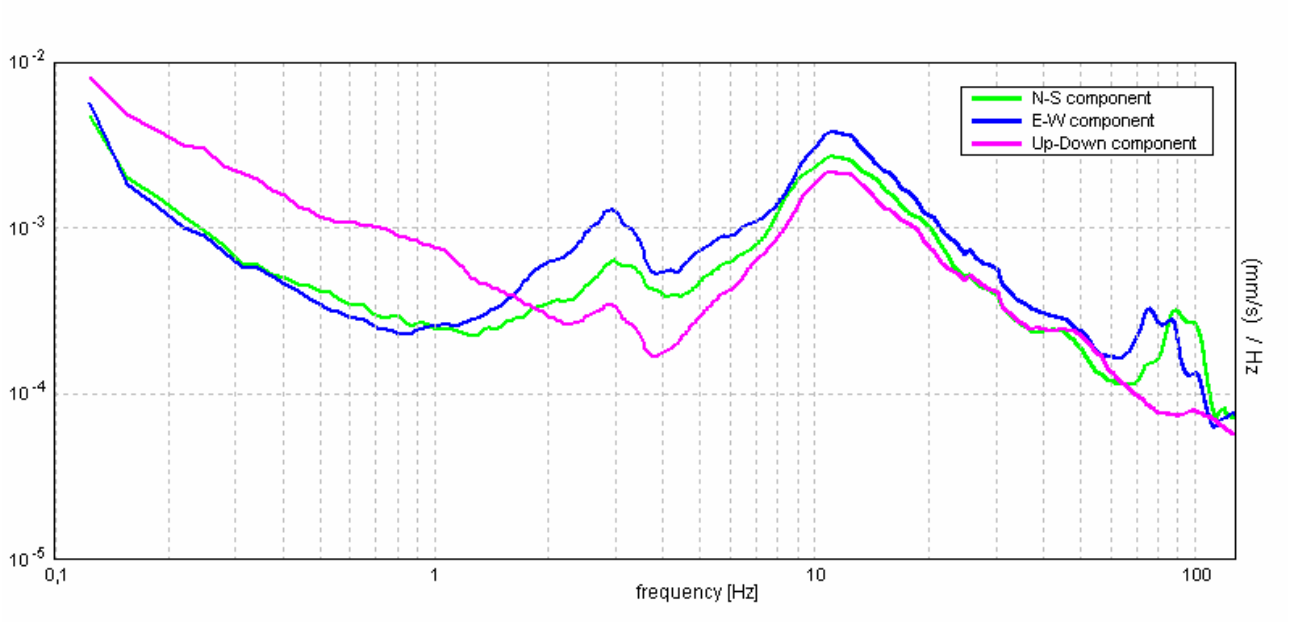
HORIZONTAL TO VERTICAL SPECTRAL RATIO



H/V TIME HISTORY



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 87,63 ± 0,06 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	87,63 > 0,50	OK	
$n_c(f_0) > 200$	105150,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 2695 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	72,469 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	105,531 Hz	OK	
$A_0 > 2$	4,24 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00032| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,02789 < 4,38125	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1131 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

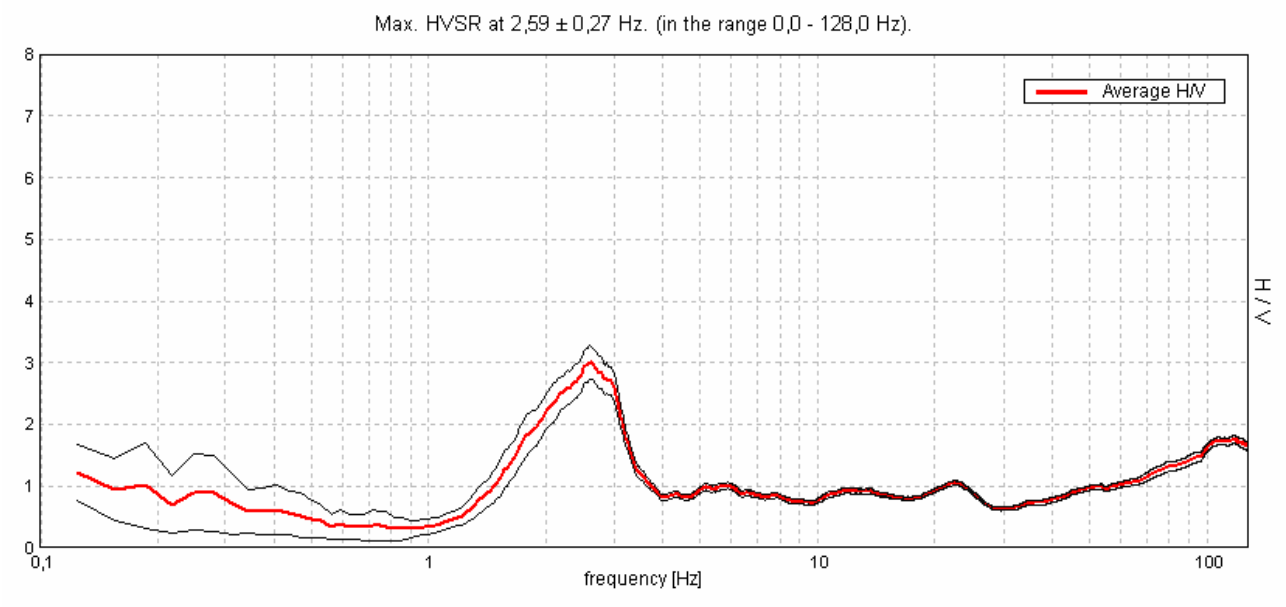
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n° 2

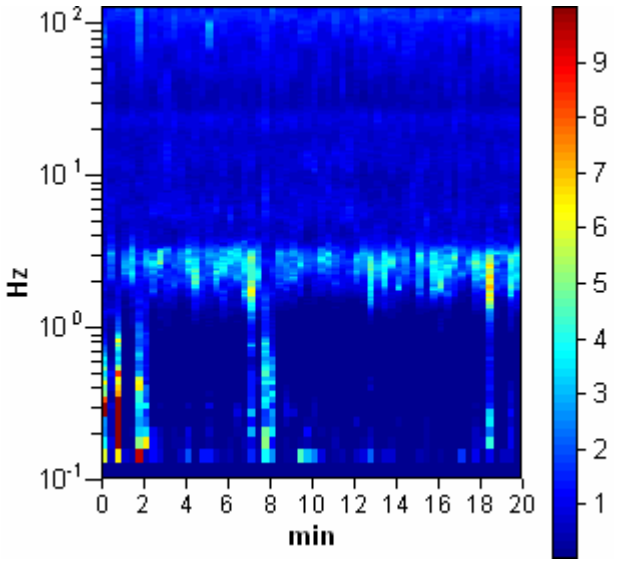
Start recording: 01/10/07 14:12:11 End recording: 01/10/07 14:32:12
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

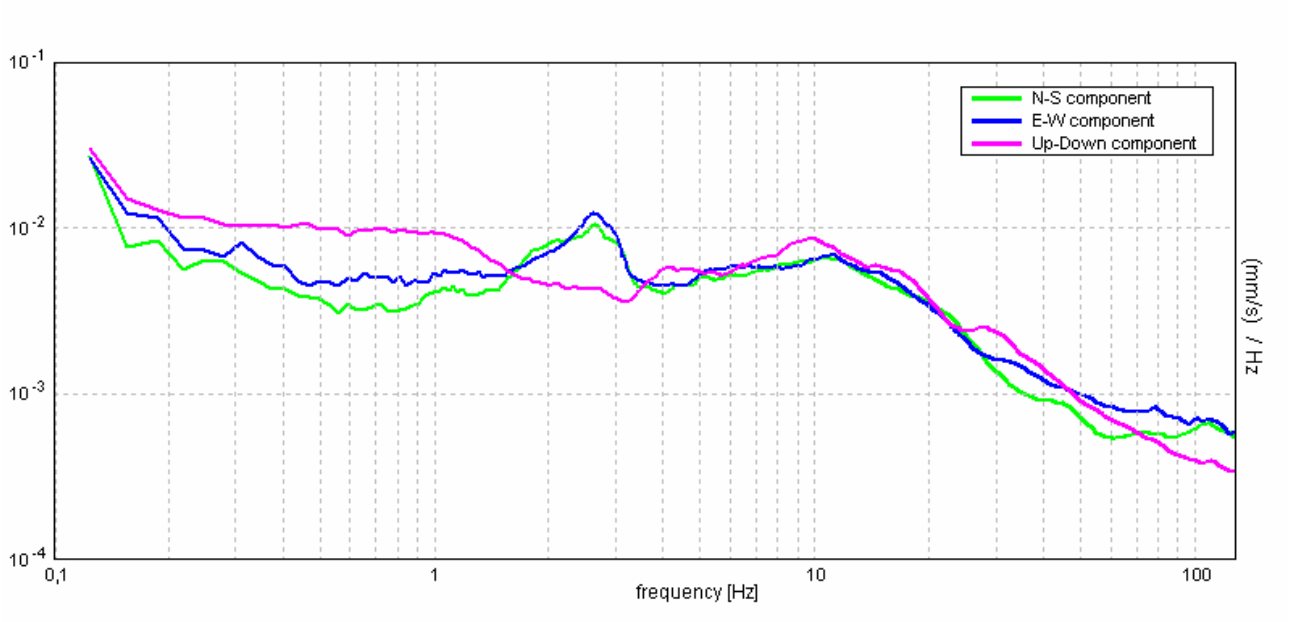
HORIZONTAL TO VERTICAL SPECTRAL RATIO



H/V TIME HISTORY



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,59 ± 0,27 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,59 > 0,50	OK	
$n_c(f_0) > 200$	3112,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 126 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,656 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	3,313 Hz	OK	
$A_0 > 2$	3,01 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,05159| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	0,13381 < 0,12969		NO
$\sigma_A(f_0) < \theta(f_0)$	0,1333 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

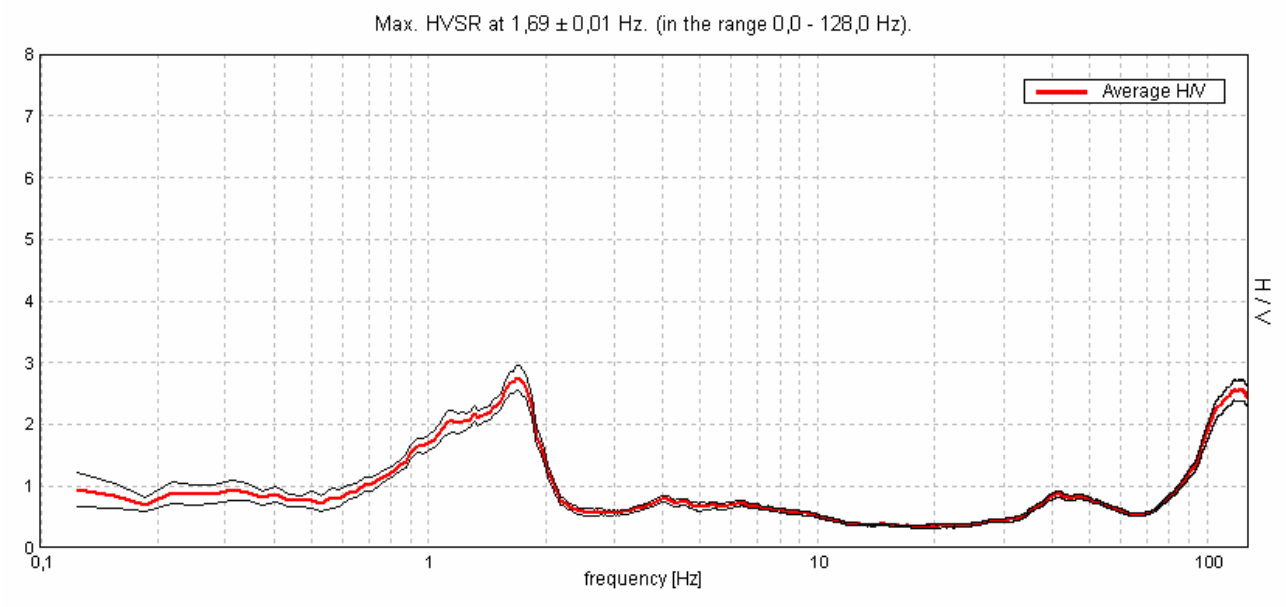
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n° 3

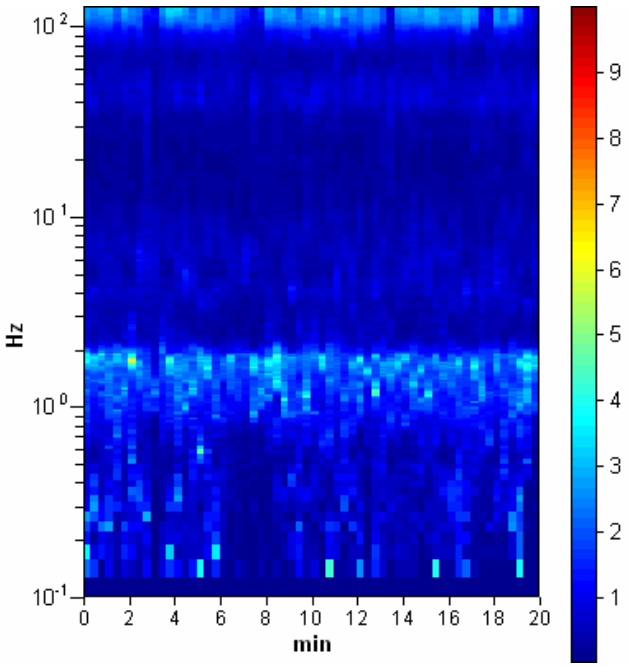
Start recording: 03/10/07 14:51:15 End recording: 03/10/07 15:11:16
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

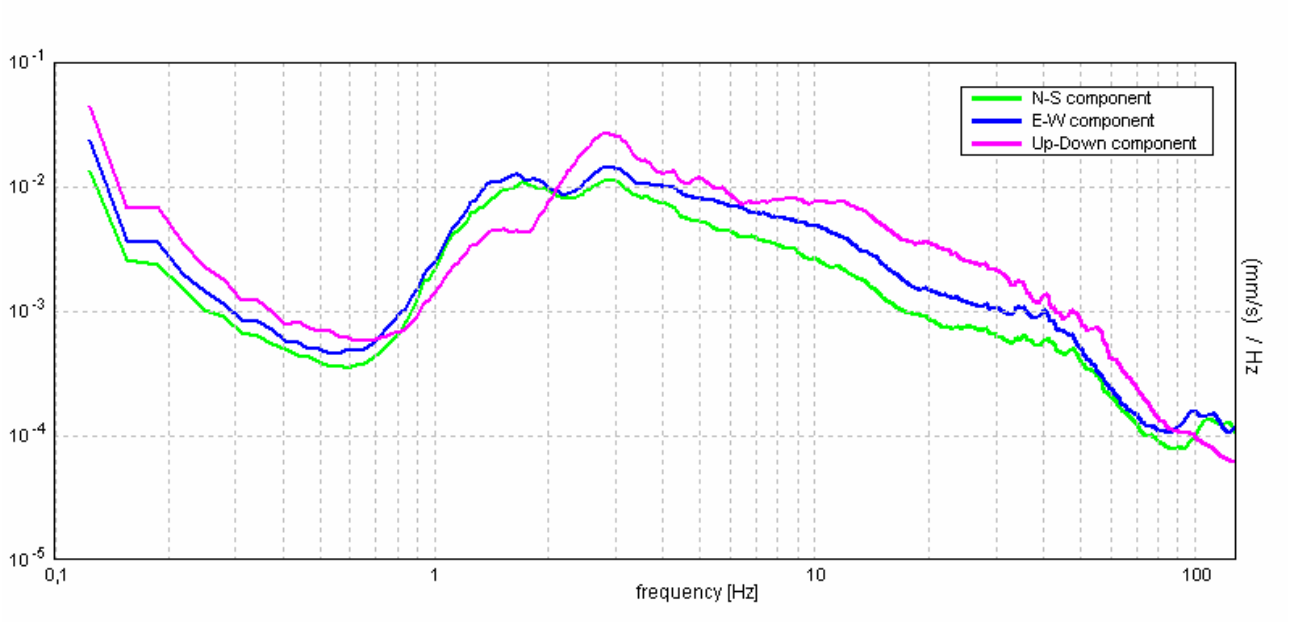
HORIZONTAL TO VERTICAL SPECTRAL RATIO



H/V TIME HISTORY



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 1,69 ± 0,01 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1,69 > 0,50	OK	
$n_c(f_0) > 200$	2025,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 82 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0,844 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2,031 Hz	OK	
$A_0 > 2$	2,76 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00387| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,00653 < 0,16875	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0958 < 1,78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

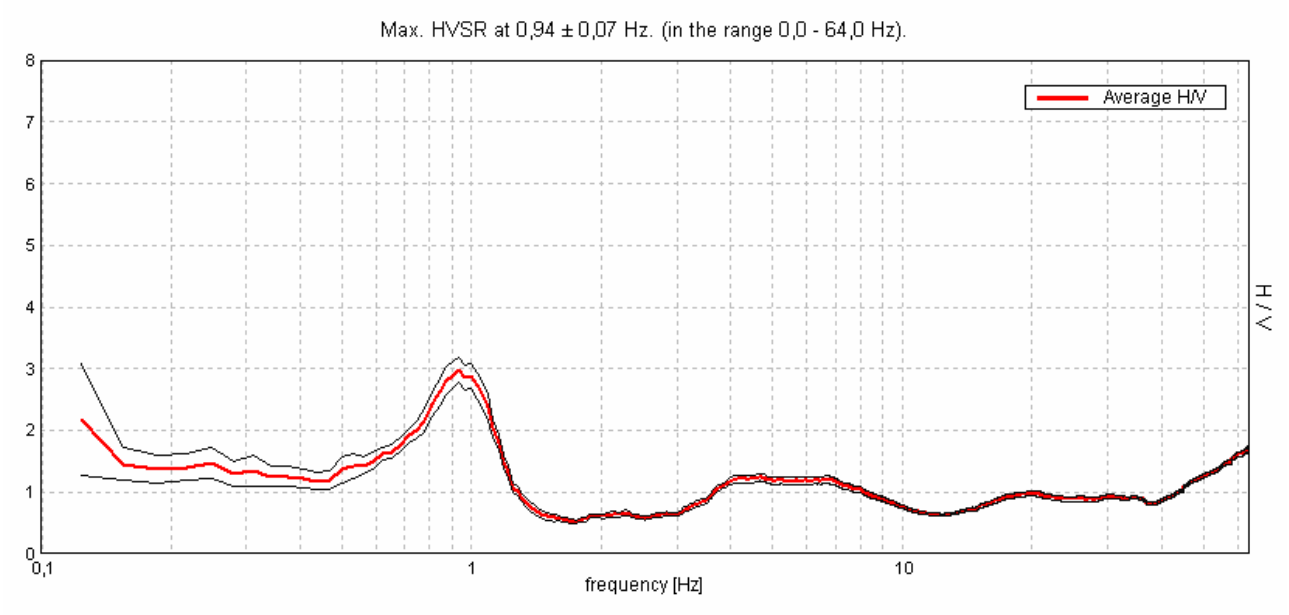
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n°4

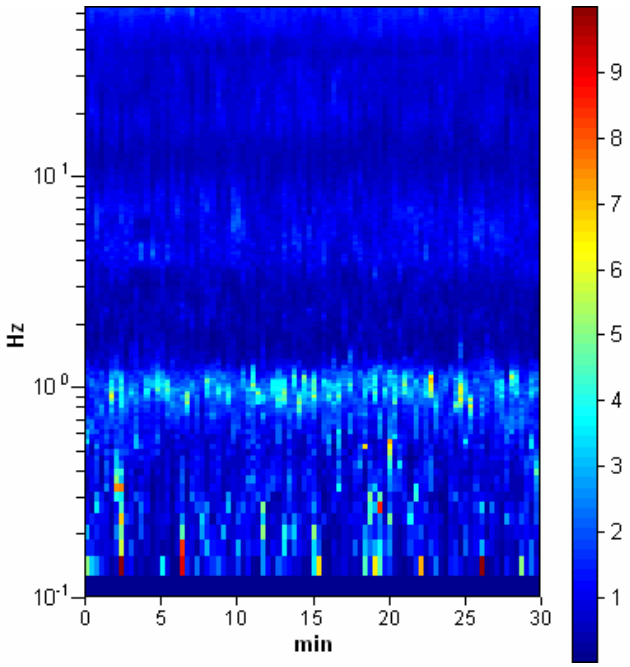
Start recording: 15/10/07 10:38:23 End recording: 15/10/07 11:08:24
GPS data not available

Trace length: 0h30'00". Analysis performed on the entire trace.
Sampling frequency: 128 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

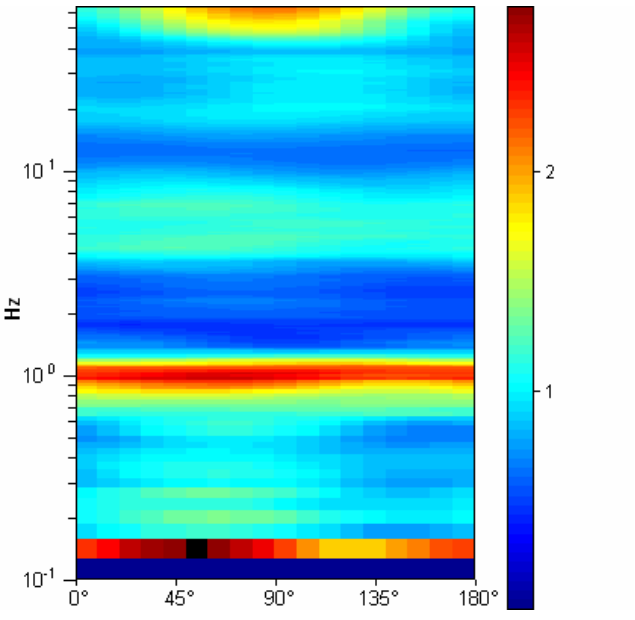
HORIZONTAL TO VERTICAL SPECTRAL RATIO



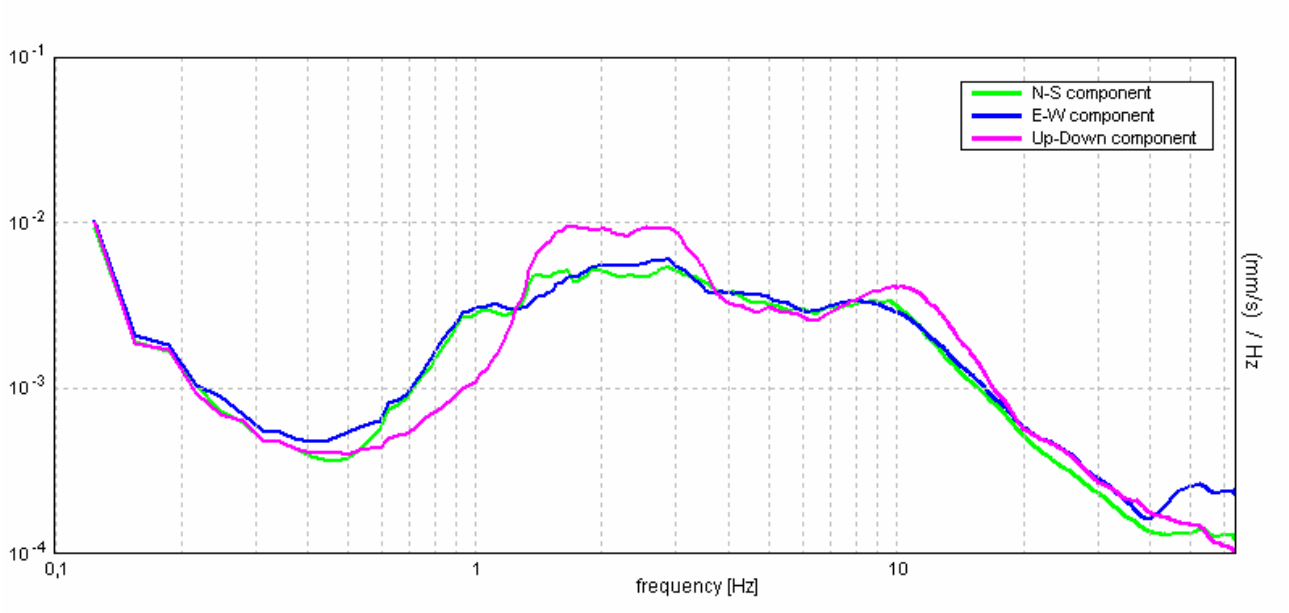
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. HVSR at 0,94 ± 0,07 Hz. (in the range 0,0 - 64,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	0,94 > 0,50	**OK**	
$n_c(f_0) > 200$	1687,5 > 200	**OK**	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 46 times	**OK**	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0,563 Hz	**OK**	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	1,188 Hz	**OK**	
$A_0 > 2$	2,98 > 2	**OK**	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,03604| < 0.05	**OK**	
$\sigma_f < \varepsilon(f_0)$	0,03379 < 0,14063	**OK**	
$\sigma_A(f_0) < \theta(f_0)$	0,105 < 2,0	**OK**	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

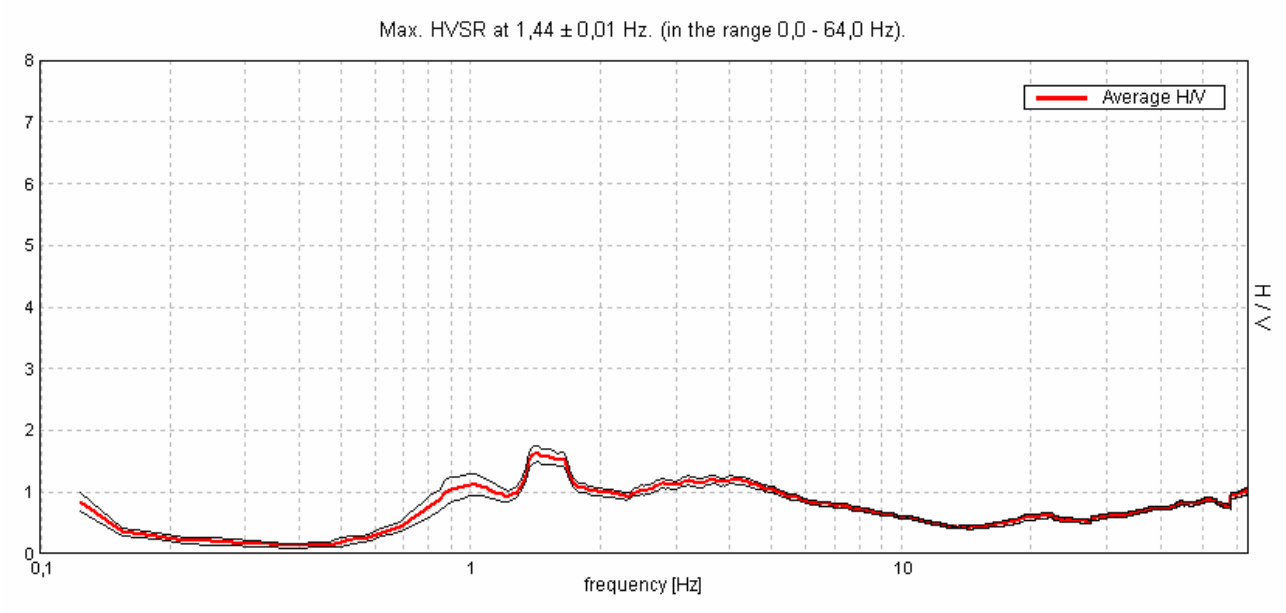
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n° 5

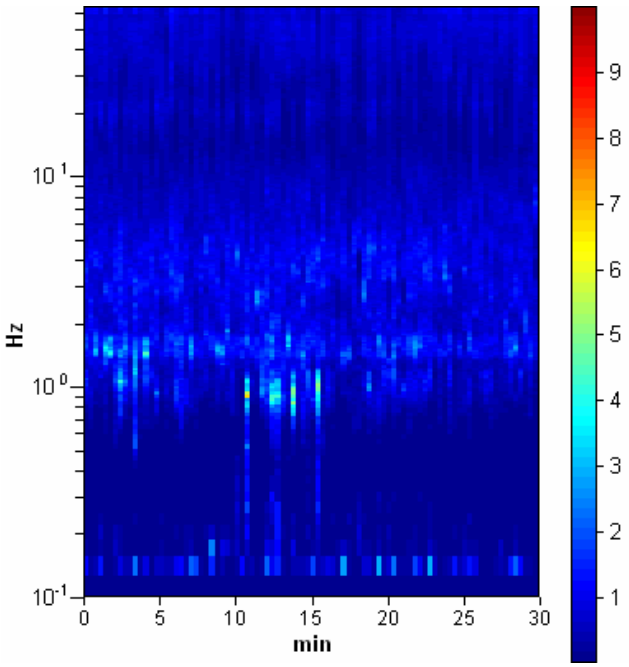
Start recording: 15/10/07 11:16:34 End recording: 15/10/07 11:46:35
GPS data not available

Trace length: 0h30'00". Analysis performed on the entire trace.
Sampling frequency: 128 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

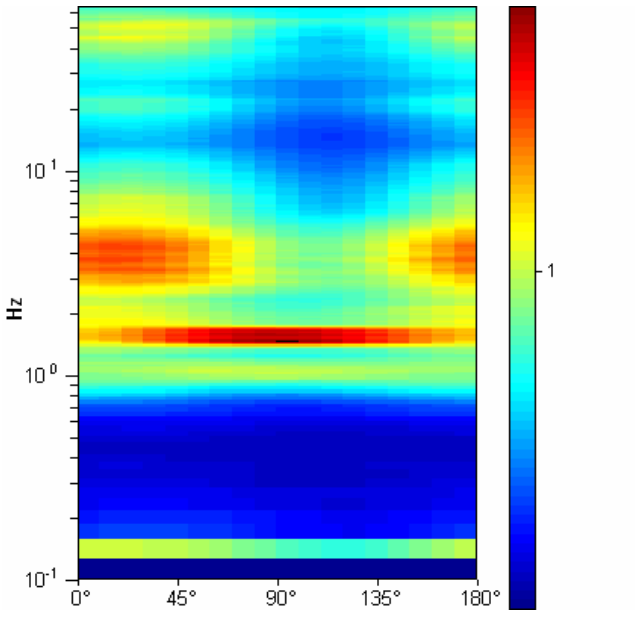
HORIZONTAL TO VERTICAL SPECTRAL RATIO



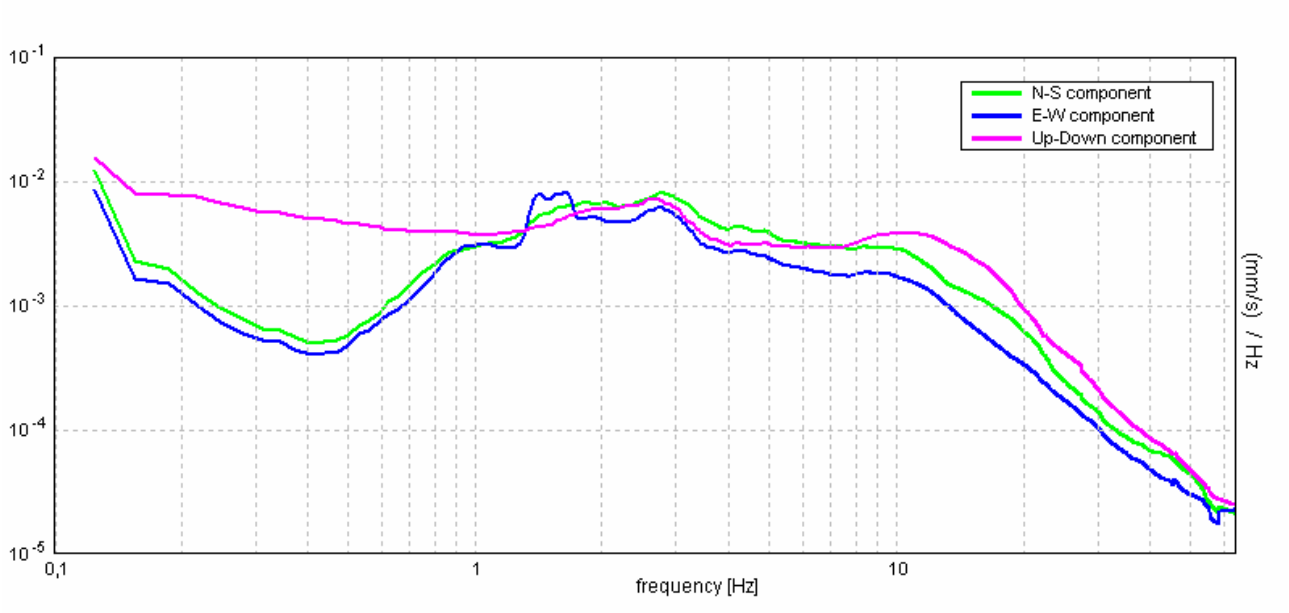
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 1,44 ± 0,01 Hz. (in the range 0,0 - 64,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1,44 > 0,50	OK	
$n_c(f_0) > 200$	2587,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 70 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0,813 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	1,62 > 2		NO
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00205| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,00295 < 0,14375	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,067 < 1,78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

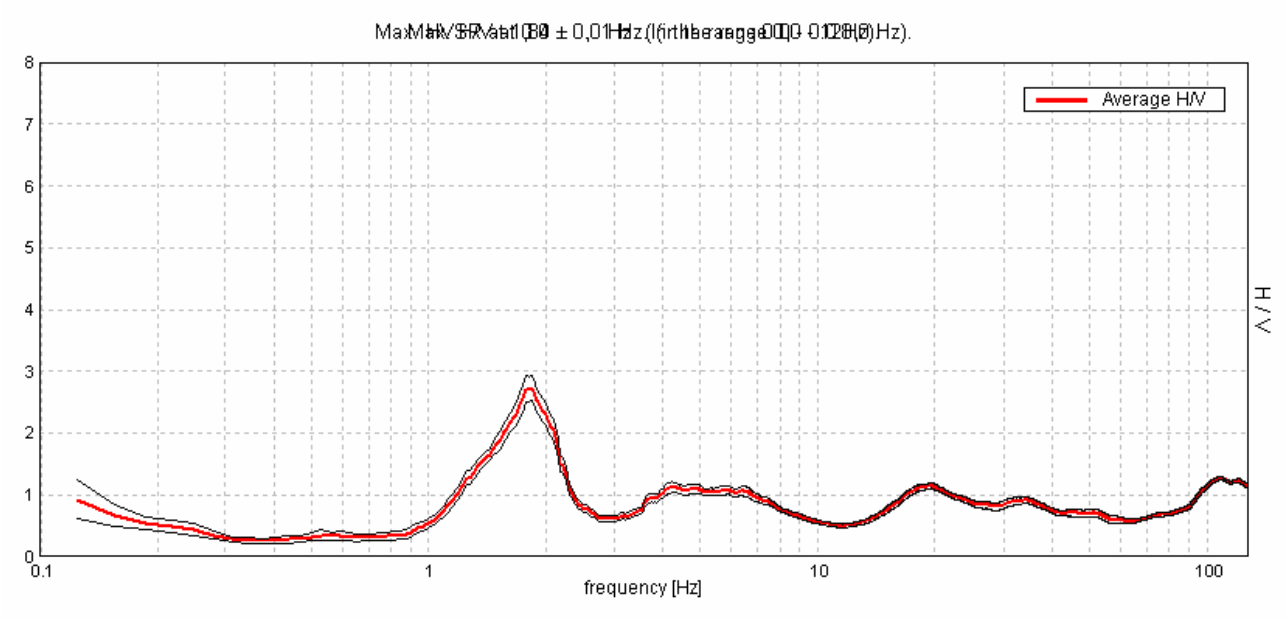
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n° 6

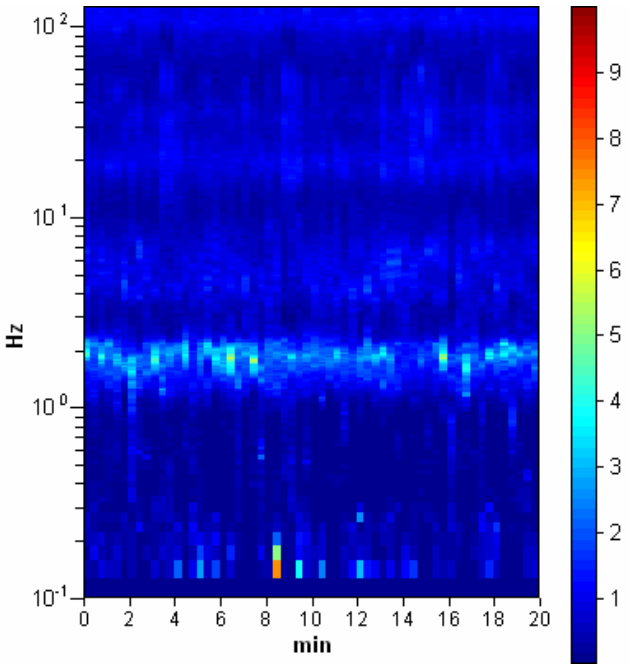
Start recording: 15/10/07 14:21:33 End recording: 15/10/07 14:41:34
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

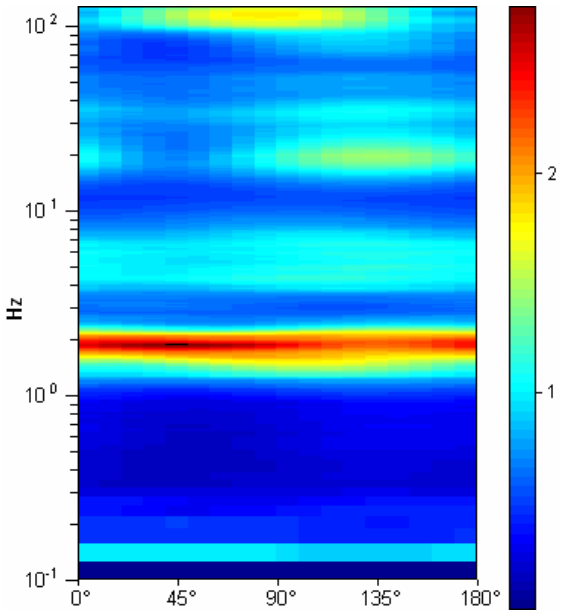
HORIZONTAL TO VERTICAL SPECTRAL RATIO



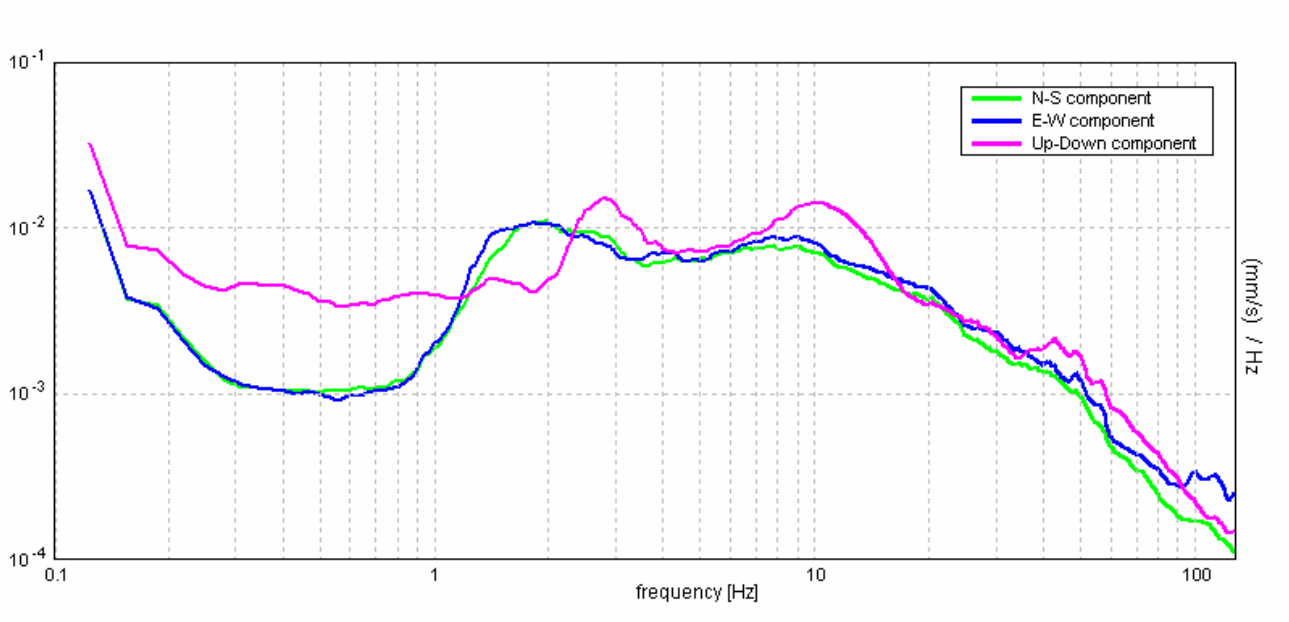
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 1,84 ± 0,01 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1,84 > 0,50	OK	
$n_c(f_0) > 200$	2212,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 90 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,281 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	2,25 Hz	OK	
$A_0 > 2$	2,74 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,0037| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,00683 < 0,18438	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1029 < 1,78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

