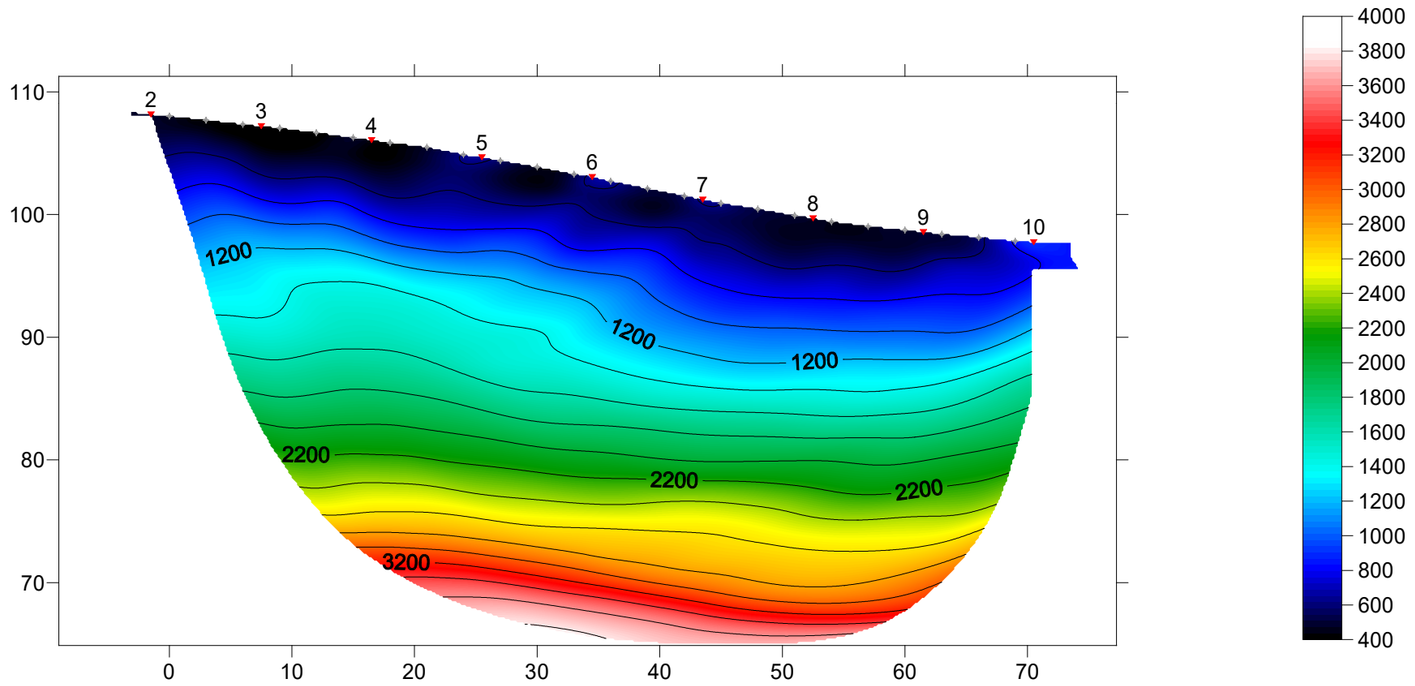
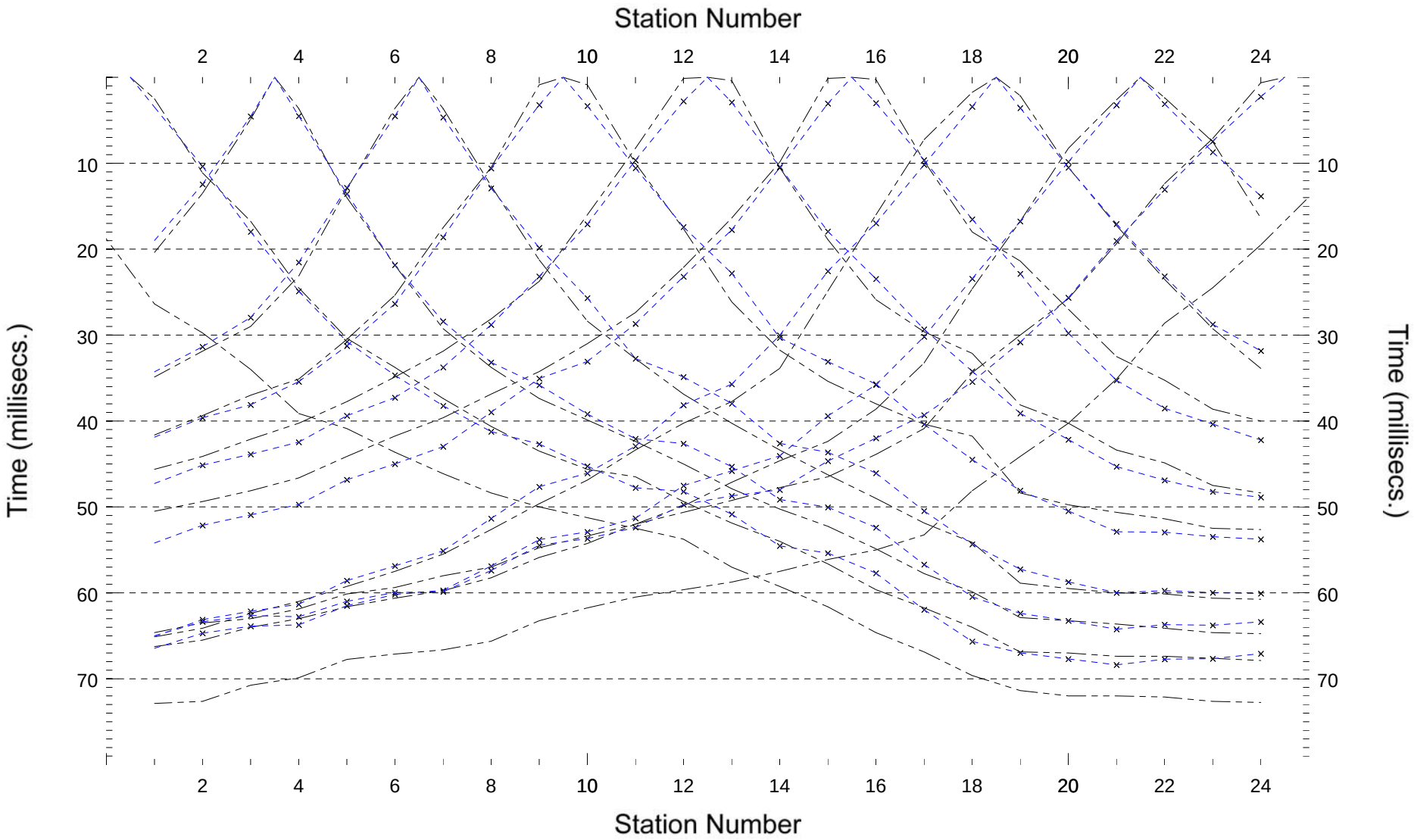
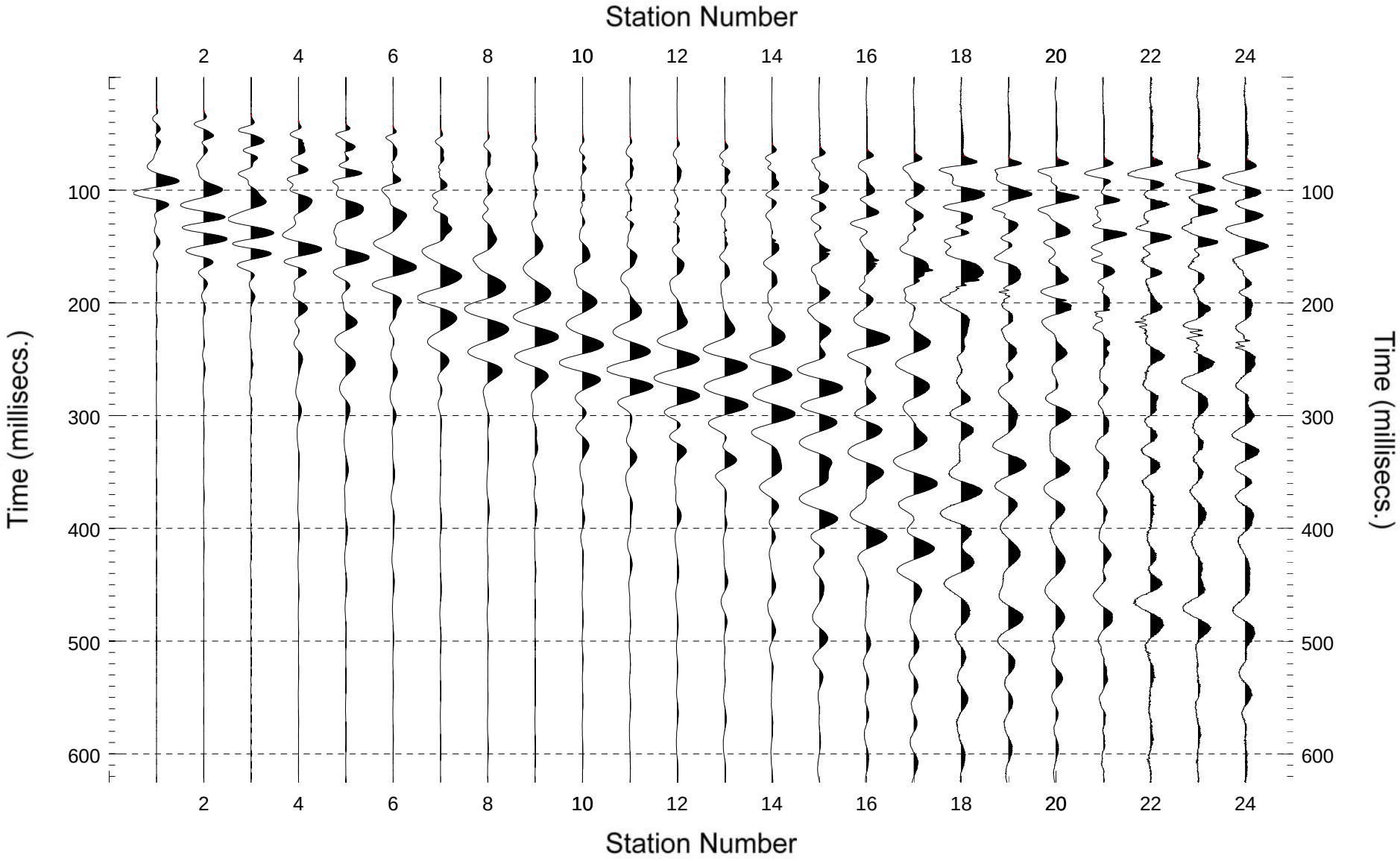
