Site characterization of the INGV station IV.SANR – SANDRIGO

Working Group:	Date: March 2017
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Subject: **Final report illustrating measurements, analysis and results at IV.SANR station**	

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1. Introduction

In this report, we present the geophysical measurements and the results obtained in the framework of the 2016 agreement between INGV and DPC, named *Allegato B2: Obiettivo 1 (Responsabile: C. Meletti) - TASK B: Caratterizzazione siti accelerometrici (Responsabili: P. Bordoni, F. Pacor)* for the characterization of sites of the Italian National Seismic Network (RSN) with accelerometers. Here the results for station IV-SANR are presented.

Geophysical measurements are 2D arrays or 1D linear array, in active (MAWS) or passive configuration and provide results in terms of dispersion curves that are inverted to obtain shear-wave velocity (V_S) profiles for the studied area and suitable for assegning the EC8 class.

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2. Geophisical investigation

Figure 1 shows the location of the stations used for the 2D array array.

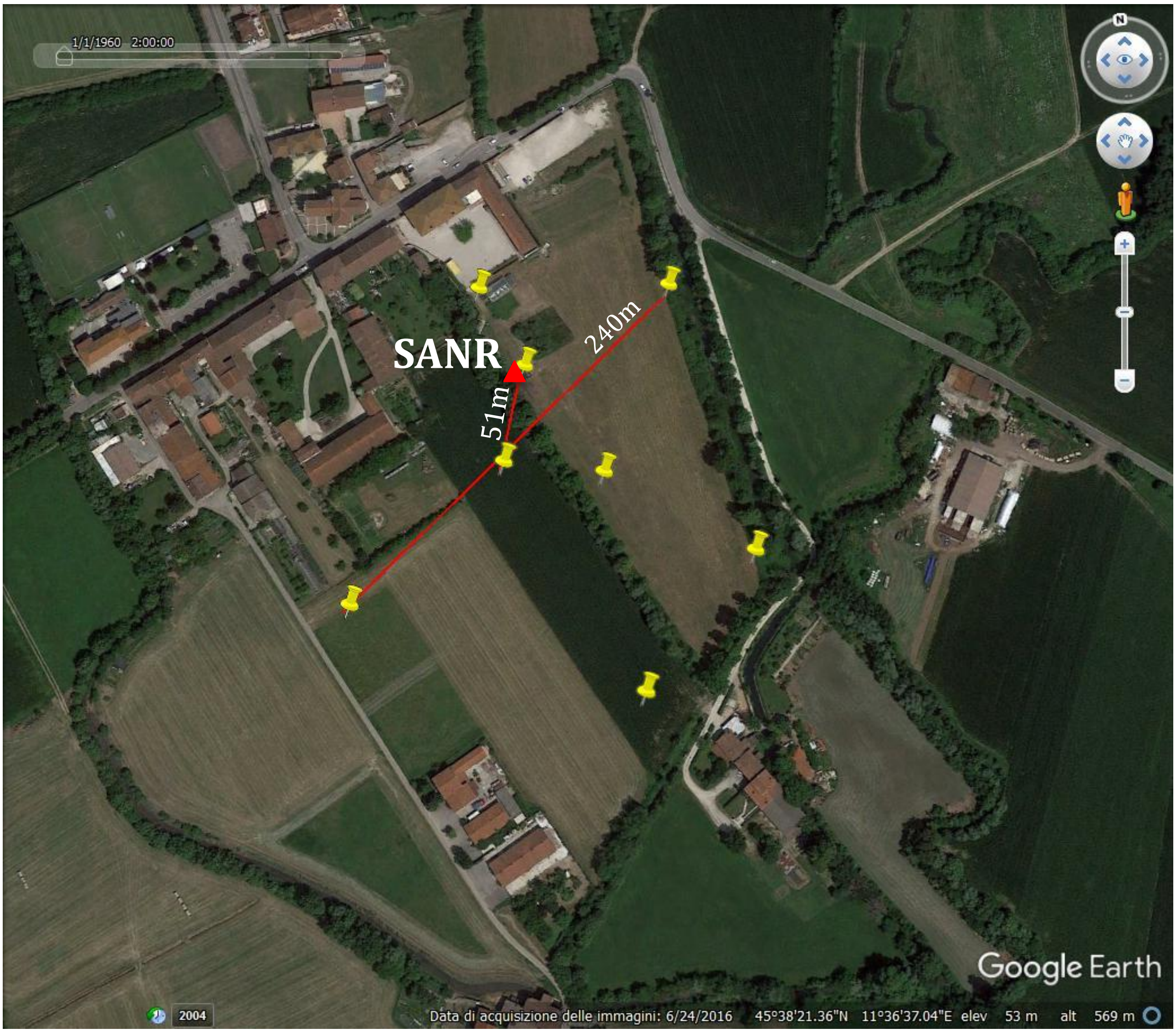

Figure 1: Plan view of the geophysical measurements performed at IV-SANR site. The yellow points are the eight stations of the 2D array in passive configuration (all stations are equipped with Reftek R130 digitizer and Lennartz 3D-5sec velocimetric sensors). The red triangle indicates station IV-SANR. The red lines indicate the minimum and maximum distances between the stations.

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2.1 ARRAY MEASUREMENTS RESULTS

A 2D array was performed using 8 single seismic stations equipped with Reftek 130 digitizers and Lennartz 3d-5s velocimetric sensors. The common noise recording lasted about 2 hours. A view of the 2D passive array survey is shown in Figure 2.

The seismic sensors were positioned in a two-dimensional geometry with irregular spacing, as shown in Figure 2.

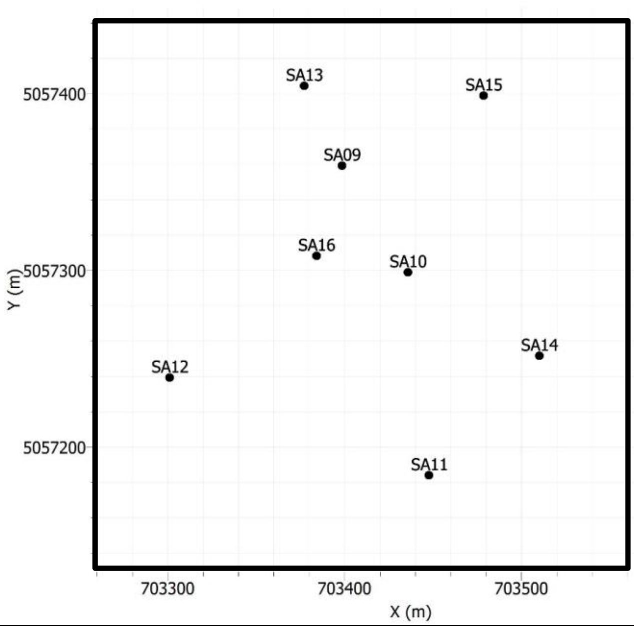

Figure 2: Top: installation of a station of the 2D array. Bottom: 2D Array geometry

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The geometry of the array allows the performance described in Figure 3

