Comune di

Amatrice

Provincia di

Rieti

Descrizione

Stabilizzazione area in dissesto dell'opera denominata "Cornelle di Sotto"

Ordinanza di finanziamento: n. 56 del 14.05.2018
COD: DISS_M_009_2017

Fase: PROGETTO DI FATTIBILITÀ TECNICA ED ECONOMICA

Elaborato n°

3b

INDAGINI GEOGNOSTICHE PRELIMINARI

Oggetto

Elaborato

Data

marzo 2020

File

C592-P19050-RGEO_prel-F-R0001I

Revisioni

ID	*data*	*revisore*	*descrizione*

Committente

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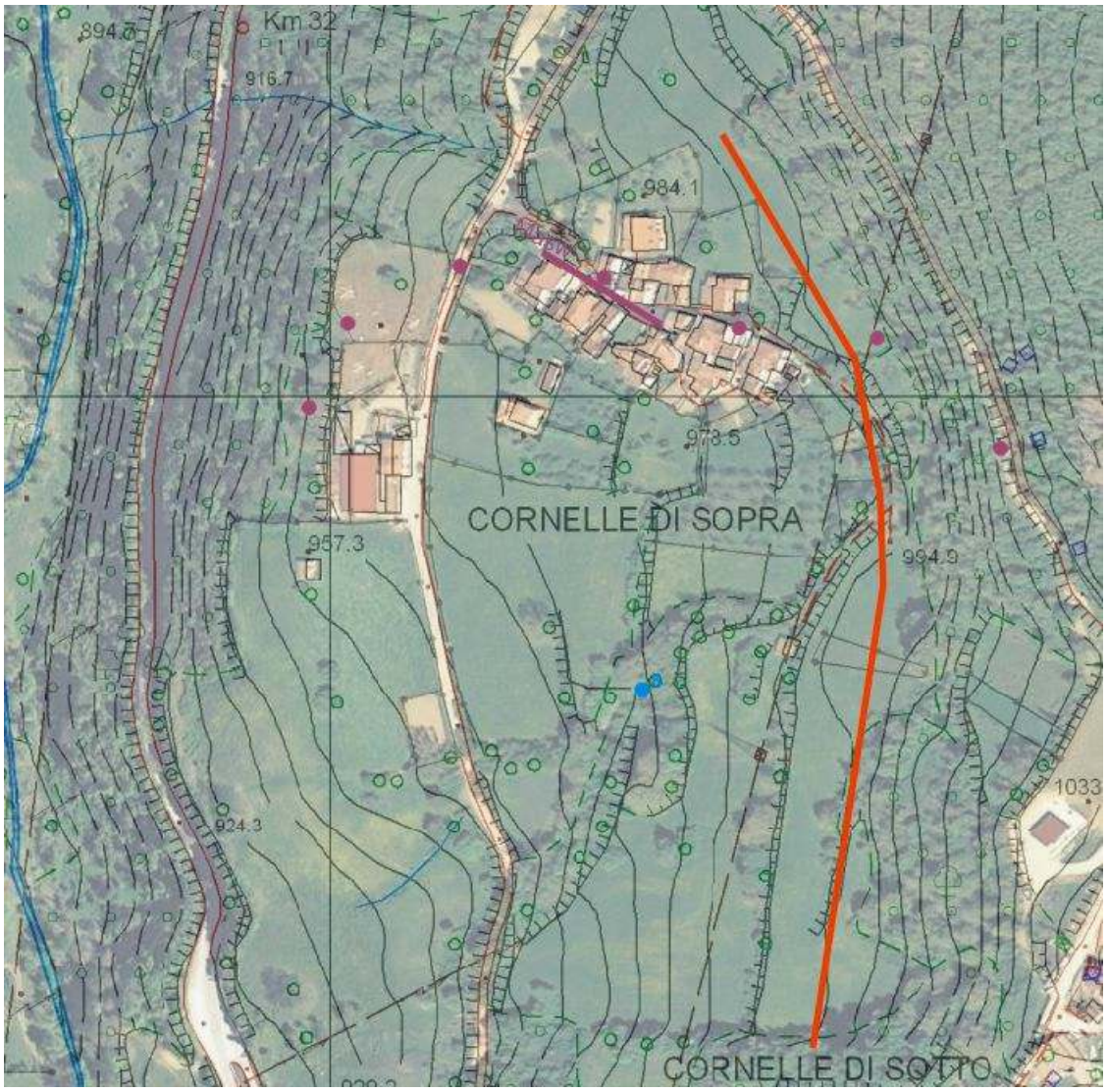
CORNELLE, AMATRICE (RI)

MASW CONGIUNTE HVSR PER INQUADRAMENTO PRELIMINARE



Linee viola masw

Punti viola hvsr

Linea rossa VLF

MASW in onde di Raylegh

Posizione Coordinate G1 direzione N75 WGS84 longitudine 13.293, , latitudine 42.674

I risultati di quanto acquisito sono riportati negli allegati alle pagine seguenti:

Tracce con caratteristiche dell'acquisizione e spettro di velocità

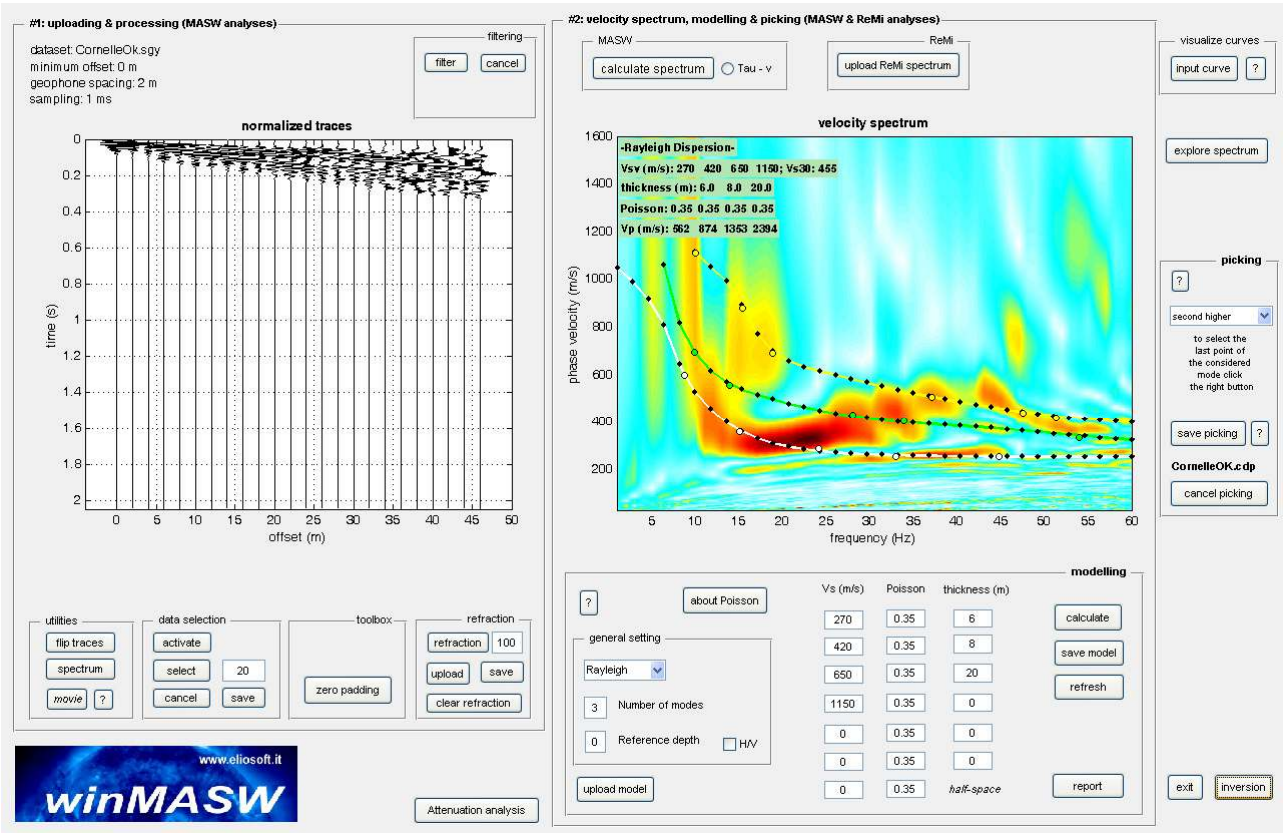
Curva di dispersione e profilo verticale

Modello del sottosuolo

MASW

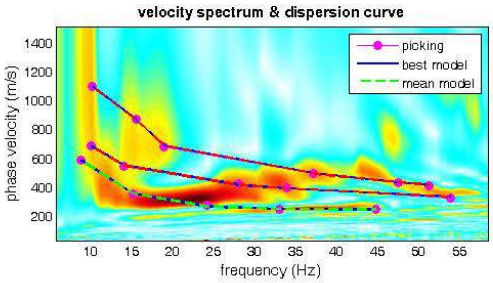
Tracce con caratteristiche dell'acquisizione e Spettro velocita'/frequenza

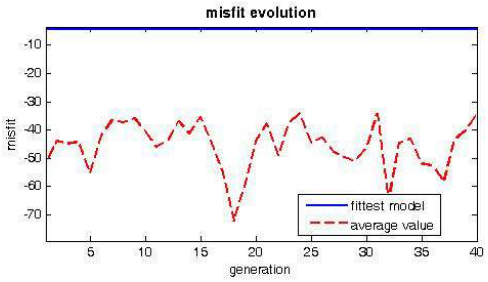
Dato filtrato

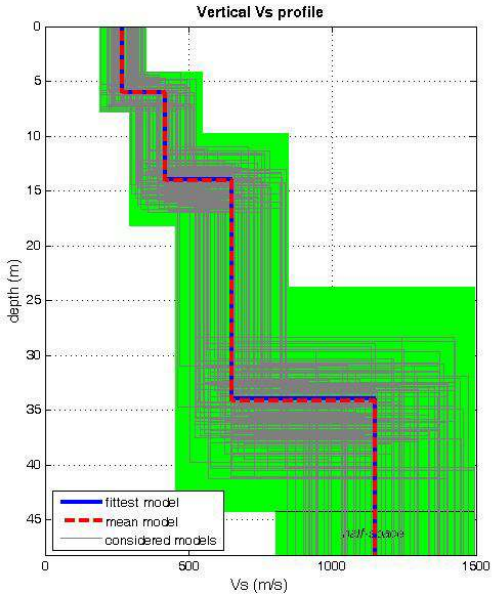


MASW

Curva di dispersione e modello del sottosuolo







dataset: CornelleOk.sgy
dispersion curve: CornelleOK.cdp
VS30 (best model): 455 m/s
VS30 (mean model): 455 m/s