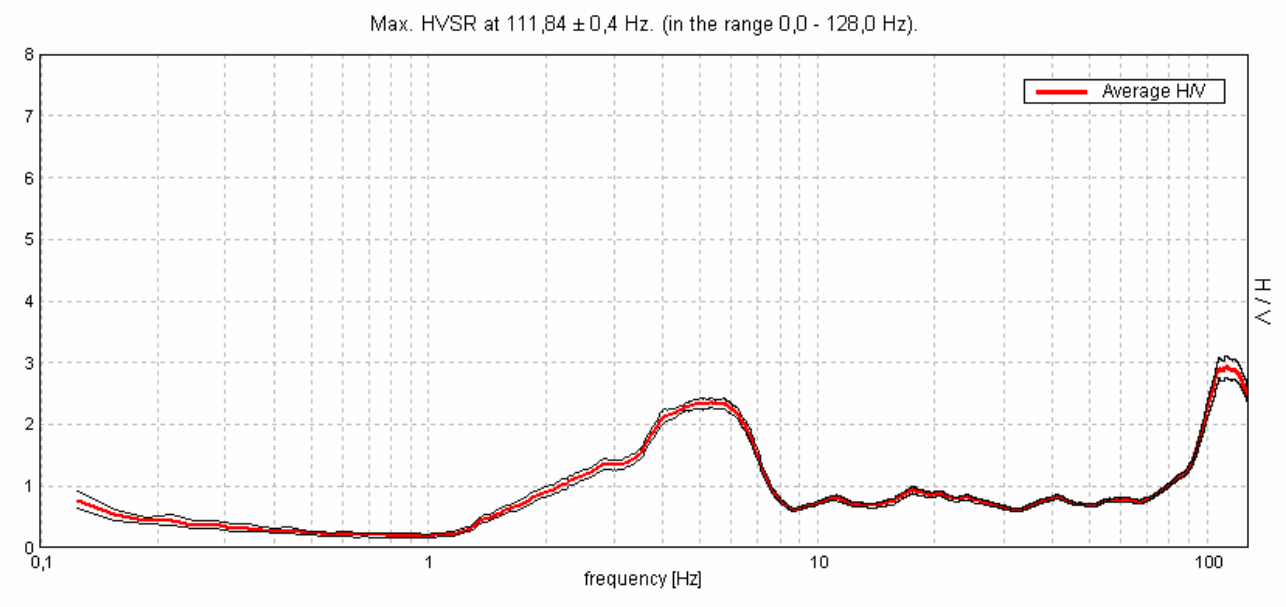
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

FILZI15_10_07, DIETRO AGIP

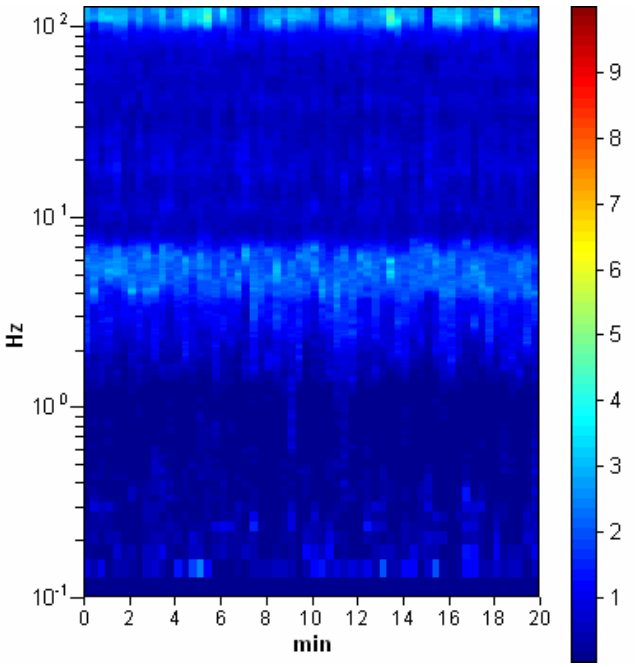
Start recording: 15/10/07 14:48:08 End recording: 15/10/07 15:08:09
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

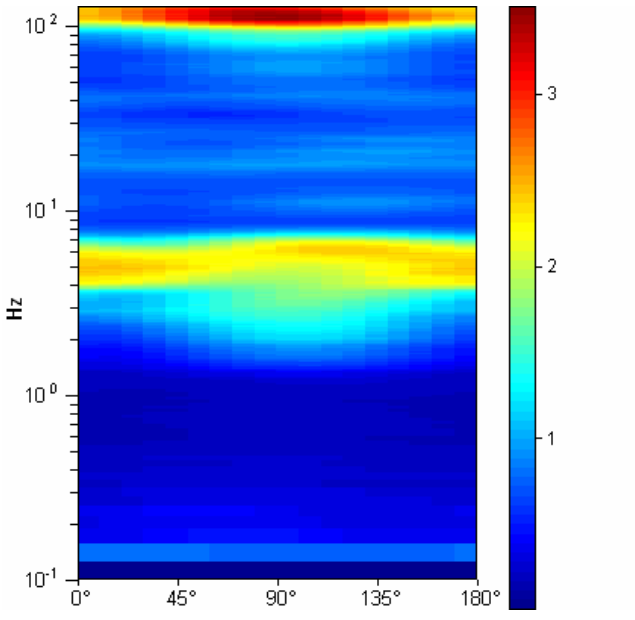
HORIZONTAL TO VERTICAL SPECTRAL RATIO



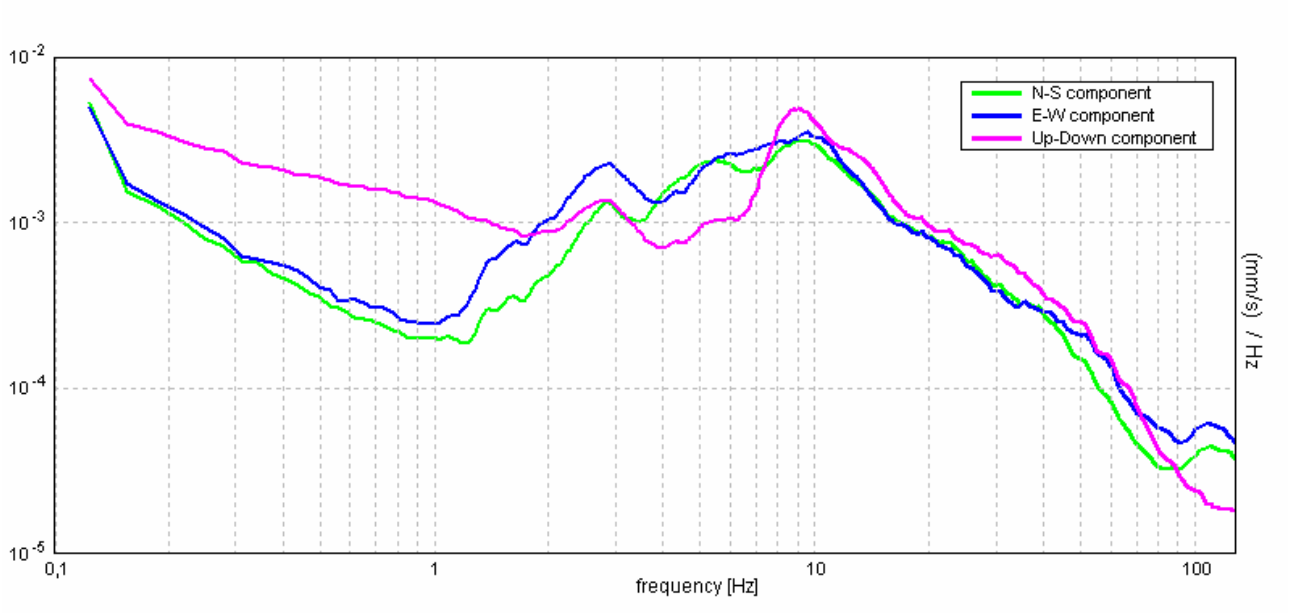
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 111,84 ± 0,4 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	111,84 > 0,50	OK	
$n_c(f_0) > 200$	134212,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 2308 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	92,813 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	2,94 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00178| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,19898 < 5,59219	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0876 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

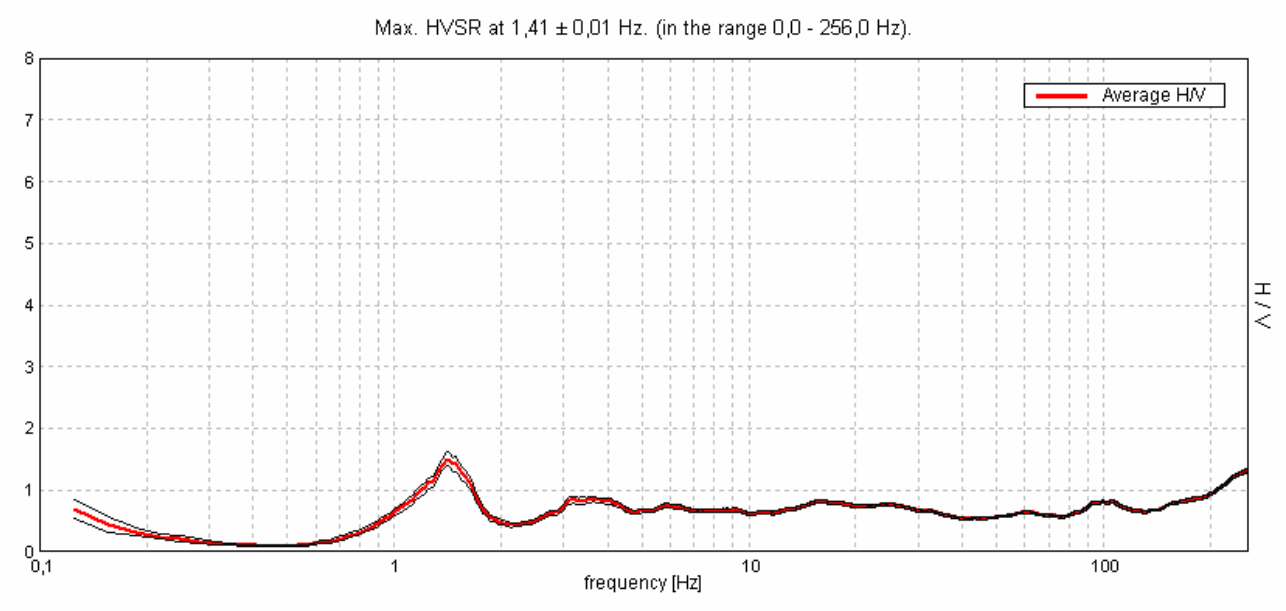
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n°8

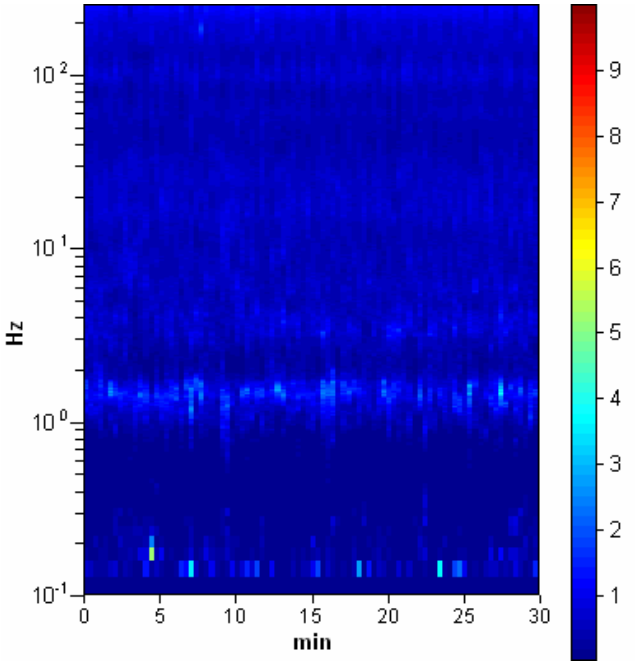
Start recording: 15/10/07 15:22:14 End recording: 15/10/07 15:52:15
GPS data not available

Trace length: 0h30'00". Analysis performed on the entire trace.
Sampling frequency: 512 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

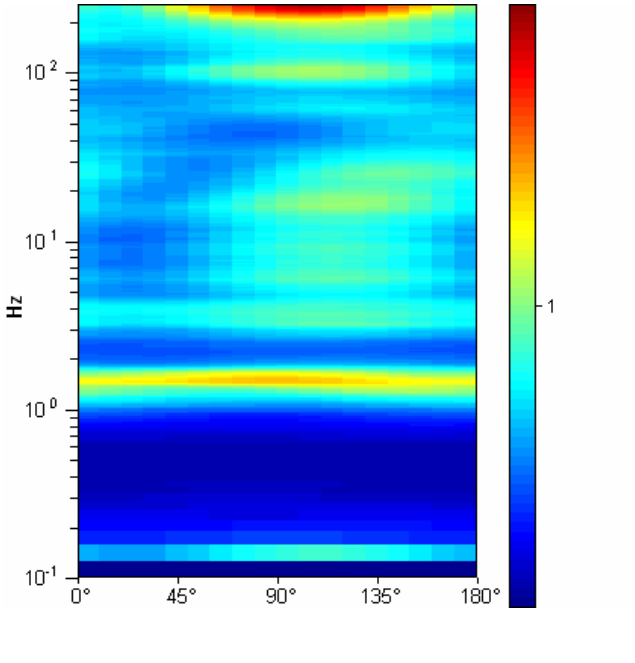
HORIZONTAL TO VERTICAL SPECTRAL RATIO



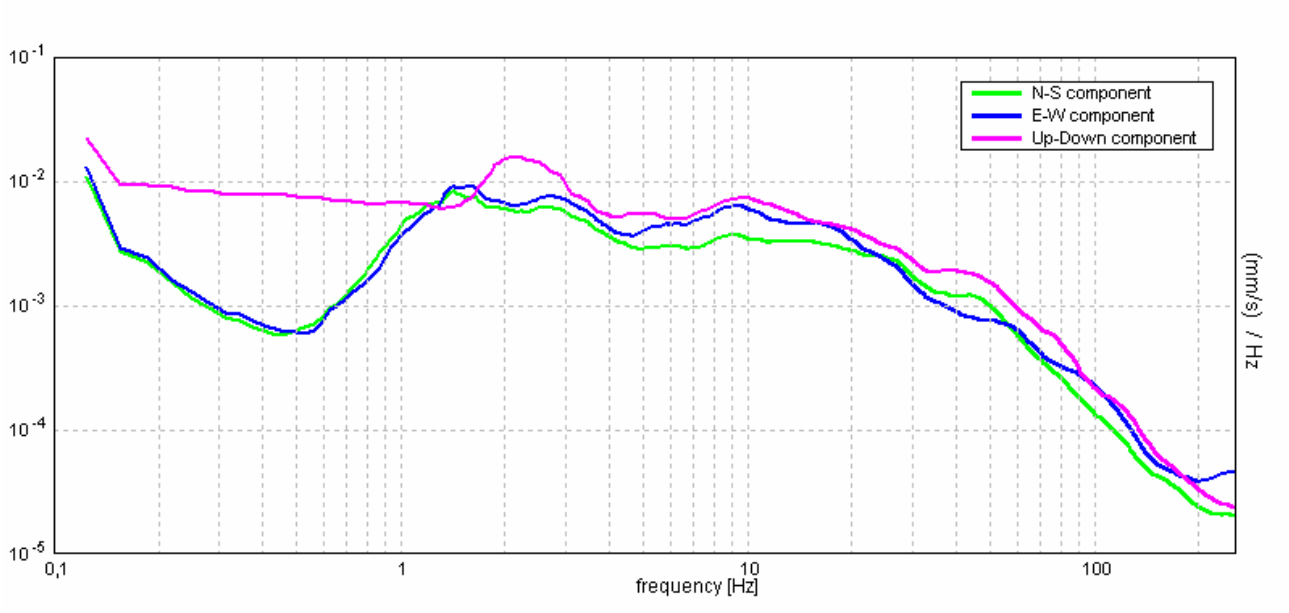
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 1,41 ± 0,01 Hz. (in the range 0,0 - 256,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1,41 > 0,50	OK	
$n_c(f_0) > 200$	2531,3 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 68 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,063 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	1,75 Hz	OK	
$A_0 > 2$	1,50 > 2		NO
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00178| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,0025 < 0,14063	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0562 < 1,78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

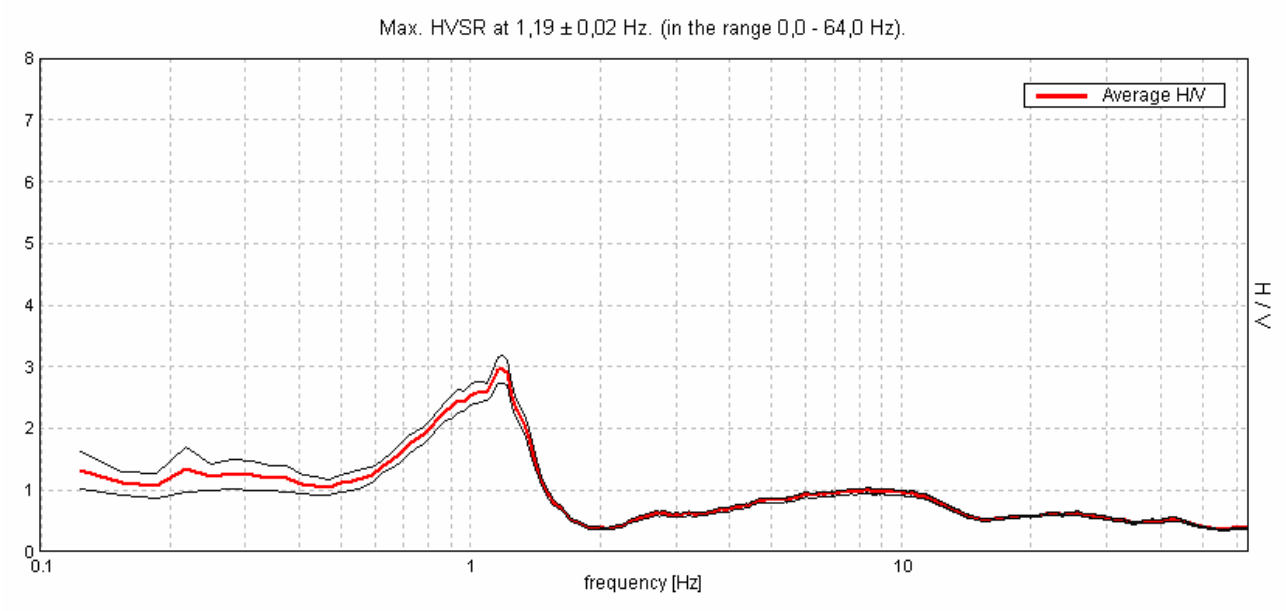
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

FILZI16_10_07, VIA LAVISOTTO SUD

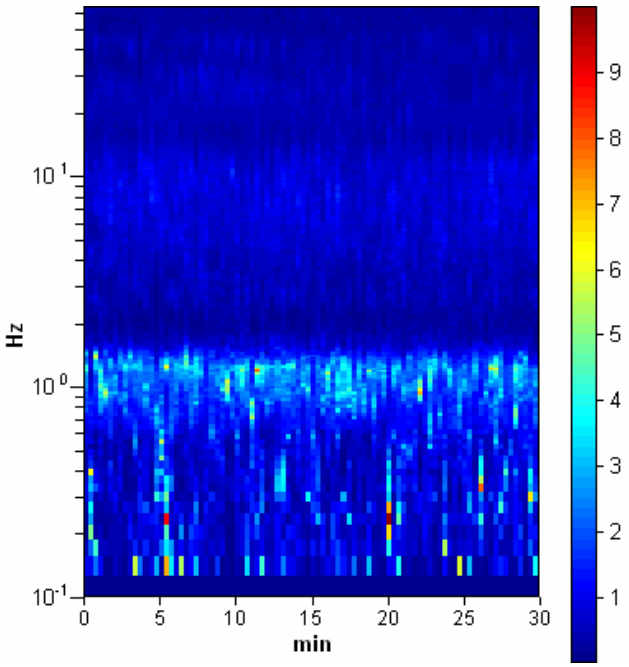
Start recording: 16/10/07 10:59:50 End recording: 16/10/07 11:29:51
GPS data not available

Trace length: 0h30'00". Analysis performed on the entire trace.
Sampling frequency: 128 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

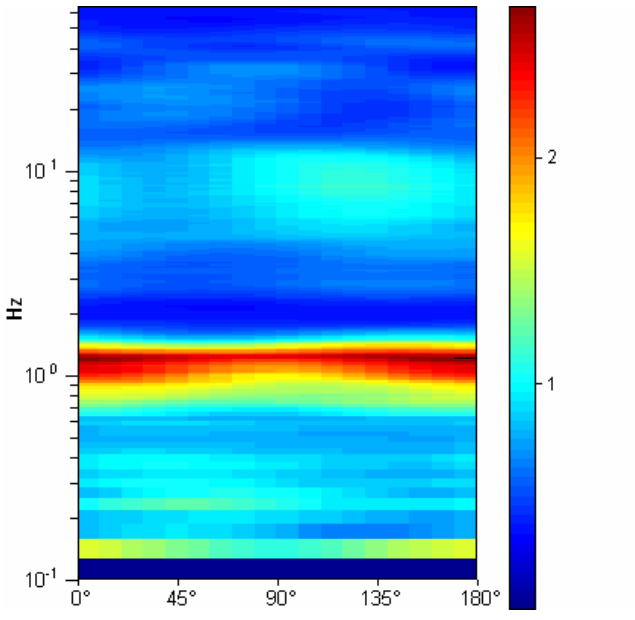
HORIZONTAL TO VERTICAL SPECTRAL RATIO



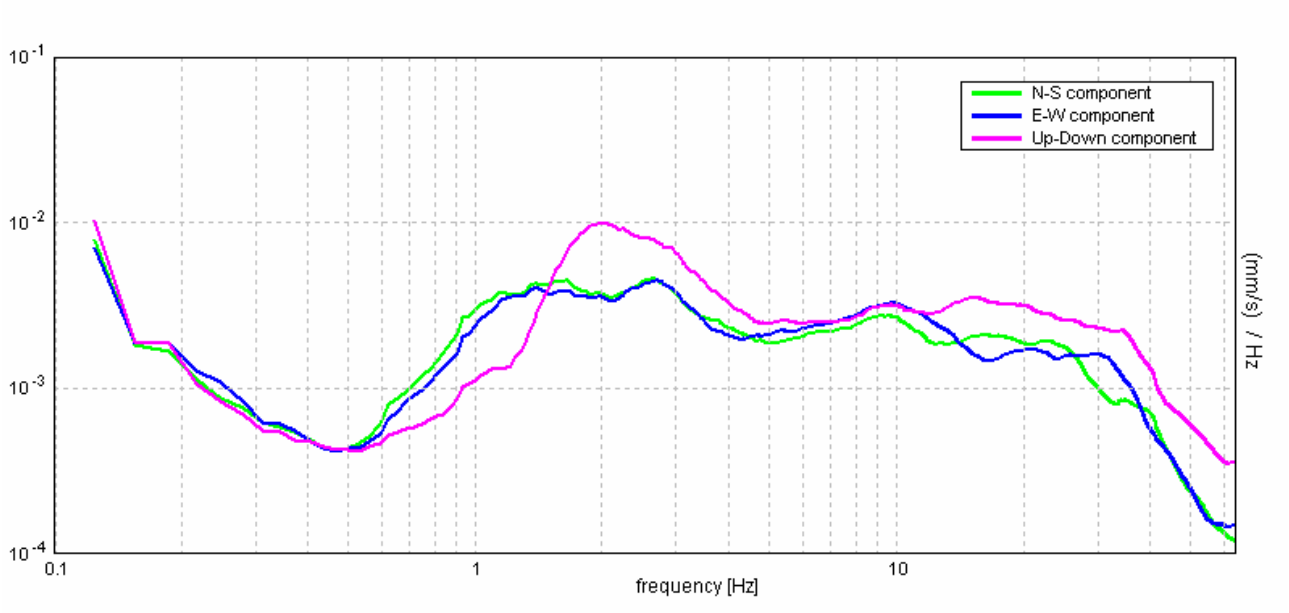
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 1,19 ± 0,02 Hz. (in the range 0,0 - 64,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1,19 > 0,50	OK	
$n_c(f_0) > 200$	2137,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 58 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0,656 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	1,438 Hz	OK	
$A_0 > 2$	2,96 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00902| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,01071 < 0,11875	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1151 < 1,78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

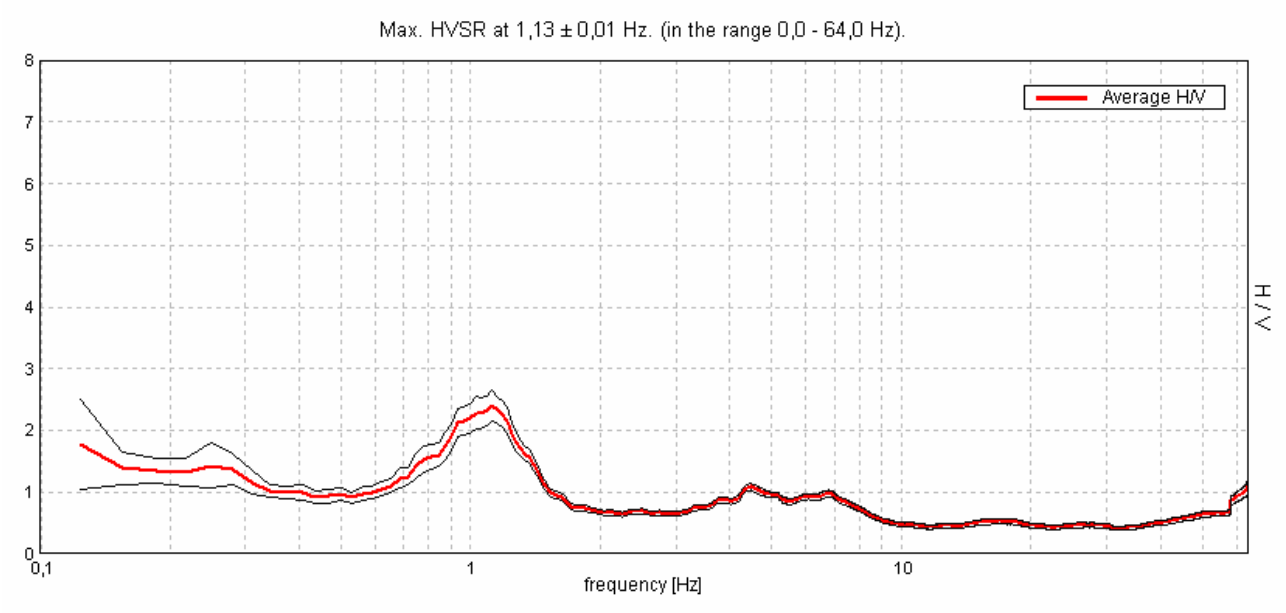
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n°10

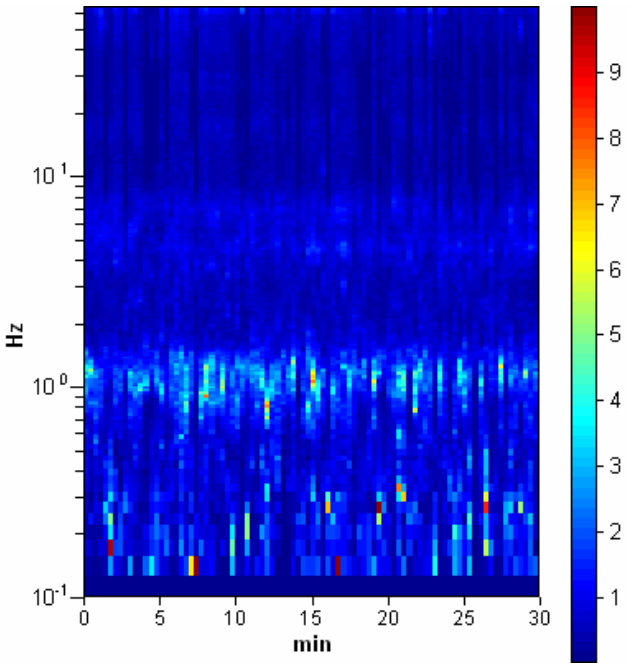
Start recording: 16/10/07 11:33:12 End recording: 16/10/07 12:03:12
GPS data not available

Trace length: 0h30'00". Analysis performed on the entire trace.
Sampling frequency: 128 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

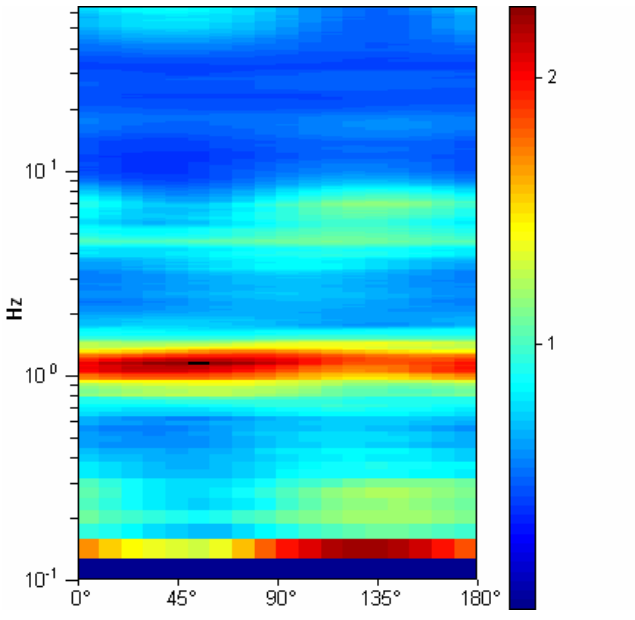
HORIZONTAL TO VERTICAL SPECTRAL RATIO



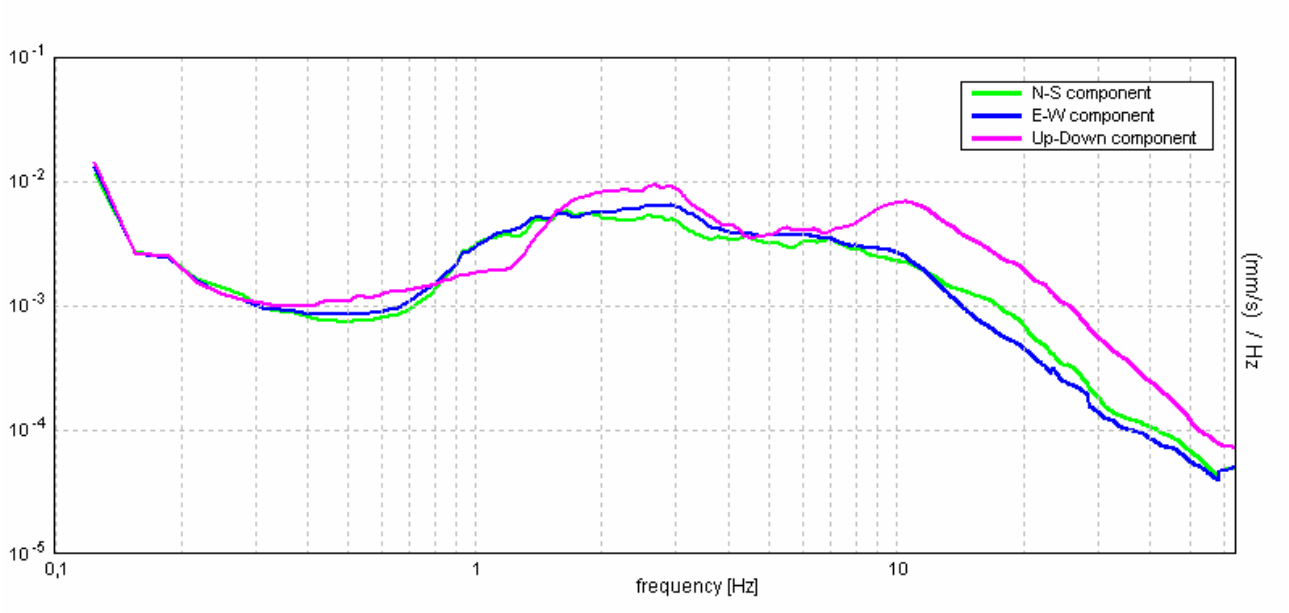
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 1,13 ± 0,01 Hz. (in the range 0,0 - 64,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1,13 > 0,50	OK	
$n_c(f_0) > 200$	2025,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 55 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0,656 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	1,469 Hz	OK	
$A_0 > 2$	2,40 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00405| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,00455 < 0,1125	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1226 < 1,78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

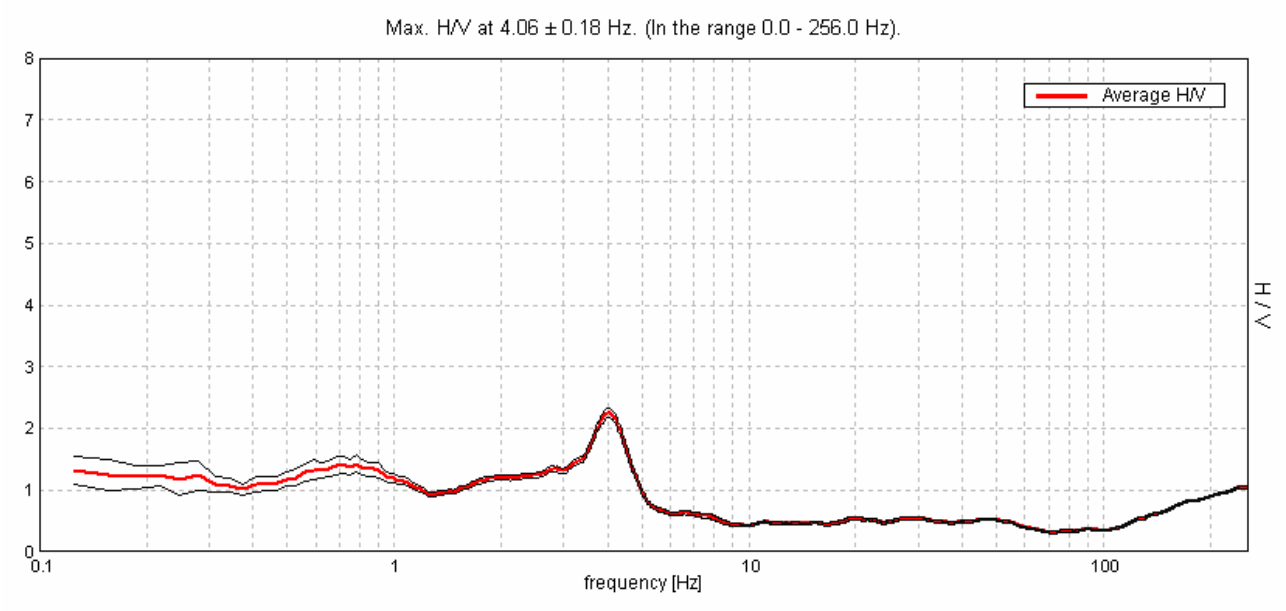
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n°11

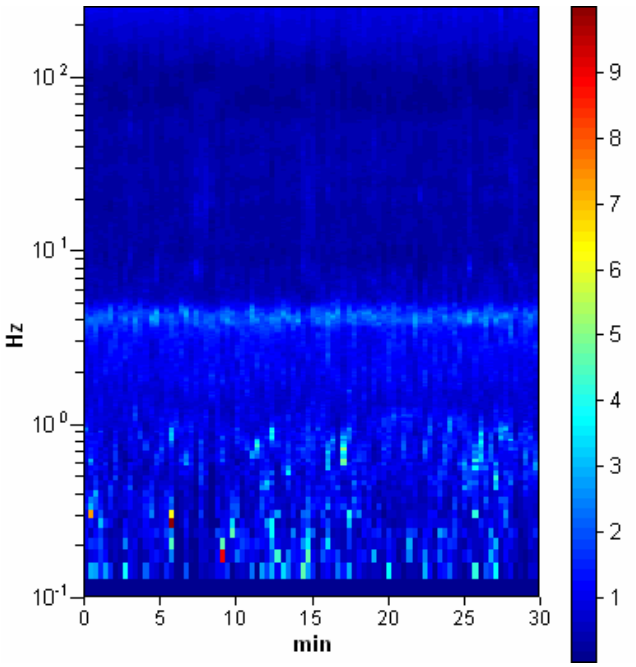
Start recording: 17/10/07 16:12:59 End recording: 17/10/07 16:43:00
GPS data not available

Trace length: 0h30'00". Analysis performed on the entire trace.
Sampling frequency: 512 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