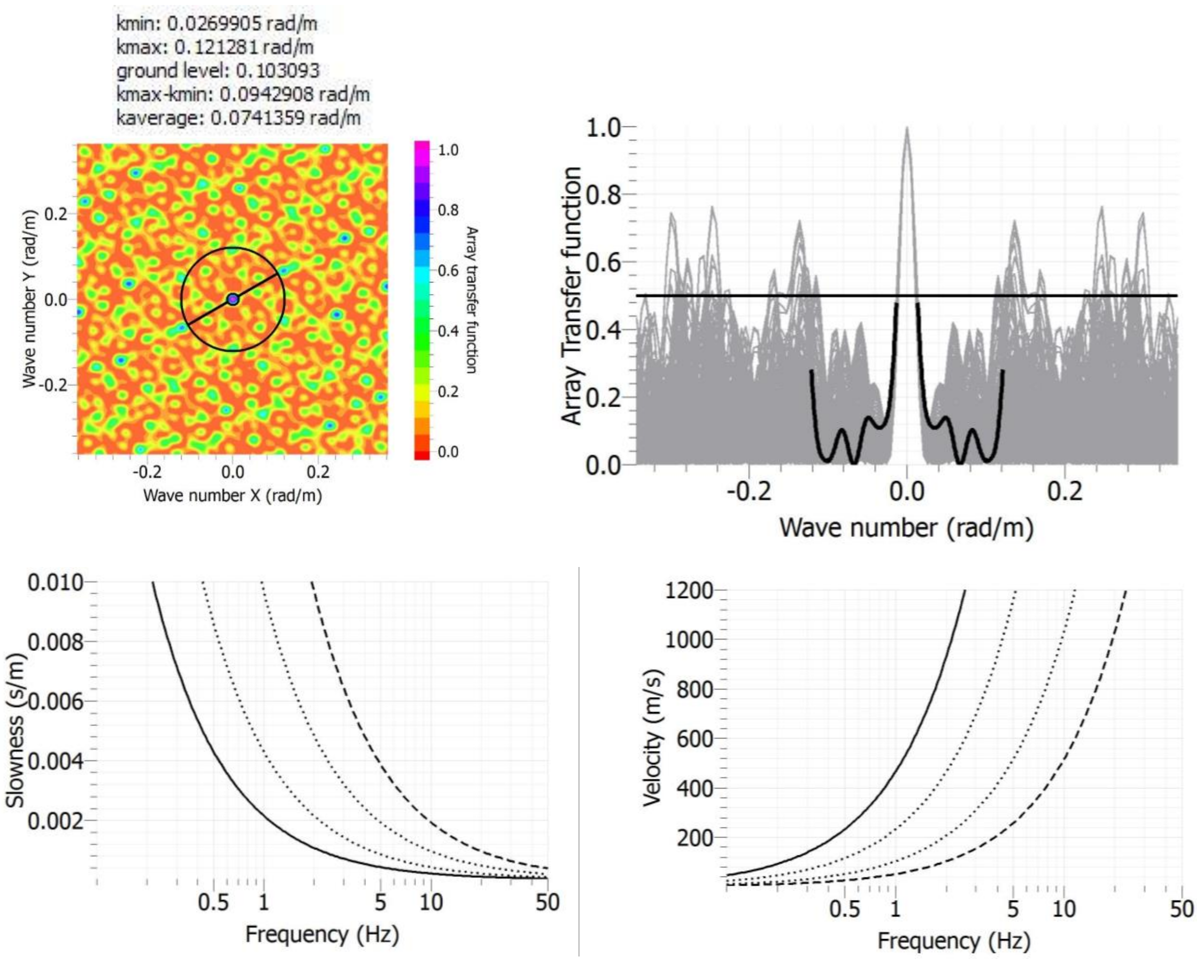

Figure 3: Theoretical Array Transfer function for the 2D array at IV-SANR

In Figure 4, the best H/V curve among the 8 stations of the array is reported, highlighting a first clear peak at 0.8 ± 0.07 Hz.