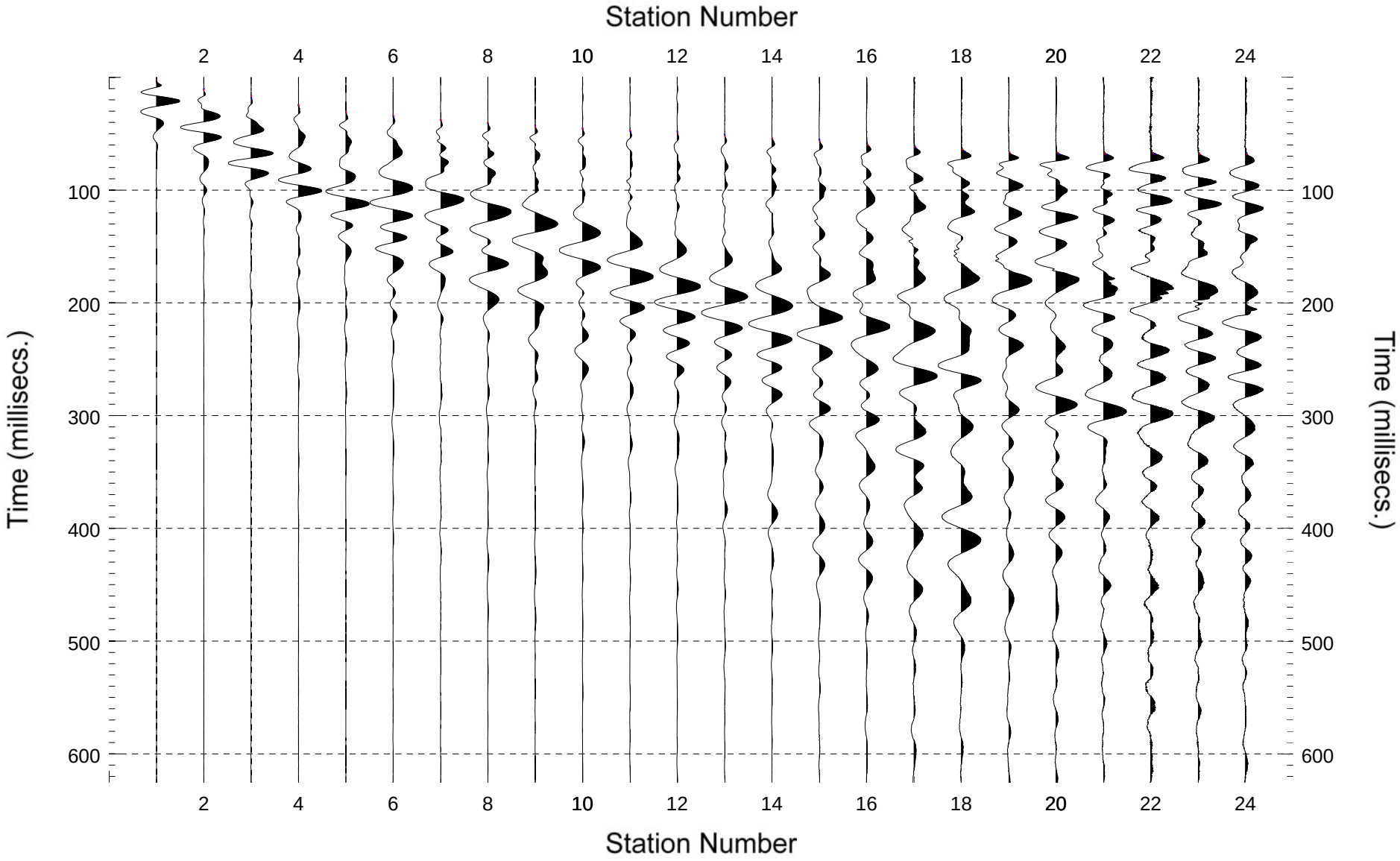
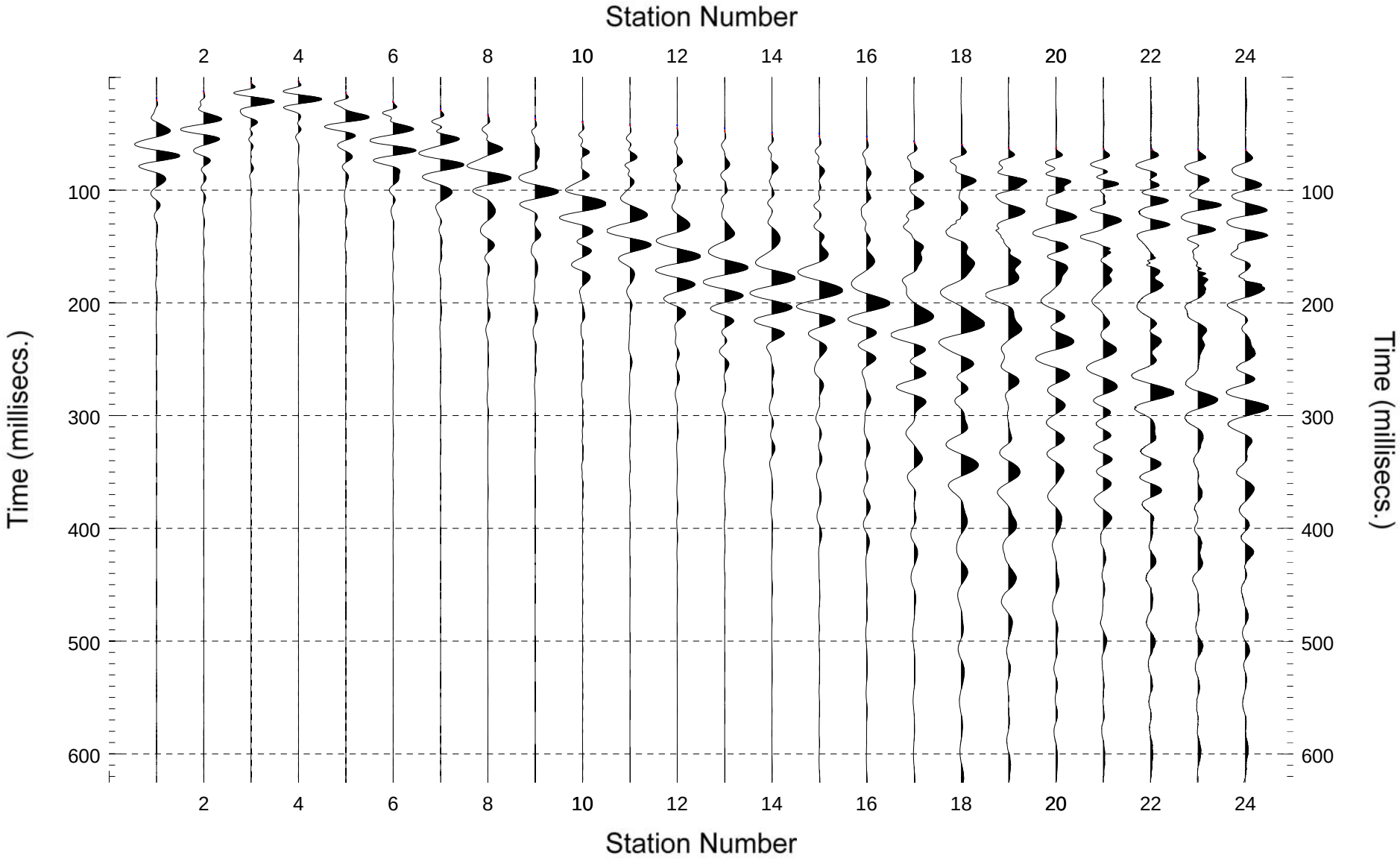
LN 0102 - BORGIANO