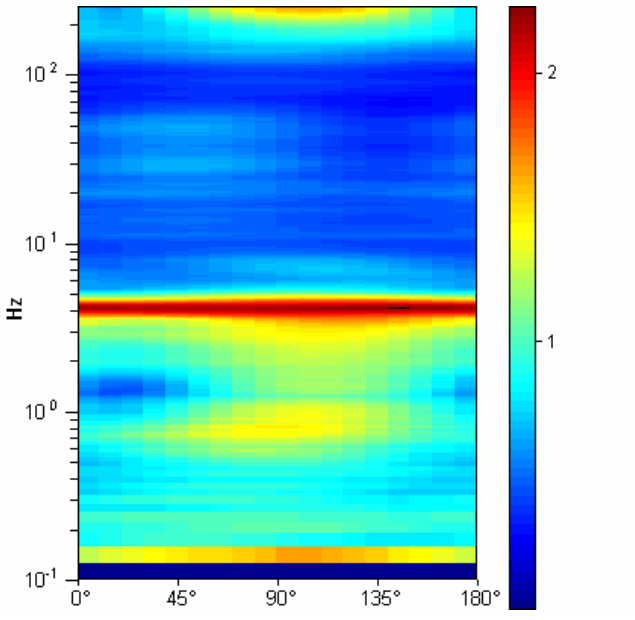
HORIZONTAL TO VERTICAL SPECTRAL RATIO



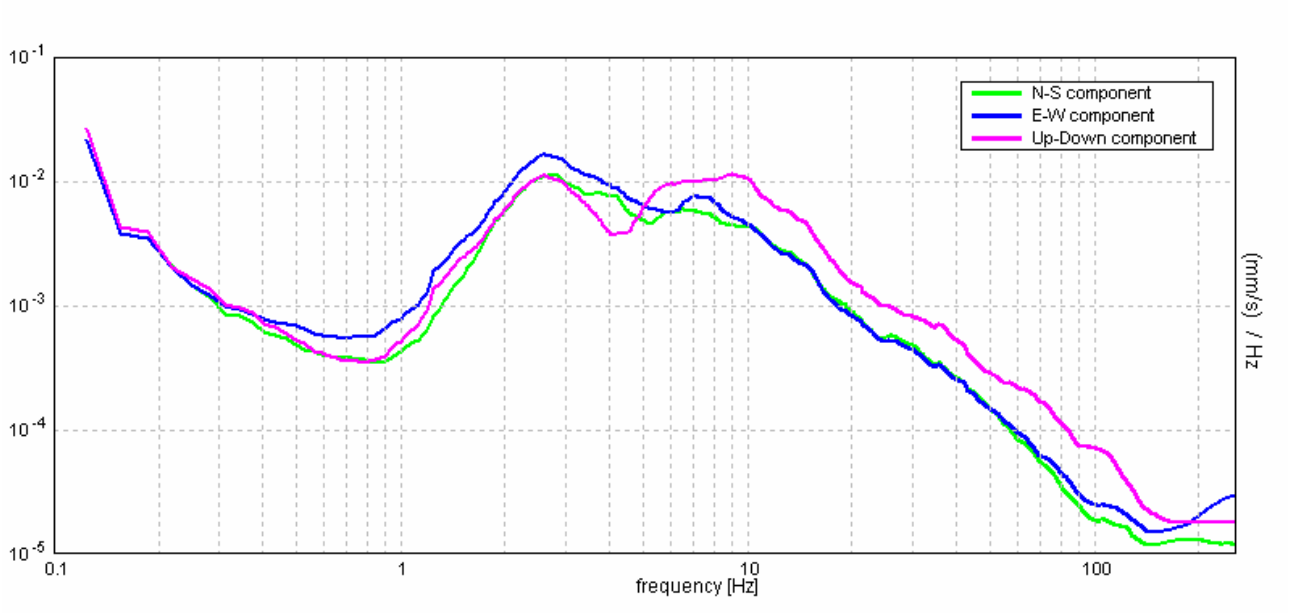
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 4.06 ± 0.18 Hz. (in the range 0.0 - 256.0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	4,06 > 0,50	OK	
$n_c(f_0) > 200$	7312,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 196 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,688 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4,906 Hz	OK	
$A_0 > 2$	2,26 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,02247| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,09129 < 0,20313	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0369 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

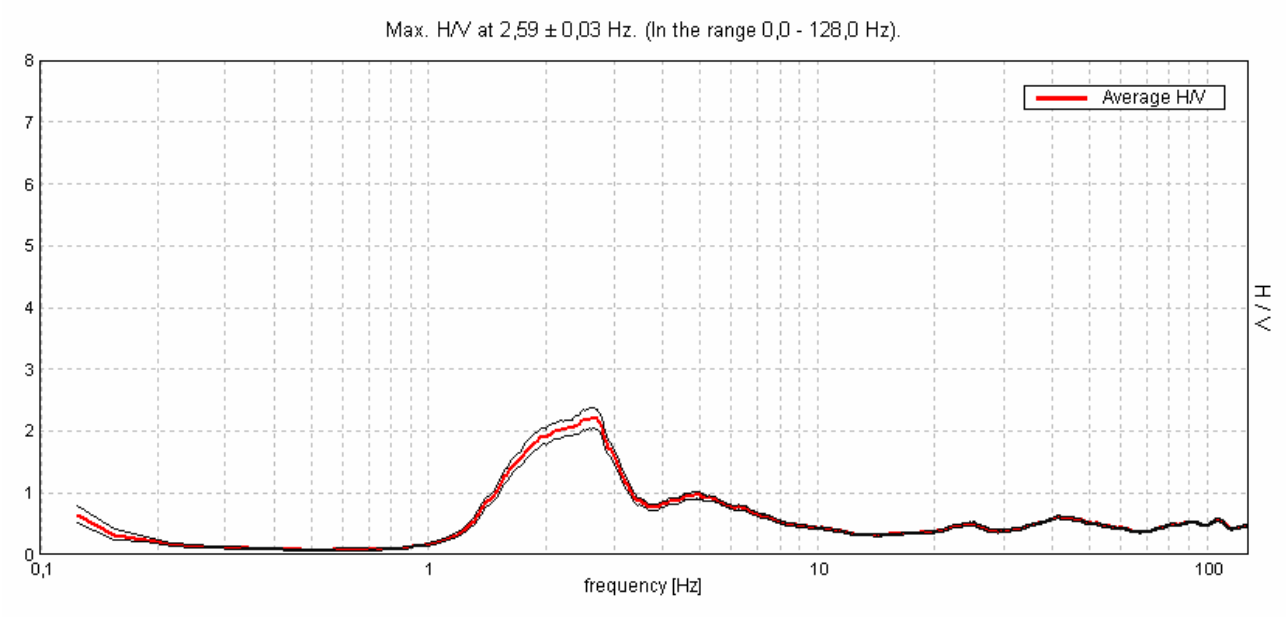
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

H/V n° 12

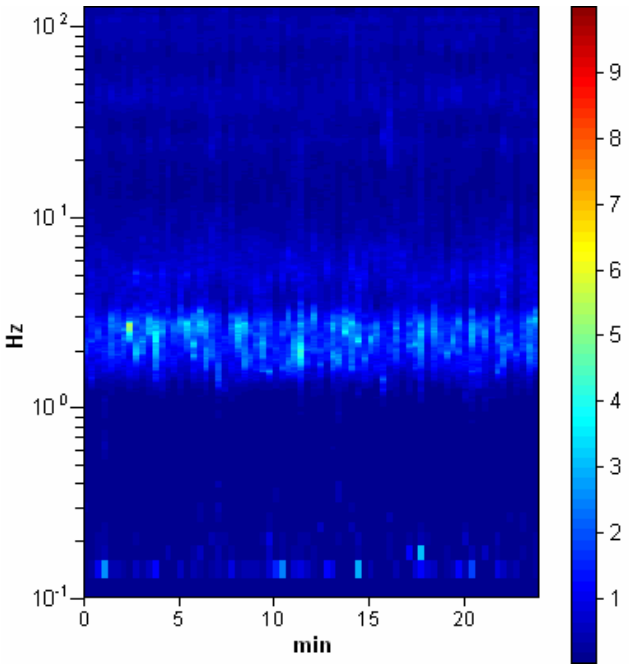
Start recording: 18/10/07 11:06:35 End recording: 18/10/07 11:30:36
GPS data not available

Trace length: 0h24'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

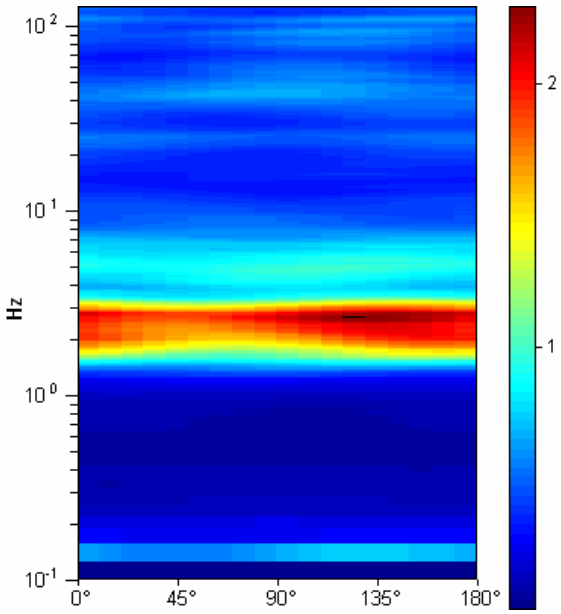
HORIZONTAL TO VERTICAL SPECTRAL RATIO



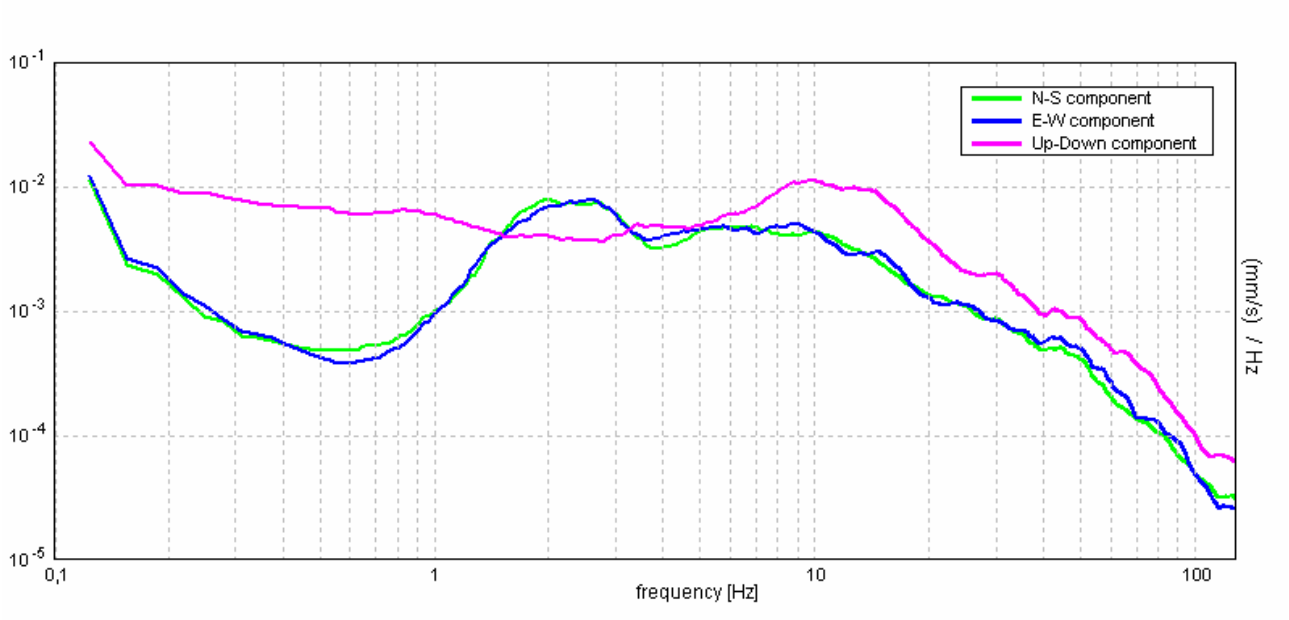
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,59 ± 0,03 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,59 > 0,50	OK	
$n_c(f_0) > 200$	3735,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 126 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,5 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	3,281 Hz	OK	
$A_0 > 2$	2,21 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00555| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,01441 < 0,12969	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0843 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

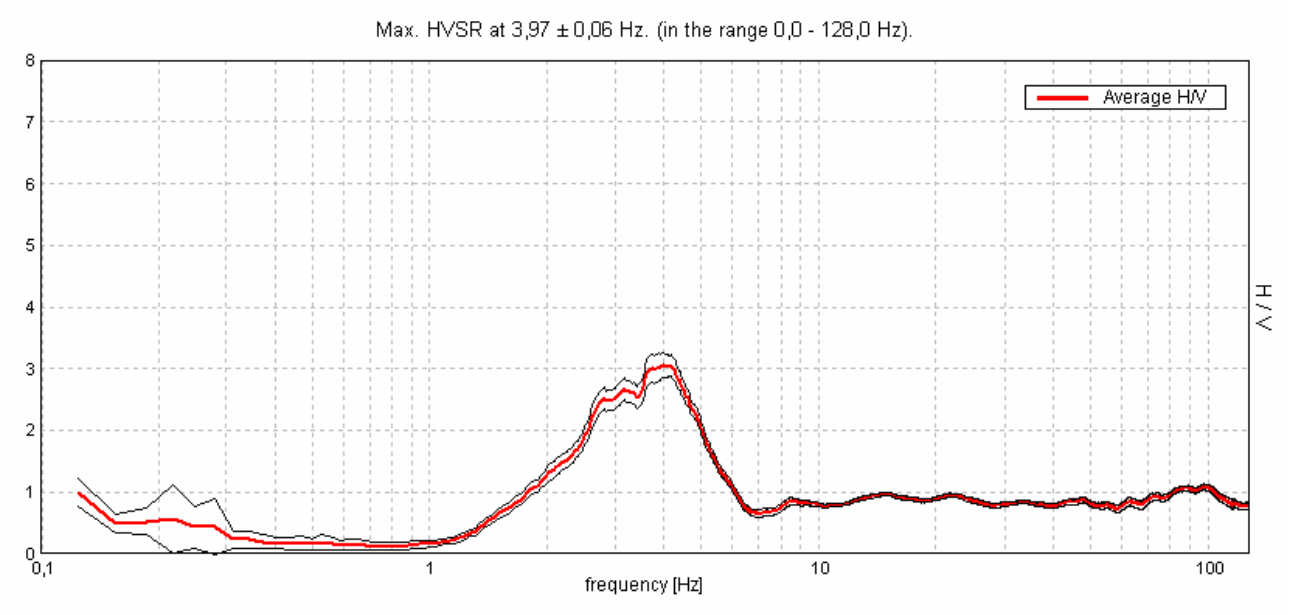
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

FILZI18_10_07, ACI

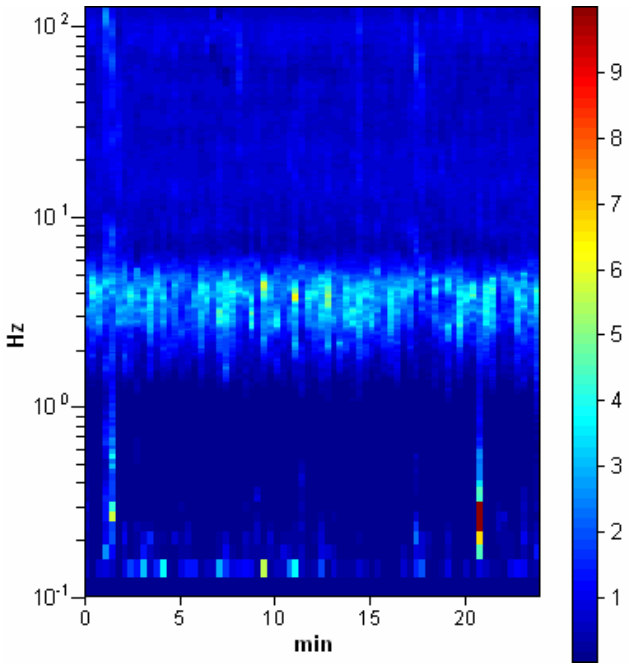
Start recording: 18/10/07 11:36:32 End recording: 18/10/07 12:00:33
GPS data not available

Trace length: 0h24'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

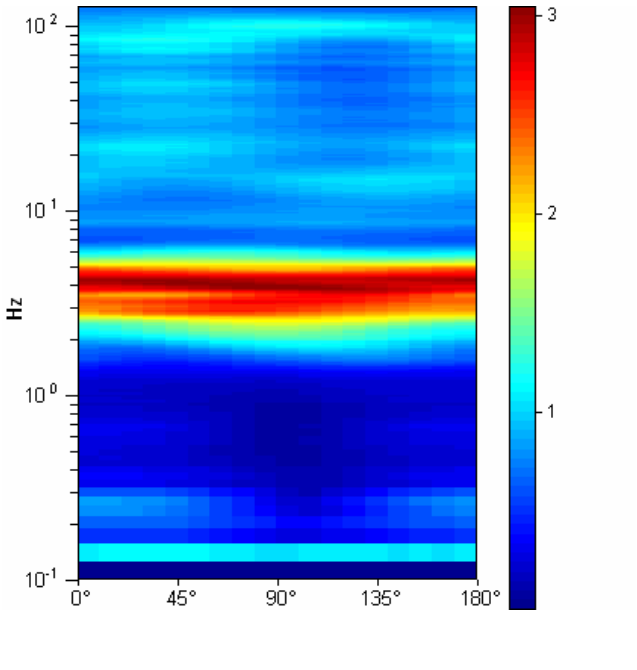
HORIZONTAL TO VERTICAL SPECTRAL RATIO



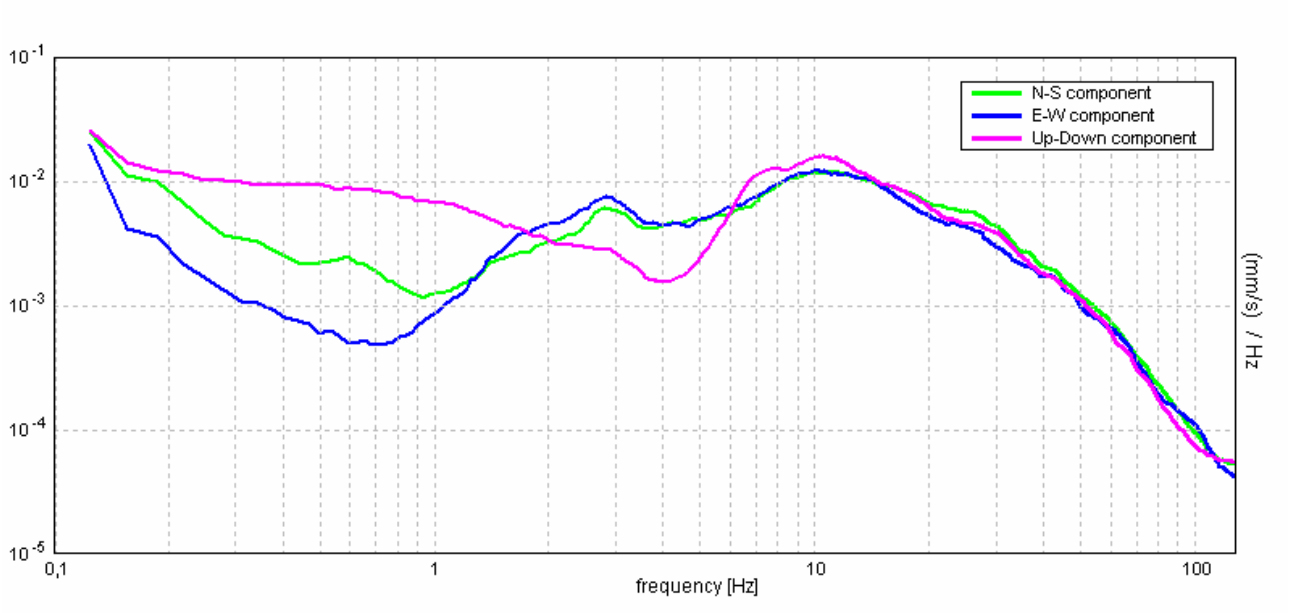
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,97 ± 0,06 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,97 > 0,50	OK	
$n_c(f_0) > 200$	5715,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 192 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2,25 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5,438 Hz	OK	
$A_0 > 2$	3,06 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00694| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,02756 < 0,19844	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1018 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

3 – Tratto Dosso San Rocco - Mattarello

Al fine di determinare con un certo grado di precisione lo spessore delle coperture quaternarie nel tratto compreso tra Mattarello – Casteller (Dosso di S. Rocco) sono stati realizzati tre sondaggi meccanici spinti sino alla presunta quota galleria.
Per consentire una buona interpolazione tra questi punti, è stata condotta un'indagine geofisica in maniera analoga a quella realizzata presso lo scalo Filzi, abbinando misure della Vs dei depositi superficiali (indagini ReMi) con la determinazione della frequenza di risonanza (indagini H/V); la presenza dei sondaggi meccanici ha consentito di operare una taratura dei risultati ottenuti.
Nello specifico sono state realizzate 10 indagini H/V e 3 indagini ReMi che sono stati confrontate con i risultati dei sondaggi meccanici effettuati presso il vivaio forestale di Casteller (SM1), l'ex villa Gentilotti (SM2) e l'ex cava Ronchi (SM3).
L'ubicazione di queste indagini e dei sondaggi è riportata nella figura seguente.

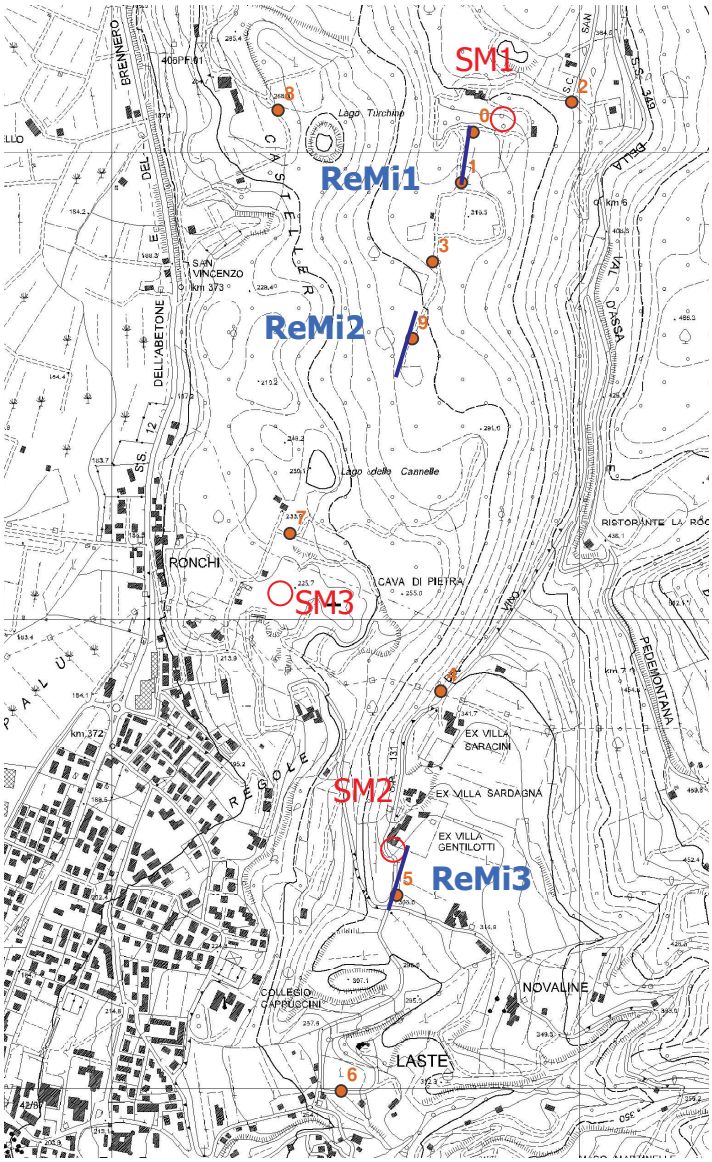


fig 6 - Ubicazione indagini

a) confronto tra ReMi 1 – H/V 0 e 1 - SM1

In allegato è presentato il profilo di velocità scaturito dall'indagine ReMi (casteller 1), realizzata a breve distanza dal SM1; esso mostra la presenza di terreni con Vs elevate anche a bassa profondità (10 ÷ 20 m circa); il limite litologico tra terreni di copertura e substrato può essere posto a quasi 65 m di profondità (62.9 m).
La velocità media delle onde S del deposito quaternario risulta pari a 517 m/s.
Le due indagini H/V sono state realizzate a breve distanza, la prima in prossimità del sito di realizzazione del sondaggio meccanico (H/V 0), la seconda presso lo stendimento ReMi (H/V 1).
La frequenza di risonanza determinata nel primo sito è pari a 1.81 Hz, la seconda 2.19.
Utilizzando il valore di velocità Vs determinato con l'indagine ReMi si ottiene una profondità del substrato pari a 71.4 m per la prima indagine e 61.5 m per la seconda.
Si osserva quindi un'ottima corrispondenza tra quanto determinato con l'indagine ReMi (62.9 m) e quella ricavata dall'analisi H/V (61.5 m).

Come sopra ricordato nel sito è stato realizzato un sondaggio meccanico per una profondità di 150 m spinto sino a quota galleria; questo sondaggio ha evidenziato il limite litologico substrato/struttura a 79.5 m di profondità.
Si rileva una differenza tra la quota determinata tramite l'indagine geofisica di 8 m circa (≈ 10%) differenza sicuramente accettabile per gli scopi dell'indagine.
Calcolando la velocità delle onde di taglio a partire dallo spessore (79,5 m) e della f_r (1.81 Hz) si ottiene una Vs pari a 575 m/s anch'essa con una differenza limitata rispetto quella determinata con l'indagine geofisica (517 m/s).

In ultimo è stato calcolato lo spessore della copertura in corrispondenza della seconda indagine H/V utilizzando il valore di Vs sopra determinato; si ottiene una profondità del substrato pari a 65.6 m con 4 m di differenza tra quanto determinato con l'indagine geofisica.

Alla luce di questa taratura l'indagine geofisica, effettuata per mezzo di stendimento ReMi e indagini HVSR è stata ritenuta idonea per la stima della profondità del substrato roccioso.

b) confronto – H/V 5 - SM2 – ReMi 3

Il confronto è stato effettuato in corrispondenza del sondaggio meccanico realizzato presso villa Gentilotti (SM2); questo sondaggio ha evidenziato la presenza del substrato roccioso a 51 m di profondità.
A breve distanza (circa una ottantina di metri) sono state realizzate una indagine ReMi (Remi 3) ed una H/V (H/V 5): i risultati ottenuti dalle due tipologie d'indagine sono sostanzialmente concordi, con una differenza, per quanto riguarda la profondità del substrato inferiore al 10%.

L'indagine Remi lo colloca a 35.5 m di profondità circa, l'analisi dei rapporti spettrali a circa 32.5; la Vs calcolata dall'indagine ReMi ed utilizzata nell'analisi HVSR è pari a circa 555 m/s in ottimo accordo con le velocità determinate nell'intera area indagata.
I dati ottenuti sono però, in apparenza, in parziale contrasto con quanto determinato dal sondaggio meccanico (substrato a 50 m) ma tale differenza può essere parzialmente riconsiderata osservando che tra i due siti d'indagine esiste una certa differenza di quota altimetrica (di una decina di metri circa); riportando la quota del substrato in quote assolute s.l.m., e ricavando la quota dalla C.T.P. si rileva come il substrato roccioso in corrispondenza del sondaggio meccanico si situa a circa 272 m s.l.m. mentre in corrispondenza dell'indagine geofisica a circa 277.
Anche in questo caso la differenza ottenuta appare sicuramente accettabile per gli scopi dell'indagine.

c) confronto – H/V 3 - ReMi 2

In questo caso i risultati tra l'indagine HVSR e quella ReMi presentano un'ottima sovrapposizione; si osserva come l'indagine ReMi mostri un profilo di velocità in cui il substrato roccioso (ipotizzato corrispondente al mezzo caratterizzato da Vs pari a 900 m/s) si colloca a 61.5 m di profondità.
La velocità media (Vs) del deposito superficiale risulta così pari a 590 m/s.
L'indagine HVSR mostra il picco in corrispondenza della frequenza di 2.5 Hz; con la velocità sopra ricavata si ottiene una profondità di 59 m.

Pertanto, sulla base dei confronti sopra esposti, è ragionevole supporre che la velocità media (Vs) del deposito quaternario presente nell'area compresa tra S. Rocco e Mattarello, sia compresa tra 530 e 590 m/s circa; in questa fase si stima pertanto un valore medio di 560 m/s che viene utilizzato nella determinazione dello spessore del deposito quaternario in corrispondenza degli altri siti in cui sono state effettuate le misure H/V; nella tabella seguente è presente una colonna che riporta la quota assoluta del substrato roccioso sul livello del mare, al fine di rendere più agevole una sua valutazione in rapporto alla prevista quota della galleria prevista, indicativamente compresa tra circa 185 m e 189 m s.l.m.

prova n°	f_r (Hz)	Vs (m/s)	h (m)	h s.l.m.
0	1,81	560	77,5	242.5
1	2,2	560	63,5	246.5
2	1,8	560	78,0	282
3	2.1	560	66,5	244
4	2,3	560	61,0	279
5	4.3	560	32,5	277.5
6	7,5	560	18,5	250
7	3,1	560	45,0	190
8	3,2	560	44,0	226
9	2,5	560	56,0	239

Nella figura seguente i valori stimati del tetto del substrato roccioso riferiti al livello del mare, sono riportati planimetricamente.

Si rileva come l'andamento del substrato sembri rispecchiare la morfologia superficiale con la quota del substrato che, in corrispondenza del tracciato ferroviario si mantiene compresa tra 230 e 250 m s.l.m. circa mentre in corrispondenza della scarpata morfologica presente verso Est il substrato tende ad innalzarsi di almeno 30 – 40 m raggiungendo quote comprese tra 270 e 280 m s.l.m.
Verso Ovest la quota del substrato tende ad abbassarsi velocemente come testimoniato dalla indagine HVSR 7 (190 m s.l.m.) ed il sondaggio meccanico n° 3 (160 m s.l.m. circa)

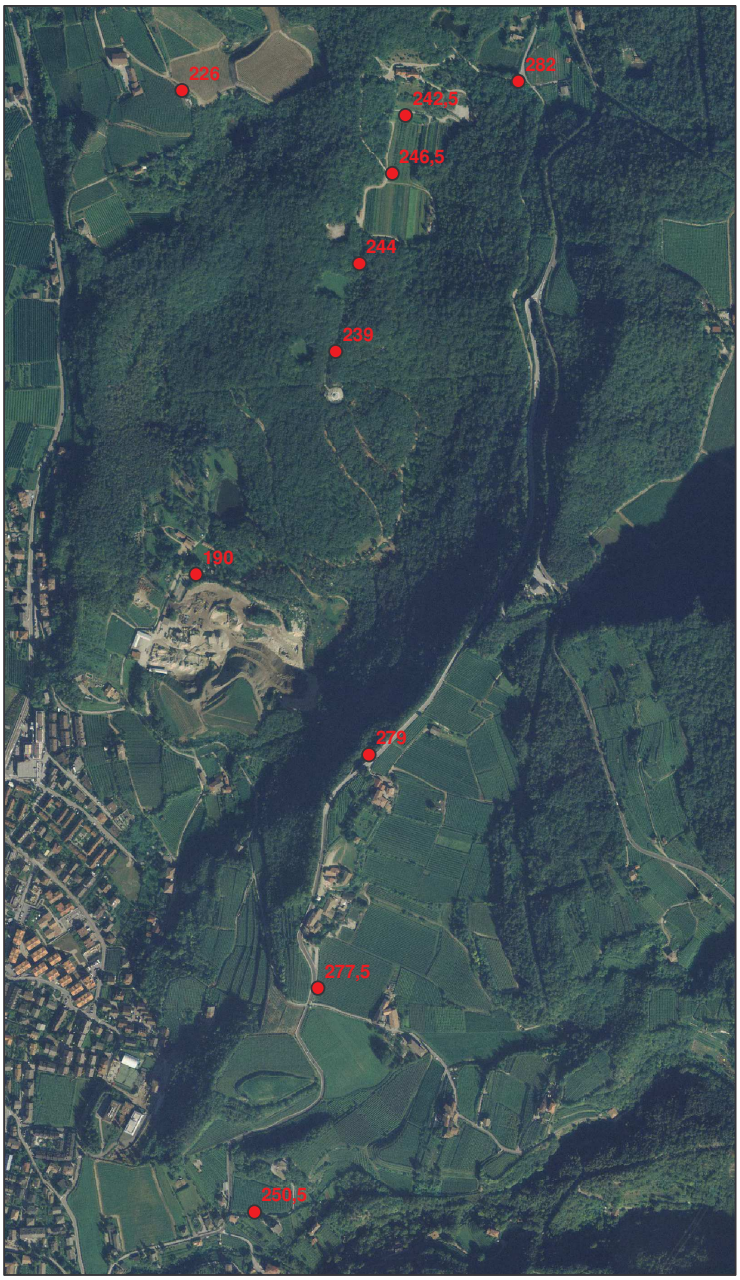


fig 7 – altezza indicativa substrato roccioso s.l.m. dedotto da indagini HVSR

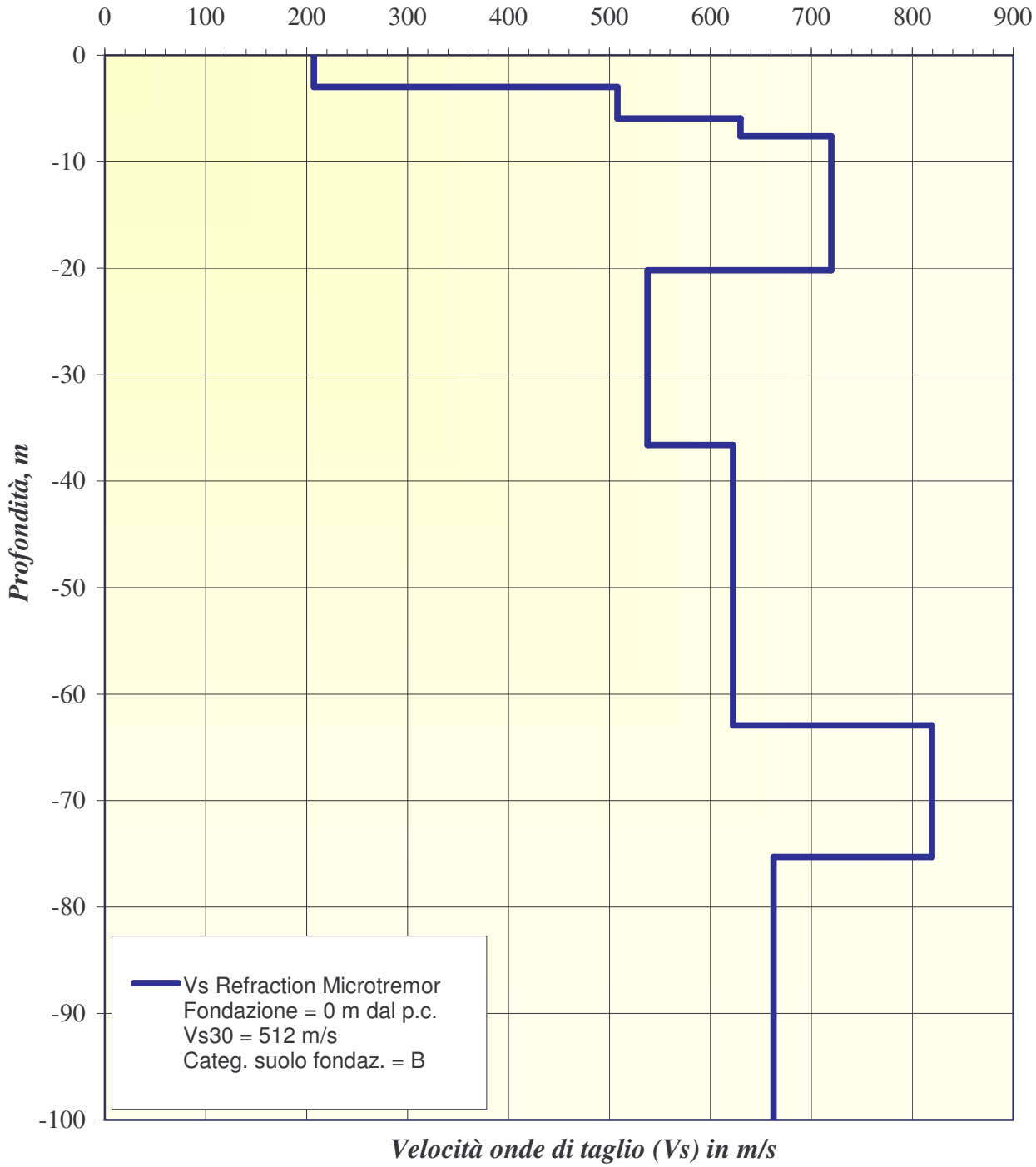
ALLEGATI

- profili di velocità ReMi

- elaborati indagini H/V

ReMi casteller 1

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

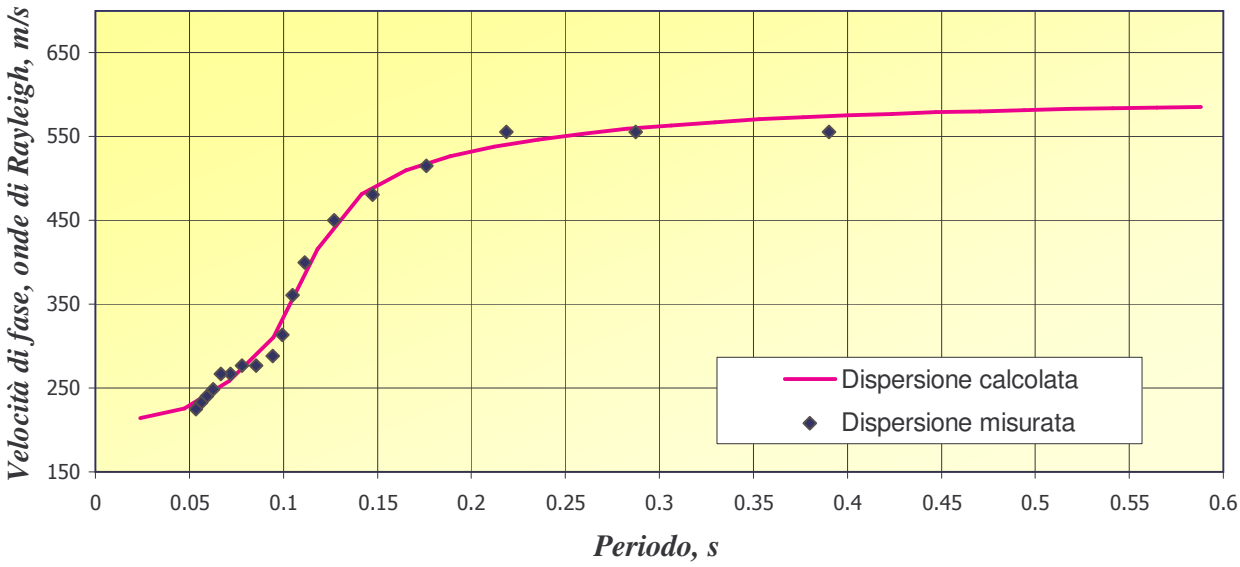
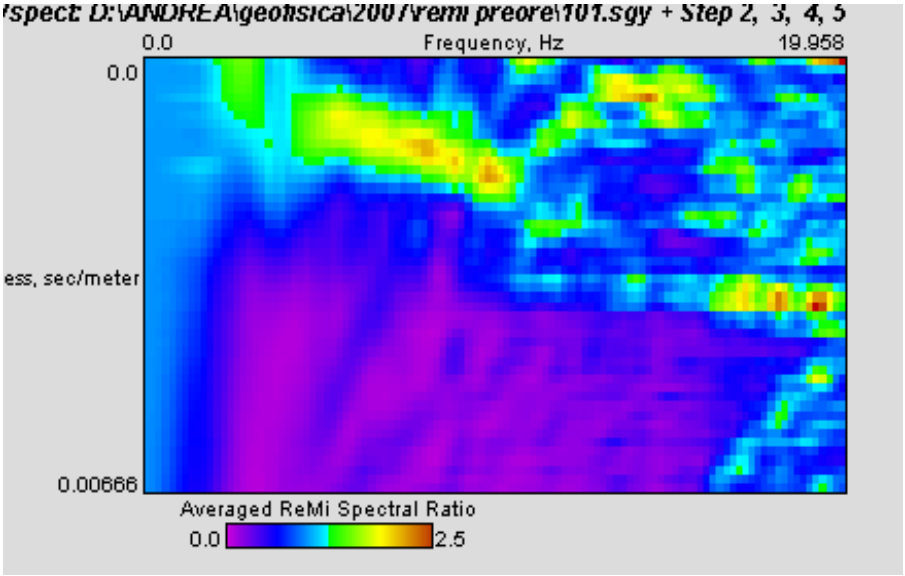
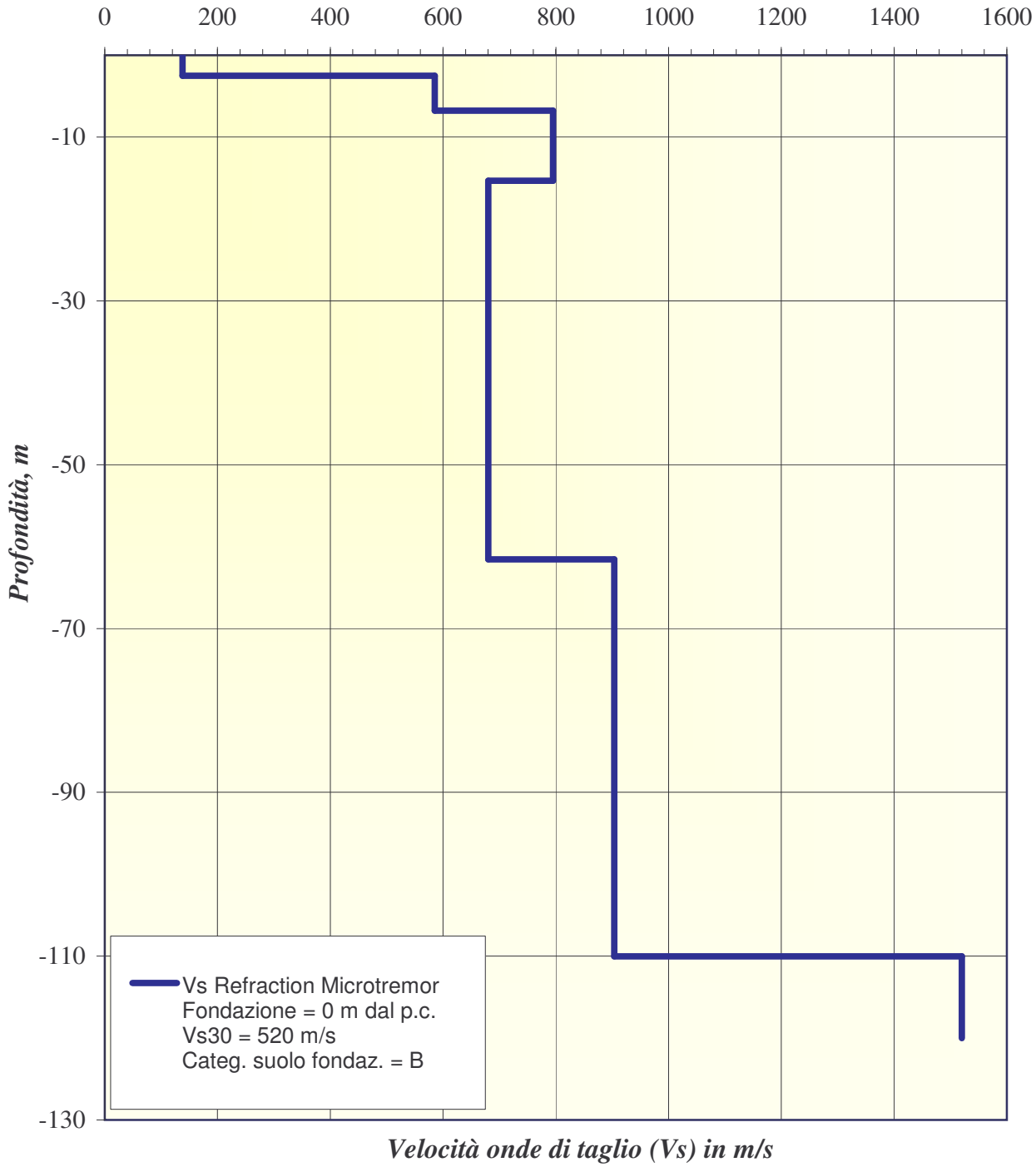