Profilo verticale Vs

Vs (m/s)	density (gr/cm^3)	thickness (m)

MASW

Risultati
MEAN MODEL

Mean model
Vs (m/s): 270, 420, 650, 1150
Thickness (m): 6.0, 8.0, 20.1

Density (gr/cm3): 1.91, 2.02, 2.13, 2.24
Shear modulus (MPa): 139, 357, 901, 2965

Analysis: Rayleigh Waves

Approximate values for Vp and elastic moduli (please, see manual)

Vp (m/s): 559, 874, 1377, 2169
Poisson: 0.35, 0.35, 0.36, 0.30
Bulk modulus (MPa): 412, 1069, 2841, 6595
Young's modulus (MPa): 376, 963, 2444, 7737
Lamé (MPa): 319, 831, 2241, 4618

MASW

Omesso Best Model

INTRODUZIONE ALLA SISMICA PASSIVA

Sulla terra esistono dei rumori di fondo che alle basse frequenze possono ad esempio essere date onde del mare, mentre alle alte frequenze dai rumori antropici. Queste onde che si propagano soprattutto attraverso onde di volume diffuse che possono essere acquisite con dei geofoni e registrate da apposita strumentazione. Le onde di volume, che si propagano costantemente, vengono modificate dalle caratteristiche del sito che amplifica certi segnali invece di altri a seconda stratificazione, legata alle variazioni di impedenza sismica.

Effettuando i rapporti spettrali tra la componente orizzontale e quella verticale del rumore sismico di fondo, si ottengono dei picchi che la sperimentazione ha associato alle frequenze di risonanza dei siti.

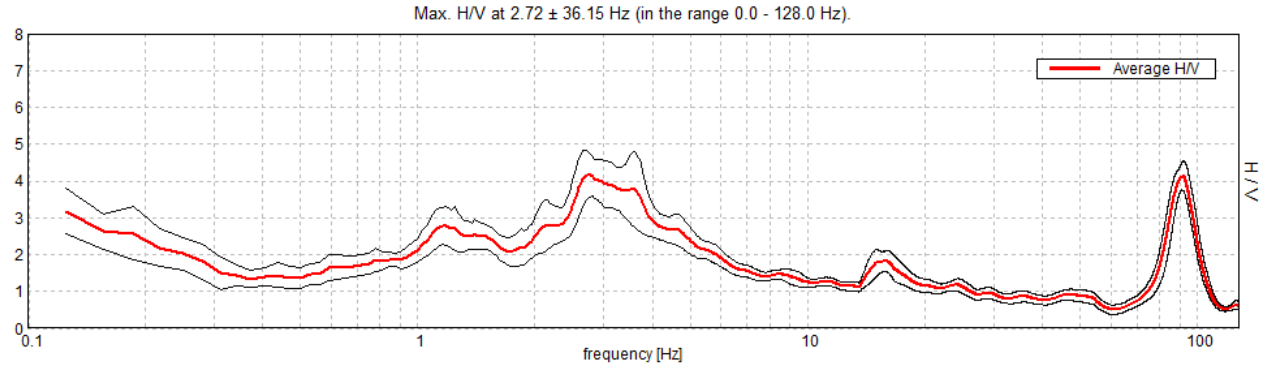
Un'analisi del segnale sismico "naturale" di questo tipo (HVSR), debitamente elaborato, può quindi dare indicazioni sulla profondità dei livelli a differente impedenza sismica, conoscendo la velocità dello onde S superficiali e dà indicazioni su quelle che sono le frequenze di risonanza del terreno. Quest'ultime possono essere importanti poiché le statistiche sui terremoti hanno visto che gli edifici che hanno la stessa frequenza di vibrazione della frequenza di risonanza del terreno si lesionano maggiormente rispetto ad altre costruzioni con caratteristiche differenti anche a parità di modalità costruttiva.

Dott. geol. Ferdinando Francia

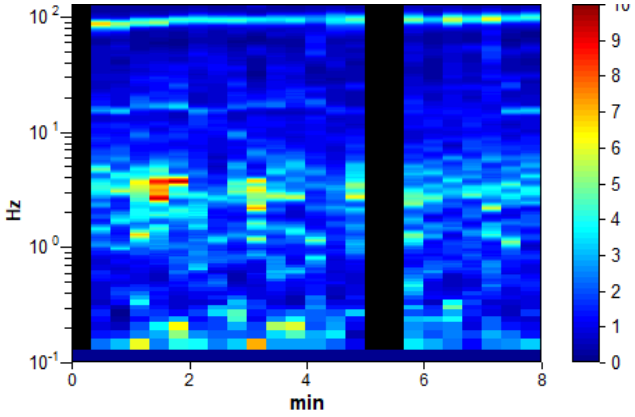
CORNELLEAMATRICE4, CASACENTRALE

Instrument: TE3-0400/02-18
Data format: 32 byte
Full scale [mV]: 51
Start recording: 04/09/19 14:46:33 End recording: 04/09/19 14:54:33
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN ; wless trig.
GPS data not available

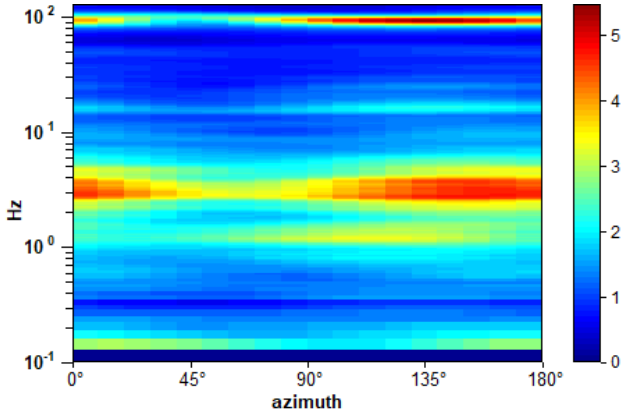
Trace length: 0h08'00''. Analyzed 88% trace (manual window selection)
Sampling rate: 256 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%



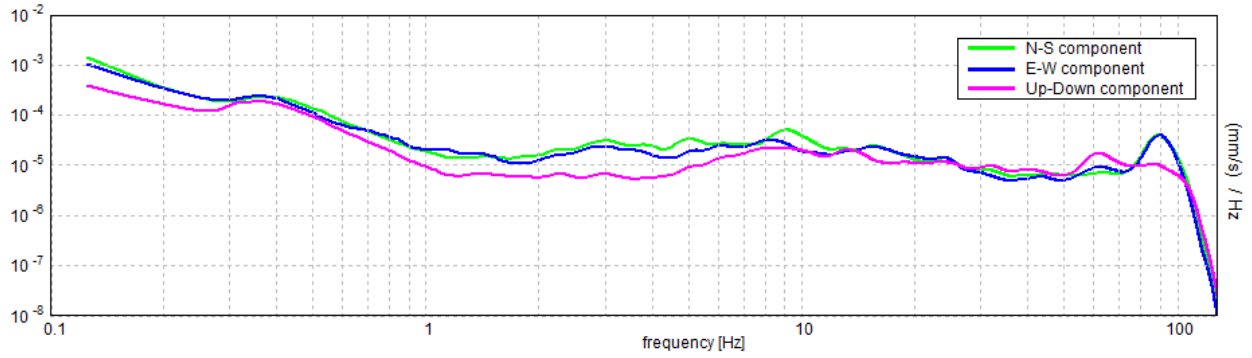
H/V TIME HISTORY



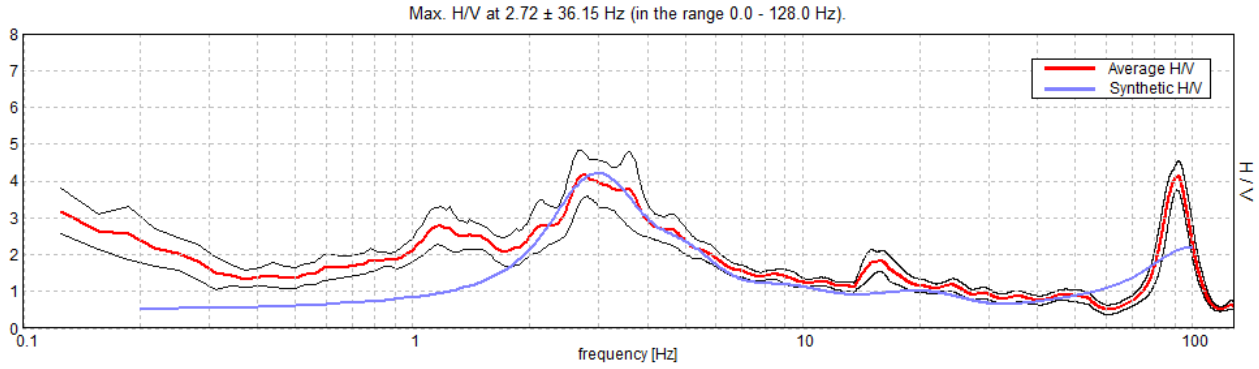
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

