



PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile



CONFERENZA DELLE REGIONI E
DELLE PROVINCE AUTONOME

Attuazione dell'articolo 11 dalla legge 24 giugno 2009, n.77

MICROZONAZIONE SISMICA

Livello 3

Allegato 2 – Report delle indagini

Regione Emilia–Romagna

Comune di Minerbio



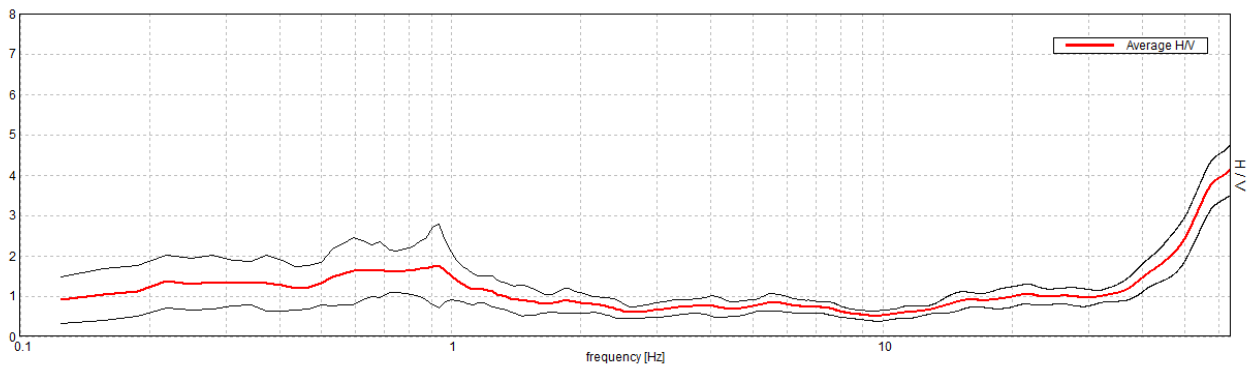
Regione	Soggetto realizzatore	Data
EMILIA–ROMAGNA	Dott. geologo Samuel Sangiorgi	Aprile 2021

MINERBIO_MS, TR1

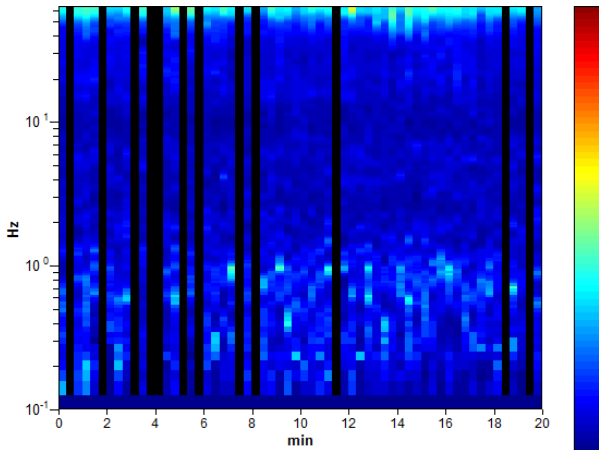
Instrument: TRZ-0108/01-10
Start recording: 05/06/20 11:21:05 End recording: 05/06/20 11:41:06
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 0h20'00". Analyzed 80% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

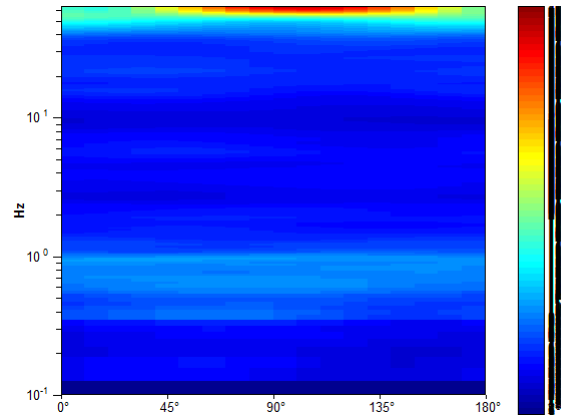
Max. H/V at 0.94 ± 0.09 Hz (in the range 0.1 - 20.0 Hz).



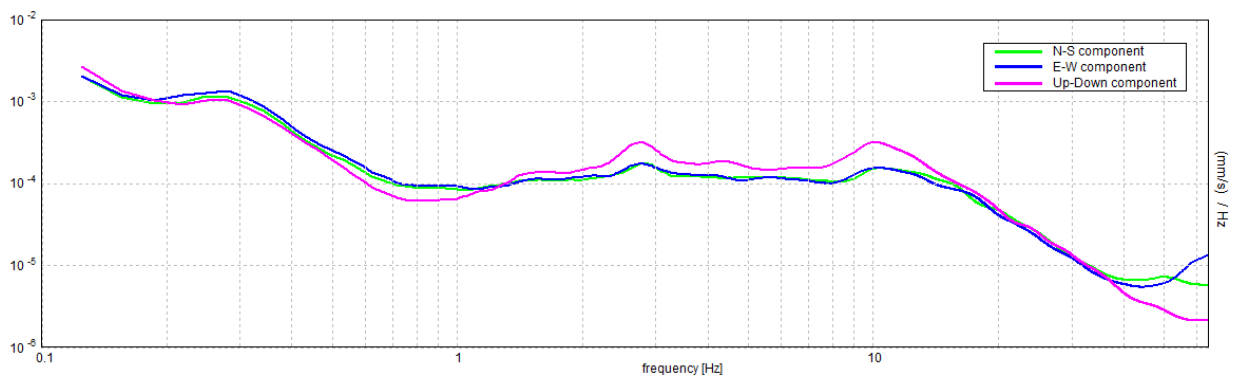
H/V TIME HISTORY



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 0.94 ± 0.09 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.94 > 0.50$	OK	
$n_c(f_0) > 200$	$900.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 46 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.531 Hz	OK	
$A_0 > 2$	$1.75 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.04806 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.04506 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.5093 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

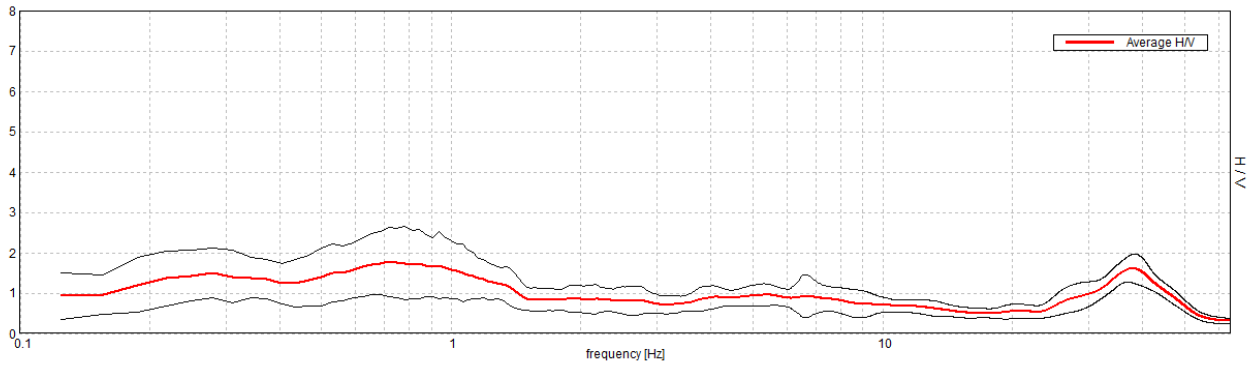
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR2

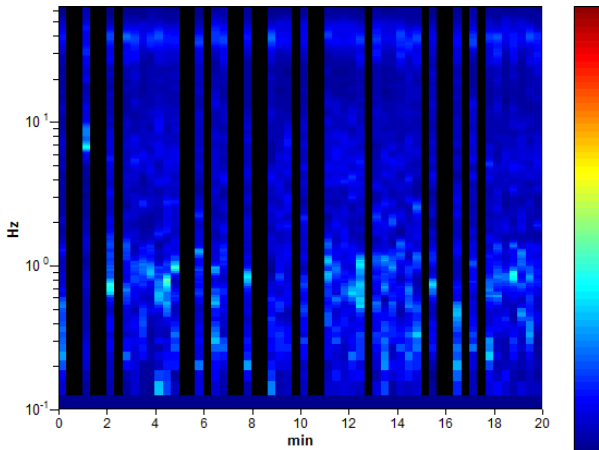
Instrument: TRZ-0108/01-10
 Start recording: 05/06/20 11:52:17 End recording: 05/06/20 12:12:18
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 0h20'00". Analyzed 65% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 20 s
 Smoothing type: Triangular window
 Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

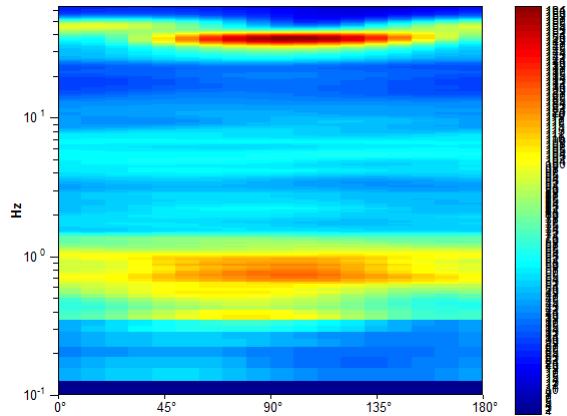
Max. H/V at 0.72 ± 0.31 Hz (in the range 0.1 - 20.0 Hz).



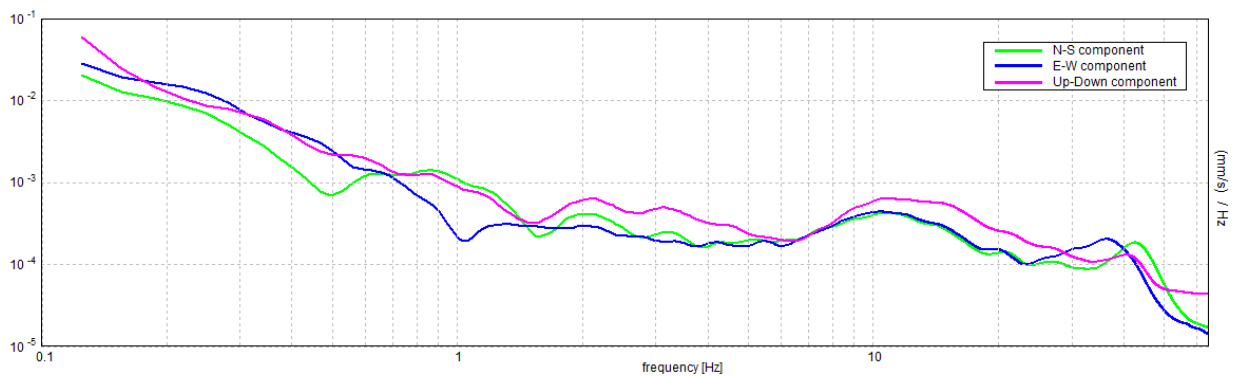
H/V TIME HISTORY



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 0.72 ± 0.31 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.72 > 0.50$	OK	
$n_c(f_0) > 200$	$560.6 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 36 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.5 Hz	OK	
$A_0 > 2$	$1.77 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.21068 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.15143 < 0.10781$		NO
$\sigma_A(f_0) < \theta(f_0)$	$0.4197 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR3

Instrument: TRZ-0108/01-10

Start recording: 05/06/20 12:26:04 End recording: 05/06/20 12:46:05

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 82% trace (manual window selection)

Sampling rate: 128 Hz

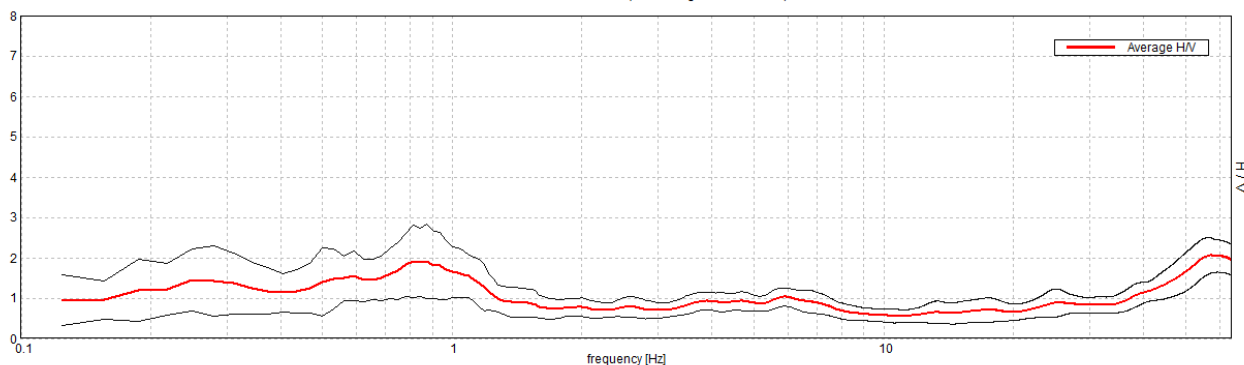
Window size: 20 s

Smoothing type: Triangular window

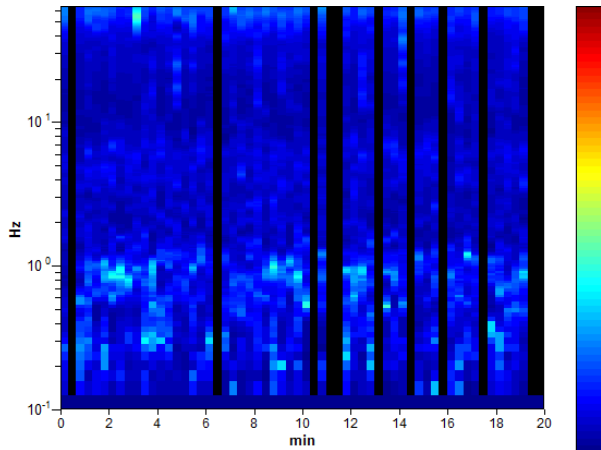
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

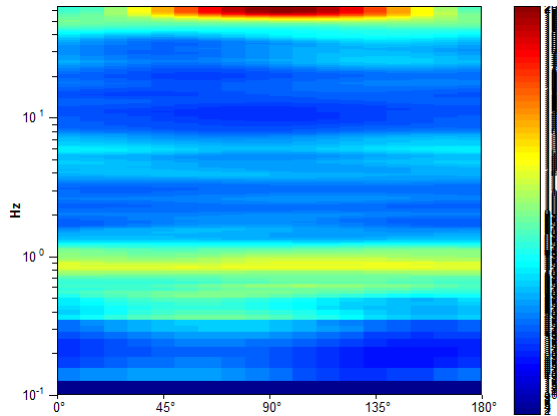
Max. H/V at 0.81 ± 0.06 Hz (in the range 0.1 - 20.0 Hz).



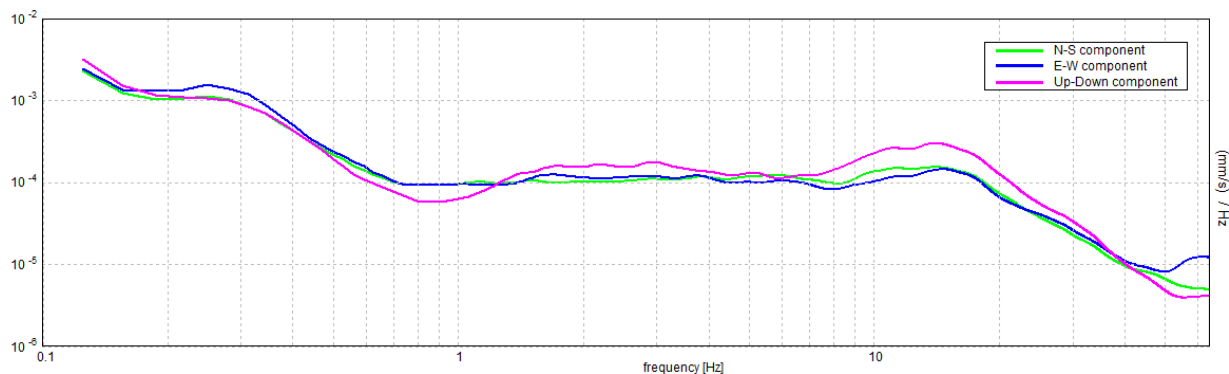
H/V TIME HISTORY



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 0.81 ± 0.06 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$796.3 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.313 Hz	OK	
$A_0 > 2$	$1.91 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03628 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.02948 < 0.12188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4371 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

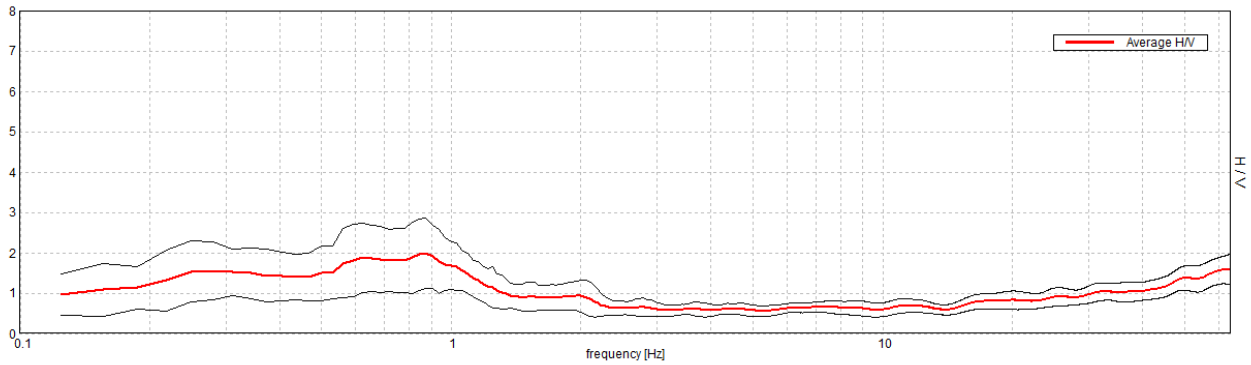
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR4

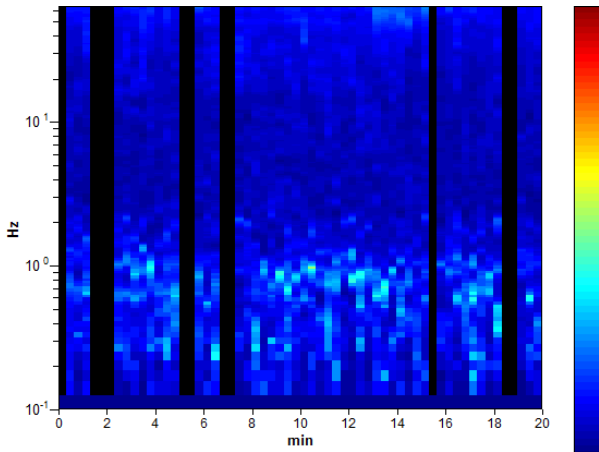
Instrument: TRZ-0108/01-10
Start recording: 05/06/20 12:55:29 End recording: 05/06/20 13:15:30
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 0h20'00". Analyzed 82% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

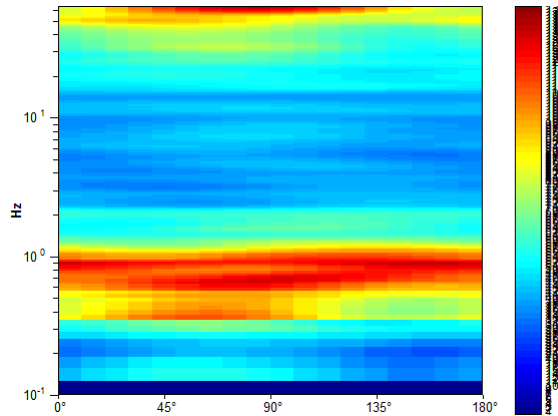
Max. H/V at 0.88 ± 0.05 Hz (in the range 0.1 - 20.0 Hz).



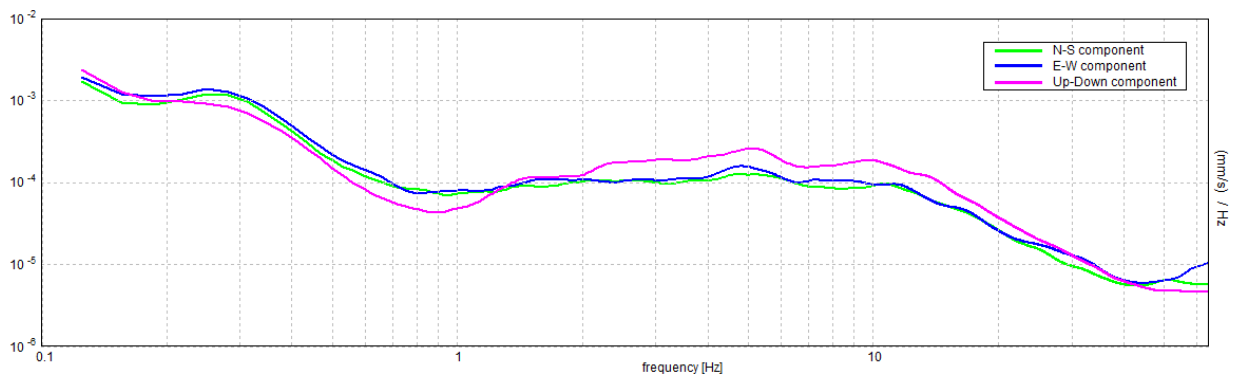
H/V TIME HISTORY



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 0.88 ± 0.05 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.88 > 0.50$	OK	
$n_c(f_0) > 200$	$857.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 43 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.344 Hz	OK	
$A_0 > 2$	$1.98 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02769 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.02423 < 0.13125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4275 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR5

Instrument: TRZ-0108/01-10

Start recording: 05/06/20 13:30:39 End recording: 05/06/20 13:50:40

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 73% trace (manual window selection)

Sampling rate: 128 Hz

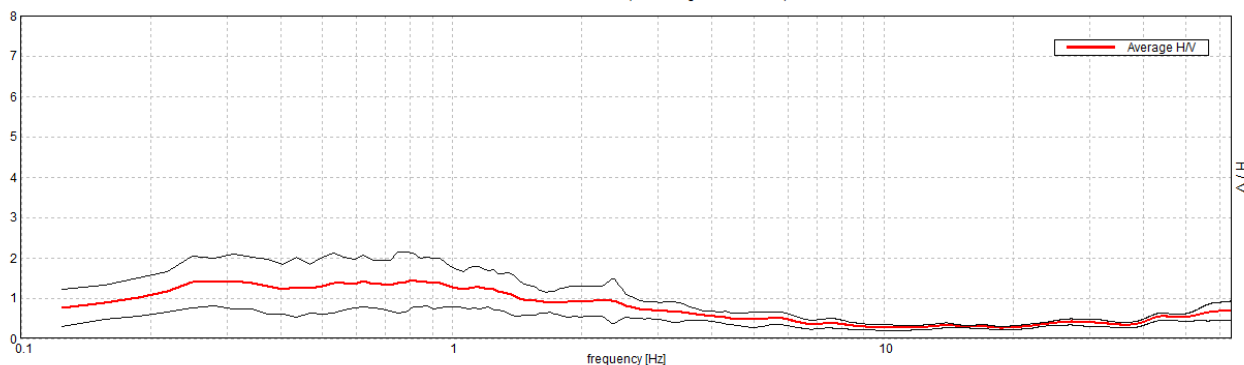
Window size: 20 s

Smoothing type: Triangular window

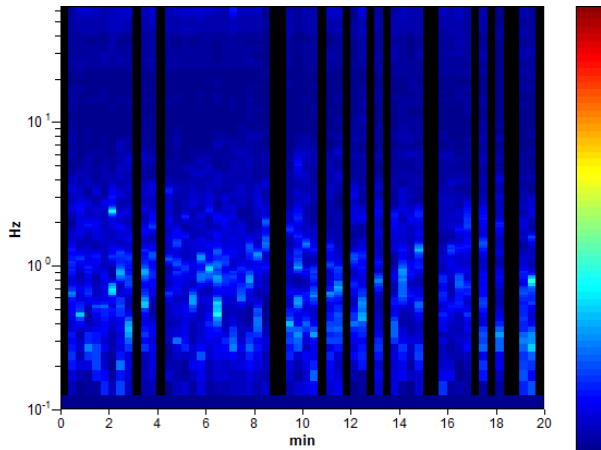
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

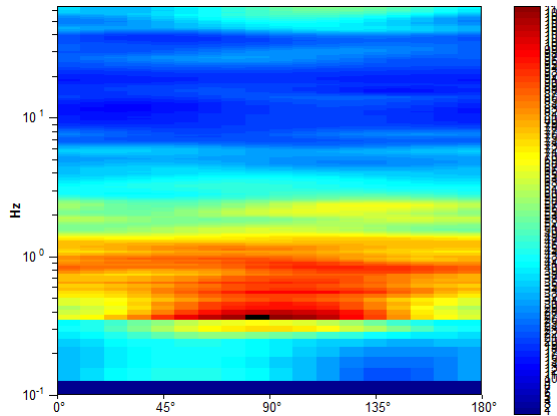
Max. H/V at 0.81 ± 0.05 Hz (in the range 0.1 - 20.0 Hz).



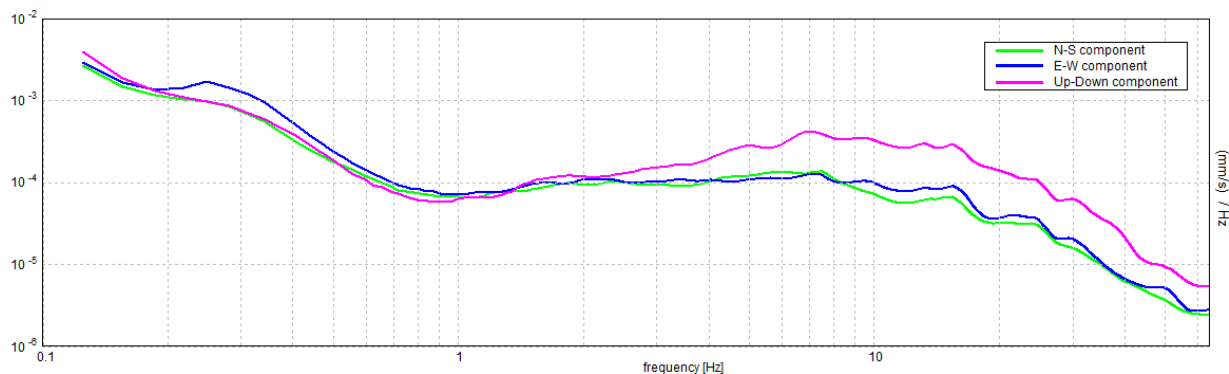
H/V TIME HISTORY



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 0.81 ± 0.05 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$715.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.719 Hz	OK	
$A_0 > 2$	$1.44 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03271 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.02657 < 0.12188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3248 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR6

037038P94623HVSR256

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 11:31:25 End recording: 14/01/01 11:51:25

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 72% trace (manual window selection)

Sampling rate: 128 Hz

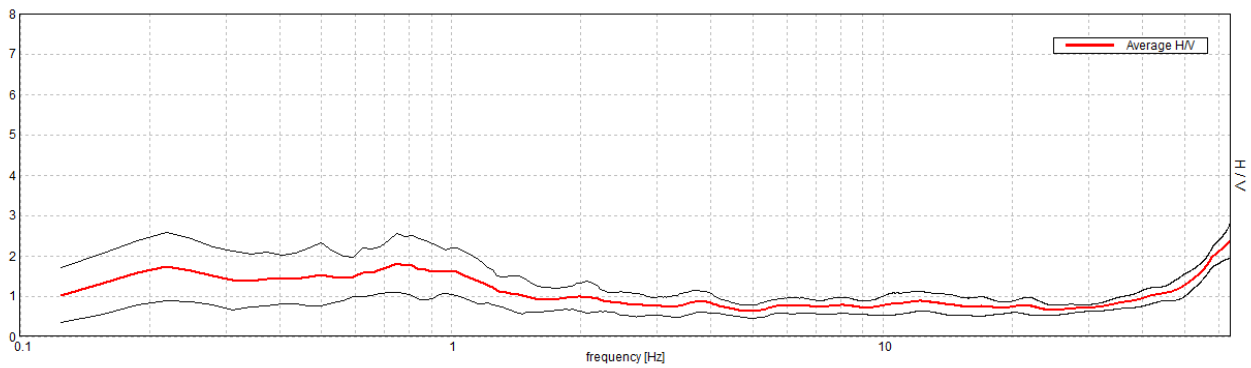
Window size: 20 s

Smoothing type: Triangular window

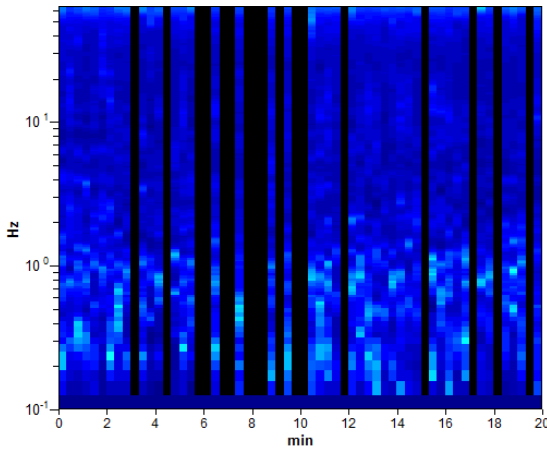
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

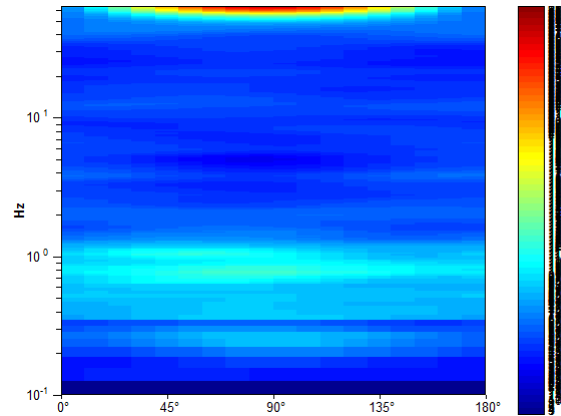
Max. H/V at 0.75 ± 0.15 Hz. (In the range 0.1 - 20.0 Hz).



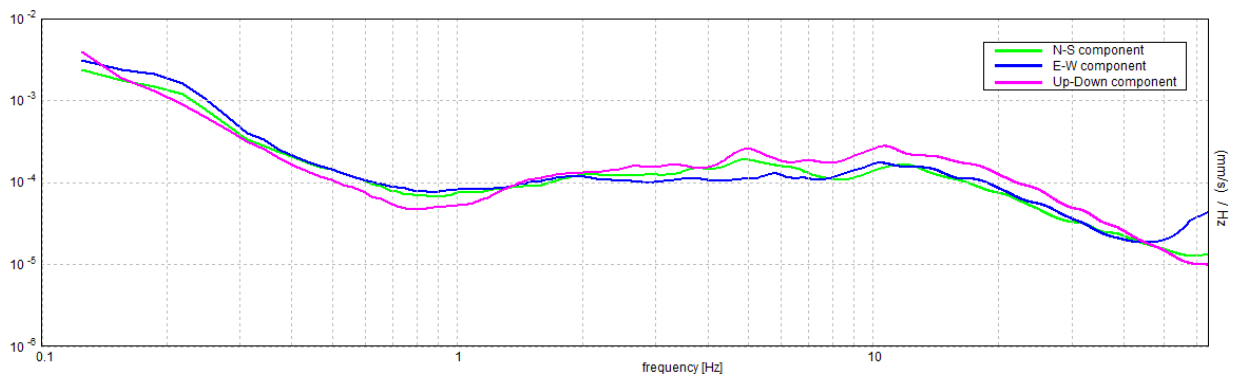
H/V TIME HISTORY



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 0.75 ± 0.15 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.75 > 0.50$	OK	
$n_c(f_0) > 200$	$645.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 37 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.219 Hz	OK	
$A_0 > 2$	$1.82 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.09638 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.07228 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3576 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

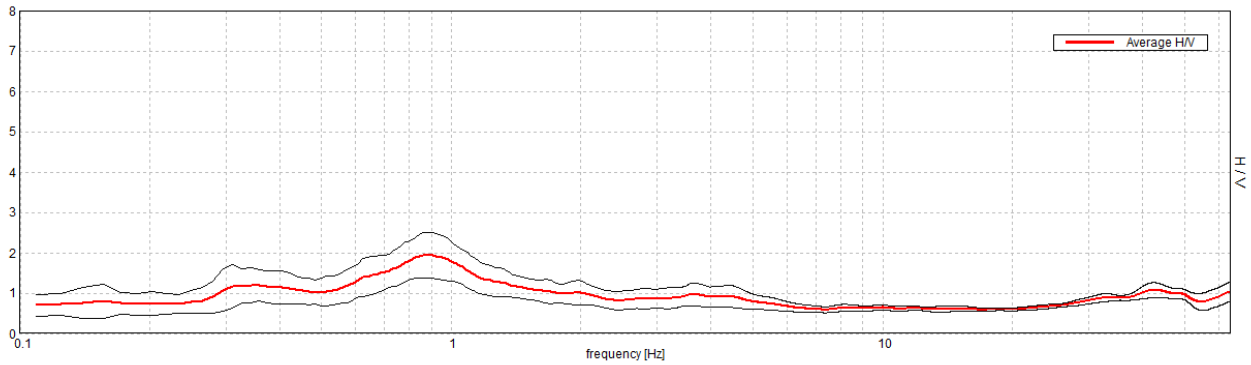
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR7

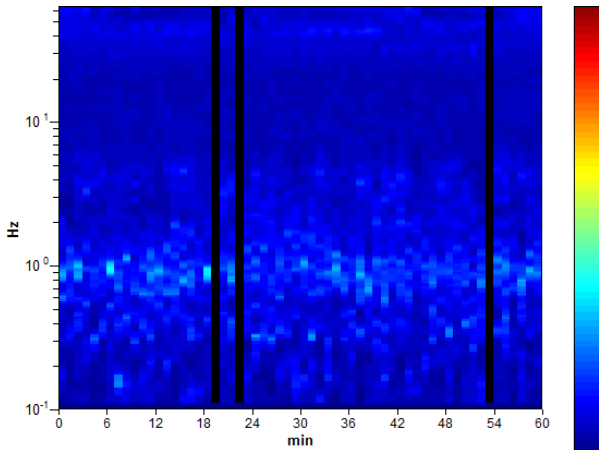
Instrument: TRZ-0108/01-10
Start recording: 06/08/20 09:39:01 End recording: 06/08/20 10:39:02
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 1h00'00". Analyzed 95% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 60 s
Smoothing type: Triangular window
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

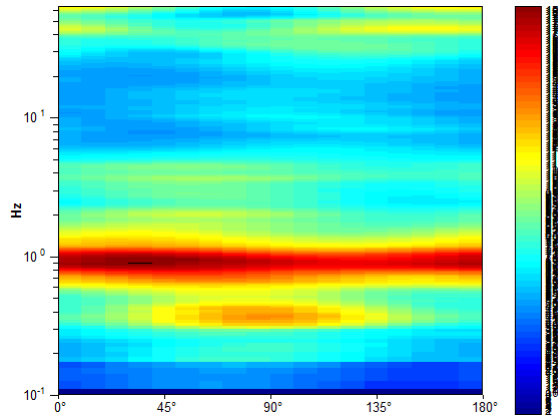
Max. H/V at 0.86 ± 0.01 Hz (in the range 0.1 - 20.0 Hz).



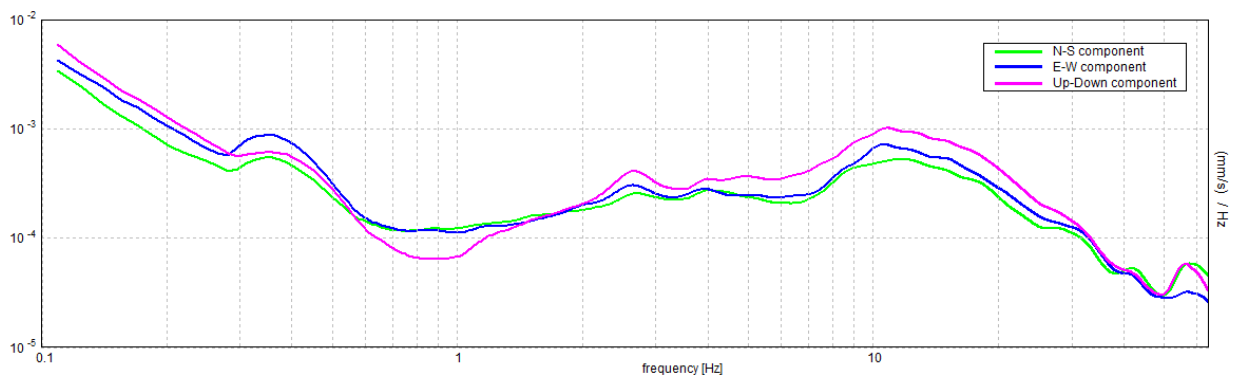
H/V TIME HISTORY



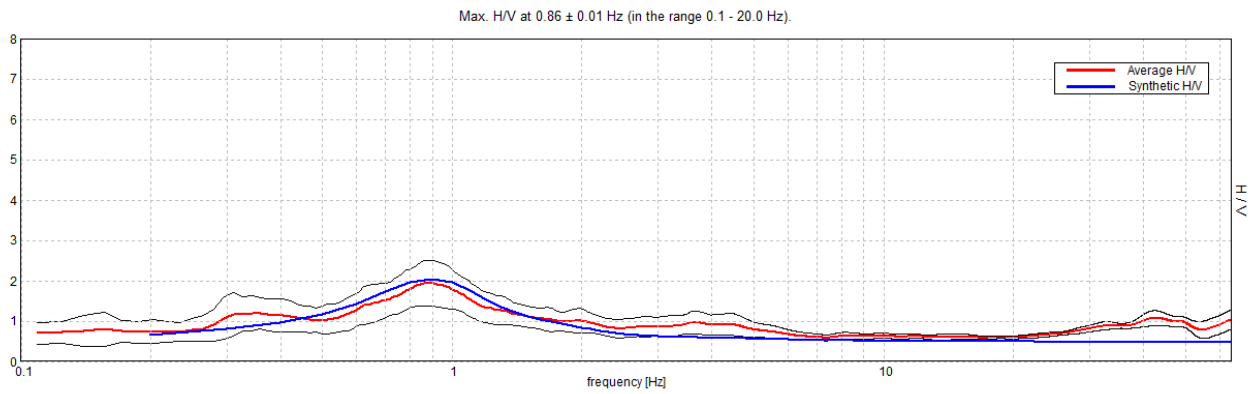
DIRECTIONAL H/V



SINGLE COMPONENT SPECTRA

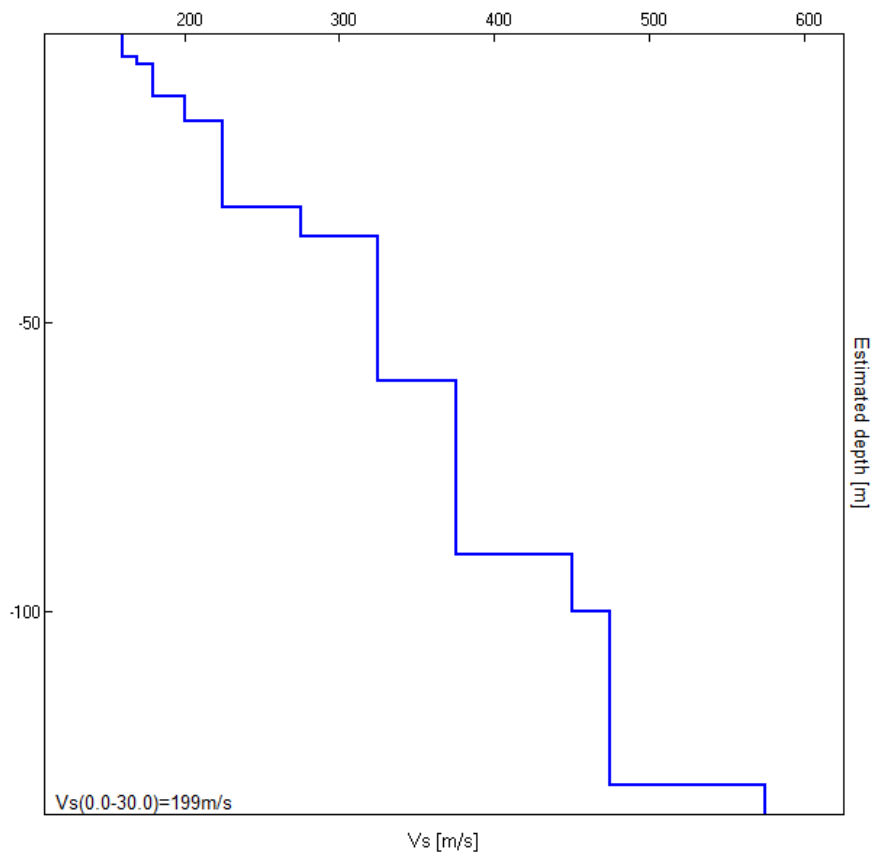


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]
4.00	4.00	160
5.30	1.30	170
10.80	5.50	180
13.60	2.80	200
15.00	1.40	200
16.00	1.00	225
30.00	14.00	225
35.00	5.00	275
60.00	25.00	325
90.00	30.00	375
100.00	10.00	450
130.00	30.00	475
inf.	inf.	575

Vs(0.0-30.0)=199m/s



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

Max. H/V at 0.86 ± 0.01 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.86 > 0.17$	OK	
$n_c(f_0) > 200$	$2939.1 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 84 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.281 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.078 Hz	OK	
$A_0 > 2$	$1.94 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.00644 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00553 < 0.12891$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2777 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR8

Instrument: TRZ-0108/01-10

Start recording: 06/08/20 15:47:48 End recording: 06/08/20 16:47:49

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 95% trace (manual window selection)

Sampling rate: 128 Hz

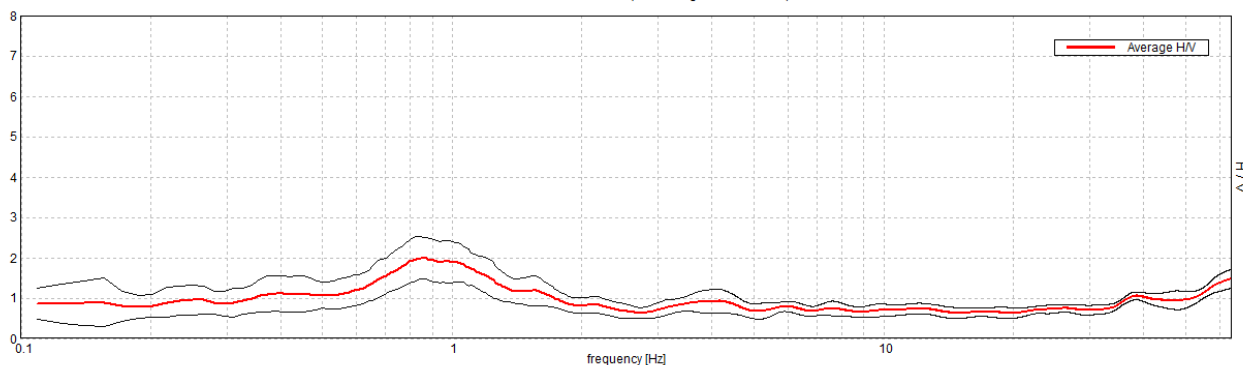
Window size: 60 s

Smoothing type: Triangular window

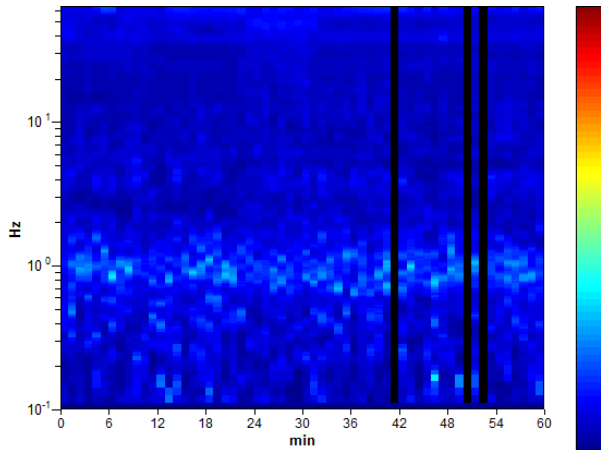
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

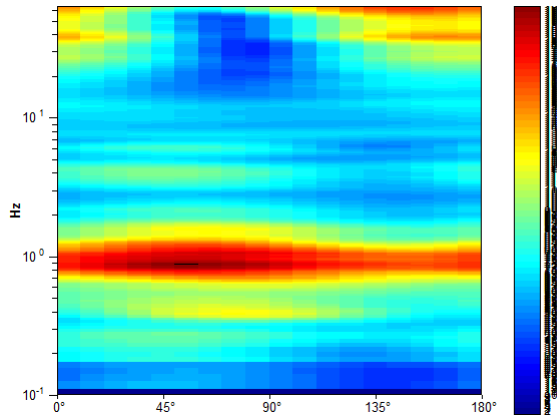
Max. H/V at 0.84 ± 0.02 Hz. (In the range 0.1 - 20.0 Hz).