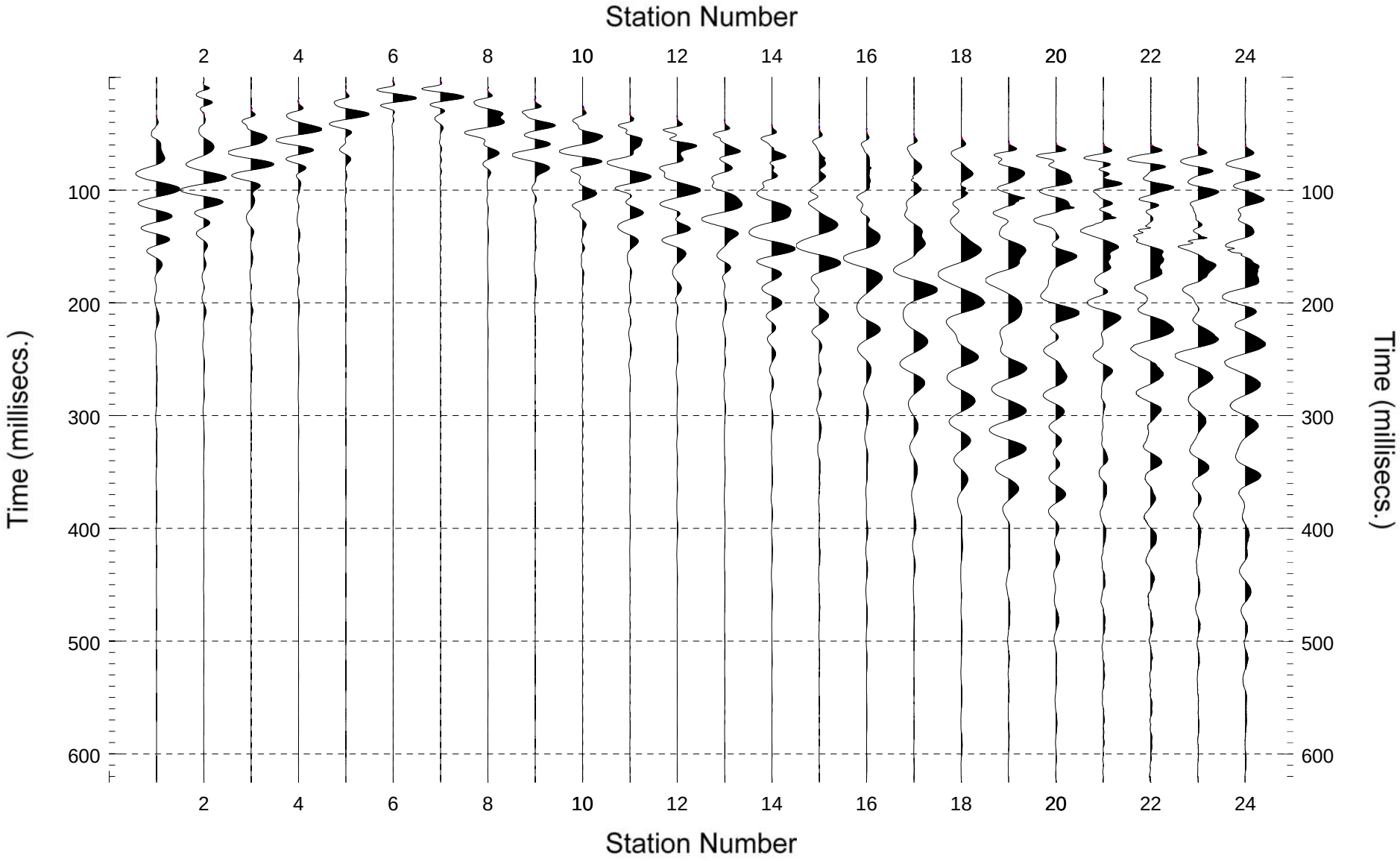


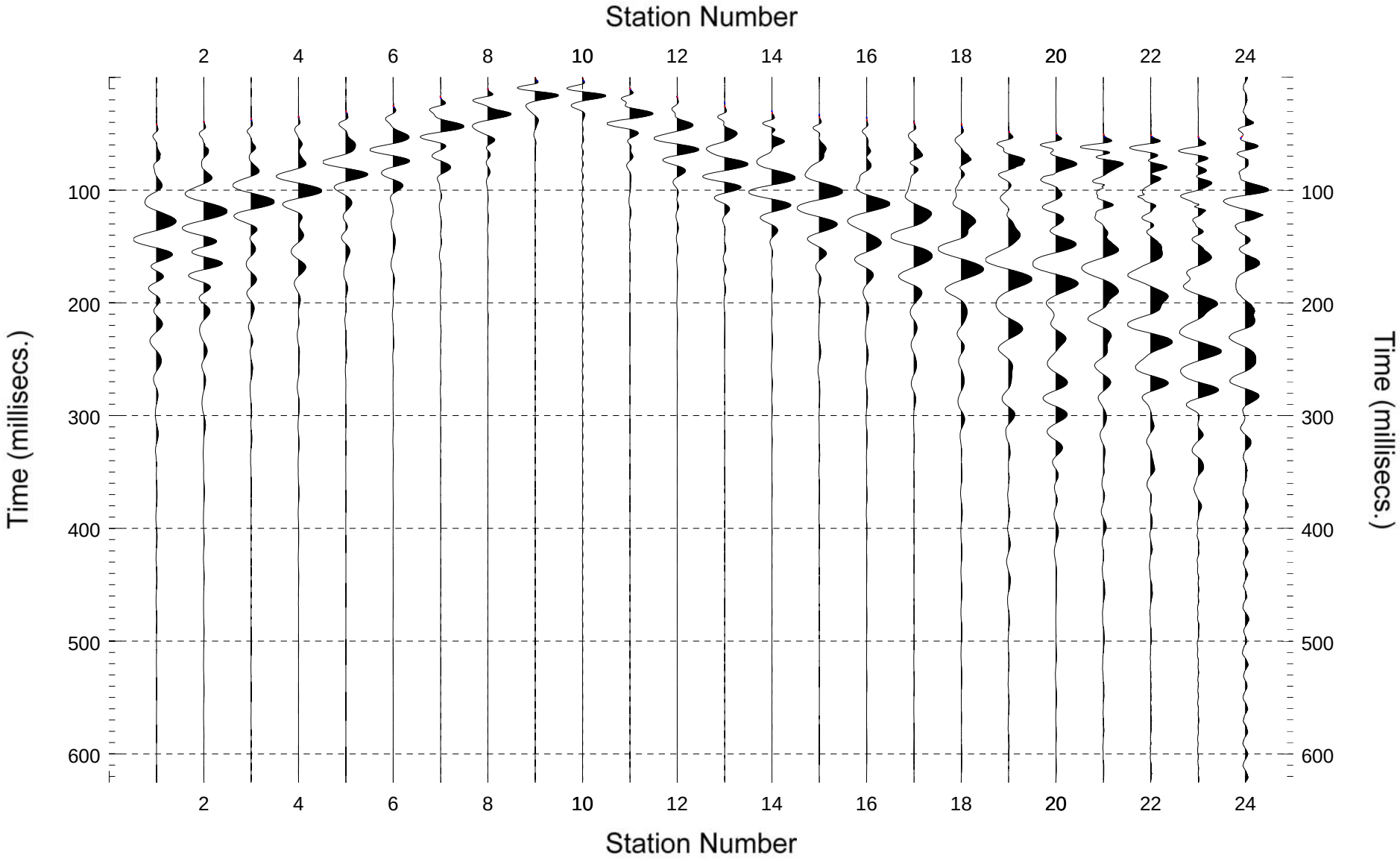

Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
10
20
30
40
50
60
70
Station Number
Time (millisecs.)

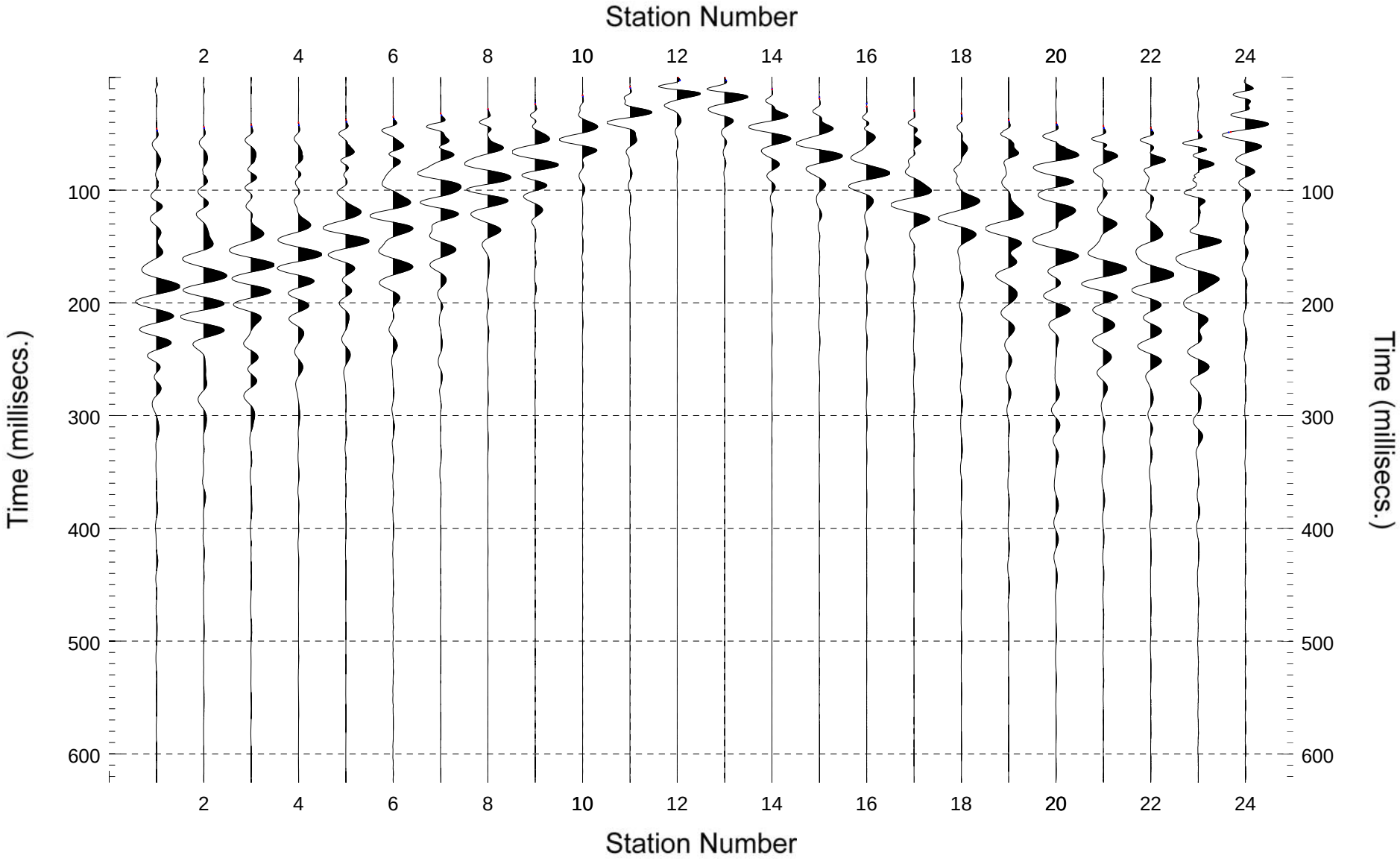

Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)