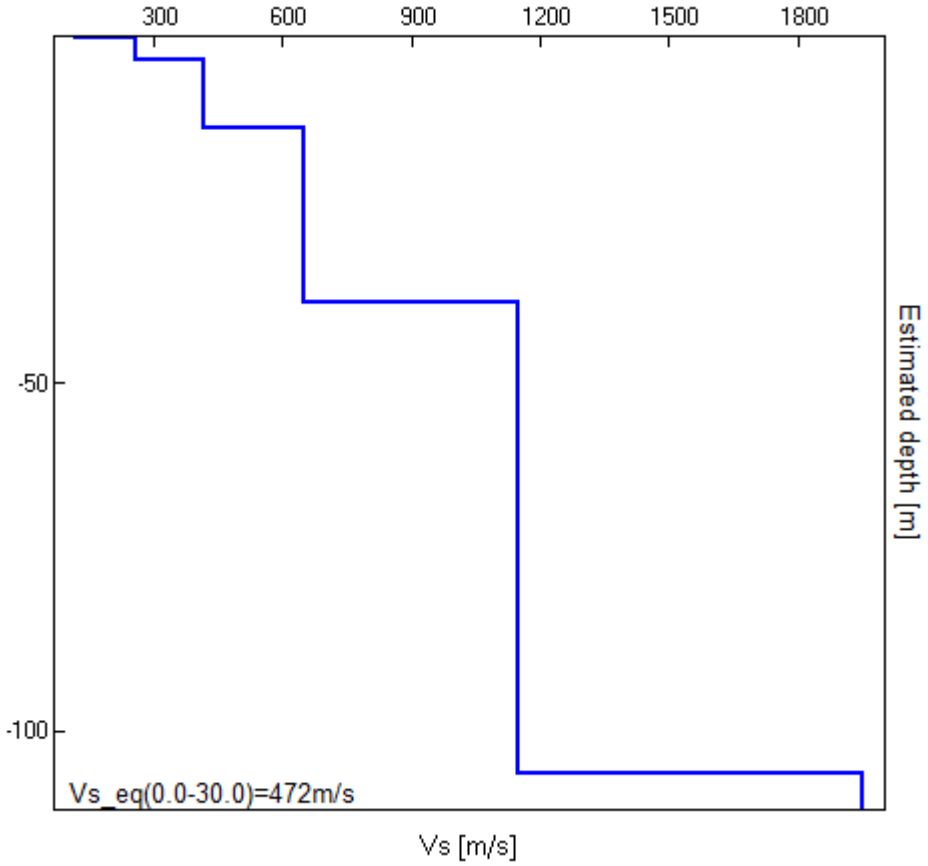


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
0.30	0.30	120	0.35
3.30	3.00	260	0.35
13.30	10.00	420	0.35
38.30	25.00	650	0.30
106.30	68.00	1150	0.30
inf.	inf.	1950	0.30

Vs_eq(0.0-0.0)=m/s



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

Max. H/V at 2.72 ± 36.15 Hz (in the range 0.0 - 128.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	2.72 > 0.50	OK	
$n_c(f_0) > 200$	1141.9 > 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 132 times	OK	
Criteria for a clear H/V 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 $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	5.656 Hz	OK	
$A_0 > 2$	4.16 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|13.29816| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	36.15438 < 0.13594		NO
$\sigma_A(f_0) < \theta(f_0)$	0.6615 < 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 $\sigma_A(f) < \theta(f_0)$

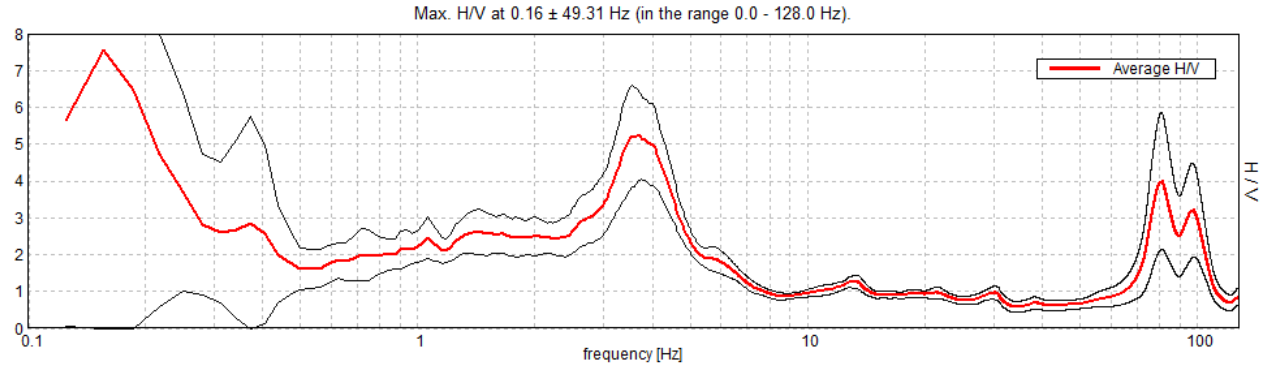
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CORNELLEAMATRICE5, CASAALTO

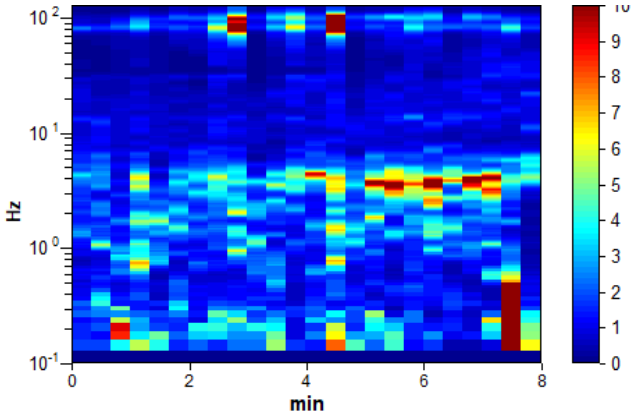
Instrument: TE3-0400/02-18
Data format: 32 byte
Full scale [mV]: 51
Start recording: 04/09/19 14:59:50 End recording: 04/09/19 15:07:50
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN ; wless trig.
GPS data not available

Trace length: 0h08'00". Analysis performed on the entire trace.
Sampling rate: 256 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

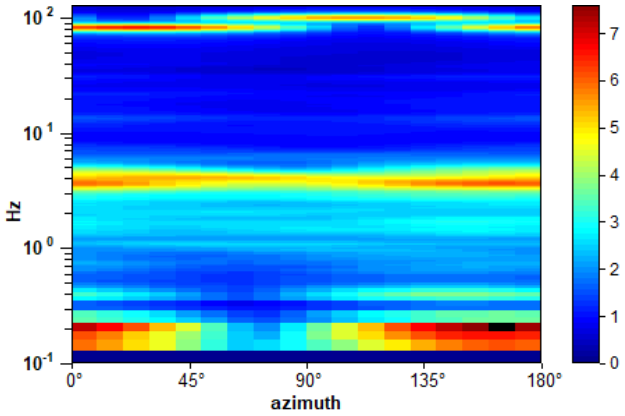
HORIZONTAL TO VERTICAL SPECTRAL RATIO



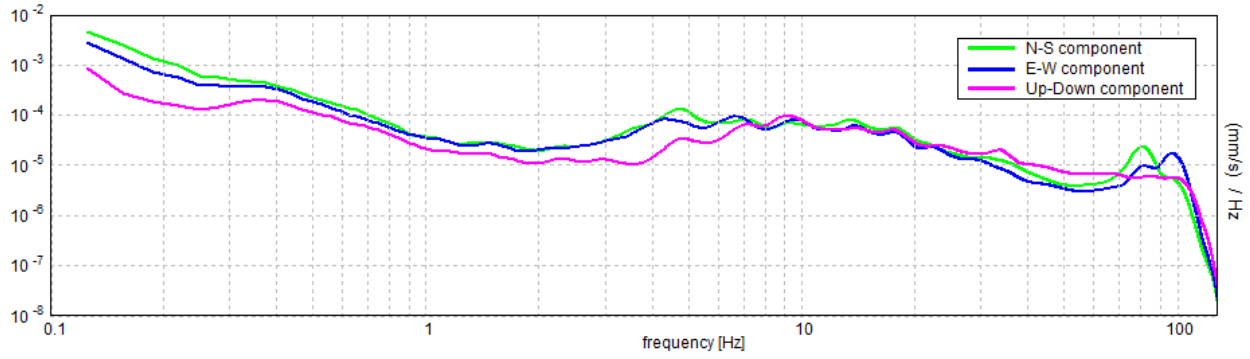
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



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

Max. H/V at 0.16 ± 49.31 Hz (in the range 0.0 - 128.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	0.16 > 0.50		**NO**
$n_c(f_0) > 200$	75.0 > 200		**NO**
$\sigma_A(f) < 2$ 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 4 out of 8 times		**NO**
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0.094 Hz	**OK**	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	0.25 Hz	**OK**	
$A_0 > 2$	7.57 > 2	**OK**	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|315.5739| < 0.05		**NO**
$\sigma_f < \varepsilon(f_0)$	49.30841 < 0.03906		**NO**
$\sigma_A(f_0) < \theta(f_0)$	8.7277 < 3.0		**NO**

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

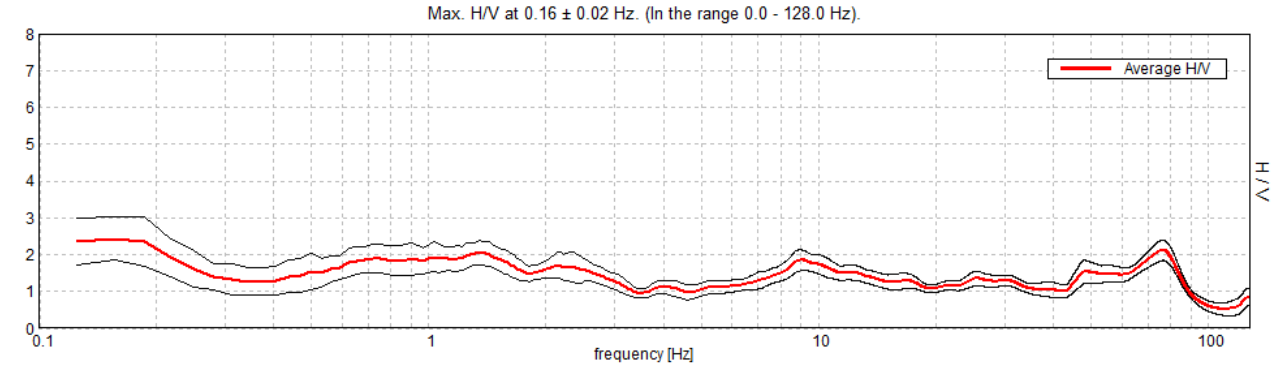
CORNELLEAMATRICE8, STRADAALTO

Instrument: TE3-0400/02-18
Data format: 32 byte
Full scale [mV]: 51

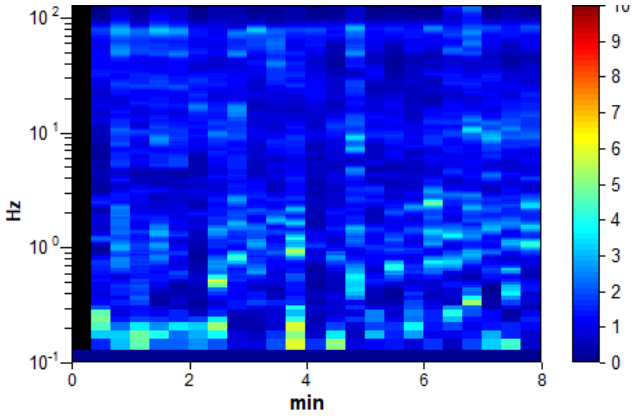
Start recording: 04/09/19 15:31:10 End recording: 04/09/19 15:39:10
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN ; wless trig.
GPS data not available