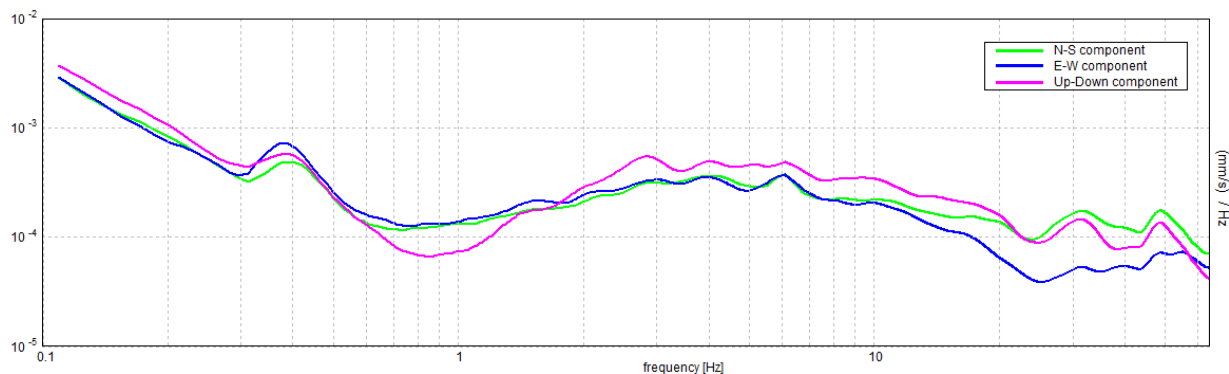
H/V TIME HISTORY



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 0.84 ± 0.02 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.84 > 0.17$	OK	
$n_c(f_0) > 200$	$2885.6 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 82 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.344 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.734 Hz	OK	
$A_0 > 2$	$1.99 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01203 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01015 < 0.12656$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2593 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

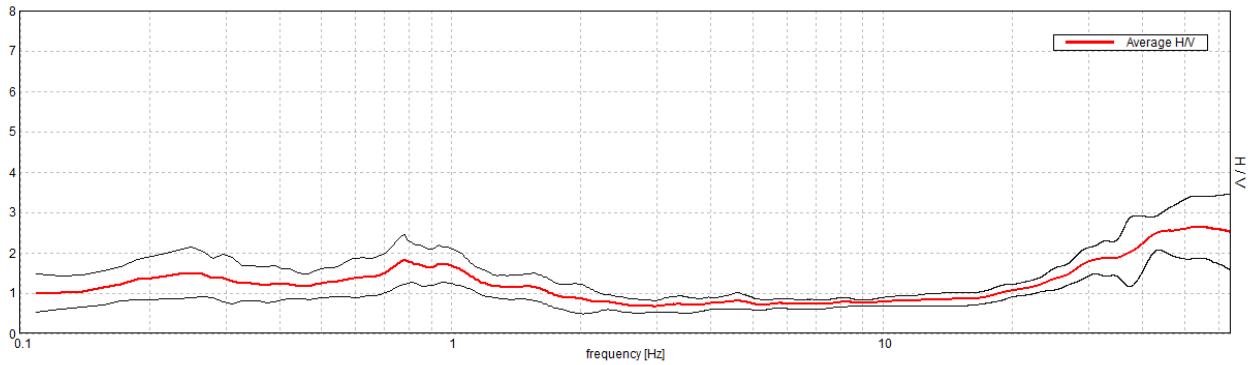
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR9

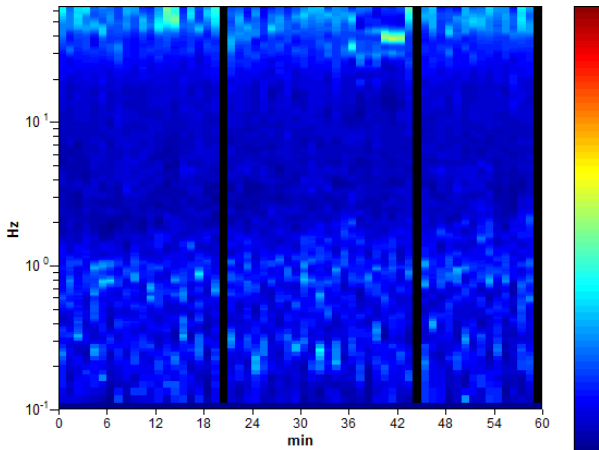
Instrument: TRZ-0108/01-10
 Start recording: 06/07/20 10:06:17 End recording: 06/07/20 11:06:18
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 1h00'00". Analyzed 95% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 60 s
 Smoothing type: Triangular window
 Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

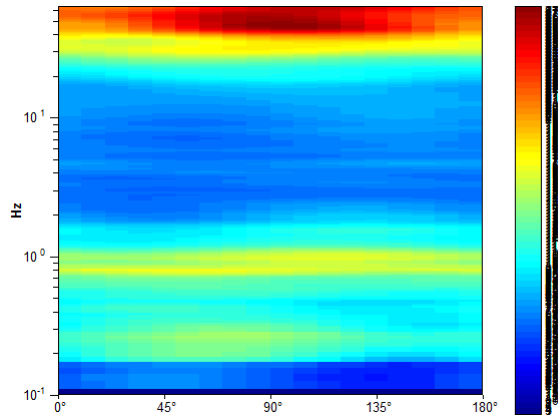
Max. H/V at 0.78 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



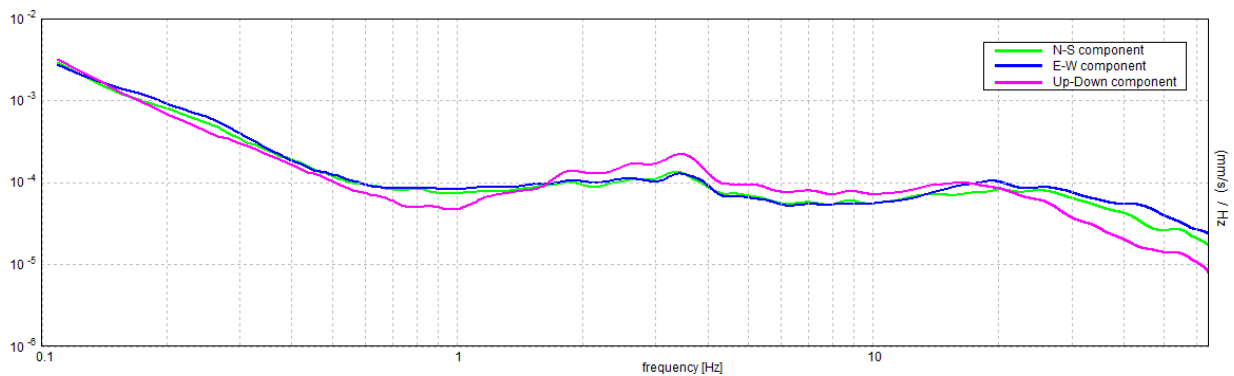
H/V TIME HISTORY



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 0.78 ± 0.03 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.78 > 0.17$	OK	
$n_c(f_0) > 200$	$2671.9 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 76 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.781 Hz	OK	
$A_0 > 2$	$1.84 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01963 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01534 < 0.11719$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3038 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

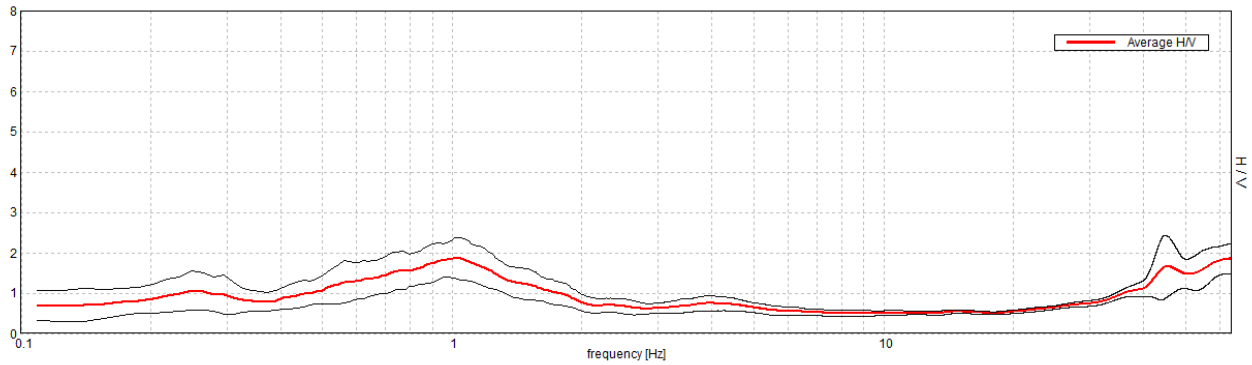
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR10

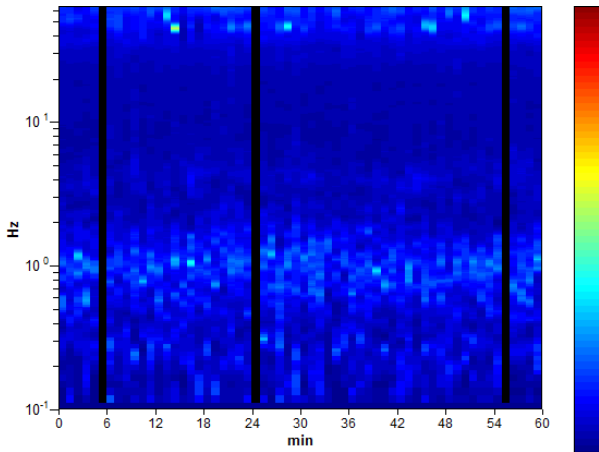
Instrument: TRZ-0108/01-10
 Start recording: 06/07/20 11:45:05 End recording: 06/07/20 12:45:05
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 1h00'00". Analyzed 95% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 60 s
 Smoothing type: Triangular window
 Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

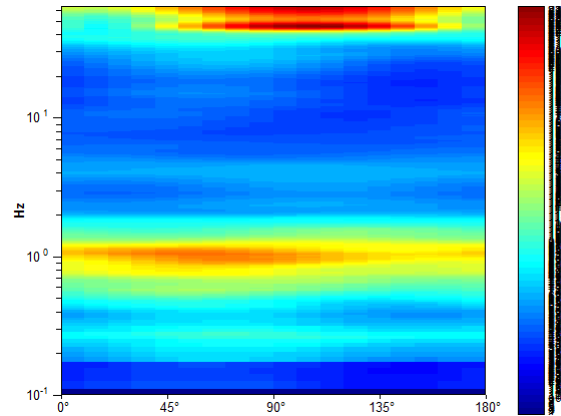
Max. H/V at 1.02 ± 0.01 Hz. (In the range 0.1 - 20.0 Hz).



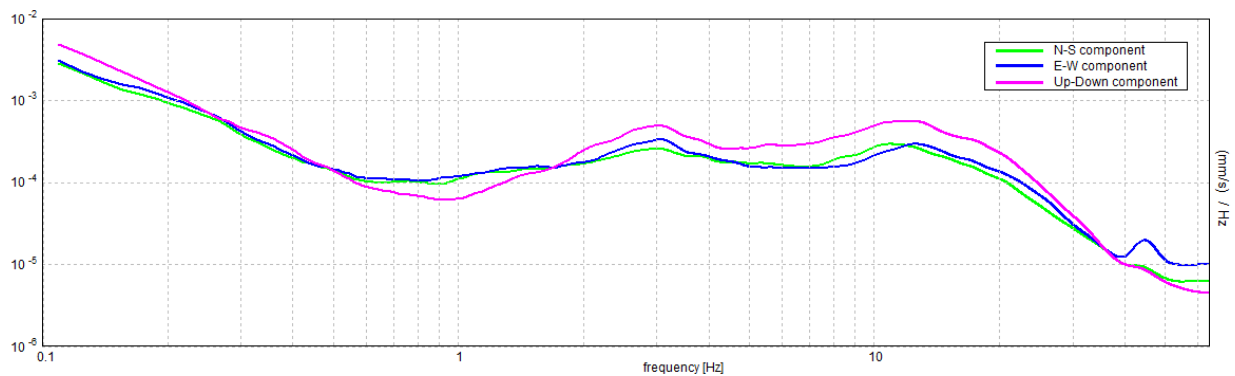
H/V TIME HISTORY



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 1.02 ± 0.01 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$1.02 > 0.17$	OK	
$n_c(f_0) > 200$	$3473.4 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 98 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$	0.422 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.859 Hz	OK	
$A_0 > 2$	$1.87 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.00334 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00339 < 0.10156$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.249 < 1.78$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR11

Instrument: TRZ-0108/01-10

Start recording: 08/07/20 09:51:20 End recording: 08/07/20 10:51:21

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 97% trace (manual window selection)

Sampling rate: 128 Hz

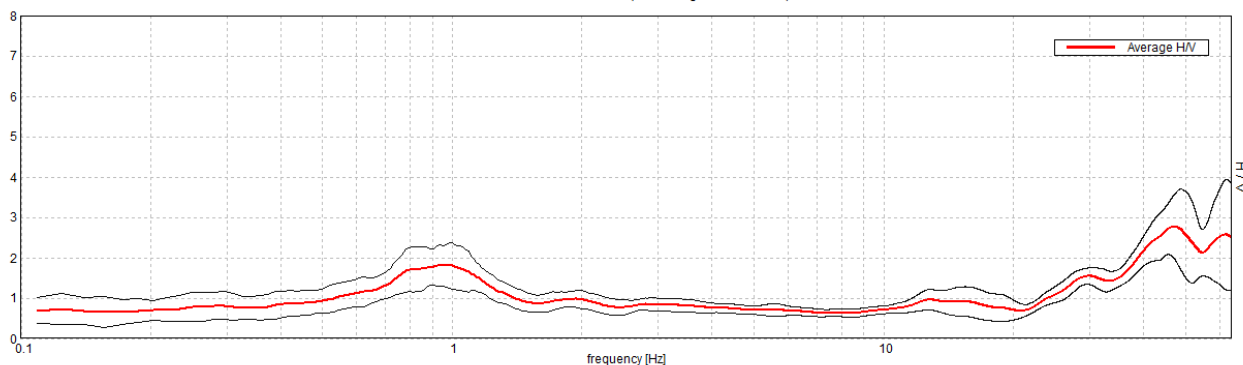
Window size: 60 s

Smoothing type: Triangular window

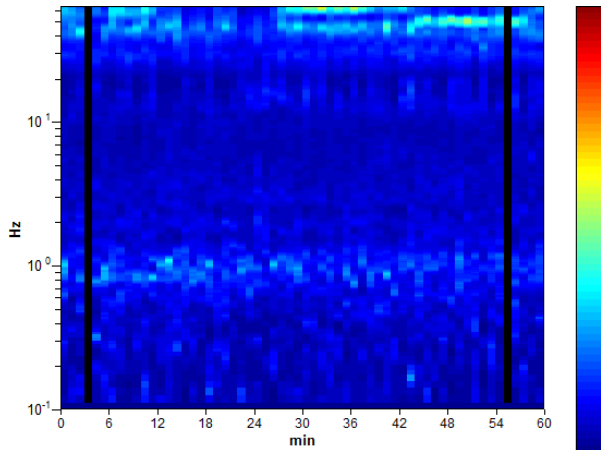
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

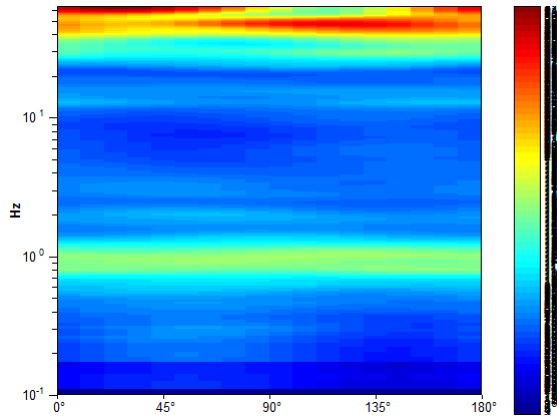
Max. H/V at 0.94 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



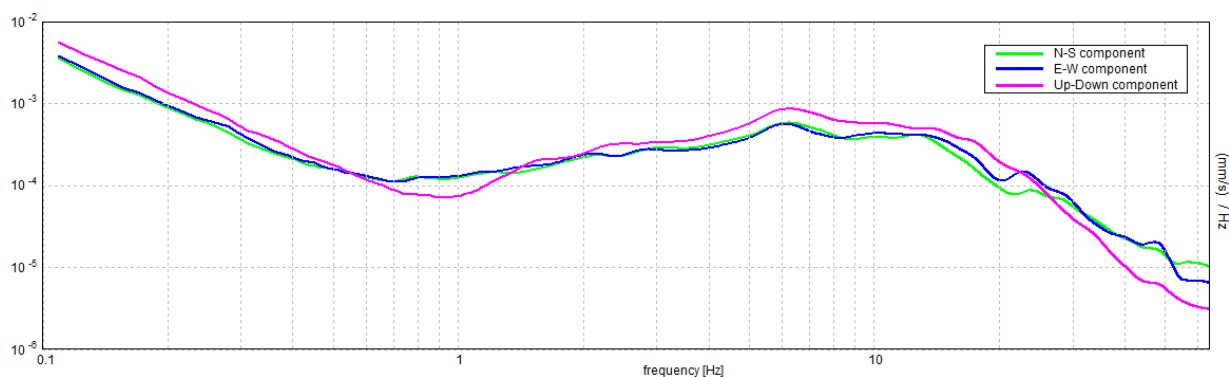
H/V TIME HISTORY



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 0.94 ± 0.03 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.94 > 0.17$	OK	
$n_c(f_0) > 200$	$3262.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 91 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.469 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.5 Hz	OK	
$A_0 > 2$	$1.81 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01459 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01368 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2498 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

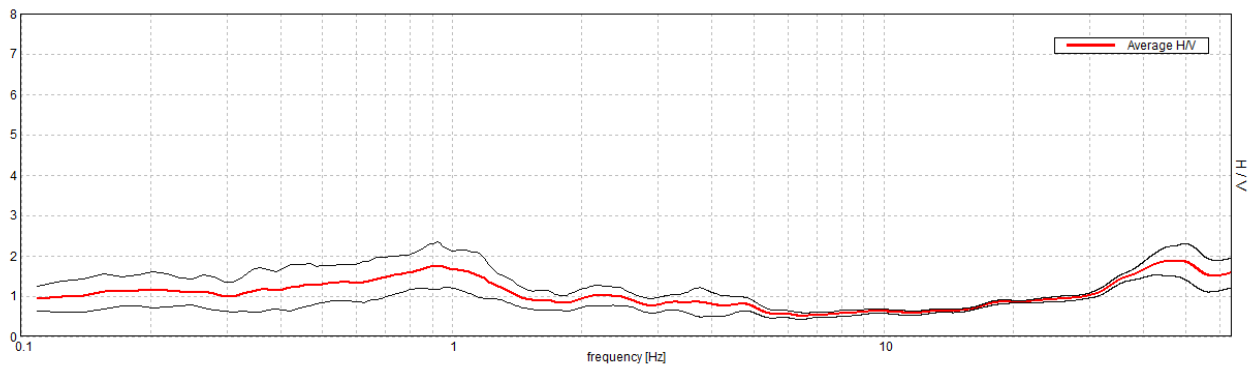
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR12

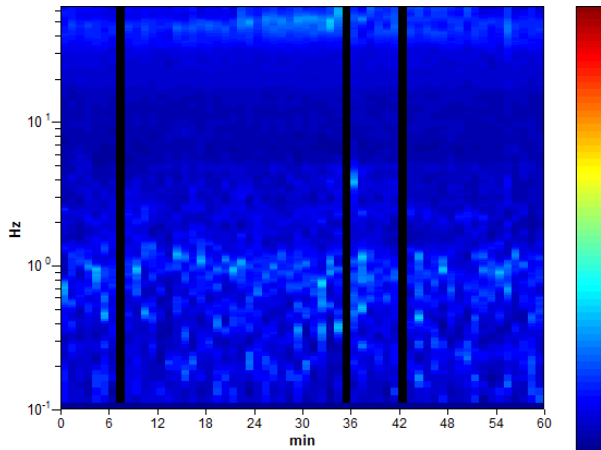
Instrument: TRZ-0108/01-10
Start recording: 08/07/20 12:00:04 End recording: 08/07/20 13:00:04
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 1h00'00". Analyzed 95% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 60 s
Smoothing type: Triangular window
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

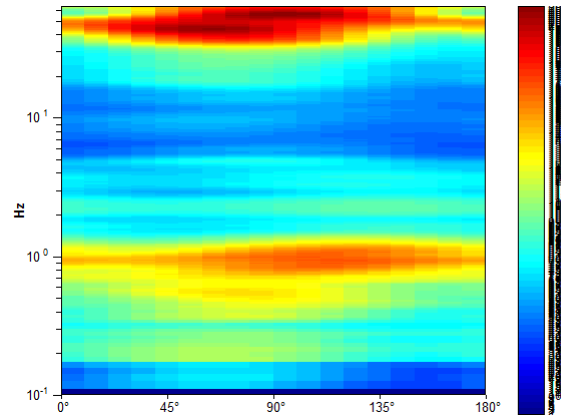
Max. H/V at 0.92 ± 0.02 Hz. (In the range 0.1 - 20.0 Hz).



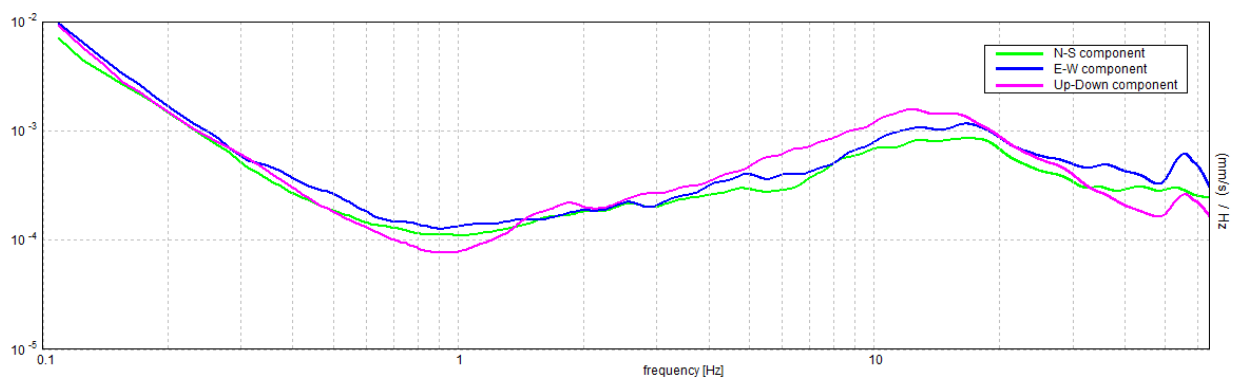
H/V TIME HISTORY



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 0.92 ± 0.02 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.92 > 0.17$	OK	
$n_c(f_0) > 200$	$3152.8 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 90 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.703 Hz	OK	
$A_0 > 2$	$1.74 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01281 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01181 < 0.13828$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2917 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR13

Instrument: TRZ-0108/01-10

Start recording: 08/07/20 14:45:27 End recording: 08/07/20 15:45:28

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 92% trace (manual window selection)

Sampling rate: 128 Hz

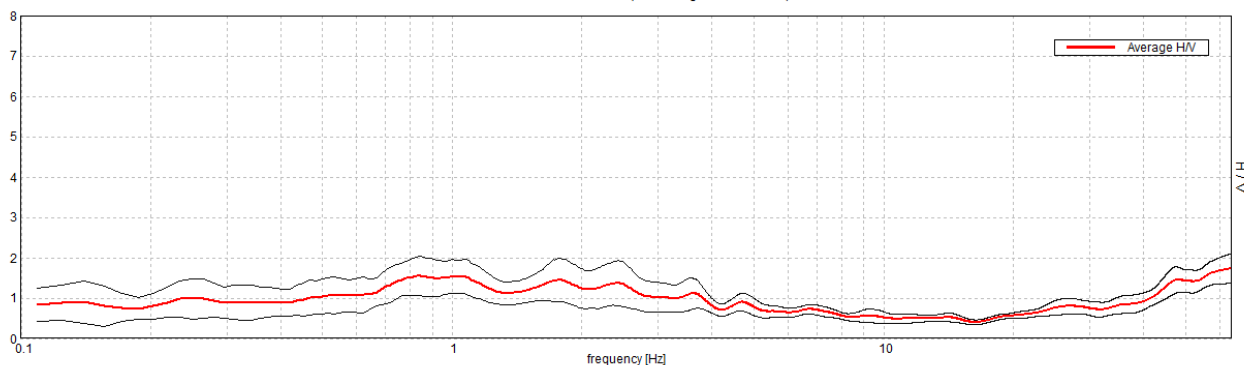
Window size: 60 s

Smoothing type: Triangular window

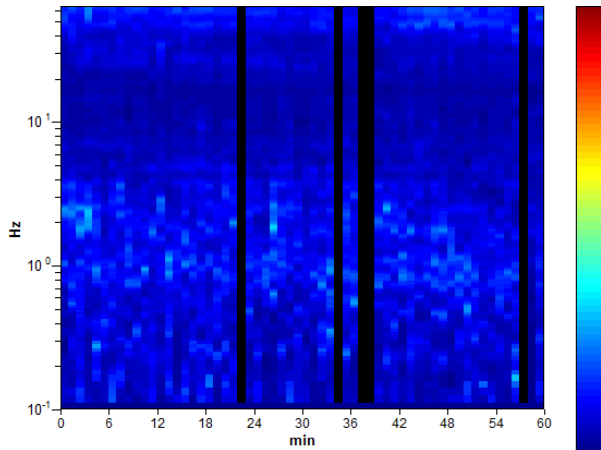
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

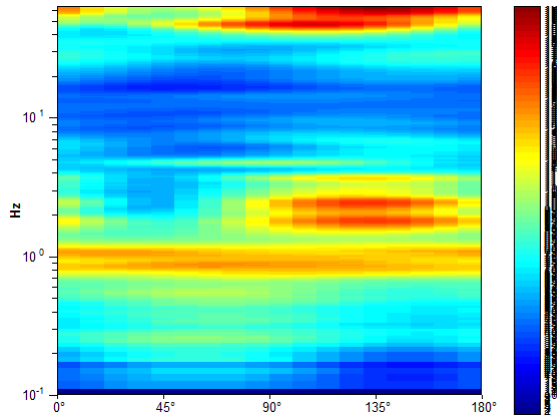
Max. H/V at 0.84 ± 0.23 Hz. (In the range 0.1 - 20.0 Hz).



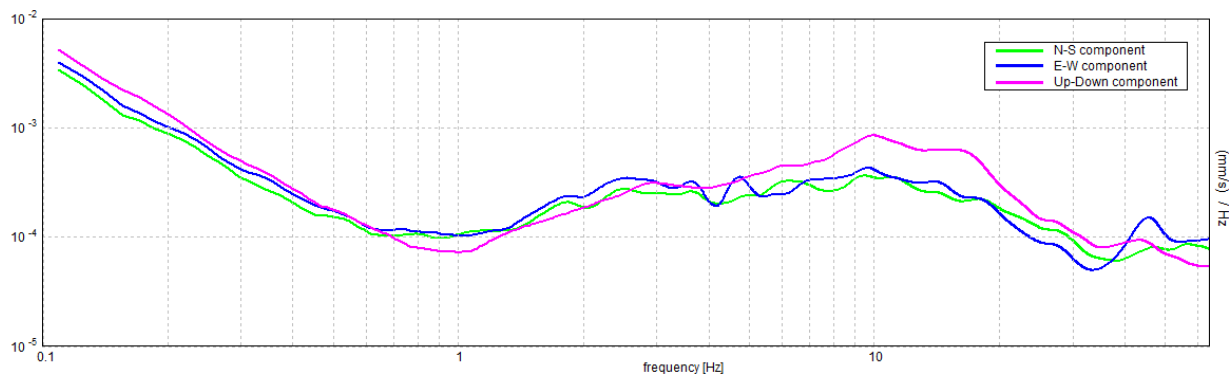
H/V TIME HISTORY



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 0.84 ± 0.23 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.84 > 0.17$	OK	
$n_c(f_0) > 200$	$2784.4 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 82 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$			NO
$A_0 > 2$	$1.54 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.13538 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.11422 < 0.12656$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2414 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR14

Instrument: TRZ-0108/01-10

Start recording: 10/07/20 10:33:12 End recording: 10/07/20 11:33:13

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 85% trace (manual window selection)

Sampling rate: 128 Hz

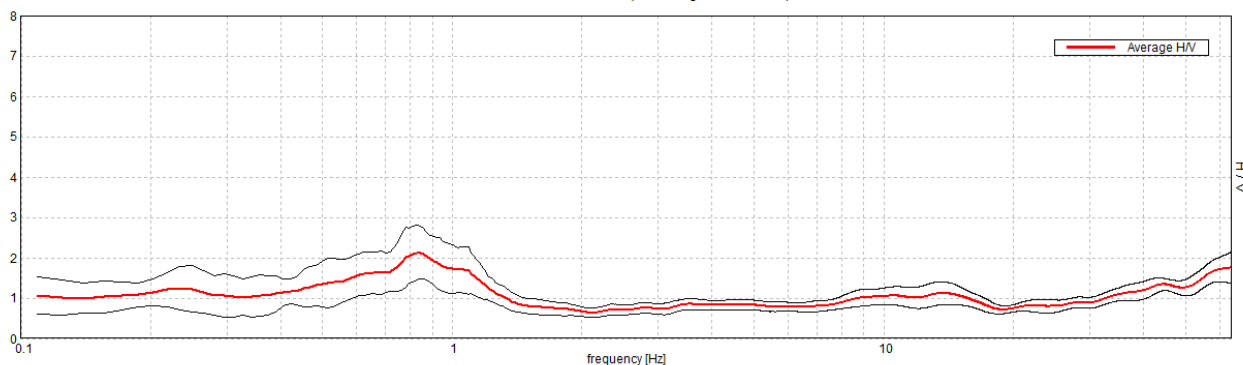
Window size: 60 s

Smoothing type: Triangular window

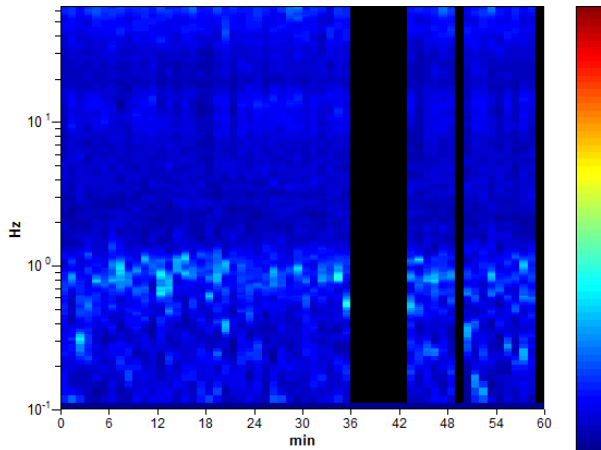
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

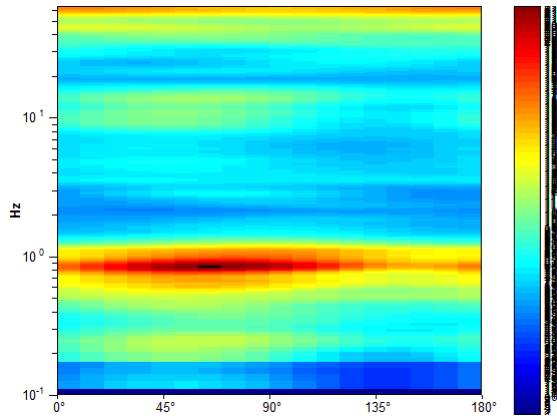
Max. H/V at 0.83 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



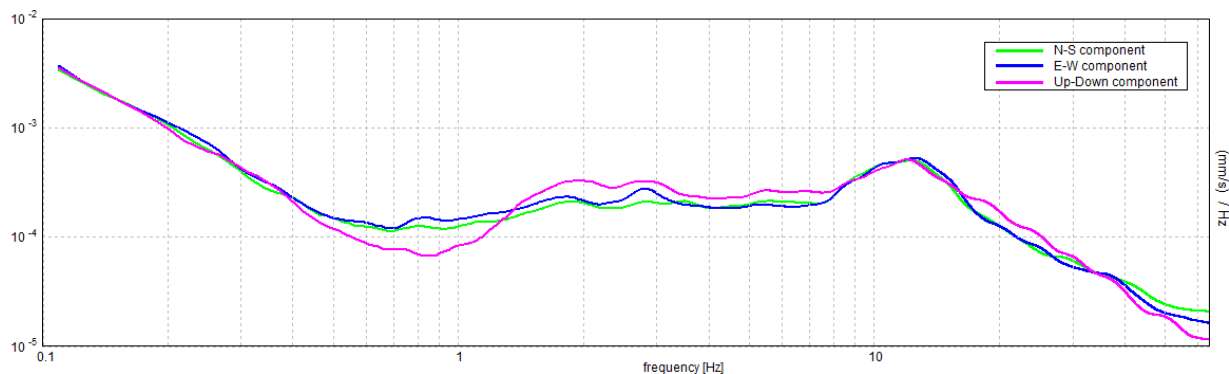
H/V TIME HISTORY



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 0.83 ± 0.03 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.83 > 0.17$	OK	
$n_c(f_0) > 200$	$2534.1 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 80 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$	0.359 Hz	OK	
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.313 Hz	OK	
$A_0 > 2$	$2.12 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.0188 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01557 < 0.12422$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3345 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

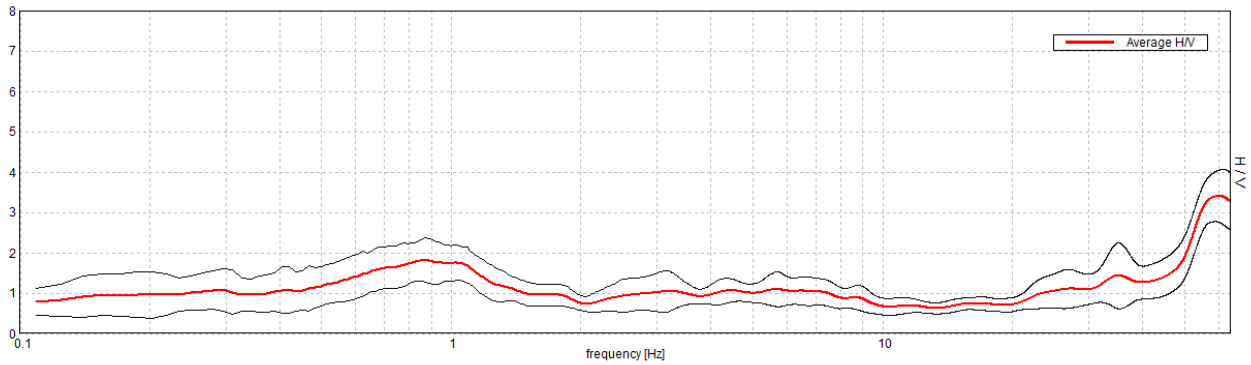
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR15

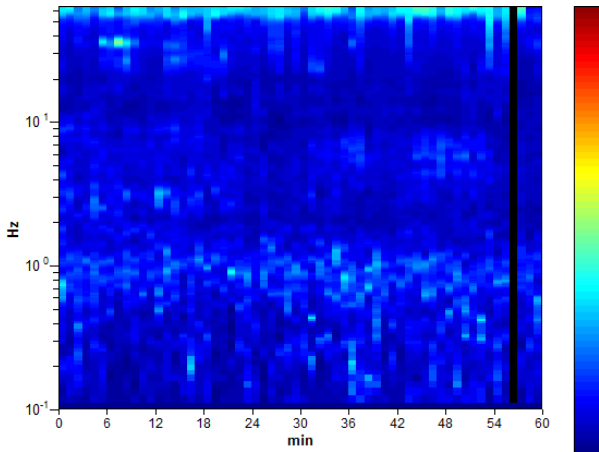
Instrument: TRZ-0108/01-10
Start recording: 10/07/20 12:07:33 End recording: 10/07/20 13:07:33
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
Trace length: 1h00'00". Analyzed 98% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 60 s
Smoothing type: Triangular window
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

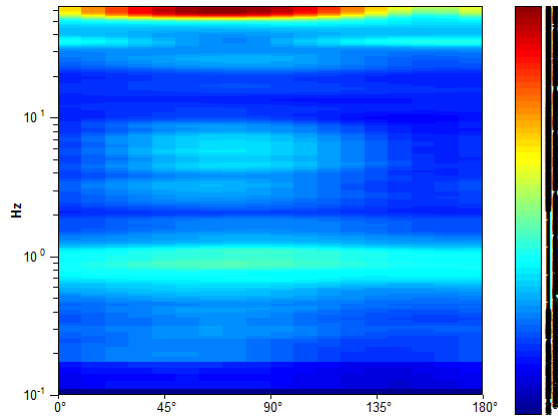
Max. H/V at 0.88 ± 0.02 Hz. (In the range 0.1 - 20.0 Hz).



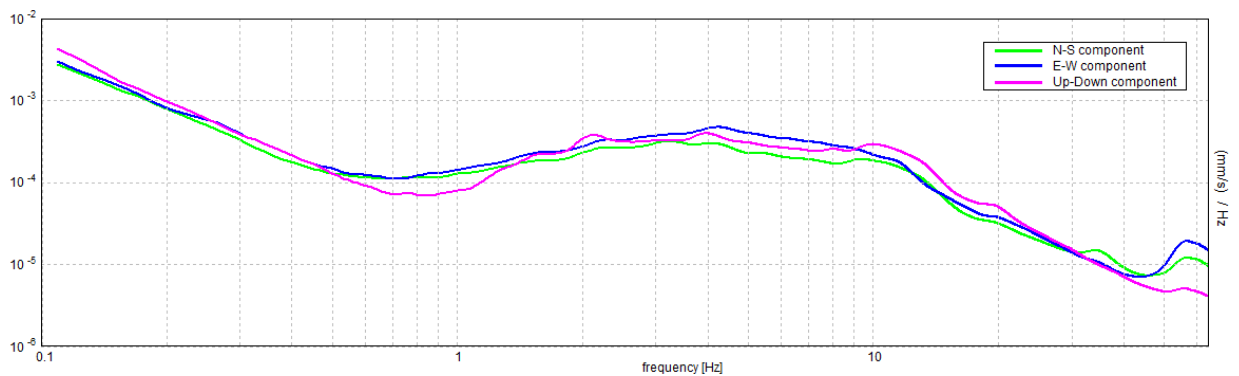
H/V TIME HISTORY



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 0.88 ± 0.02 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.88 > 0.17$	OK	
$n_c(f_0) > 200$	$3097.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 85 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.859 Hz	OK	
$A_0 > 2$	$1.82 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01283 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01123 < 0.13125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.273 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_A(f_0)$

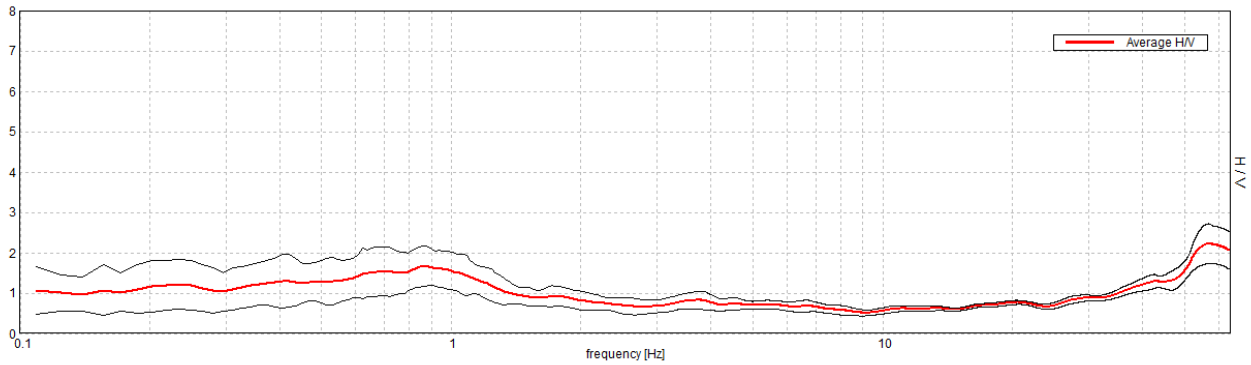
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	$0.25 f_0$	$0.2 f_0$	$0.15 f_0$	$0.10 f_0$	$0.05 f_0$
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
$\log \theta(f_0)$ for $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR16

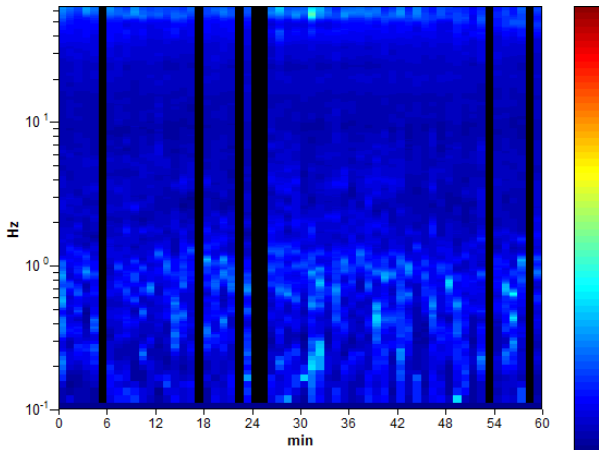
Instrument: TRZ-0108/01-10
 Start recording: 10/07/20 14:13:04 End recording: 10/07/20 15:13:04
 Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
 Trace length: 1h00'00". Analyzed 88% trace (manual window selection)
 Sampling rate: 128 Hz
 Window size: 60 s
 Smoothing type: Triangular window
 Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

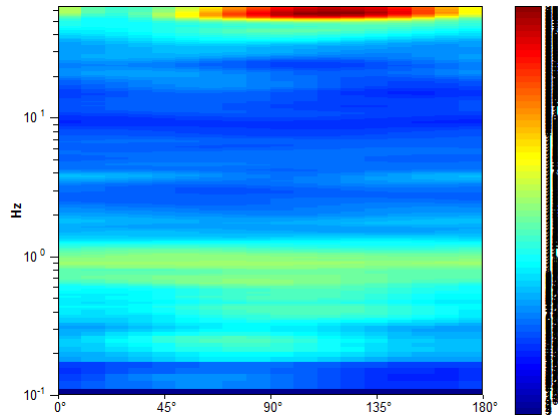
Max. H/V at 0.88 ± 0.02 Hz. (In the range 0.1 - 20.0 Hz).



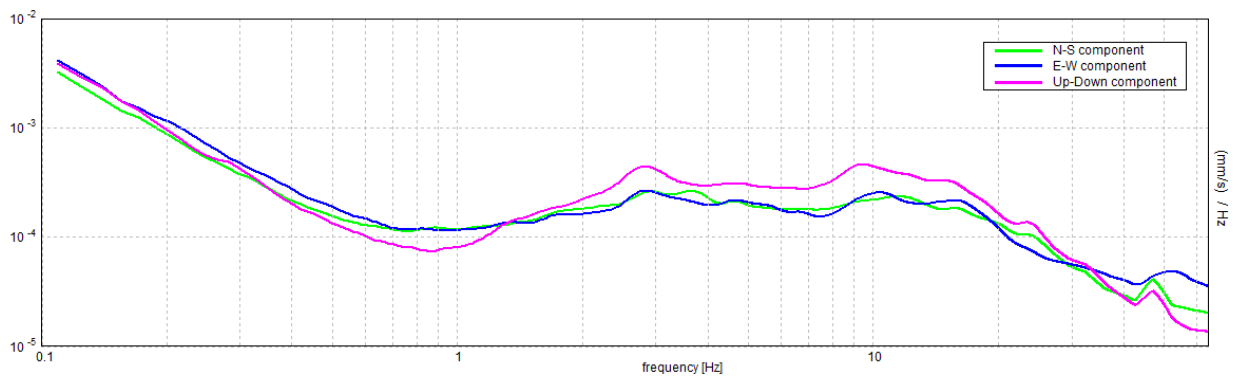
H/V TIME HISTORY



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 0.88 ± 0.02 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.88 > 0.17$	OK	
$n_c(f_0) > 200$	$2782.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 85 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.953 Hz	OK	
$A_0 > 2$	$1.67 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01063 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.0093 < 0.13125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2476 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR17

Instrument: TRZ-0108/01-10

Start recording: 29/07/20 11:39:50 End recording: 29/07/20 12:39:51

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 1h00'00". Analyzed 98% trace (manual window selection)

Sampling rate: 128 Hz

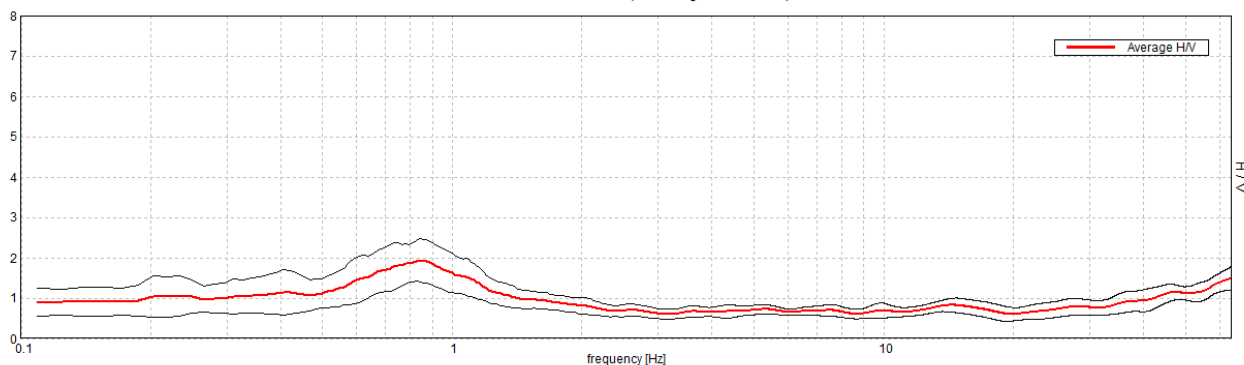
Window size: 60 s

Smoothing type: Triangular window

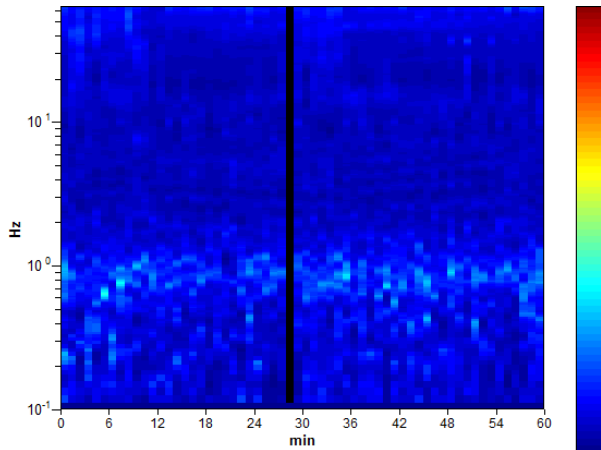
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

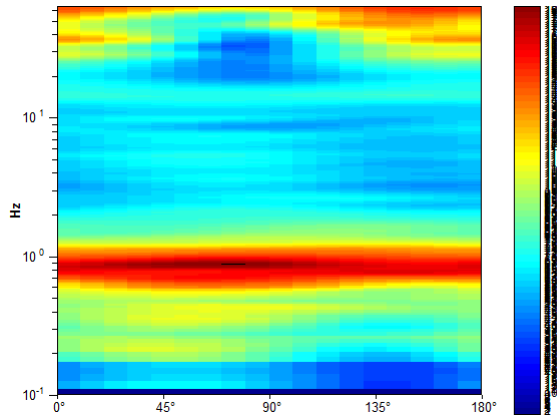
Max. H/V at 0.84 ± 0.01 Hz. (In the range 0.1 - 20.0 Hz).



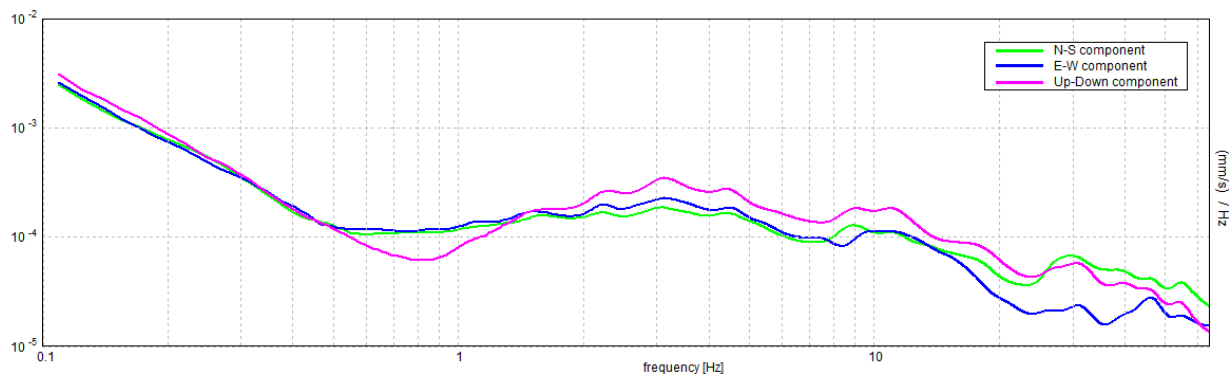
H/V TIME HISTORY



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 0.84 ± 0.01 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.84 > 0.17$	OK	
$n_c(f_0) > 200$	$2986.9 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 82 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.469 Hz	OK	
$A_0 > 2$	$1.93 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.00696 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.00587 < 0.12656$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.2638 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

GEOLOG S.R.L.

Cone Penetration Test (CPTU) - Date: 16/07/2020 13:42:18

Site: Indagini geognostiche per microzonazione sismica - Test: SCPTU1

Company information

Name: GEOLOG S.R.L.