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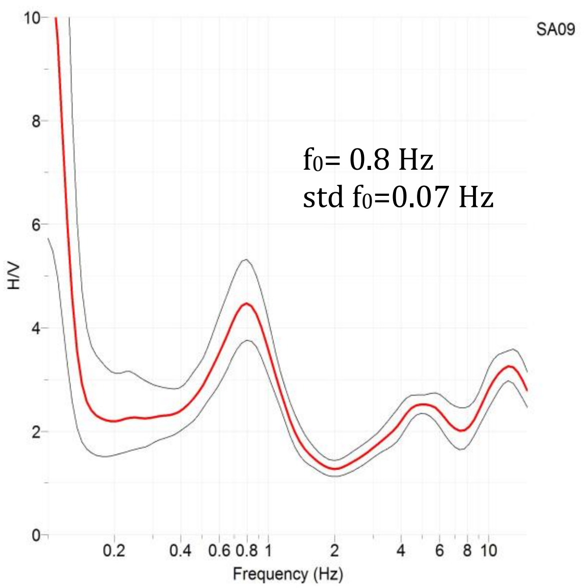
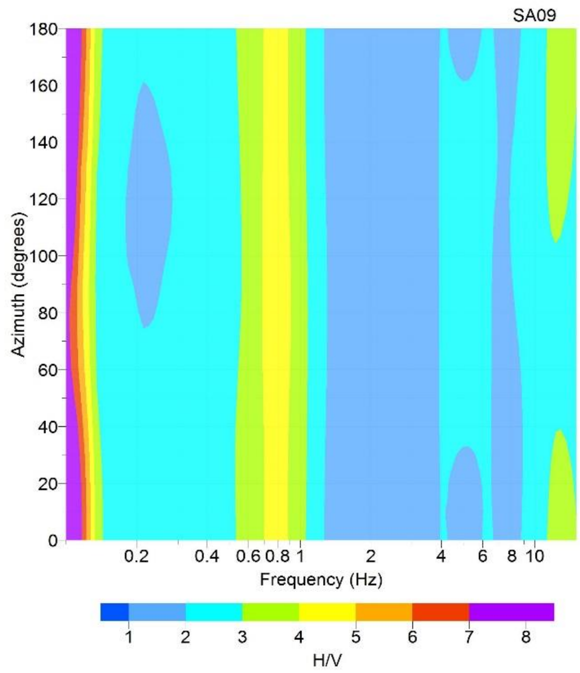
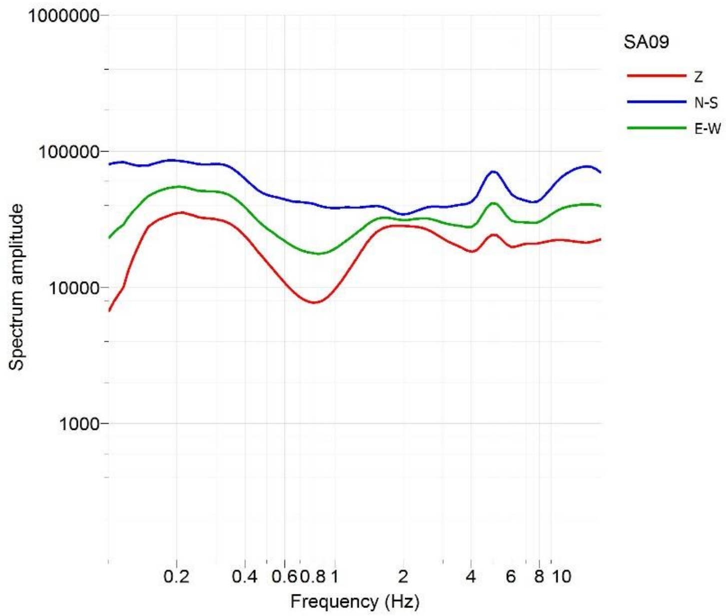




a)



c)

Figure 4: a) the best H/V curve obtained from the 8 seismic stations of the array. The red and the black curves are the average and the standard deviation respectively. b) and c) illustrate the correspondent rotated H/V and Fourier spectra respectively.