Trace length: 0h08'00". Analyzed 96% trace (manual window selection)
Sampling rate: 256 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

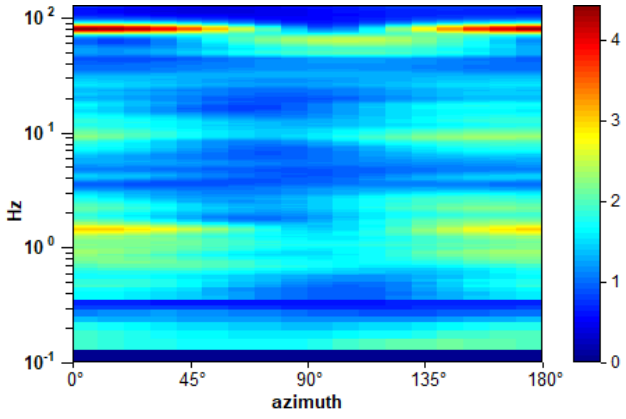
HORIZONTAL TO VERTICAL SPECTRAL RATIO



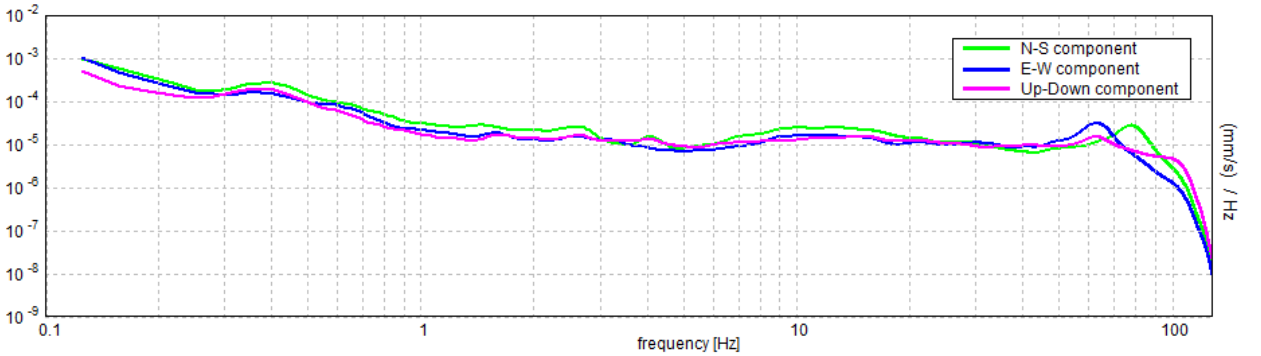
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



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

Max. H/V at 0.16 ± 0.02 Hz (in the range 0.0 - 128.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	0.16 > 0.50		NO
$n_c(f_0) > 200$	71.9 > 200		NO
$\sigma_A(f) < 2$ 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 8 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	0.094 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	2.44 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.11795| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	0.01843 < 0.03906	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.5959 < 3.0	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 $\sigma_A(f) < \theta(f_0)$

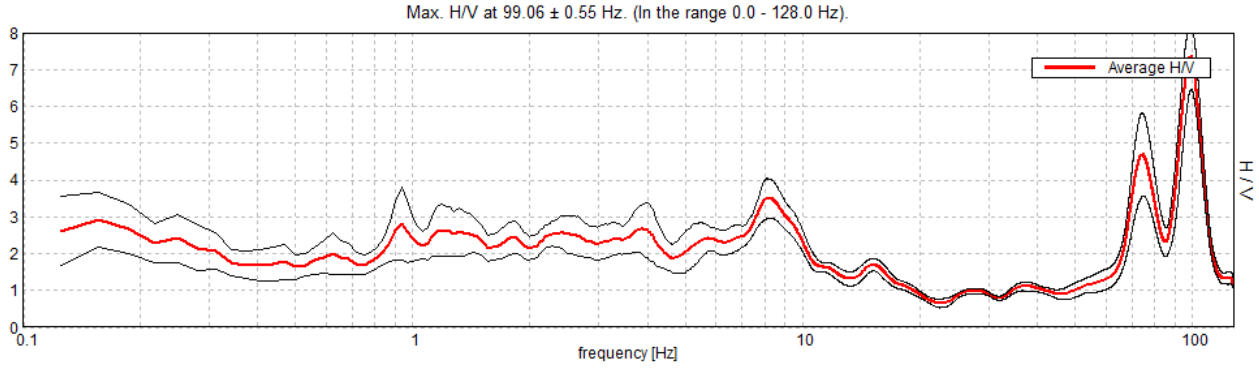
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CORNELLEAMATRICE9, STRADABASSO

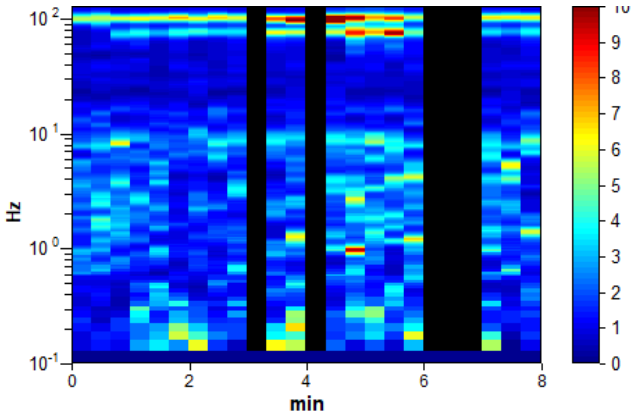
Instrument: TE3-0400/02-18
Data format: 32 byte
Full scale [mV]: 51
Start recording: 04/09/19 15:43:44 End recording: 04/09/19 15:51:44
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN ; wless trig.
GPS data not available

Trace length: 0h08'00''. Analyzed 79% trace (manual window selection)
Sampling rate: 256 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

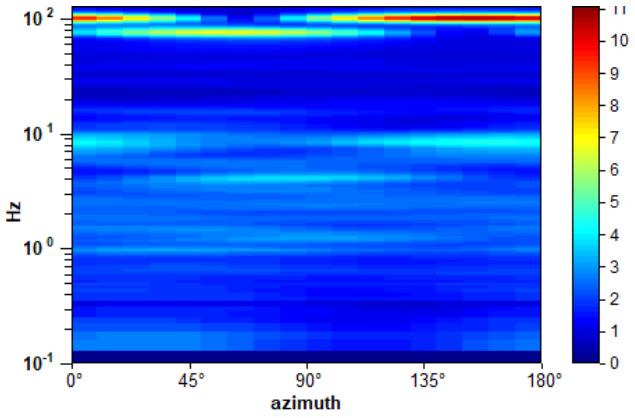
HORIZONTAL TO VERTICAL SPECTRAL RATIO



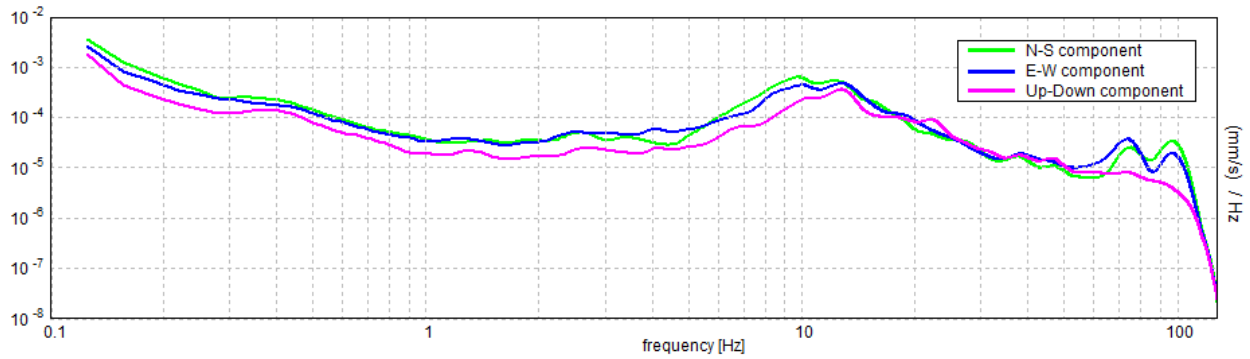
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



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

Max. H/V at 99.06 ± 0.55 Hz (in the range 0.0 - 128.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	99.06 > 0.50	OK	
$n_c(f_0) > 200$	37643.8 > 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 2512 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	90.344 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	107.688 Hz	OK	
$A_0 > 2$	7.35 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.00552| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.54698 < 4.95313	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.881 < 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 $\sigma_A(f_0)$