Address: VIALE DELLA LIRICA, 15

Zip code: 48124

City: RAVENNA

P.IVA: 02194680399

E-Mail: geologsrl@virgilio.it

Phone number: 0544/202700

Fax number: 0544/202700

Site information

Name: Indagini geognostiche per microzonazione sismica

Date: 15/07/2020

Commissioner: Dr. Geol. Samuel Sangiorgi

Locality: Minerbio -BO-

Test information

Name: SCPTU1

Location:

Date: 16/07/2020 13:42:18

Prehole mode: Y

Prehole depth [cm]: 100

Hydrostatic line [cm]: 300

Ground level [cm]: 0

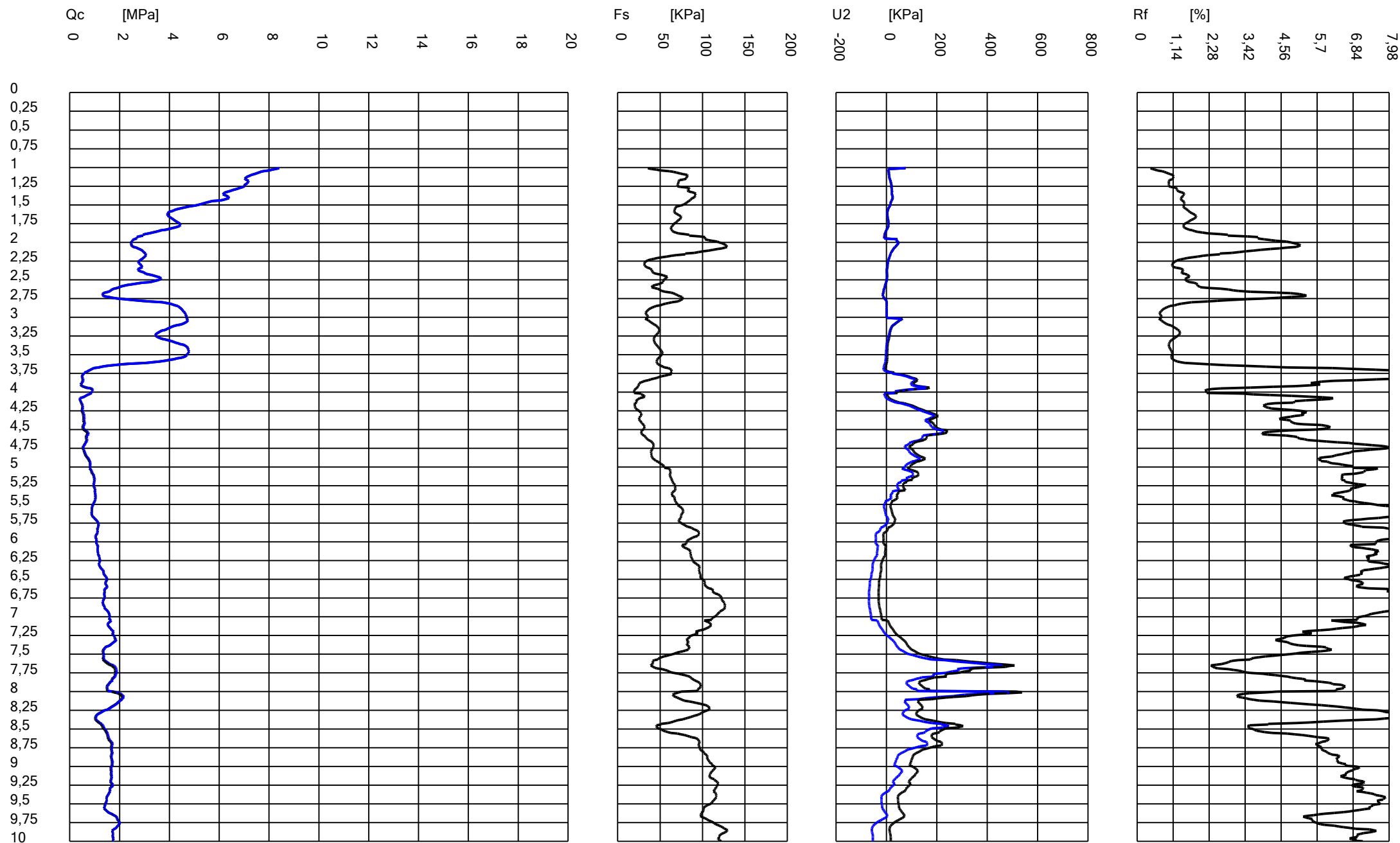
Latitude: 0

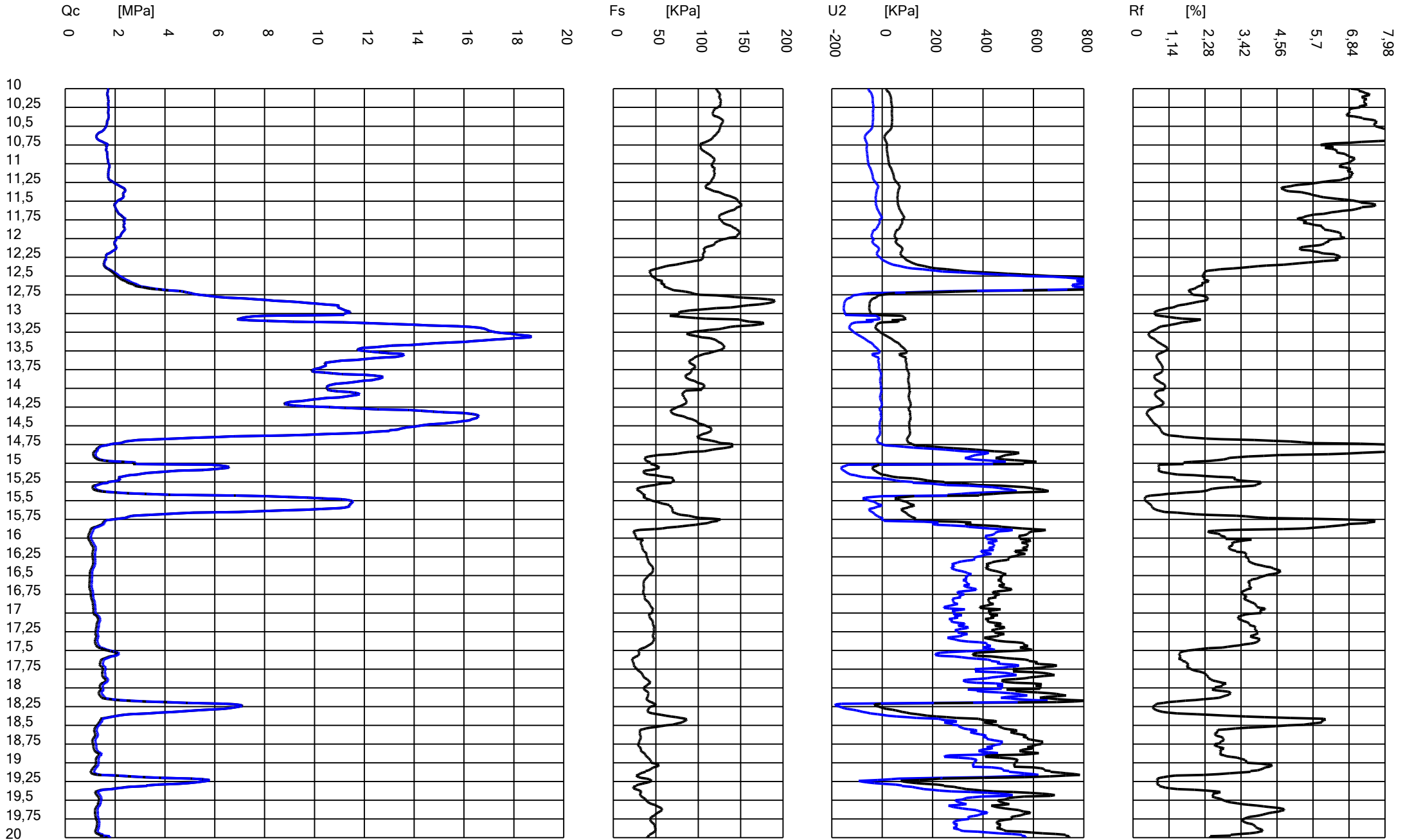
Longitude: 0

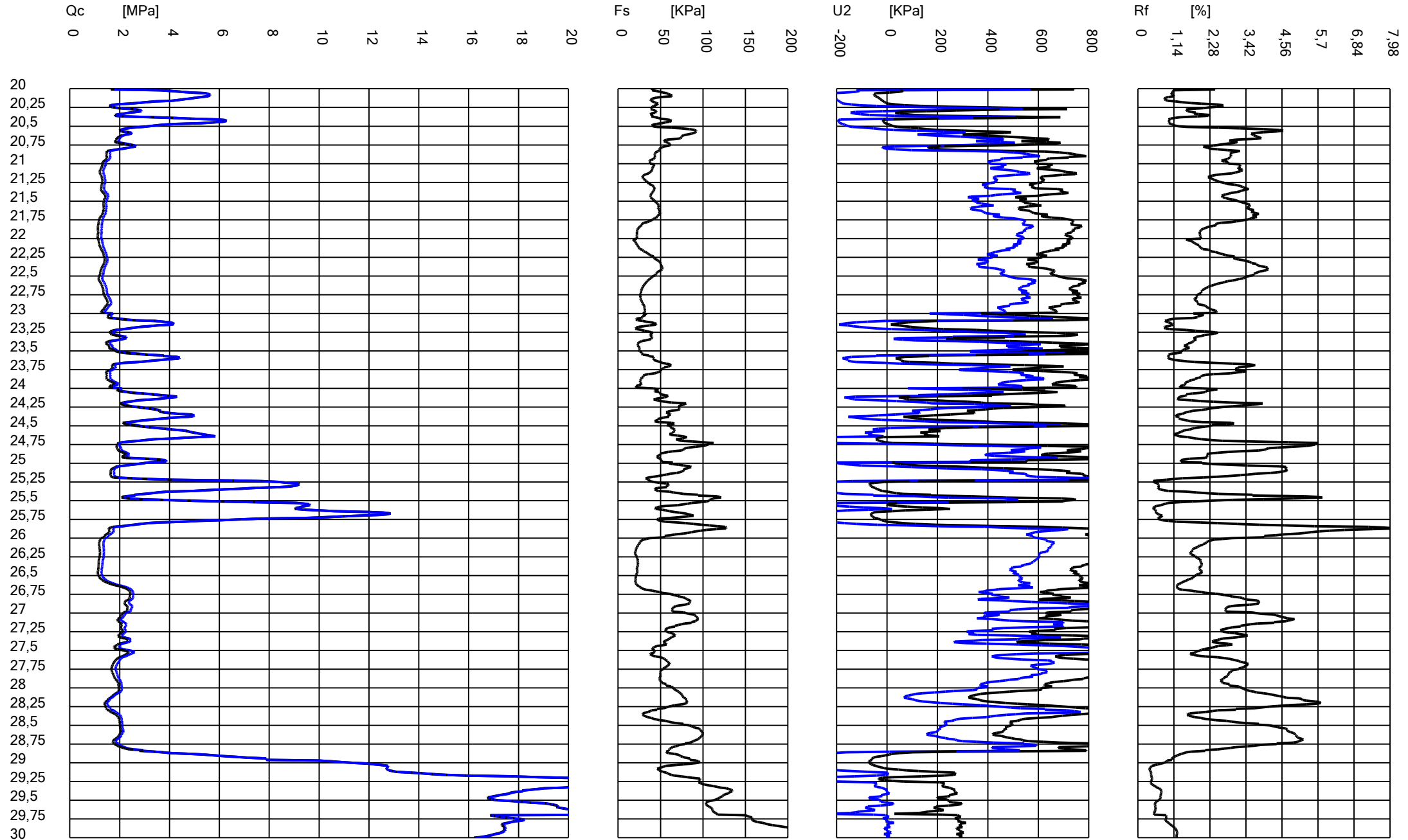
Operator:

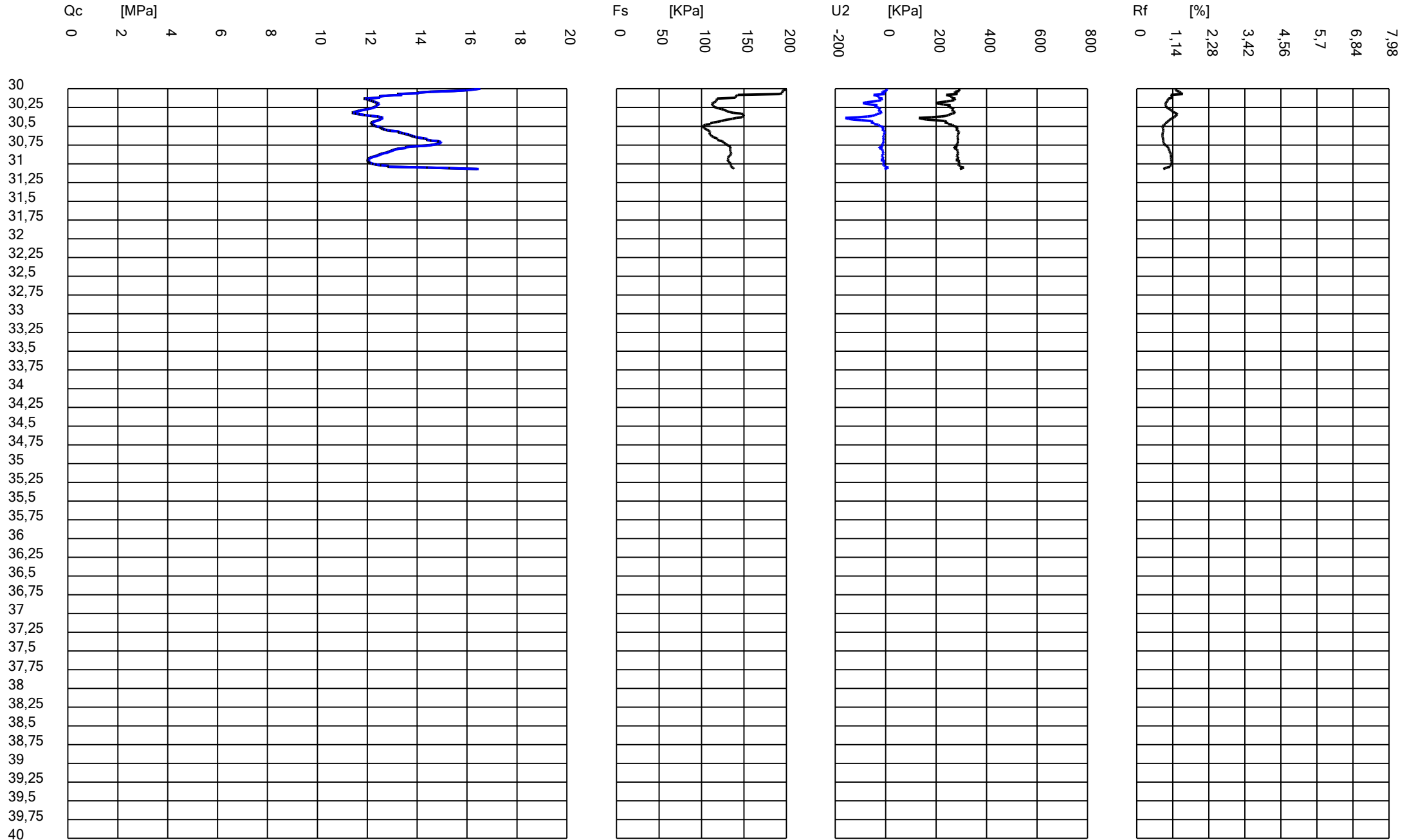
Comments:

Probe code: MKj584

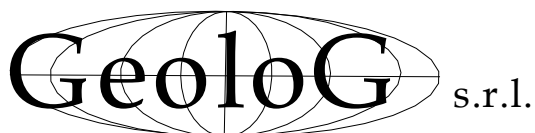








STIMA DELLA Vs30
MINERBIO-BO-VIALE DELLA REPUBBLICA



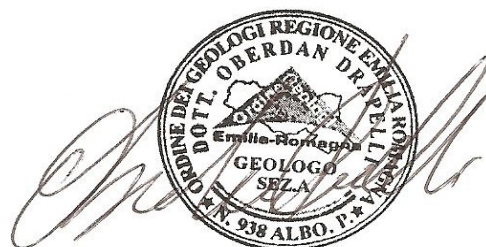
PROVA N	SCPTU 1
DATA	16/07/2020

COMMITTENTE	COMUNE DI MINERBIO-BO-
LOCALITA'	MINERBIO VIALE DELLA REPUBBLICA
PROFONDITA' DELLA PROVA	31
PROFONDITA' DELLA FALDA	3,00 m
PREFORO	1

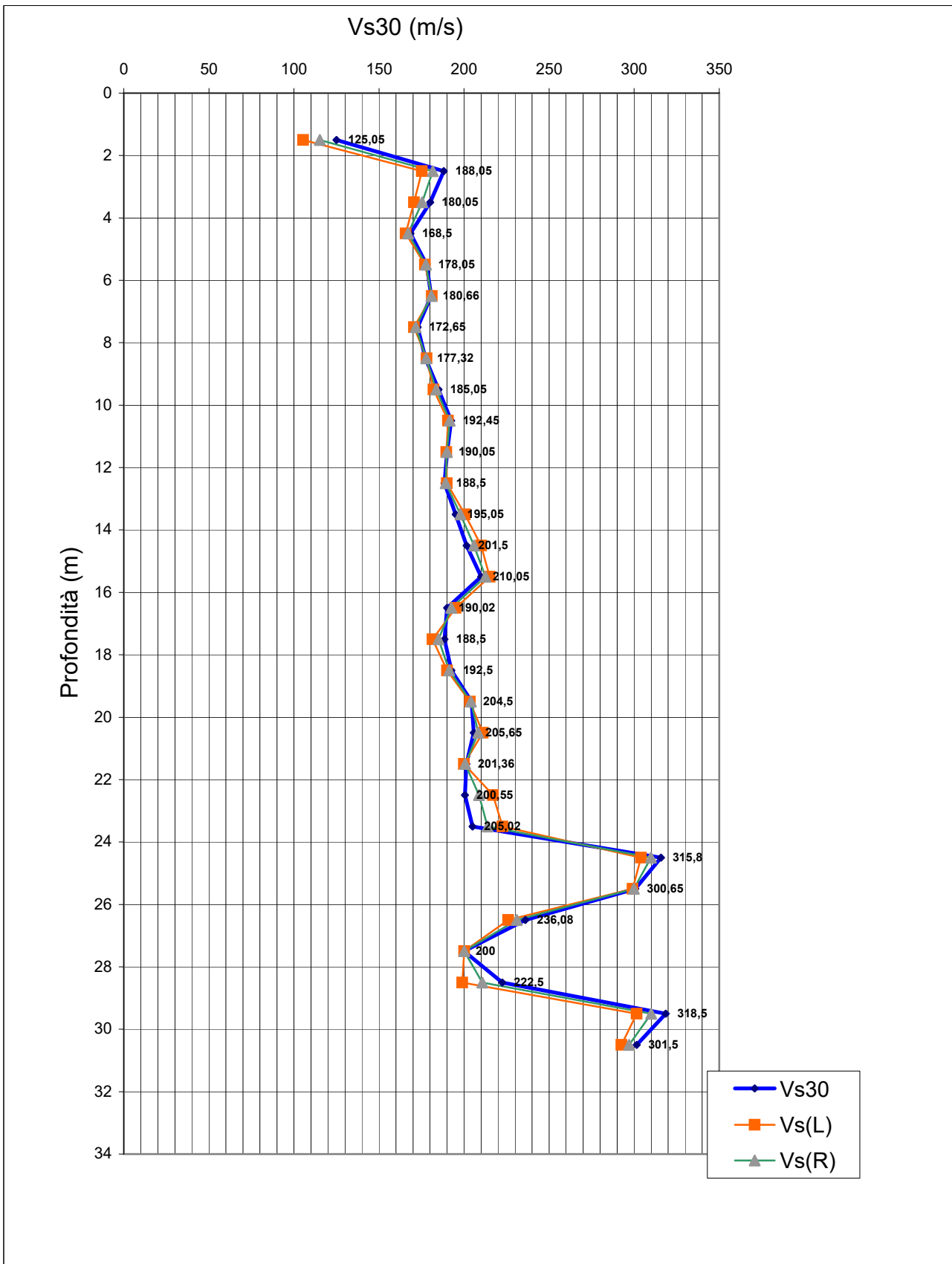
Depth [m]	Vs [m/s]		Vs [m/s] RIGHT	Vs [m/s] MEDIA
	LEFT			
1,5	105,5		125,05	115,275
2,5	175,2		188,05	181,625
3,5	170,65		180,05	175,35
4,5	165,65		168,5	167,075
5,5	177,05		178,05	177,55
6,5	181,02		180,66	180,84
7,5	170,55		172,65	171,6
8,5	178,05		177,32	177,685
9,5	182,02		185,05	183,535
10,5	190,65		192,45	191,55
11,5	189,68		190,05	189,865
12,5	189,95		188,5	189,225
13,5	200,55		195,05	197,8
14,5	210,05		201,5	205,775
15,5	215,02		210,05	212,535
16,5	195,02		190,02	192,52
17,5	181,5		188,5	185
18,5	190,05		192,5	191,275
19,5	203,5		204,5	204
20,5	211,05		205,65	208,35
21,5	200,01		201,36	200,685
22,5	216,98		200,55	208,765
23,5	222,65		205,02	213,835
24,5	304,05		315,8	309,925
25,5	299,05		300,65	299,85
26,5	226		236,08	231,04
27,5	200,14		200	200,07
28,5	198,98		222,5	210,74
29,5	301,5		318,5	310
30,5	292,52		301,5	297,01

STIMA DELLA Vs30 192,42 196,38 MEDIA 194,57

GEOLOG SRL
DOTT GEOL DRAPELLI OBERDAN



STIMA DELLA Vs 30 -MINERBIO-BO-VIALE DELLA REPUBBLICA



GEOLOG S.R.L.

Cone Penetration Test (CPTU) - Date: 16/07/2020 16:23:11

Site: Indagini geognostiche per microzonazione sismica - Test: SCPTU 2

Company information

Name: GEOLOG S.R.L.

Address: VIALE DELLA LIRICA, 15

Zip code: 48124

City: RAVENNA

P.IVA: 02194680399

E-Mail: geologsrl@virgilio.it

Phone number: 0544/202700

Fax number: 0544/202700

Site information

Name: Indagini geognostiche per microzonazione sismica

Date: 15/07/2020

Commissioner: Dr. Geol. Samuel Sangiorgi

Locality: Minerbio -BO-

Test information

Name: SCPTU 2

Location: MINERBIO

Date: 16/07/2020 16:23:11

Prehole mode:

Prehole depth [cm]: 0

Hydrostatic line [cm]: 300

Ground level [cm]: 0

Latitude: 0

Longitude: 0

Operator:

Comments: D_R

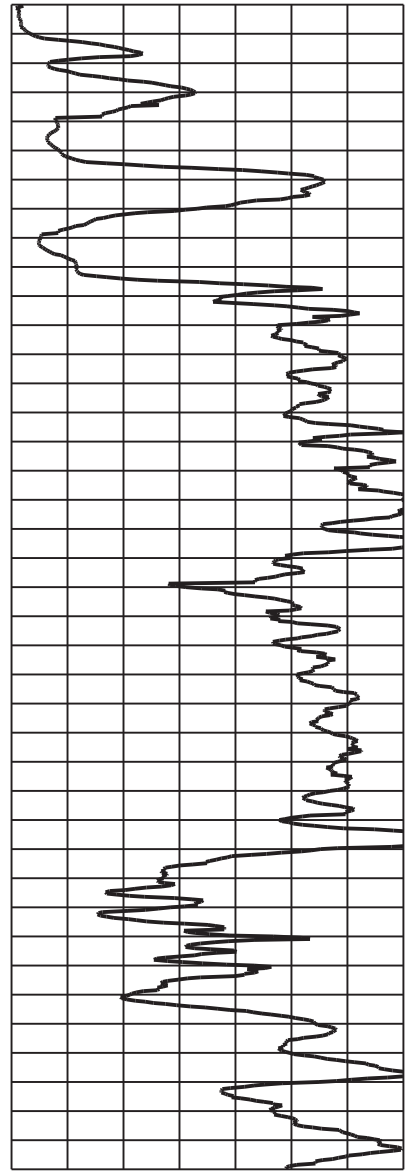
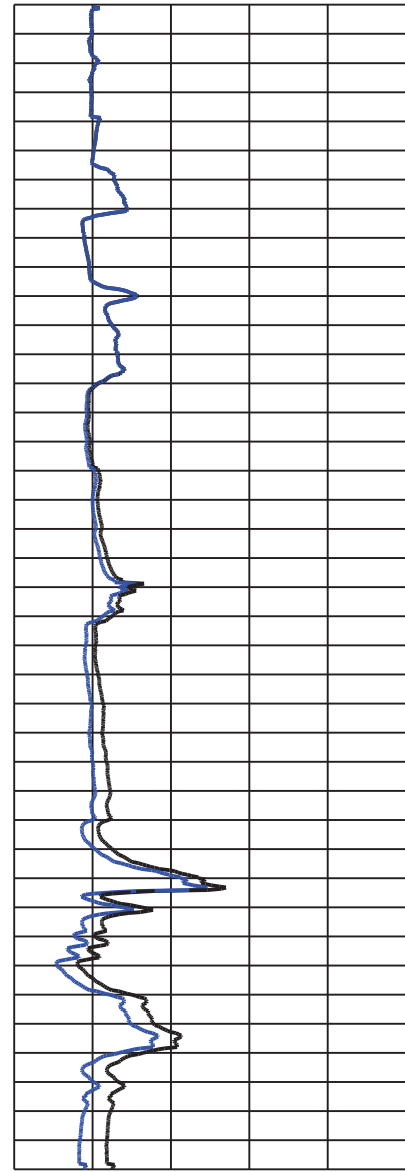
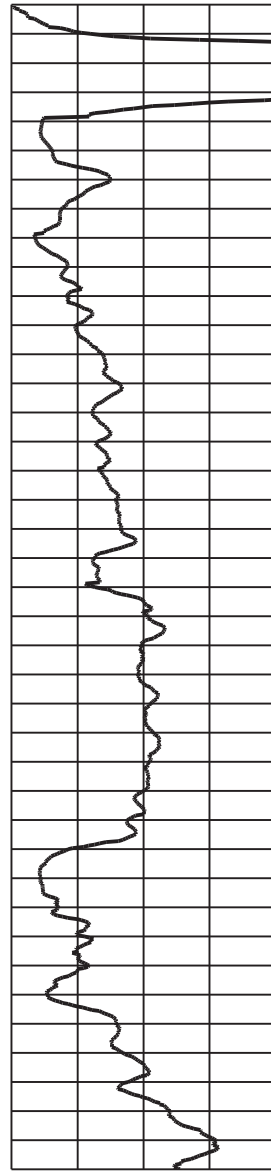
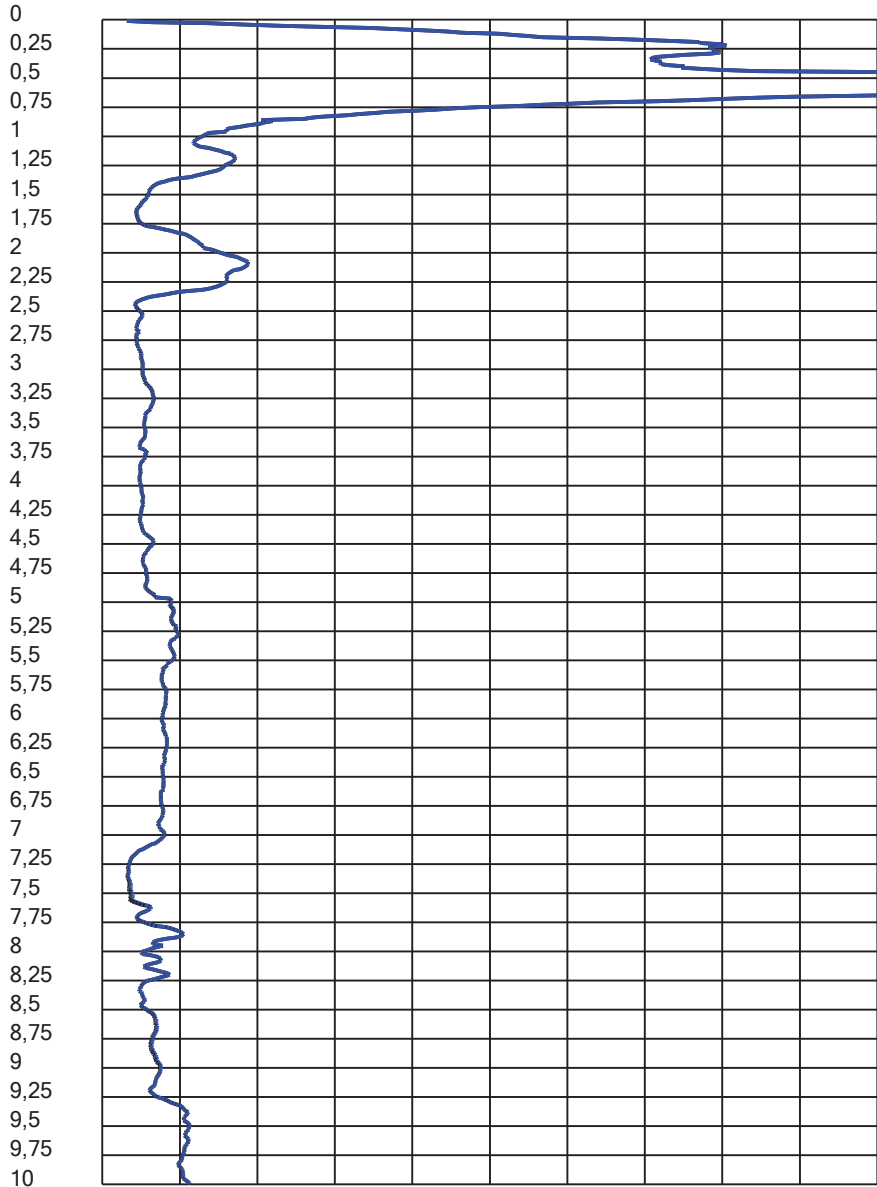
Probe code: MKj584

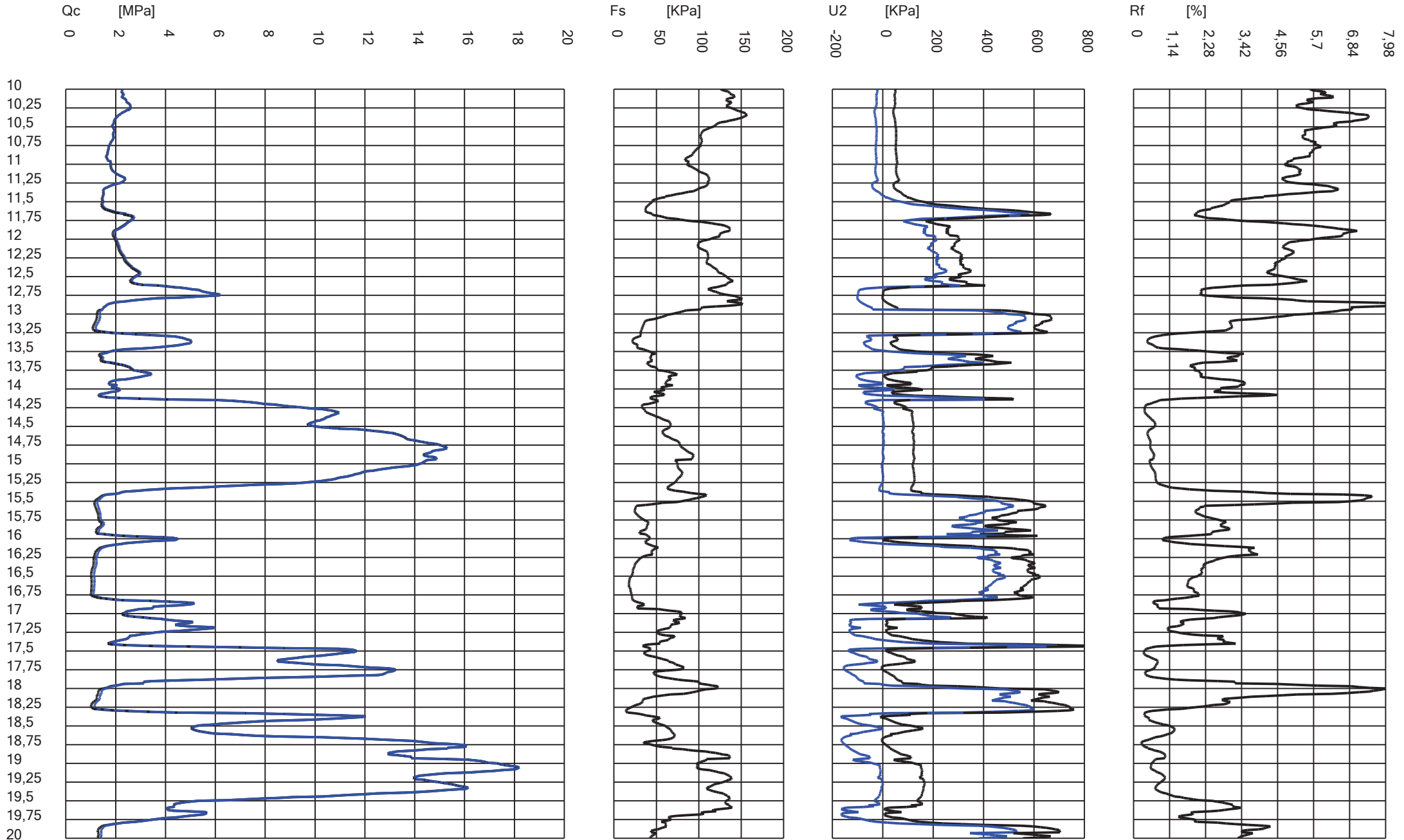
Qc [MPa]
0 2 4 6 8 10 12 14 16 18 20

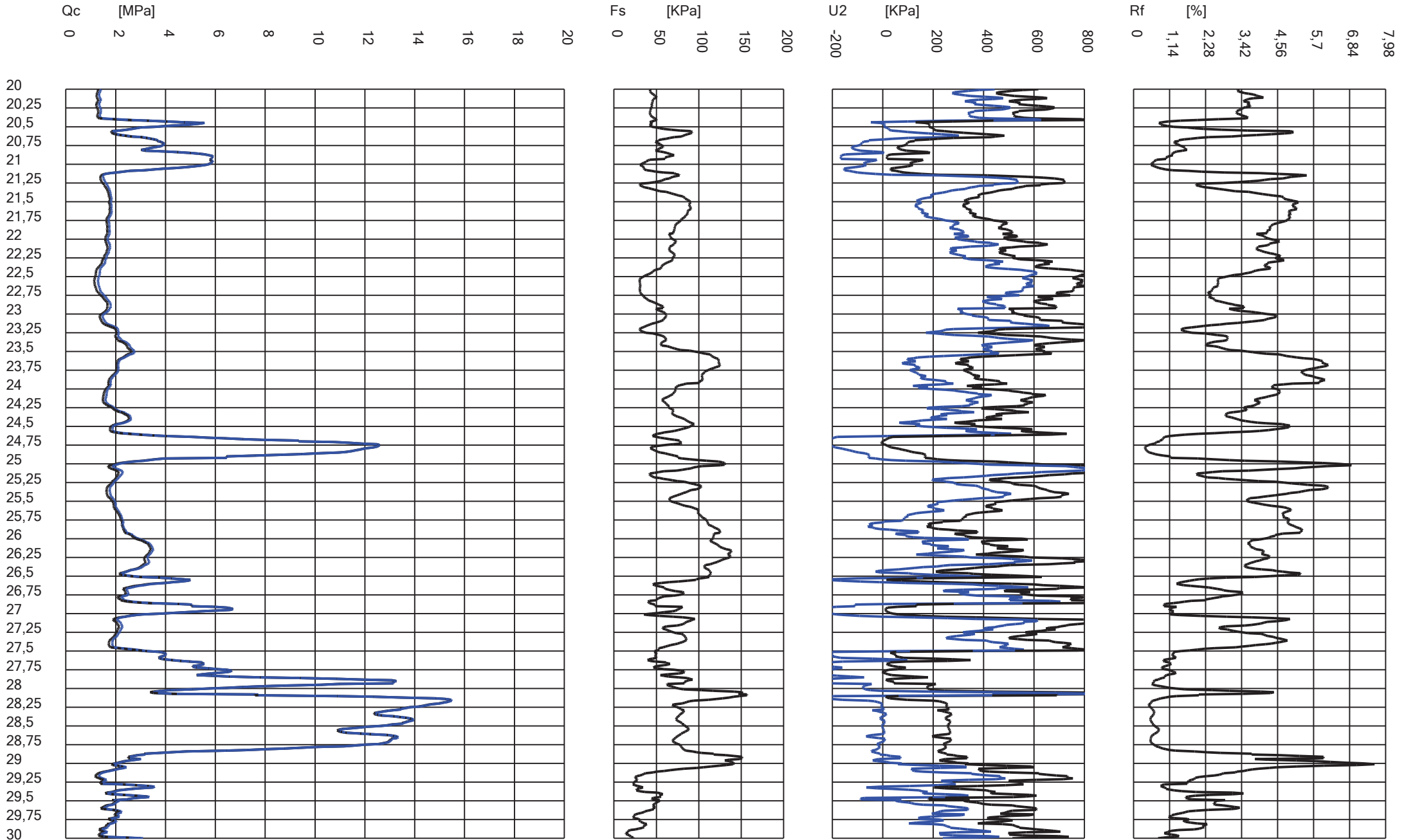
Fs [KPa]
0 50 100 150 200

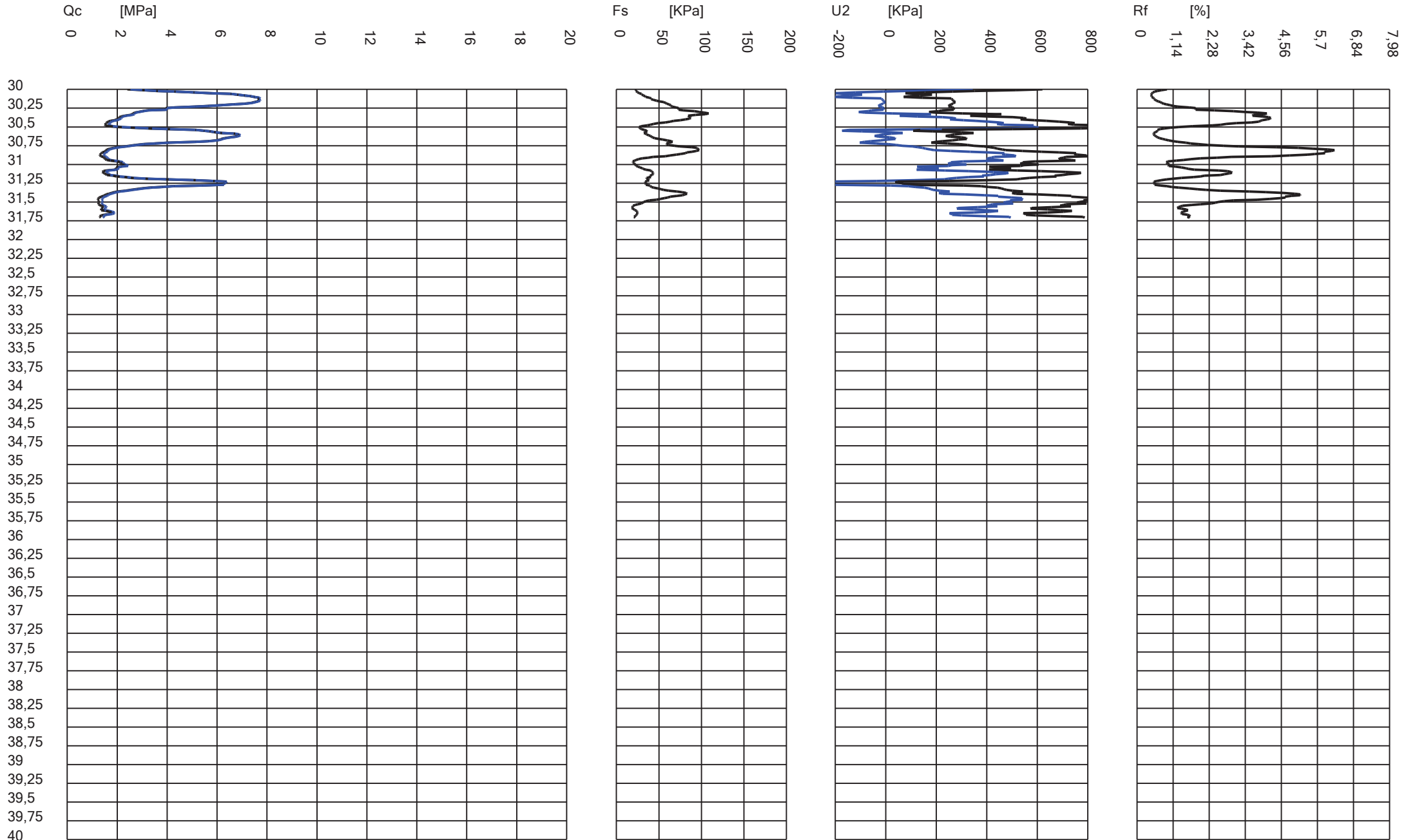
U2 [KPa]
-200 0 200 400 600 800

Rf [%]
0 1,14 2,28 3,42 4,56 5,7 6,84 7,98

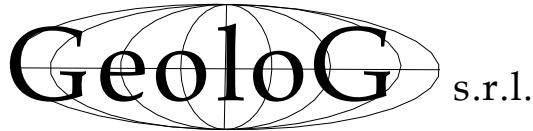








STIMA DELLA Vs30
MINERBIO-BO-CA FABBRI



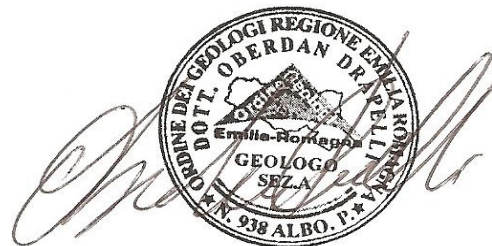
PROVA N	SCPTU 2
DATA	16/07/2020

COMMITTENTE	COMUNE DI MINERBIO-BO-
LOCALITA'	MINERBIO CA FABBRI
PROFONDITA' DELLA PROVA	31
PROFONDITA' DELLA FALDA	3,00 m
PREFORO	1,00 m

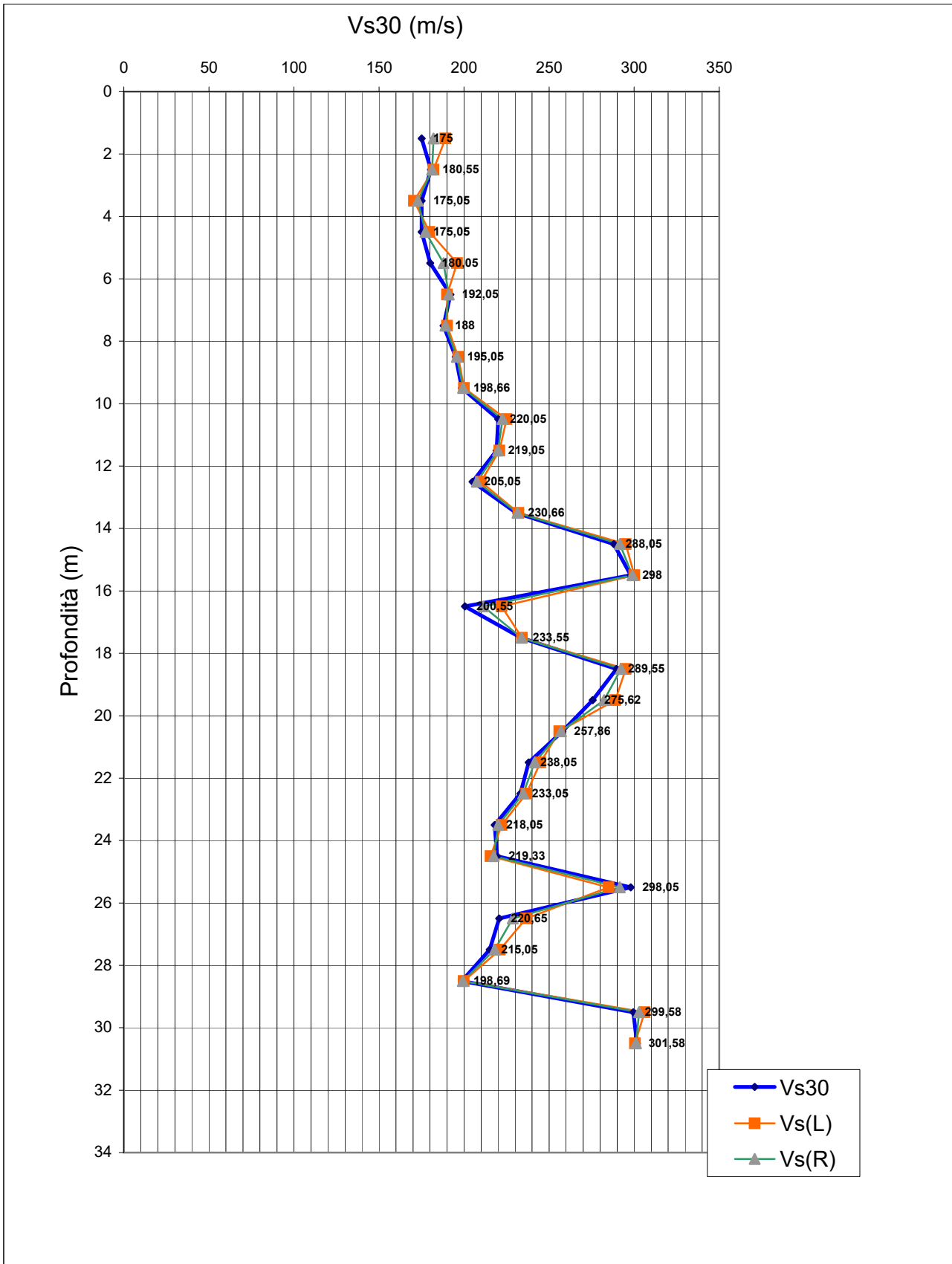
Depth [m]	Vs [m/s]		Vs [m/s] MEDIA
	LEFT	RIGHT	
1,5	189,02	175	182,01
2,5	182,02	180,55	181,285
3,5	170,65	175,05	172,85
4,5	179,65	175,05	177,35
5,5	195,86	180,05	187,955
6,5	190,05	192,05	191,05
7,5	189,98	188	188,99
8,5	196,58	195,05	195,815
9,5	200,01	198,66	199,335
10,5	225,05	220,05	222,55
11,5	220,85	219,05	219,95
12,5	209,88	205,05	207,465
13,5	232,05	230,66	231,355
14,5	295,08	288,05	291,565
15,5	300,02	298	299,01
16,5	222,05	200,55	211,3
17,5	234,05	233,55	233,8
18,5	295,08	289,55	292,315
19,5	288,95	275,62	282,285
20,5	256,05	257,86	256,955
21,5	244,88	238,05	241,465
22,5	236,55	233,05	234,8
23,5	222,01	218,05	220,03
24,5	215,65	219,33	217,49
25,5	285	298,05	291,525
26,5	236,5	220,65	228,575
27,5	221,05	215,05	218,05
28,5	199,88	198,69	199,285
29,5	306,05	299,58	302,815
30,5	300,55	301,58	301,065

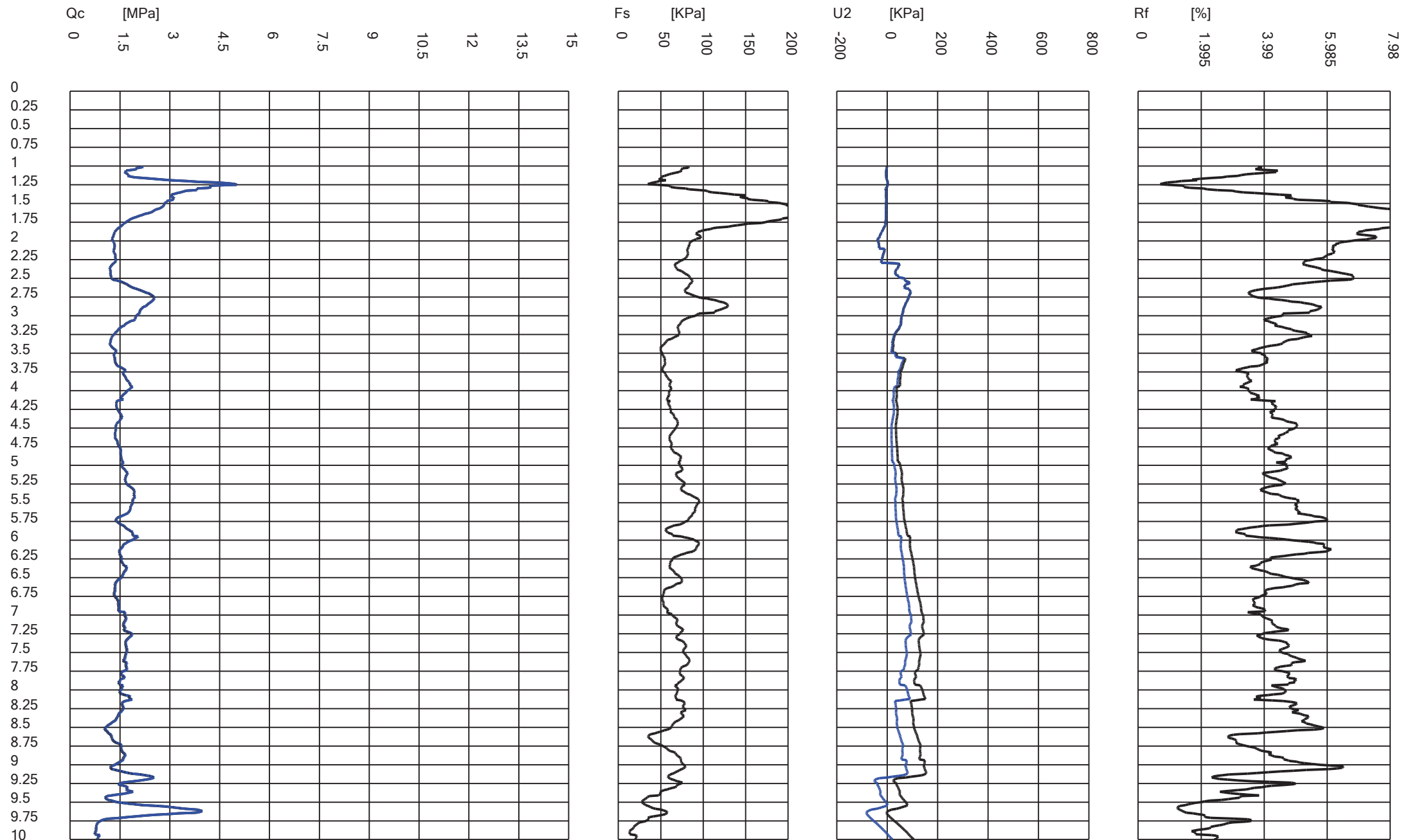
STIMA DELLA Vs30 223,01 218,41 MEDIA 220,77