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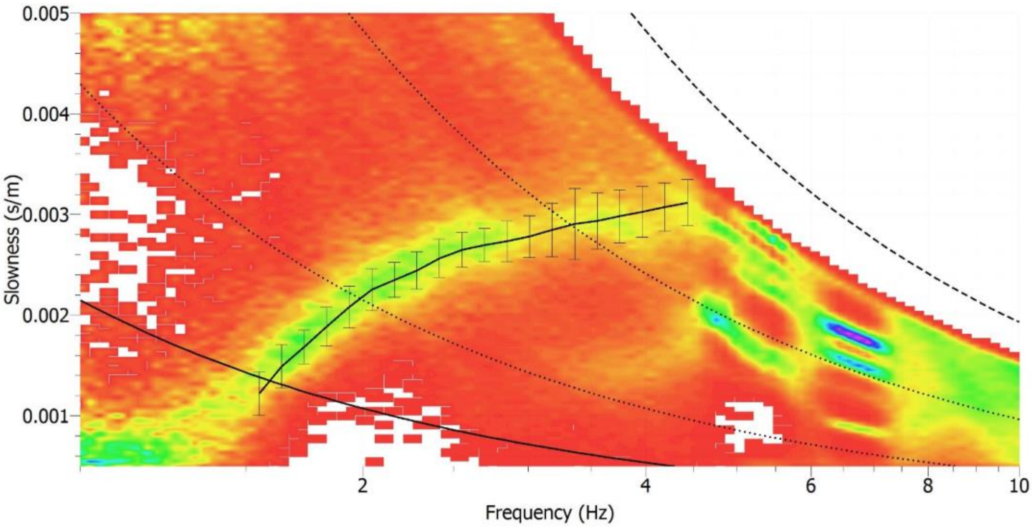
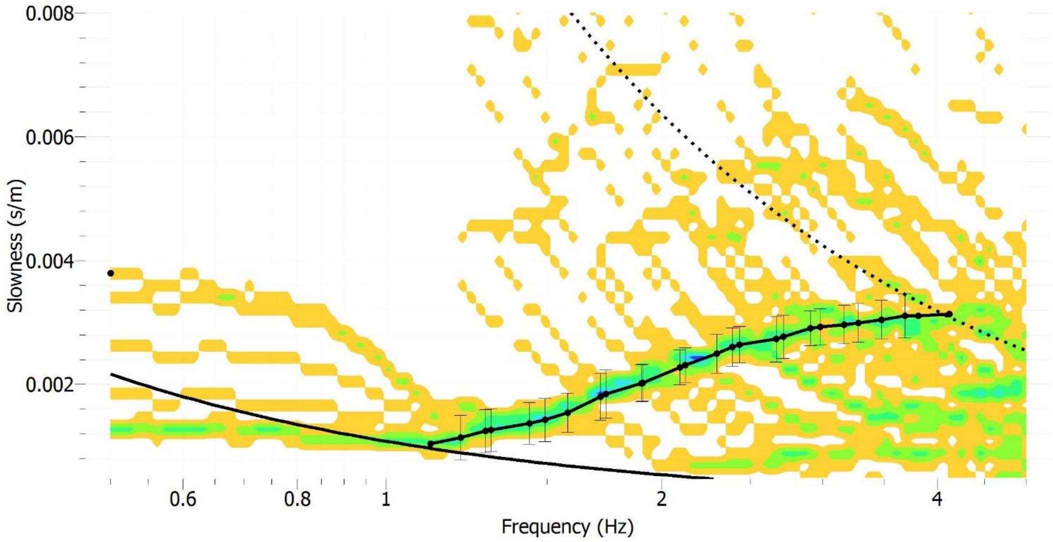
Data from the 2D array have been analyzed in terms of FK analysis and MSPAC analysis. The two techniques were both considered for the definition of the Rayleigh wave dispersion curve (Figure 5). For the analysis we used the code GEOPSY (http://www.geopsy.org).



a)



b)

Figure 5: picked dispersion curve for the 2D array, with the FK method (a) and MSPAC method (b)

We interpret and assume that the dispersion curve obtained with the 2D array is relative to the fundamental mode of the Rayleigh dispersive waves.