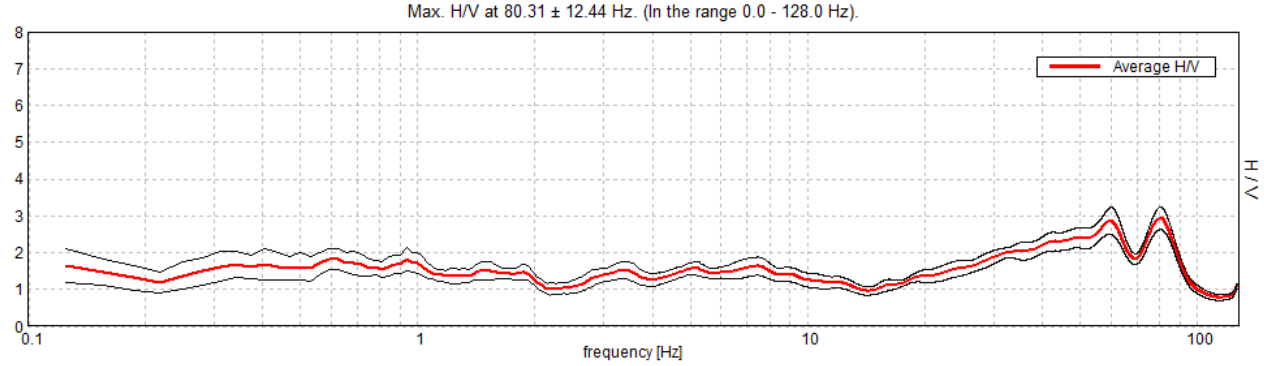
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CORNELLEAMATRICE29, LIMITEBOSCOALTO

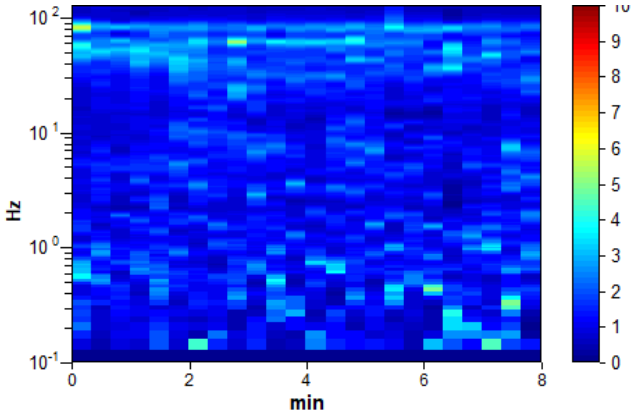
Instrument: TE3-0400/02-18
Data format: 32 byte
Full scale [mV]: 51
Start recording: 25/10/19 08:45:57 End recording: 25/10/19 08:53:57
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN ; wless trig.
GPS data not available

Trace length: 0h08'00''. Analysis performed on the entire trace.
Sampling rate: 256 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

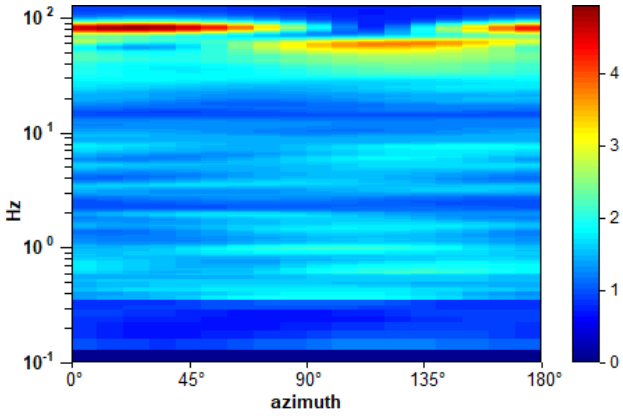
HORIZONTAL TO VERTICAL SPECTRAL RATIO



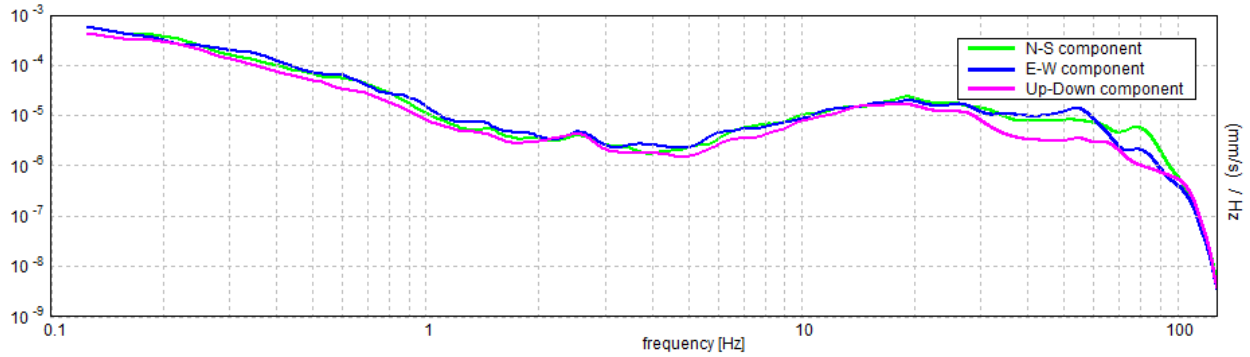
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



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

Max. H/V at 80.31 ± 12.44 Hz (in the range 0.0 - 128.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	80.31 > 0.50	OK	
$n_c(f_0) > 200$	38550.0 > 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 2812 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	22.531 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	92.281 Hz	OK	
$A_0 > 2$	2.94 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.15496| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	12.44487 < 4.01563		NO
$\sigma_A(f_0) < \theta(f_0)$	0.3067 < 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 $\sigma_A(f_0)$

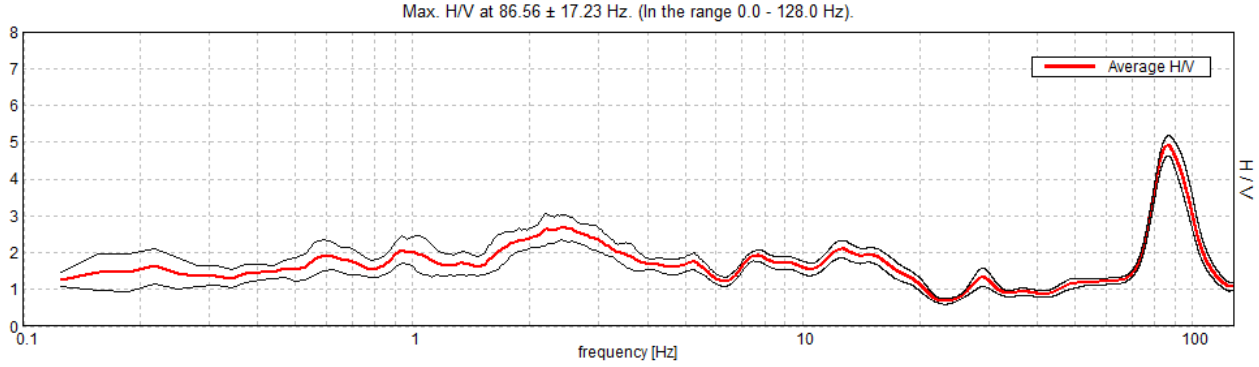
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CORNELLEAMATRICE30, TENDONEMUCCHE

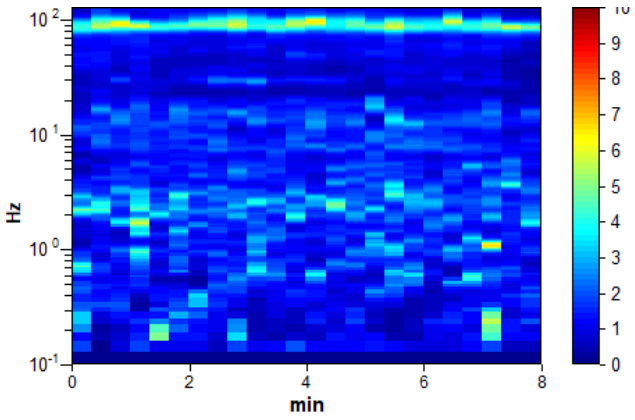
Instrument: TE3-0400/02-18
Data format: 32 byte
Full scale [mV]: 51
Start recording: 25/10/19 10:11:43 End recording: 25/10/19 10:19:43
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN ; wless trig.
GPS data not available

Trace length: 0h08'00". Analysis performed on the entire trace.
Sampling rate: 256 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

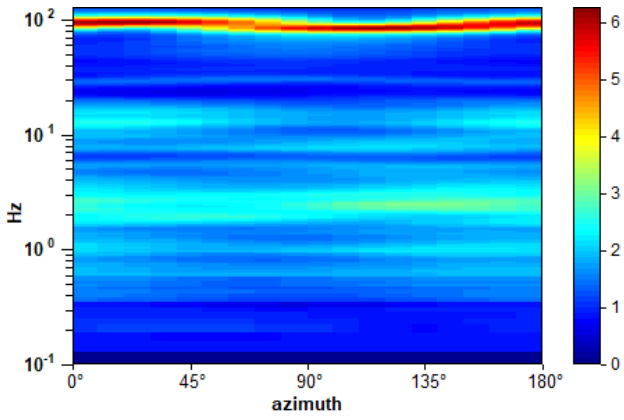
HORIZONTAL TO VERTICAL SPECTRAL RATIO



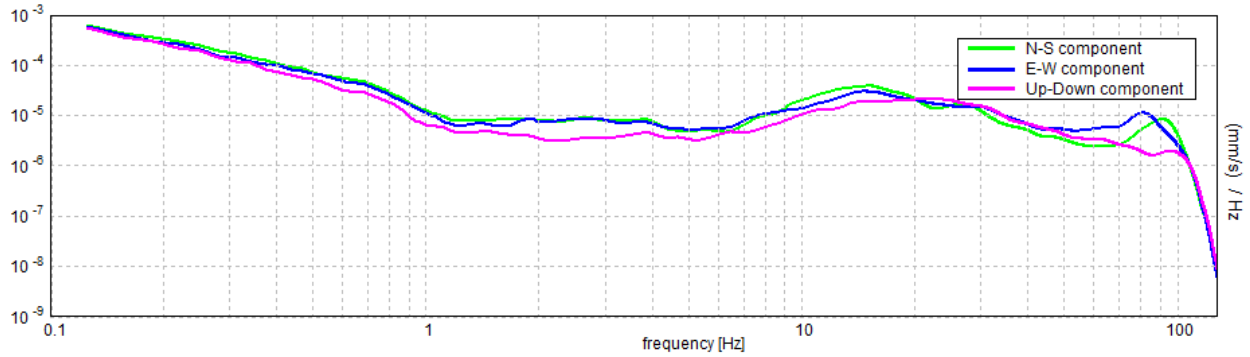
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