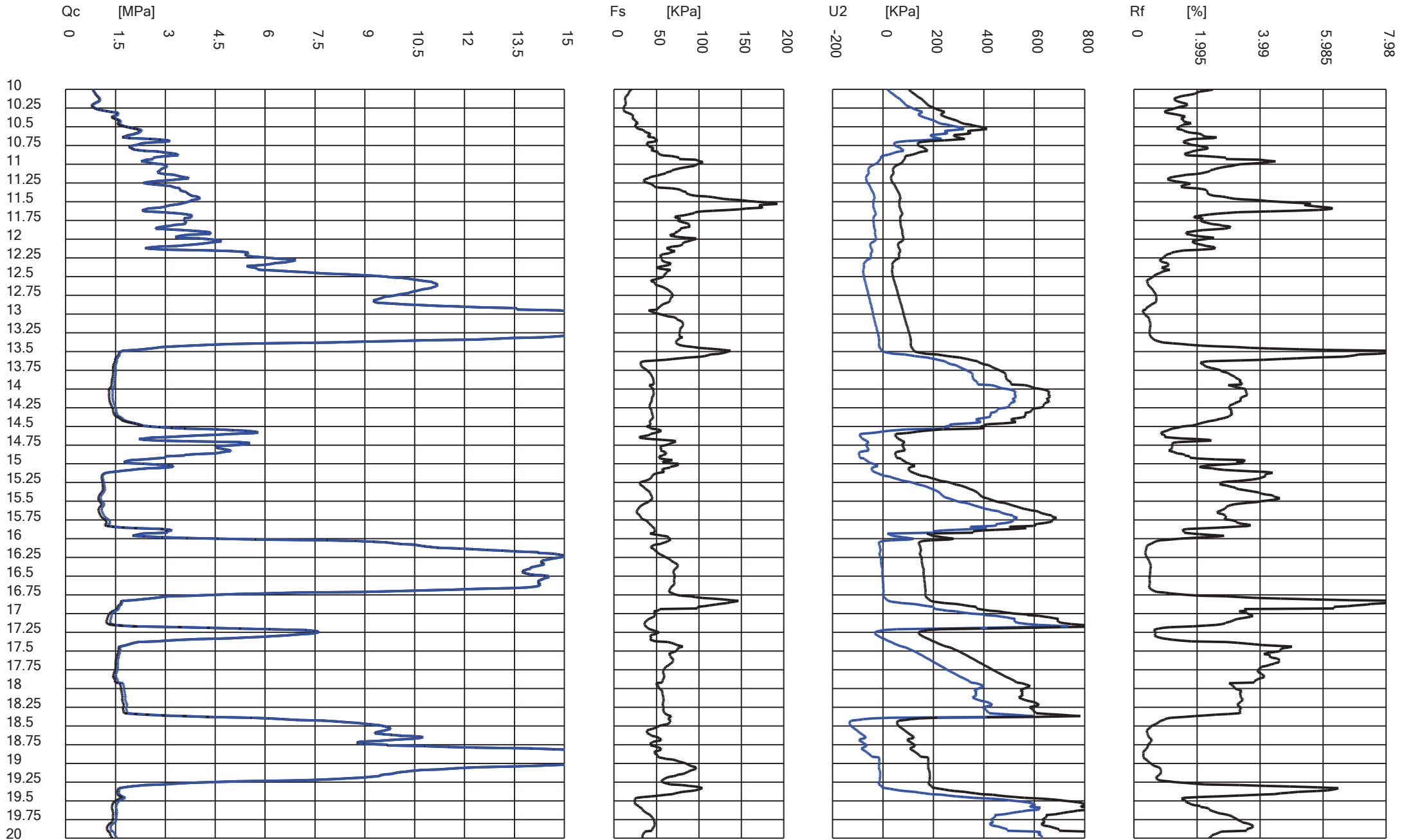
GEOLOG SRL
DOTT GEOL DRAPELLI OBERDAN

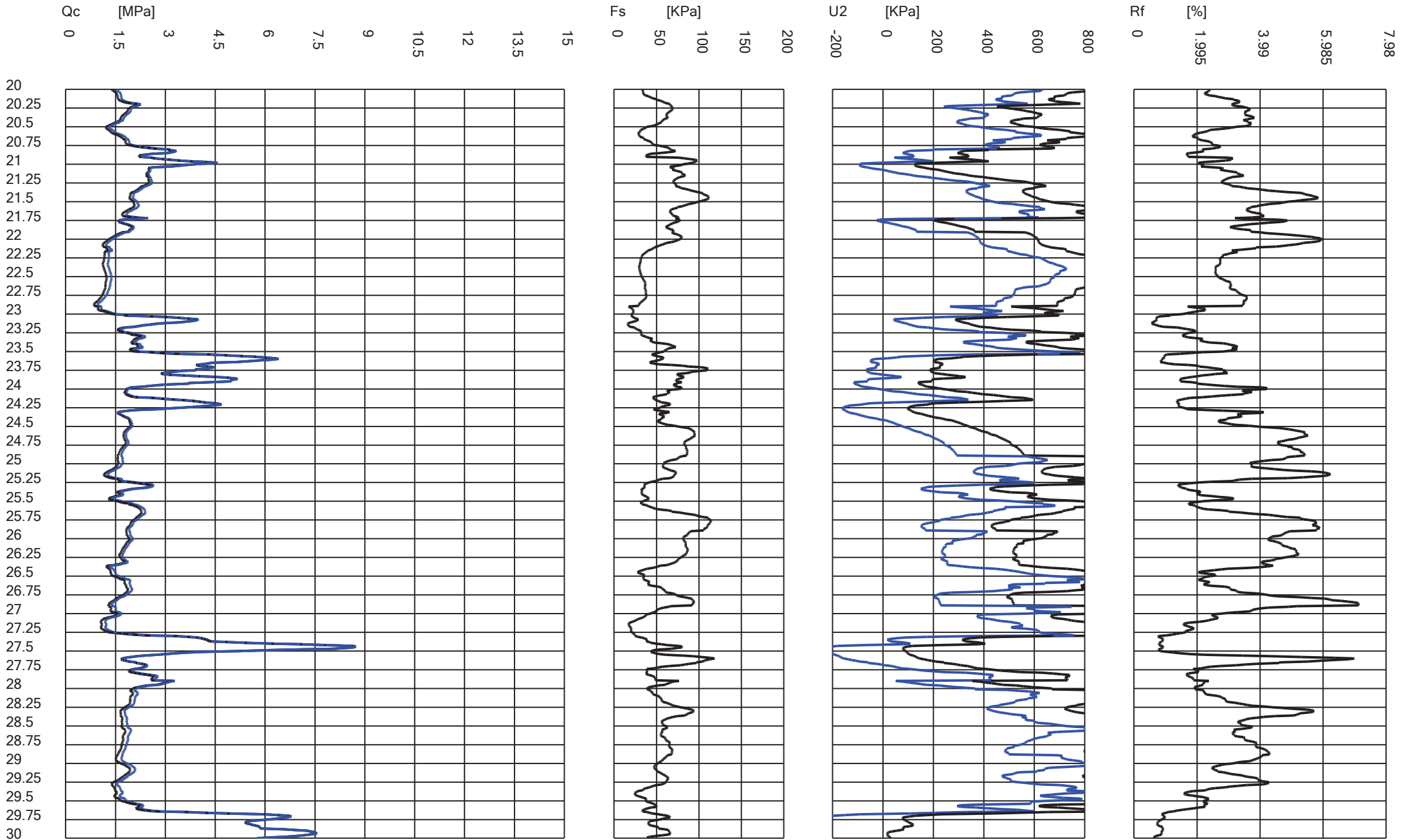


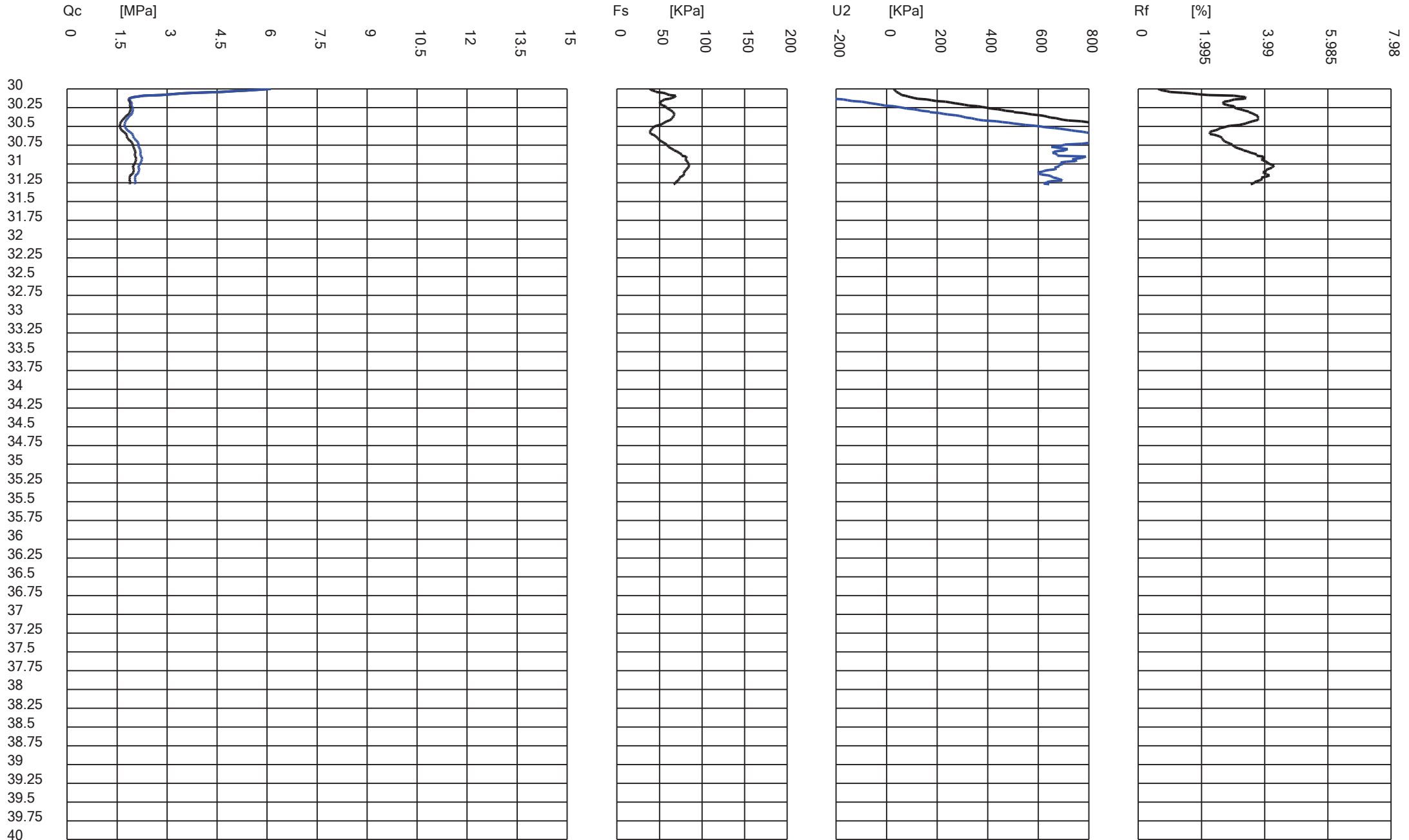
STIMA DELLA Vs 30 -MINERBIO-BO-CA FABBRI



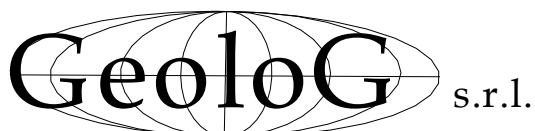








STIMA DELLA Vs30
MINERBIO -BO- VIA CAVALIERI DI VITTORIO VENETO



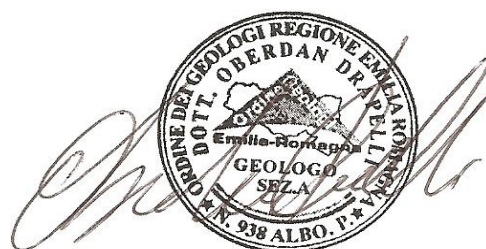
PROVA N	SCPTU 3
DATA	15/07/2020

COMMITTENTE	COMUNE DI MINERBIO-BO-
LOCALITA'	MINERBIO VIA CAVALIERI DI VITTORIO VENETO
PROFONDITA' DELLA PROVA	31
PROFONDITA' DELLA FALDA	3,10 m
PREFORO	1,00 m

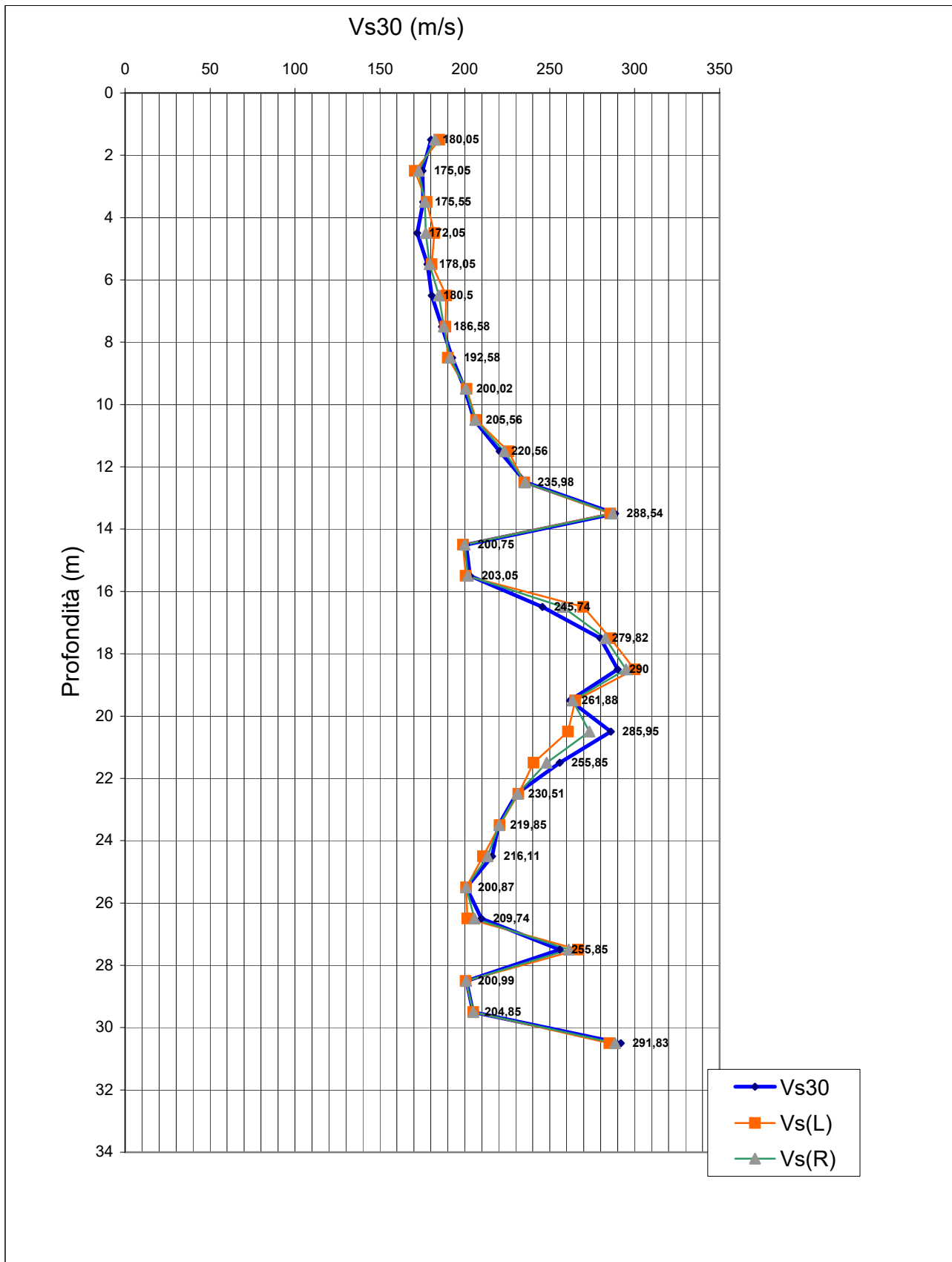
Depth [m]	Vs [m/s]		Vs [m/s] MEDIA
	LEFT	RIGHT	
1,5	185,05	180,05	182,55
2,5	170,55	175,05	172,8
3,5	177,52	175,55	176,535
4,5	182,05	172,05	177,05
5,5	180,55	178,05	179,3
6,5	189,05	180,5	184,775
7,5	188,66	186,58	187,62
8,5	190,05	192,58	191,315
9,5	201,05	200,02	200,535
10,5	206,66	205,56	206,11
11,5	225,66	220,56	223,11
12,5	235,05	235,98	235,515
13,5	285,65	288,54	287,095
14,5	199,05	200,75	199,9
15,5	200,55	203,05	201,8
16,5	269,8	245,74	257,77
17,5	285,66	279,82	282,74
18,5	299,88	290	294,94
19,5	265,05	261,88	263,465
20,5	260,85	285,95	273,4
21,5	240,52	255,85	248,185
22,5	231,55	230,51	231,03
23,5	220,54	219,85	220,195
24,5	210,74	216,11	213,425
25,5	200,85	200,87	200,86
26,5	201,56	209,74	205,65
27,5	266,69	255,85	261,27
28,5	200,52	200,99	200,755
29,5	205,02	204,85	204,935
30,5	285,05	291,83	288,44

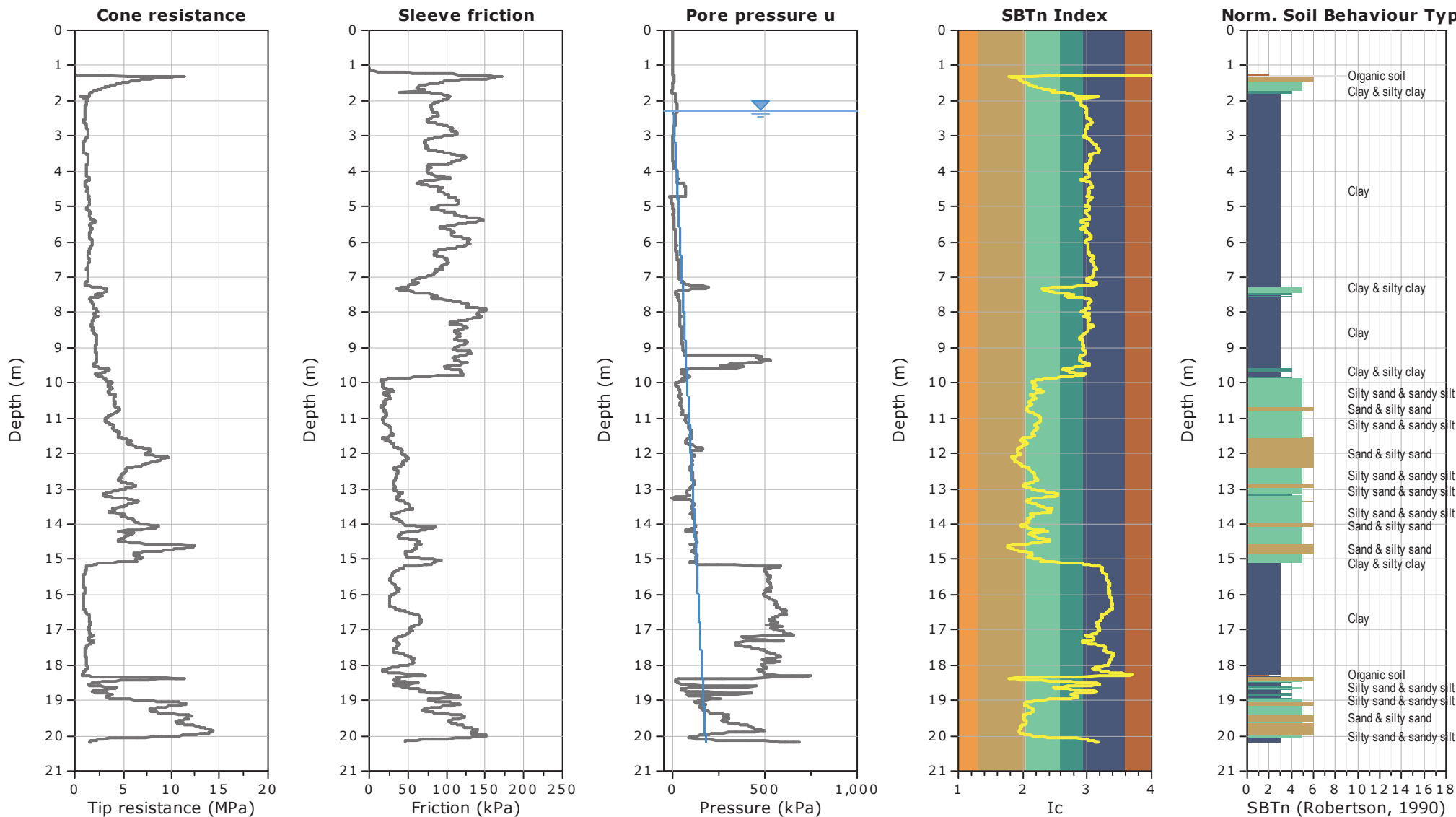
STIMA DELLA Vs30 214,73 213,79 MEDIA 214,32

GEOLOG SRL
DOTT GEOL DRAPELLI OBERDAN



STIMA DELLA Vs 30 -MINERBIO-BO-VIA CAVALIERI DI VITTORIO VENETO



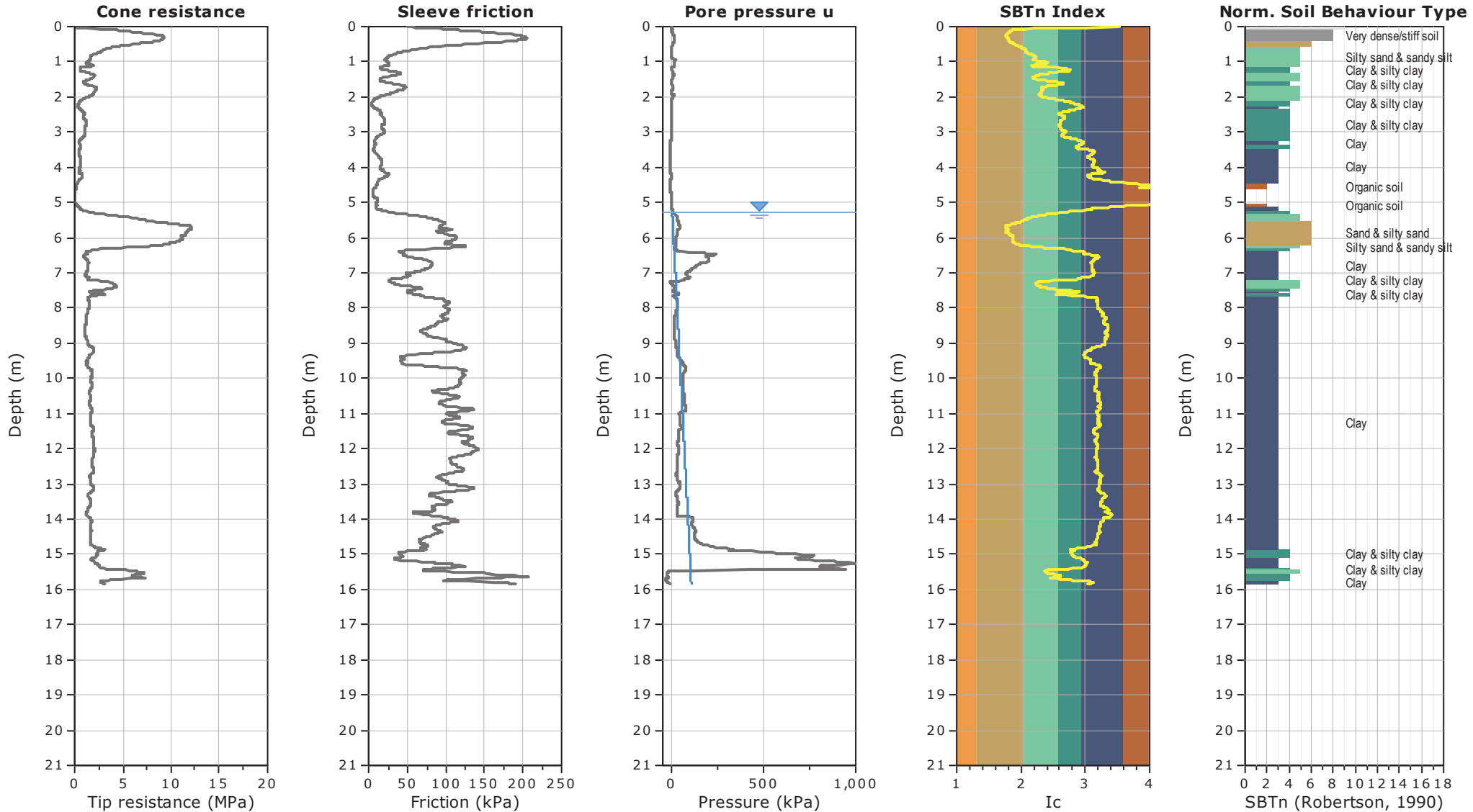


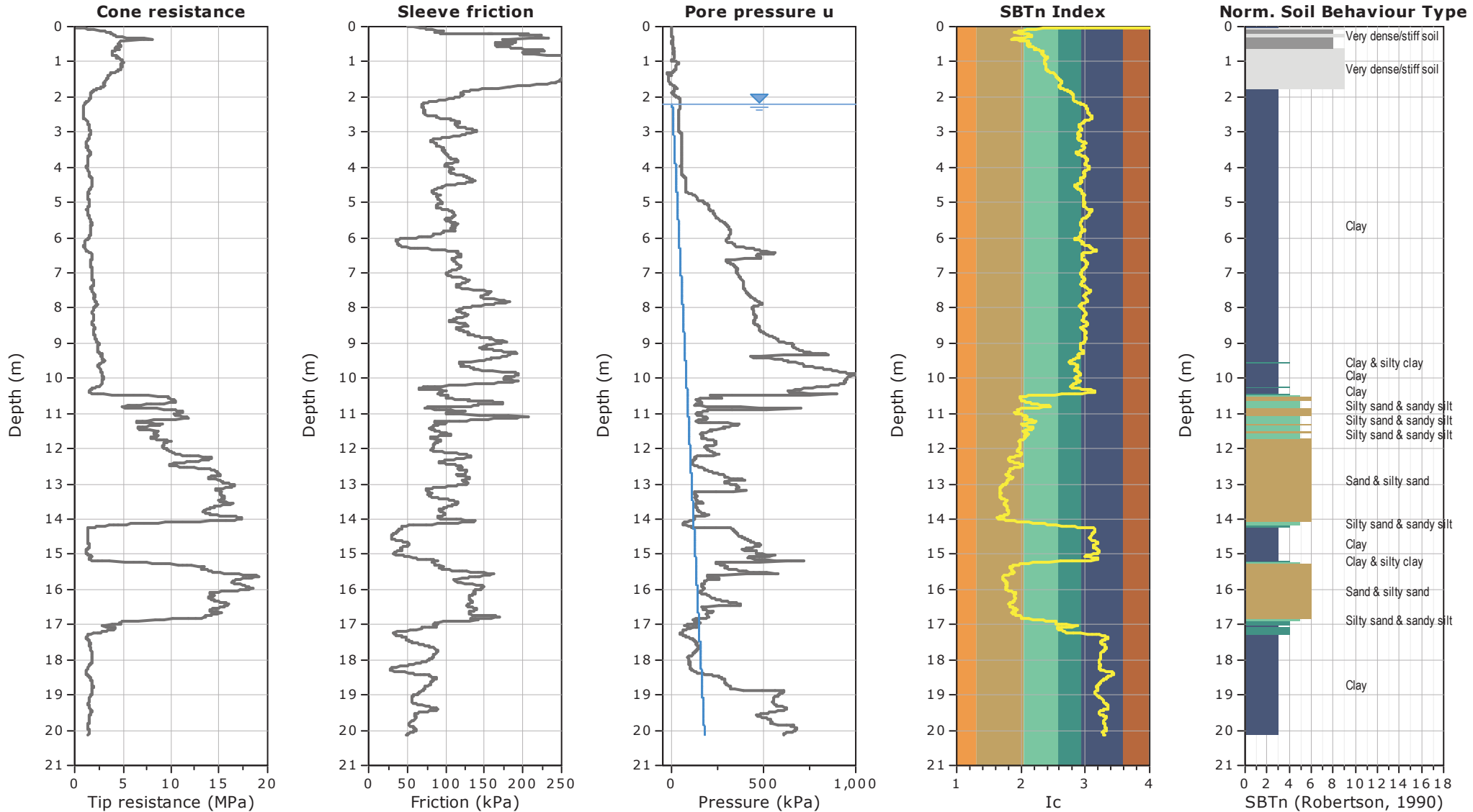
Project: Microzonazione Sismica Livello 3

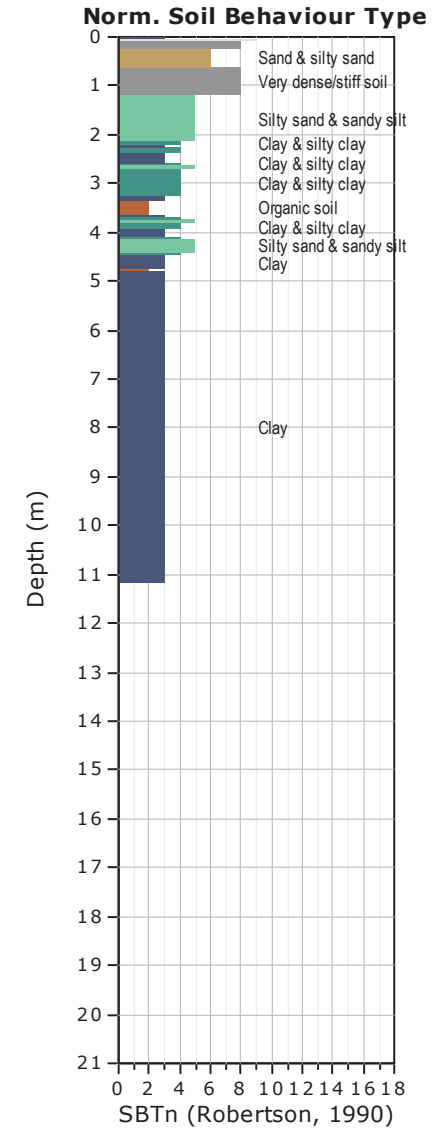
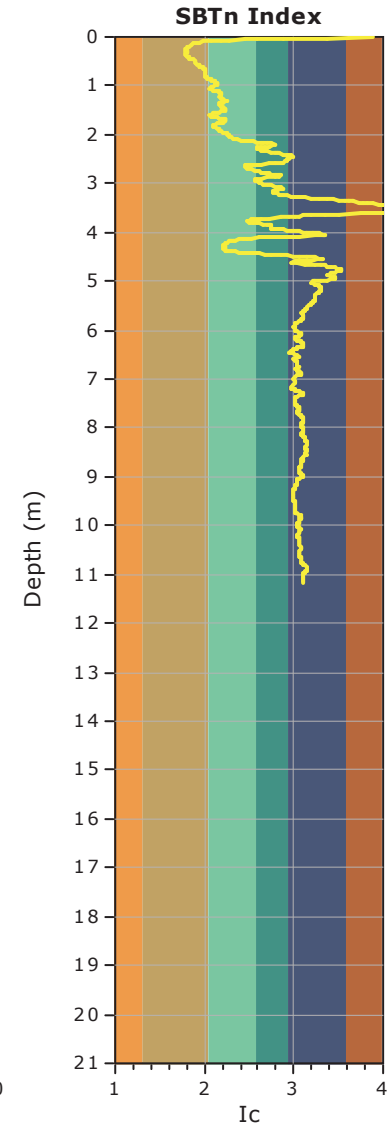
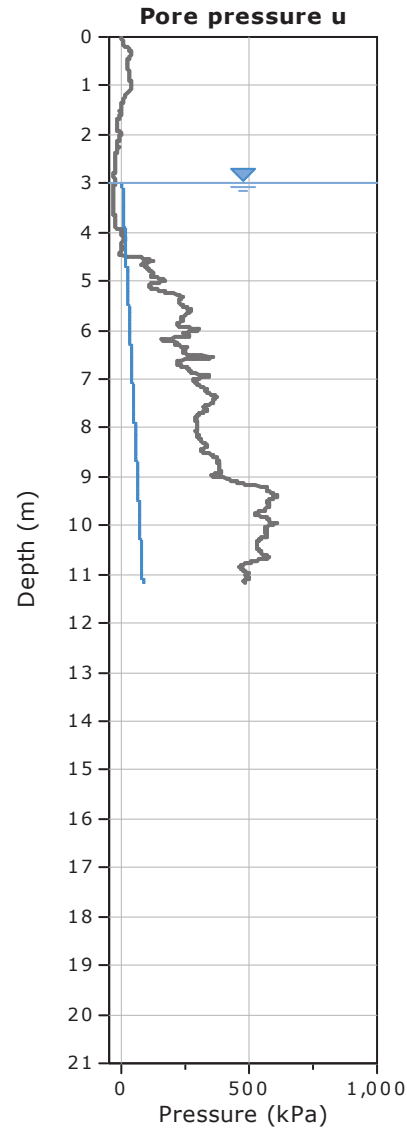
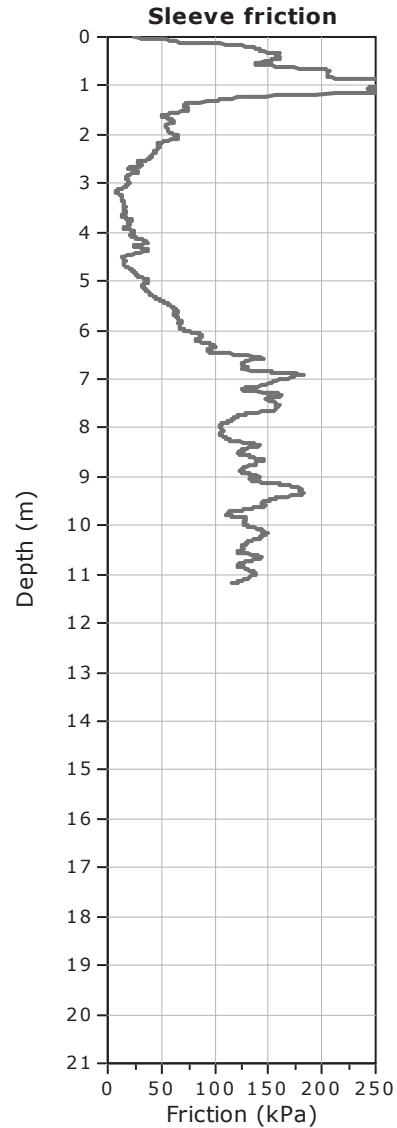
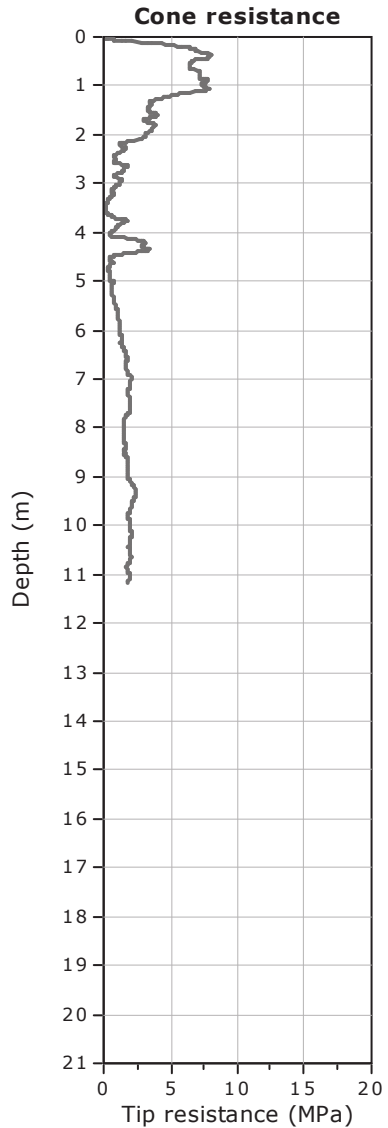
Location: Capo d'Argine - Minerbio (BO)

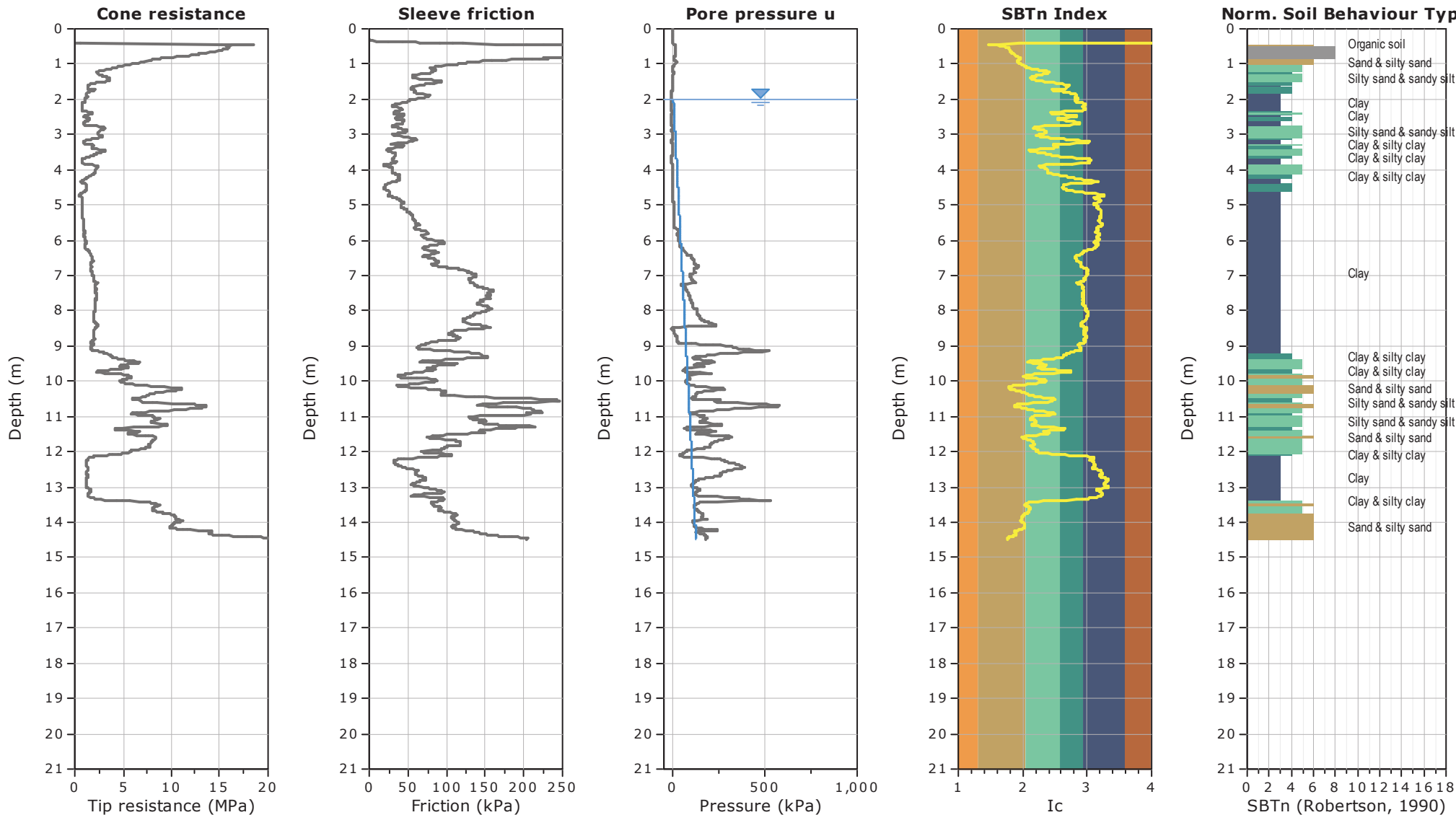
CPT: CPTU5

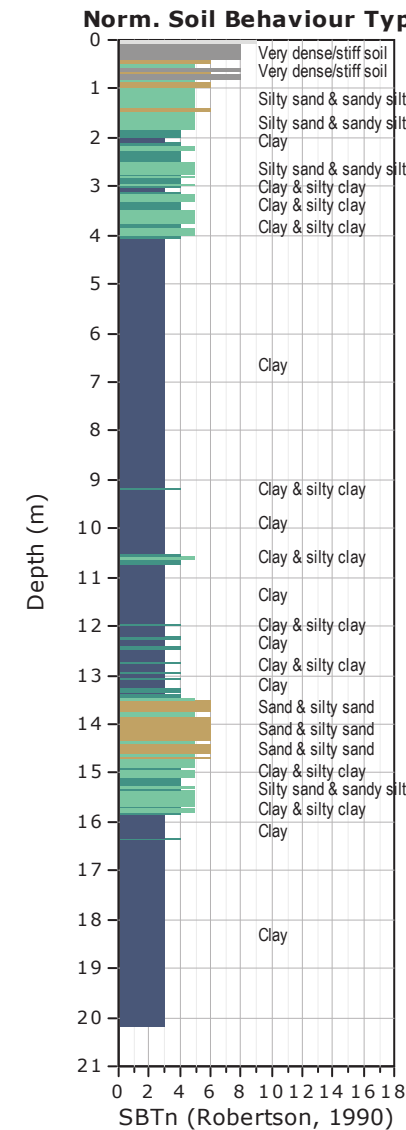
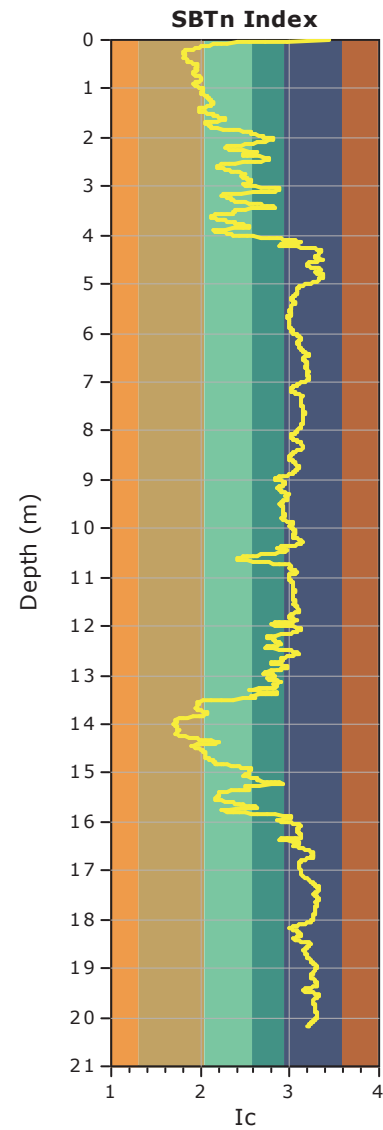
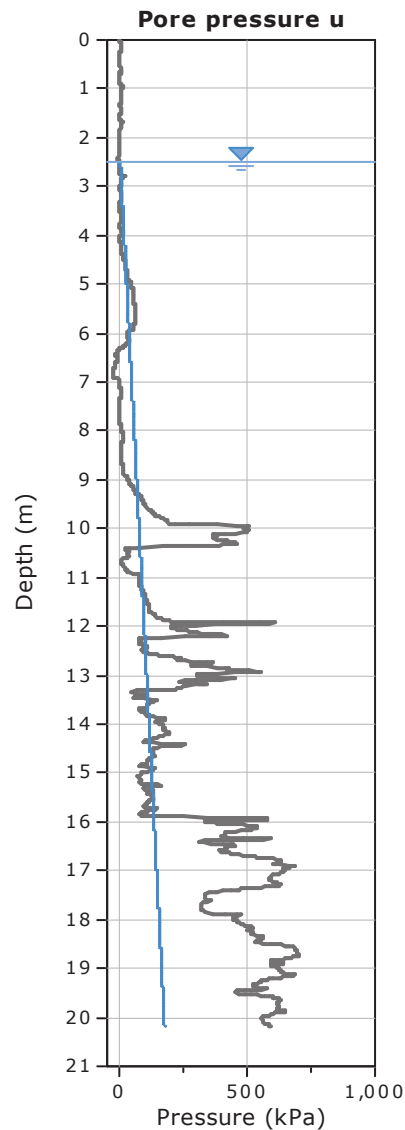
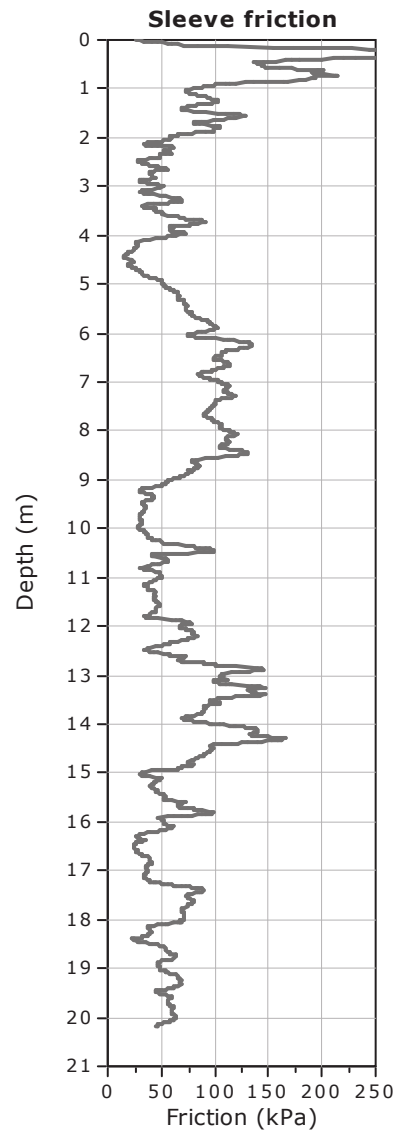
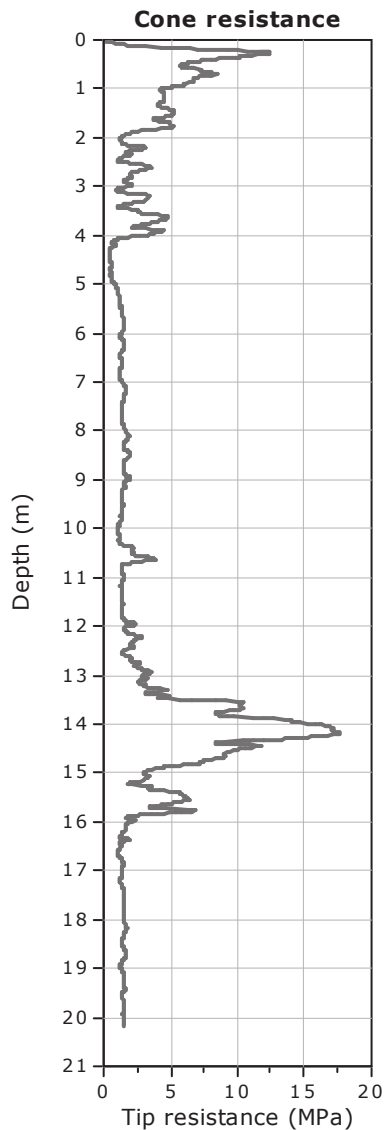
Total depth: 15.85 m, Date: 29/07/2020









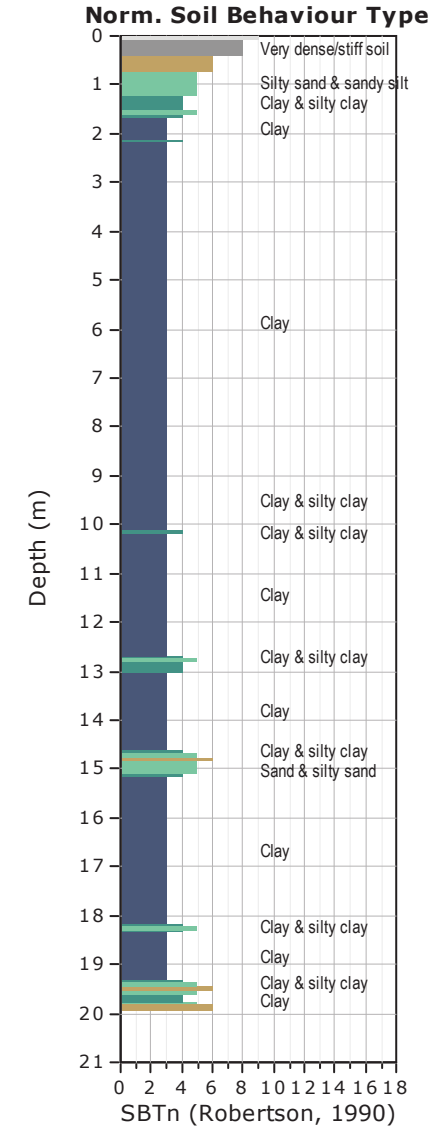
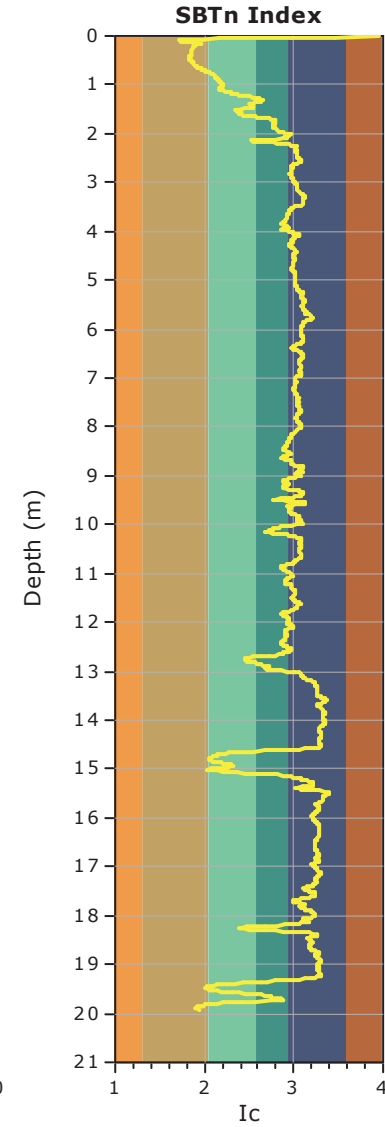
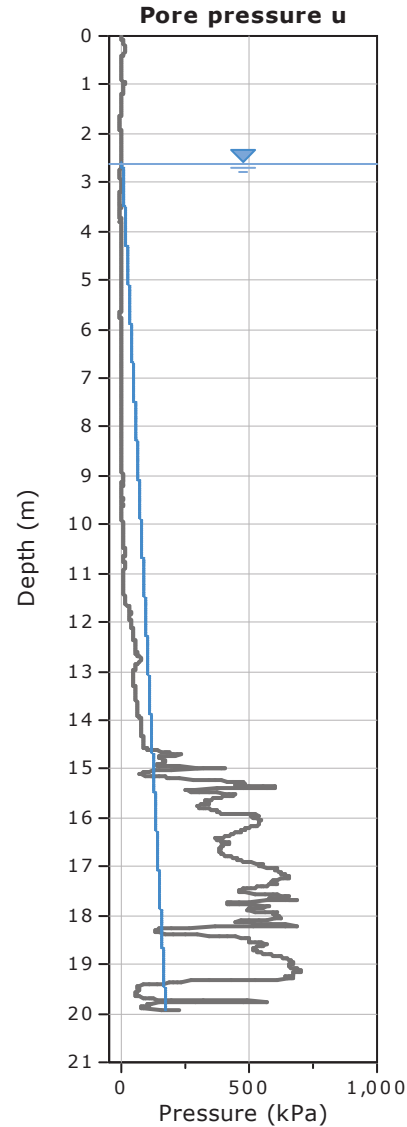
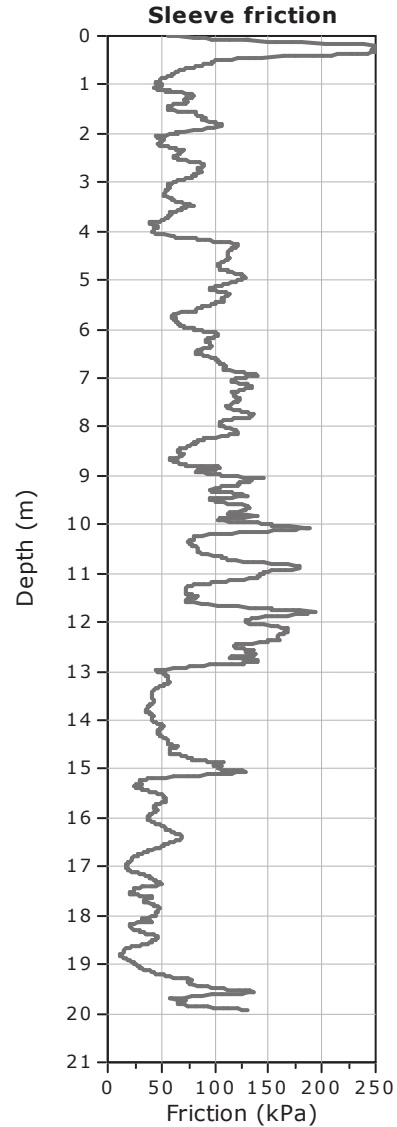
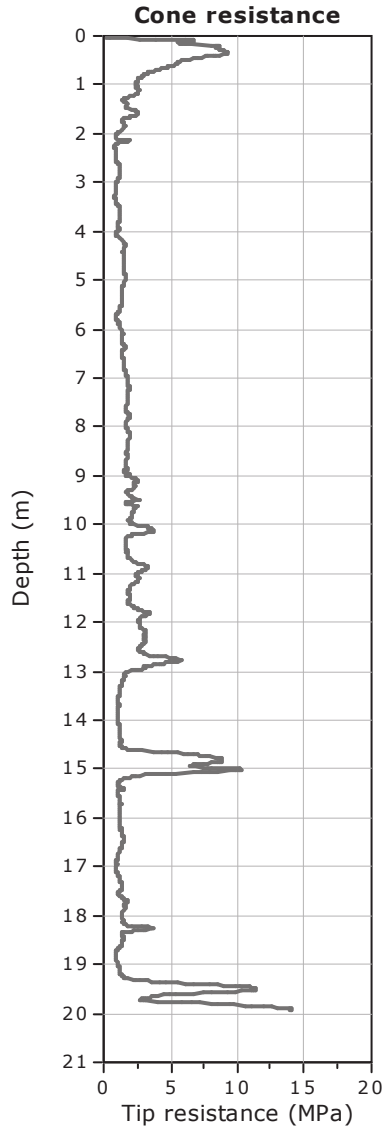