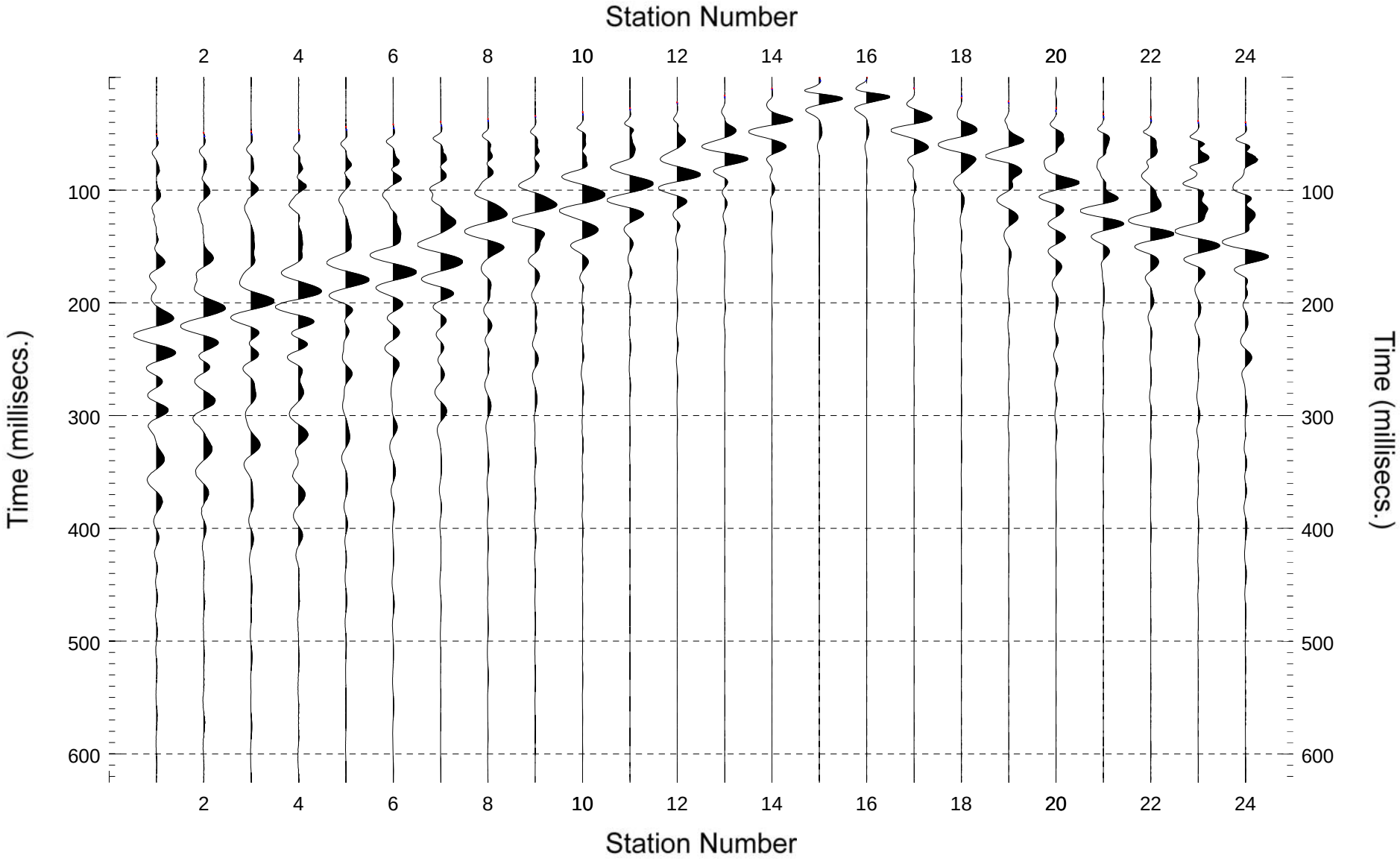

Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)

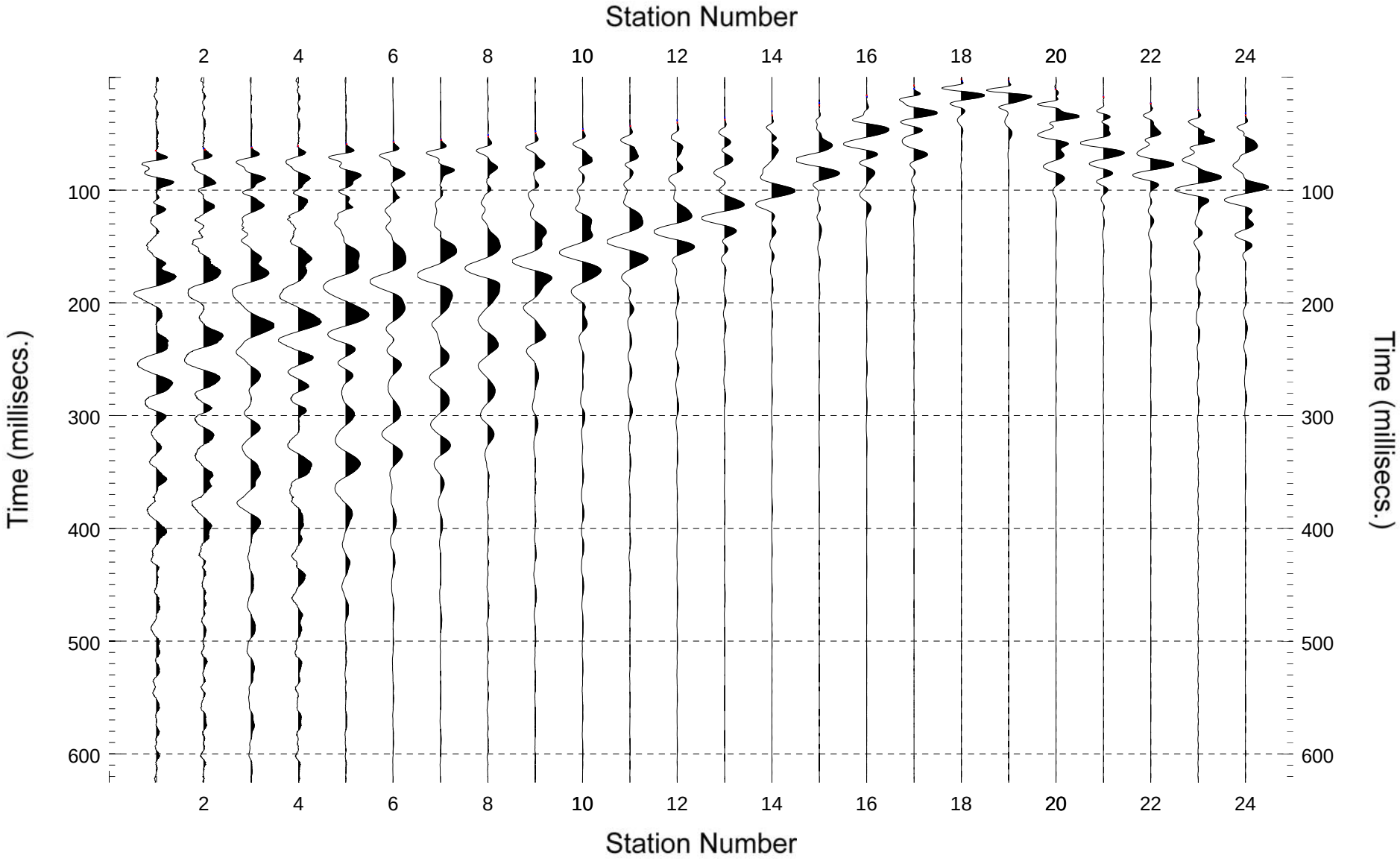

Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)

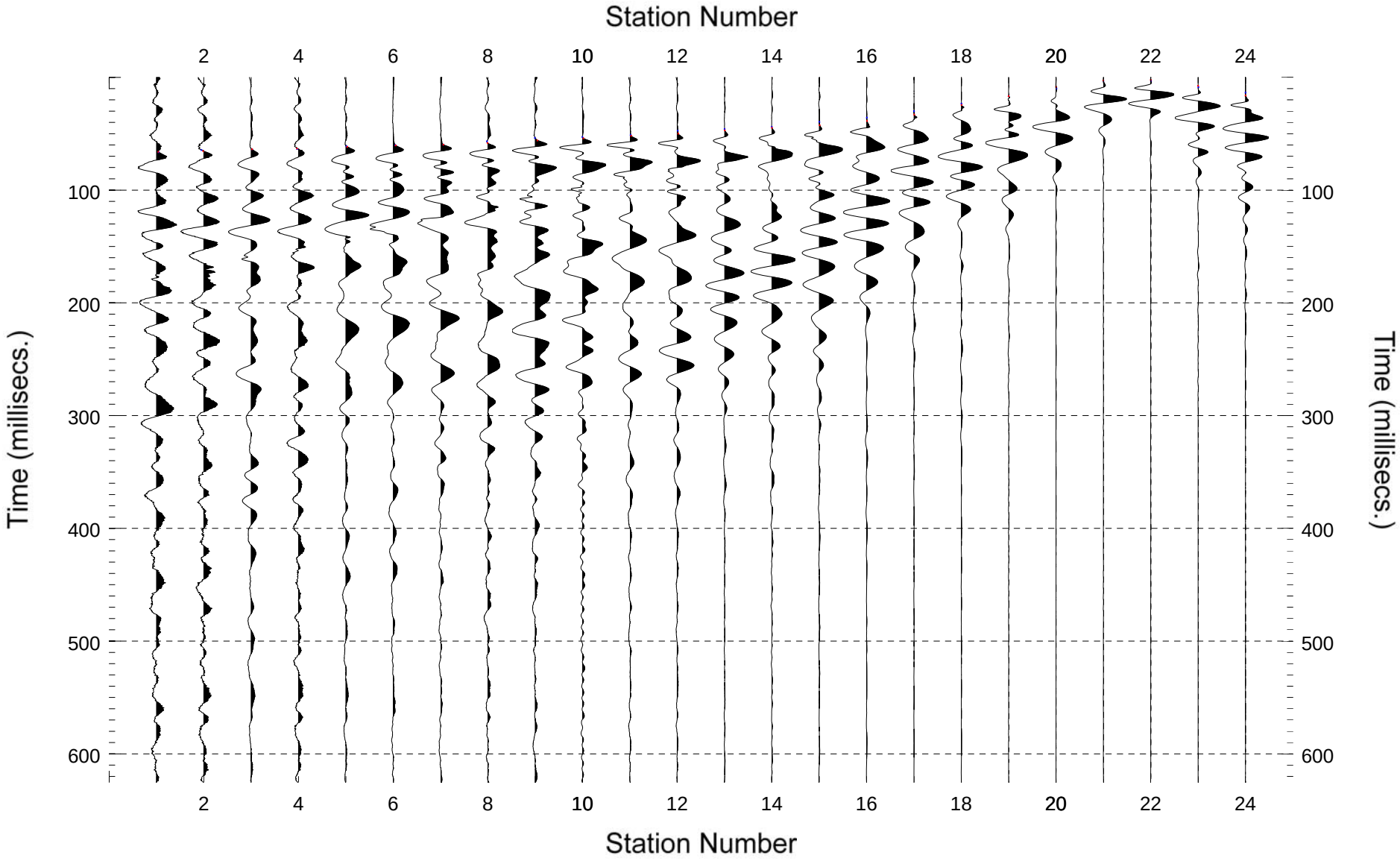

Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)