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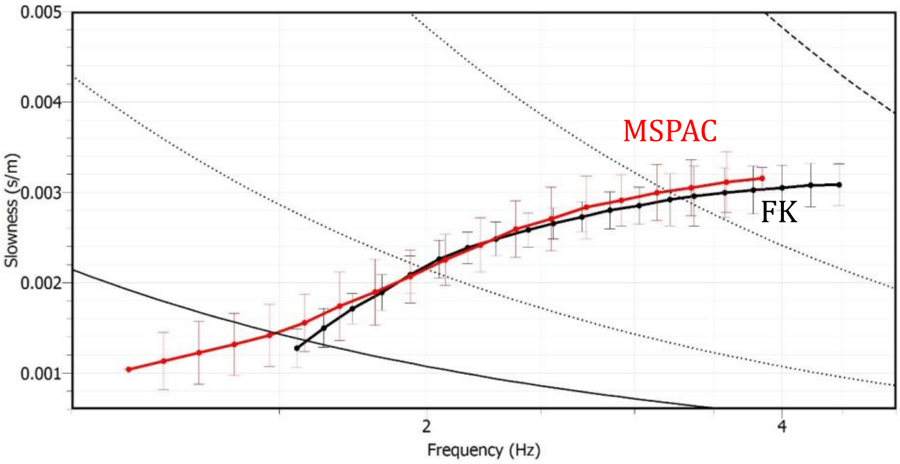
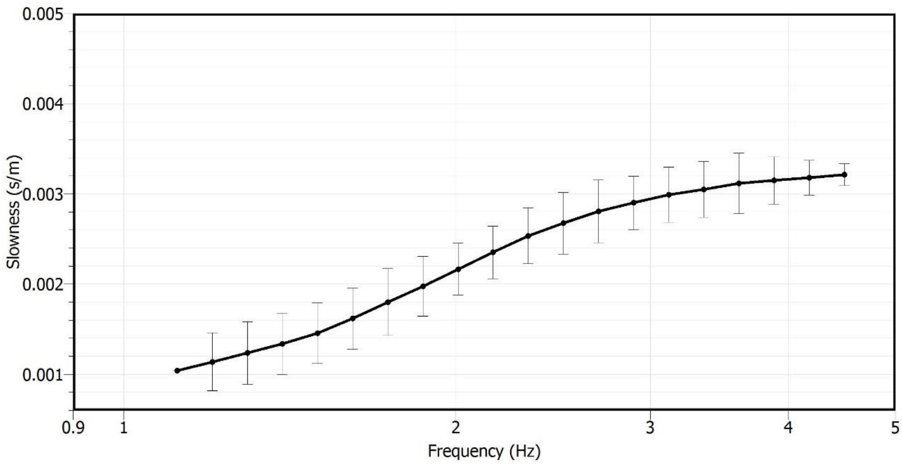
3. Vs Model

Comparing the two dispersion curves in Figure 5, coming from the 2D passive array, we observe a good match (Figure 6a). In particular, the MSPAC method can better define the lower frequencies, whereas the FK method can better define the higher frequencies, therefore the final dispersion curve considered for the inversion is a combination between the two (Figure 6b).



a)



b)

Figure 6: a) comparison between the dispersion curves obtained with different methodologies; b) dispersion curve considered for the inversion.

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To proceed with the inversion, we estimate the ellipticity curve from the H/V curve (Figure 4a), considering in particular the flanks of the main peak, where the influence of the Rayleigh waves is higher. Moreover, a common practice to remove the contribution of other waves in the H/V flanks is to reduce the amplitude for the squared root of 2 (Figure 7).

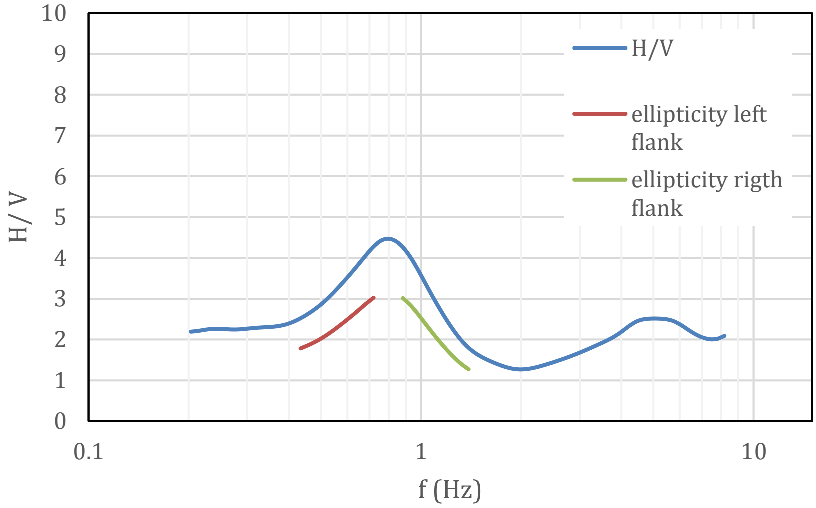

Figure 7: estimation of the ellipticity curve from the H/V curve.