Project: Microzonazione Sismica Livello 3

Location: Spettoleria - Minerbio (BO)

CPT: CPTU10

Total depth: 19.93 m, Date: 31/07/2020

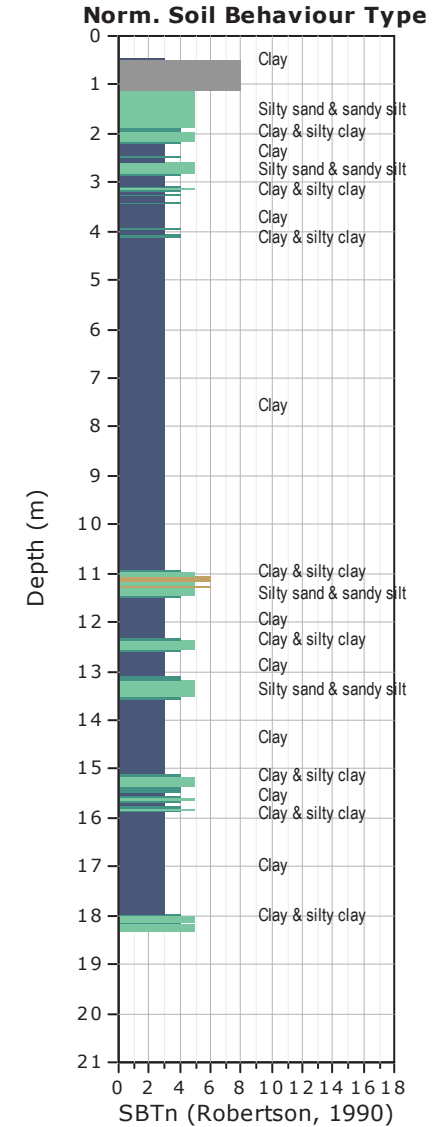
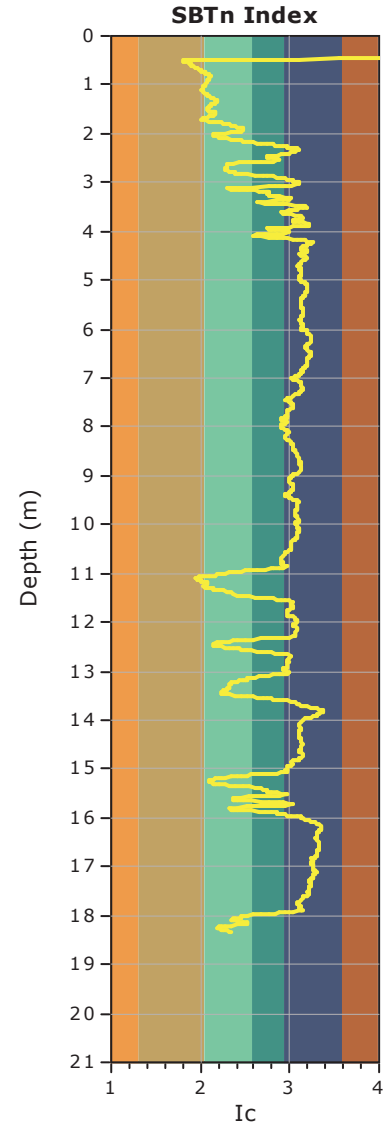
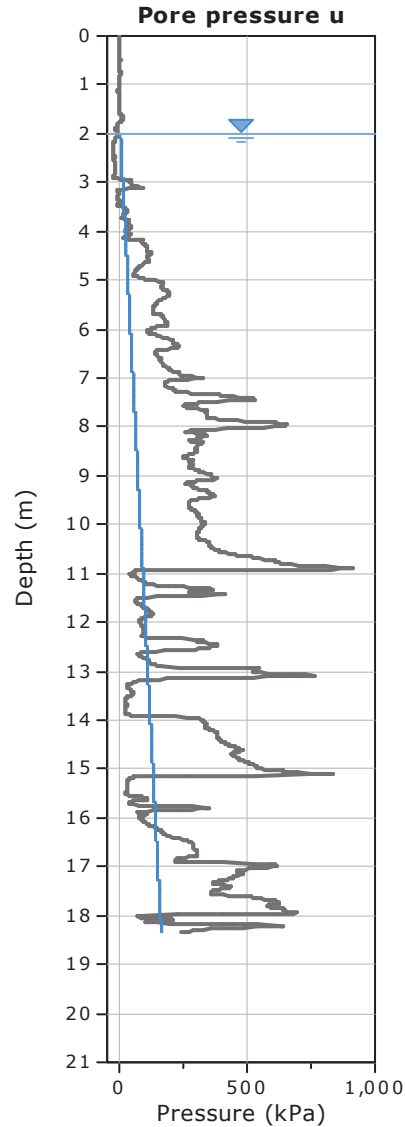
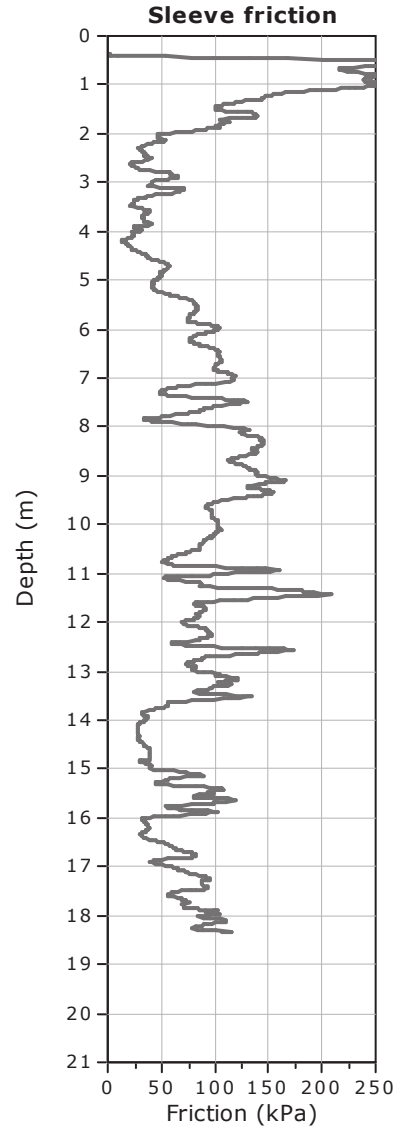
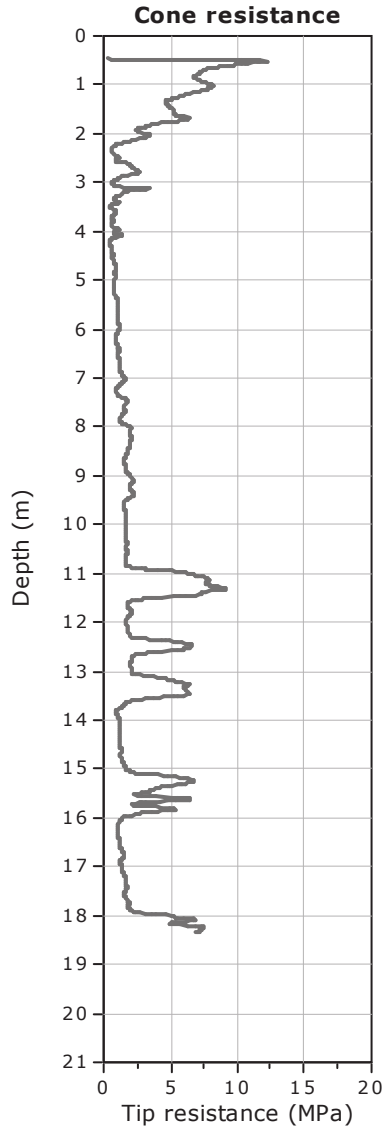


Project: Microzonazione Sismica Livello 3

Location: Sanità - Minerbio (BO)

CPT: CPTU11

Total depth: 18.35 m, Date: 07/08/2020

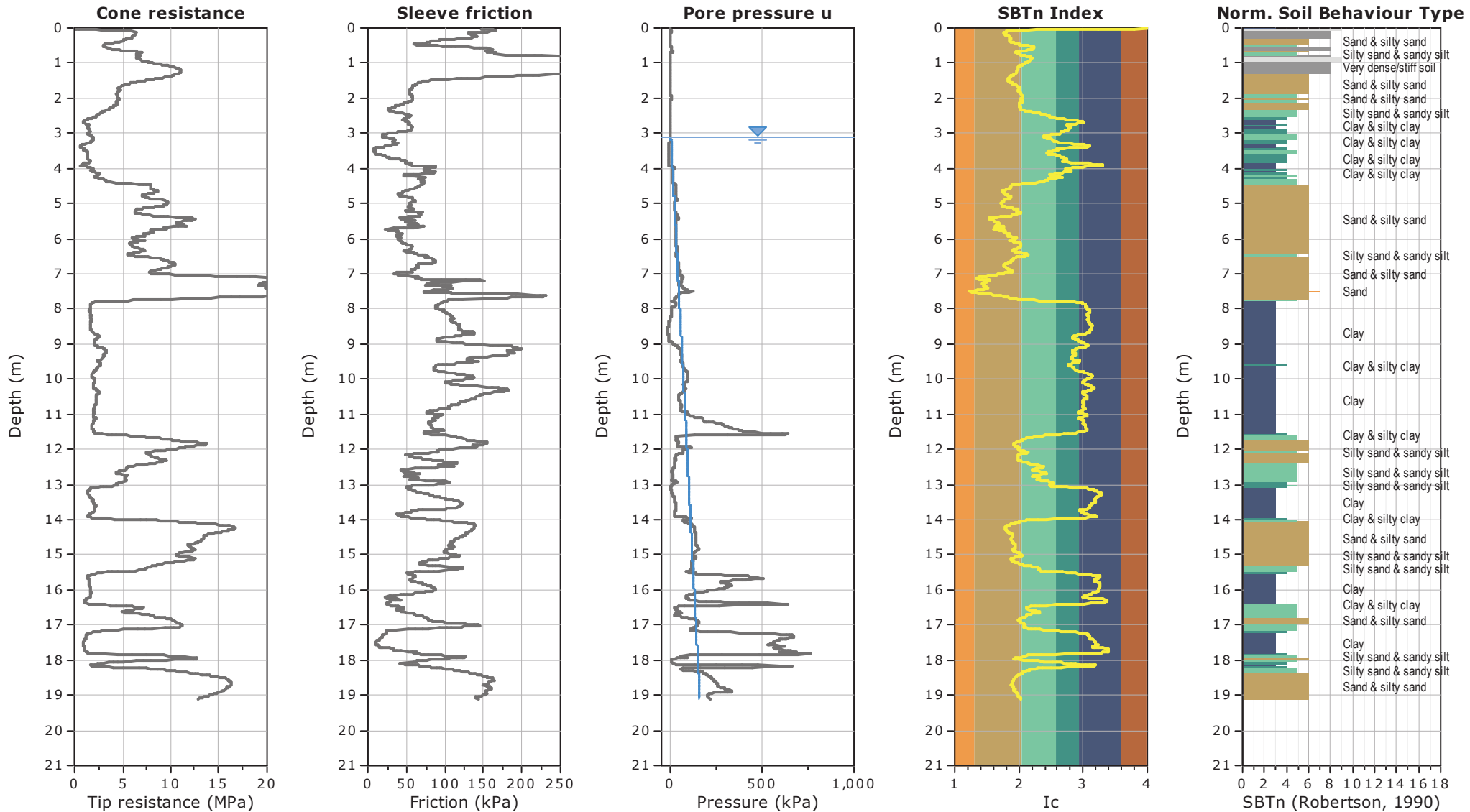


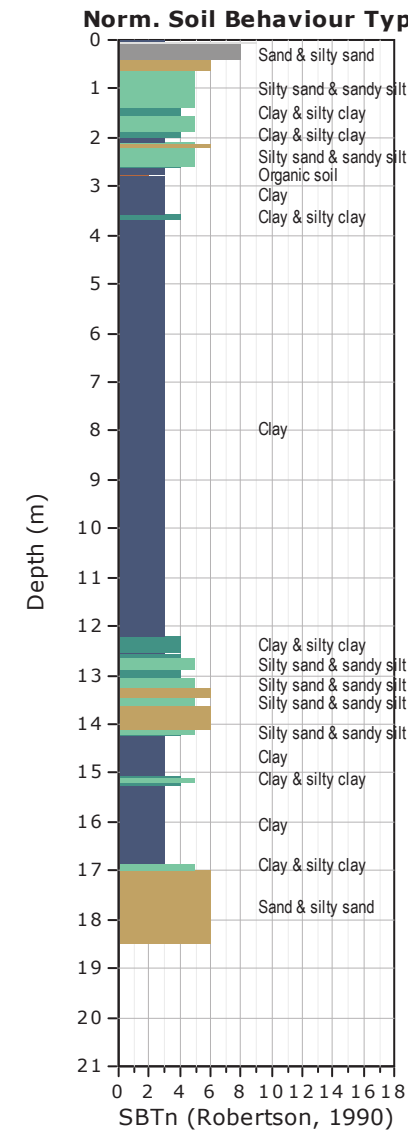
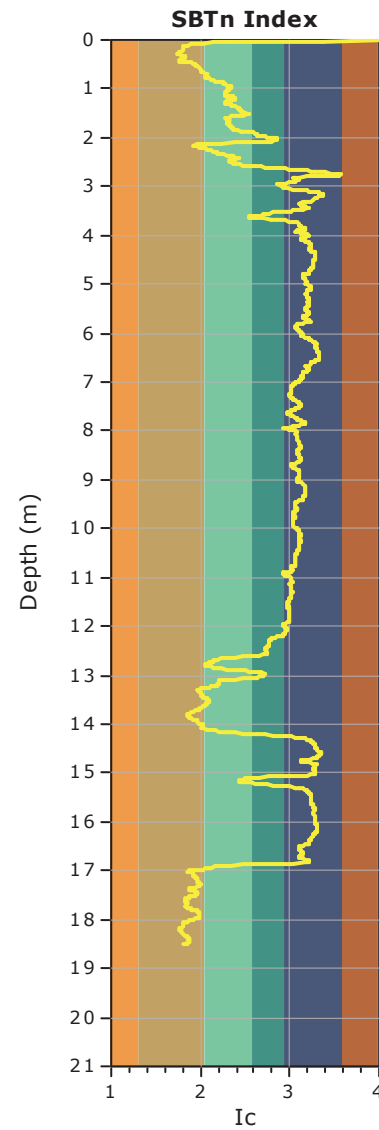
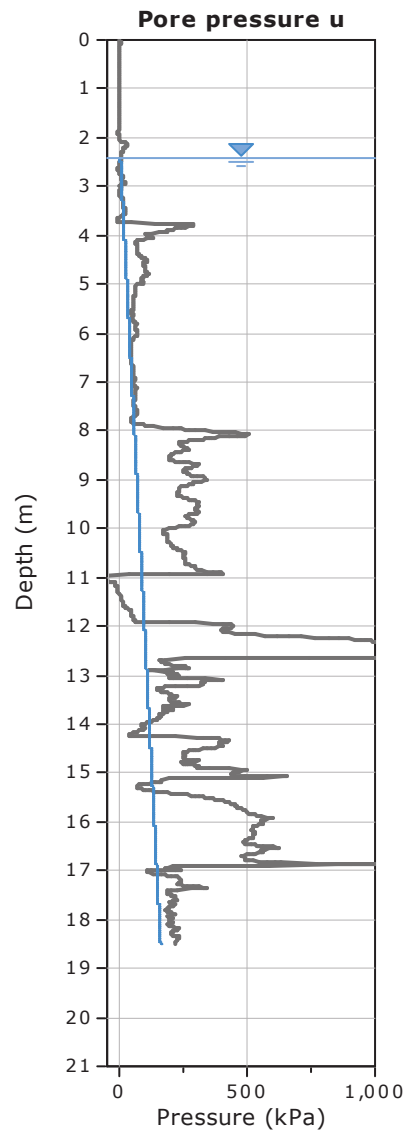
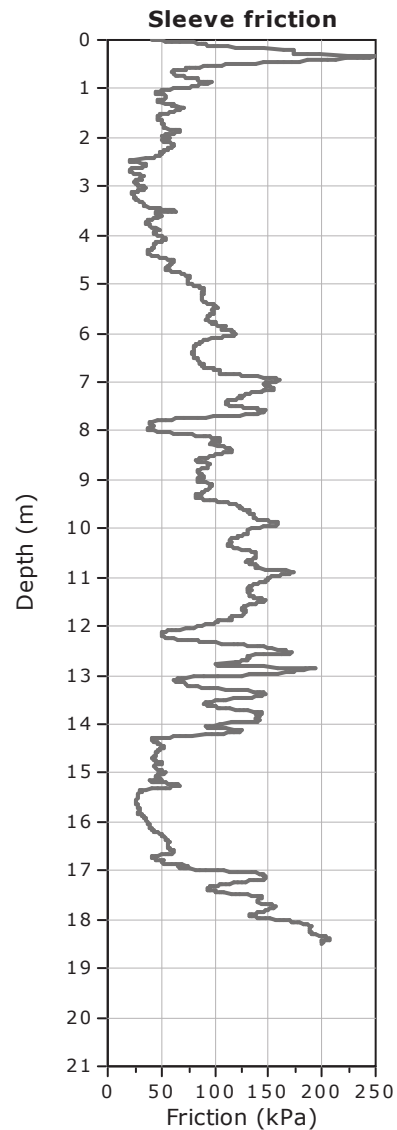
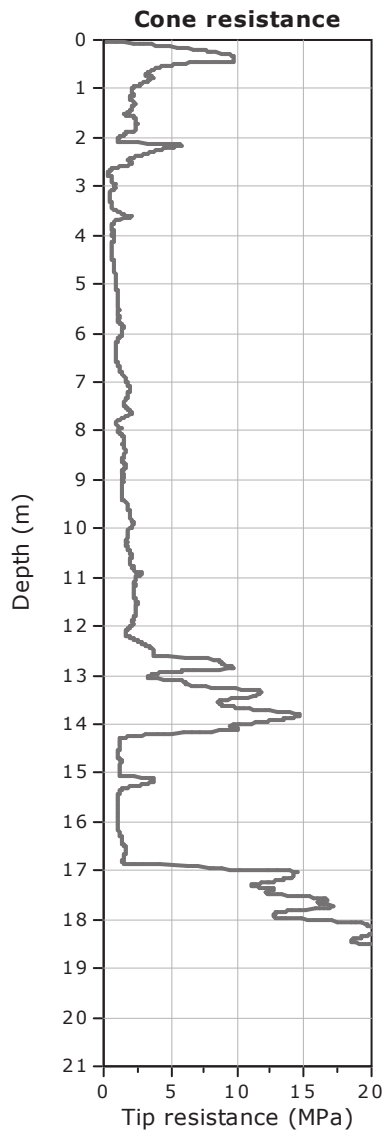
Project: Microzonazione Sismica Livello 3

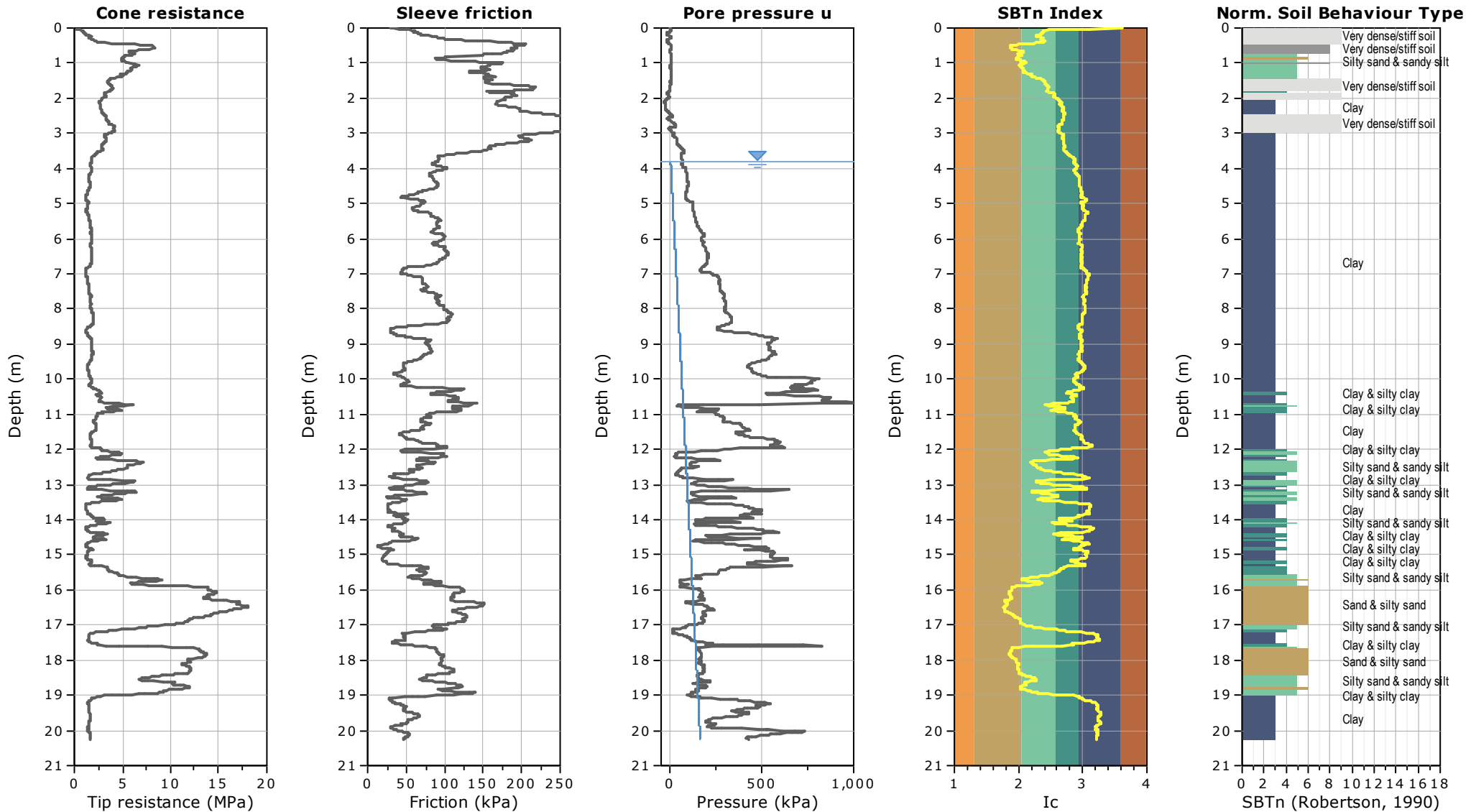
Location: San Martino in Soverzano - Minerbio (BO)

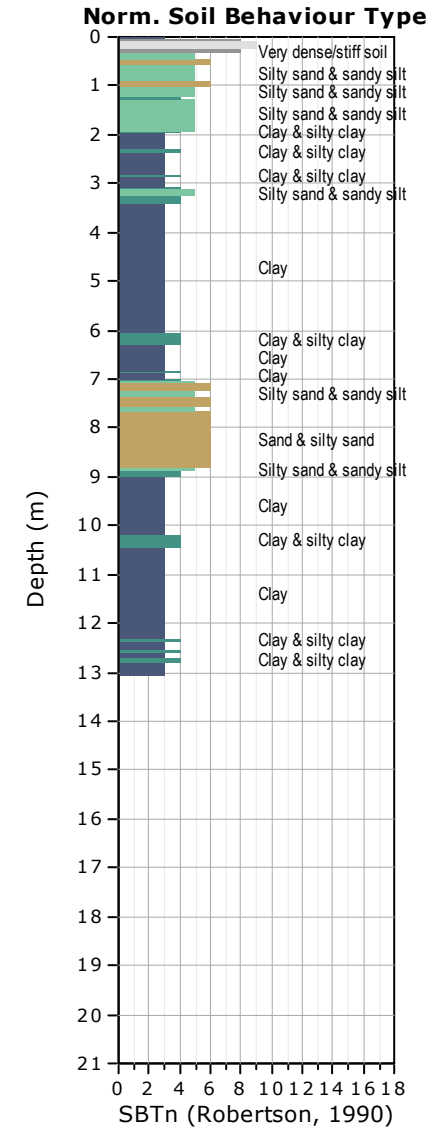
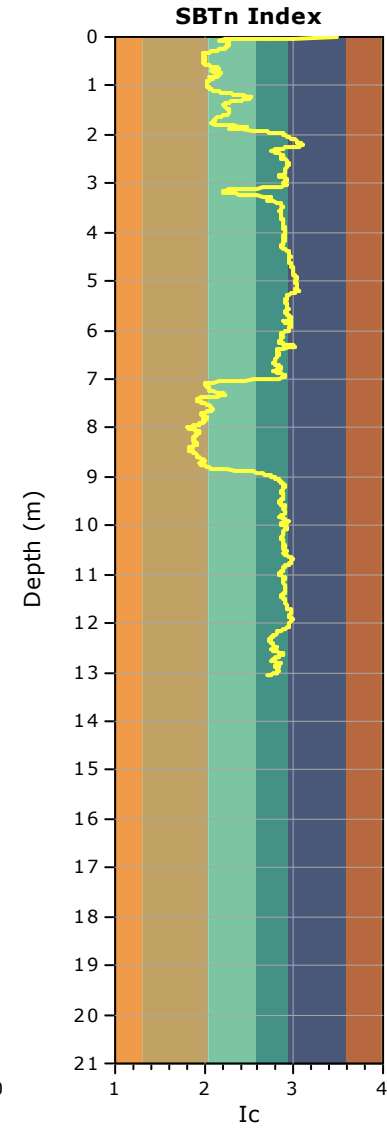
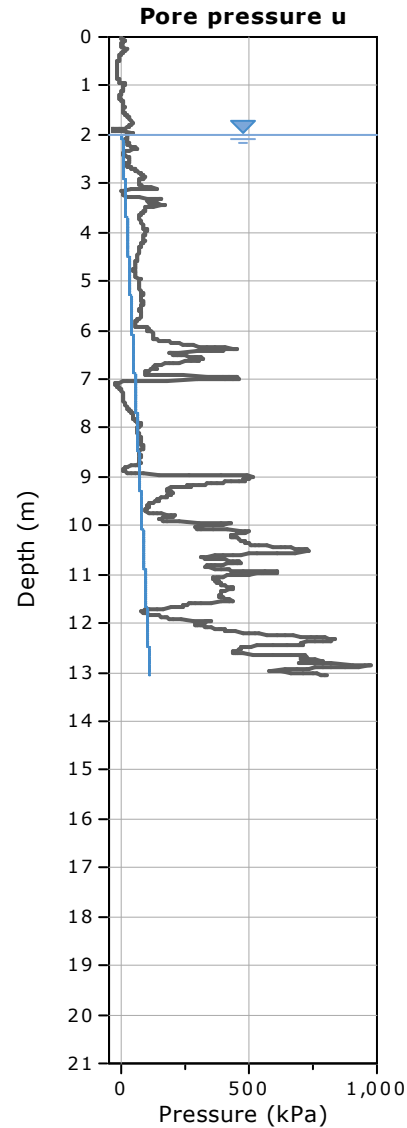
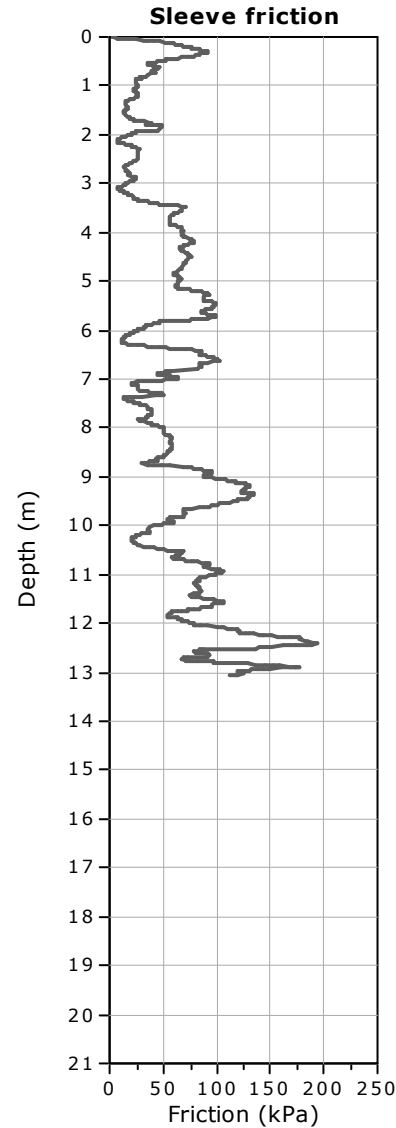
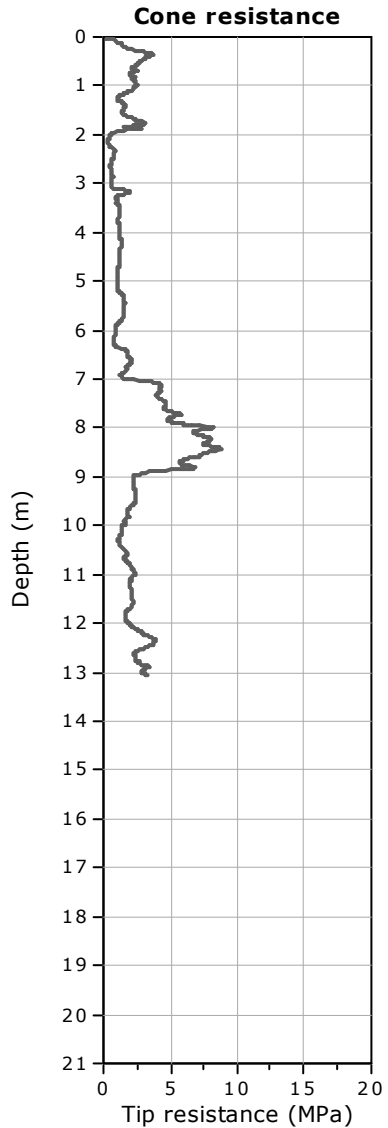
CPT: CPTU12

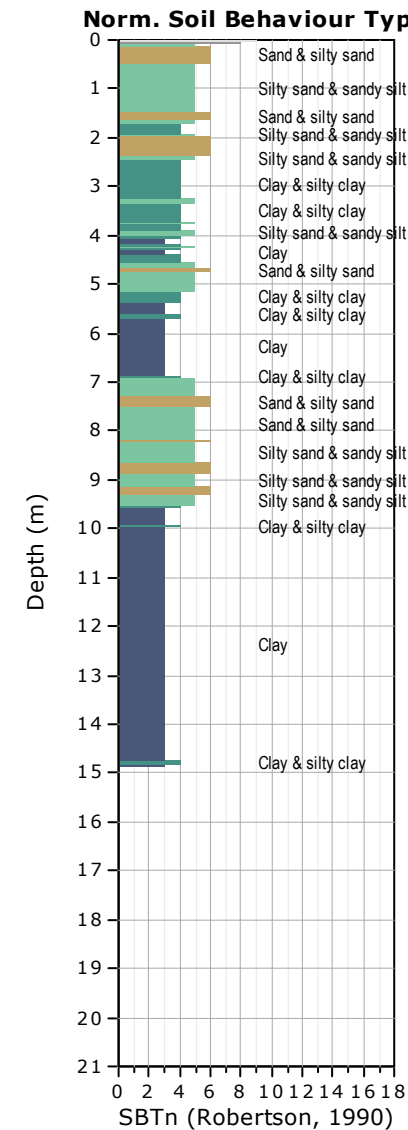
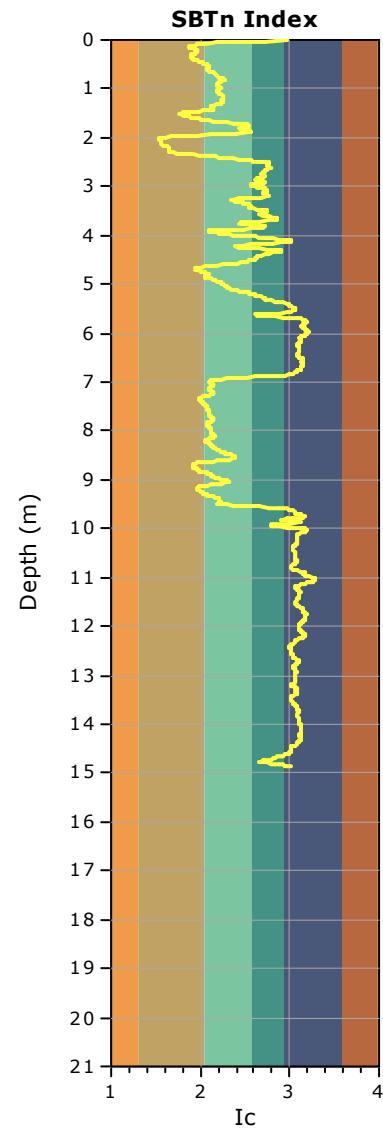
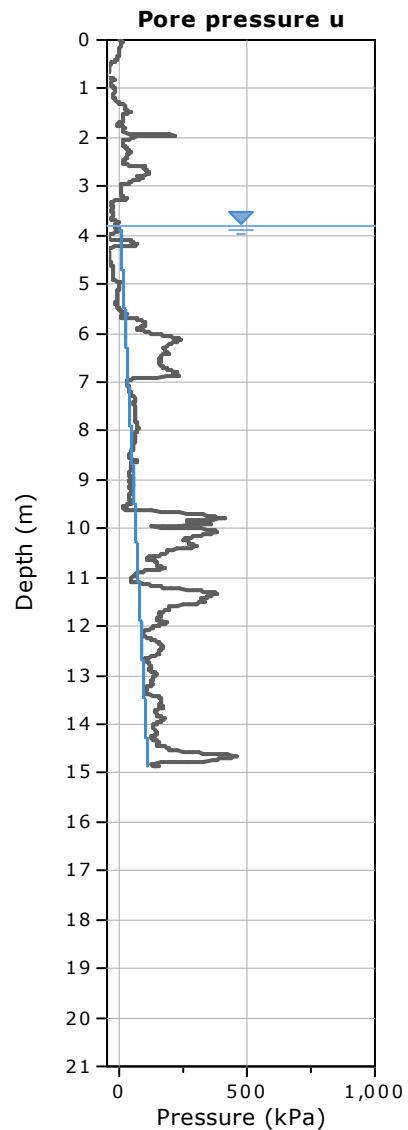
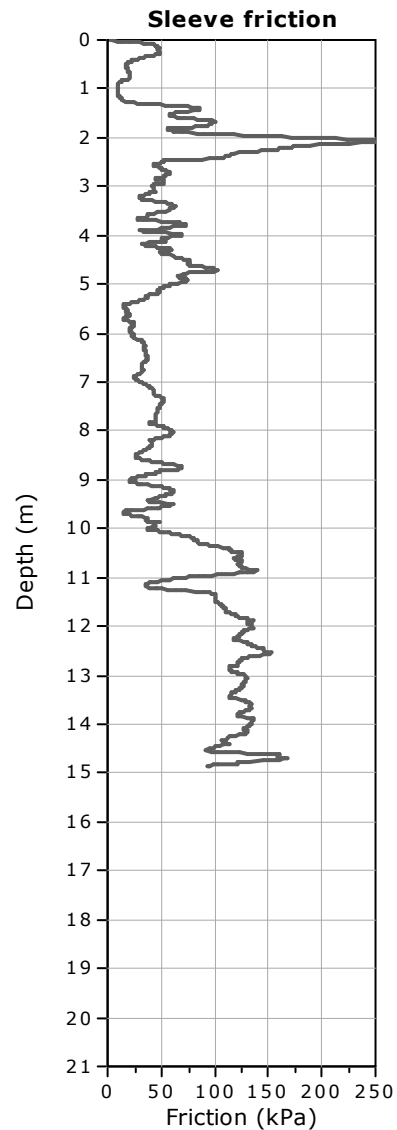
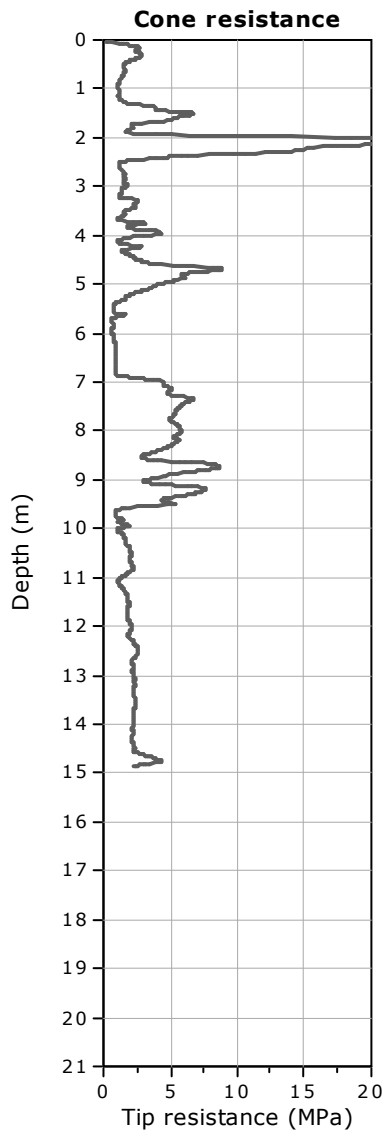
Total depth: 19.10 m, Date: 07/09/2020









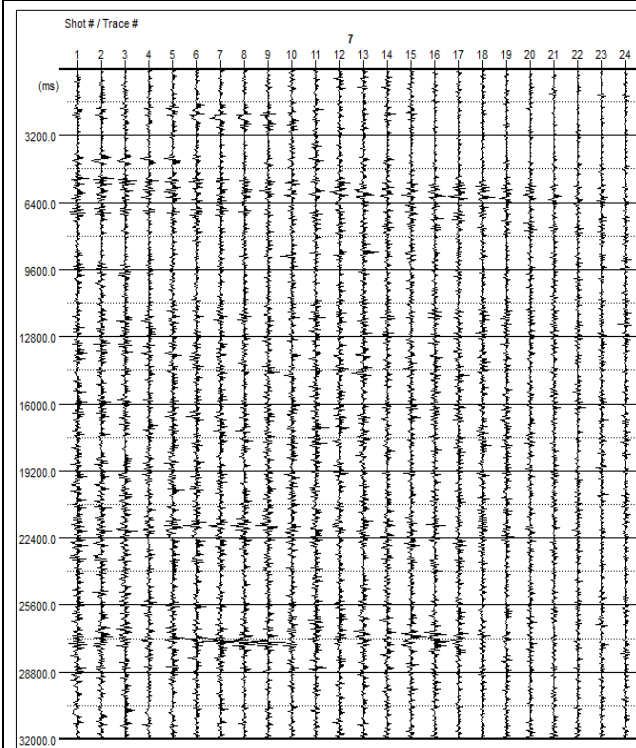


PROSPEZIONE SISMICA CON METODOLOGIA ESAC

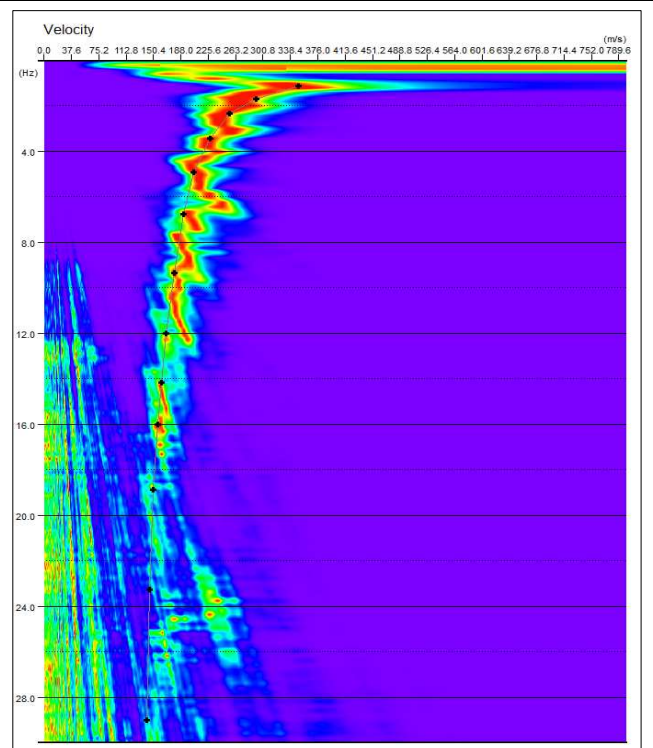
Via della Repubblica Italiana, Comune di Minerbio (BO) - 037038P94648ESAC_SPAC284

n° tracce	Δt (ms)	T (s)
25	2,0	32,0

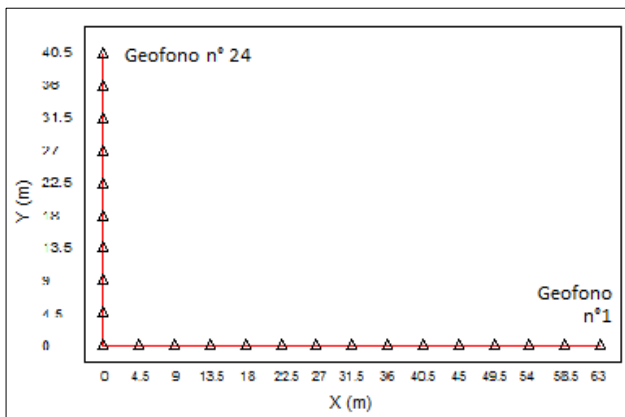
Δt : passo di campionamento; T: durata registrazione.



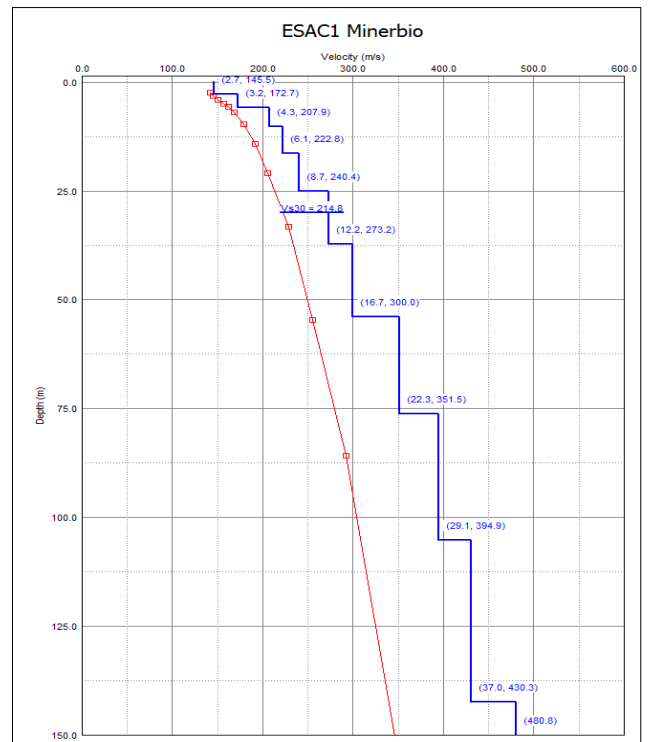
Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Geometria dello stendimento sismico bidimensionale.



Modello di sottosuolo (1D) descritti in termini di V_s e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	V _s (m/s)
1	2.7	2.7	145.5
2	5.9	3.2	172.7
3	10.2	4.3	207.9
4	16.3	6.1	222.8
5	25.0	8.7	240.4
6	37.2	12.2	273.2
7	53.9	16.7	300.0
8	76.2	22.3	351.5
9	105.3	29.1	394.9
10	142.3	37.0	430.3
11	∞	∞	480.8

$$V_{S30} = 214.8 \pm 10\% \text{ [m/s]}$$

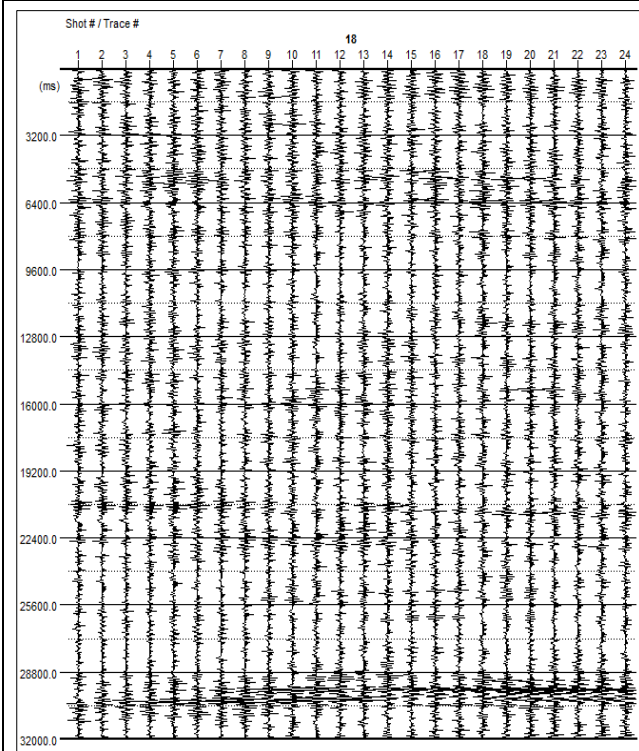
Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.

PROSPEZIONE SISMICA CON METODOLOGIA ESAC

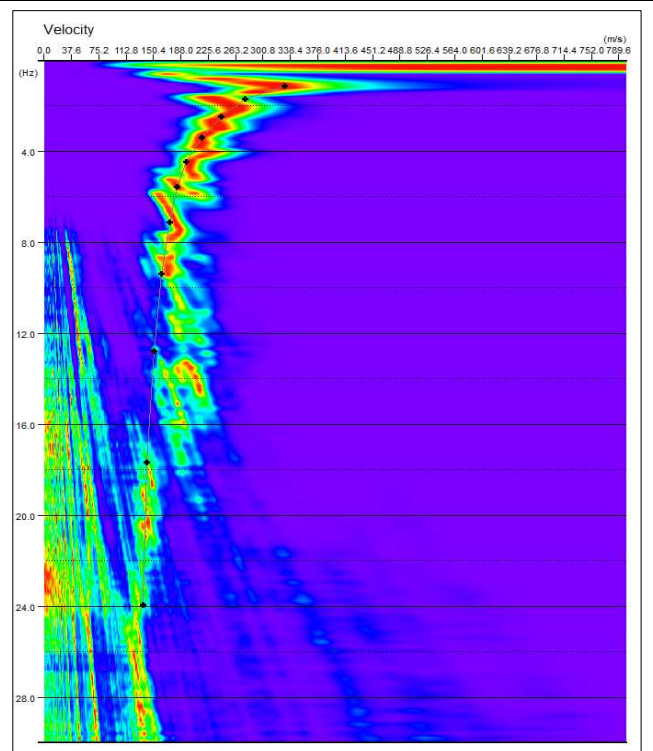
Cà dé Fabbri, Comune di Minerbio (BO) - 037038P94649ESAC_SPAC285

n° tracce	Δt (ms)	T (s)
25	2,0	32,0

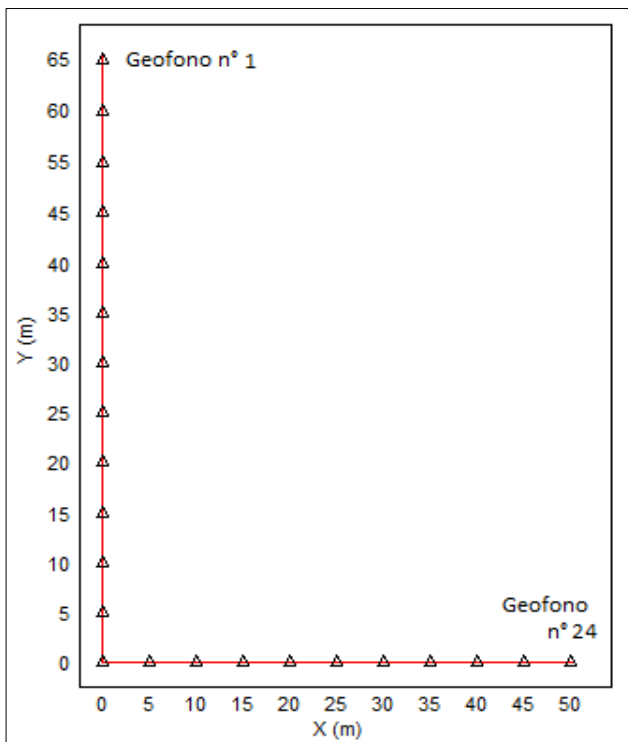
Δt : passo di campionamento; T: durata registrazione.