grafico slowness/frequenza



ReMi casteller 2

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

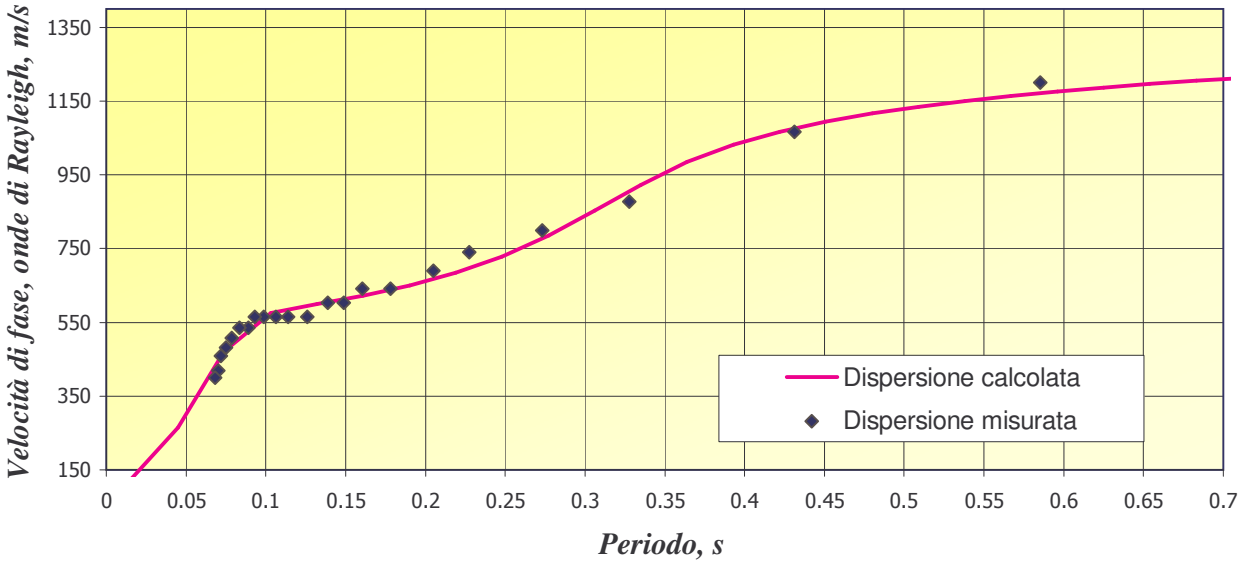
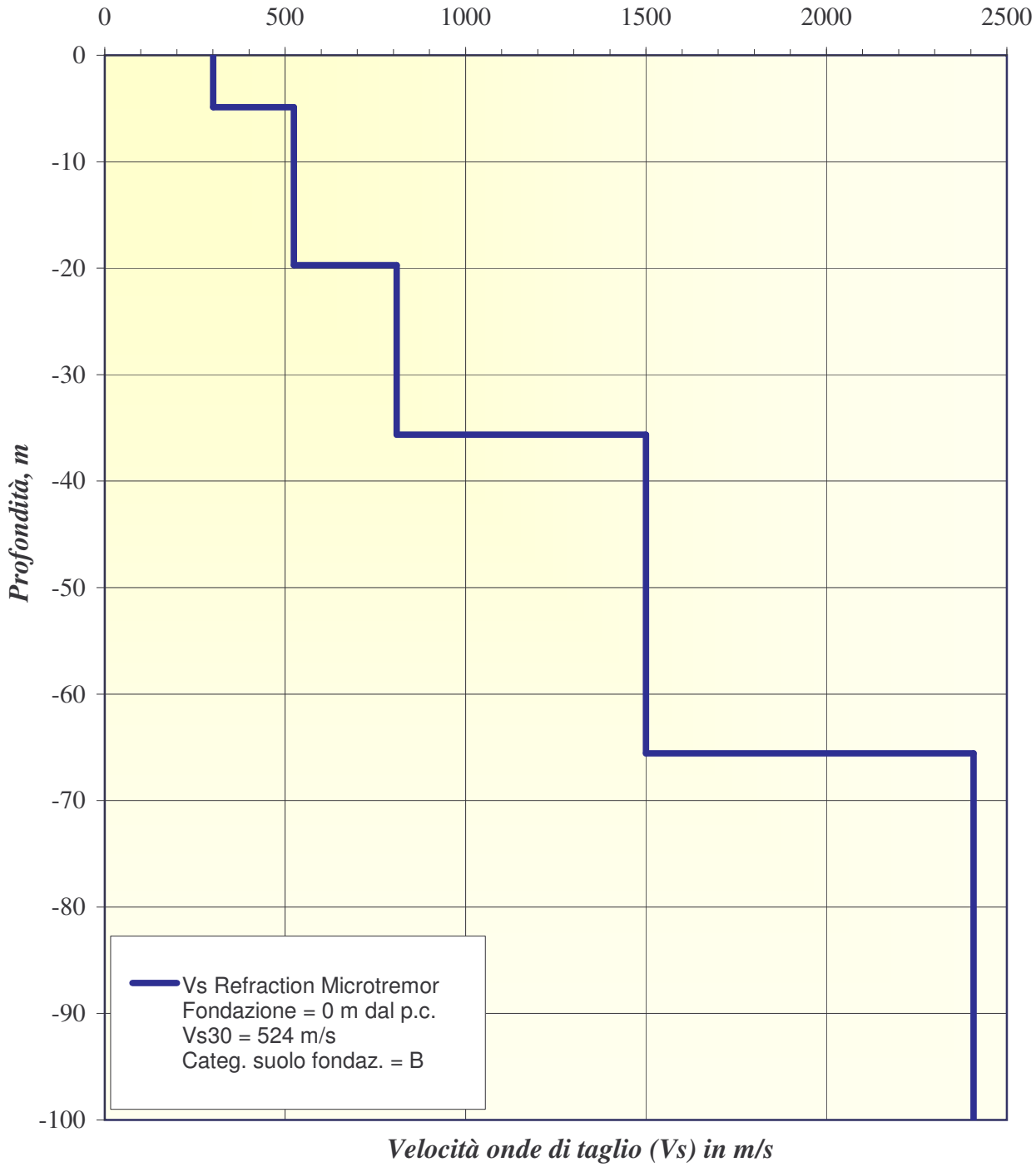


grafico slowness/frequenza

ReMi casteller 3

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

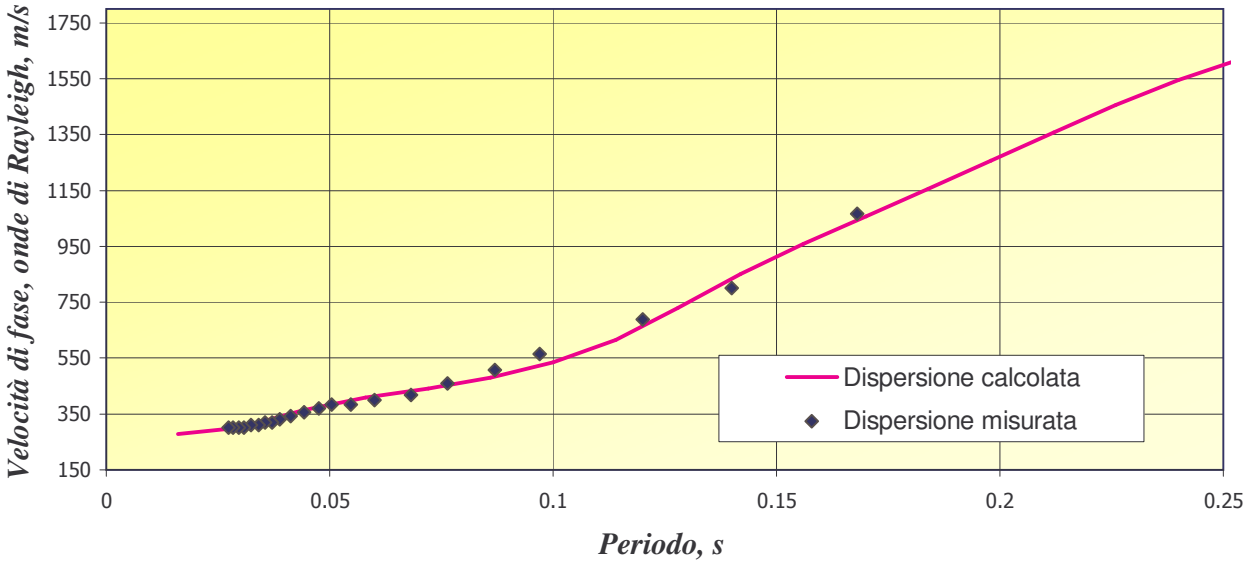


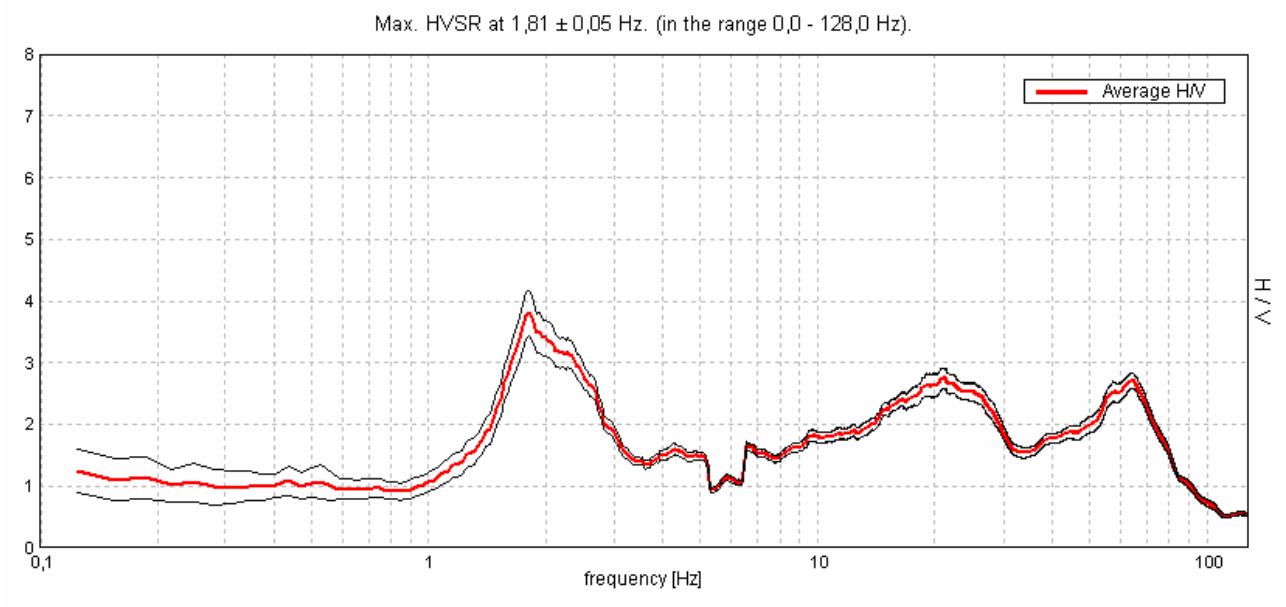
grafico slowness/frequenza

CASTELLER H/V n°0

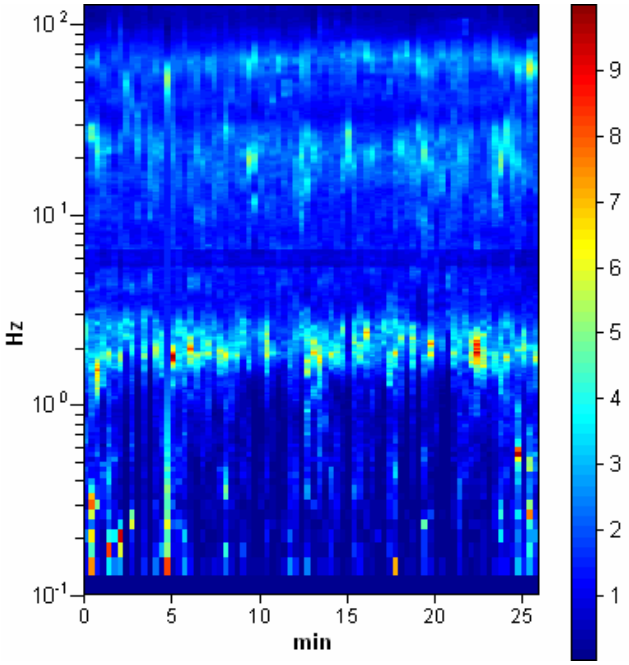
Start recording: 12/10/07 09:45:33 End recording: 12/10/07 10:11:34
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

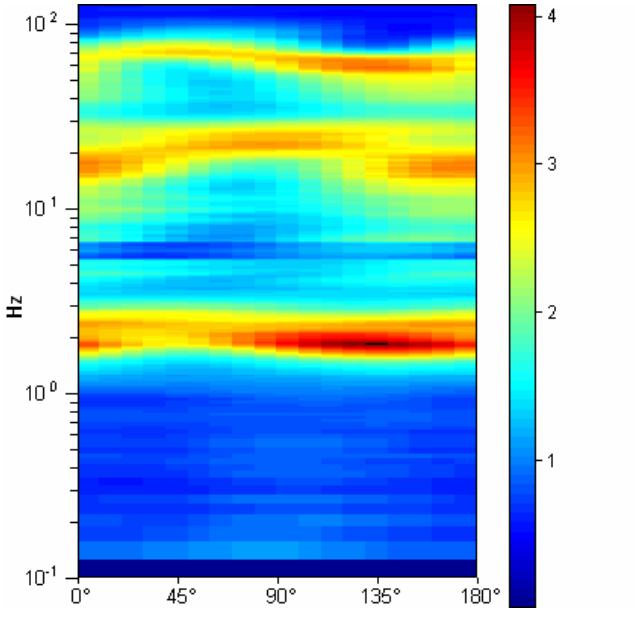
HORIZONTAL TO VERTICAL SPECTRAL RATIO



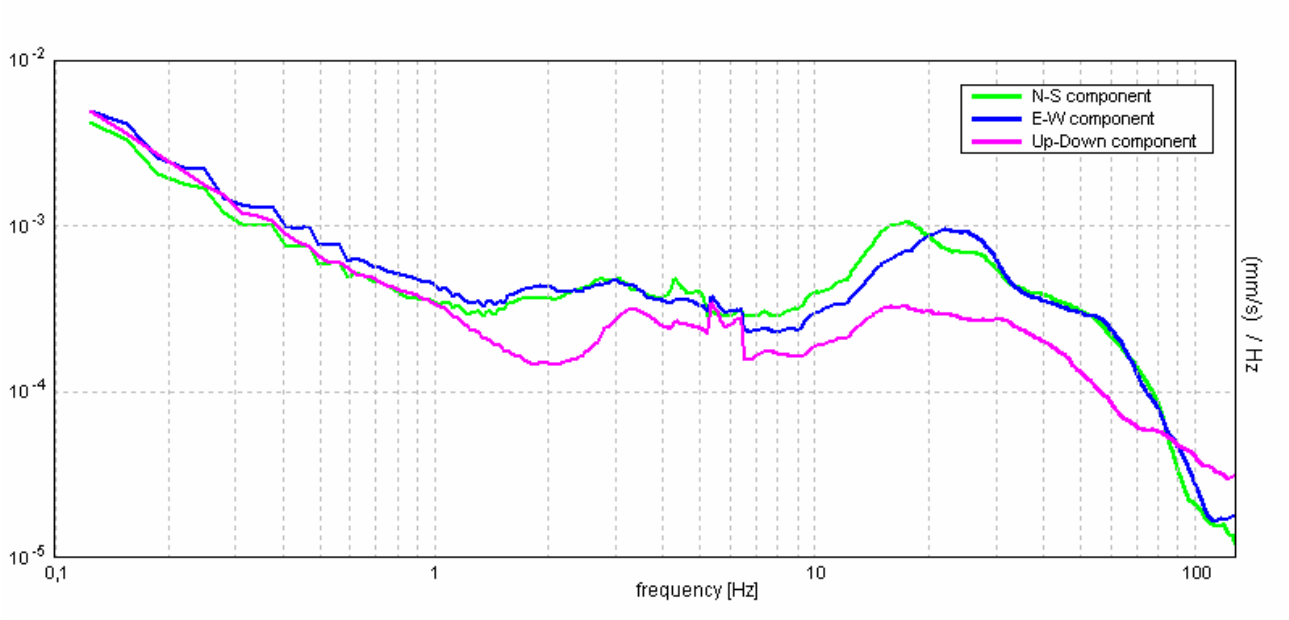
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 1,81 ± 0,05 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	1,81 > 0,50	OK	
$n_c(f_0) > 200$	2827,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 88 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,406 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	3,0 Hz	OK	
$A_0 > 2$	3,80 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,01292| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,02342 < 0,18125	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1866 < 1,78	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

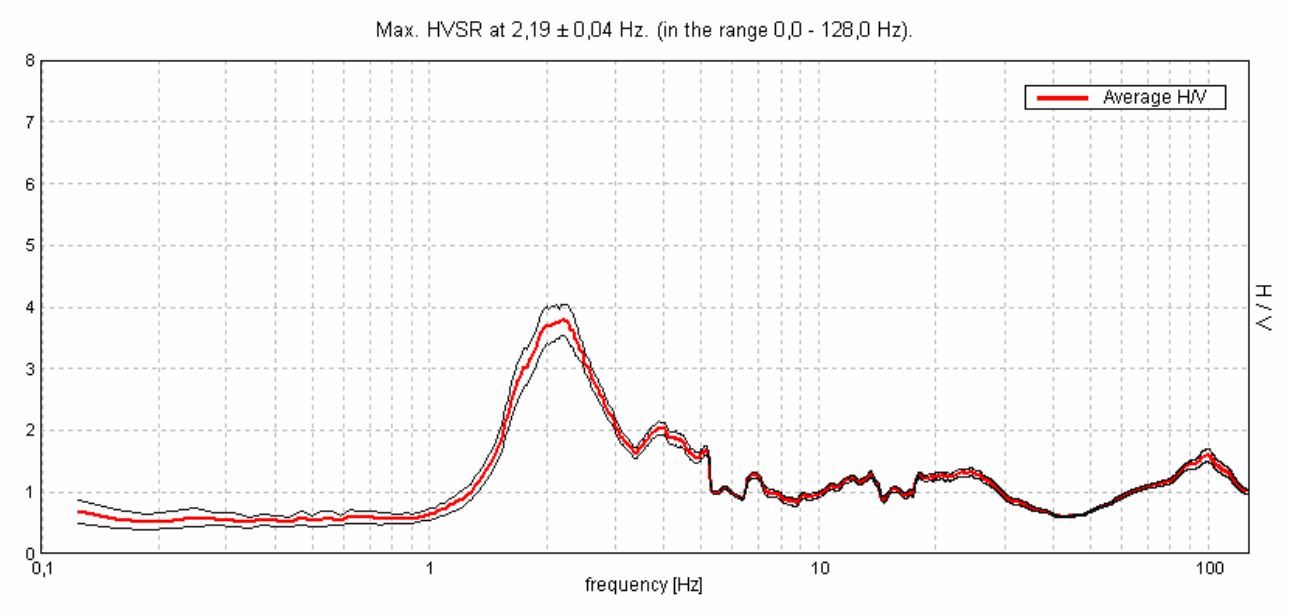
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n°1

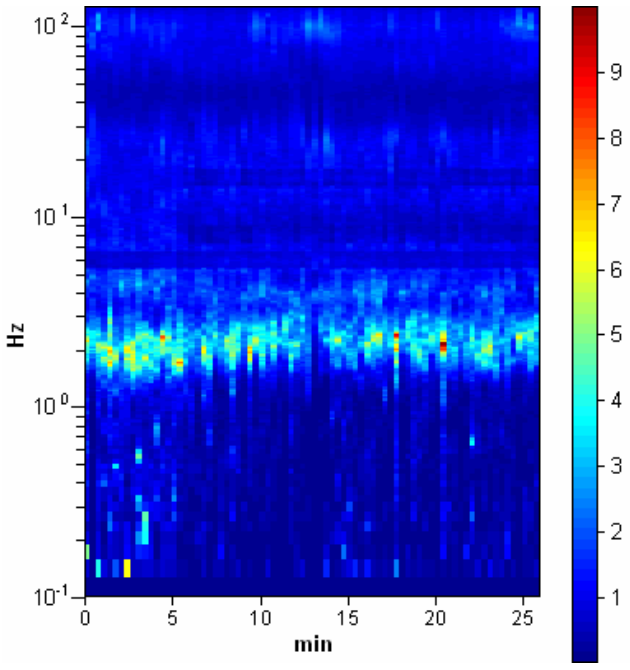
Start recording: 12/10/07 10:22:33 End recording: 12/10/07 10:48:34
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

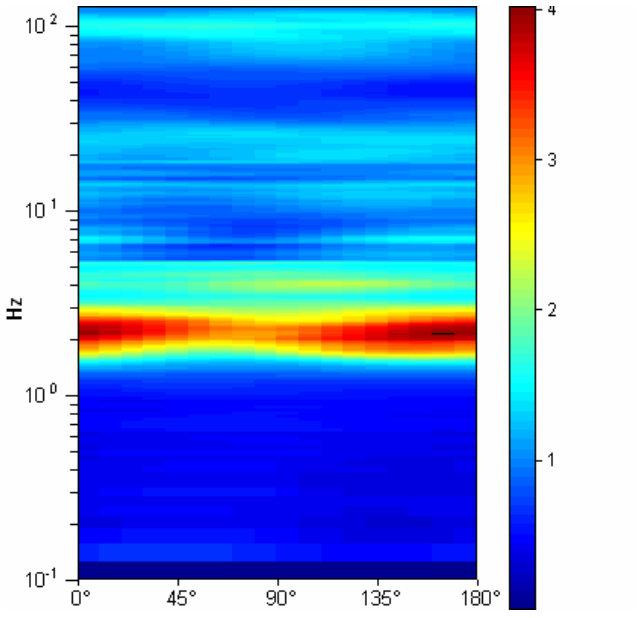
HORIZONTAL TO VERTICAL SPECTRAL RATIO



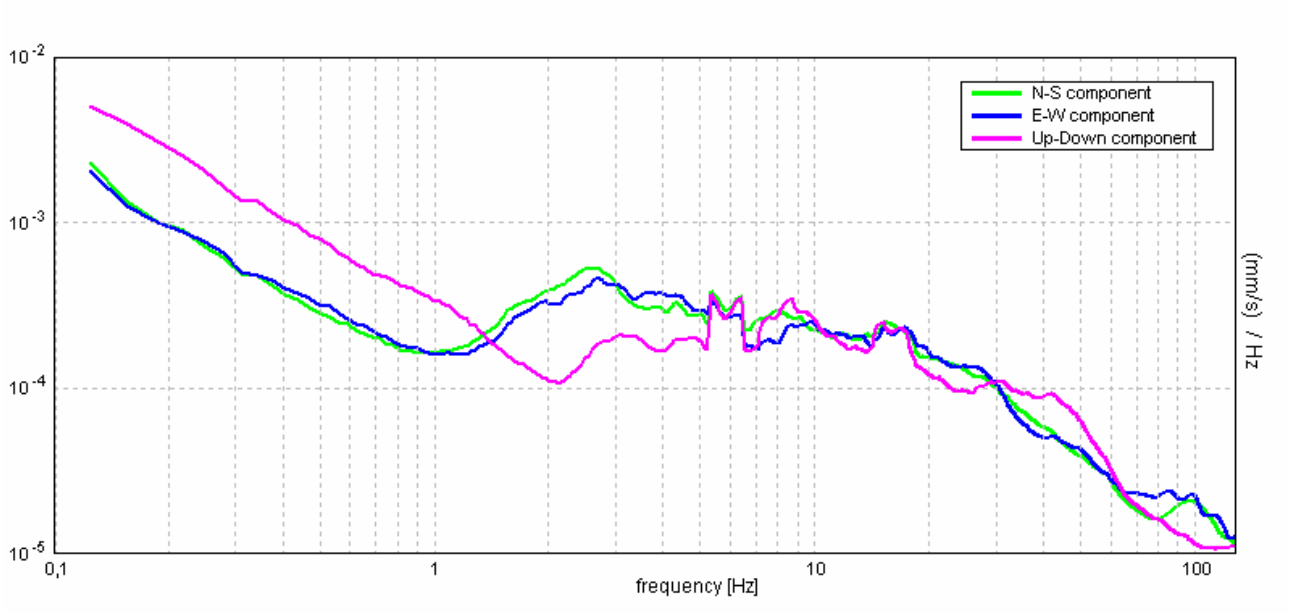
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,19 ± 0,04 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,19 > 0,50	OK	
$n_c(f_0) > 200$	3412,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 106 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,531 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	3,125 Hz	OK	
$A_0 > 2$	3,79 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00799| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,01748 < 0,10938	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1244 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

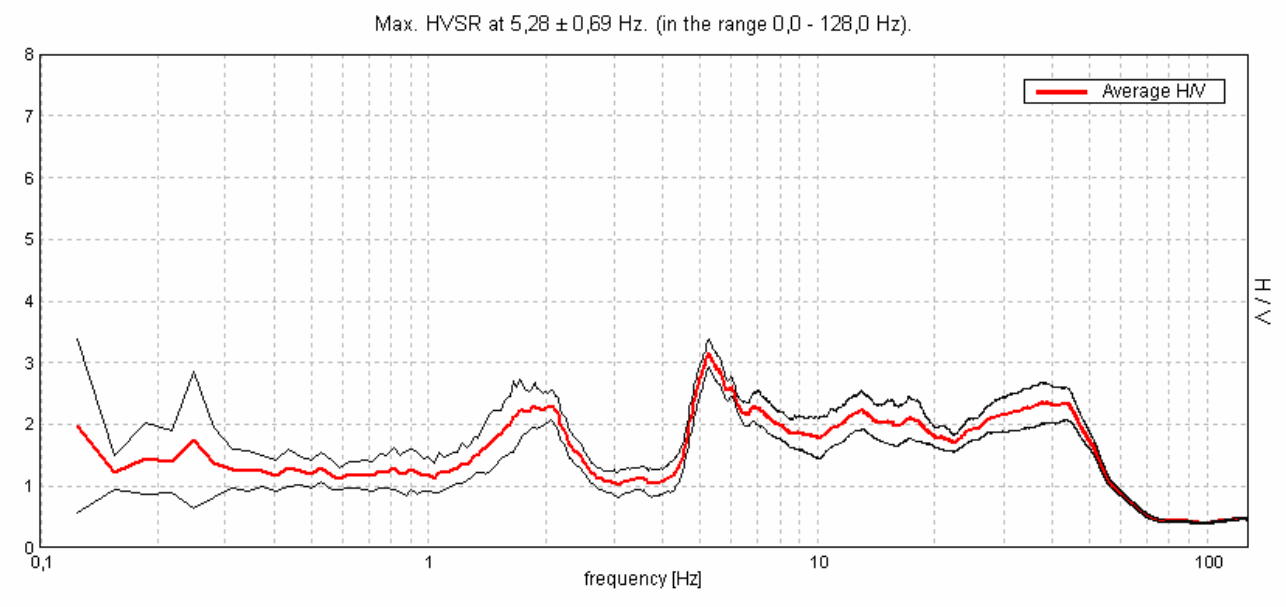
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n° 2

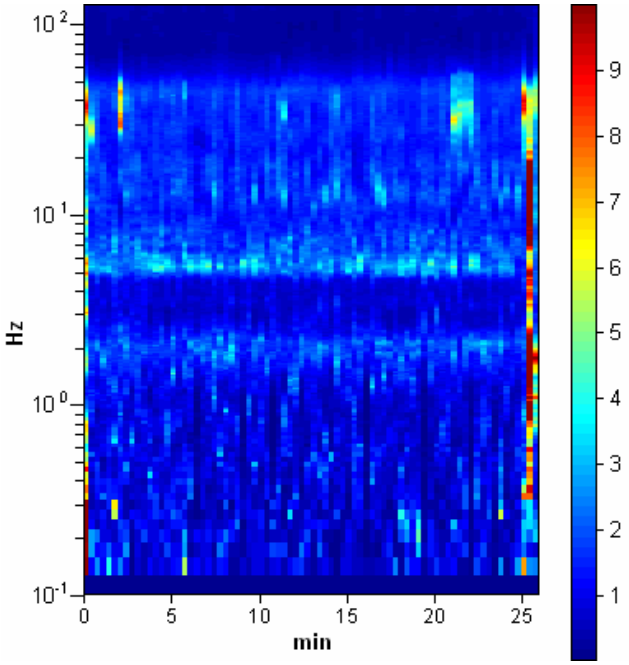
Start recording: 18/01/08 10:18:11 End recording: 18/01/08 10:44:12
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

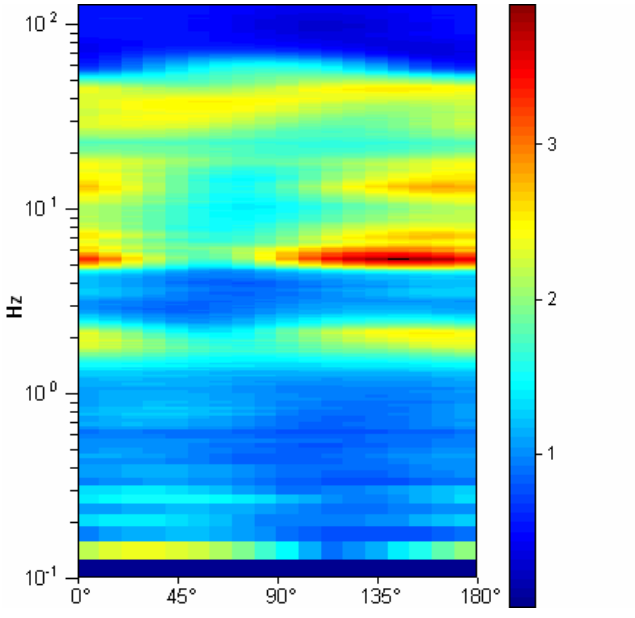
HORIZONTAL TO VERTICAL SPECTRAL RATIO



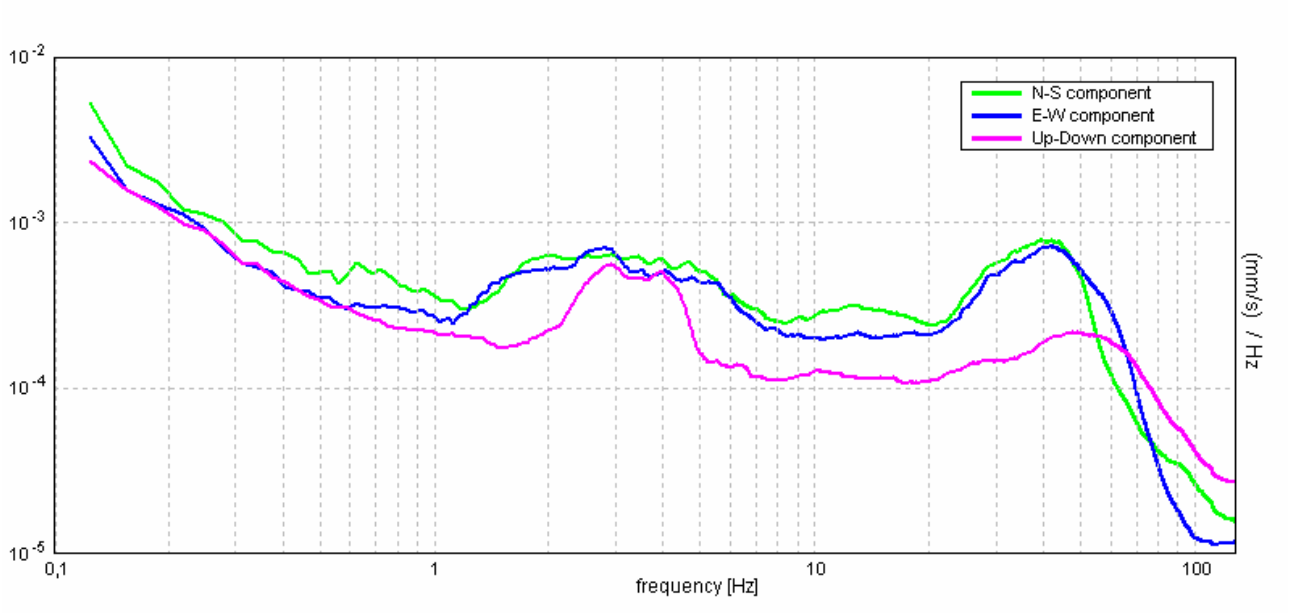
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 5,28 ± 0,69 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	5,28 > 0,50	OK	
$n_c(f_0) > 200$	8238,8 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 254 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	4,531 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	3,16 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,06504| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	0,3435 < 0,26406		NO
$\sigma_A(f_0) < \theta(f_0)$	0,1124 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

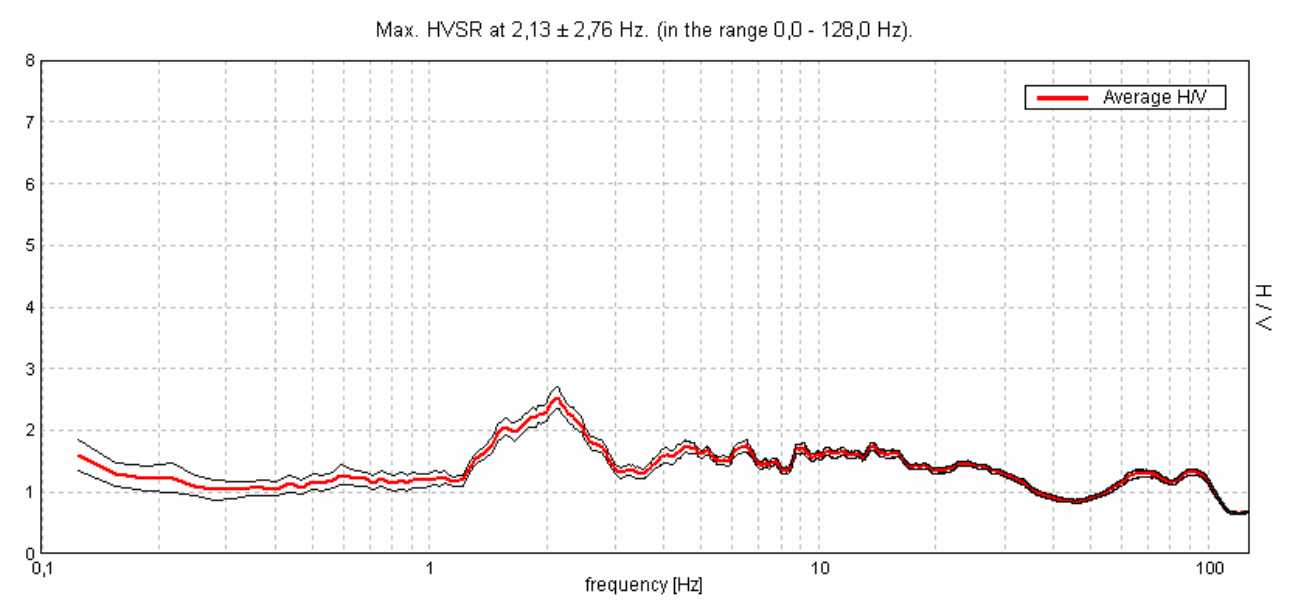
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n° 3