Finally, we jointly invert the following targets:

1) Ellipticity curve as in Figure 7 (red and green curves)
2) Fundamental frequency as indicated in Figure 4a (Fo=0.8 Hz)
3) Rayleigh wave dispersion curve (fundamental mode) in Figure 6b

Figure 8 shows the comparison between the targets obtained experimentally and the ones expected for the Vs model proposed for this site.

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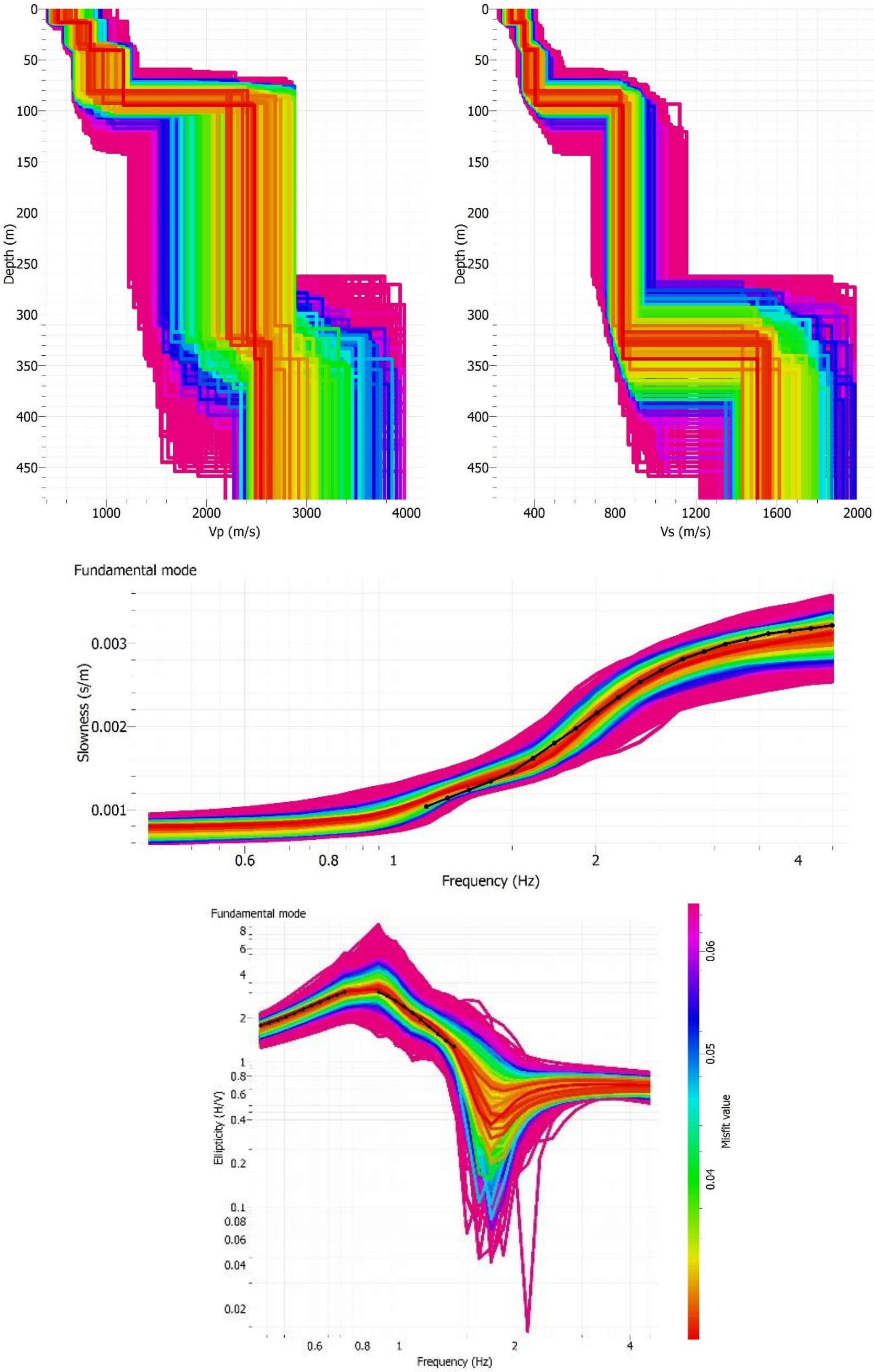