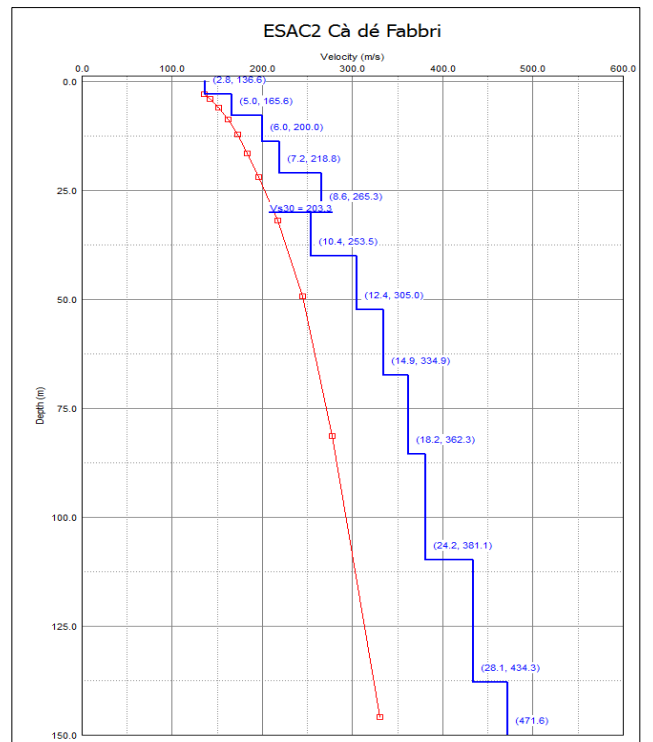
Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Geometria dello stendimento sismico bidimensionale.



Modello di sottosuolo (1D) descritti in termini di V_s e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	V _s (m/s)
1	2.8	2.8	136.6
2	7.8	5.0	165.6
3	13.8	6.0	200.0
4	21.0	7.2	218.8
5	29.6	8.6	265.3
6	40.0	10.4	253.5
7	52.4	12.4	305.0
8	67.3	14.9	334.9
9	85.5	18.2	362.3
10	109.7	24.2	381.1
11	137.8	28.1	434.3
12	∞	∞	471.6

$$V_{s30} = 203.3 \pm 10\% \text{ [m/s]}$$

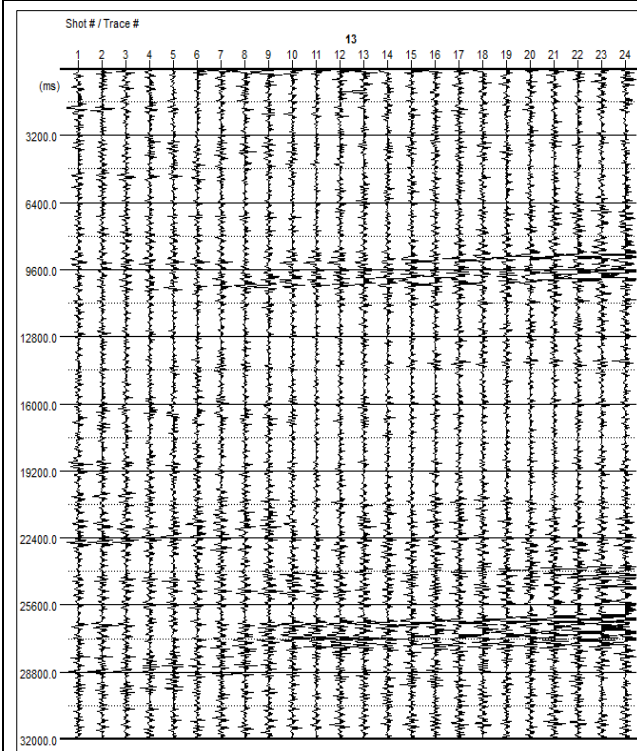
Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.

PROSPEZIONE SISMICA CON METODOLOGIA ESAC

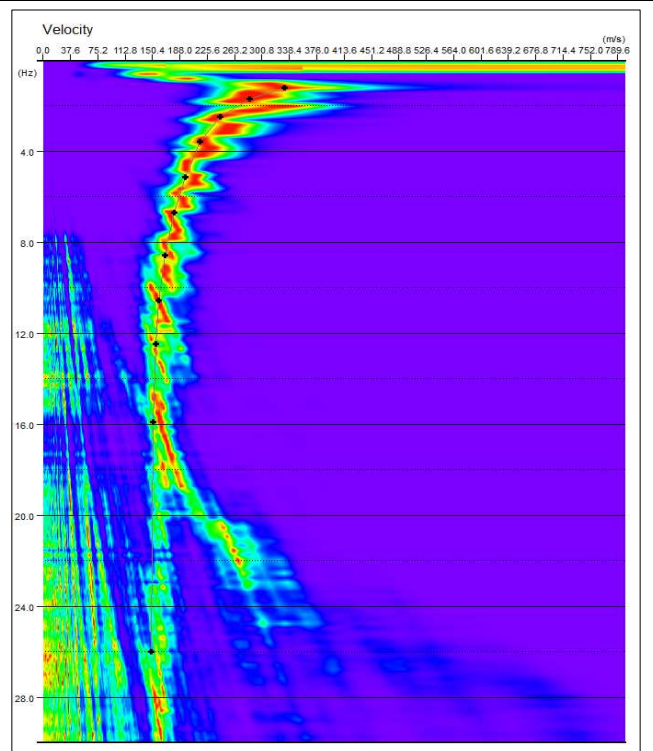
Tintoria, Comune di Minerbio (BO) - 037038P94650ESAC_SPAC286

n° tracce	Δt (ms)	T (s)
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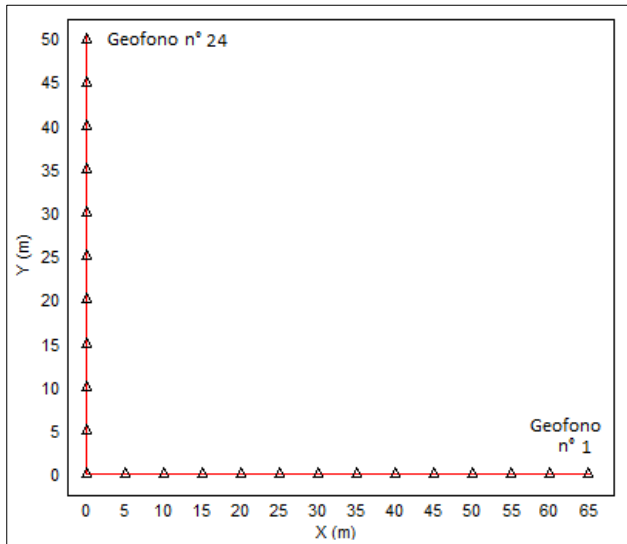
Δt : passo di campionamento; T: durata registrazione.



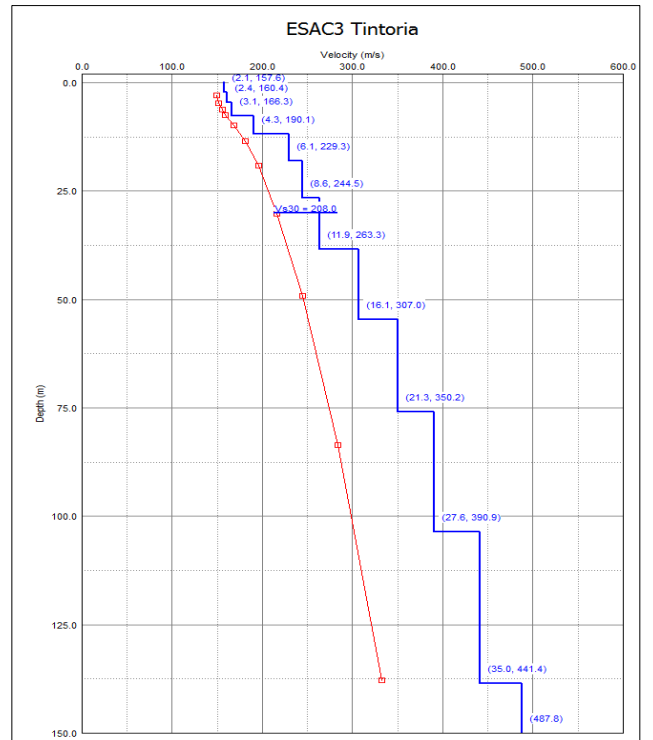
Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Geometria dello stendimento sismico bidimensionale.



Modello di sottosuolo (1D) descritti in termini di Vs e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	V _s (m/s)
1	2.1	2.1	157.6
2	4.5	2.4	160.4
3	7.6	3.1	166.3
4	11.9	4.3	190.1
5	18.0	6.1	229.3
6	26.6	8.6	244.5
7	38.5	11.9	263.3
8	54.6	16.1	307.0
9	75.9	21.3	350.2
10	103.4	27.6	390.9
11	138.4	35.0	441.4
12	∞	∞	487.8

$$V_{s30} = 208.0 \pm 10\% \text{ [m/s]}$$

Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.



Via A. Ascari, 6 - 44019 Gualdo di Voghiera (FE)

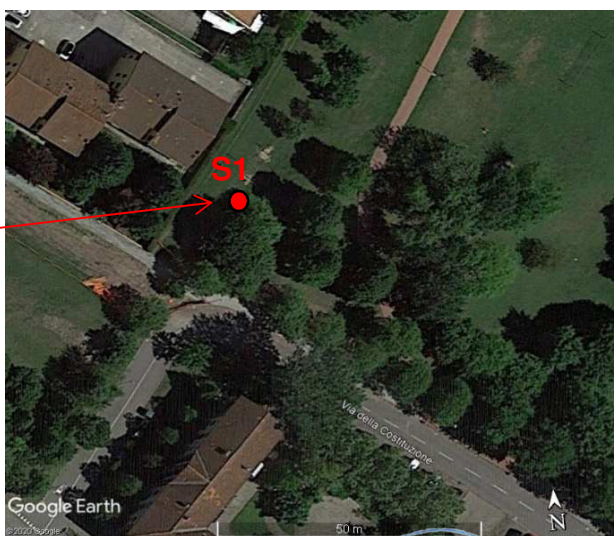
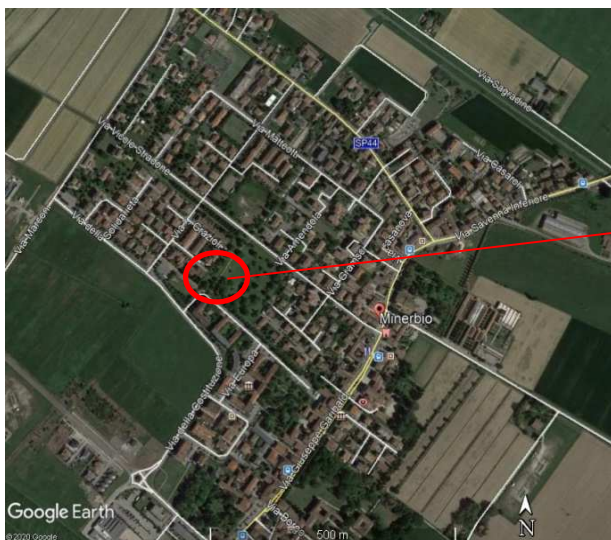
Tel. 0532 773136 - 0532 815683 Fax 0532 776455

www.songeo.it info@songeo.it

P.IVA e C.F. 01083140382

Certificazione UNI EN ISO 9001: 2015 N° 17493 rilasciata da Certiquality
Albo Nazionale Gestori Ambientali Iscrizione n° BO 03079 Cat. 9-Ee 2BIS**Commessa** 76/20 del 09/10/2020**Località** Minerbio (BO)**Cantiere** via delle Nazioni Unite**Committente****Studio Samuel Sangiorgi
Geologia Applicata****Elenco dei certificati**

Rif.	Certificato	del	Prova	Specifica	Metodo
S1	179/20	06/11/2020	Sondaggio geognostico	ASTM D 2488-90; AGI 1977	Carotaggio continuo

Corografia e Planimetria

Sperimentatore

Direttore



QUOTA

p.c.

ATTREZZI:

Carotiere semplice Ø 101 mm

Rivestimenti Ø 127 mm

SONDA IDRAULICA

CMV MK420 (TR 600)

COMMITTENTE Studio Samuel Sangiorgi geologia applicata

LOCALITA' Minerbio (Bo) Via delle Nazioni Unite.

PIEZOMETRO Assente

NOTE

CAMPIONI

● SPT

■ **CAMPIONI INDISTURBATI**

LIVELLO ACQUA
DATA MT. dal P.C.

05/11/20

3,40

PROF. FORO

30,00 m

PROF. RIVEST.

26,50 m

ASSISTENTI

Luca Malservigi - Alessio Bosi

OPERATORI

Renato Sacchetti

mt.	QUOTA da P.C.	SIMBOLOGIA	CAMPIONI			DESCRIZIONE STRATIGRAFICA	POCKET kg/cm ²	TORVANE kg/cm ²	PIEZOMETRO
			TIPO	NUM.	PROF.				
1	0,10					Terreno vegetale e limo sabbioso marrone.			
	0,20					Limo sabbioso e sabbia limosa nocciola con frammenti di laterizi.			
2	2,00					Sabbia fine con limo nocciola alternata a sabbia limosa, presenti puntature brune e qualche livelletto limoso.	1,1	0,15	
	3	2,50				Limo da argilloso a sabbioso nocciola con laminazioni brune e punti ocra.	1,7	0,3	
						Sabbia fine debolmente limosa nocciola con locali livelletti limosi.	1,9	0,6	
4	3,90					Limo argilloso sabbioso grigio verdastro con locali sfumature verdastre intervallate ad argilla più frequente al tetto e alla base.	0,5	0,3	
	4,50					Argilla grigia che da 4,80 m passa a grigio plumbeo, con qualche frustolo.	0,3	0,1	
5	6,60		OST1	5,00	5,60	Argilla molto consistente grigia verdastra con concrezioni calcaree.	0,8	0,4	
							0,9	0,45	
6	6,60		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,5	1,0	
							2,5	1,0	
7	11,00		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,5	1,0	
							2,4	0,9	
8	11,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,4	1,2	
							3,1	1,2	
9	11,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,7	0,6	
							2,1	0,7	
10	13,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	0,8	0,4	
							0,8	0,4	
11	14,20		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,0	1,0	
							2,5	1,1	
12	14,60		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,3	1,0	
							2,8	1,0	
13	15,00		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,9	1,4	
							2,8	1,4	
14	15,60		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,8	1,4	
							3,5	1,4	
15	16,10		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	3,2	1,3	
							2,9	1,2	
16	17,40		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,8	1,8	
							1,4	1,4	
17	17,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	2,5	1,2	
							2,5	1,2	
18	18,00		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	3,2	1,3	
							4,0	1,8	
19	18,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	3,2	1,3	
							4,0	1,8	
20	20,10		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
21	20,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	
22	14,20		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
23	14,60		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	
24	15,00		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
25	15,60		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	
26	16,10		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
27	17,40		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	
28	17,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
29	18,00		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	
30	18,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
31	19,50		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	
32	19,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
33	20,10		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	
34	20,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	4,0	1,8	
							3,2	1,4	
35	20,80		OST2	10,10	10,70	Argilla molto consistente nocciola grigia azzurra, con concrezioni calcaree sparse e talora concentrate. Tra 7,40 m e 7,70 m argilla limosa con livelletto centrale a 7,50 m di limo argilloso con sabbia fine.	1,5	1,3	
							1,4	0,6	

Certificato n°	179/20	data	06/11/20	N°Commessa	76/20	data	09/10/2020	
Procedure di riferimento ASTM D 2488-90; AGI 1977								
responsabili	Dott. Gian Luca Carli		revisione	0	inizio lavori	4 novembre 2020	fine lavori	5 novembre 2020
elaborazione	Dott. Gian Luca Carli		0	responsabile cantiere	Dott. Geol. Renato Sacchetti			
verifica	Dott. Geol. Renato Sacchetti			direzione lavori	Dott., Geol. Samuel Sangiorgi			
SPERIMENTATORE				DIRETTORE				



QUOTA

p.c.

ATTREZZI:

Carotiere semplice Ø 101 mm
Rivestimenti Ø 127 mm

SONDA IDRAULICA

CMV MK420 (TR 600)

COMMITTENTE Studio Samuel Sangiorgi geologia applicata

LOCALITA' Minerbio (Bo) Via delle Nazioni Unite.

PIEZOMETRO Assente

NOTE

CAMPIONI

- SPT
- CAMPIONI RIMANEGGIATI
- CAMPIONI INDISTURBATI

LIVELLO ACQUA
DATA MT. dal P.C.

PROF. FORO

PROF. RIVEST.

ASSISTENTI
Luca Malservigi - Alessio Bosi

OPERATORI
Renato Sacchetti

mt.	QUOTA da P.C.	SIMBOLOGIA	CAMPIONI			DESCRIZIONE STRATIGRAFICA	POCKET kg/cm ²	TORVANE kg/cm ²	PIEZOMETRO
			TIPO	NUM.	PROF.				
21	20,80					Sabbia fine limosa grigia passante a 20,40 m ad alternanze limo, limo argilloso con livelletti centimetrici sabbiosi.	1,0	0,2	
						1,0	0,4		
22	21,90					Argilla grigia con sfumature verdastre consistente e livelli centimetrici limosi.	1,1	0,5	
						1,8	0,7		
						1,4	0,7		
23	22,50					Argilla organica nerastra plastica.	1,1	0,6	
						1,1	0,3		
						1,1	0,4		
24	22,90					Argilla limosa grigia.	1,2	0,4	
						1,6	0,6		
25	23,30					Argilla grigia chiara debolmente limosa e limosa con concrezioni calcaree.	1,0	0,4	
						1,6	0,4		
						1,5	0,4		
26	25,20					Sabbia fine con limo passante a limo - limo argilloso color grigio, con rare concrezioni calcaree.	0,9	0,4	
						1,0	0,2		
27	26,30					Limo e limo argilloso grigio con sfumature verdastre e ocre, a tratti sabbioso, alla base sabbia.	1,4	0,3	
						1,0	0,4		
28	26,50			OST4	26,50 27,00	Argilla grigia con sfumature ocre con livelli limosi sabbiosi tra 27,10 m e 27,30 m e tra 28,50 m e 28,70 m.	1,1	0,2	
						1,7	0,7		
29	28,40						1,6	0,8	
						1,8	0,6		
30	29,40						2,0	0,6	
						1,3	0,6		
31	30,00					Sabbia medio fine grigia a tratti debolmente limosa.	2,2	1,0	
						2,2	0,4		
32									
33									
34									
35									
36									
37									
38									
39									
40									

Certificato n°	167/20	data	06/11/20	N°Commessa	76/20	data	09/10/2020
Procedure di riferimento ASTM D 2488-90; AGI 1977							
responsabili		revisione		inizio lavori		fine lavori	
Dott. Gian Luca Carli		0		4 novembre 2020		5 novembre 2020	
elaborazione	Dott. Gian Luca Carli			responsabile cantiere	Dott. Geol. Renato Sacchetti		
verifica	Dott. Geol. Renato Sacchetti			direzione lavori	Dott., Geol. Samuel Sangiorgi		
SPERIMENTATORE				DIRETTORE			



MINERBIO_MS, TR18

037038P94651HVSR288

Instrument: TRZ-0108/01-10

Start recording: 12/01/21 10:58:28 End recording: 12/01/21 11:18:29

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 78% trace (manual window selection)

Sampling rate: 128 Hz

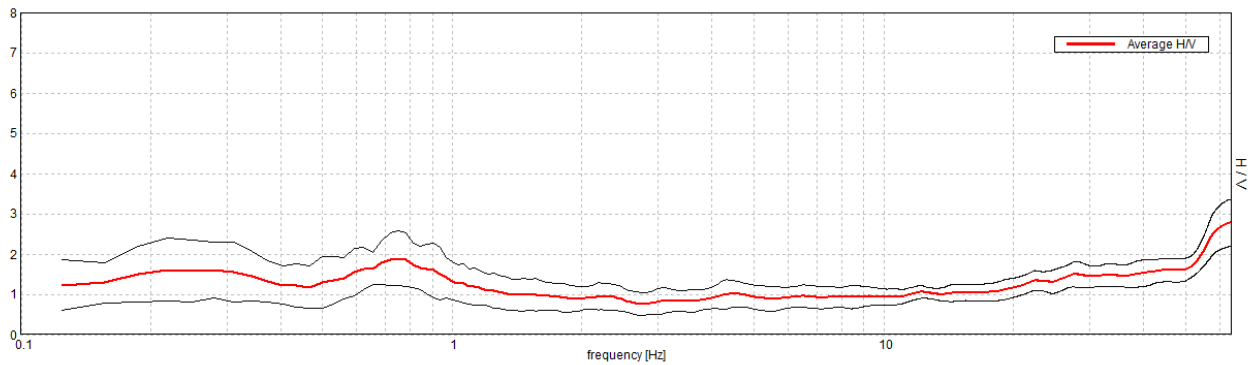
Window size: 20 s

Smoothing type: Triangular window

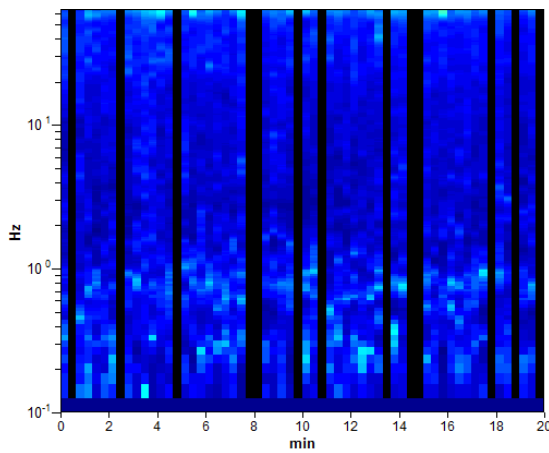
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

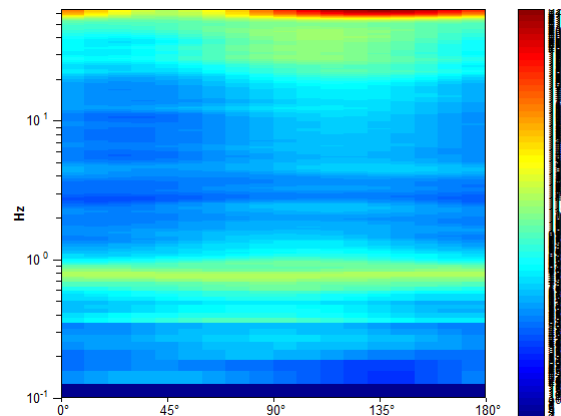
Max. H/V at 0.75 ± 0.07 Hz. (In the range 0.1 - 20.0 Hz).



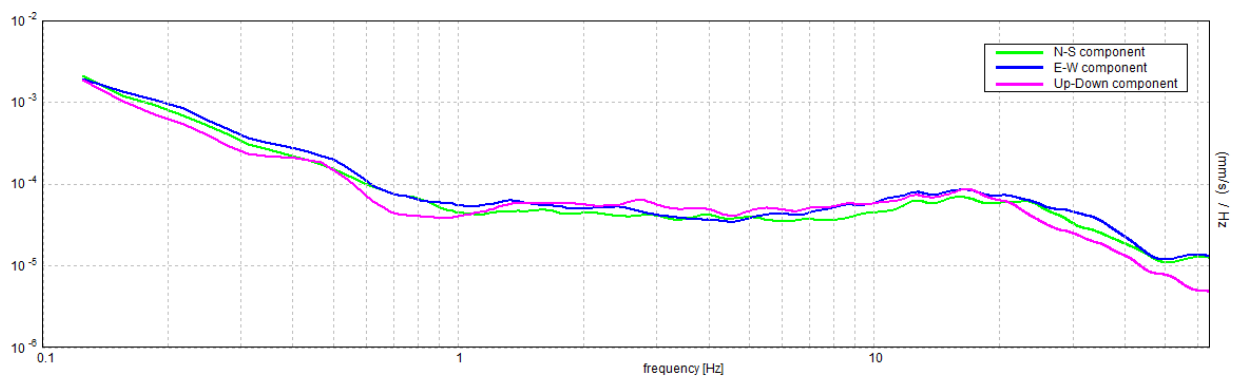
H/V TIME HISTORY



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 0.75 ± 0.07 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.75 > 0.50$	OK	
$n_c(f_0) > 200$	$705.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 37 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	1.719 Hz	OK	
$A_0 > 2$	$1.90 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.04784 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.03588 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3391 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR19

037038P94652HVSR289

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 12:32:30 End recording: 14/01/01 12:52:31

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 75% trace (manual window selection)

Sampling rate: 128 Hz

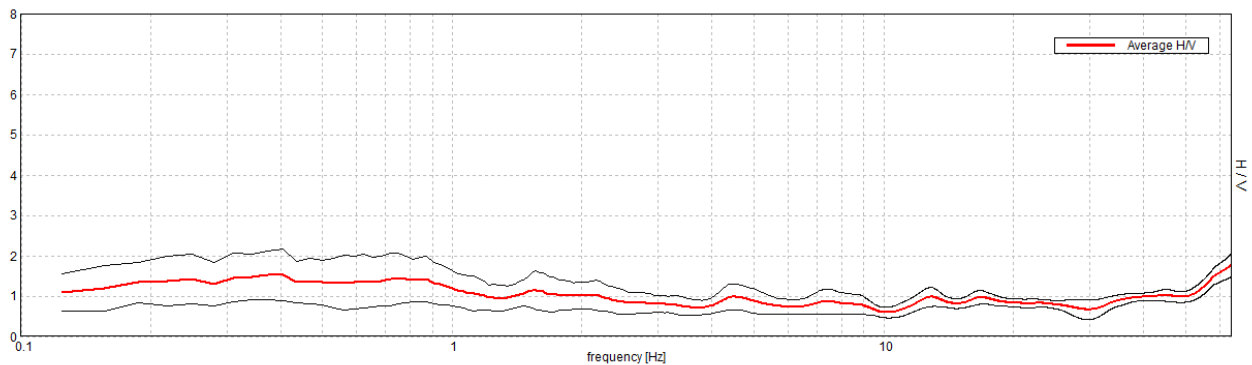
Window size: 20 s

Smoothing type: Triangular window

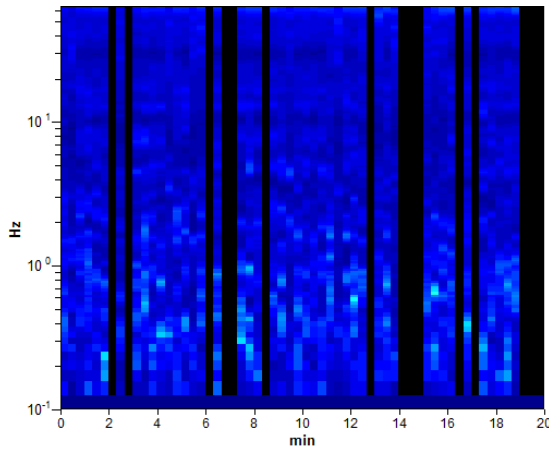
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

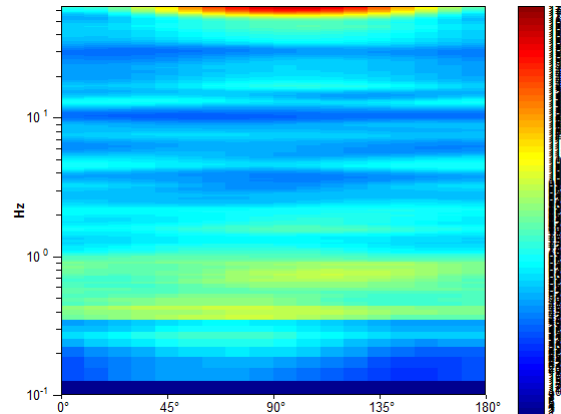
Max. H/V at 0.41 ± 0.05 Hz (in the range 0.1 - 20.0 Hz).



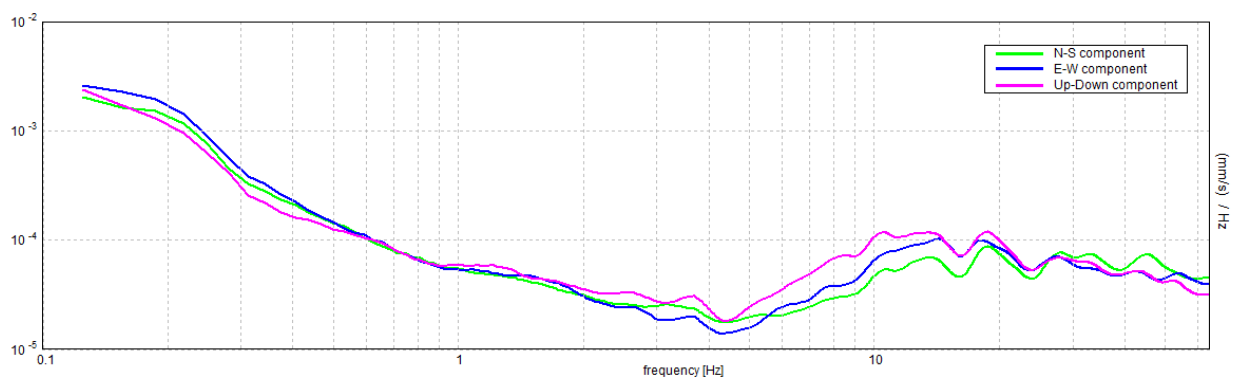
H/V TIME HISTORY



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 0.41 ± 0.05 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.41 > 0.50$		NO
$n_c(f_0) > 200$	$365.6 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 20 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
$A_0 > 2$	$1.52 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.05754 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.02338 < 0.08125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.311 < 2.5$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR20

037038P94653HVSR290

Instrument: TRZ-0108/01-10

Start recording: 12/01/21 12:37:40 End recording: 12/01/21 12:56:07

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h18'24". Analyzed 82% trace (manual window selection)

Sampling rate: 128 Hz

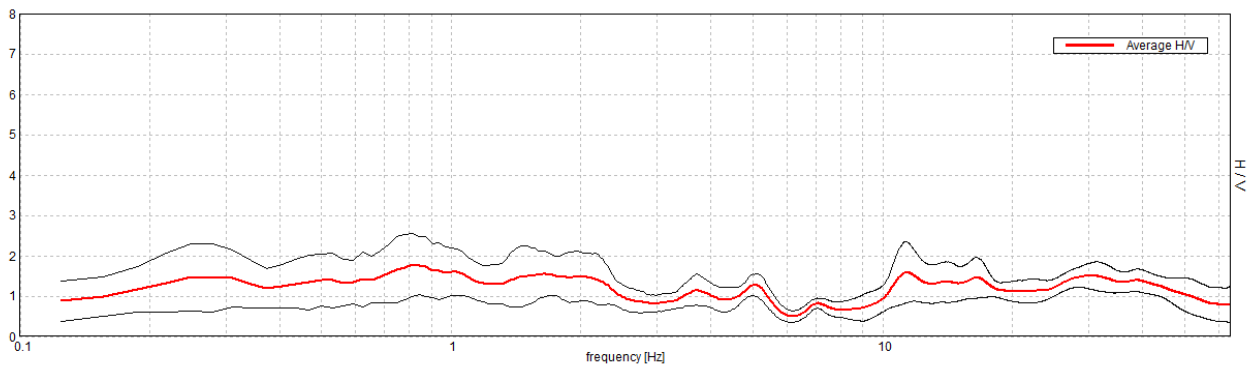
Window size: 20 s

Smoothing type: Triangular window

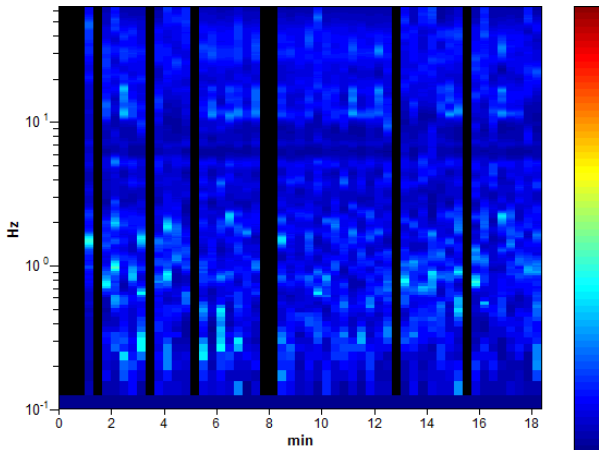
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

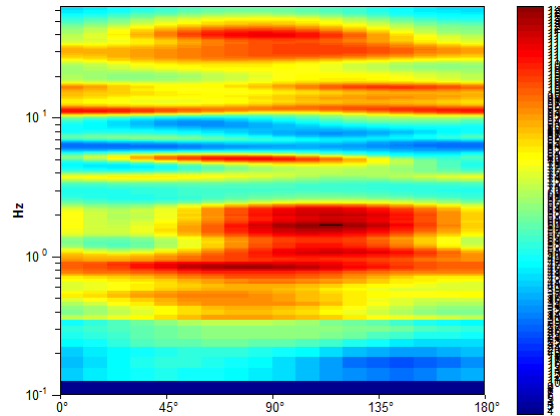
Max. H/V at 0.81 ± 0.82 Hz. (In the range 0.1 - 20.0 Hz).



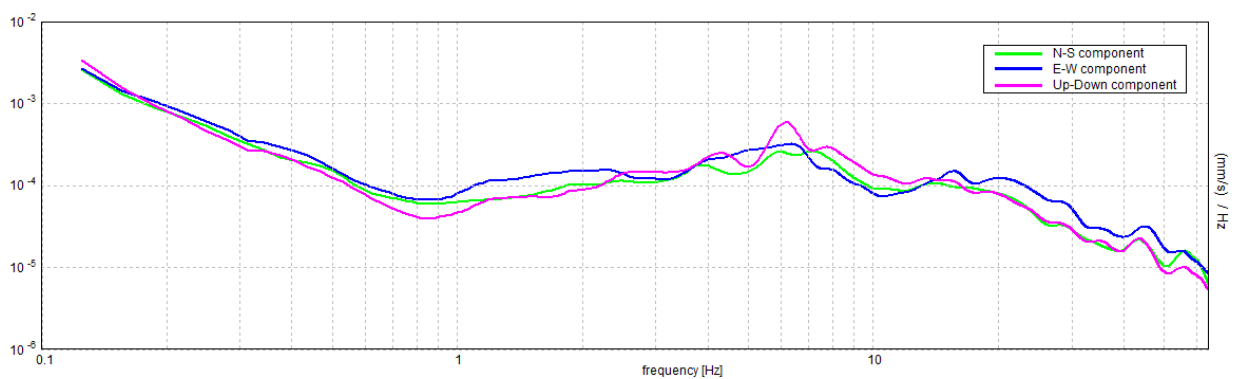
H/V TIME HISTORY



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 0.81 ± 0.82 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$731.3 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.656 Hz	OK	
$A_0 > 2$	$1.77 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.49735 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.4041 < 0.12188$		NO
$\sigma_A(f_0) < \theta(f_0)$	$0.379 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR21

037038P94654HVSR291

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 12:02:32 End recording: 14/01/01 12:22:33

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 77% trace (manual window selection)

Sampling rate: 128 Hz

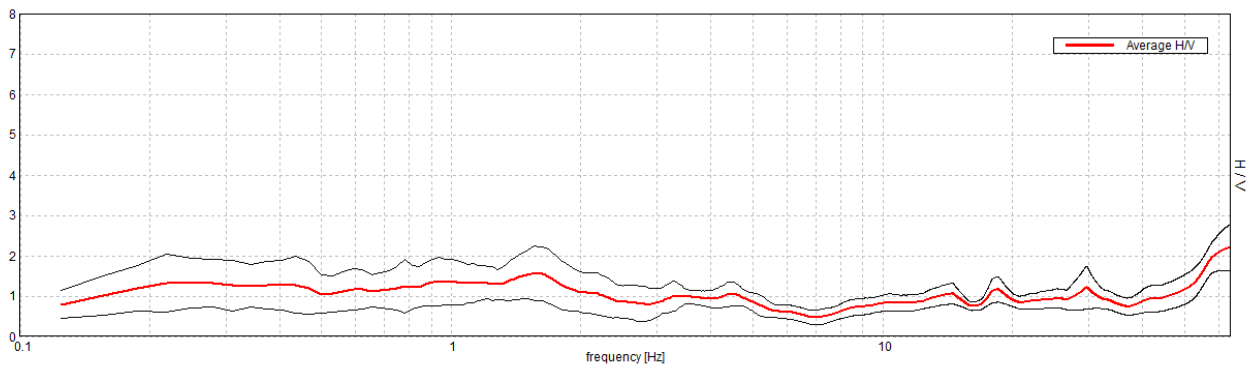
Window size: 20 s

Smoothing type: Triangular window

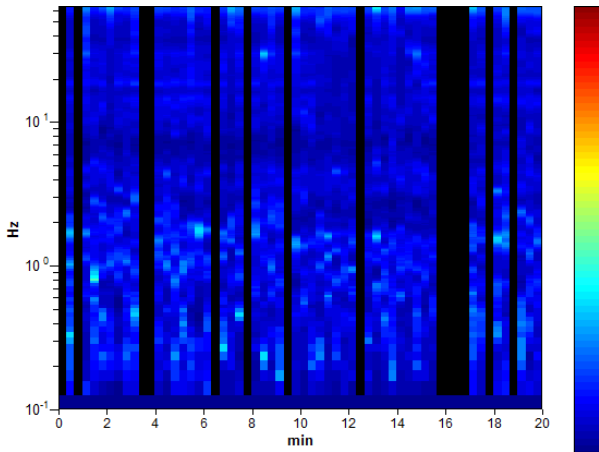
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

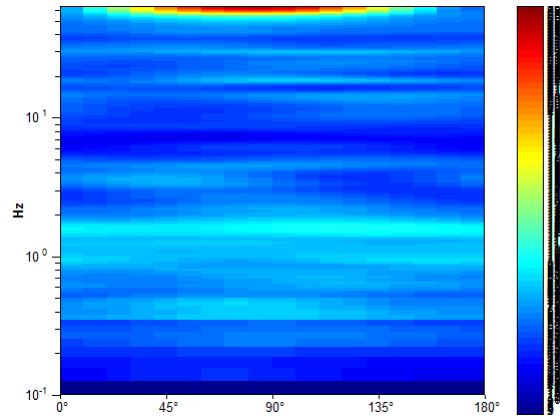
Max. H/V at 1.56 ± 0.1 Hz. (In the range 0.1 - 20.0 Hz).



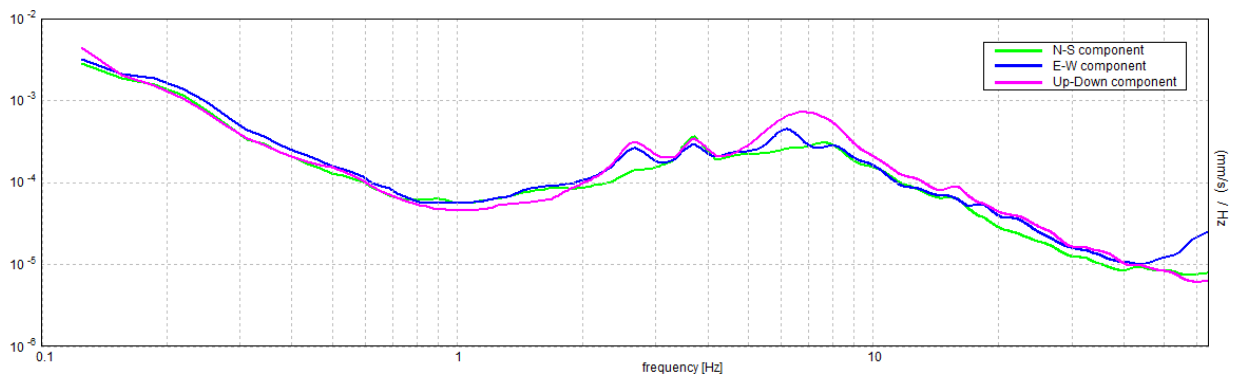
H/V TIME HISTORY



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 1.56 ± 0.1 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$1.56 > 0.50$	OK	
$n_c(f_0) > 200$	$1437.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 76 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	5.188 Hz	OK	
$A_0 > 2$	$1.56 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03081 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.04813 < 0.15625$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3302 < 1.78$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR22

037038P94655HVSR292

Instrument: TRZ-0108/01-10

Start recording: 12/01/21 13:18:01 End recording: 12/01/21 13:38:02

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 78% trace (manual window selection)

Sampling rate: 128 Hz

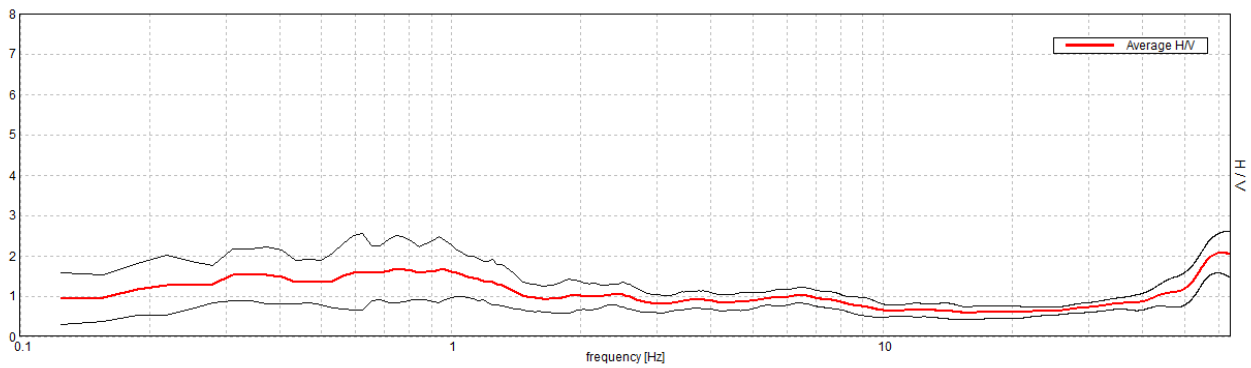
Window size: 20 s

Smoothing type: Triangular window

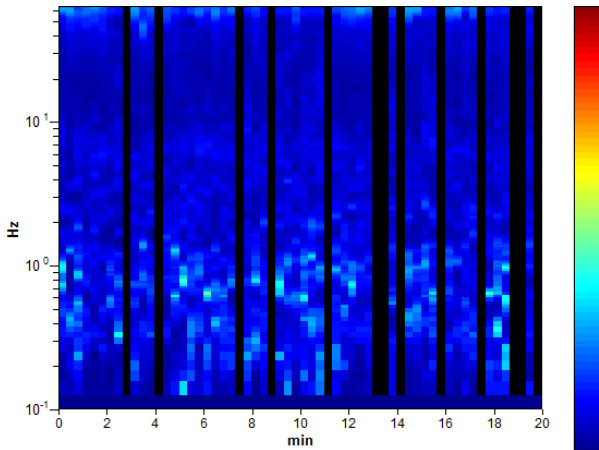
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

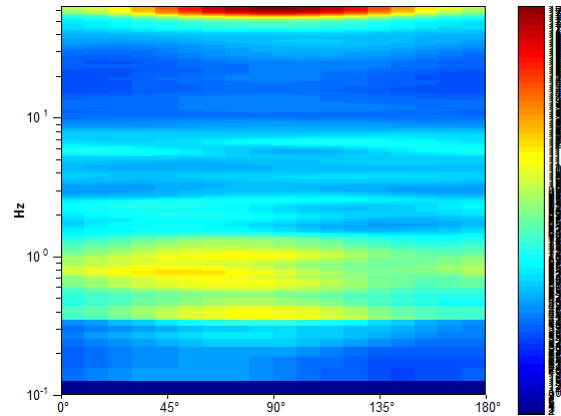
Max. H/V at 0.75 ± 0.04 Hz. (In the range 0.1 - 20.0 Hz).



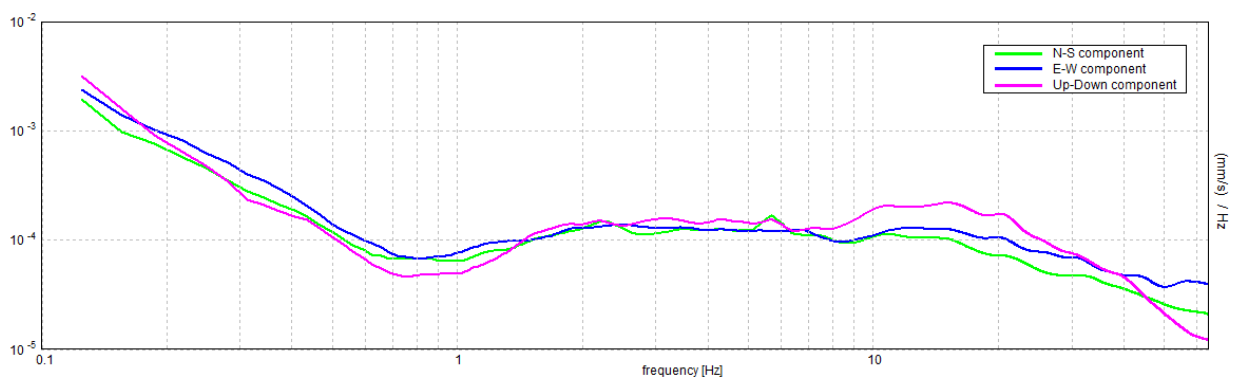
H/V TIME HISTORY



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 0.75 ± 0.04 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.75 > 0.50$	OK	
$n_c(f_0) > 200$	$705.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 37 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.875 Hz	OK	
$A_0 > 2$	$1.67 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.02512 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01884 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4097 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR23

037038P94656HVSR293

Instrument: TRZ-0108/01-10

Start recording: 12/01/21 14:48:41 End recording: 12/01/21 15:08:42

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 80% trace (manual window selection)

Sampling rate: 128 Hz

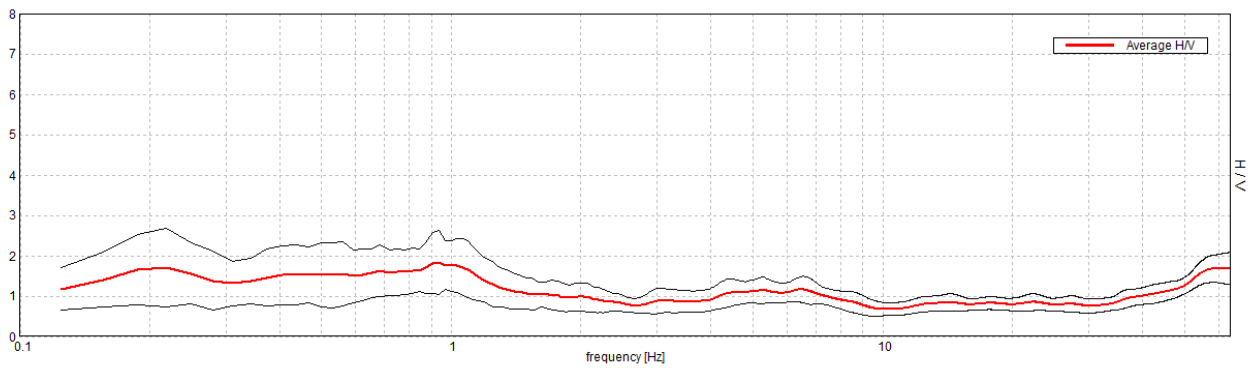
Window size: 20 s

Smoothing type: Triangular window

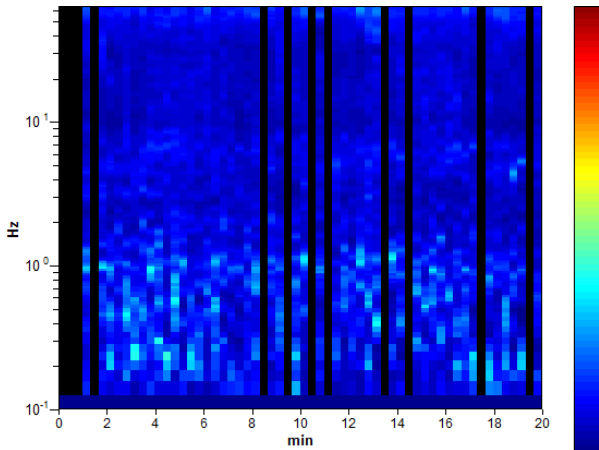
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

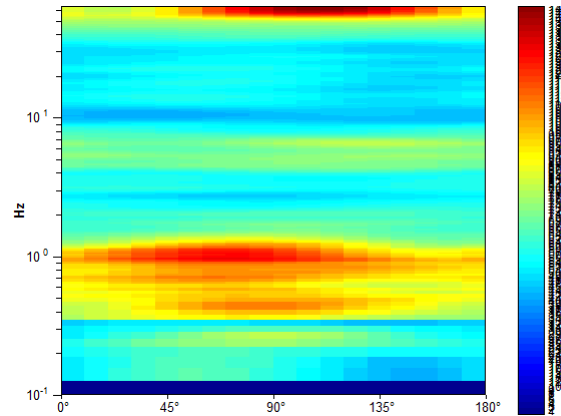
Max. H/V at 0.94 ± 0.06 Hz. (In the range 0.1 - 20.0 Hz).