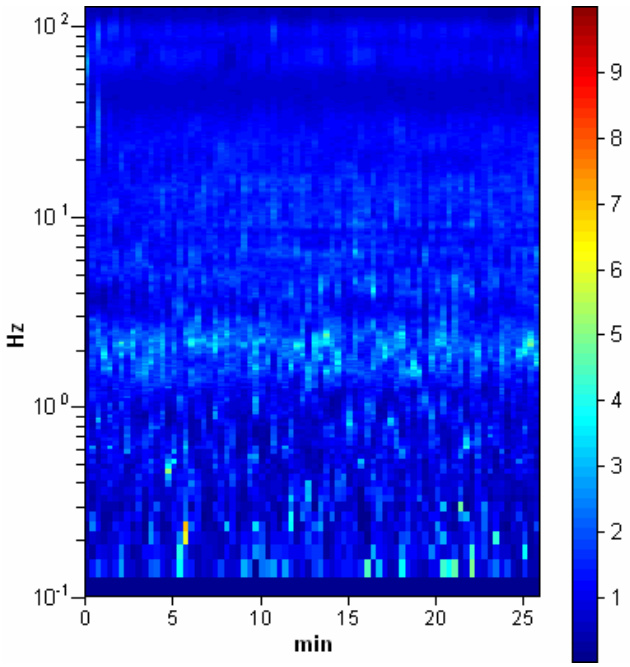
Start recording: 18/01/08 10:51:03 End recording: 18/01/08 11:17:04
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

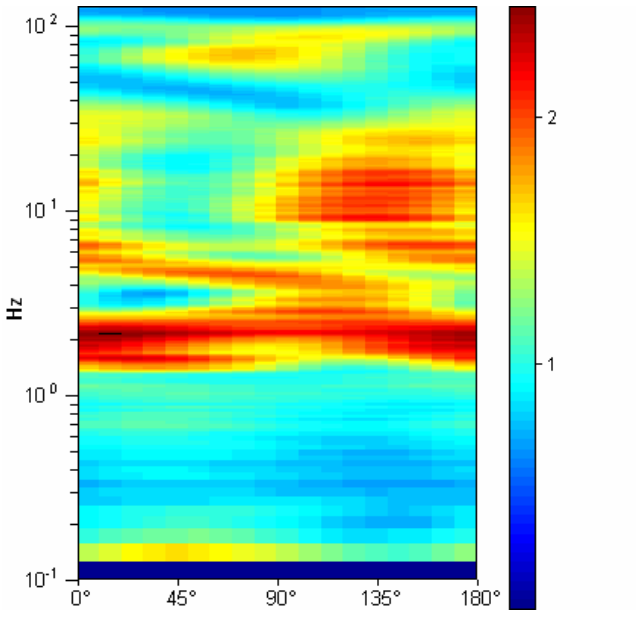
HORIZONTAL TO VERTICAL SPECTRAL RATIO



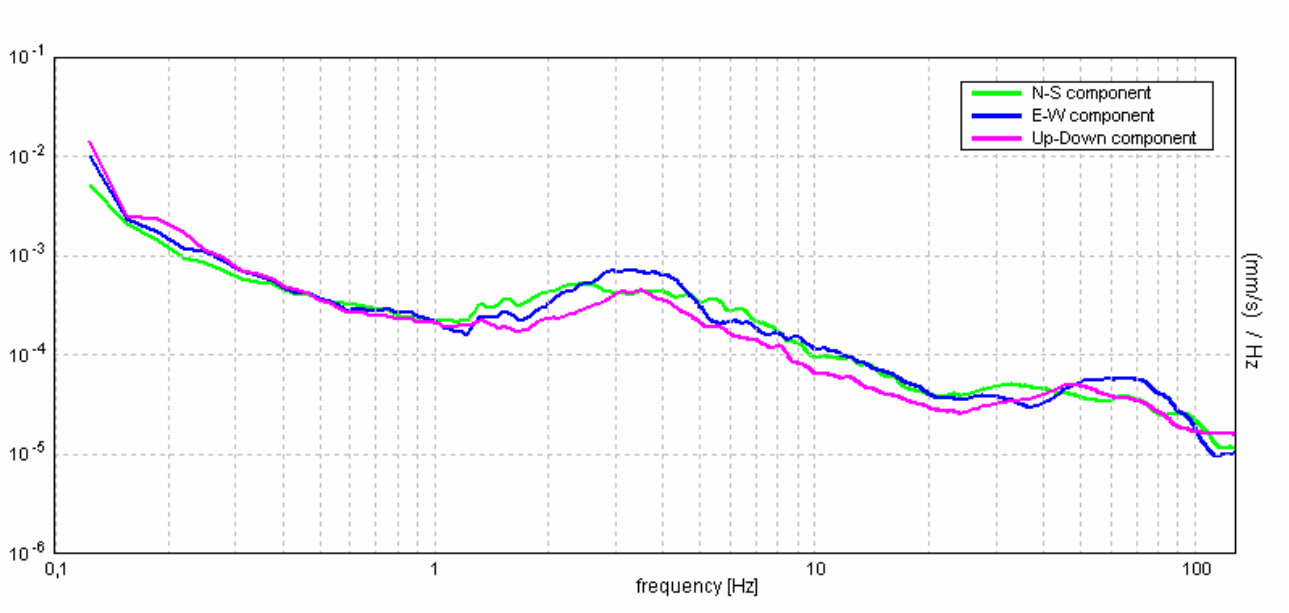
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,13 ± 2,76 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,13 > 0,50	OK	
$n_c(f_0) > 200$	3315,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 103 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,219 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	2,52 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,6468| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	1,37446 < 0,10625		NO
$\sigma_A(f_0) < \theta(f_0)$	0,0879 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

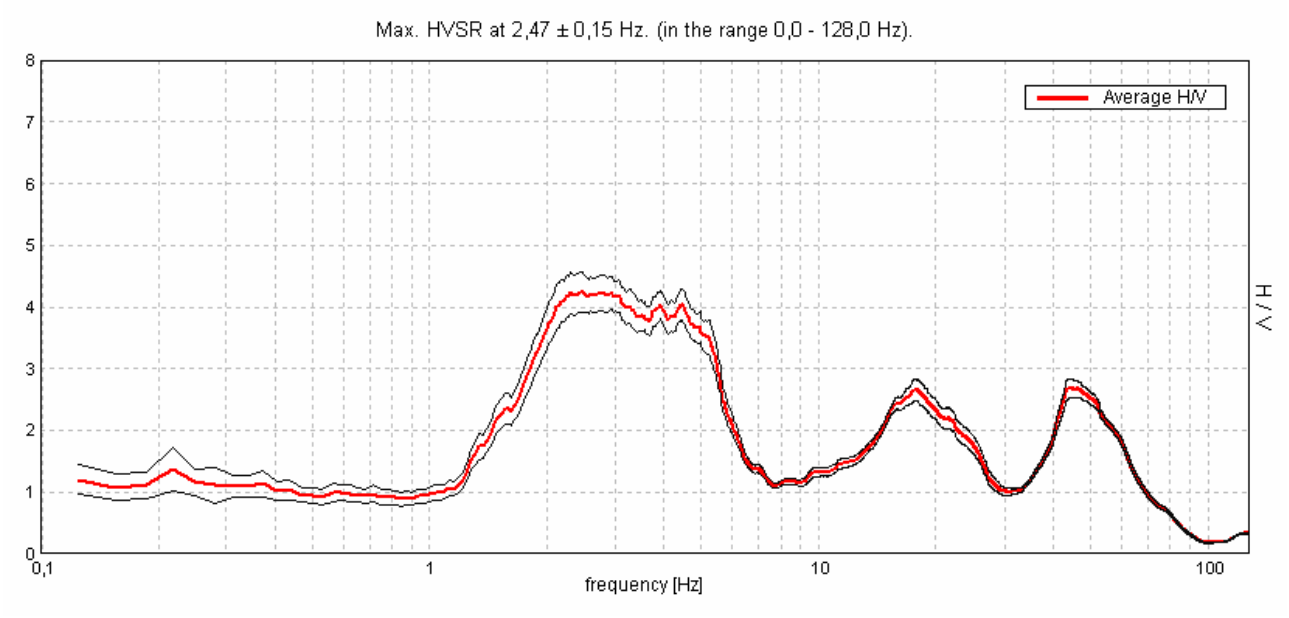
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n° 4

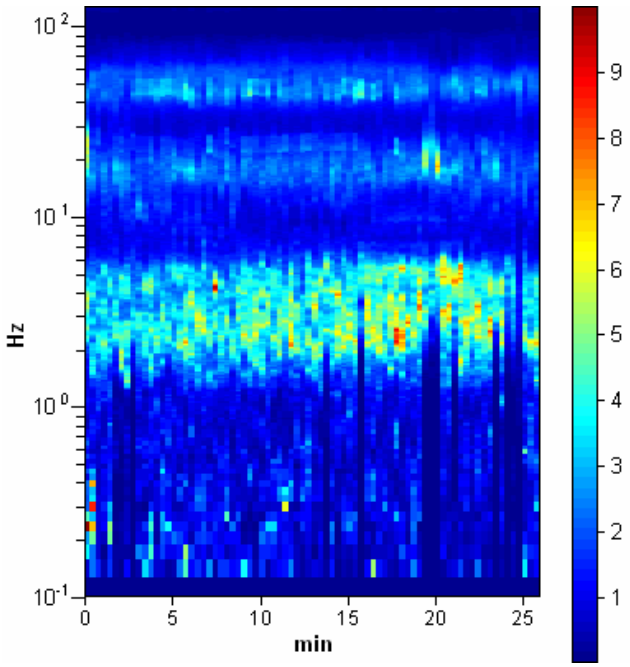
Start recording: 18/01/08 12:46:02 End recording: 18/01/08 13:12:03
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

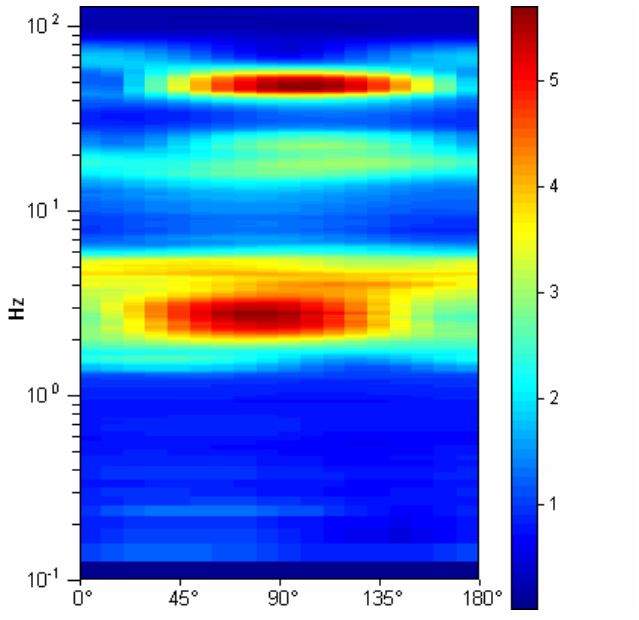
HORIZONTAL TO VERTICAL SPECTRAL RATIO



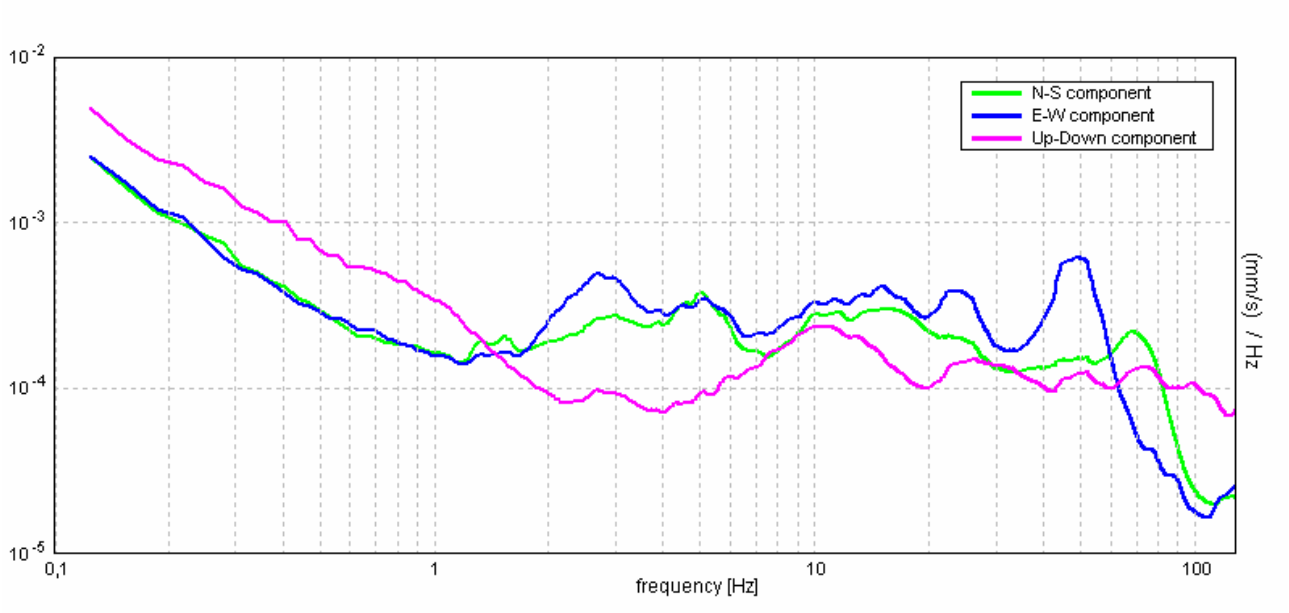
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,47 ± 0,15 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,47 > 0,50	OK	
$n_c(f_0) > 200$	3851,3 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 120 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,469 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	6,0 Hz	OK	
$A_0 > 2$	4,25 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,02931| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,07236 < 0,12344	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1628 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

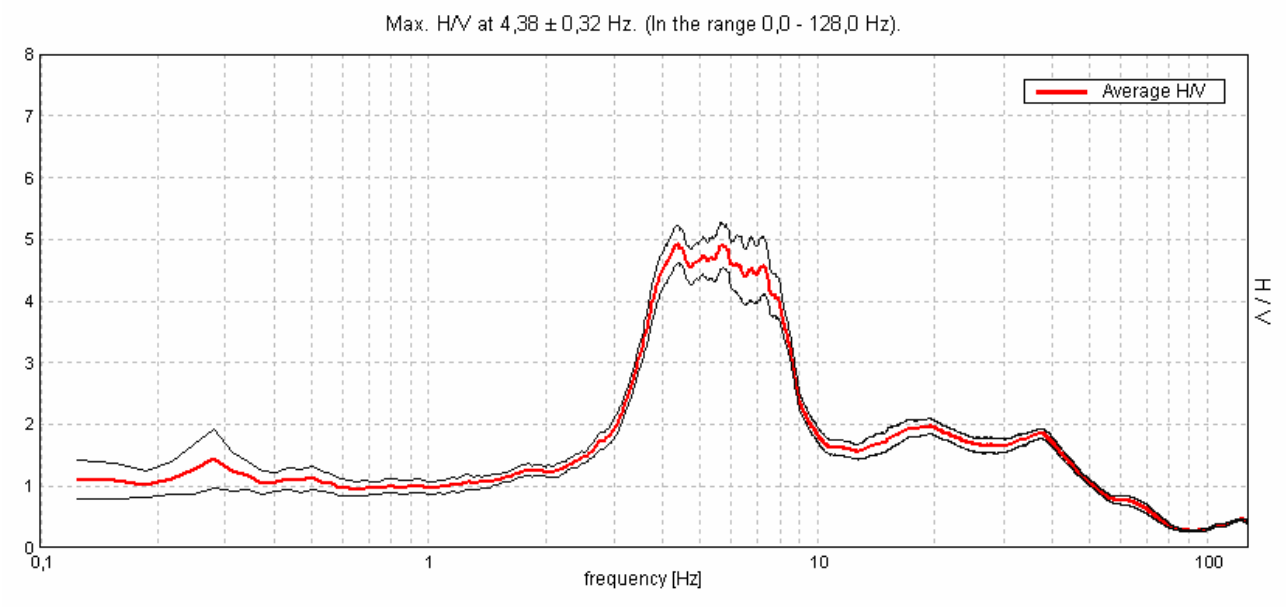
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n°5

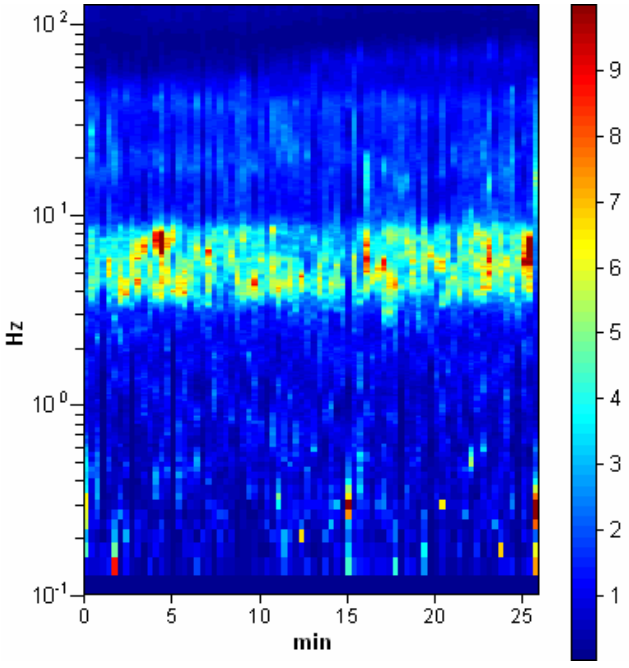
Start recording: 25/01/08 14:26:27 End recording: 25/01/08 14:52:28
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

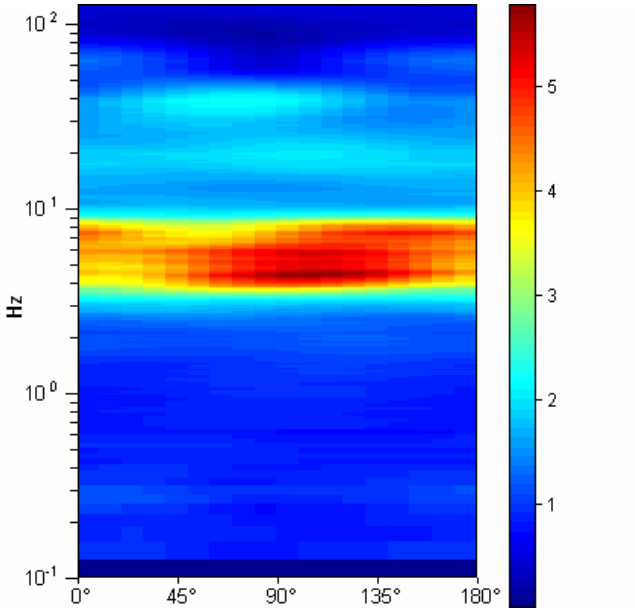
HORIZONTAL TO VERTICAL SPECTRAL RATIO



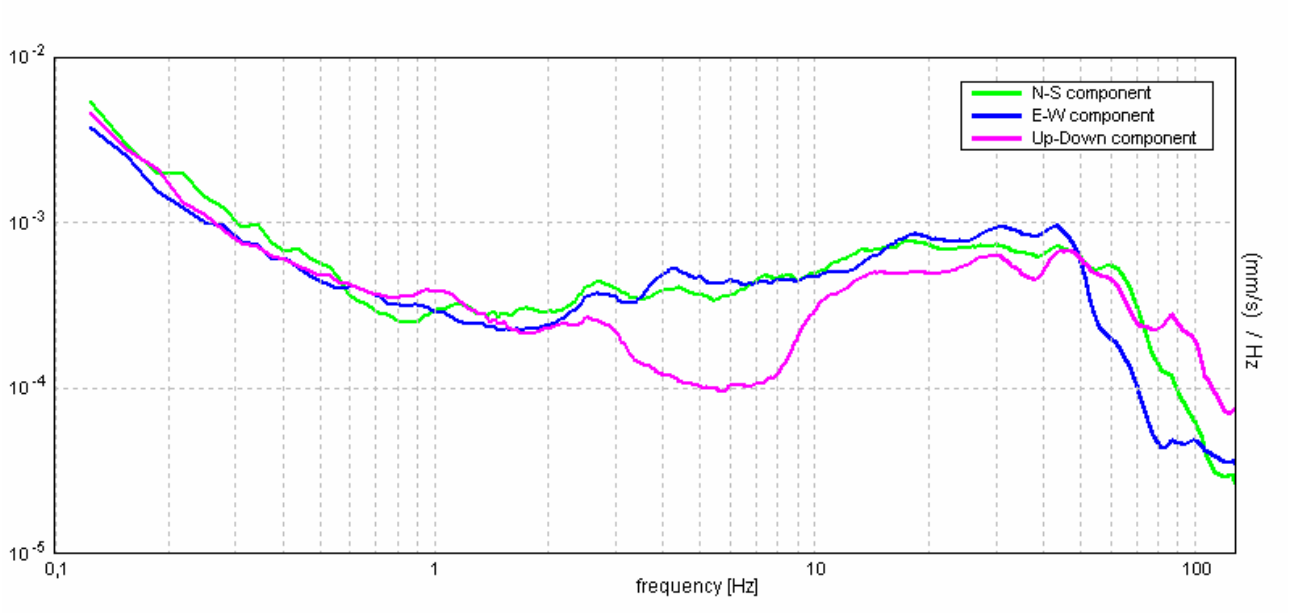
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 4,38 ± 0,32 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	4,38 > 0,50	OK	
$n_c(f_0) > 200$	6825,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 211 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	3,219 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	8,938 Hz	OK	
$A_0 > 2$	4,92 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,03688| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,16133 < 0,21875	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1488 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

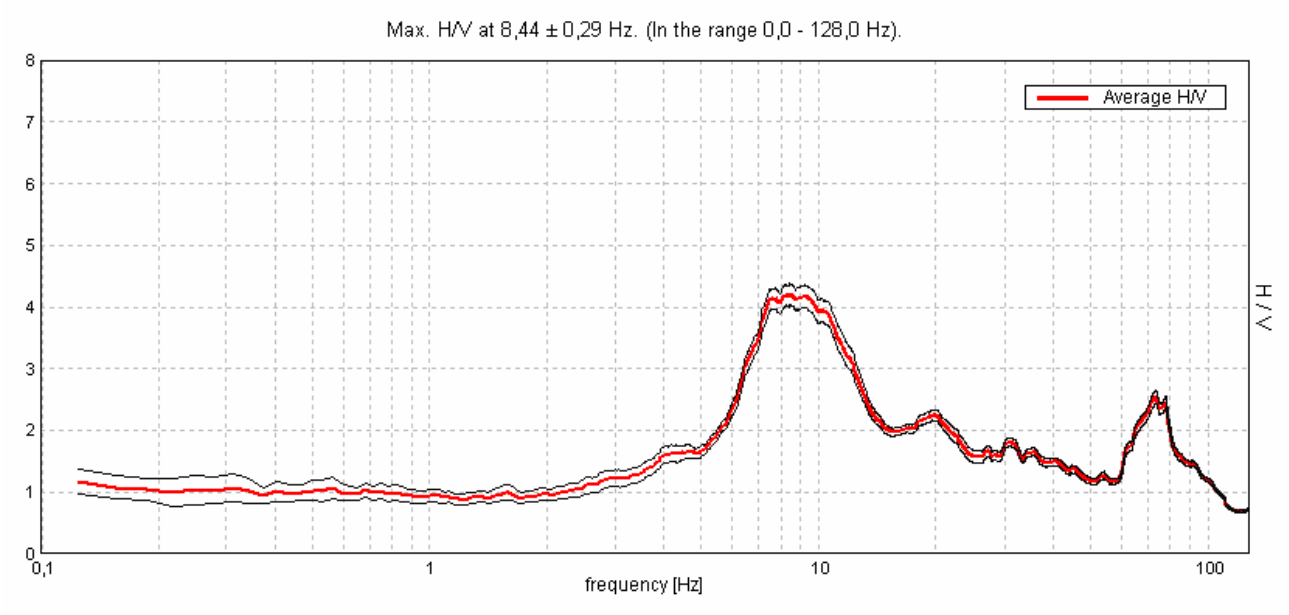
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n°6

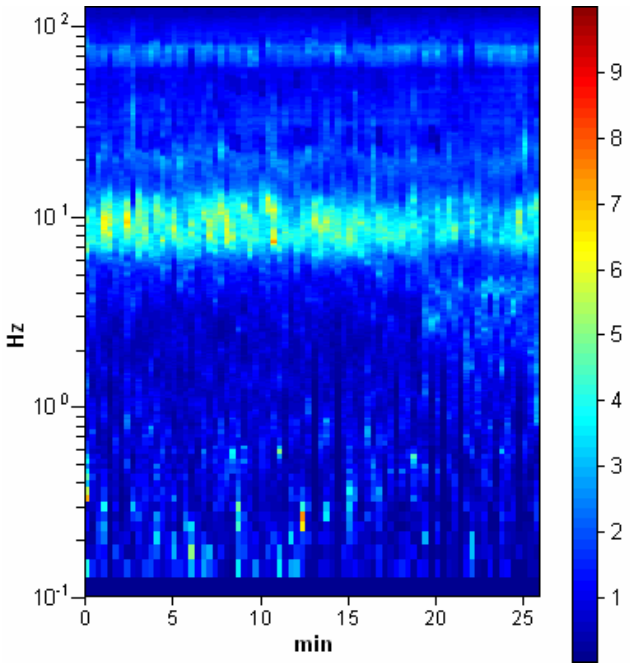
Start recording: 22/01/08 11:21:14 End recording: 22/01/08 11:47:15
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

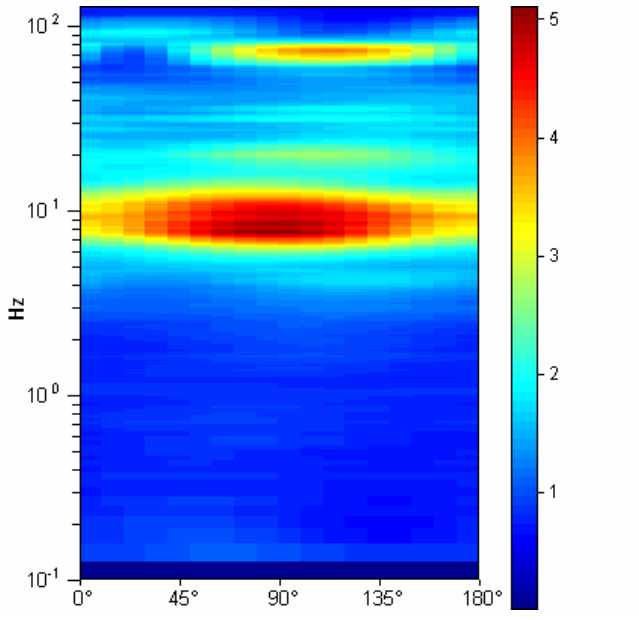
HORIZONTAL TO VERTICAL SPECTRAL RATIO



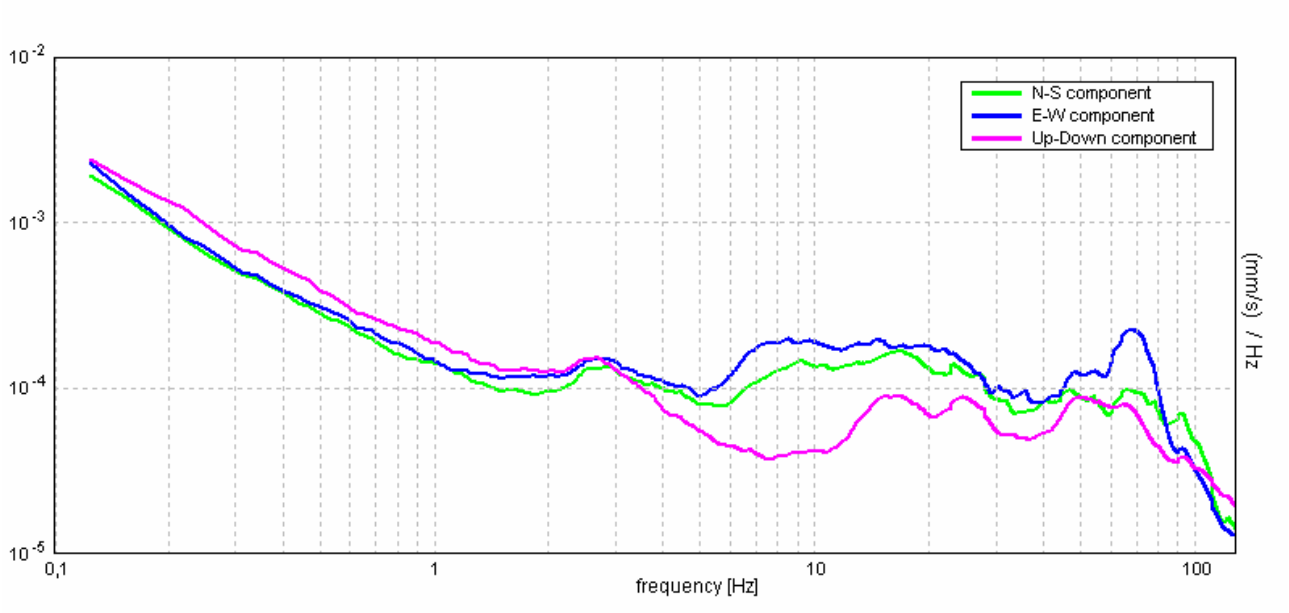
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 8,44 ± 0,29 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	8,44 > 0,50	OK	
$n_c(f_0) > 200$	13162,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 406 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	5,75 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	14,563 Hz	OK	
$A_0 > 2$	4,20 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,01736| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,14649 < 0,42188	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0869 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

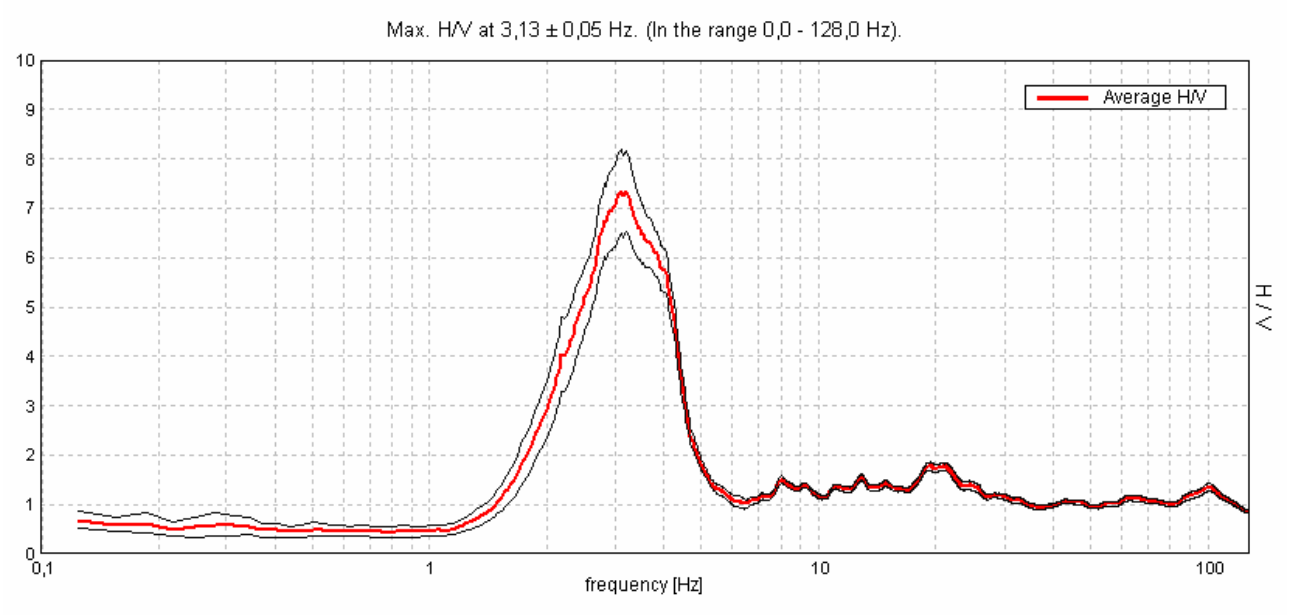
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n°7

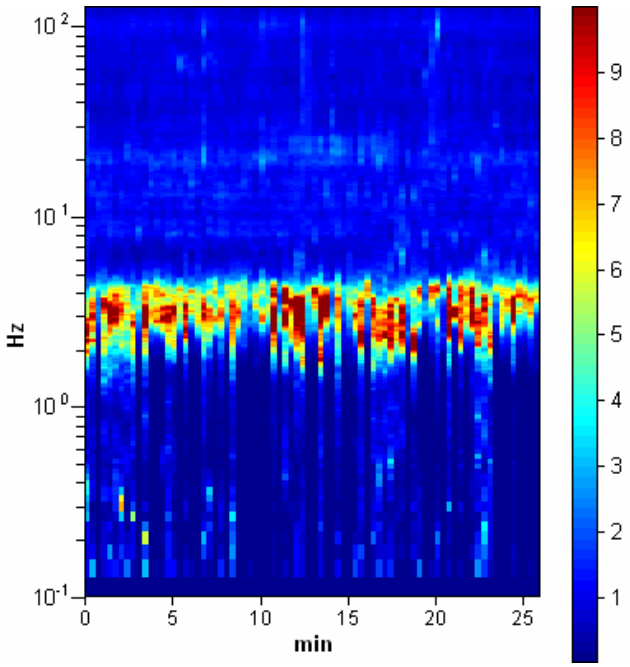
Start recording: 22/01/08 11:58:26 End recording: 22/01/08 12:24:27
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

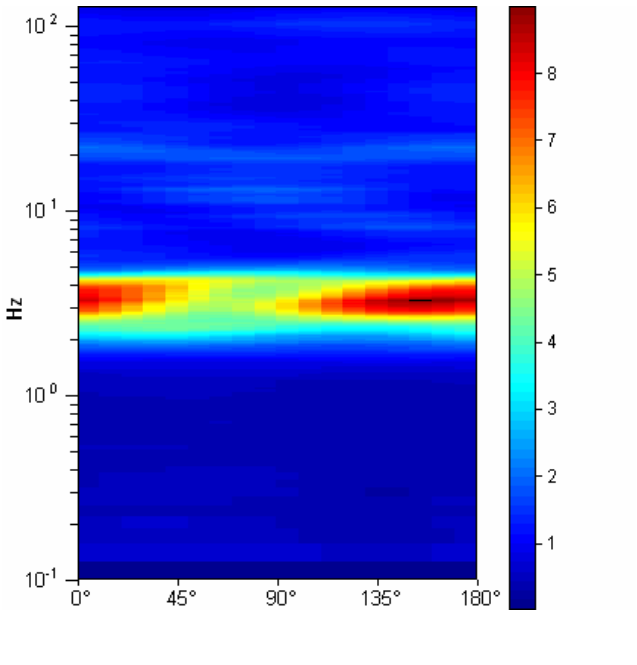
HORIZONTAL TO VERTICAL SPECTRAL RATIO



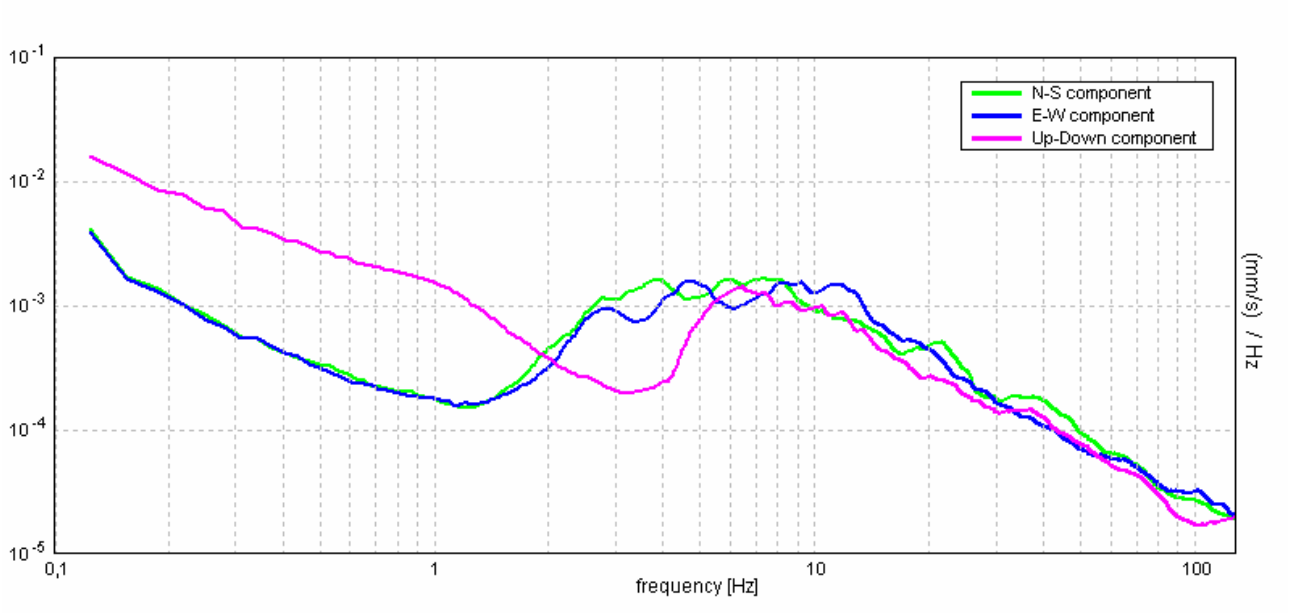
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,13 ± 0,05 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,13 > 0,50	OK	
$n_c(f_0) > 200$	4875,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 151 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2,125 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4,438 Hz	OK	
$A_0 > 2$	7,35 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00856| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,02674 < 0,15625	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,4293 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

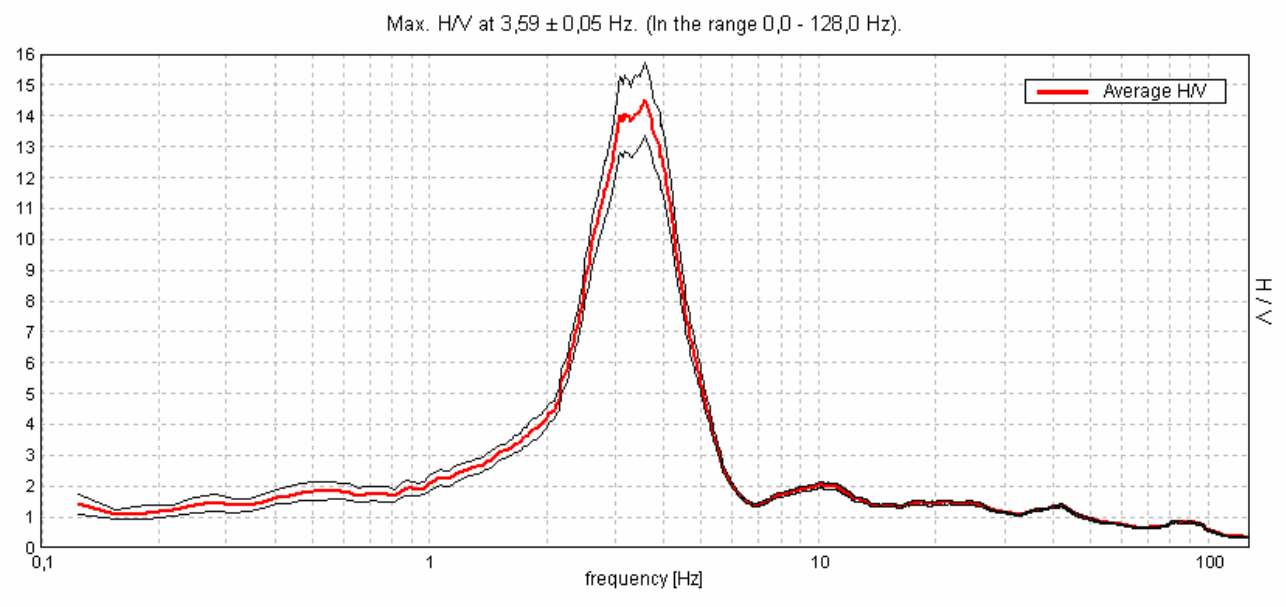
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n°8