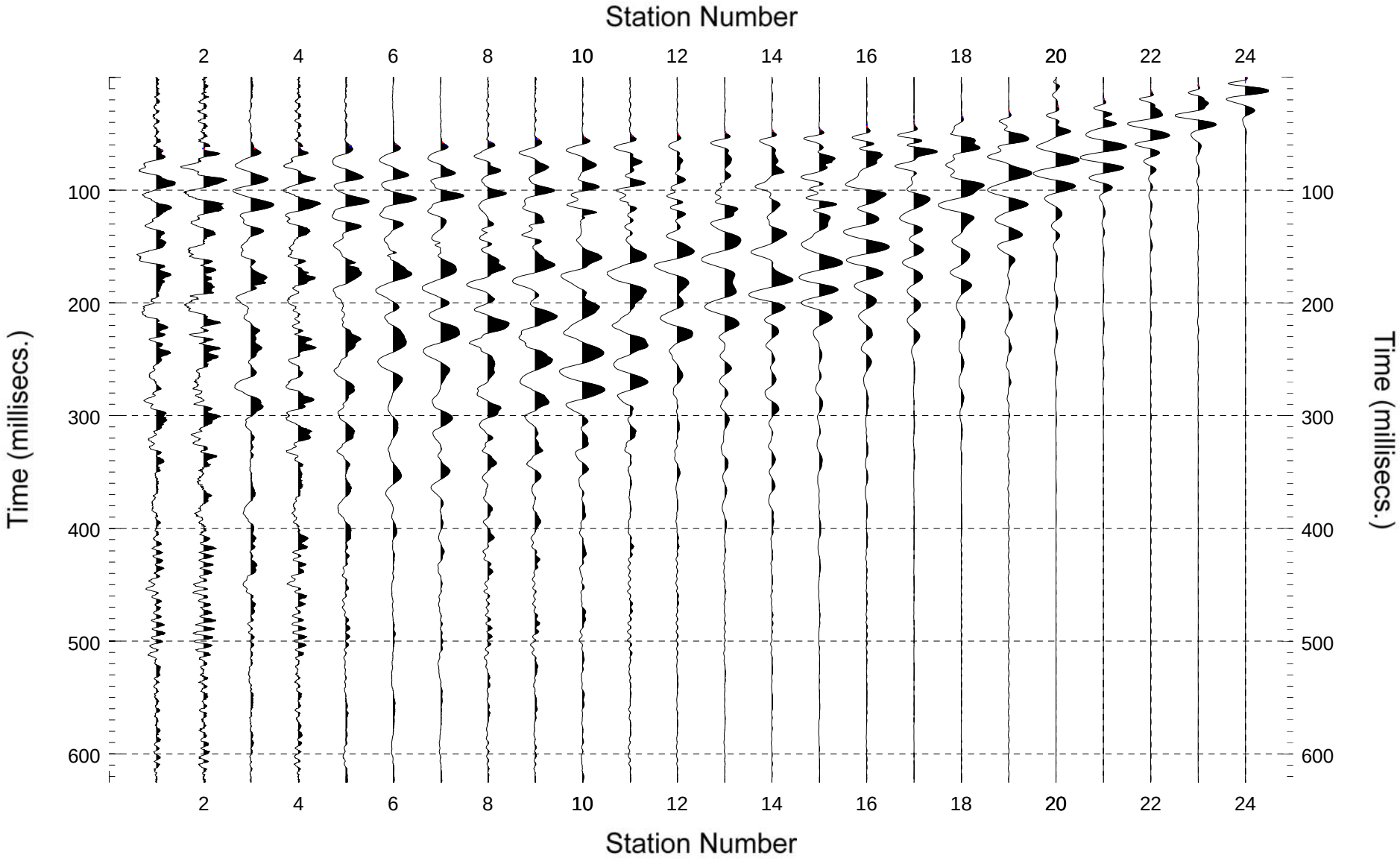

Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)

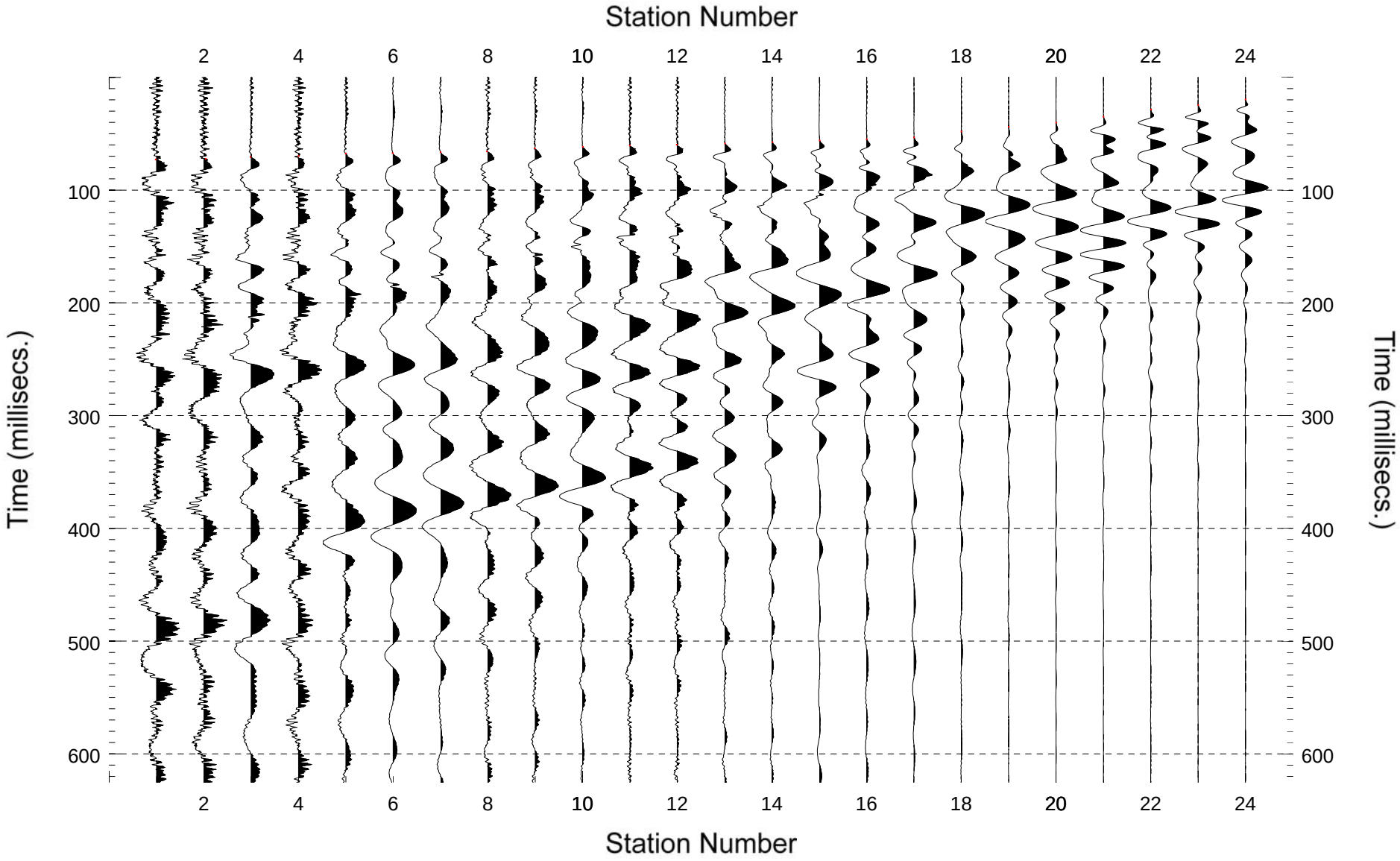

Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)


Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)


Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)


Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)


Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)


Station Number
2
4
6
8
10
12
14
16
18
20
22
24
Time (millisecs.)
100
200
300
400
500
600
Station Number
Time (millisecs.)

LN 0102 MASW

Analyzing Phase velocities

==o== SECTION#1
dataset: 15 245 ser2 taglio.sgy
minimum offset (m): 1.5
geophone spacing (m): 3
sampling (ms): 0.125
Dispersion curve: BORGIANO LN0102 ser2.cdp
Number of individuals: 80
Number of generations: 81

Rayleigh-wave dispersion analysis

Analyzing Phase Velocities

Adopted search space (minimum Vs & thickness): 118.8 1.848 330
2.376 198 2.508 330 1.452
270.6 2.64 468.6 6.336 792
Adopted search space (maximum Vs & thickness): 252 3.92 700
5.04 420 5.32 700 3.08
574 5.6 994 13.44 1680
Adopted Poisson values: 0.35134 0.35006 0.35031 0.35044 0.34978
0.3003 0.299

Output folder: ..\IO\output_disp

==o== SECTION#2

Rayleigh wave analysis
Optimizing Vs & Thickness - generation: 1; average & best misfits: -116.3944
-21.81331
Optimizing Vs & Thickness - generation: 2; average & best misfits: -104.9916
-20.93213
Optimizing Vs & Thickness - generation: 3; average & best misfits: -96.7563
-20.9321
Optimizing Vs & Thickness - generation: 4; average & best misfits: -83.9412
-20.9321
Optimizing Vs & Thickness - generation: 5; average & best misfits: -82.7316
-20.9321
Optimizing Vs & Thickness - generation: 6; average & best misfits: -74.0261
-20.9321
Optimizing Vs & Thickness - generation: 7; average & best misfits: -70.0808
-16.4179
Optimizing Vs & Thickness - generation: 8; average & best misfits: -61.5838
-16.4179
Optimizing Vs & Thickness - generation: 9; average & best misfits: -55.9711
-14.2984
Optimizing Vs & Thickness - generation: 10; average & best misfits: -50.6376
-14.2984
Optimizing Vs & Thickness - generation: 11; average & best misfits: -46.5761
-14.2905
Optimizing Vs & Thickness - generation: 12; average & best misfits: -47.5332
-14.2905
Optimizing Vs & Thickness - generation: 13; average & best misfits: -46.3933
-14.2905
Optimizing Vs & Thickness - generation: 14; average & best misfits: -45.0574
-14.2905
Optimizing Vs & Thickness - generation: 15; average & best misfits: -45.7338
-10.1491
Optimizing Vs & Thickness - generation: 16; average & best misfits: -47.6828
-10.1491
Optimizing Vs & Thickness - generation: 17; average & best misfits: -45.6727