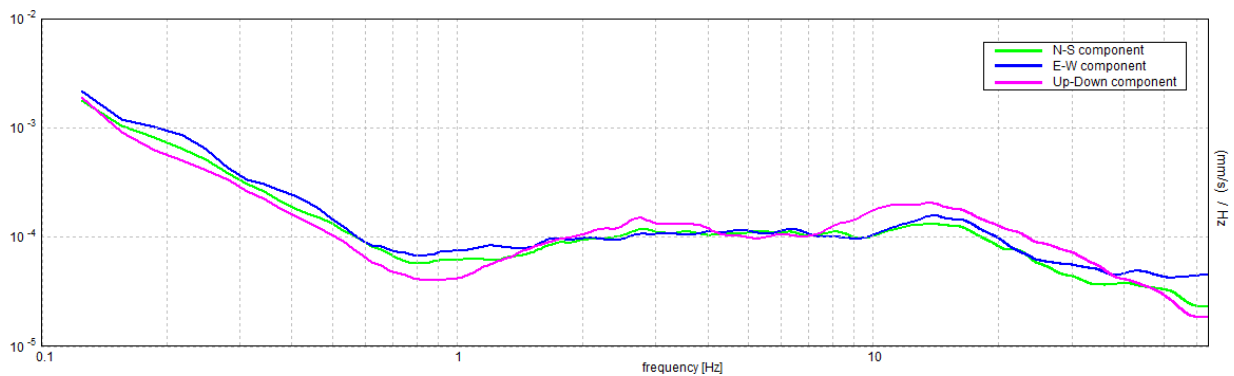
H/V TIME HISTORY



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 0.94 ± 0.06 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.94 > 0.50$	OK	
$n_c(f_0) > 200$	$900.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 46 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.156 Hz	OK	
$A_0 > 2$	$1.84 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03382 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.03171 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3928 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR24

037038P94657HVSR294

Instrument: TRZ-0108/01-10

Start recording: 12/01/01 15:40:18 End recording: 12/01/01 16:00:19

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 75% trace (manual window selection)

Sampling rate: 128 Hz

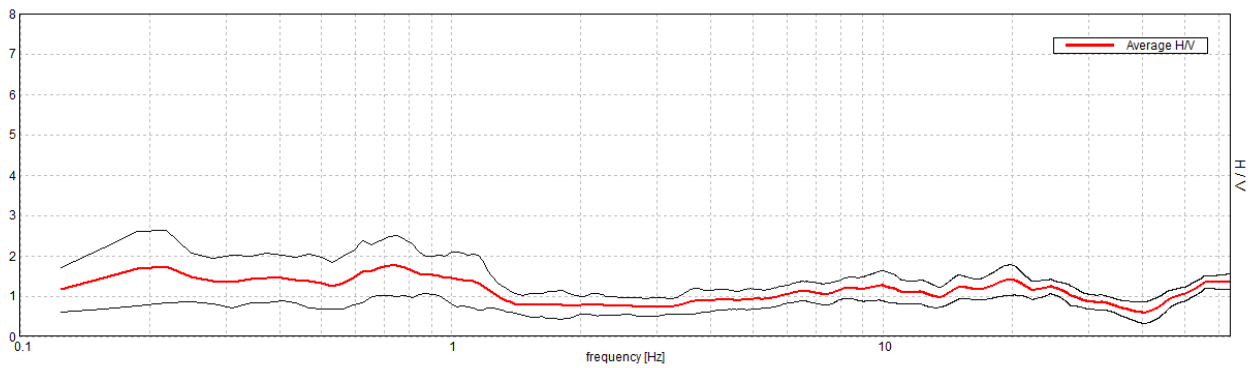
Window size: 20 s

Smoothing type: Triangular window

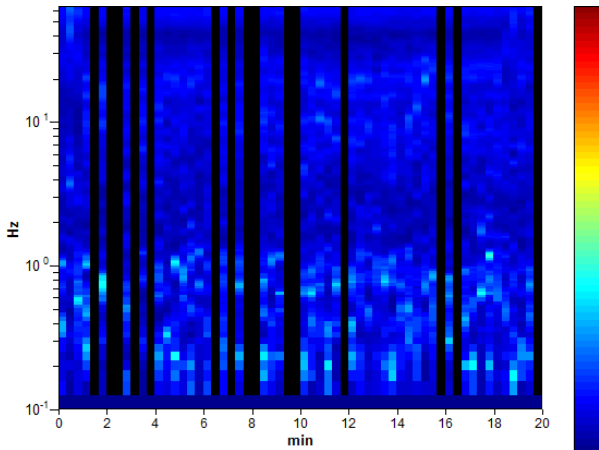
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

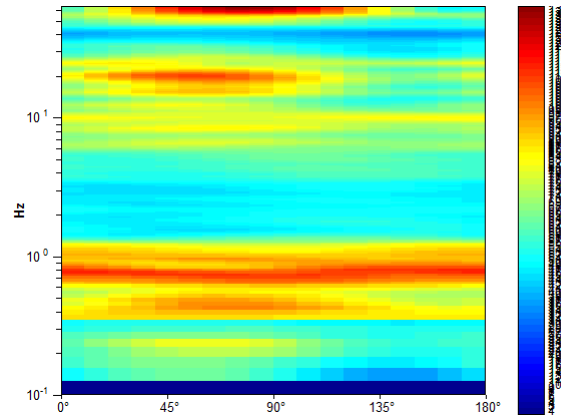
Max. H/V at 0.75 ± 0.09 Hz. (In the range 0.1 - 20.0 Hz).



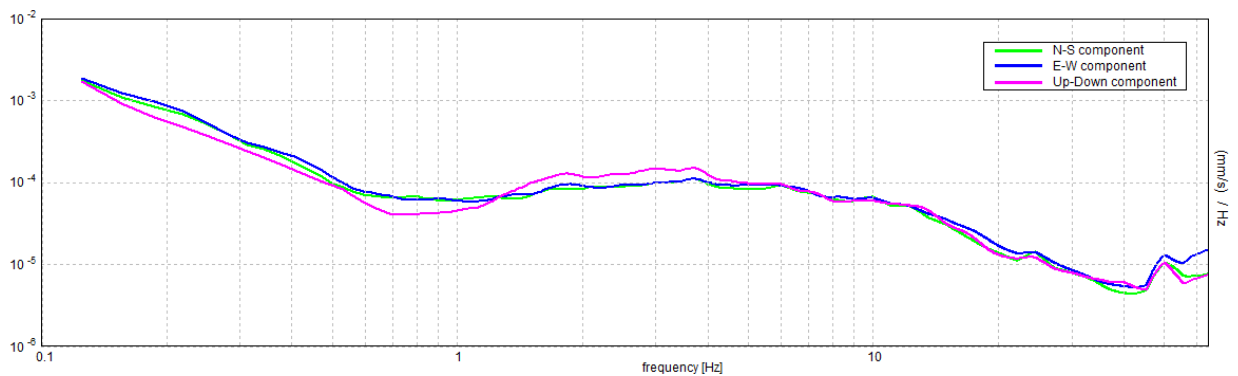
H/V TIME HISTORY



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 0.75 ± 0.09 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.75 > 0.50$	OK	
$n_c(f_0) > 200$	$675.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 37 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.375 Hz	OK	
$A_0 > 2$	$1.75 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.06022 < 0.05$		NO
$\sigma_f < \varepsilon(f_0)$	$0.04517 < 0.1125$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3674 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR25

037038P94658HVSR295

Instrument: TRZ-0108/01-10

Start recording: 12/01/01 16:09:08 End recording: 12/01/01 16:29:09

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 85% trace (manual window selection)

Sampling rate: 128 Hz

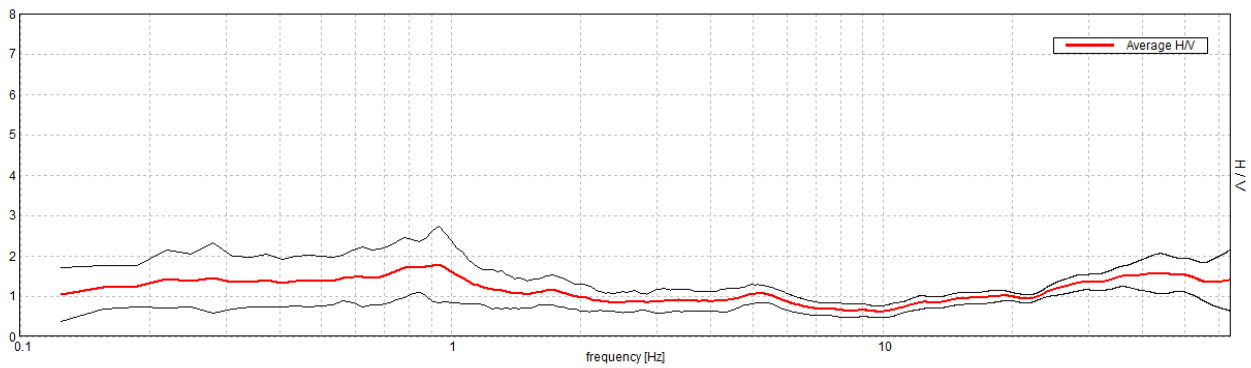
Window size: 20 s

Smoothing type: Triangular window

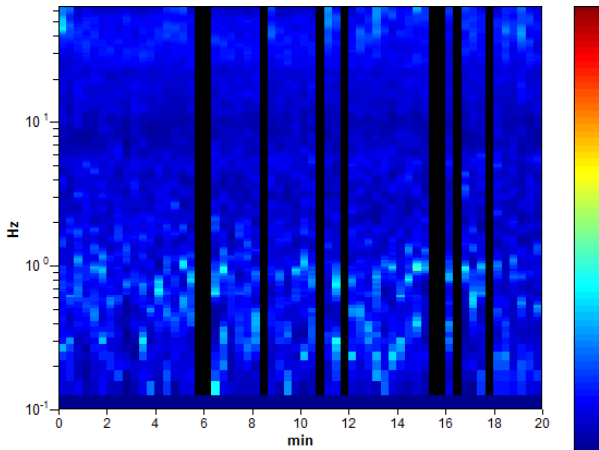
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

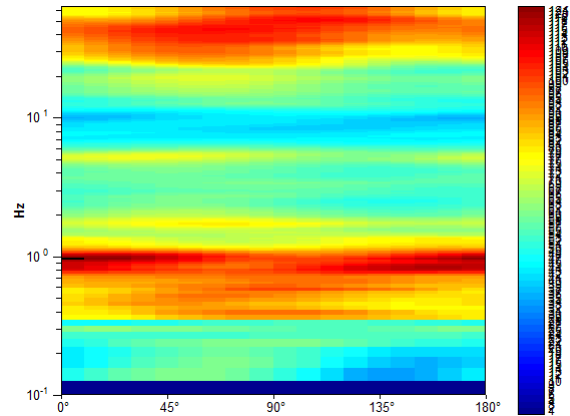
Max. H/V at 0.94 ± 0.07 Hz. (In the range 0.1 - 20.0 Hz).



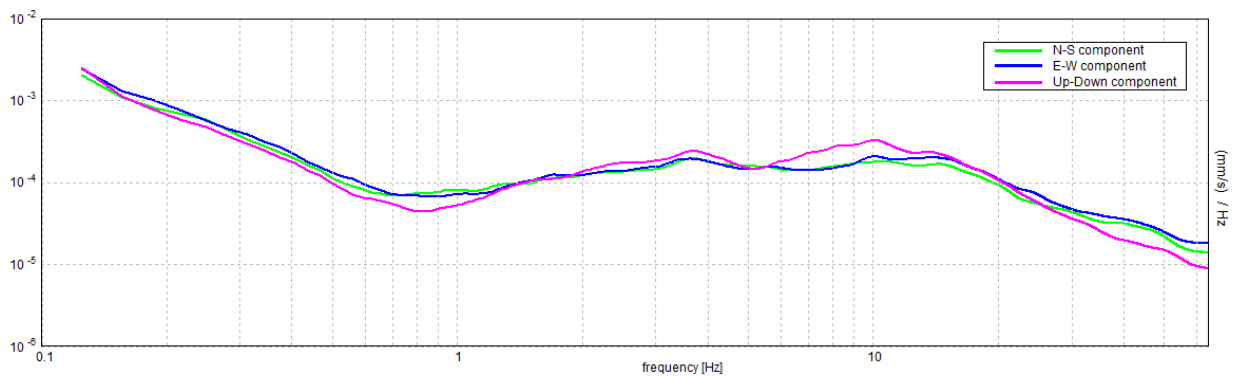
H/V TIME HISTORY



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 0.94 ± 0.07 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.94 > 0.50$	OK	
$n_c(f_0) > 200$	$956.3 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 46 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.188 Hz	OK	
$A_0 > 2$	$1.78 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03473 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.03256 < 0.14063$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4636 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR26

037038P94659HVSR296

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 09:09:20 End recording: 14/01/01 09:29:20

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 67% trace (manual window selection)

Sampling rate: 128 Hz

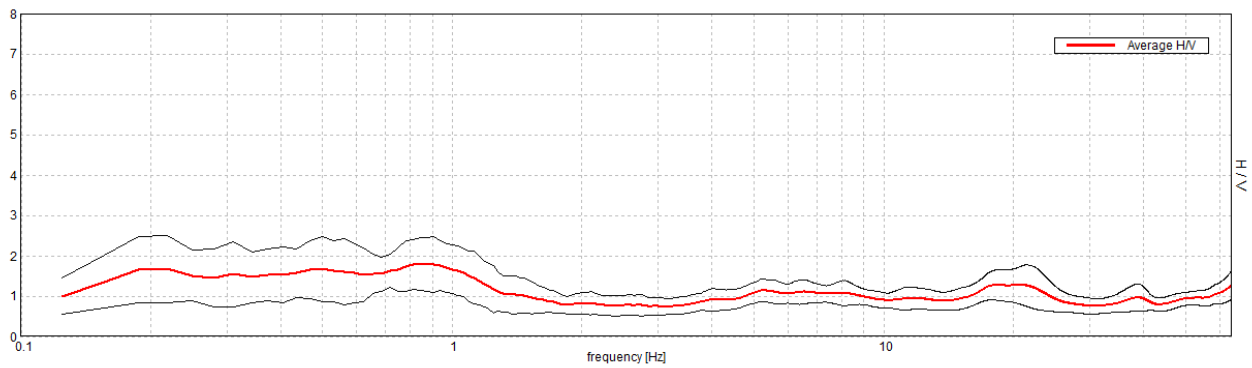
Window size: 20 s

Smoothing type: Triangular window

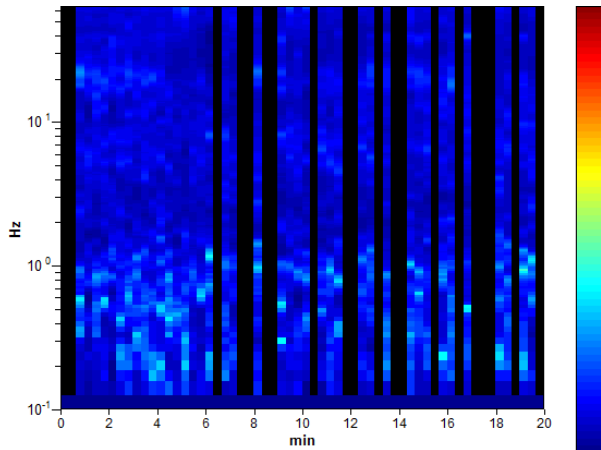
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

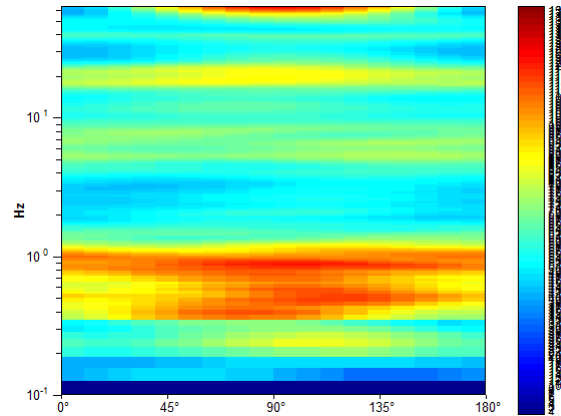
Max. H/V at 0.84 ± 0.07 Hz. (In the range 0.1 - 20.0 Hz).



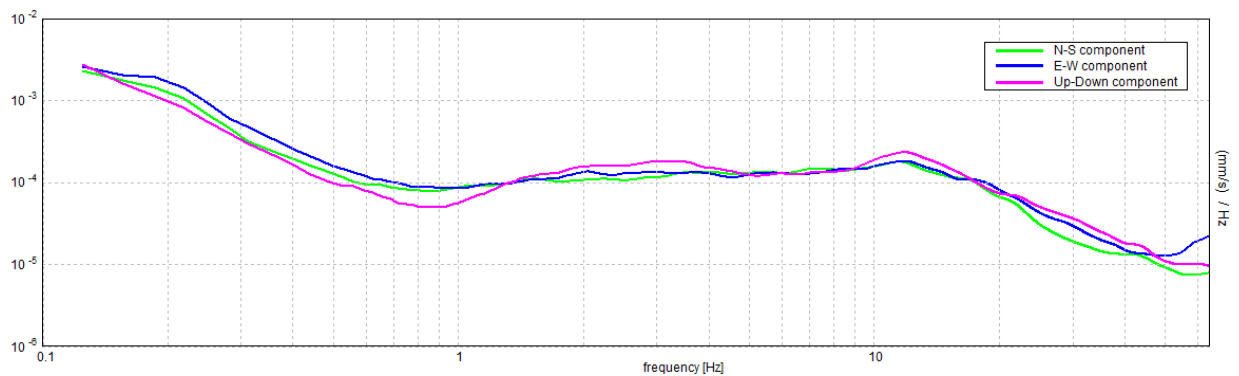
H/V TIME HISTORY



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 0.84 ± 0.07 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.84 > 0.50$	OK	
$n_c(f_0) > 200$	$675.0 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 42 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.656 Hz	OK	
$A_0 > 2$	$1.80 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.04261 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.03595 < 0.12656$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3198 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR27

037038P94660HVSR297

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 09:39:49 End recording: 14/01/01 09:59:50

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 62% trace (manual window selection)

Sampling rate: 128 Hz

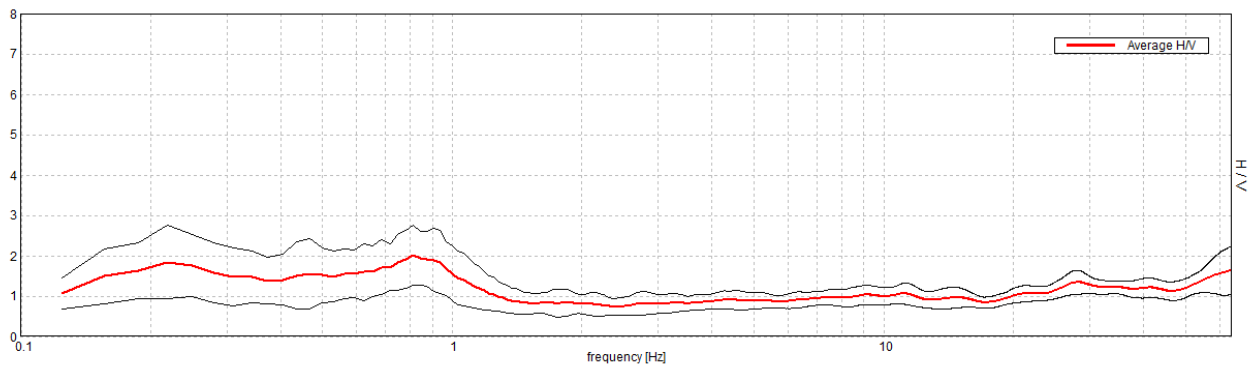
Window size: 20 s

Smoothing type: Triangular window

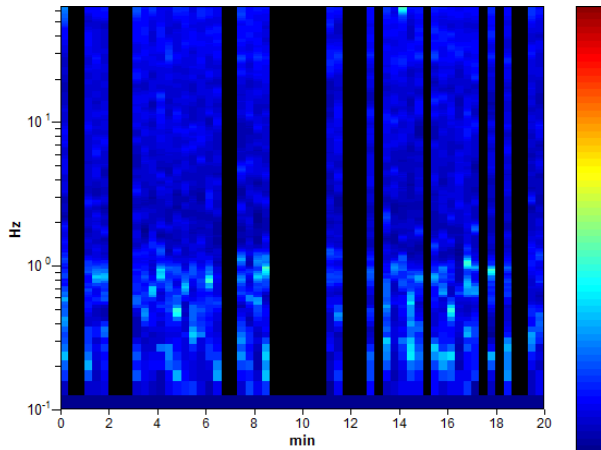
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

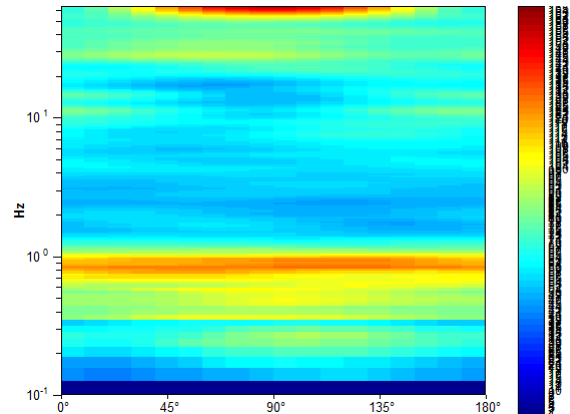
Max. H/V at 0.81 ± 0.06 Hz. (In the range 0.1 - 20.0 Hz).



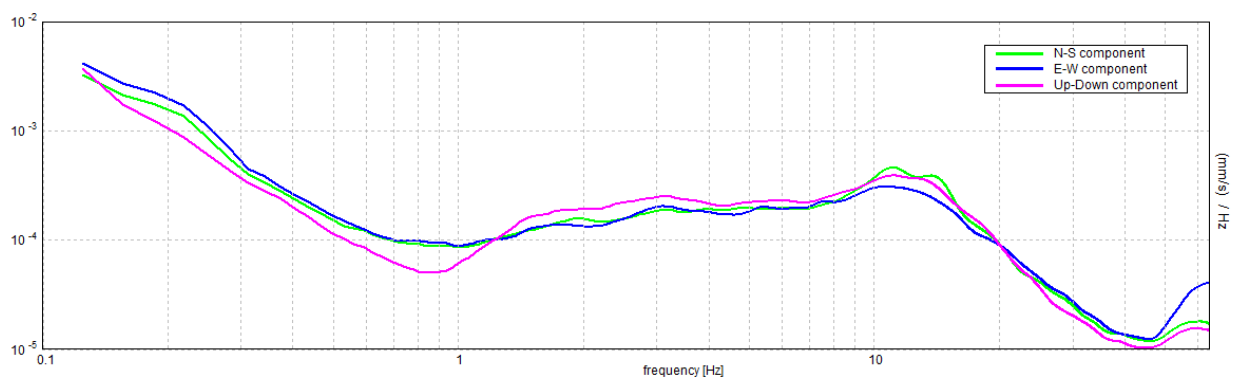
H/V TIME HISTORY



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 0.81 ± 0.06 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$601.3 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.281 Hz	OK	
$A_0 > 2$	$2.01 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03421 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.02779 < 0.12188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3582 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR28

037038P94661HVSR298

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 10:05:14 End recording: 14/01/01 10:25:14

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 77% trace (manual window selection)

Sampling rate: 128 Hz

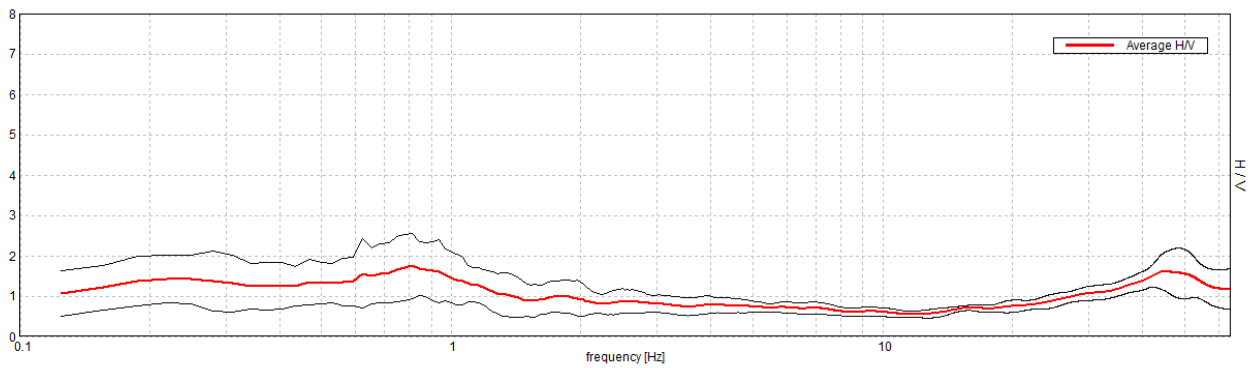
Window size: 20 s

Smoothing type: Triangular window

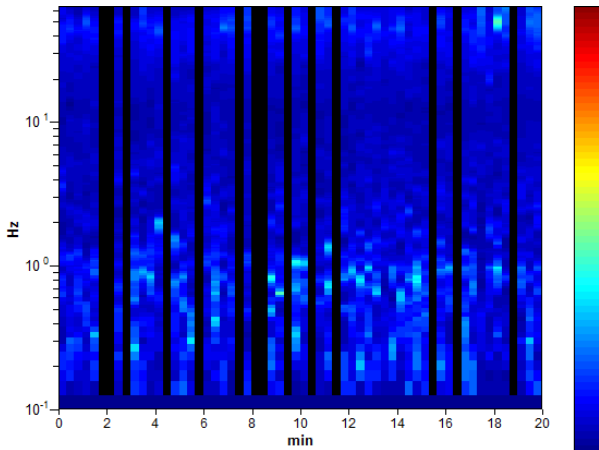
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

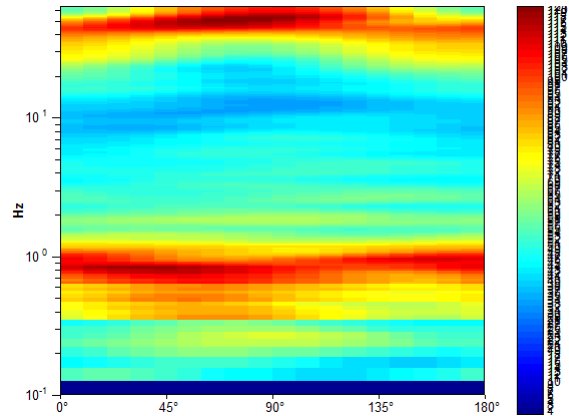
Max. H/V at 0.81 ± 0.06 Hz. (In the range 0.1 - 20.0 Hz).



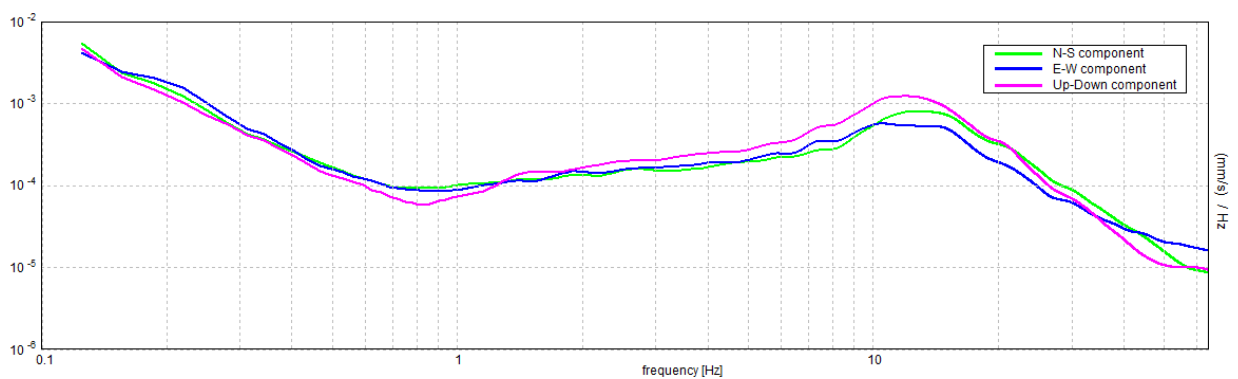
H/V TIME HISTORY



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 0.81 ± 0.06 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$747.5 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	2.063 Hz	OK	
$A_0 > 2$	$1.75 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.03603 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.02928 < 0.12188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.3989 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR29

037038P94662HVSR299

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 10:34:14 End recording: 14/01/01 10:54:15

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 75% trace (manual window selection)

Sampling rate: 128 Hz

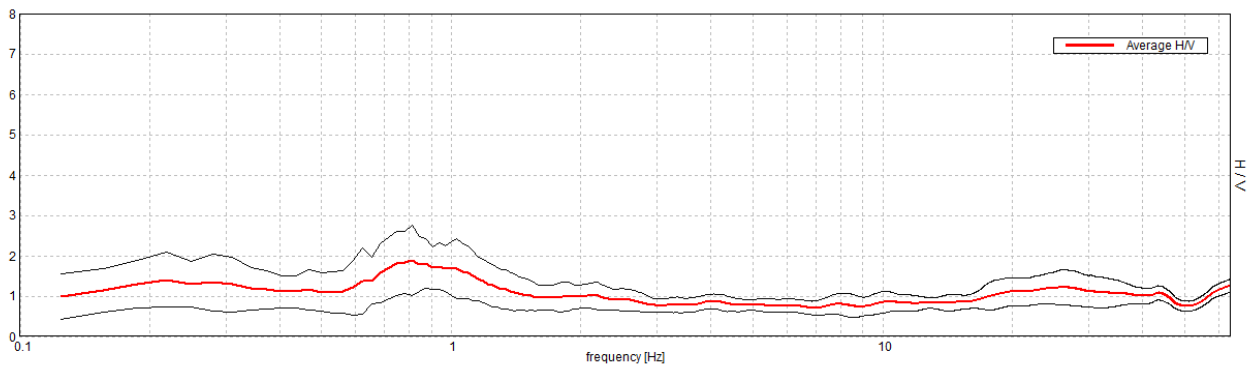
Window size: 20 s

Smoothing type: Triangular window

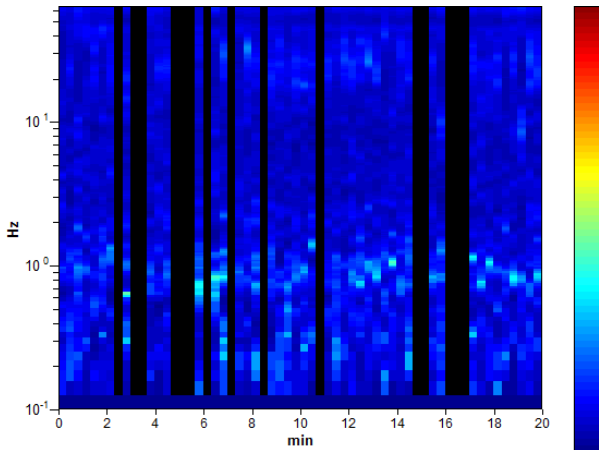
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

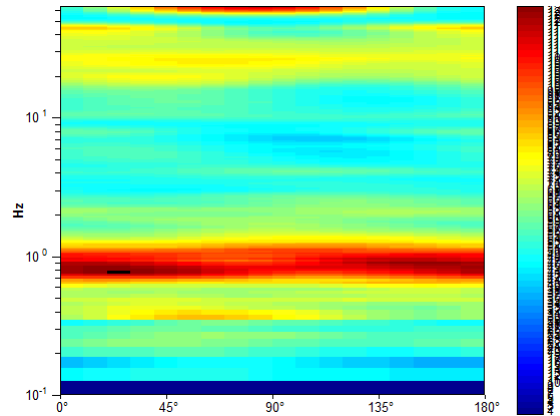
Max. H/V at 0.81 ± 0.03 Hz. (In the range 0.1 - 20.0 Hz).



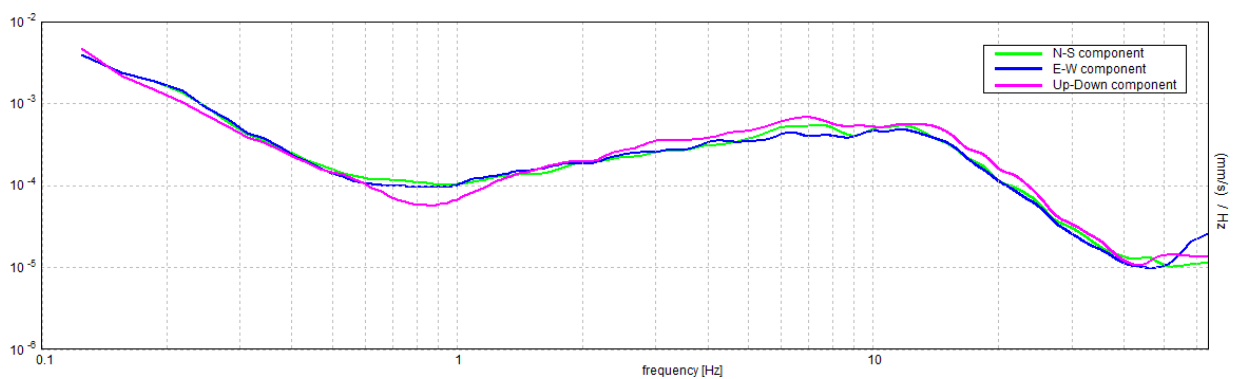
H/V TIME HISTORY



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 0.81 ± 0.03 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.81 > 0.50$	OK	
$n_c(f_0) > 200$	$731.3 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 40 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0]$ $A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0]$ $A_{H/V}(f^+) < A_0 / 2$	2.313 Hz	OK	
$A_0 > 2$	$1.88 > 2$		NO
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.01882 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.01529 < 0.12188$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.426 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

MINERBIO_MS, TR30

037038P94663HVSR300

Instrument: TRZ-0108/01-10

Start recording: 14/01/01 11:00:14 End recording: 14/01/01 11:20:15

Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN

Trace length: 0h20'00". Analyzed 68% trace (manual window selection)

Sampling rate: 128 Hz

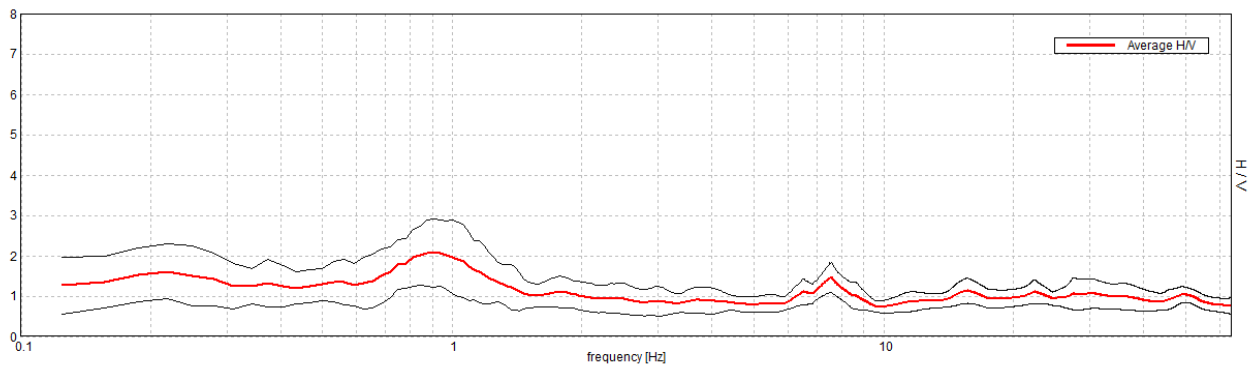
Window size: 20 s

Smoothing type: Triangular window

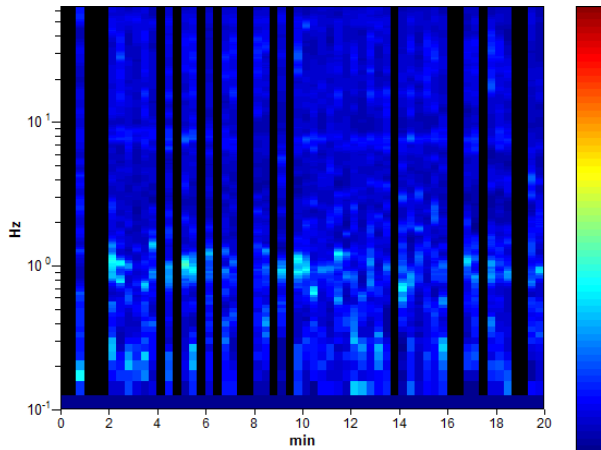
Smoothing: 10%

HORIZONTAL TO VERTICAL SPECTRAL RATIO

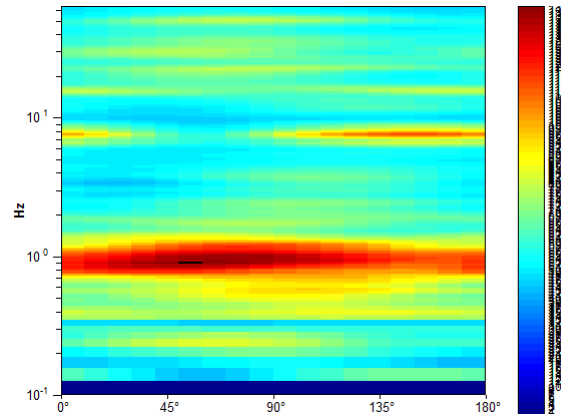
Max. H/V at 0.91 ± 0.07 Hz. (In the range 0.1 - 20.0 Hz).



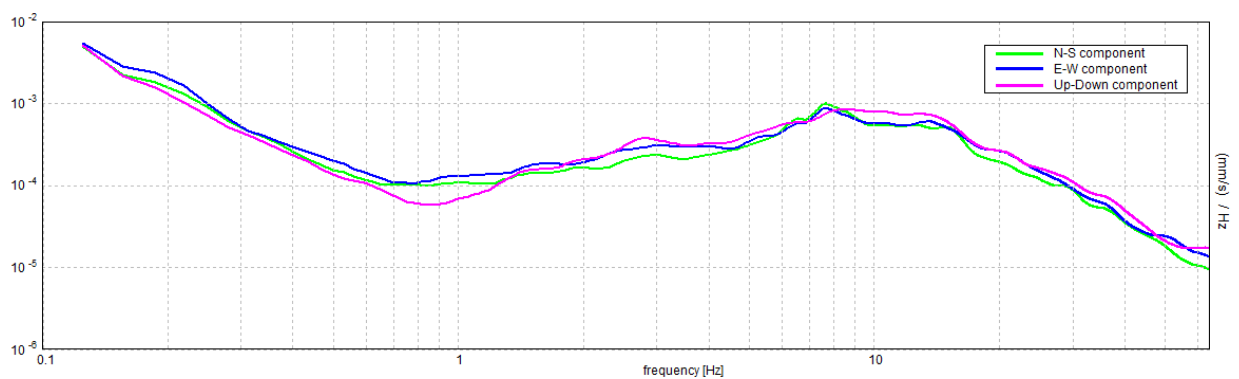
H/V TIME HISTORY



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 0.91 ± 0.07 Hz (in the range 0.1 - 20.0 Hz).

Criteria for a reliable H/V curve

[All 3 should be fulfilled]

$f_0 > 10 / L_w$	$0.91 > 0.50$	OK	
$n_c(f_0) > 200$	$743.1 > 200$	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5\text{Hz}$ $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5\text{Hz}$	Exceeded 0 out of 44 times	OK	

Criteria for a clear H/V peak

[At least 5 out of 6 should be fulfilled]

Exists f^- in $[f_0/4, f_0] \mid A_{H/V}(f^-) < A_0 / 2$			NO
Exists f^+ in $[f_0, 4f_0] \mid A_{H/V}(f^+) < A_0 / 2$	1.5 Hz	OK	
$A_0 > 2$	$2.07 > 2$	OK	
$f_{\text{peak}}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	$ 0.04037 < 0.05$	OK	
$\sigma_f < \varepsilon(f_0)$	$0.03659 < 0.13594$	OK	
$\sigma_A(f_0) < \theta(f_0)$	$0.4144 < 2.0$	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
$\sigma_{\log H/V}(f)$	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 $\sigma_{\log H/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

FERRARA DEPARTMENT

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SCHEDE GENERALE DEL CAMPIONE

COMMITTENTE:	Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32
CANTIERE:	Minerbio (BO)
CAMPIONE:	S1OST1 m 5.00 - 5.60
COMMESSA:	22146FE/20
VERBALE ACC.:	113/21
DATA CONSEGNA:	15/03/21

il campione è stato conservato in vasca umida termostatica

alto 5.00	P.P. kPa	T.V. kPa	LUNGHEZZA (cm): 50 GRADO DI QUALITA': AGI Q5 EC 7-3 Q1
	150	-	DESCRIZIONE: 0-7 rimaneggiato 7-50 argilla con limo grigio scuro
			W naturale (%) 32.6 γ naturale (Mg/m ³) γ secco (Mg/m ³) γ immerso (Mg/m ³) porosità (%) indice dei vuoti grado di saturazione (%) massa specifica stimata (Mg/m ³) 2.700
5.60 basso	180	-	PROVE ESEGUITE Umidità Naturale - Trassiale UU - Limiti Atterberg SI Trassiale CIU - Gran. Setacciatura SI Edometria - Gran. Sedimentazione SI Taglio Diretto - Peso di Volume - Espansione L.L. - Peso Specifico - Trassiale Cicl. + C.M. - Analisi Chimica - Colonna Risonante - Taglio Torsionale Cicl. -
			NOTE: -

Io Sperimentatore
dott. Roberto Bellanova

Il Direttore del Laboratorio terre
dott. geol. Massimo Romagnoli

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SOCOTEC

LIMITI DI ATTERBERG (norma ASTM D4318 metodo A)

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S1OST1 m 5.00 - 5.60**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

il campione è stato conservato in vasca umida termostatica

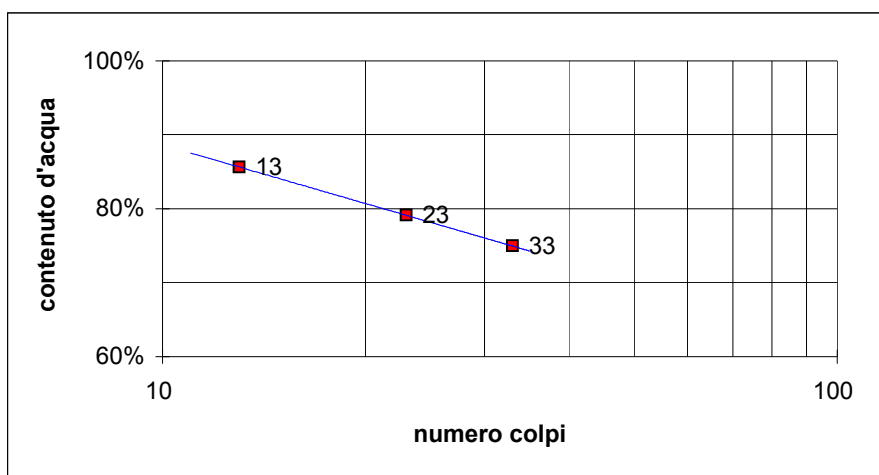
ASPETTO MACROSCOPICO DEL CAMPIONE:

Argilla con limo grigio scuro

codice cucchiaino: 344; codice bilancia: 480; codice stufa: 419

	LIMITE LIQUIDO			LIMITE PLASTICO		UMIDITA'
	1	2	3	1	2	
impasto						
N° colpi	33	23	13			
massa umida+ tara (g)	25.06	25.65	26.31	13.65	13.36	627.16
massa secca+ tara (g)	15.72	15.77	15.69	11.19	10.95	549.37
acqua contenuta (g)	9.34	9.88	10.62	2.46	2.41	77.79
tara (g)	3.26	3.28	3.29	3.26	3.22	310.67
peso secco (g)	12.46	12.49	12.40	7.93	7.73	238.70
contenuto d'acqua	75.0%	79.1%	85.6%	31.0%	31.2%	32.6%

Umidità Naturale Wn = 33%
 Limite Liquido LL = 78%
 Limite Plastico LP = 31%
 Indice Plastico IP = 47%



Io Sperimentatore:
dott. Roberto Bellanova

Il Direttore del Laboratorio terre:
dott. geol. Massimo Romagnoli

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ANALISI GRANULOMETRICA

(per setacciatura e sedimentazione) norma A.S.T.M. D 422

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S10ST1 m 5.00 - 5.60**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

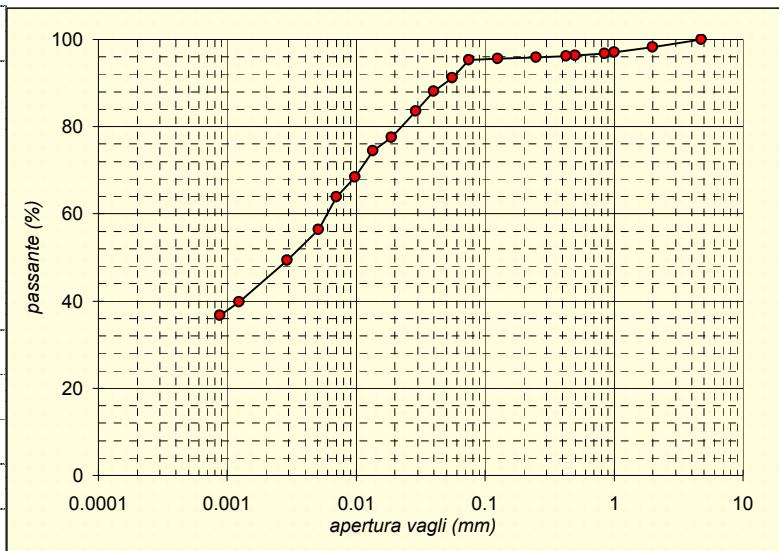
il campione è stato conservato in vasca umida termostatica Codici strumentazione: bilancia 480, vasca 557, stufa 419, densimetro 151H 348, termometro 588mescolatore 432.