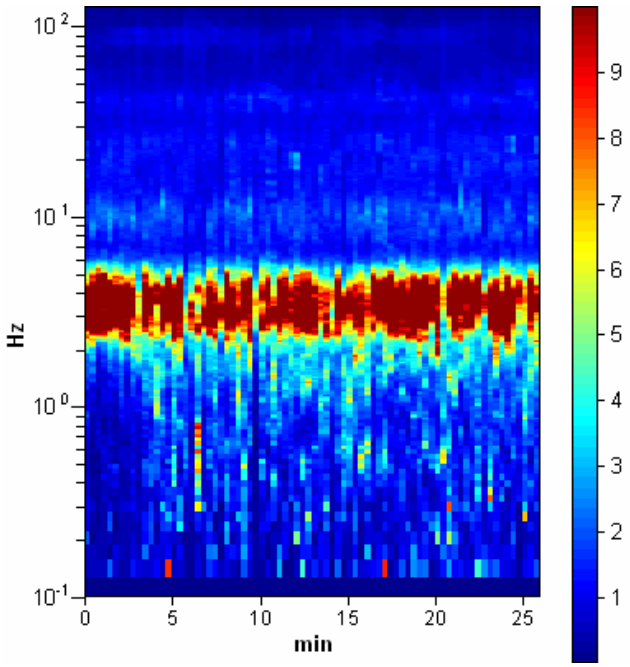
Start recording: 22/01/08 12:40:06 End recording: 22/01/08 13:06:07
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

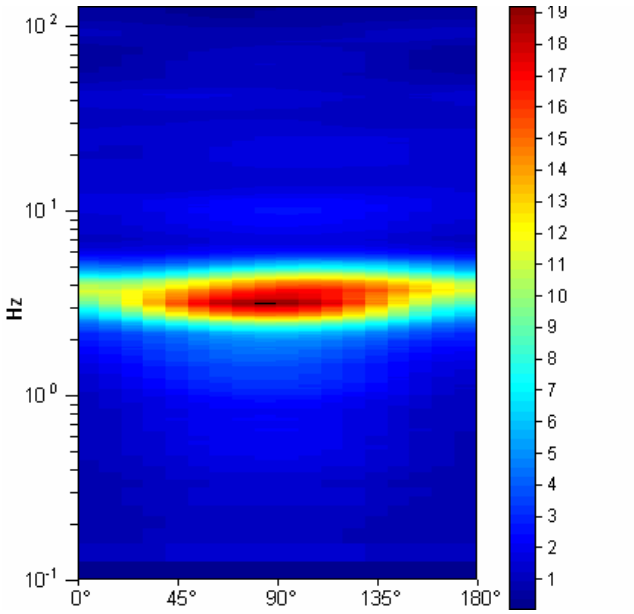
HORIZONTAL TO VERTICAL SPECTRAL RATIO



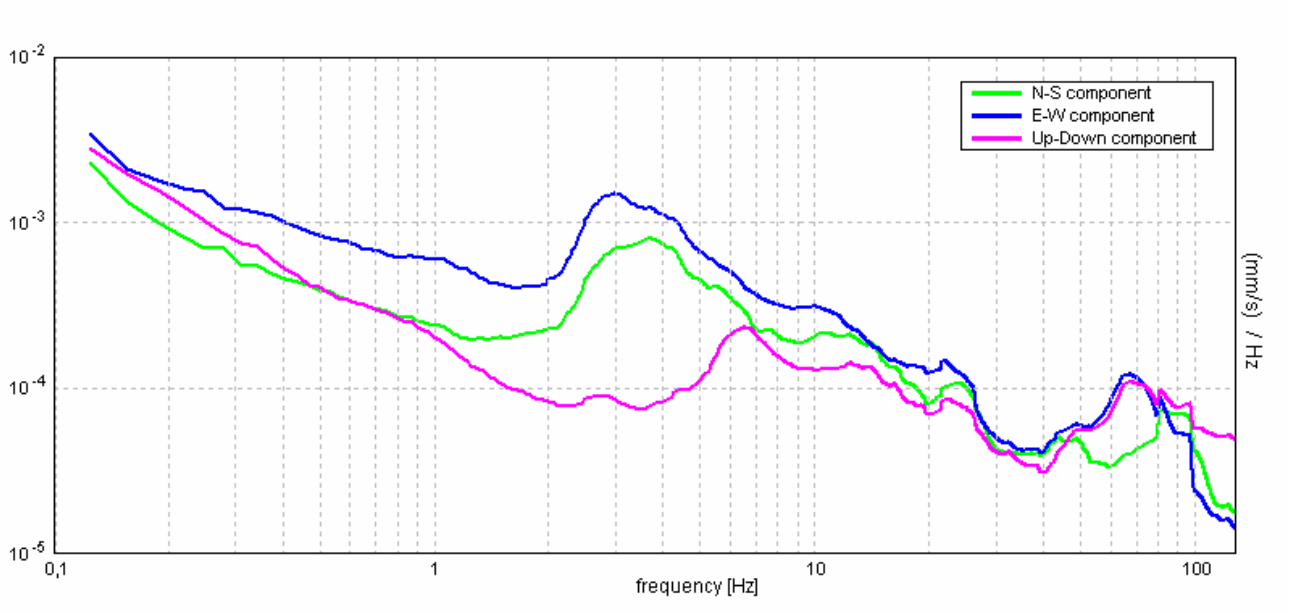
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,59 ± 0,05 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,59 > 0,50	OK	
$n_c(f_0) > 200$	5606,3 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 174 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2,406 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4,625 Hz	OK	
$A_0 > 2$	14,53 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00713| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,02564 < 0,17969	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,5975 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

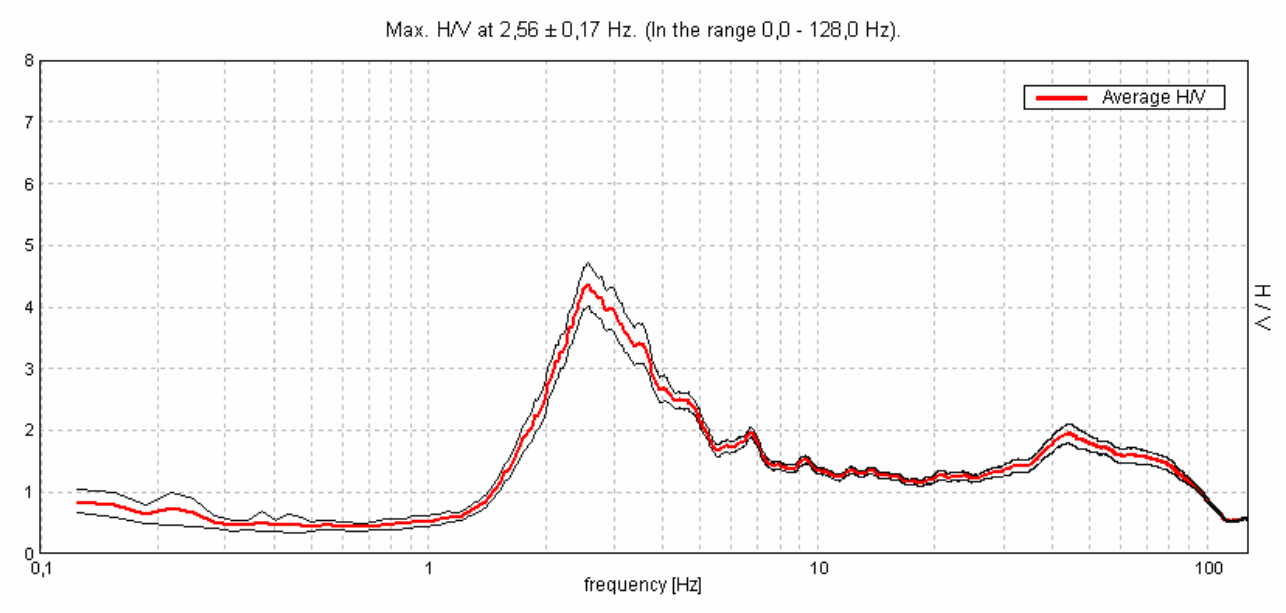
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CASTELLER H/V n°9

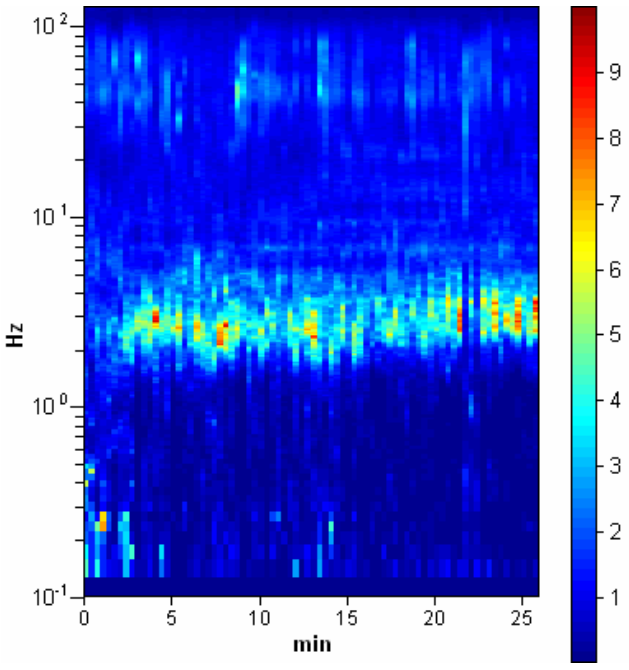
Start recording: 23/01/08 10:25:19 End recording: 23/01/08 10:51:20
GPS data not available

Trace length: 0h26'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

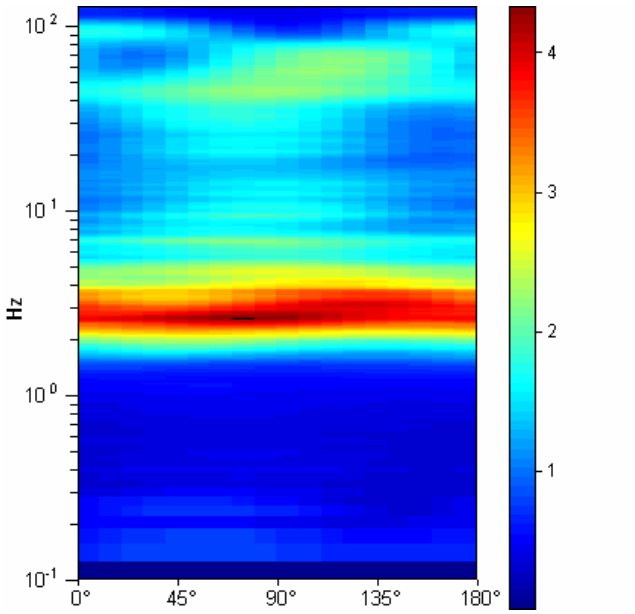
HORIZONTAL TO VERTICAL SPECTRAL RATIO



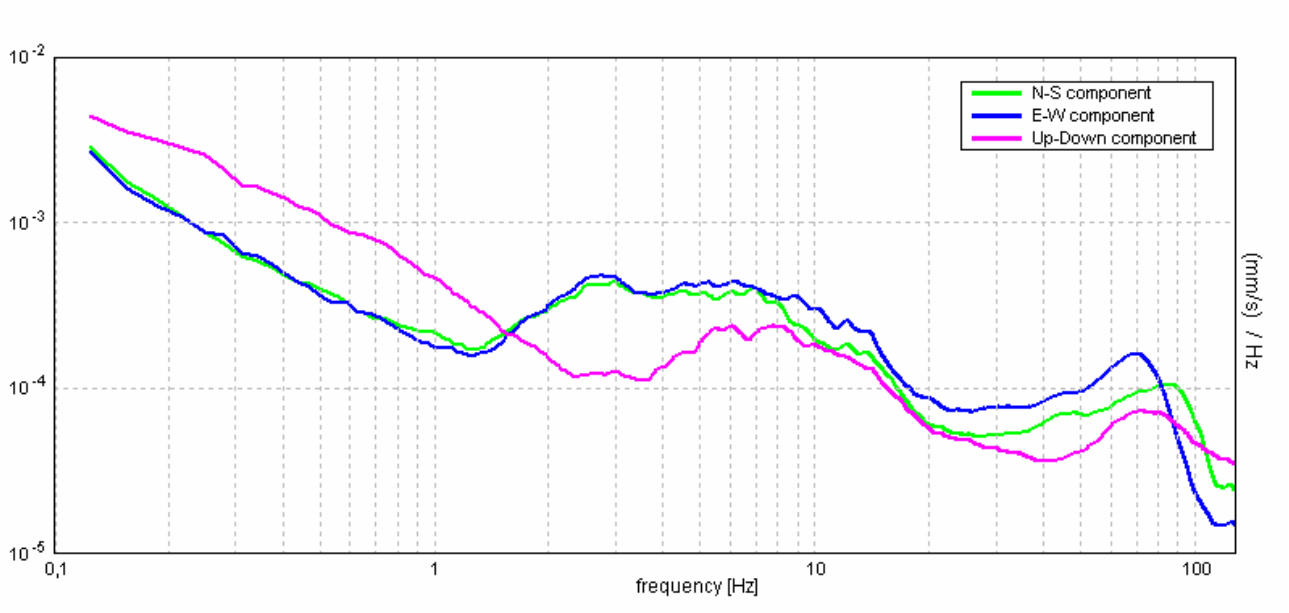
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,56 ± 0,17 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,56 > 0,50	OK	
$n_c(f_0) > 200$	3997,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 124 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,844 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5,0 Hz	OK	
$A_0 > 2$	4,37 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,03277| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,08398 < 0,12813	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1755 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

4 – Area Serravalle

Nell'ambito della fase di valutazione del tracciato della parte terminale del tratto in galleria compreso tra Besenello – Rovereto Sud è stata condotta una indagine geofisica al fine di approfondire le conoscenze, in merito allo spessore delle coperture sciolte in prossimità della frazione di Serravalle.
A tale scopo sono stati realizzati due sentimenti ReMi (ReMi1 e ReMi2) e 7 indagini H/V; la figura seguente ne riporta l'ubicazione.

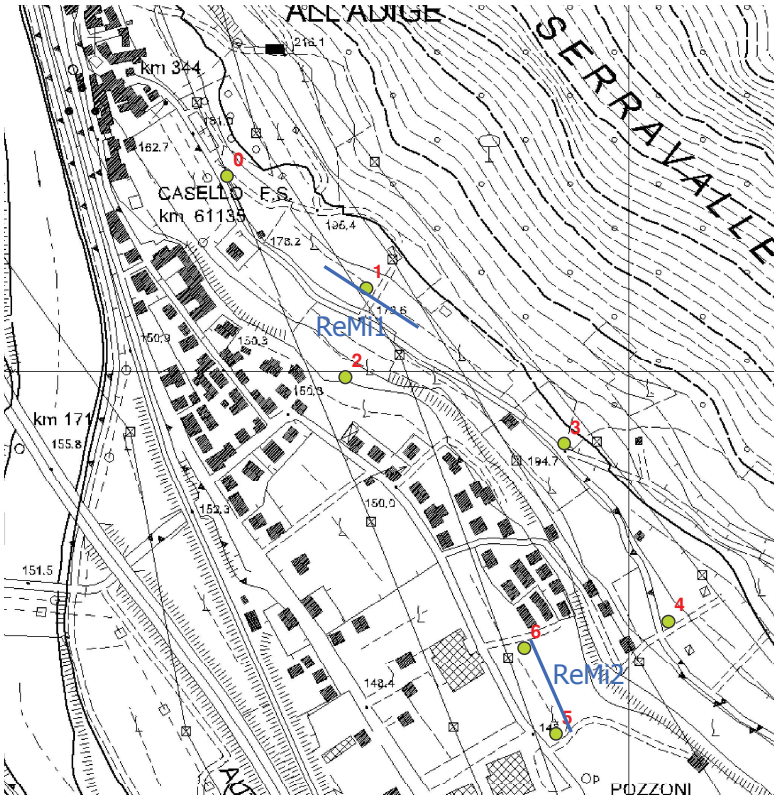


fig. 8 - Ubicazione indagini H/V e ReMi

Come nei casi precedenti il confronto tra queste metodologie differenti ha consentito di migliorare la qualità e l'attendibilità delle informazioni acquisite.

a) indagini H/V

Nella figura e nella tabella seguenti è riportato il valore della frequenza di risonanza dedotto dalle indagini HVSR; si osserva come vi sia una buona corrispondenza tra le indagini n° 0 ÷ 4 realizzate sul terrazzo soprastante la parte nuova della frazione e le n° 5 e 6 realizzate a valle.

I valori ottenuti nel primo caso sono compresi tra 3.03 e 3.8 Hz e, come possibile osservare dai diagrammi allegati, i picchi relativi sono ben individuati e chiari.
Nel secondo caso invece lo spettro di amplificazione mostra una maggiore complessità in entrambe le misure con frequenti picchi difficilmente eliminabili (nella valutazione) a priori; in questa prima fase si è scelto per entrambi di considerare i valori relativi ai picchi che presentano maggior valore nel rapporto H/V.

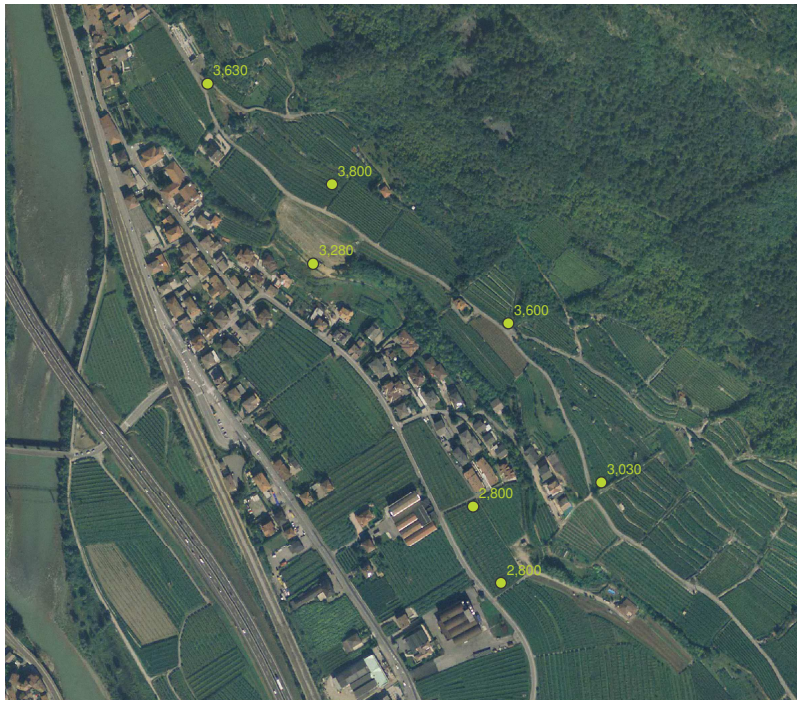


fig. 9 – Valori di frequenza rilevati

b) Indagini ReMi

Le due indagini sono state rispettivamente realizzate sul terrazzo soprastante la frazione (ReMi1) e sul fondovalle (ReMI2) ciò in considerazione della possibile variabilità litologica.
I profili di velocità sono presentati in allegato.
Nell'indagine ReMi1 il profilo di velocità mostra la possibile presenza dell'interfaccia deposito superficiale/substrato roccioso a circa 20 m di profondità e una velocità Vs media del deposito quaternario di 325 m/s.
Utilizzando questo valore di velocità e quello delle frequenze di risonanza individuate si ottengono valori di profondità comprese tra 21.5 e 27 m circa.

Il confronto tra l'indagine ReMi1 e H/V n° 1 effettuate nello stesso sito mostra una buona corrispondenza (20.3 m ReMi – 21,4 m H/V)

prova n°	f_r (Hz)	Vs (m/s)	h (m)
0	3,6	325	22,4
1	3,8	325	21.4
2	3,28	325	24,8
3	3,6	325	22,4
4	3,03	325	26,8
5	2,8	405	36,1
6	2,8	405	36,1

La seconda indagine ReMi evidenzia una situazione più complessa; il profilo di velocità che meglio si adatta alla curva di dispersione misurata mostra la presenza del substrato roccioso a 25,5 m di profondità con una Vs media della copertura quaternaria pari a 405 m/s.
Purtroppo utilizzando questo valore di velocità si osserva come non vi sia una buona corrispondenza con i dati H/V perché, come è possibile osservare dalla tabella presentata, utilizzando il valore di frequenza corrispondente al picco del rapporto H/V più elevato, si ottengono valori di profondità molto maggiori di quelli scaturiti dall'indagine ReMi.
Ciò è probabilmente legato ad una erronea individuazione del picco H/V corrispondente alla presenza dell'interfaccia deposito quaternario/substrato roccioso.
I limitati tempi per l'effettuazione delle indagini non hanno consentito l'effettuazione di ulteriori prove di controllo e verifica e pertanto in questa fase è possibile ipotizzare che il substrato in prossimità dell'indagine ReMi2 si trovi ad almeno 25 m di profondità.

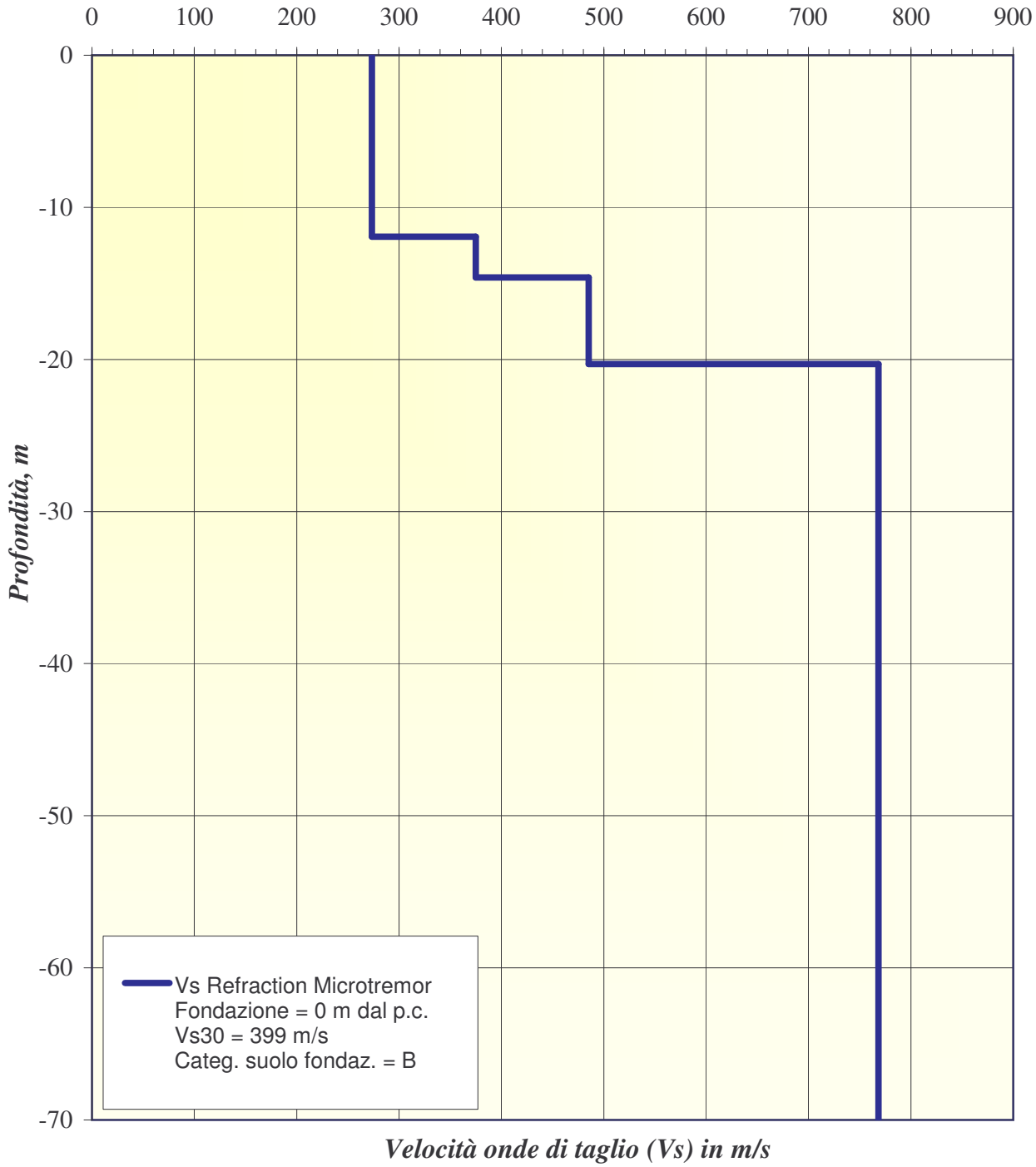
ALLEGATI

- profili di velocità ReMi

- elaborati indagini H/V

Serravalle ReMi 1

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

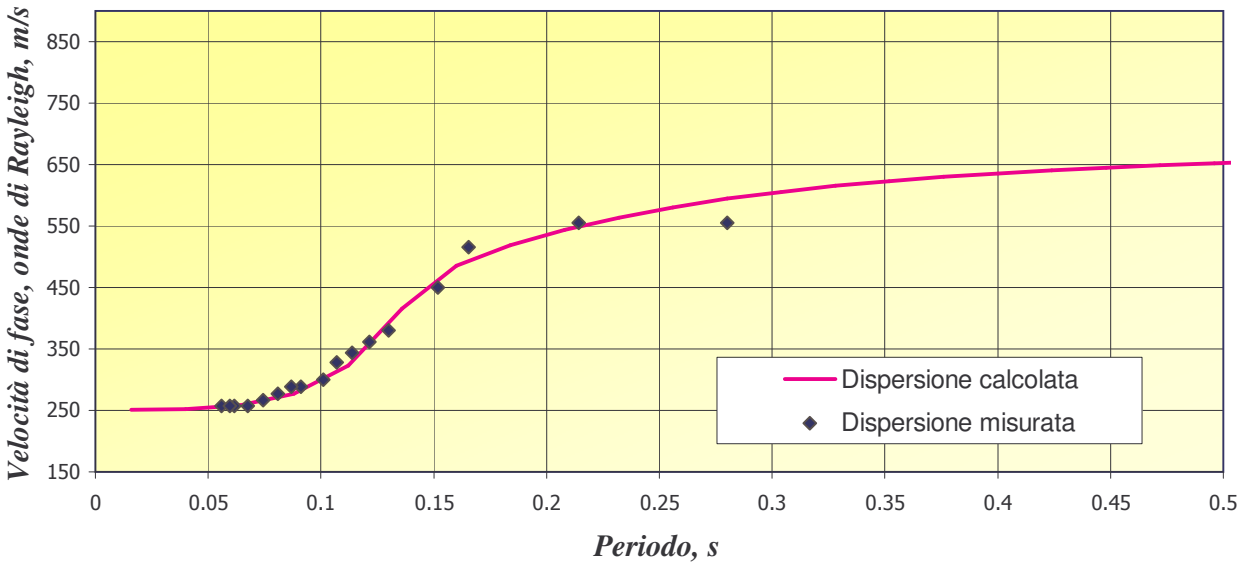
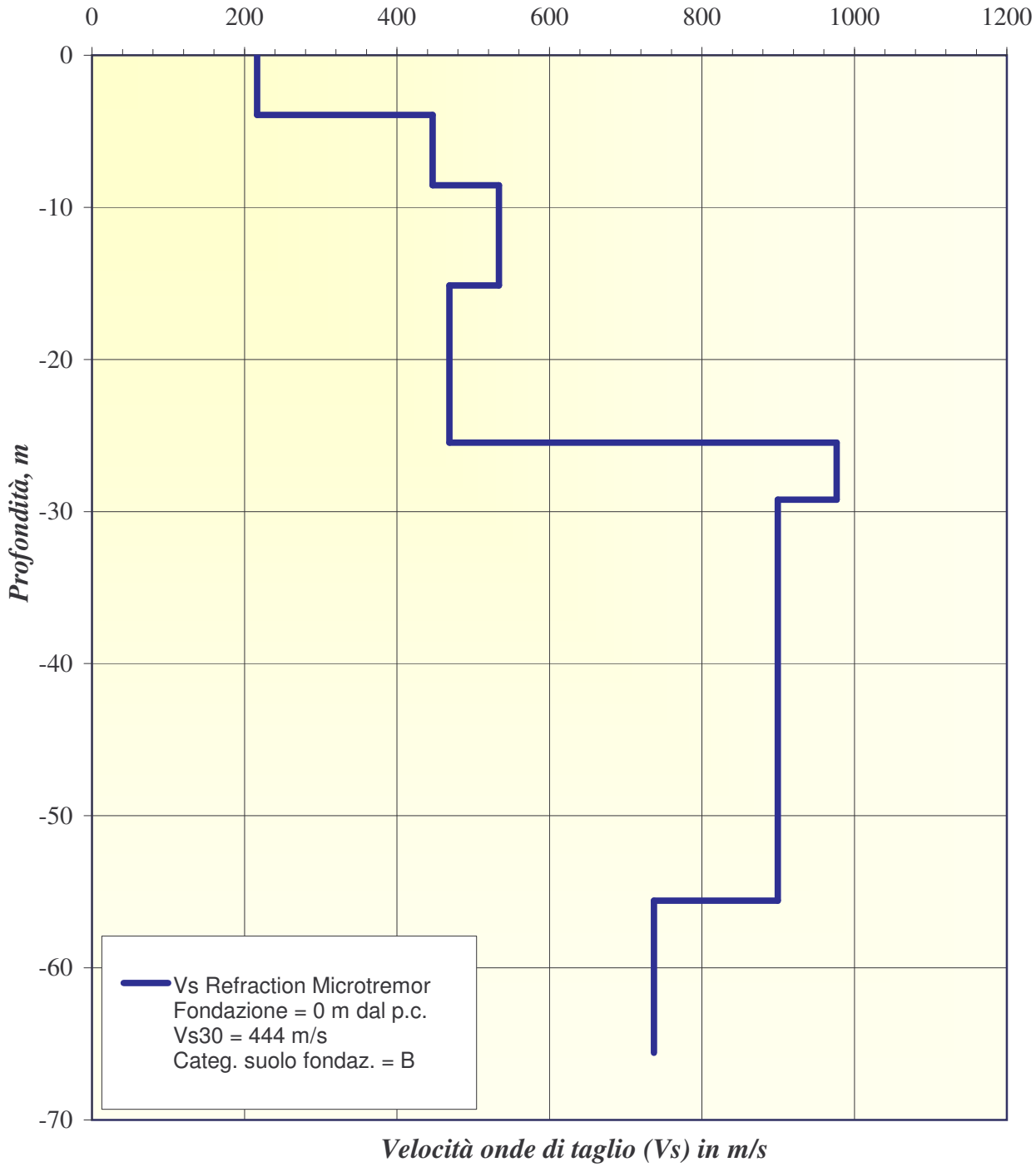


grafico slowness/frequenza

Serravalle ReMi 2

Vertical Seismic Profile delle Vs (calcolato con ReMi)



Curva di dispersione

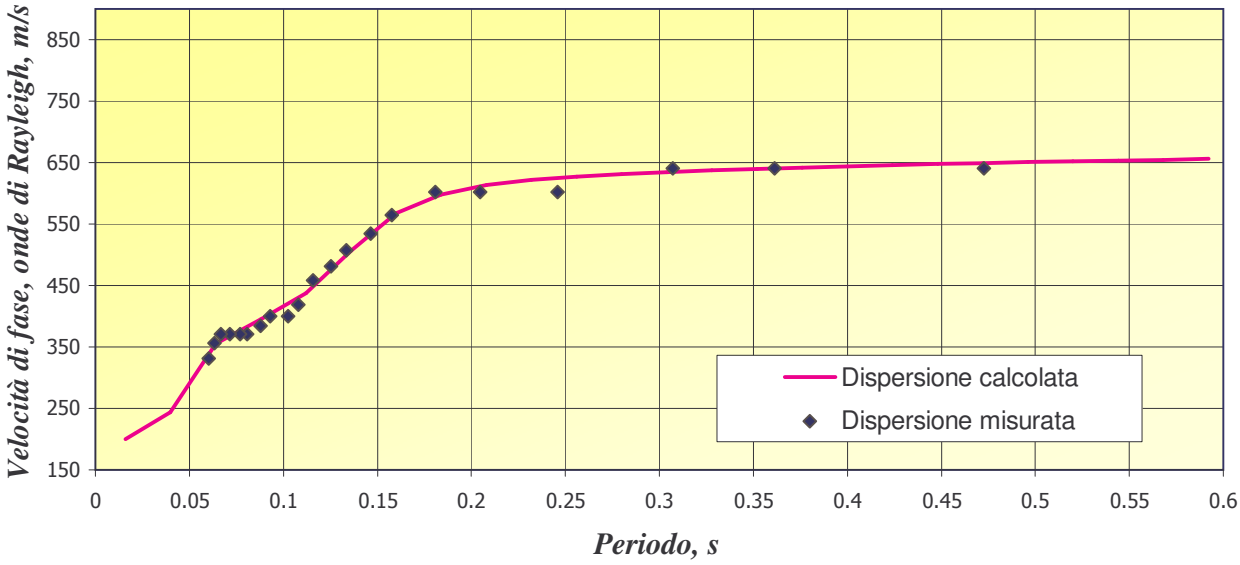


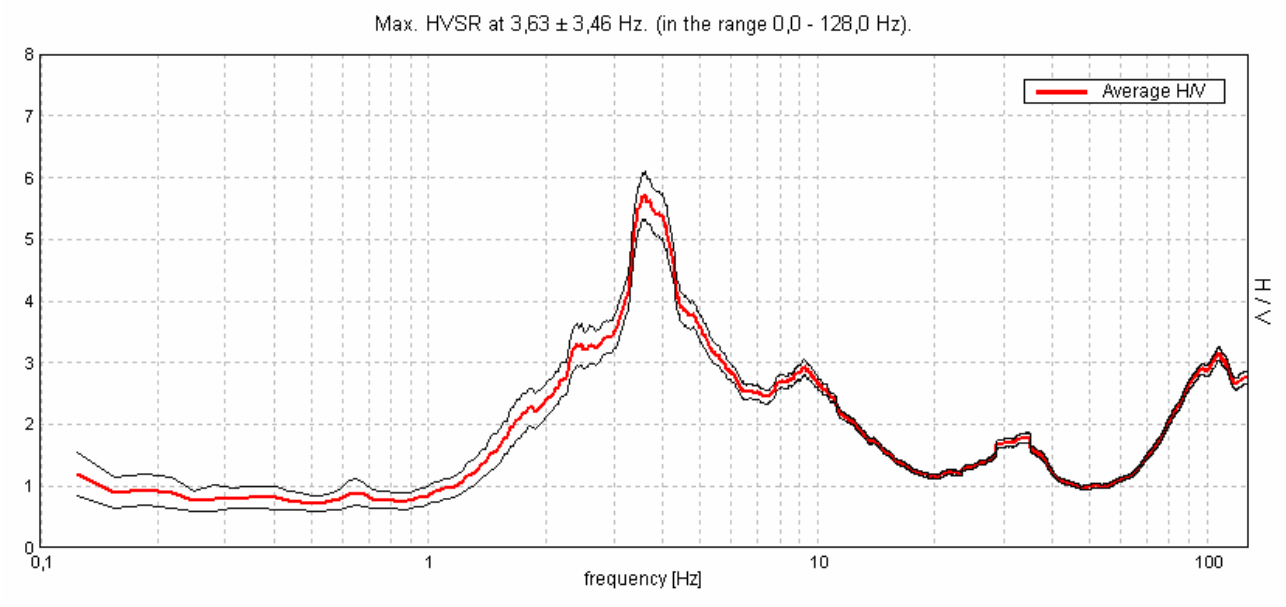
grafico slowness/frequenza

SERRAVALLE, 1

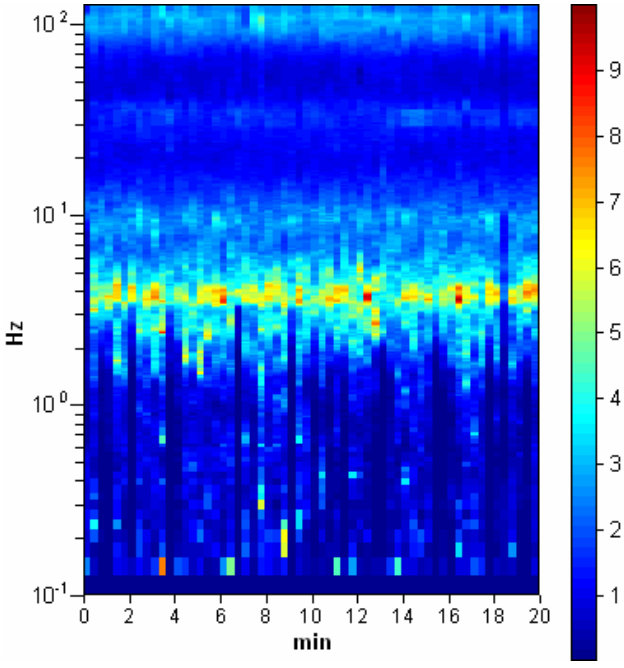
Start recording: 14/11/07 10:24:09 End recording: 14/11/07 10:44:10
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