-10.1491
Optimizing Vs & Thickness - generation: 18; average & best misfits: -43.3434
-10.1491
Optimizing Vs & Thickness - generation: 19; average & best misfits: -43.4549
-10.1491
Optimizing Vs & Thickness - generation: 20; average & best misfits: -38.628
-10.1491
Optimizing Vs & Thickness - generation: 21; average & best misfits: -32.1435
-9.34188
Optimizing Vs & Thickness - generation: 22; average & best misfits: -35.4019
-9.34188
Optimizing Vs & Thickness - generation: 23; average & best misfits: -37.5444
-9.34188
Optimizing Vs & Thickness - generation: 24; average & best misfits: -34.6793
-9.34188
Optimizing Vs & Thickness - generation: 25; average & best misfits: -34.3257
-9.34188
Optimizing Vs & Thickness - generation: 26; average & best misfits: -39.4828
-9.34188
Optimizing Vs & Thickness - generation: 27; average & best misfits: -32.2596
-9.34188
Optimizing Vs & Thickness - generation: 28; average & best misfits: -34.685
-9.34188
Optimizing Vs & Thickness - generation: 29; average & best misfits: -40.2134
-9.34188
Optimizing Vs & Thickness - generation: 30; average & best misfits: -40.1592
-9.34188
Optimizing Vs & Thickness - generation: 31; average & best misfits: -39.4825
-9.34188
Optimizing Vs & Thickness - generation: 32; average & best misfits: -39.1995
-9.34188
Optimizing Vs & Thickness - generation: 33; average & best misfits: -37.0987
-9.34188
Optimizing Vs & Thickness - generation: 34; average & best misfits: -31.1413
-9.34188
Optimizing Vs & Thickness - generation: 35; average & best misfits: -29.8088
-9.34188
Optimizing Vs & Thickness - generation: 36; average & best misfits: -30.7569
-9.34188
Optimizing Vs & Thickness - generation: 37; average & best misfits: -33.9842
-9.34188
Optimizing Vs & Thickness - generation: 38; average & best misfits: -36.265
-9.34188
Optimizing Vs & Thickness - generation: 39; average & best misfits: -32.6238
-9.34188
Optimizing Vs & Thickness - generation: 40; average & best misfits: -29.7976
-9.34188
Optimizing Vs & Thickness - generation: 41; average & best misfits: -32.6357
-9.34188
Optimizing Vs & Thickness - generation: 42; average & best misfits: -36.9426
-9.34188
Optimizing Vs & Thickness - generation: 43; average & best misfits: -37.022
-9.34188
Optimizing Vs & Thickness - generation: 44; average & best misfits: -34.0093
-9.34188
Optimizing Vs & Thickness - generation: 45; average & best misfits: -35.7765
-9.34188
Optimizing Vs & Thickness - generation: 46; average & best misfits: -33.0127
-9.34188
Optimizing Vs & Thickness - generation: 47; average & best misfits: -32.2073
-9.34188
Optimizing Vs & Thickness - generation: 48; average & best misfits: -28.5858
-9.34188
Optimizing Vs & Thickness - generation: 49; average & best misfits: -25.9673
-9.34188
Optimizing Vs & Thickness - generation: 50; average & best misfits: -29.5068
-9.34188
Optimizing Vs & Thickness - generation: 51; average & best misfits: -36.2979

-9.34188
Optimizing Vs & Thickness - generation: 52; average & best misfits: -35.204
-9.34188
Optimizing Vs & Thickness - generation: 53; average & best misfits: -37.801
-9.34188
Optimizing Vs & Thickness - generation: 54; average & best misfits: -34.1627
-9.34188
Optimizing Vs & Thickness - generation: 55; average & best misfits: -37.3006
-9.34188
Optimizing Vs & Thickness - generation: 56; average & best misfits: -37.3726
-9.34188
Optimizing Vs & Thickness - generation: 57; average & best misfits: -36.5751
-9.34188
Optimizing Vs & Thickness - generation: 58; average & best misfits: -35.4985
-9.18742
Optimizing Vs & Thickness - generation: 59; average & best misfits: -37.7355
-9.18742
Optimizing Vs & Thickness - generation: 60; average & best misfits: -39.476
-9.18742
Optimizing Vs & Thickness - generation: 61; average & best misfits: -38.979
-9.18742
Optimizing Vs & Thickness - generation: 62; average & best misfits: -30.5374
-9.18742
Optimizing Vs & Thickness - generation: 63; average & best misfits: -30.5127
-9.18742
Optimizing Vs & Thickness - generation: 64; average & best misfits: -30.1573
-9.18742
Optimizing Vs & Thickness - generation: 65; average & best misfits: -33.1656
-8.81549
Optimizing Vs & Thickness - generation: 66; average & best misfits: -25.5434
-8.81549
Optimizing Vs & Thickness - generation: 67; average & best misfits: -30.3234
-8.81549
Optimizing Vs & Thickness - generation: 68; average & best misfits: -30.7384
-8.81549
Optimizing Vs & Thickness - generation: 69; average & best misfits: -28.9013
-8.81549
Optimizing Vs & Thickness - generation: 70; average & best misfits: -27.8007
-8.81549
Optimizing Vs & Thickness - generation: 71; average & best misfits: -26.8644
-8.81549
Optimizing Vs & Thickness - generation: 72; average & best misfits: -33.2605
-8.81549
Optimizing Vs & Thickness - generation: 73; average & best misfits: -25.4742
-8.81549
Optimizing Vs & Thickness - generation: 74; average & best misfits: -26.6808
-8.81549
Optimizing Vs & Thickness - generation: 75; average & best misfits: -23.6948
 -8.5846
Optimizing Vs & Thickness - generation: 76; average & best misfits: -26.2721
 -8.5846
Optimizing Vs & Thickness - generation: 77; average & best misfits: -29.1342
 -8.5846
Optimizing Vs & Thickness - generation: 78; average & best misfits: -30.2744
 -8.5846
Optimizing Vs & Thickness - generation: 79; average & best misfits: -29.5926
 -8.5846
Optimizing Vs & Thickness - generation: 80; average & best misfits: -25.2398
 -8.5846
Optimizing Vs & Thickness - generation: 81; average & best misfits: -29.3956
 -8.5846

Checking the new search space (for the finer search)

Now a finer search around the most promising search space area

Rayleigh wave analysis
Optimizing Vs & Thickness - generation: 1; average & best misfits: -113.3251

-8.584596
Optimizing Vs & Thickness - generation: 2; average & best misfits: -94.4349
-8.51072
Optimizing Vs & Thickness - generation: 3; average & best misfits: -84.7324
-8.51072
Optimizing Vs & Thickness - generation: 4; average & best misfits: -76.2957
-8.51072
Optimizing Vs & Thickness - generation: 5; average & best misfits: -74.4459
-8.51072
Optimizing Vs & Thickness - generation: 6; average & best misfits: -72.3414
-8.51072
Optimizing Vs & Thickness - generation: 7; average & best misfits: -65.9131
-8.51072
Optimizing Vs & Thickness - generation: 8; average & best misfits: -66.9842
-8.51072
Optimizing Vs & Thickness - generation: 9; average & best misfits: -65.1937
-8.51072
Optimizing Vs & Thickness - generation: 10; average & best misfits: -56.1266
-8.51072
Optimizing Vs & Thickness - generation: 11; average & best misfits: -55.7508
-8.51072
Optimizing Vs & Thickness - generation: 12; average & best misfits: -60.2275
-8.51072
Optimizing Vs & Thickness - generation: 13; average & best misfits: -56.8236
-7.58144
Optimizing Vs & Thickness - generation: 14; average & best misfits: -45.0268
-7.58144
Optimizing Vs & Thickness - generation: 15; average & best misfits: -36.494
-7.58144
Optimizing Vs & Thickness - generation: 16; average & best misfits: -36.1991
-7.58144
Optimizing Vs & Thickness - generation: 17; average & best misfits: -34.9604
-7.58144
Optimizing Vs & Thickness - generation: 18; average & best misfits: -33.631
-7.57949
Optimizing Vs & Thickness - generation: 19; average & best misfits: -34.3404
-7.57949
Optimizing Vs & Thickness - generation: 20; average & best misfits: -35.4791
-7.57949
Optimizing Vs & Thickness - generation: 21; average & best misfits: -34.0162
-7.57949

Model after the Vs & Thickness optimization (fixed Poisson values):
Vs (m/s): 171 500 332 572 424 712 1170
Thickness (m): 2.6 2.8 2.5 2.7 5 13

Poisson: 0.351 0.35 0.35 0.35 0.35 0.3 0.299
Number of models considered to calculate the average model: 45

##
RESULTS
##

Dataset: 15 245 ser2 taglio.sgy
Analyzed curve: BORGIANO LN0102 ser2.cdp

==o== SECTION#3

Analyzing Phase Velocities

Analyzing Rayleigh-Wave Dispersion

==
MEAN MODEL

Vs (m/s): 174 501 337 551 432 712 1179

LN 0102 MASW

Standard deviations (m/s): 2 5 23 53 22 0 14

Thickness (m): 2.7 3.7 2.7 2.3 4.5 12.6

Standard deviations (m): 0.0 0.5 0.3 0.3 0.2 0.2

Approximate values for Vp, density, Poisson & Shear modulus

Vp (m/s): 363 1043 702 1148 899 1333 2202

Density (gr/cm3): 1.81 2.06 1.97 2.09 2.03 2.12 2.25

Vp/Vs ratio: 2.09 2.08 2.08 2.08 2.08 1.87 1.87

Poisson: 0.35 0.35 0.35 0.35 0.35 0.30 0.30

Shear modulus (MPa): 55 518 224 634 378 1077 3122

Fundamental mode

Mean model

frequency (Hz)	VR(m/s)
5.50461	915.5377
6.92697	857.0167
7.97829	804.2868
8.90592	730.025

First higher mode

Mean model

14.1625	676.5778
16.4507	600.2197
19.1099	512.1622
24.552	388.8723
27.7059	347.5263
28.9428	341.6667

==o== SECTION#4

==========

BEST MODEL

Vs (m/s): 171 500 332 572 424 712 1170

thickness (m): 2.59692 2.75695 2.508 2.71295 5.02765 12.5647

Approximate values for Vp, density, Poisson & Shear modulus

Vp (m/s): 357 1041 692 1192 882 1333 2185

Density (gr/cm3): 1.81 2.06 1.96 2.10 2.02 2.12 2.24

Vp/Vs ratio: 2.09 2.08 2.08 2.08 2.08 1.87 1.87

Poisson: 0.35 0.35 0.35 0.35 0.35 0.30 0.30

Shear modulus (MPa): 53 516 217 686 364 1077 3072

dispersion curve (frequency - Rayleigh phase velocity)