ASPETTO MACROSCOPICO DEL CAMPIONE:

Argilla con limo grigio scuro

codici	vaglio	trattenuto	trattenuto	trattenuto	cum. tratt.	passante
	(mm)	(g)	(%)	(%)	(%)	(%)
571	setaccio	4.75	0.00	0.00	0.00	100.00
572	setaccio	2	4.27	1.79	1.79	98.21
573	setaccio	1	2.88	1.21	3.00	97.00
290	setaccio	0.85	0.50	0.21	3.20	96.80
291	setaccio	0.5	1.20	0.50	3.71	96.29
292	setaccio	0.425	0.26	0.11	3.82	96.18
293	setaccio	0.250	0.60	0.25	4.07	95.93
282	setaccio	0.125	0.81	0.34	4.41	95.59
283	setaccio	0.075	0.54	0.23	4.63	95.37
-	calcolato	0.0558	10.09	4.23	8.86	91.14
-	calcolato	0.0400	7.23	3.03	11.89	88.11
-	calcolato	0.0289	10.84	4.54	16.43	83.57
-	calcolato	0.0188	14.45	6.05	22.48	77.52
-	calcolato	0.0135	7.23	3.03	25.51	74.49
-	calcolato	0.0098	14.45	6.05	31.57	68.43
-	calcolato	0.0070	10.84	4.54	36.11	63.89
-	calcolato	0.0051	18.07	7.57	43.68	56.32
-	calcolato	0.0029	16.59	6.95	50.63	49.37
-	calcolato	0.0012	22.94	9.61	60.23	39.77
-	calcolato	0.0009	7.22	3.03	63.26	36.74
	fondo		87.70	36.74	100.00	0.00
TOTALE			238.70			ϕ max (mm) = 2.6

Passante effettivo setaccio 0.075 (g) in areometro	49.99	
t° C	Tempo (s)	Letture
15	30	34.5
15	60	33.5
15	120	32.0
15	300	30.0
15	600	29.0
15	1200	27.0
15	2400	25.5
15	4800	23.0
19	14400	20.0
18	86400	17.0
18	172800	16.0
Rapporti granulometrici		
USCS		
GHIAIA	> 4,75 mm	> 2,00 mm
	0.0%	1.8%
SABBIA	> 0,075 mm	> 0,075 mm
	4.6%	3%
LIMO	> 2 μ	> 2 μ
	50.2%	50.2%
ARGILLA	< 2 μ	< 2 μ
	45.2%	45.2%



Soluzione disperdente preparata al momento

Io Sperimentatore:
dott. Roberto Bellanove

Il Direttore del Laboratorio
dott. geol. Massimo Romagnoli

FERRARA DEPARTMENT

Via Annibale Zucchini, 69 – 44122 Ferrara (FE)

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SCHEDA GENERALE DEL CAMPIONECOMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**CANTIERE: **Minerbio (BO)**CAMPIONE: **S1OST2 m 10.10 - 10.70**

COMMESSA: 22146FE/20

VERBALE ACC.: 113/21

DATA CONSEGNA: 15/03/21

il campione è stato conservato in vasca umida termostatica

alto 10.10	P.P. kPa	T.V. kPa	LUNGHEZZA (cm): 50 GRADO DI QUALITA': AGI Q5 EC 7-3 Q1
	390	-	DESCRIZIONE: 0-25 limo argilloso marrone 25-50 limo argilloso marrone-nerastro con sporadiche concrezioni carbonatiche
	265	-	W naturale (%) 31.9 γ naturale (Mg/m ³) γ secco (Mg/m ³) γ immerso (Mg/m ³) porosità (%) indice dei vuoti grado di saturazione (%) massa specifica stimata (Mg/m ³) 2.700
	295	-	PROVE ESEGUITE Umidità Naturale - Trassiale UU - Limiti Atterberg SI Trassiale CIU - Gran. Setacciatura SI Edometria - Gran. Sedimentazione SI Taglio Diretto - Peso di Volume - Espansione L.L. - Peso Specifico - Trassiale Cicl. + C.M. - Analisi Chimica - Colonna Risonante - Taglio Torsionale Cicl. -
10.70 basso			NOTE: -

Io Sperimentatore:
dott. Roberto BellanovaIl Direttore del Laboratorio terre:
dott. geol. Massimo Romagnoli

FERRARA DEPARTMENT

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SOCOTEC

LIMITI DI ATTERBERG (norma ASTM D4318 metodo A)

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S1OST2 m 10.10 - 10.70**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

il campione è stato conservato in vasca umida termostatica

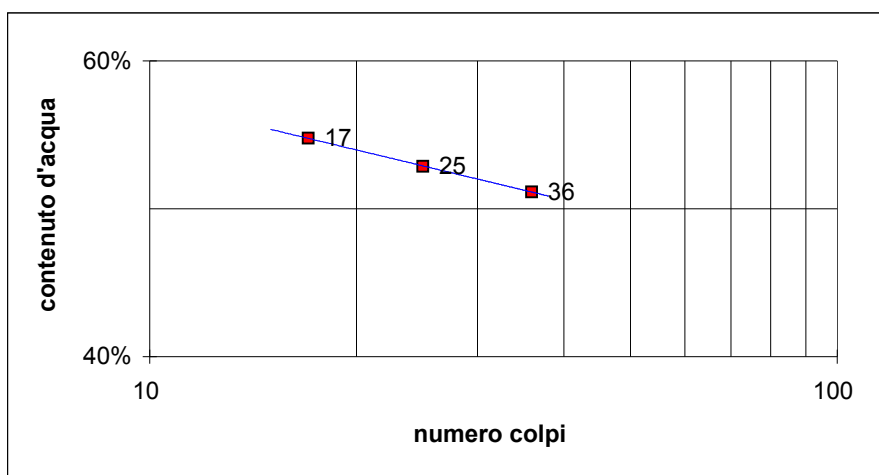
ASPETTO MACROSCOPICO DEL CAMPIONE:

Limo argilloso marrone

codice cucchiaino: 344; codice bilancia: 480; codice stufa: 419

	LIMITE LIQUIDO			LIMITE PLASTICO		UMIDITA'
	1	2	3	1	2	
impasto						
N° colpi	36	25	17			
massa umida+ tara (g)	19.17	18.98	18.49	13.78	13.57	519.67
massa secca+ tara (g)	13.78	13.54	13.10	10.97	10.82	469.79
acqua contenuta (g)	5.39	5.44	5.39	2.81	2.75	49.88
tara (g)	3.24	3.25	3.26	3.25	3.22	313.61
peso secco (g)	10.54	10.29	9.84	7.72	7.60	156.18
contenuto d'acqua	51.1%	52.9%	54.8%	36.4%	36.2%	31.9%

Umidità Naturale Wn = 32%
 Limite Liquido LL = 53%
 Limite Plastico LP = 36%
 Indice Plastico IP = 17%



lo Sperimentatore:
dott. Roberto Bellanova

Il Direttore del Laboratorio terre:
dott. geol. Massimo Romagnoli

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ANALISI GRANULOMETRICA

(per setacciatura e sedimentazione) norma A.S.T.M. D 422

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S1OST2 m 10.10 - 10.70**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

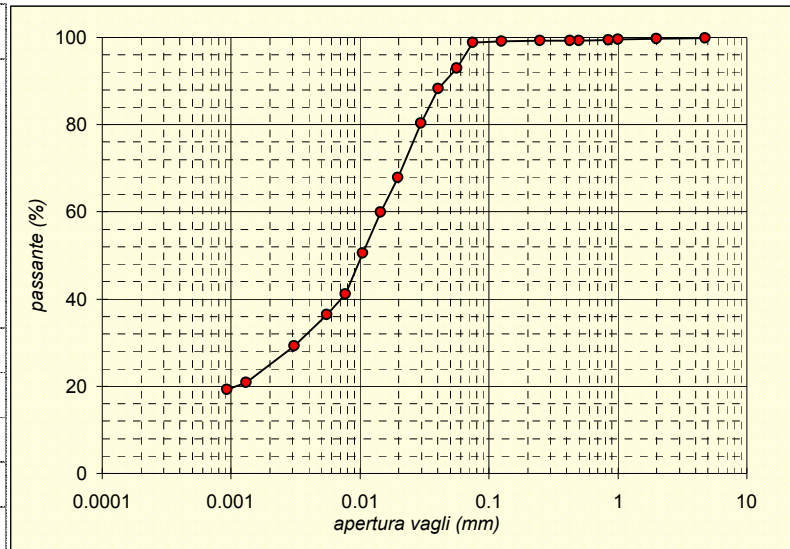
il campione è stato conservato in vasca umida termostatica Codici strumentazione: bilancia 480, vasca 557, stufa 419, densimetro 151H 348, termometro 588mescolatore 432.

ASPETTO MACROSCOPICO DEL CAMPIONE:

Limo argilloso marrone

codici	vaglio	trattenuto	trattenuto	trattenuto	passante
	(mm)	(g)	(%)	(%)	(%)
571	setaccio	4.75	0.25	0.16	99.84
572	setaccio	2	0.15	0.10	99.74
573	setaccio	1	0.34	0.22	99.53
290	setaccio	0.85	0.11	0.07	99.46
291	setaccio	0.5	0.20	0.13	99.33
292	setaccio	0.425	0.02	0.01	99.31
293	setaccio	0.250	0.15	0.10	99.22
282	setaccio	0.125	0.23	0.15	99.07
283	setaccio	0.075	0.32	0.20	98.87
-	calcolato	0.0562	9.33	5.97	92.90
-	calcolato	0.0406	7.35	4.71	88.19
-	calcolato	0.0297	12.25	7.84	80.34
-	calcolato	0.0198	19.60	12.55	67.79
-	calcolato	0.0144	12.25	7.84	59.95
-	calcolato	0.0105	14.70	9.41	50.54
-	calcolato	0.0077	14.70	9.41	41.12
-	calcolato	0.0055	7.35	4.71	36.42
-	calcolato	0.0031	11.23	7.19	29.23
-	calcolato	0.0013	13.11	8.40	20.83
-	calcolato	0.0009	2.45	1.57	19.26
	fondo	30.09	19.26	100.00	0.00
TOTALE		156.18		φ max (mm) = 6.5	

Passante effettivo setaccio 0.075 (g) in areometro	50.00	
t° C	Tempo (s)	Lettura
15	30	34.0
15	60	32.5
15	120	30.0
15	300	26.0
15	600	23.5
15	1200	20.5
15	2400	17.5
15	4800	16.0
19	14400	13.0
18	86400	10.5
18	172800	10.0
Rapporti granulometrici		
USCS		
UNI		
GHIAIA	> 4,75 mm	> 2,00 mm
	0.2%	0.3%
SABBIA	> 0,075 mm	> 0,075 mm
	1.0%	0.9%
LIMO	> 2 μ	> 2 μ
	73.9%	73.9%
ARGILLA	< 2 μ	< 2 μ
	24.9%	24.9%



Soluzione disperdente preparata al momento

Io Sperimentatore:
dott. Roberto Bellanove

Il Direttore del Laboratorio
dott. geol. Massimo Romagnoli

FERRARA DEPARTMENT

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Laboratorio Geotecnico autorizzato con Dec. n. 486 del 20/09/2019, art. 59 del D.P.R. 380/2001, Circolari Ministeriali 7618/STC

SCHEDA GENERALE DEL CAMPIONECOMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**CANTIERE: **Minerbio (BO)**CAMPIONE: **S1OST3 m 17.50 - 18.10**

COMMESSA: 22146FE/20

VERBALE ACC.: 113/21

DATA CONSEGNA: 15/03/21

il campione è stato conservato in vasca umida termostatica

alto 17.50	P.P. kPa	T.V. kPa	LUNGHEZZA (cm): 48 GRADO DI QUALITA': AGI Q5 EC 7-3 Q1
	270	-	DESCRIZIONE: 0-23 limo argilloso debolmente sabbioso 23-30 limo argilloso 30-48 limo argilloso debolmente sabbioso grigio marrone
	220	-	W naturale (%) 24.4 γ naturale (Mg/m ³) γ secco (Mg/m ³) γ immerso (Mg/m ³) porosità (%) indice dei vuoti grado di saturazione (%) massa specifica stimata (Mg/m ³) 2.700
	200	-	PROVE ESEGUITE Umidità Naturale - Trassiale UU - Limiti Atterberg SI Trassiale CIU - Gran. Setacciatura SI Edometria - Gran. Sedimentazione SI Taglio Diretto - Peso di Volume - Espansione L.L. - Peso Specifico - Trassiale Cicl. + C.M. - Analisi Chimica - Colonna Risonante - Taglio Torsionale Cicl. -
basso 18.10			NOTE: -

Io Sperimentatore:
dott. Roberto BellanovaIl Direttore del Laboratorio terre:
dott. geol. Massimo Romagnoli

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SOCOTEC

LIMITI DI ATTERBERG (norma ASTM D4318 metodo A)

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S1OST3 m 17.50 - 18.10**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

il campione è stato conservato in vasca umida termostatica

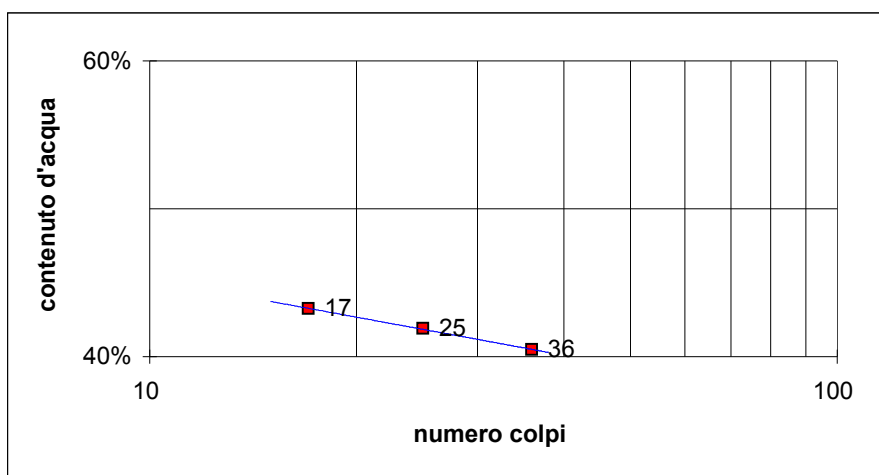
ASPETTO MACROSCOPICO DEL CAMPIONE:

Limo argilloso debolmente sabbioso grigio scuro

codice cucchiaino: 344; codice bilancia: 480; codice stufa: 419

	LIMITE LIQUIDO			LIMITE PLASTICO		UMIDITA'
	1	2	3	1	2	
impasto						
N° colpi	36	25	17			
massa umida+ tara (g)	19.49	19.74	19.97	13.58	13.37	620.55
massa secca+ tara (g)	14.80	14.86	14.91	11.61	11.42	559.49
acqua contenuta (g)	4.69	4.88	5.06	1.97	1.95	61.06
tara (g)	3.21	3.21	3.21	3.23	3.20	308.76
peso secco (g)	11.59	11.65	11.70	8.38	8.22	250.73
contenuto d'acqua	40.5%	41.9%	43.2%	23.5%	23.7%	24.4%

Umidità Naturale Wn = 24%
 Limite Liquido LL = 42%
 Limite Plastico LP = 24%
 Indice Plastico IP = 18%



lo Sperimentatore:
dott. Roberto Bellanova

Il Direttore del Laboratorio terre:
dott. geol. Massimo Romagnoli

FERRARA DEPARTMENT

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ANALISI GRANULOMETRICA

(per setacciatura e sedimentazione) norma A.S.T.M. D 422

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S1OST3 m 17.50 - 18.10**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

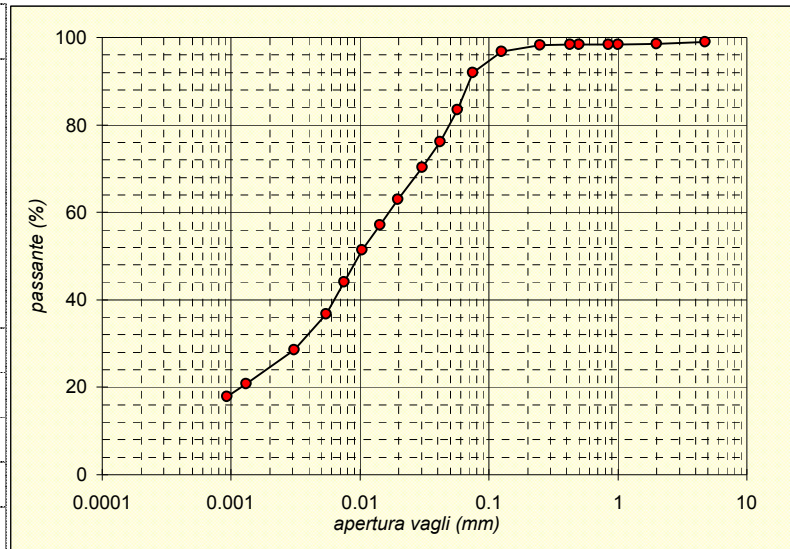
il campione è stato conservato in vasca umida termostatica Codici strumentazione: bilancia 480, vasca 557, stufa 419, densimetro 151H 348, termometro 588mescolatore 432.

ASPETTO MACROSCOPICO DEL CAMPIONE:

Limo argilloso debolmente sabbioso grigio scuro

codici	vaglio	trattenuto	trattenuto	trattenuto	cum. tratt.	passante
	(mm)	(g)	(%)	(%)	(%)	(%)
571	setaccio	4.75	2.55	1.02	1.02	98.98
572	setaccio	2	1.24	0.49	1.51	98.49
573	setaccio	1	0.26	0.10	1.62	98.38
290	setaccio	0.85	0.05	0.02	1.64	98.36
291	setaccio	0.5	0.08	0.03	1.67	98.33
292	setaccio	0.425	0.02	0.01	1.68	98.32
293	setaccio	0.250	0.05	0.02	1.70	98.30
282	setaccio	0.125	3.95	1.58	3.27	96.73
283	setaccio	0.075	12.14	4.84	8.11	91.89
-	calcolato	0.0570	21.27	8.48	16.59	83.41
-	calcolato	0.0417	18.28	7.29	23.88	76.12
-	calcolato	0.0303	14.62	5.83	29.72	70.28
-	calcolato	0.0198	18.28	7.29	37.00	63.00
-	calcolato	0.0143	14.62	5.83	42.84	57.16
-	calcolato	0.0103	14.62	5.83	48.67	51.33
-	calcolato	0.0075	18.28	7.29	55.96	44.04
-	calcolato	0.0054	18.28	7.29	63.25	36.75
-	calcolato	0.0031	20.40	8.14	71.38	28.62
-	calcolato	0.0013	19.56	7.80	79.19	20.81
-	calcolato	0.0009	7.31	2.91	82.10	17.90
-	fondo	44.88	17.90		100.00	0.00
TOTALE		250.73				φ max (mm) = 6.6

Passante effettivo setaccio 0.075 (g) in areometro	50.01	
t° C	Tempo (s)	Letture
15	30	33.0
15	60	30.5
15	120	28.5
15	300	26.0
15	600	24.0
15	1200	22.0
15	2400	19.5
15	4800	17.0
19	14400	13.5
18	86400	11.0
18	172800	10.0
Rapporti granulometrici		
USCS		
UNI		
GHIAIA	> 4,75 mm	> 2,00 mm
	1.0%	1.5%
SABBIA	> 0,075 mm	> 0,075 mm
	7.1%	6.6%
LIMO	> 2 μ	> 2 μ
	67.2%	67.2%
ARGILLA	< 2 μ	< 2 μ
	24.7%	24.7%



Soluzione disperdente preparata al momento

Io Sperimentatore:
dott. Roberto Bellanovè

Il Direttore del Laboratorio
dott. geol. Massimo Romagnoli

FERRARA DEPARTMENT

Via Annibale Zucchini, 69 – 44122 Ferrara (FE)

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SCHEMA GENERALE DEL CAMPIONE

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**
 CANTIERE: **Minerbio (BO)**
 CAMPIONE: **S1OST4 m 26.50 - 27.00**
 COMMESSA: 22146FE/20
 VERBALE ACC.: 113/21
 DATA CONSEGNA: 15/03/21

il campione è stato conservato in vasca umida termostatica

alto 26.50	P.P. kPa	T.V. kPa	LUNGHEZZA (cm): 44 GRADO DI QUALITA': AGI Q5 EC 7-3 Q1
	370	-	DESCRIZIONE: 0-24 limo argilloso debolmente sabbioso 24-44 limo argilloso grigio verde
	370	-	W naturale (%) 25.3 γ naturale (Mg/m ³) γ secco (Mg/m ³) γ immerso (Mg/m ³) porosità (%) indice dei vuoti grado di saturazione (%) massa specifica stimata (Mg/m ³) 2.700
	390	-	PROVE ESEGUITE Umidità Naturale - Trassiale UU - Limiti Atterberg SI Trassiale CIU - Gran. Setacciatura SI Edometria - Gran. Sedimentazione SI Taglio Diretto - Peso di Volume - Espansione L.L. - Peso Specifico - Trassiale Cicl. + C.M. - Analisi Chimica - Colonna Risonante - Taglio Torsionale Cicl. -
27.00 basso			NOTE: -

Io Sperimentatore:
dott. Roberto Bellanova

Il Direttore del Laboratorio terre:
dott. geol. Massimo Romagnoli

FERRARA DEPARTMENT

Via Annibale Zucchini, 69 – 44122 Ferrara (FE)

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Headquarters: Via Bariola, 101-103 - 20020 Lainate (MI)

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LIMITI DI ATTERBERG (norma ASTM D4318 metodo A)

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S1OST4 m 26.50 - 27.00**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

il campione è stato conservato in vasca umida termostatica

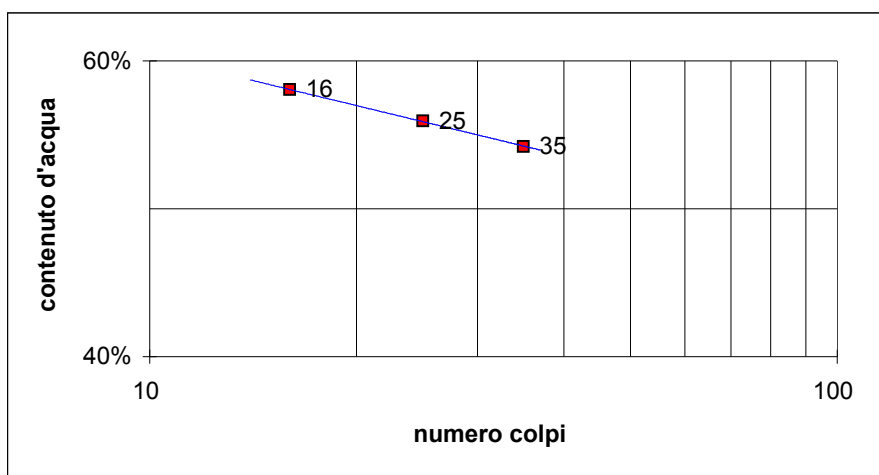
ASPETTO MACROSCOPICO DEL CAMPIONE:

Limo con argilla grigio verde

codice cucchiaino: 344; codice bilancia: 480; codice stufa: 419

	LIMITE LIQUIDO			LIMITE PLASTICO		UMIDITA'
	1	2	3	1	2	
impasto						
N° colpi	35	25	16			
massa umida+ tara (g)	18.83	18.70	18.65	13.71	13.41	663.42
massa secca+ tara (g)	13.35	13.15	12.98	11.25	11.05	591.94
acqua contenuta (g)	5.48	5.55	5.67	2.46	2.36	71.48
tara (g)	3.24	3.23	3.21	3.22	3.20	309.85
peso secco (g)	10.11	9.92	9.77	8.03	7.85	282.09
contenuto d'acqua	54.2%	55.9%	58.0%	30.6%	30.1%	25.3%

Umidità Naturale Wn = 25%
 Limite Liquido LL = 56%
 Limite Plastico LP = 30%
 Indice Plastico IP = 26%



lo Sperimentatore:
dott. Roberto Bellanova

Il Direttore del Laboratorio terre:
dott. geol. Massimo Romagnoli

FERRARA DEPARTMENT

Via Annibale Zucchini, 69 – 44122 Ferrara (FE)

Tel.: +39 0532 56771 - Fax.: +39 0532 56119

SOCOTEC ITALIA Srl – P.Iva 01872430648

Headquarters: Via Bariola, 101-103 - 20020 Lainate (MI)

Tel.: +39 02 9375 0000 - Fax: +39 02 9375 0099

www.socotec.it



Laboratorio Geotecnico autorizzato con Dec. n. 486 del 20/09/2019, art. 59 del D.P.R. 380/2001, Circolari Ministeriali 7618/S1

ANALISI GRANULOMETRICA

(per setacciatura e sedimentazione) norma A.S.T.M. D 422

COMMITTENTE: **Studio Samuel Sangiorgi – Geologia Applicata -Via Valsellustra n.32**

CANTIERE: **Minerbio (BO)**

CAMPIONE: **S10ST4 m 26.50 - 27.00**

COMMESSA: 22146FE/20 DURATA PROVE: 15-23/03/2021

VERBALE ACC.: 113/21 DATA CONSEGNA: 15/03/21

GEO - CERT. n°: 0 rev.00 del: 00/01/00

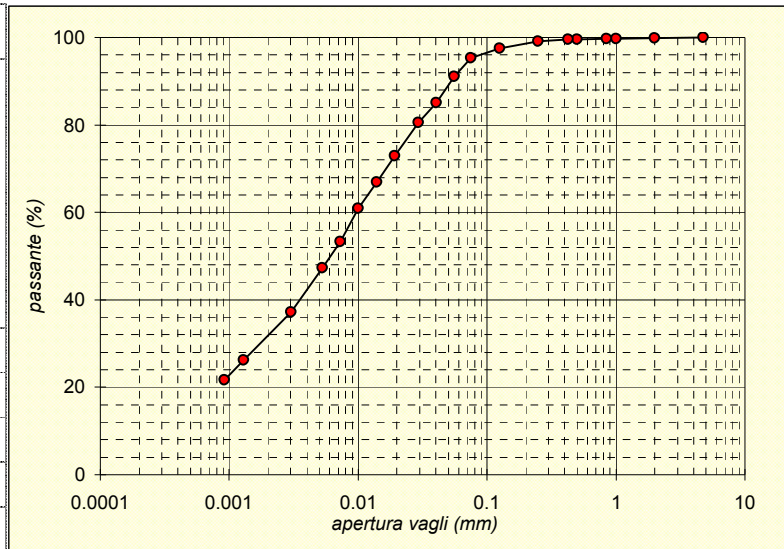
il campione è stato conservato in vasca umida termostatica Codici strumentazione: bilancia 480, vasca 557, stufa 419, densimetro 151H 348, termometro 588mescolatore 432.

ASPETTO MACROSCOPICO DEL CAMPIONE:

Limo con argilla grigio verde

codici	vaglio	trattenuto	trattenuto	trattenuto	cum. tratt.	passante
	(mm)	(g)	(%)	(%)	(%)	(%)
571	setaccio	4.75	0.00	0.00	0.00	100.00
572	setaccio	2	0.46	0.16	0.16	99.84
573	setaccio	1	0.44	0.16	0.32	99.68
290	setaccio	0.85	0.13	0.05	0.37	99.63
291	setaccio	0.5	0.29	0.10	0.47	99.53
292	setaccio	0.425	0.06	0.02	0.49	99.51
293	setaccio	0.250	1.13	0.40	0.89	99.11
282	setaccio	0.125	4.59	1.63	2.52	97.48
283	setaccio	0.075	6.05	2.14	4.66	95.34
-	calcolato	0.0558	11.97	4.24	8.91	91.09
-	calcolato	0.0406	17.07	6.05	14.96	85.04
-	calcolato	0.0293	12.80	4.54	19.50	80.50
-	calcolato	0.0192	21.34	7.56	27.06	72.94
-	calcolato	0.0139	17.07	6.05	33.11	66.89
-	calcolato	0.0101	17.07	6.05	39.16	60.84
-	calcolato	0.0073	21.34	7.56	46.73	53.27
-	calcolato	0.0053	17.07	6.05	52.78	47.22
-	calcolato	0.0030	28.11	9.96	62.74	37.26
-	calcolato	0.0013	31.37	11.12	73.86	26.14
-	calcolato	0.0009	12.80	4.54	78.40	21.60
-	fondo	60.93	21.60	21.60	100.00	0.00
TOTALE		282.09				φ max (mm) = 2.5

Passante effettivo setaccio 0.075 (g) in areometro	50.00	
t° C	Tempo (s)	Lettura
15	30	34.5
15	60	32.5
15	120	31.0
15	300	28.5
15	600	26.5
15	1200	24.5
15	2400	22.0
15	4800	20.0
19	14400	16.0
18	86400	12.5
18	172800	11.0
Rapporti granulometrici		
USCS		
UNI		
GHIAIA	> 4,75 mm	> 2,00 mm
	0.0%	0.2%
SABBIA	> 0,075 mm	> 0,075 mm
	4.7%	4.5%
LIMO	> 2 μ	> 2 μ
	63.5%	63.5%
ARGILLA	< 2 μ	< 2 μ
	31.9%	31.9%



Soluzione disperdente preparata al momento

Io Sperimentatore:
dott. Roberto Bellanove

Il Direttore del Laboratorio
dott. geol. Massimo Romagnoli

rev.	data emiss.	sperimentatore	direttore
0	18/05/2021	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

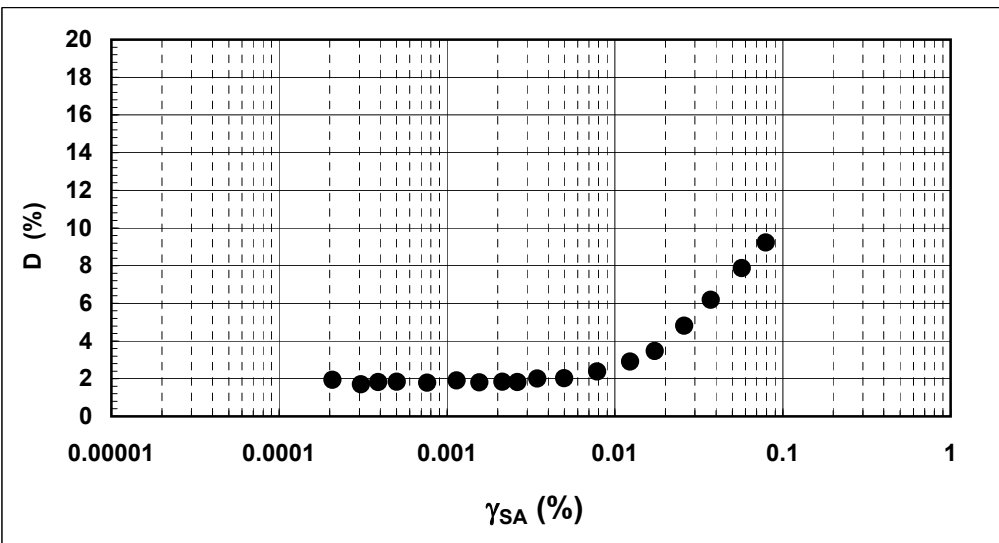
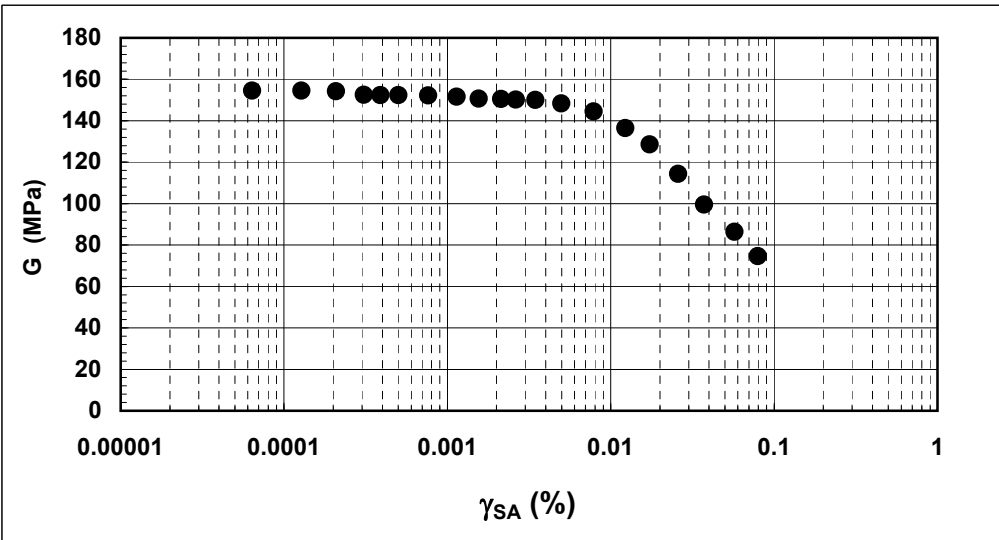
N° certificato di prova:

N° verbale di accettazione: 040/2021

Committente:	SOCOTEC
Cantiere:	CANTIERI VARI
Sondaggio:	-
Campione:	S10ST4
Profondità prova [m]:	26.86 - 27.00
Prova:	RC
Provino:	1
Data prova:	13/05/2021

Dati generali dei provini

Dati iniziali					Dati a fine consolidazione										Informazioni generali		
Φ	H	γ _w	w	e	σ' _a	σ' _r	K	B.P.	B	D	H	γ _w	w	e	S	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	metodo di preparazione	
50.00	101.50	18.60	25.1	0.781	240	240	1.0	200.0	0.90	49.6	101.3	19.28	27.4	0.749	99	INDISTURBATO	
																FUSTELLAZIONE	
																PIETRA POROSA	
																TORSIONALE	
																peso specifico (-)	2.700



Legenda:

- Φ = diametro del provino
- H = altezza del provino
- γ_w = peso di volume umido
- w = contenuto d'acqua
- e = indice dei vuoti
- σ' = tensioni efficaci
- K = σ_r / σ_a
- B.P. = back pressure
- B = coefficiente di Skempton
- G = Modulo di taglio
- γ_{SA} = def. di taglio in singola ampiezza
- D = Rapporto di smorzamento di taglio
- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- S = grado di saturazione

Note:	
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rev.	data emiss.	sperimentatore	direttore
0	18/05/2021	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

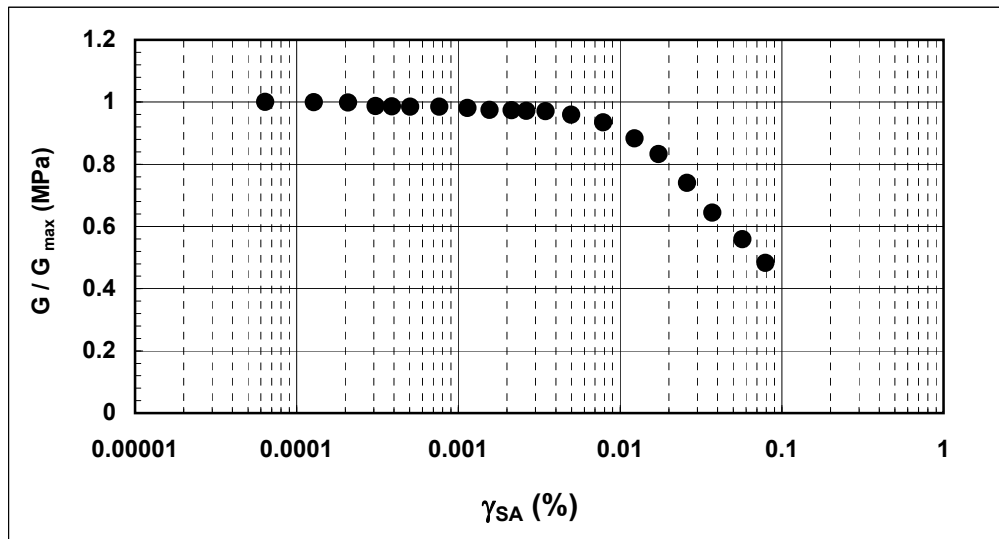
N° certificato di prova:

N° verbale di accettazione: 040/2021

Committente:	SOCOTEC
Cantiere:	CANTIERI VARI
Sondaggio:	-
Campione:	S10ST4
Profondità prova [m]:	26.86 - 27.00
Prova:	RC
Provino:	1
Data prova:	13/05/2021

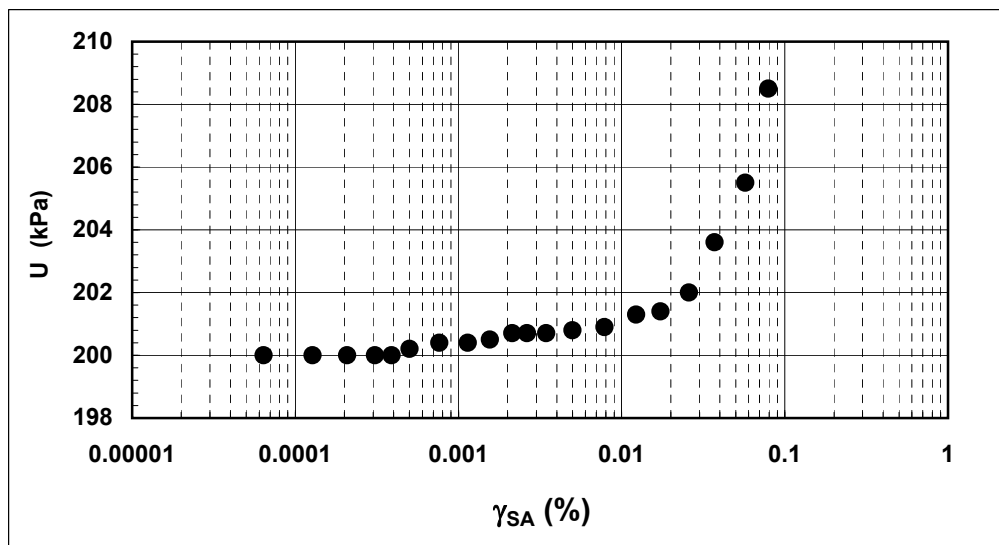
Dati generali dei provini

Dati iniziali					Dati a fine consolidazione										Informazioni generali		
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	S	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	%	metodo di preparazione	
50.00	101.50	18.60	25.1	0.781	240	240	1.0	200.0	0.90	49.6	101.3	19.28	27.4	0.7	99	INDISTURBATO	
																FUSTELLAZIONE	
																PIETRA POROSA	
																TORSIONALE	
																peso specifico	2.700



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- Subscritto 'a' = assiale
- Subscritto 'r' = radiale
- S = grado di saturazione



Note:	
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Concessione Ministeriale Decreto n° 55126 del 12 luglio 2006 - Settori A, B e C

rev.	data emiss.	sperimentatore	direttore
0	18/05/2021	Angeloni	Saccenti

Normativa di riferimento: ASTM D4015/95

N° certificato di prova:

N° verbale di accettazione: 040/2021

Committente:	SOCOTEC
Cantiere:	CANTIERI VARI
Sondaggio:	-
Campione:	S1OST4
Profondità prova [m]:	26.86 - 27.00
Prova:	RC
Provino:	1
Data prova:	13/05/2021

Dati generali dei provini

Dati iniziali					Dati di prova										Informazioni generali	
Φ	H	γ_w	w	e	σ'_a	σ'_r	K	B.P.	B	D	H	γ_w	w	e	tipo di provino	
mm	mm	kN/m ³	%	-	kPa	kPa	-	kPa	-	mm	mm	kN/m ³	%	-	metodo di preparazione	
50.00	101.50	18.60	25.1	0.781	240	240	1.0	200.0	0.90	49.6	101.3	19.28	27.4	0.749	superficie di appoggio	INDISTURBATO
															eccitazione	FUSTELLAZIONE
																PIETRA POROSA
																TORSIONALE

Valori numerici

G	G/G _{MAX}	γ	D	U
(MPa)	(-)	(%)	(%)	(kPa)
154.58	1.000	0.00006		200.0
154.43	0.999	0.00013		200.0
154.25	0.998	0.00021	1.93	200.0
152.55	0.987	0.00031	1.70	200.0
152.40	0.986	0.00039	1.82	200.0
152.29	0.985	0.00050	1.83	200.2
152.22	0.985	0.00076	1.78	200.4
151.57	0.981	0.00114	1.91	200.4
150.60	0.974	0.00156	1.80	200.5
150.42	0.973	0.00214	1.84	200.7
150.24	0.972	0.00263	1.82	200.7
149.95	0.970	0.00346	2.00	200.7
148.34	0.960	0.00500	2.03	200.8
144.51	0.935	0.00786	2.38	200.9
136.42	0.883	0.01231	2.91	201.3
128.63	0.832	0.01729	3.47	201.4
114.32	0.740	0.02593	4.81	202.0
99.51	0.644	0.03724	6.19	203.6
86.38	0.559	0.05720	7.87	205.5
74.64	0.483	0.07944	9.23	208.5

Legenda:

Φ = diametro del provino

H = altezza del provino

γ_w = peso di volume umido

w = contenuto d'acqua

e = indice dei vuoti

σ' = tensioni efficaci

K = σ_r / σ_a

B.P. = back pressure

B = coefficiente di Skempton

G = Modulo di taglio

γ_{SA} = def.di taglio in singola ampiezza

D = Rapporto di smorzamento di taglio

Subscritto 'a' = assiale

Subscritto 'r' = radiale

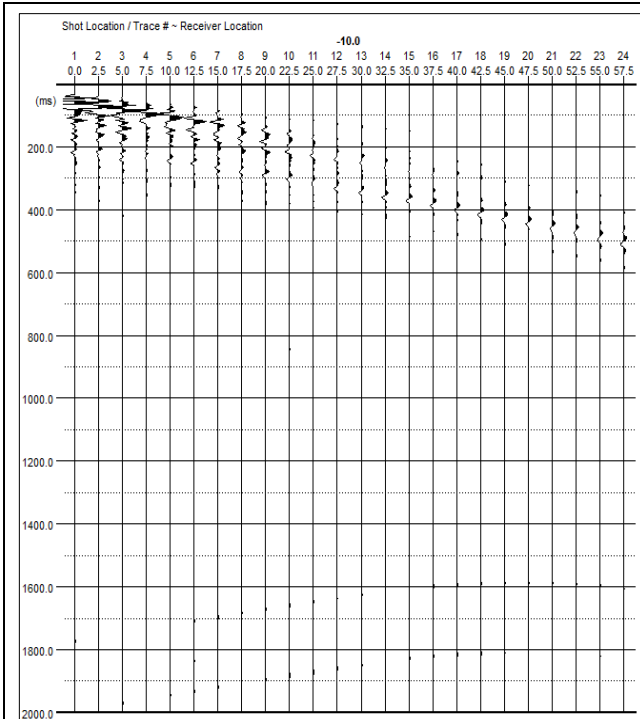
Note:

PROSPEZIONE SISMICA CON METODOLOGIA ATTIVA/PASSIVA MASW/Re.Mi.

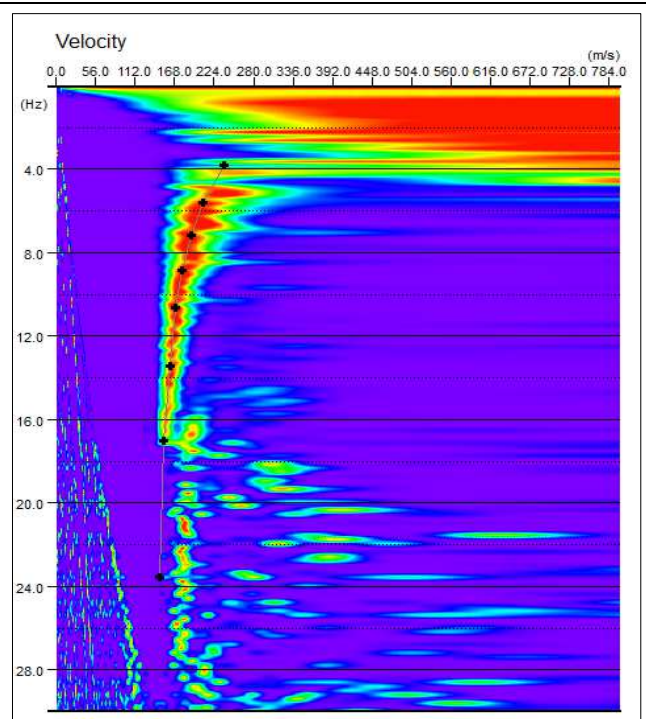
Capo d'Argine, Comune di Minerbio (BO) – 037038L7MASW7

n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
15	2,5	57,5	0,5/2,0	2,0/32,0

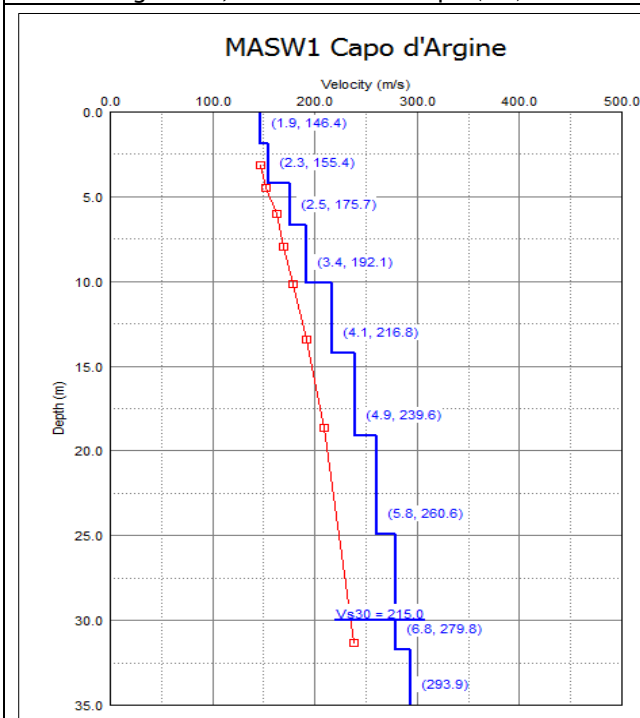
Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.



Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Modello di sottosuolo (1D) descritti in termini di Vs e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n. Strato	Profondità letto (m dal p.c.)	Spessore (m)	Vs (m/s)
1	1.9	1.9	146.4
2	4.2	2.3	155.4
3	6.7	2.5	175.7
4	10.1	3.4	192.1
5	14.2	4.1	216.8
6	19.1	4.9	239.6
7	24.9	5.8	260.6
8	31.7	6.8	279.8
9	∞	∞	293.9

$V_{S30} = 215.0 \pm 10\% \text{ [m/s]}$

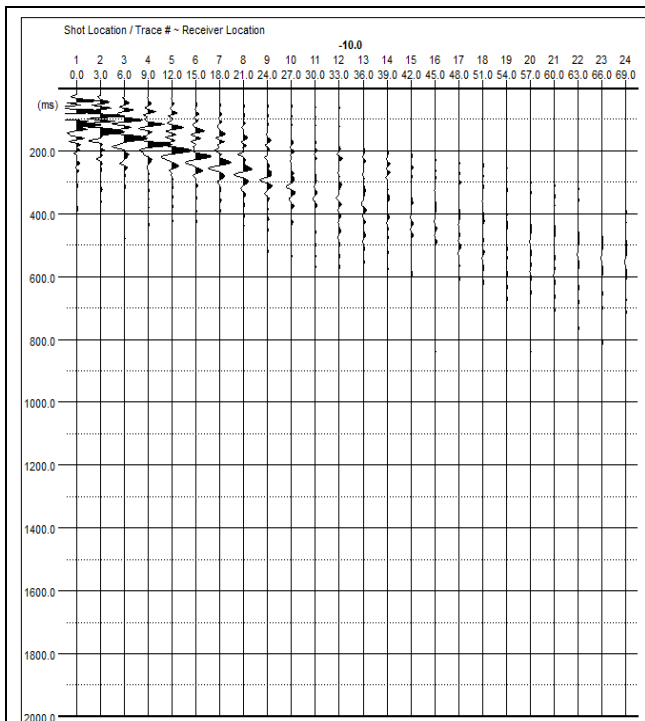
Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di Vs30 calcolato.

PROSPEZIONE SISMICA CON METODOLOGIA ATTIVA/PASSIVA MASW/Re.Mi.

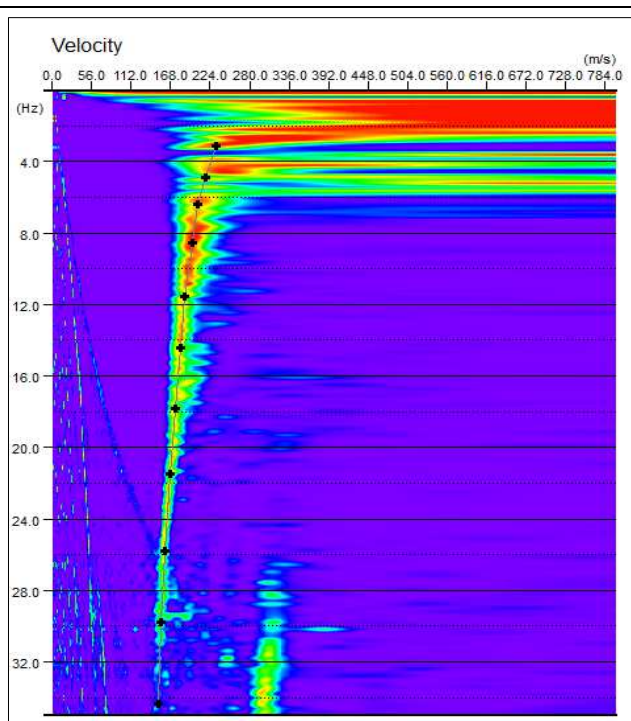
San Martino in Soverzano, Comune di Minerbio (BO) – 037038L8MASW8

n° tracce	Δx (m)	L tot (m)	Δt (ms)	T (s)
15	3,0	69,0	0,5/2,0	2,0/32,0

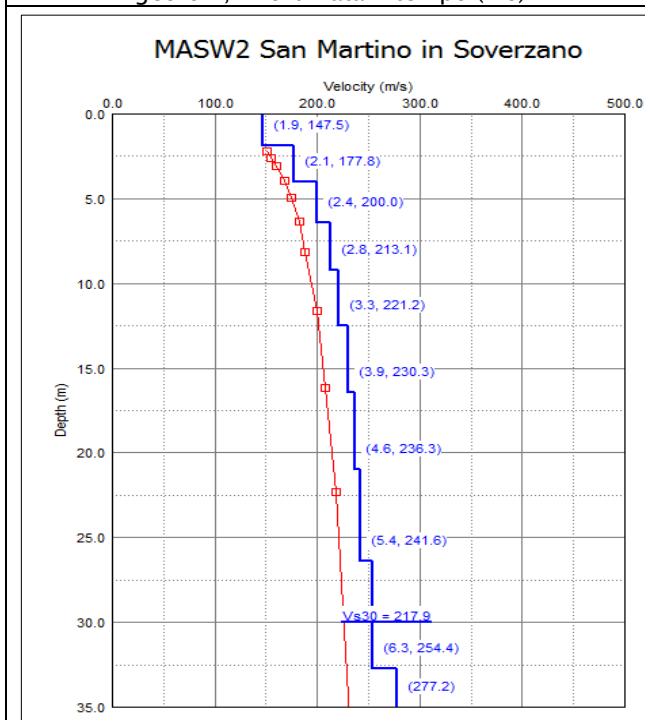
Δx : interdistanza geofonica; L tot: lunghezza profilo; Δt : passo di campionamento; T: durata registrazione.



Sismogramma registrato durante le acquisizioni di microtremore sismico. In ascissa il numero dei geofoni, in ordinata il tempo (ms).



Spettro di potenza nel dominio $f-v$ e Picking della curva sperimentale delle onde R (croci nere).



Modello di sottosuolo (1D) descritti in termini di V_s e spessore dei sismostrati (spezzata blu) e curva di dispersione sperimentale delle onde R (curva rossa).

Tabella di sintesi

n.	Profondità letto (m dal p.c.)	Spessore (m)	V_s (m/s)
1	1.9	1.9	147.5
2	4.0	2.1	177.8
3	6.4	2.4	200.0
4	9.2	2.8	213.1
5	12.5	3.3	221.2
6	16.4	3.9	230.3
7	21.0	4.6	236.3
8	26.4	5.4	241.6
9	32.7	6.3	254.4
10	∞	∞	277.2

$$V_{s30} = 217.9 \pm 10\% \text{ [m/s]}$$

Sintesi dei parametri del modello di sottosuolo ottenuto e Valore di V_{s30} calcolato.