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

Max. H/V at 86.56 ± 17.23 Hz (in the range 0.0 - 128.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	86.56 > 0.50	OK	
$n_c(f_0) > 200$	41550.0 > 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 2712 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	76.031 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	103.188 Hz	OK	
$A_0 > 2$	4.91 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.19908| < 0.05		NO
$\sigma_f < \varepsilon(f_0)$	17.23252 < 4.32813		NO
$\sigma_A(f_0) < \theta(f_0)$	0.2775 < 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 $\sigma_A(f_0)$

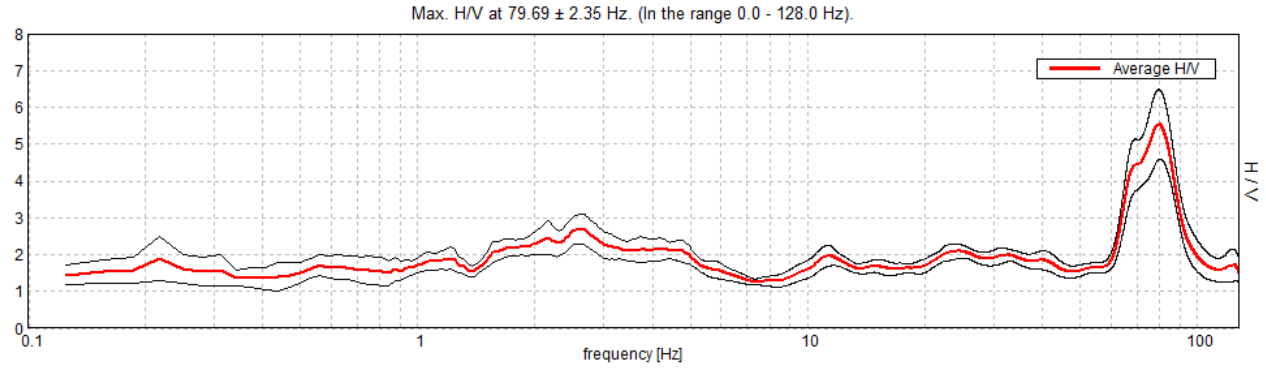
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

CORNELLEAMATRICE31, SCARPATASOTTOTENDONE

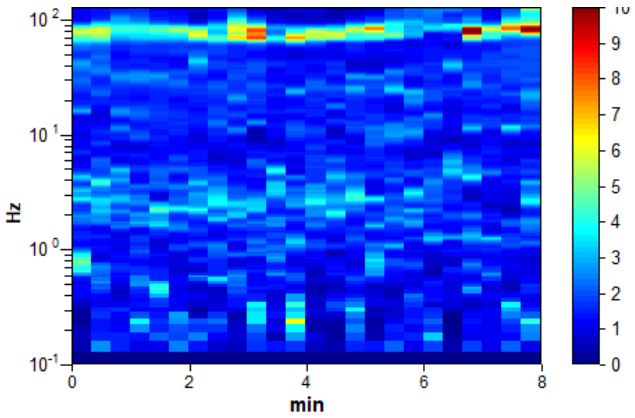
Instrument: TE3-0400/02-18
Data format: 32 byte
Full scale [mV]: 51
Start recording: 25/10/19 10:32:35 End recording: 25/10/19 10:40:35
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN ; wless trig.
GPS data not available

Trace length: 0h08'00". Analysis performed on the entire trace.
Sampling rate: 256 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

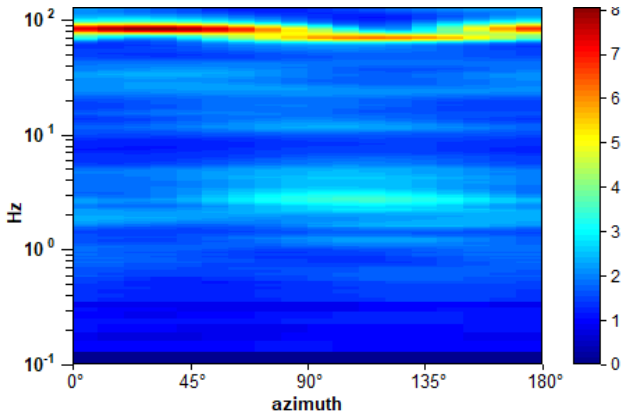
HORIZONTAL TO VERTICAL SPECTRAL RATIO



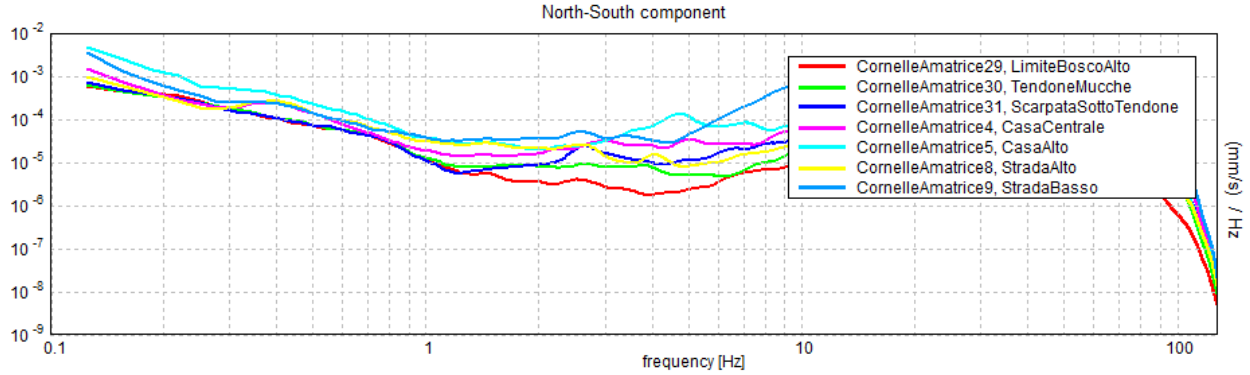
H/V TIME HISTORY



DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA



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

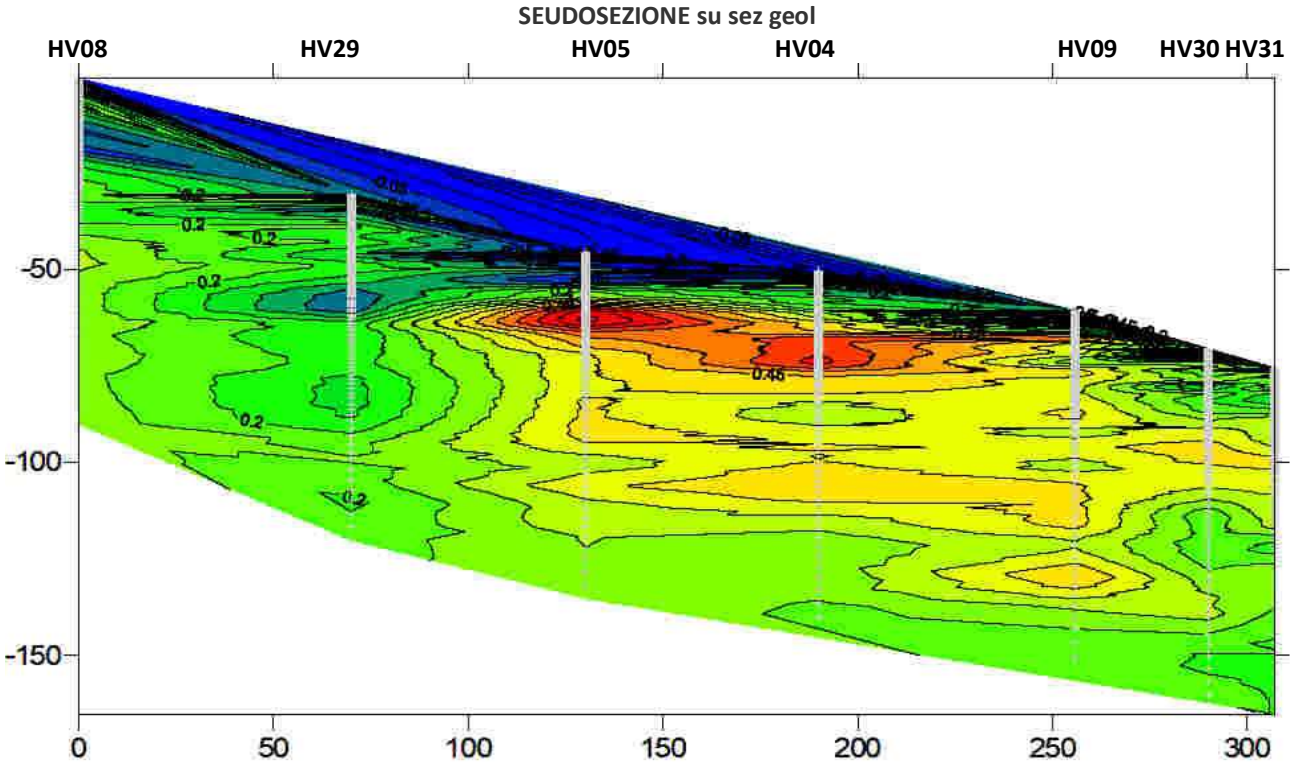
Max. H/V at 79.69 ± 2.35 Hz (in the range 0.0 - 128.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	79.69 > 0.50	OK	
$n_c(f_0) > 200$	38250.0 > 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 2822 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	63.469 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	92.0 Hz	OK	
$A_0 > 2$	5.54 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.02953| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	2.35306 < 3.98438	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.9515 < 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 $\sigma_A(f_0)$