Fundamental mode

best model

F(Hz)	VR(m/s)
5.50461	912.1777
6.92697	855.0113
7.97829	802.3496
8.90592	730.0808

First higher mode)

best model

14.1625	674.2214

16.4507	594.3272
19.1099	506.1286
24.552	384.6078
27.7059	343.4626
28.9428	335.9121

Vs5 (mean model): 250 452 m/s
Vs5 (best model): 250 451 m/s

Vs20 (mean model): 392 452 m/s
Vs20 (best model): 392 451 m/s

Vs30 (mean model): 468 452 m/s
Vs30 (best model): 468 451 m/s

==o== SECTION#6

For Italian Users:
Decreto 17 gennaio 2018 in aggiornamento alle Norme Tecniche per le Costruzioni e pubblicato sul Supplemento ordinario n° 8 alla Gazzetta Ufficiale del 20/02/2018:
A - Ammassi rocciosi affioranti o terreni molto rigidi caratterizzati da valori di velocità delle onde di taglio superiori a 800 m/s, eventualmente comprendenti in superficie terreni di caratteristiche meccaniche più scadenti con spessore massimo pari a 3 m.
B - Rocce tenere e depositi di terreni a grana grossa molto addensati o terreni a grana fina molto consistenti, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 360 m/s e 800 m/s.
C - Depositi di terreni a grana grossa mediamente addensati o terreni a grana fina mediamente consistenti con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 180 m/s e 360 m/s.
D - Depositi di terreni a grana grossa scarsamente addensati o di terreni a grana fina scarsamente consistenti, con profondità del substrato superiori a 30 m, caratterizzati da un miglioramento delle proprietà meccaniche con la profondità e da valori di velocità equivalente compresi tra 100 e 180 m/s.
E - Terreni con caratteristiche e valori di velocità equivalente riconducibili a quelle definite per le categorie C o D, con profondità del substrato non superiore a 30 m.

Per qualsiasi condizione di sottosuolo non classificabile nelle categorie precedenti, è necessario predisporre specifiche analisi di risposta locale per la definizione delle azioni sismiche.

Results saved in the folder "..\IO\output_disp".

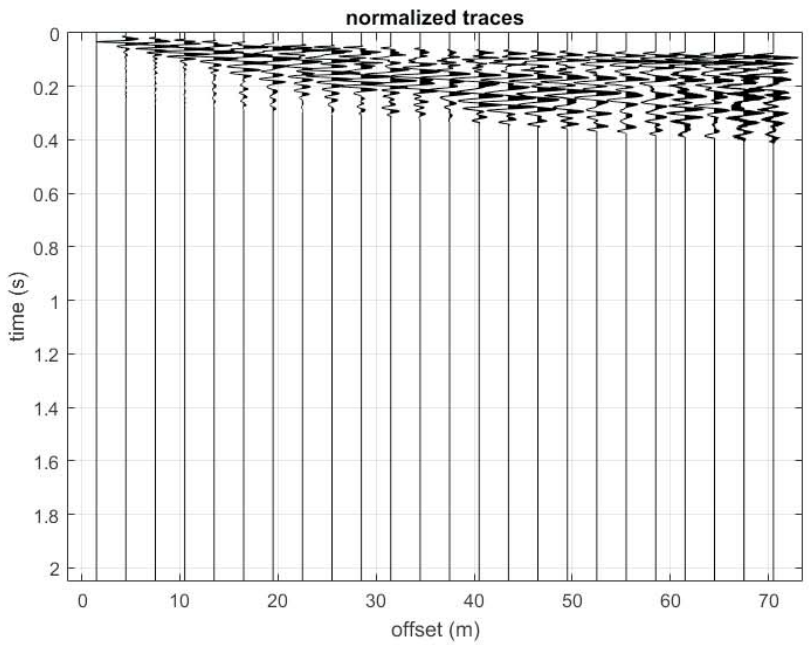
==========

winMASW - Surface Waves & Beyond

www.winmasw.com
Number of models used to define the mean model: 45
Vs5 for the best model: 250 451
Vs30 for the best model: 468 451

#1: uploading & processing (MASW analyses)

dataset: 15 245 ser2 taglio.sgy
sampling: 0.125 ms
minimum offset: 1.5 m
geophone spacing: 3 m



resampling: 0.5 | resample | accept

data selection: activate | select | 60 | cancel | save

filtering & spectra: filter | cancel | spectrum | spectrogram

refraction: refraction | 100 | upload | save | clear refraction

other tools & setting: 2.04787 time length to visualize (s) | done | cut | flip traces | zero padding

#2: velocity spectrum, modelling & picking (MASW/ReMi/ESAC analyses)

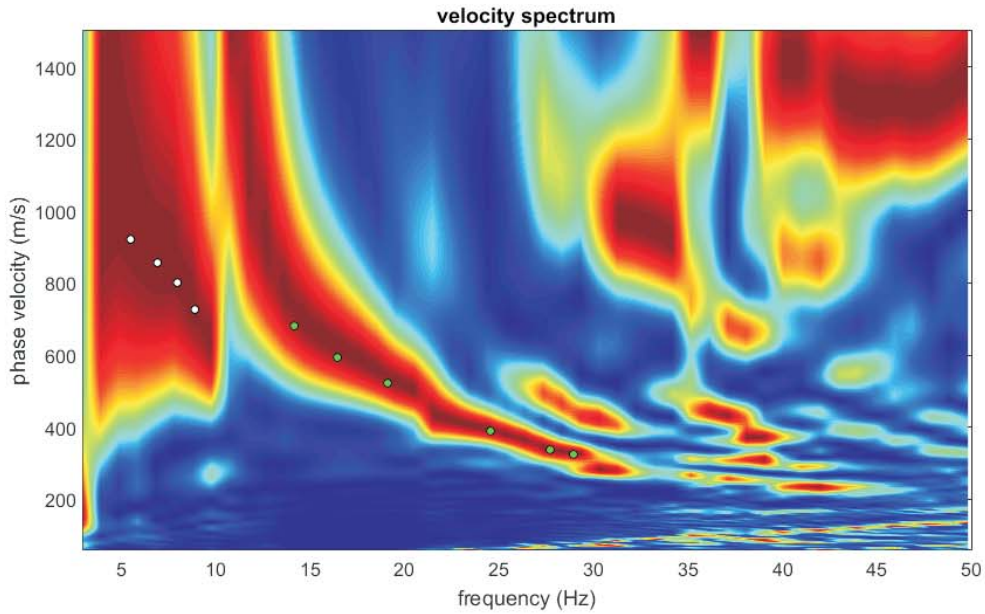
MASW: compute velocity spectrum: phase velocity | f-k | group velocity

handling the spectra: save | upload | merge

explore spectrum | mode separation

visualize curves: input curve | ?

picking: ? | show f-k | first higher | to select the last point of the considered mode click the right button | save picking | ? | BORGIANO LN0102 ser2.cdp | cancel picking



inversion: inversion | Joint DC-HV inv.

modelling

Vs (m/s)	Poisson	thickness (m)
180	0.35	2.8
500	0.35	3.6
300	0.35	3.8
500	0.35	2.2
410	0.35	4
710	0.3	9.6
1200	0.3	0
0	0.2	

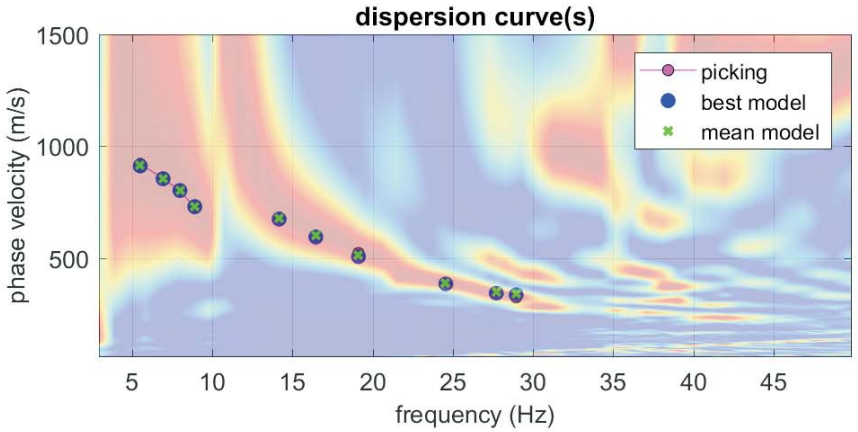
? | about Poisson

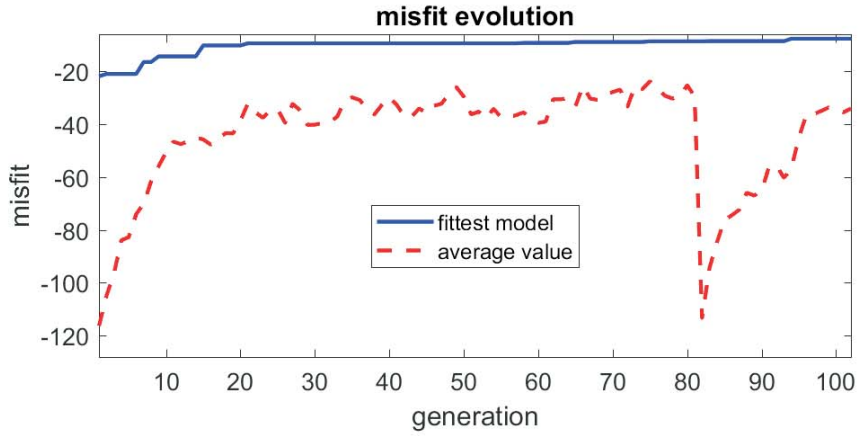
general setting: Rayleigh | 2 | phase vel | 0 Reference depth | Refraction | H/V body waves | 0 H/V modes (SW ellipticity)