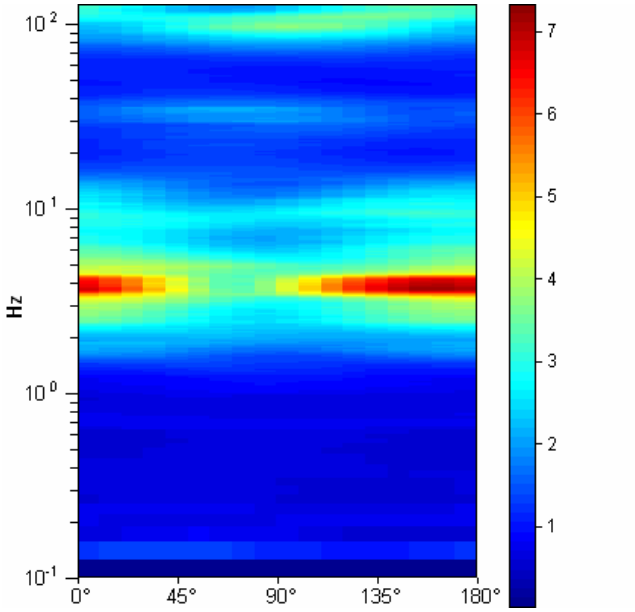
HORIZONTAL TO VERTICAL SPECTRAL RATIO



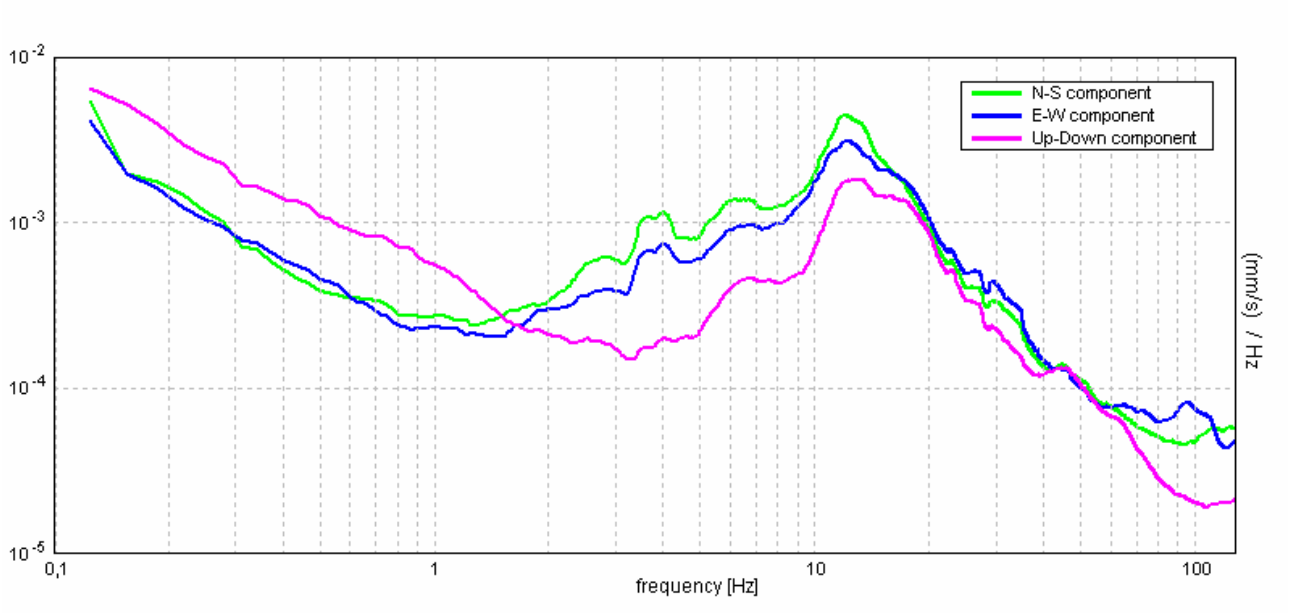
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,63 ± 3,46 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,63 > 0,50	OK	
$n_c(f_0) > 200$	4350,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 175 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2,281 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5,969 Hz	OK	
$A_0 > 2$	5,72 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,47242| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	1,71254 < 0,18125		NO
$\sigma_A(f_0) < \theta(f_0)$	0,1951 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

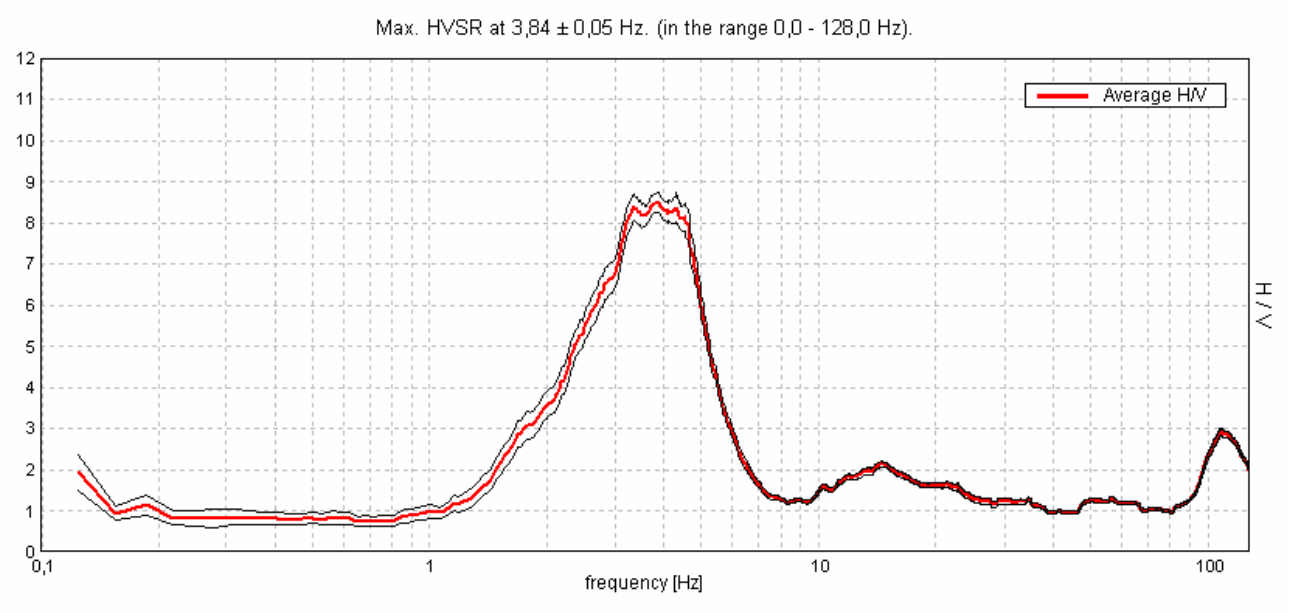
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

SERRAVALLE, 2

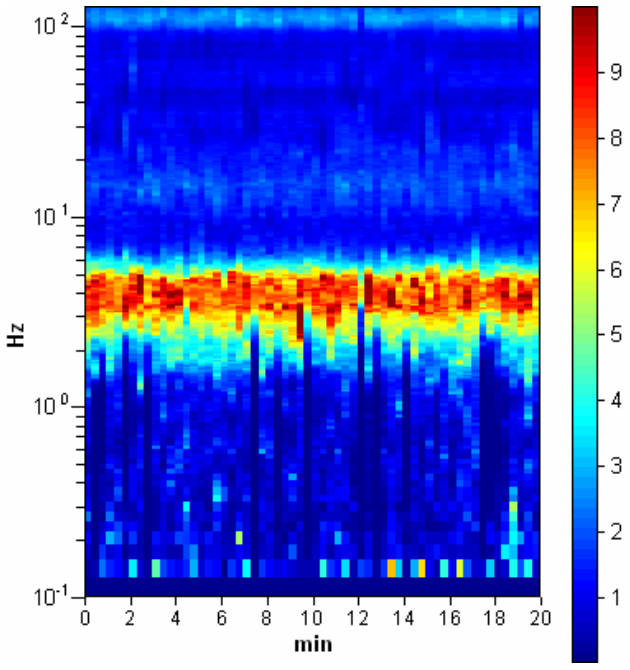
Start recording: 14/11/07 10:49:03 End recording: 14/11/07 11:09:04
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

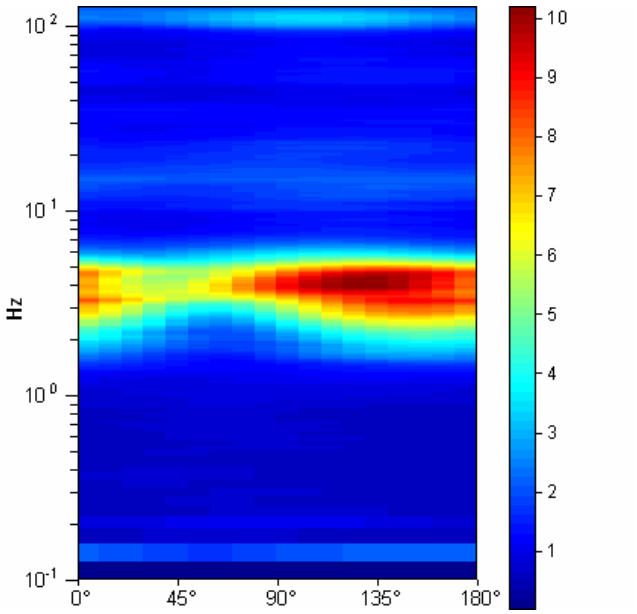
HORIZONTAL TO VERTICAL SPECTRAL RATIO



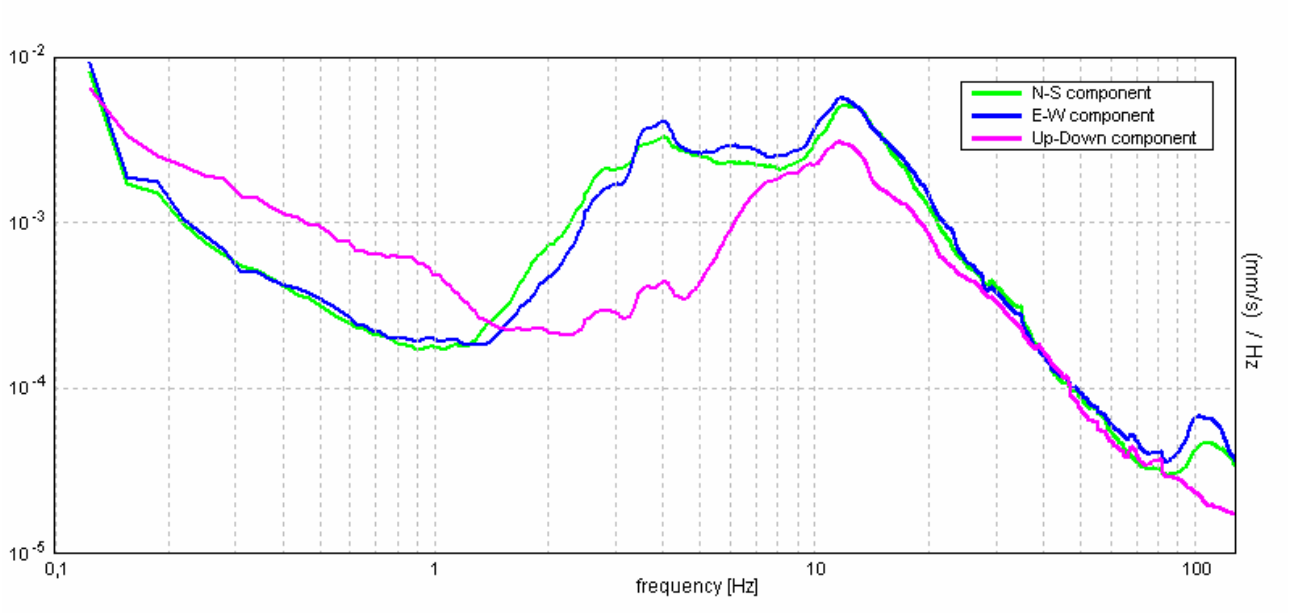
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,84 ± 0,05 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,84 > 0,50	OK	
$n_c(f_0) > 200$	4612,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 186 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2,219 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5,5 Hz	OK	
$A_0 > 2$	8,49 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00625| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,02402 < 0,19219	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,117 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

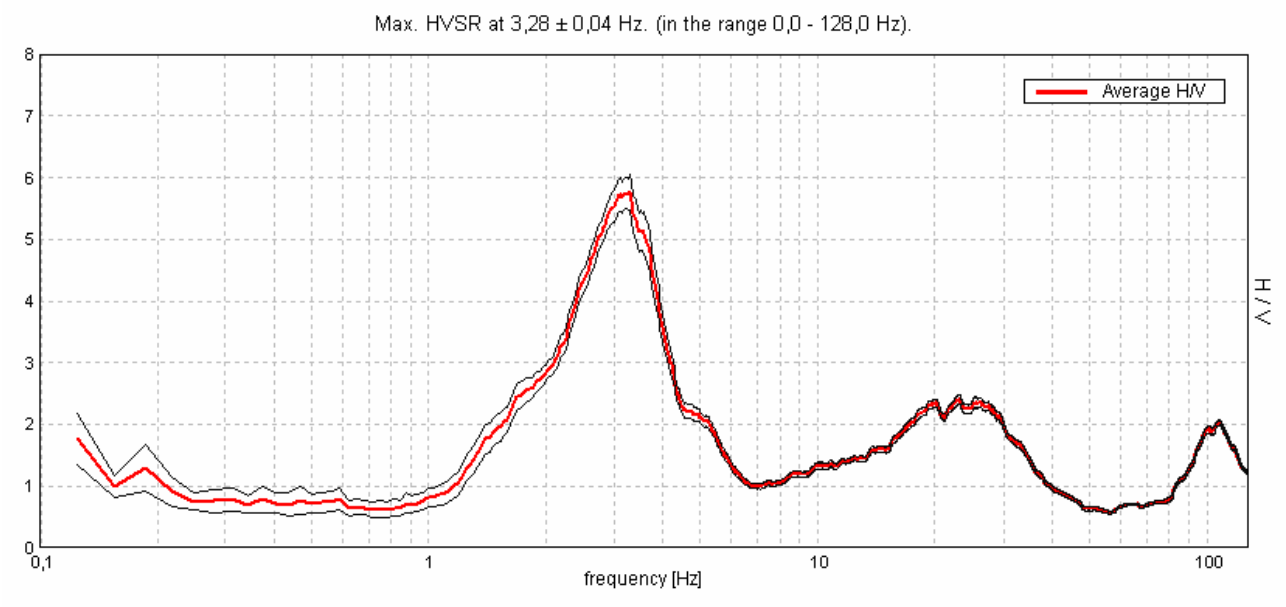
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

SERRAVALLE, H/V n° 2

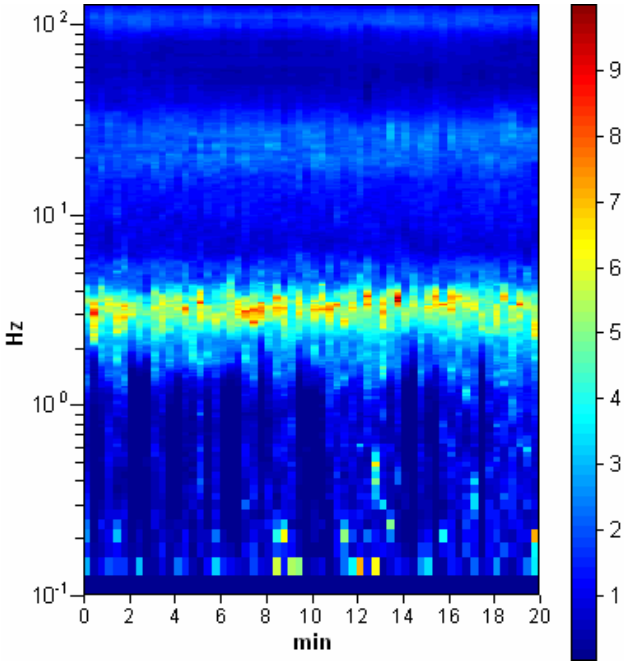
Start recording: 14/11/07 11:13:38 End recording: 14/11/07 11:33:38
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

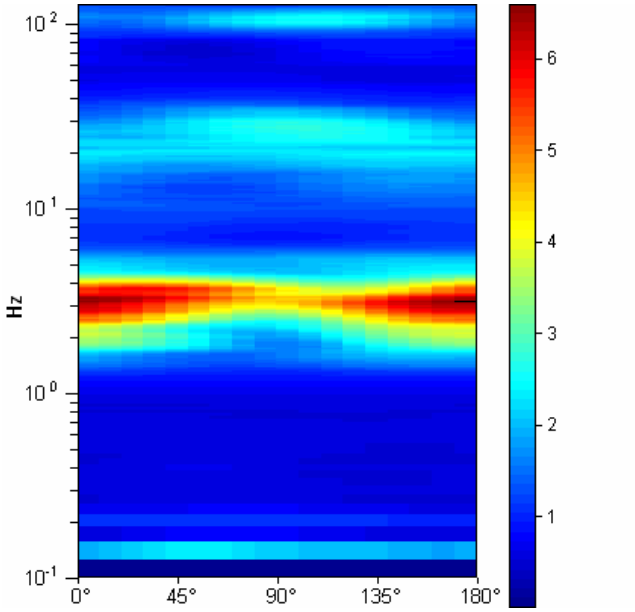
HORIZONTAL TO VERTICAL SPECTRAL RATIO



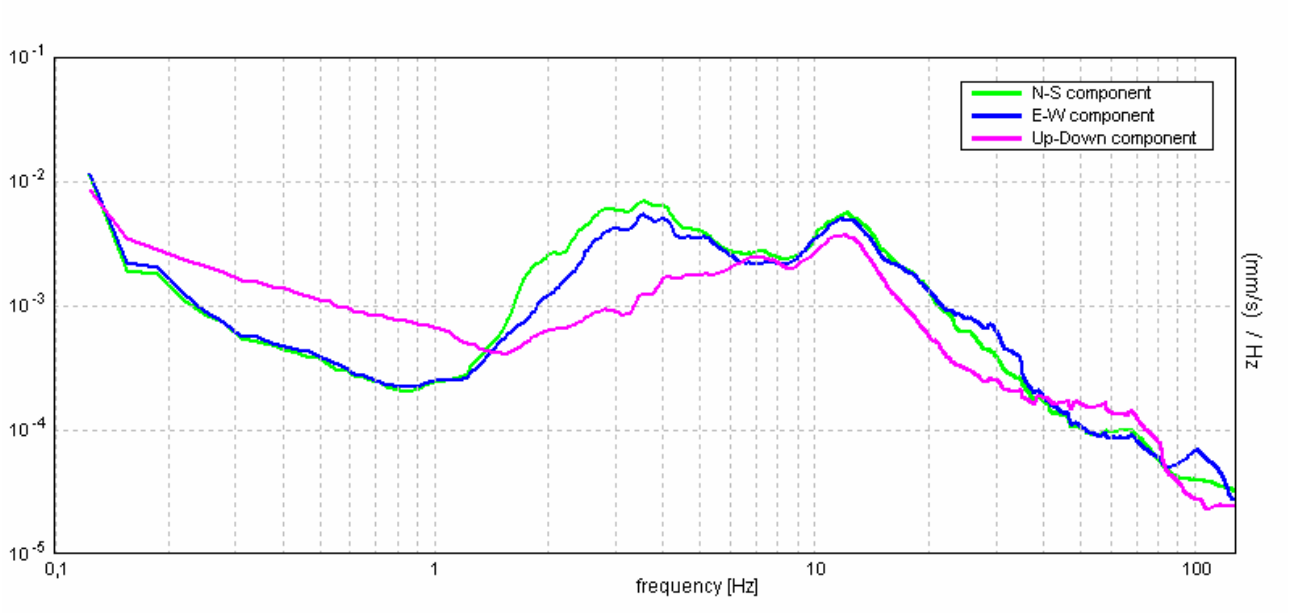
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,28 ± 0,04 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,28 > 0,50	OK	
$n_c(f_0) > 200$	3937,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 158 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	2,0 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4,25 Hz	OK	
$A_0 > 2$	5,77 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00663| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,02176 < 0,16406	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1416 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

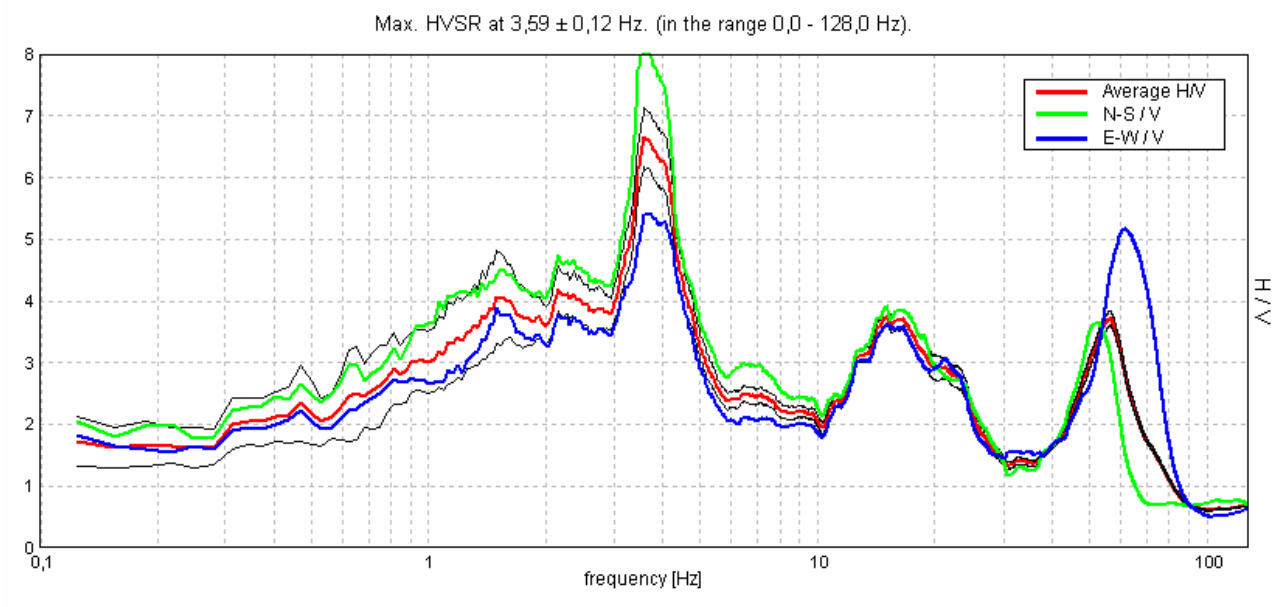
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

SERRAVALLE, H/V n°3

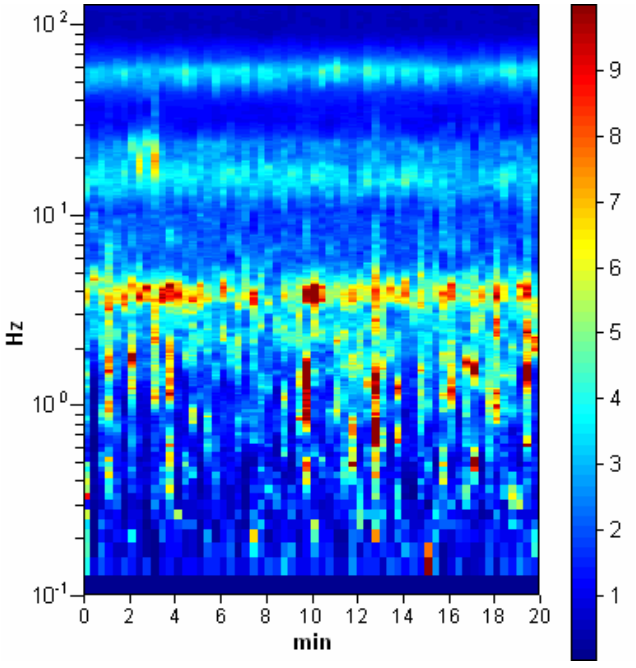
Start recording: 14/11/07 11:54:32 End recording: 14/11/07 12:14:33
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

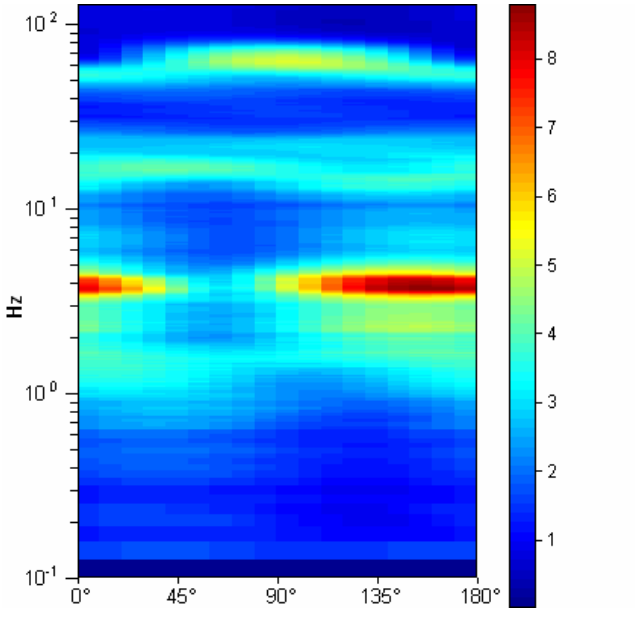
HORIZONTAL TO VERTICAL SPECTRAL RATIO



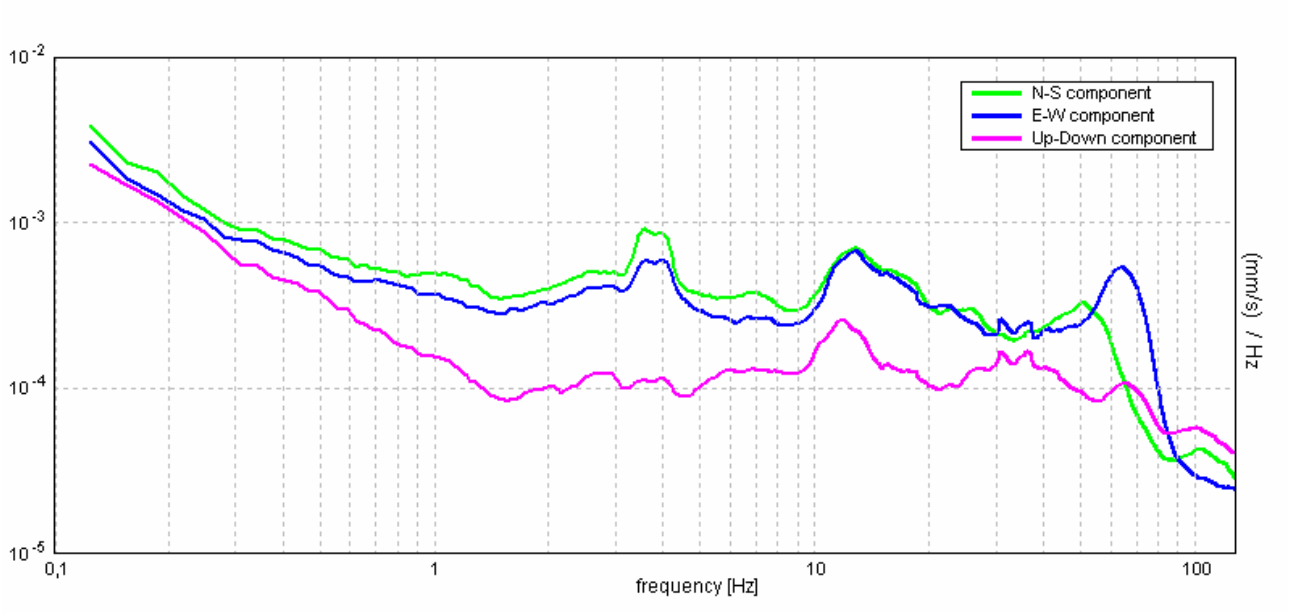
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,59 ± 0,12 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,59 > 0,50	OK	
$n_c(f_0) > 200$	4312,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 174 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,156 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4,969 Hz	OK	
$A_0 > 2$	6,65 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,01639| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,0589 < 0,17969	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,2363 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

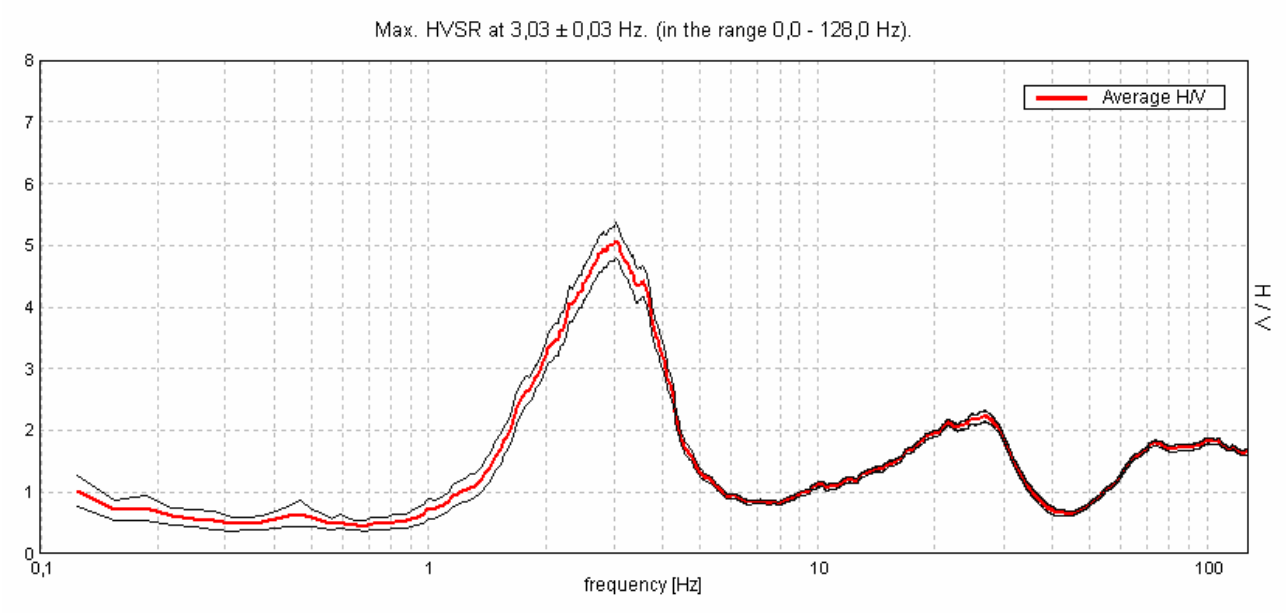
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

SERRAVALLE, H/V n° 4

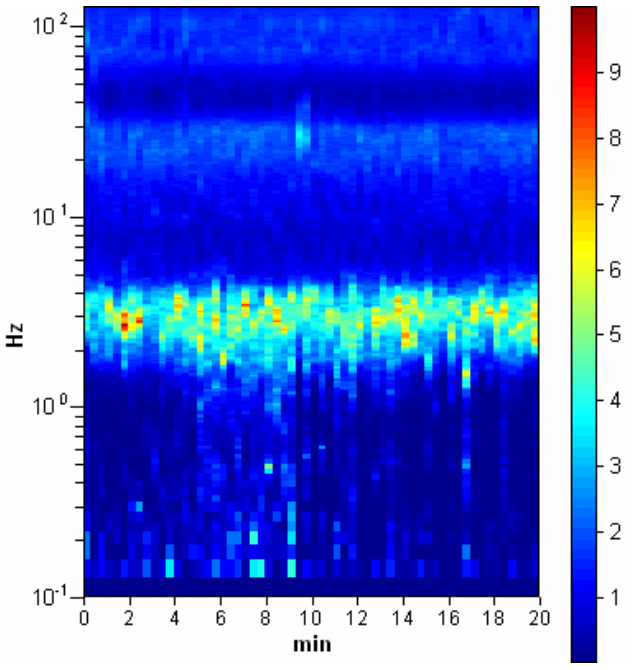
Start recording: 14/11/07 12:22:51 End recording: 14/11/07 12:42:52
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

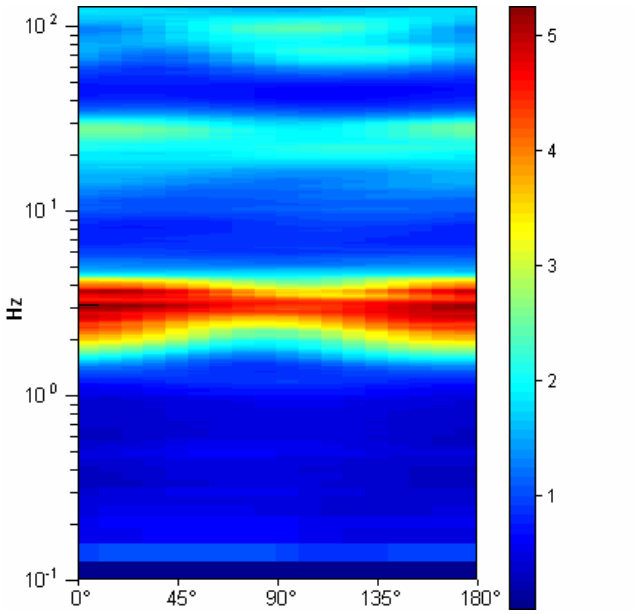
HORIZONTAL TO VERTICAL SPECTRAL RATIO



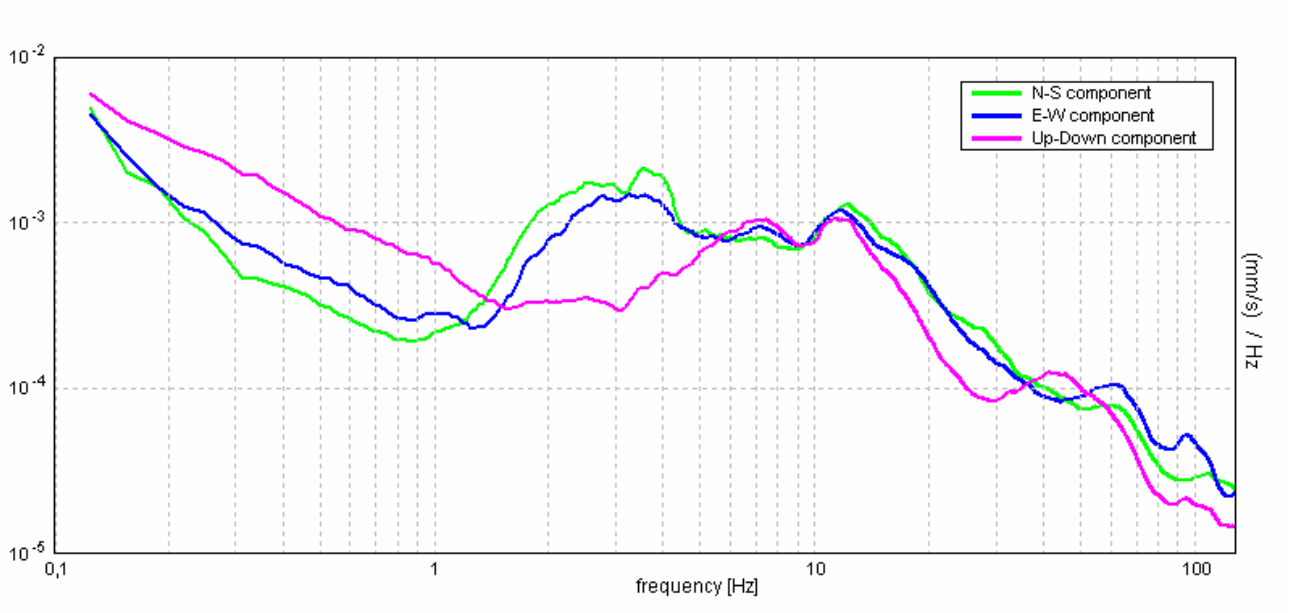
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 3,03 ± 0,03 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	3,03 > 0,50	OK	
$n_c(f_0) > 200$	3637,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 146 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,719 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4,281 Hz	OK	
$A_0 > 2$	5,08 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00508| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,0154 < 0,15156	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,1407 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

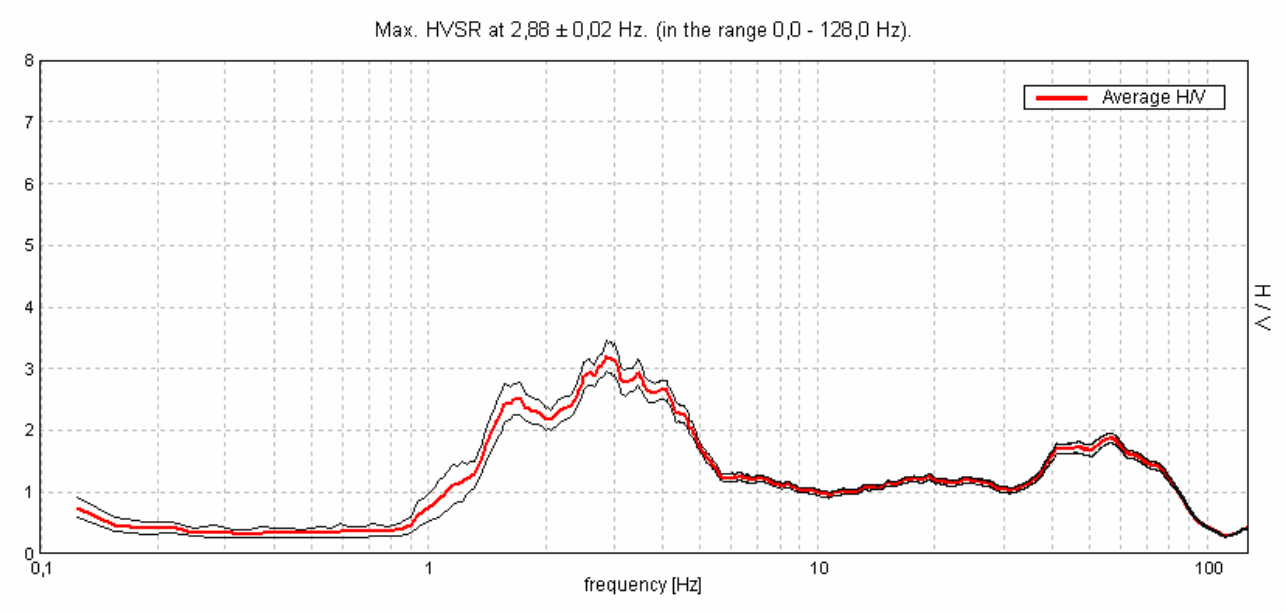
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

SERRAVALLE, H/V n°5

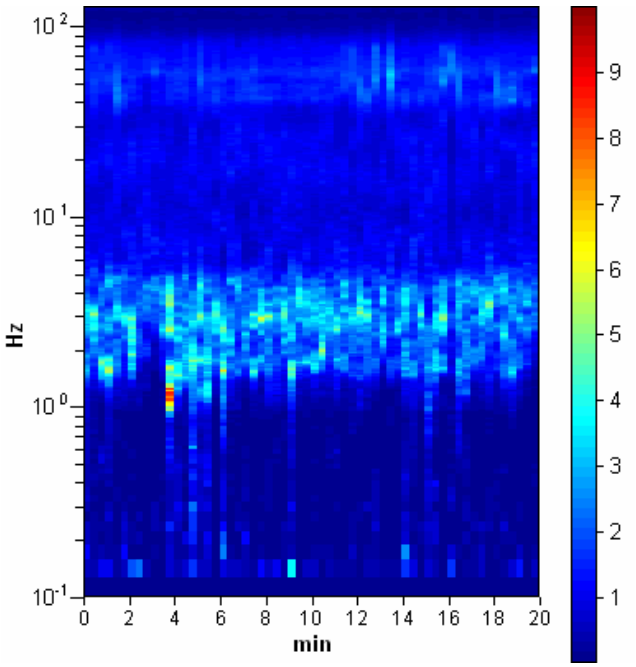
Start recording: 14/11/07 12:53:13 End recording: 14/11/07 13:13:14
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