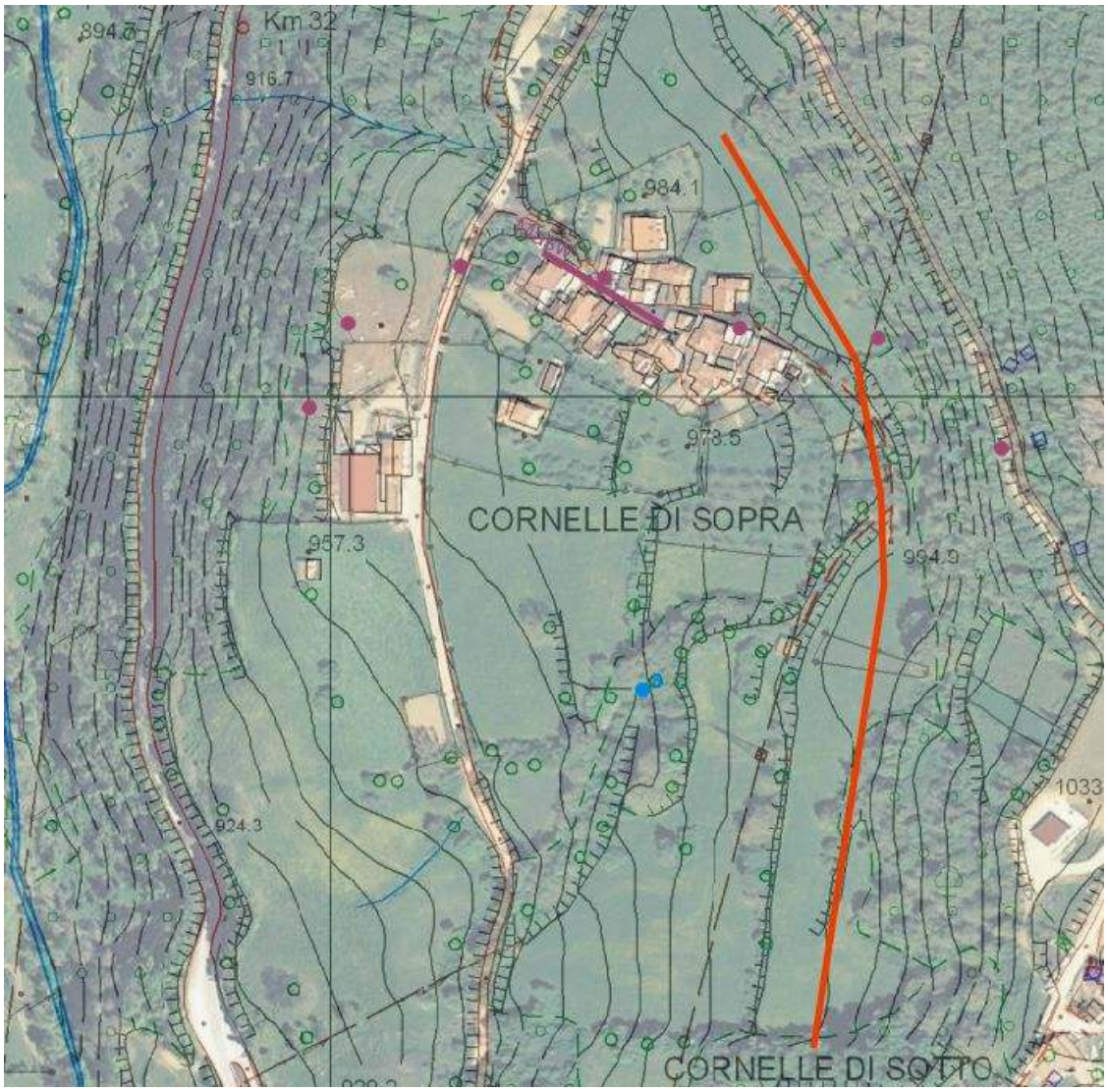
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20



TPC Progetti snc – Viale Roma, n. 55 - 55022 - Bagni di Lucca (LU) – tel 0583.805622 – email info@tpcprogetti.it

CORNELLE, AMATRICE (RI)

INDAGINE VLF PER INQUADRAMENTO PRELIMINARE



Linee viola masw

Punti viola hvsr

Linea rossa VLF

CENNI SULLA METODOLOGIA D'INDAGINE GEOFISICA VLF

La strumentazione elettromagnetica per la captazione di onde very low frequency (VLF) consiste in una antenna ricevente, in grado di utilizzare questa particolare gamma di frequenze e in un sistema di acquisizione dati. L'indagine viene realizzata mediante una stesa lungo la quale si effettuano un certo numero di registrazioni, ognuna delle quali ha una durata di pochi secondi, con un passo di campionamento costante, con interasse variabile seconda dell'oggetto della ricerca e della profondità d'indagine prevista, ma anche dello spazio a disposizione.

Cenni sulla teoria del metodo

Durante e dopo la seconda guerra mondiale è nata una rete mondiale di trasmittenti radio con frequenza compresa fra 3 e 30 kHz, denominate VLF (Very Low Frequency), con potenze radianti dell'ordine di 500 ÷ 1000 kW.

Utilizzando un misuratore di intensità di segnale radio sintonizzato su stazioni VLF di cui è nota la posizione si possono osservare variazioni della componente orizzontale e verticale del campo elettromagnetico ricevuto in corrispondenza dei corpi conduttori sepolti. Una zona a diversa conduttività provoca infatti correnti indotte secondarie facendo variare il campo elettromagnetico prodotto dall'onda primaria, in positivo (rosso) se il corpo è maggiormente conduttivo (ad esempio una falda acquifera localizzata) ed in negativo (blu) se il corpo è meno conduttivo (ad esempio una cavità).

La metodologia VLF per quanto si cerchi di applicarla con raziocinio, cioè lungo sezioni e misurando la posizione dei vari punti di misura fornisce perlopiù soluzioni qualitative e le soluzioni quantitative proposte vanno analizzate con cautela, anche se questa è una problematica che si ha un po' su tutte le indagini geofisiche.

I dati una volta captati dal misuratore posto quanto più perpendicolarmente possibile alla direzione di emissione vengono poi elaborati con filtro di Karous e Hjelt che ne esalta le variazioni dando i risultati in intensità di corrente %, e quindi interpolati da un software tomografico che fornisce i risultati sia per la componente reale che immaginaria alle varie profondità.

I risultati di quanto acquisito sono riportati negli allegati alle pagine seguenti:

Grafico misure vlf parte Reale

Grafico misure trattate con filtro Fraser parte Reale

Grafico tomografico con Filtro Karous-Hjelt parte Reale

RIASSUNTO DELL'INDAGINE GEOFISICA

In Loc. Cornelle di sotto nel Comune di Amatrice (RI) è stata eseguita un'indagine elettromagnetica VLF al limite monte della zona ritenuta instabile dalla schefa di fattibilità. Si è così eseguito uno stendimento di circa 160 m, con un interasse tra le misurazioni di 4.5 m lungo il limite del bosco all'incirca in direzione Nord-Sud.
Questo permette di fare delle elaborazioni anche con distanze multiple, poiché elaborando le misure con spaziatura doppia, il programma permette di avere meno dettaglio in superficie ma di evidenziare le anomalie più in profondità.

Il segnale emittente utilizzato è ICV che trasmette dal'isola di Tavolara nei pressi della Sardegna.
Con questa indagine si è andati alla ricerca di circolazioni d'acqua secondo direttrici preferenziali, per semplicità si può riassumere che quando lo strumento incontra una zona a maggiore conduttività rispetto al contesto generale riesce a misurare delle correnti indotte positive che ivi si formano ottenendo, in un grafico tomografico di elaborazione, una colorazione rossa