Figure 6: Inversion of the dispersion curves obtained with the 2D passive array, constrained with the H/V results.

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The best-fit Vp and Vs model are proposed in Figure 9 and Tab 1.

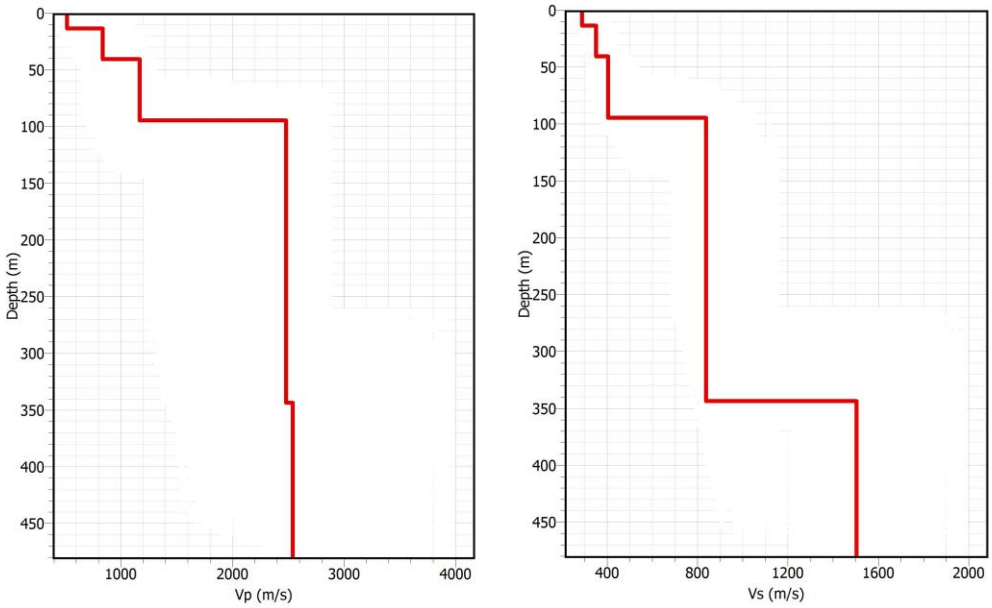

Figure 9: Best-fit model of Vp (left panel) and Vs (right panel) values

From	*To*	*Thickness (m)*	*Vs (m/s)*	*Vp (m/s)*
0	13	13	286	514
13	40	27	354	840
40	94	54	404	1166
94	343	249	838	2480
343			1500	2544

Tab 1 Best-fit model

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4. Conclusions

The H/V analysis for this site shows a clear peak at about 0.8 Hz that could be related to an impedance contrast at about 94 mt.

The very first layer of 10-13 meters could be linked to the presence of superficial fine deposits. The second and third layers together reach a depth of about 90 meters that could be related to the depth of poorly consolidated deposits. Finally, a stiffer layer, likely related to calcareous deposits, represents the seismic bedrock (V_S >800 m/s) of this site.

The V_{S30} retrieved from the inversion of the dispersion curves is 326 m/s (Tab 2), therefore IV-SANR is classified as soil class C in terms of NTC 08 seismic classification.

V_{S30} (m/s)	***Soil class***
326	C

Tab 2: Soil Class

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