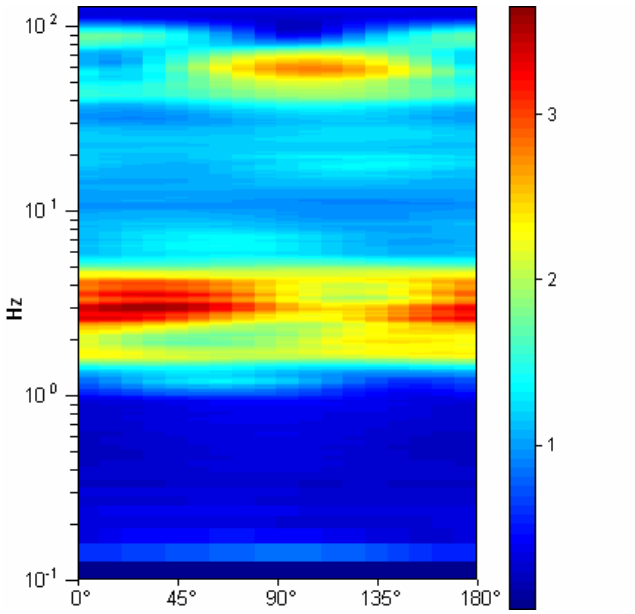
HORIZONTAL TO VERTICAL SPECTRAL RATIO



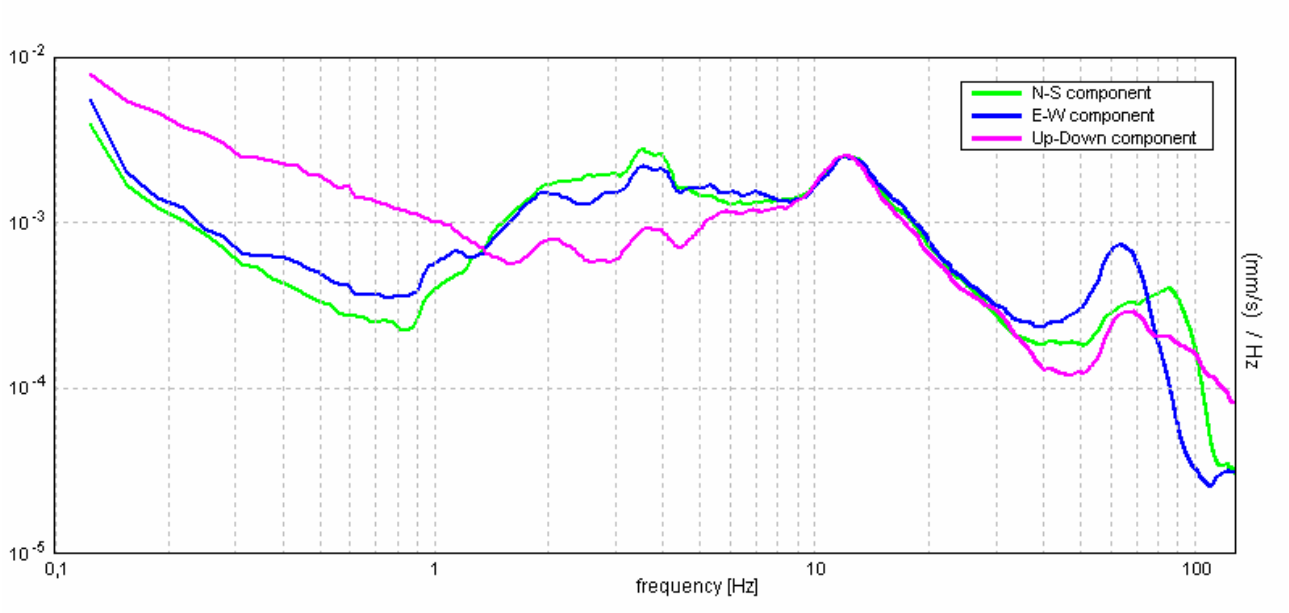
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,88 ± 0,02 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,88 > 0,50	OK	
$n_c(f_0) > 200$	3450,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 139 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,375 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5,156 Hz	OK	
$A_0 > 2$	3,21 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00281| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,00809 < 0,14375	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,12 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

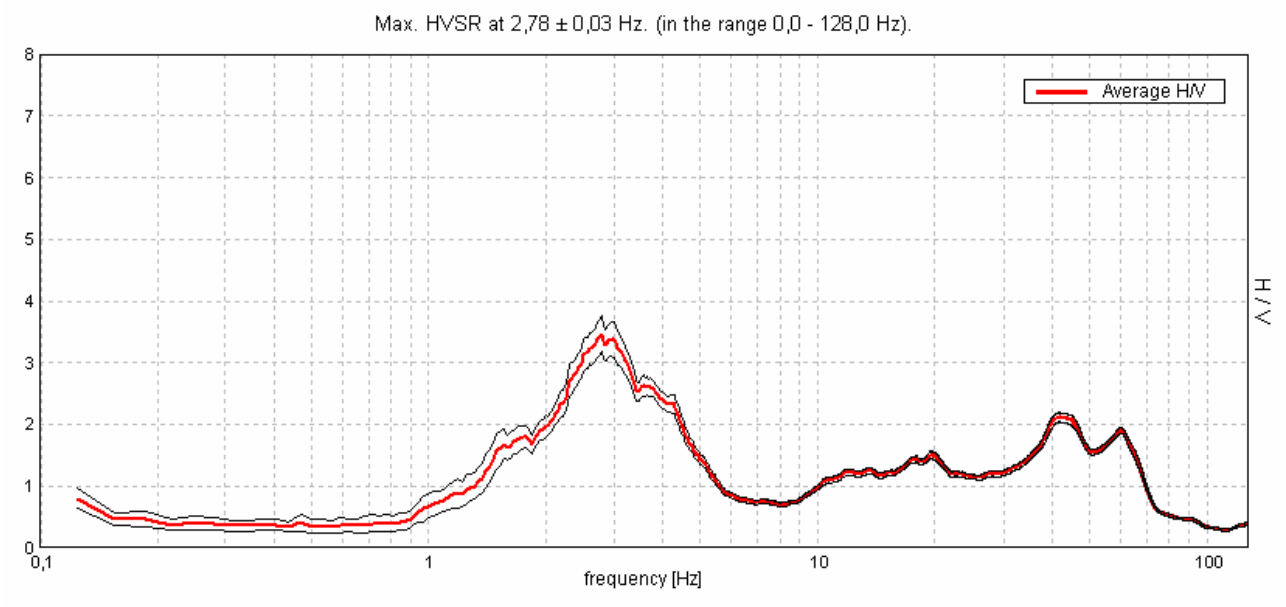
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

SERRAVALLE, H/V n°6

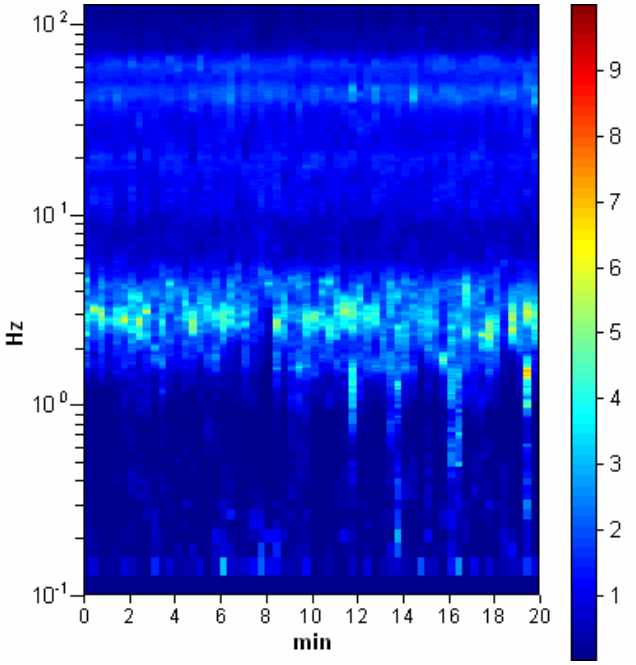
Start recording: 14/11/07 13:26:24 End recording: 14/11/07 13:46:25
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

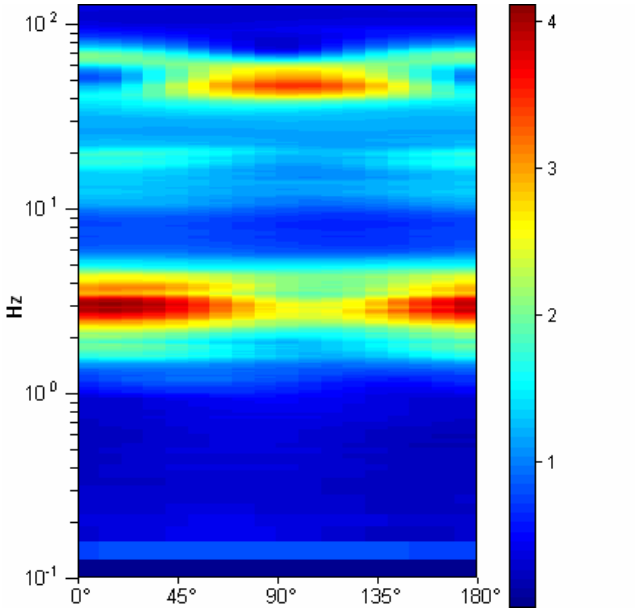
HORIZONTAL TO VERTICAL SPECTRAL RATIO



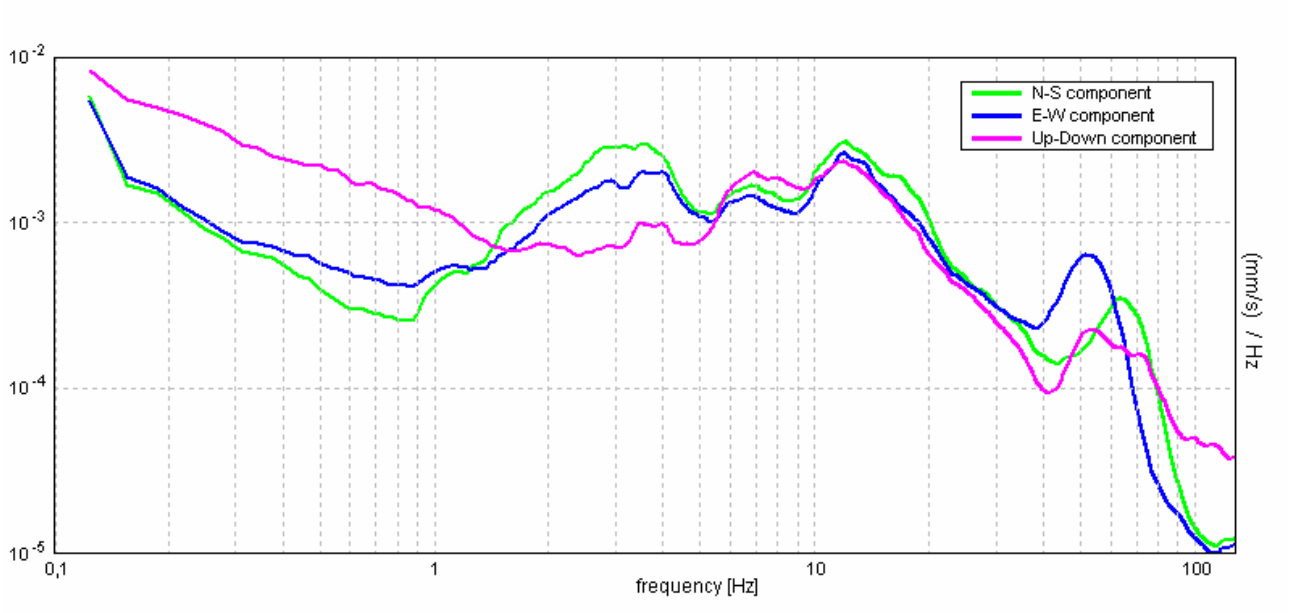
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 2,78 ± 0,03 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2,78 > 0,50	OK	
$n_c(f_0) > 200$	3337,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 134 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	1,844 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	4,688 Hz	OK	
$A_0 > 2$	3,47 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00465| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,01294 < 0,13906	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,147 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

5 – Area Dietrobeseno

Un altro sito d'indagine speditiva è stato quello ubicato nella forra del rio Cavallo in corrispondenza della frazione di Dietrobeseno (vedi corografia generale fig. 10).

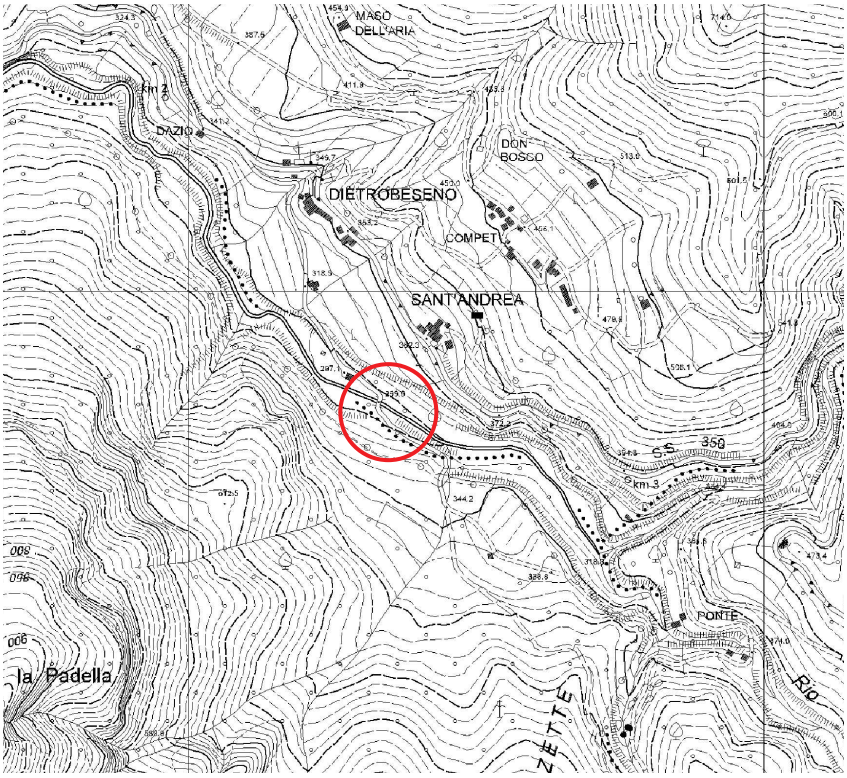


fig. 10 – Area d'indagine

Il fine di questa indagine preliminare era quella di acquisire alcune informazioni relativamente allo spessore della copertura alluvionale in alveo, ciò ai fini di valutare la possibilità che nella fase di realizzazione del cunicolo esplorativo, fossero intercettati terreni sciolti granulari.
Difficoltà legate all'accessibilità del sito hanno in questo momento impedito la realizzazione di un apposito sondaggio meccanico e pertanto in questa fase preliminare d'indagine, si è ritenuto sufficiente realizzare alcune indagini HVSR in alveo in corrispondenza del punto di previsto attraversamento da parte del tracciato ferroviario.
Nello specifico, come presentato nella figura seguente sono state realizzate tre indagini rispettivamente su ciascuna sponda (H/v n° 0 in dx, H/V n° 1 in sx) ed in prossimità del centro alveo (H/V n° 2).
I risultati acquisiti, riassunti nella tabella seguente mostrano una buona corrispondenza tra loro mostrando valori di frequenza compresi tra 14,4 e 20 Hz.

fig. 11 – Valori di frequenza rilevati

Allo stato attuale non è nota la velocità delle onde di taglio dei depositi alluvionali presenti nell'alveo del torrente e pertanto in questa fase è stata adottata la soluzione maggiormente cautelativa.
Si osserva infatti che il valore dello spessore presenta una relazione diretta con il del valore di velocità delle onde di taglio ed inversa con quello della frequenza di risonanza; pertanto l'ipotesi maggiormente cautelativa la si avrà ipotizzando una velocità Vs pari ad almeno 700 m/s ed un valore di frequenza di 14,4 Hz (HVSR 2).
Si ottiene un valore di spessore di circa 12 m che pertanto costituisce, cautelativamente, il massimo valore di spessore della copertura quaternaria ricavabile dai dati utilizzati.

Trento, gennaio 2008 dott. Andrea Franceschini

ALLEGATI

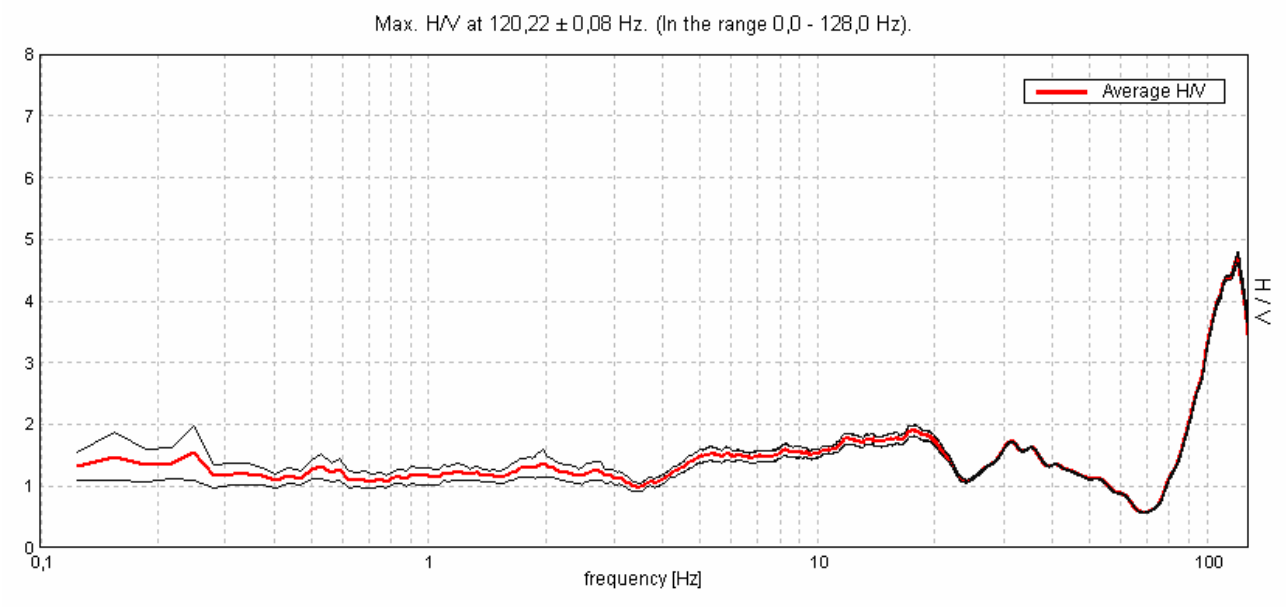
- elaborati indagini H/V

DIETROBESENO H/V n° 0

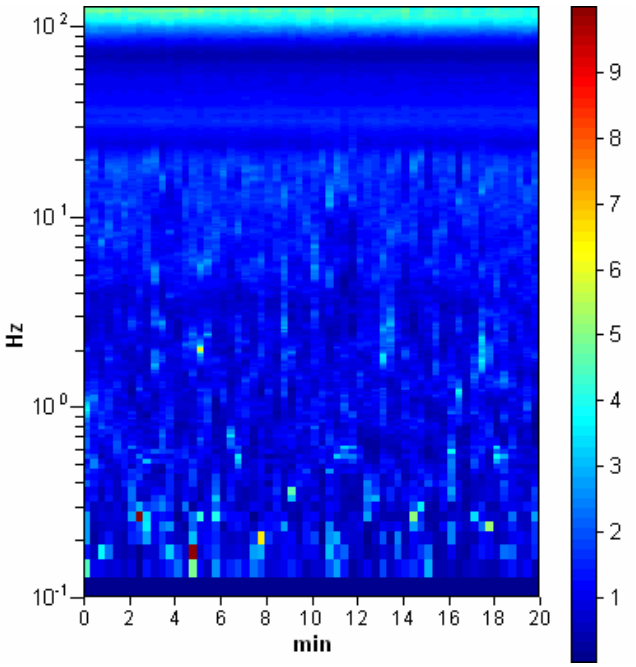
Start recording: 12/09/07 09:36:41 End recording: 12/09/07 09:56:42
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

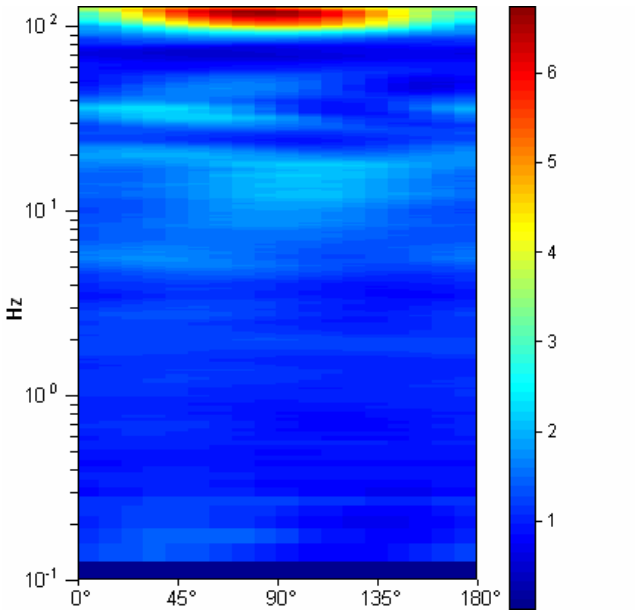
HORIZONTAL TO VERTICAL SPECTRAL RATIO



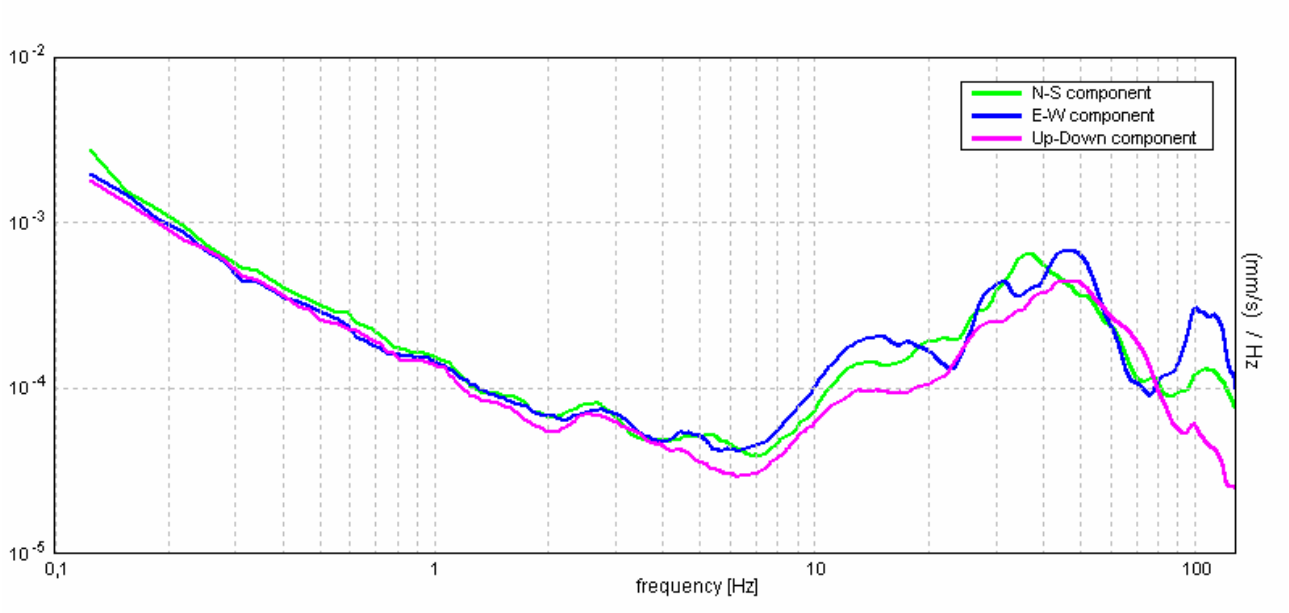
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 120,22 ± 0,08 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	120,22 > 0,50	OK	
$n_c(f_0) > 200$	144262,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 2174 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	92,719 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	4,70 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,00034| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,04145 < 6,01094	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,0387 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

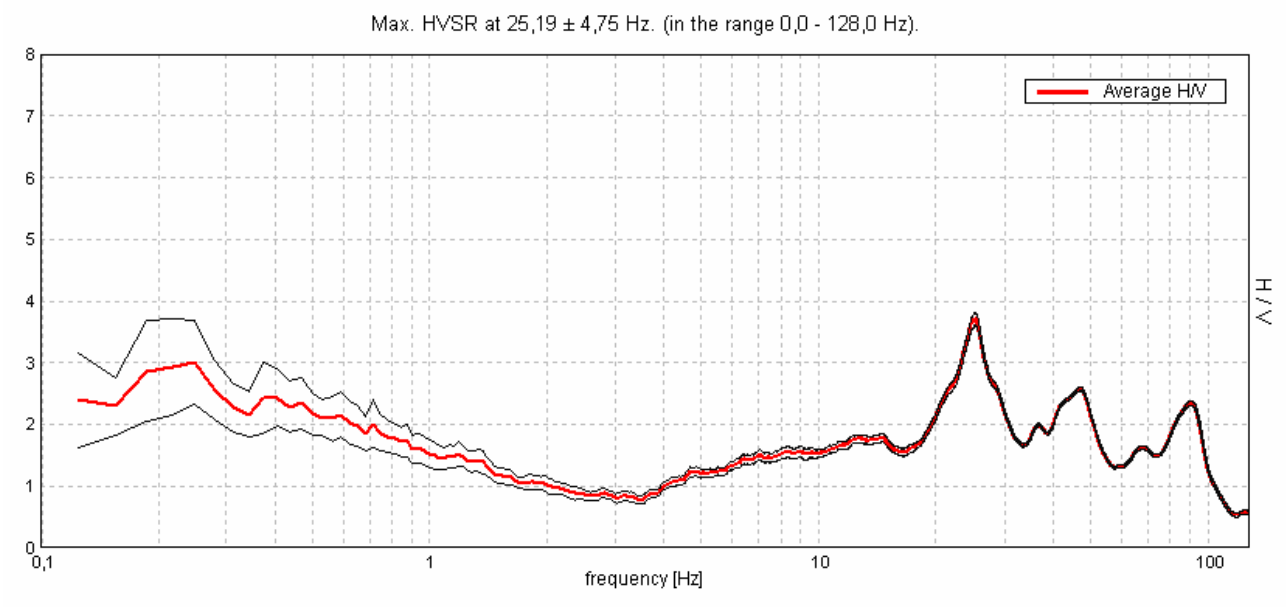
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

DIETROBESENO H/V n°1

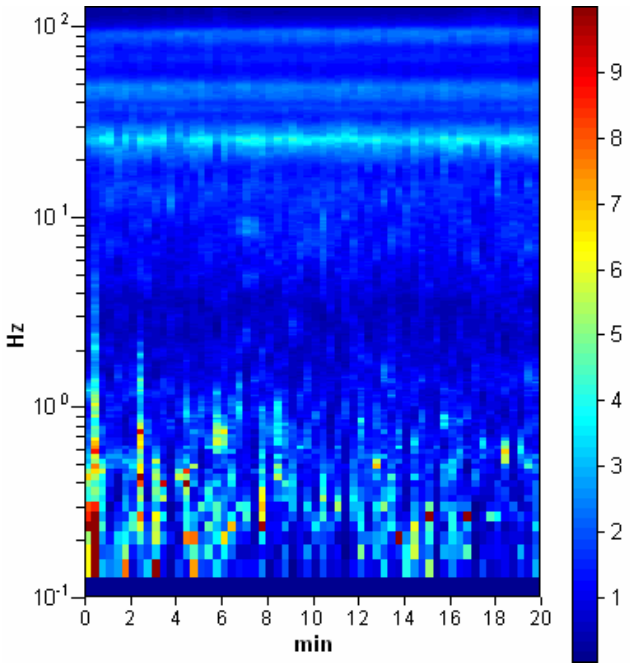
Start recording: 12/09/07 10:02:00 End recording: 12/09/07 10:22:01
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

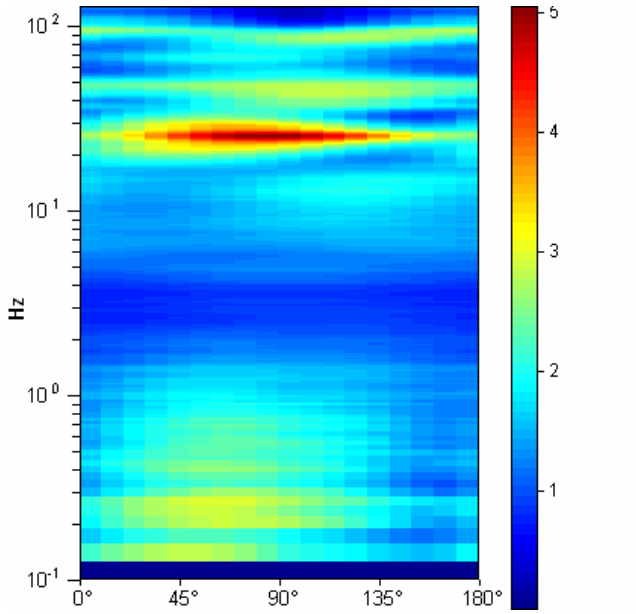
HORIZONTAL TO VERTICAL SPECTRAL RATIO



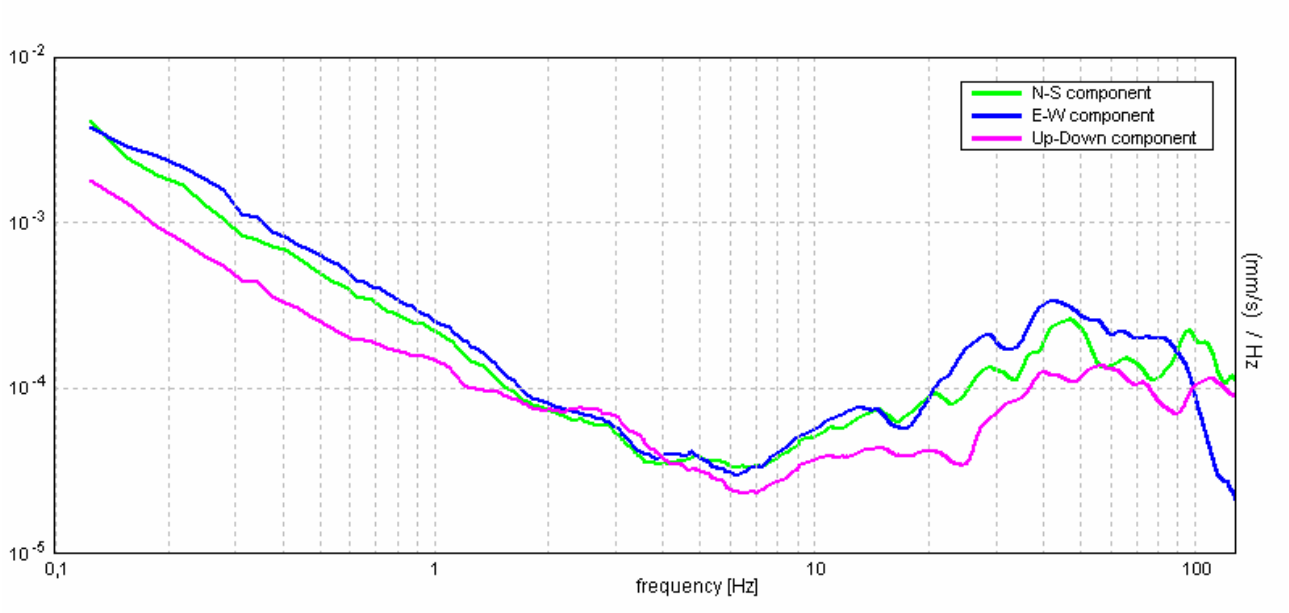
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 25,19 ± 4,75 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	25,19 > 0,50	OK	
$n_c(f_0) > 200$	30225,0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 1210 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	18,906 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	31,563 Hz	OK	
$A_0 > 2$	3,71 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,09351| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	2,35519 < 1,25938		NO
$\sigma_A(f_0) < \theta(f_0)$	0,0519 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

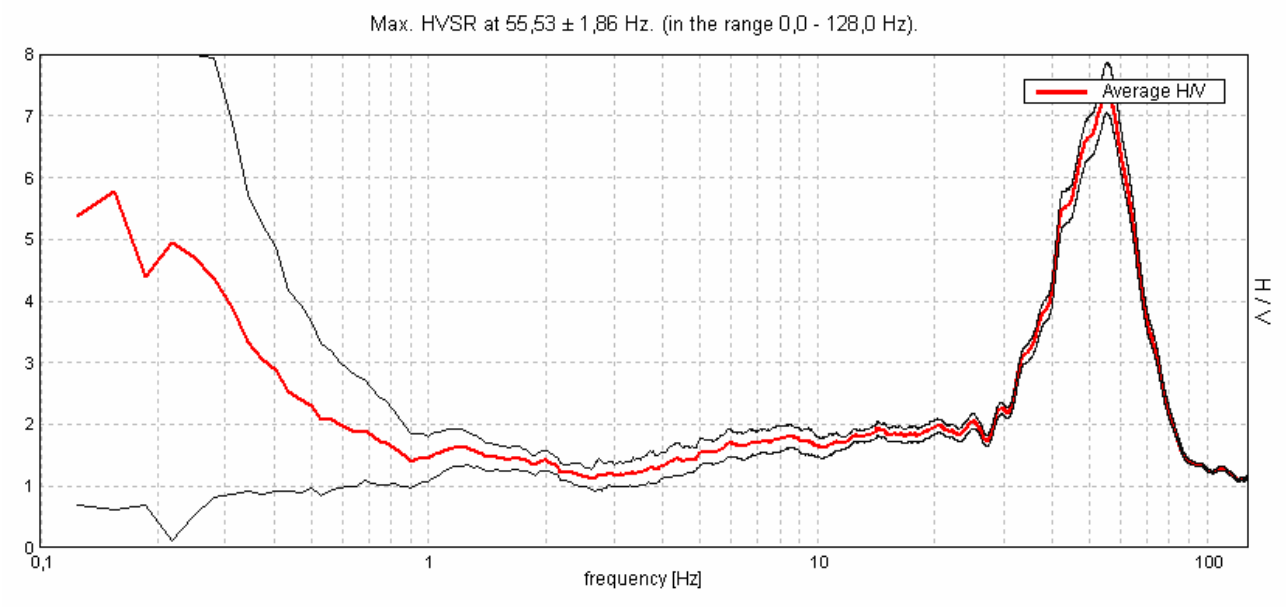
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

DIETROBESENO H/V n°2

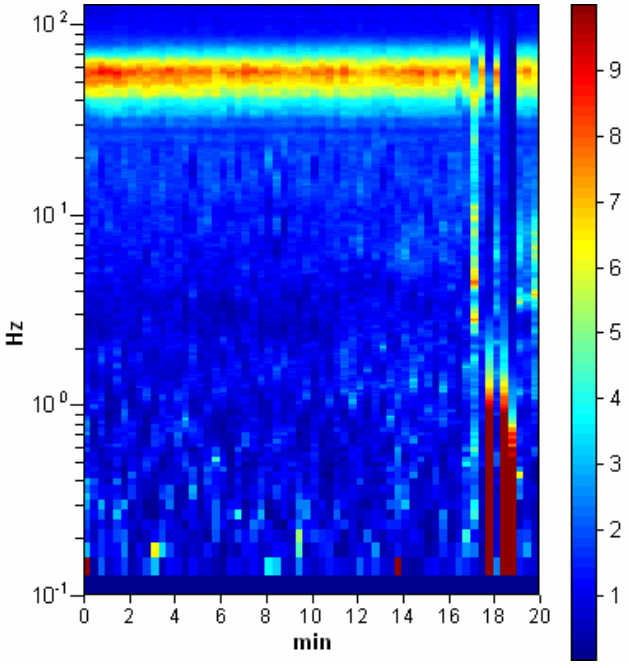
Start recording: 12/09/07 10:25:52 End recording: 12/09/07 10:45:53
GPS data not available

Trace length: 0h20'00". Analysis performed on the entire trace.
Sampling frequency: 256 Hz
Window size: 20 s
Smoothing window: Triangular window
Smoothing: 10%

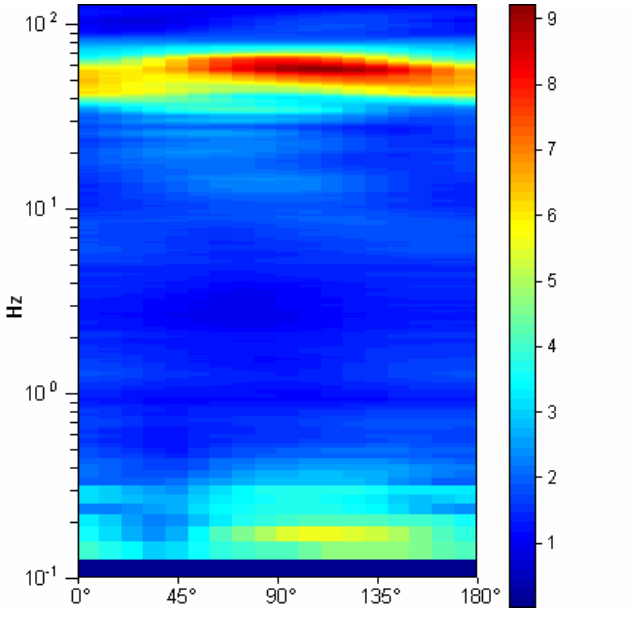
HORIZONTAL TO VERTICAL SPECTRAL RATIO



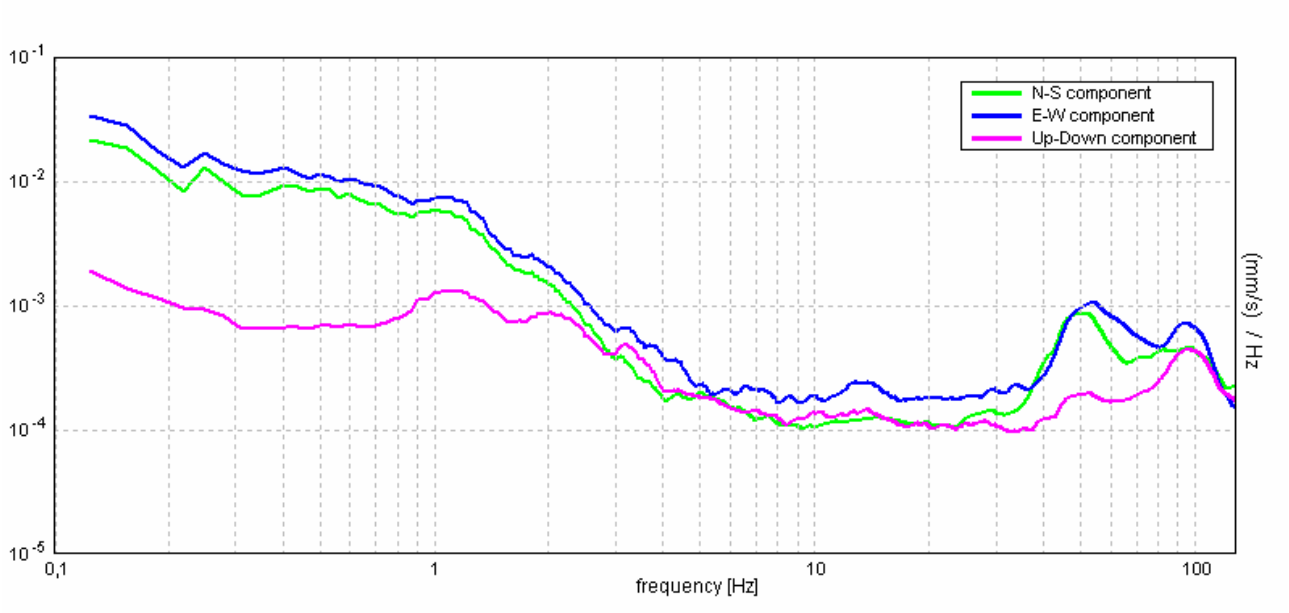
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



[According to the Sesame, 2005 guidelines. **Please read carefully the** *Grilla* **manual before interpreting the following tables**.]

Max. HVSR at 55,53 ± 1,86 Hz. (in the range 0,0 - 128,0 Hz).

Criteria for a reliable HVSR curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	55,53 > 0,50	OK	
$n_c(f_0) > 200$	66637,5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 2666 times	OK	
Criteria for a clear HVSR peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	37,531 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	69,906 Hz	OK	
$A_0 > 2$	7,46 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0,01664| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0,92411 < 2,77656	OK	
$\sigma_A(f_0) < \theta(f_0)$	0,2044 < 1,58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq.range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
Log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20