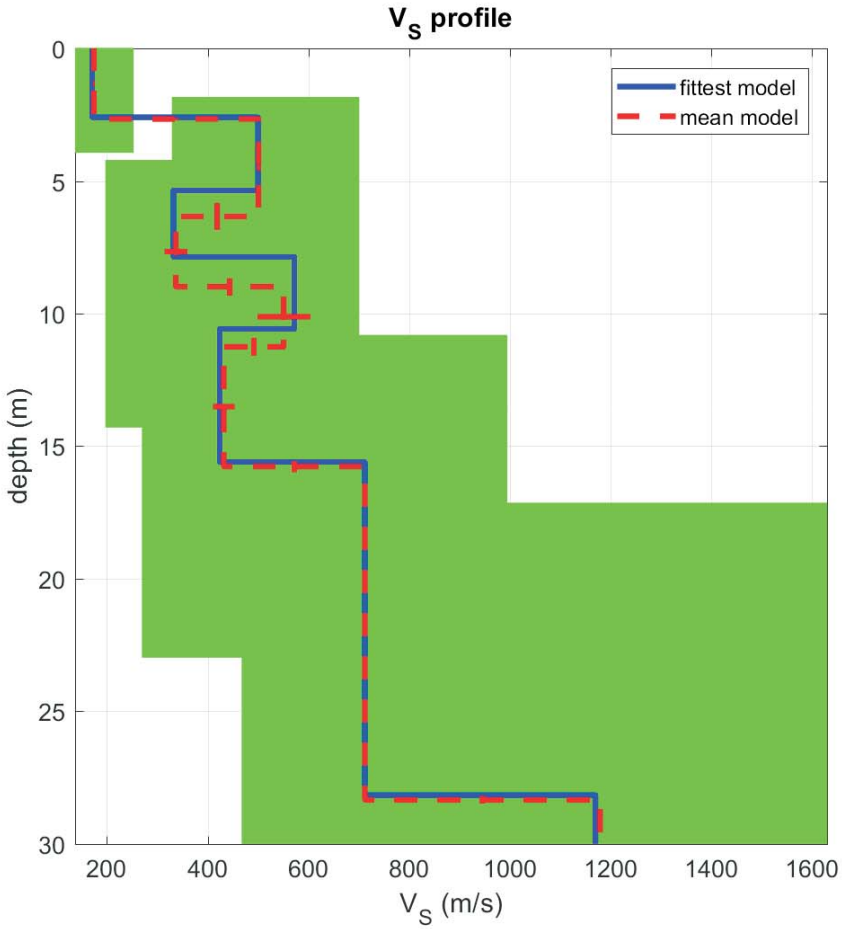
compute | upload mod. | save model | refresh | report

synthetics: ZVF | shows DC | synthetics

www.winmasw.com







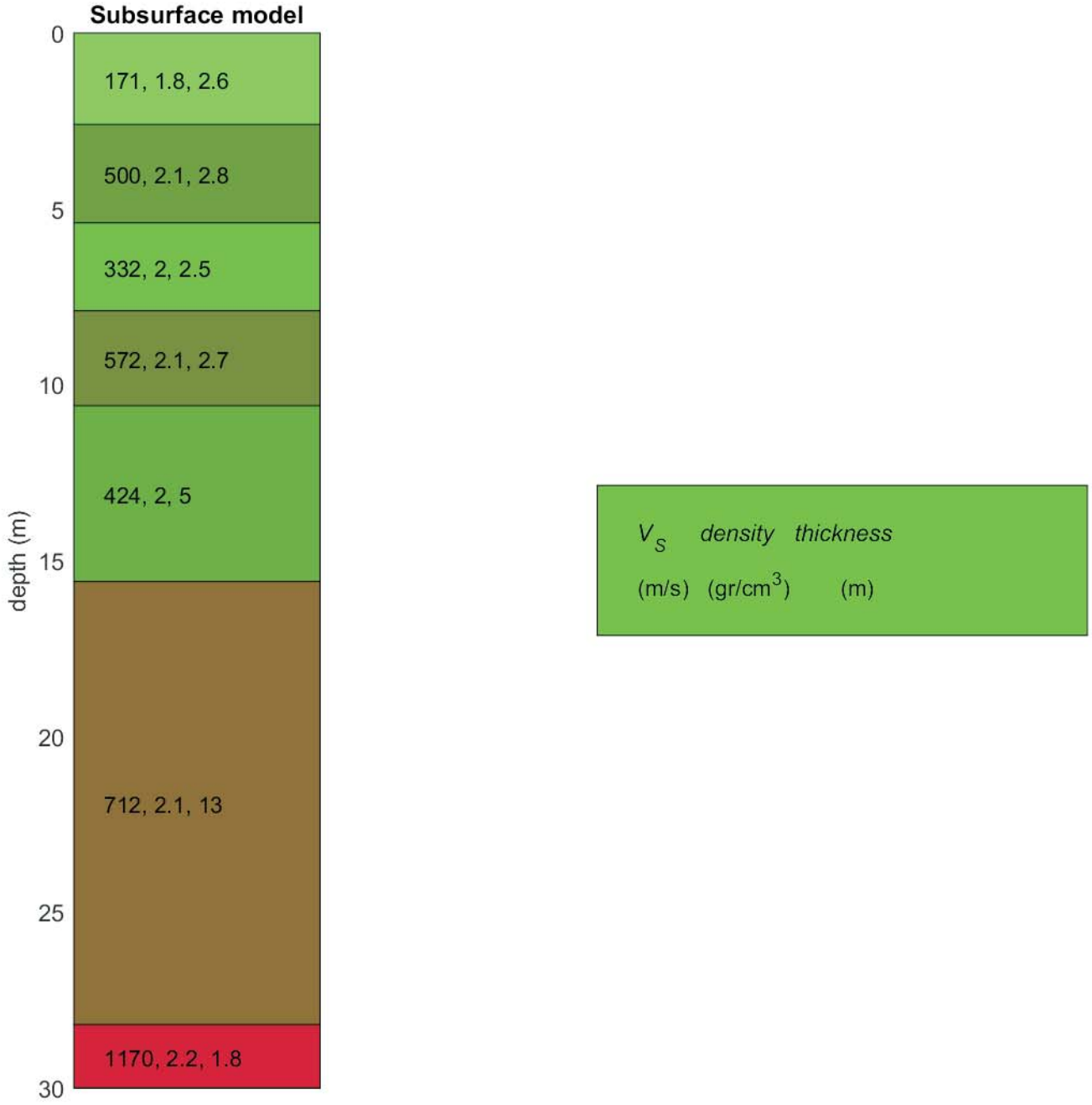
www.winmasw.com

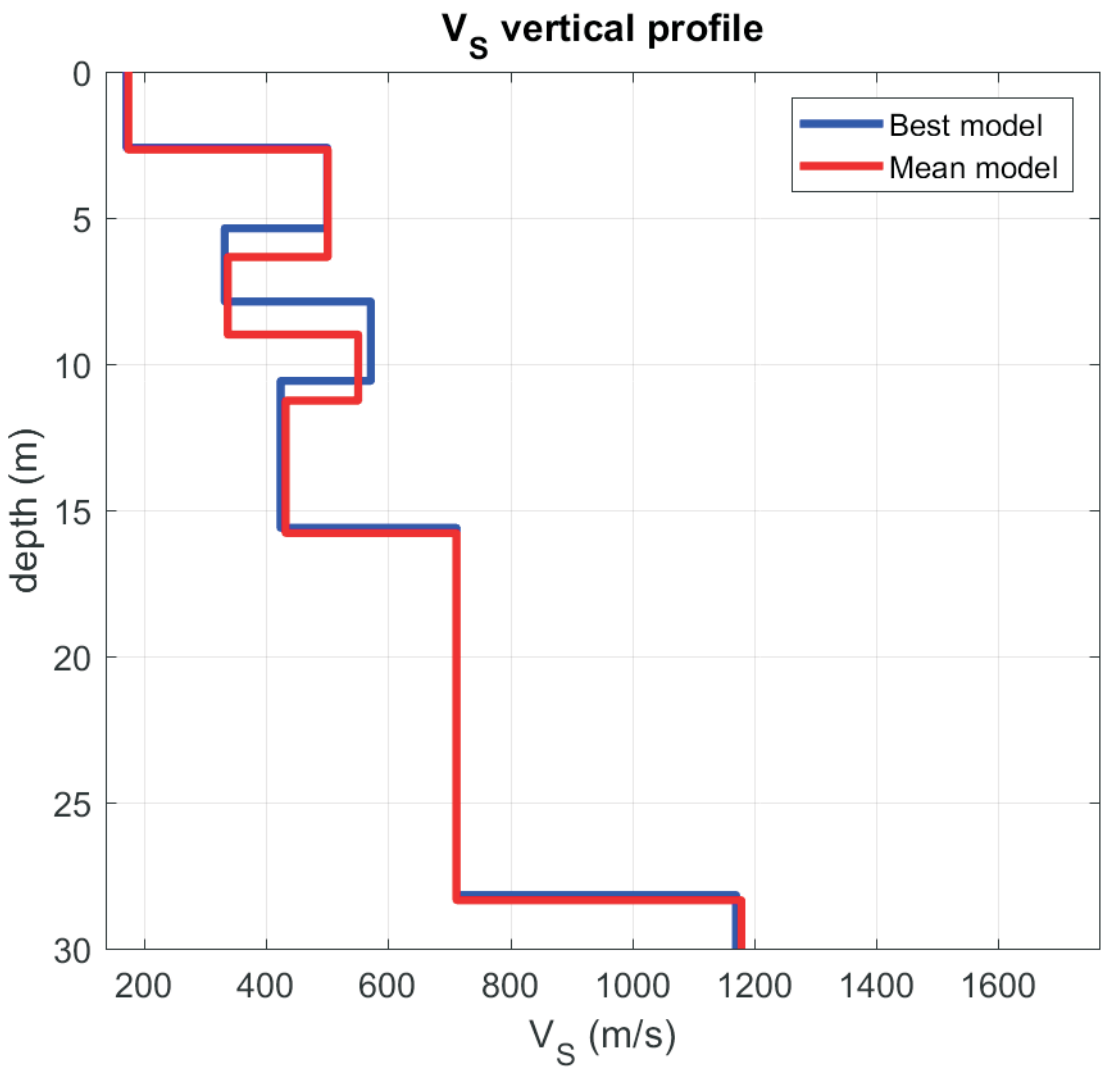
dataset: 15 245 ser2 taglio.sgy

dispersion curve: BORGIANO LN0102 ser2.cdp

Vs30 & VsE (best model): 468 451 m/s

Vs30 & VsE (mean model): 468 452 m/s *half-space*


Subsurface model
0
5
10
15
20
25
30
depth (m)
171, 1.8, 2.6
500, 2.1, 2.8
332, 2, 2.5
572, 2.1, 2.7
424, 2, 5
712, 2.1, 13
1170, 2.2, 1.8
V_S density thickness
(m/s) (gr/cm^3) (m)


V_S vertical profile
Best model
Mean model
depth (m)
0
5
10
15
20
25
30
200
400
600
800
1000
1200
1400
1600
V_S (m/s)