L'elaboratore Dott. geol. Ferdinando Francia

Grafico misure vlf parte Reale VLF 4.5m

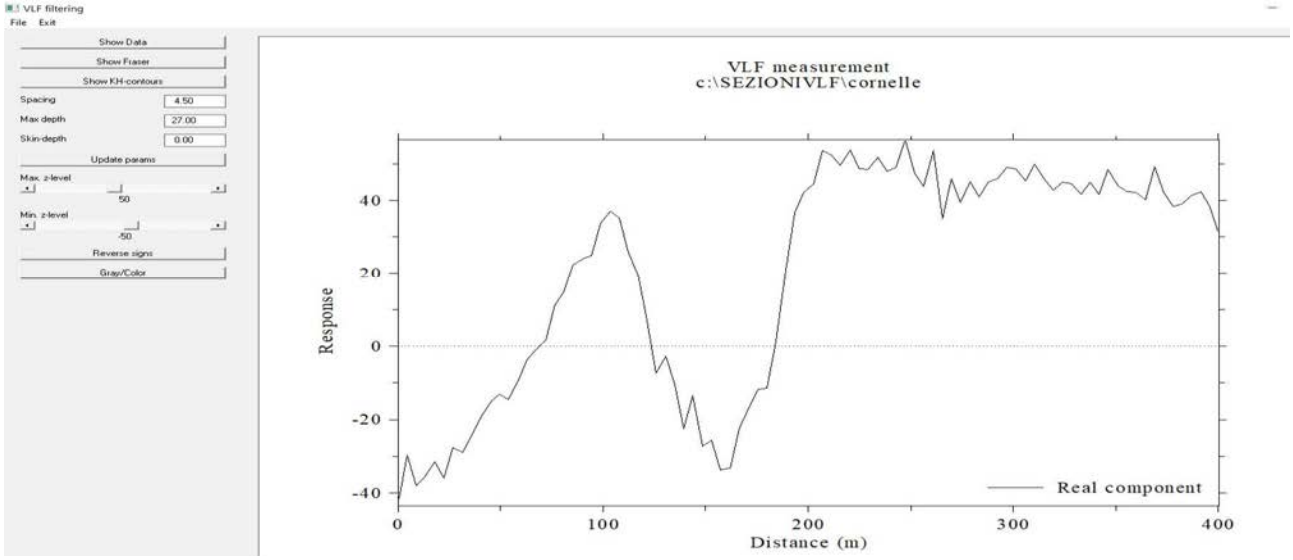


Grafico misure trattate con filtro Fraser parte Reale VLF 4.5m

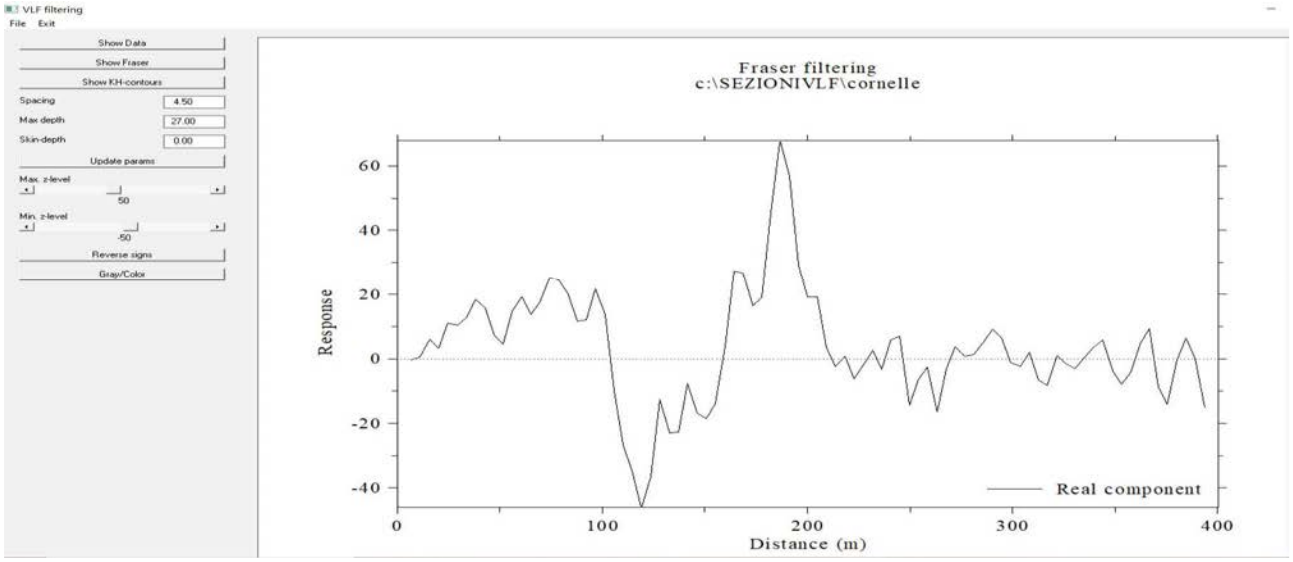


Grafico tomografico con Filtro Karous-Hjelt parte Reale VLF 4.5 m

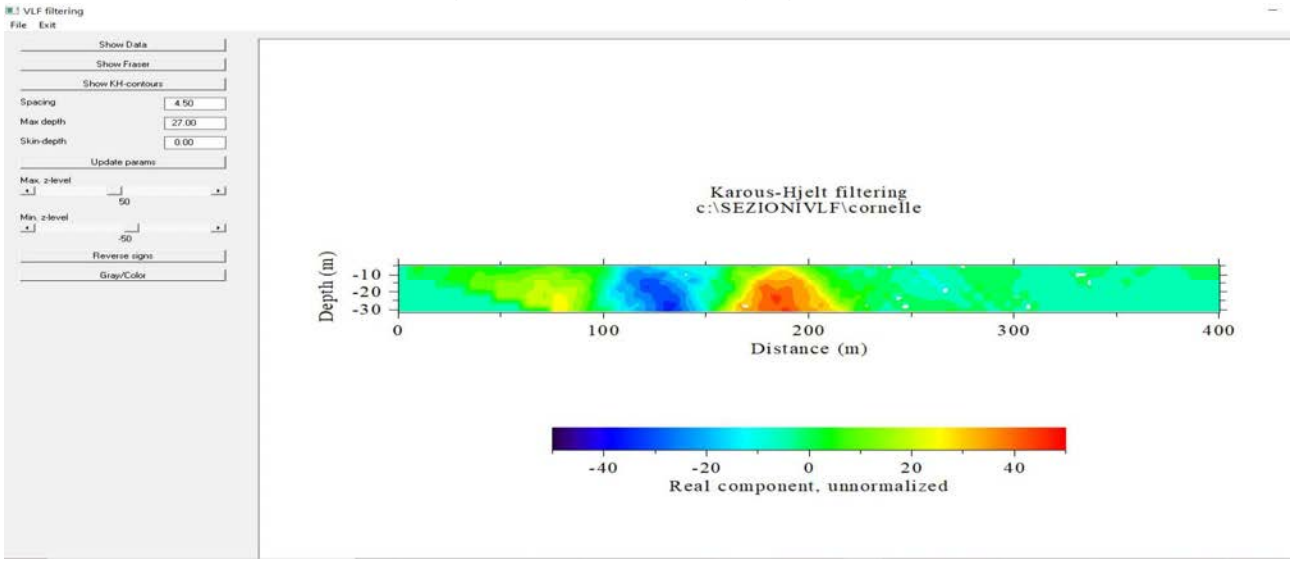


Grafico misure vlf parte Reale VLF 9m

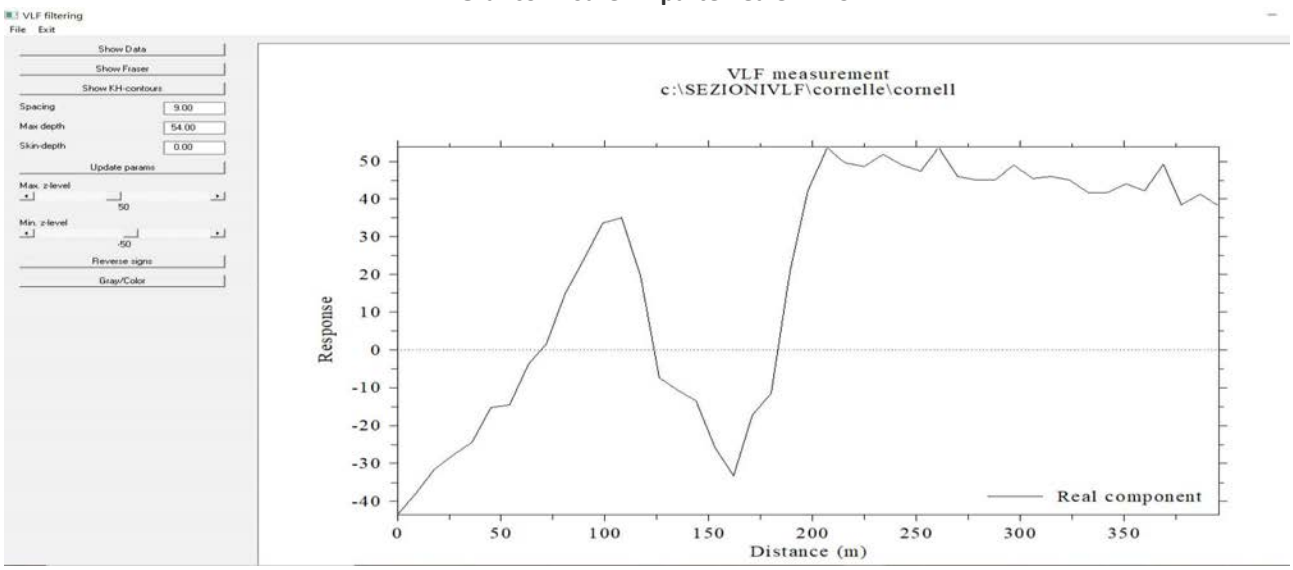


Grafico misure trattate con filtro Fraser parte Reale VLF 9m

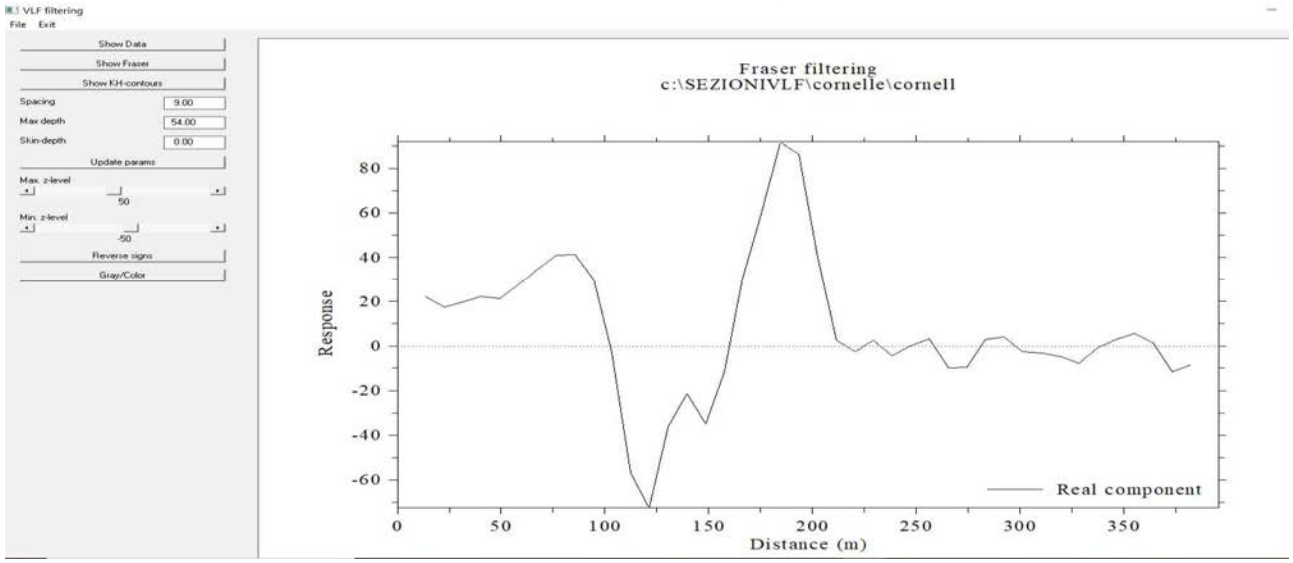


Grafico tomografico con Filtro Karous-Hjelt parte Reale VLF 9m