



Site characterization of the INGV station IV.OPPE – OPPEANO

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Subject: Final report illustrating measurements, analysis and results at IV.OPPE station	



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1. Introduction

In this report, we present the geophysical measurements and the results obtained in the framework of the 2017 agreement between INGV and DPC, named *Allegato B2: Obiettivo 1 - TASK B: Caratterizzazione siti accelerometrici* for the characterization of sites of the Italian National Seismic Network (RSN-INGV) with accelerometers and of the Italian Accelerometric Network (RAN-DPC). Here the results for station IV-OPPE are presented.

Geophysical measurements are 2D microtremor arrays that provide results in terms of dispersion curves, inverted to obtain shear-wave velocity (V_s) profiles for the studied area, suitable for assigning the EC8 class.



2. Geophysical investigation

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

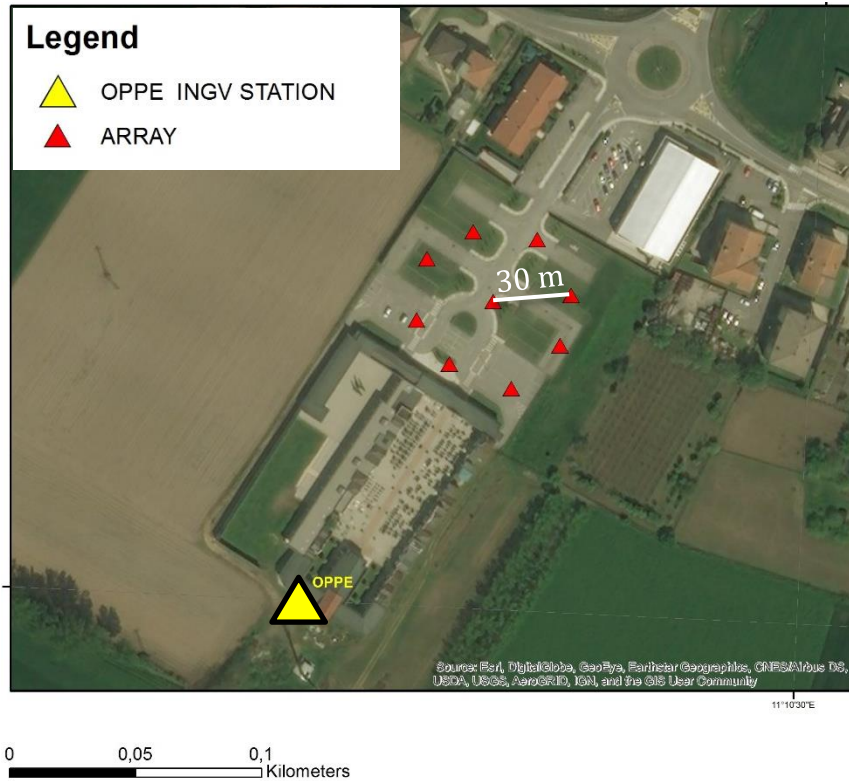


Figure 1: Plan view of the geophysical measurements performed at IV-OPPE site. The red points are the nine stations of the 2D array in passive configuration (all stations are equipped with Reftek R130 digitizer and Lennartz 3D-5sec velocimetric sensors). The yellow triangle indicates station IV-OPPE. The array is in a circular configuration with a ray of 30 m.



2.1 ARRAY MEASUREMENTS RESULTS

A 2D array was performed using 9 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 circular geometry with ray of 30 m, as shown in Figure 2.

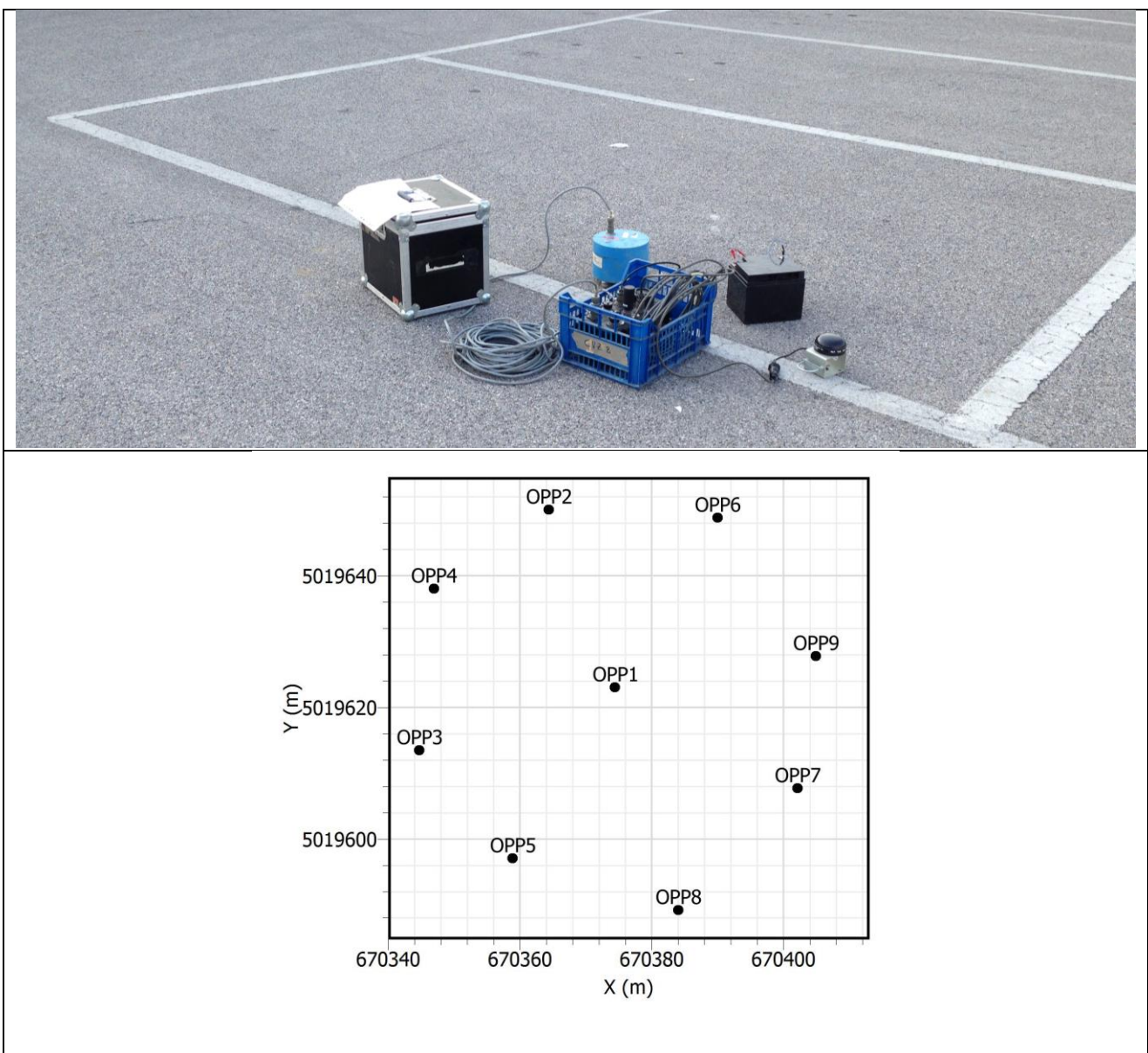


Figure 2: Top: installation of a station of the 2D array. Bottom: 2D Array geometry



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

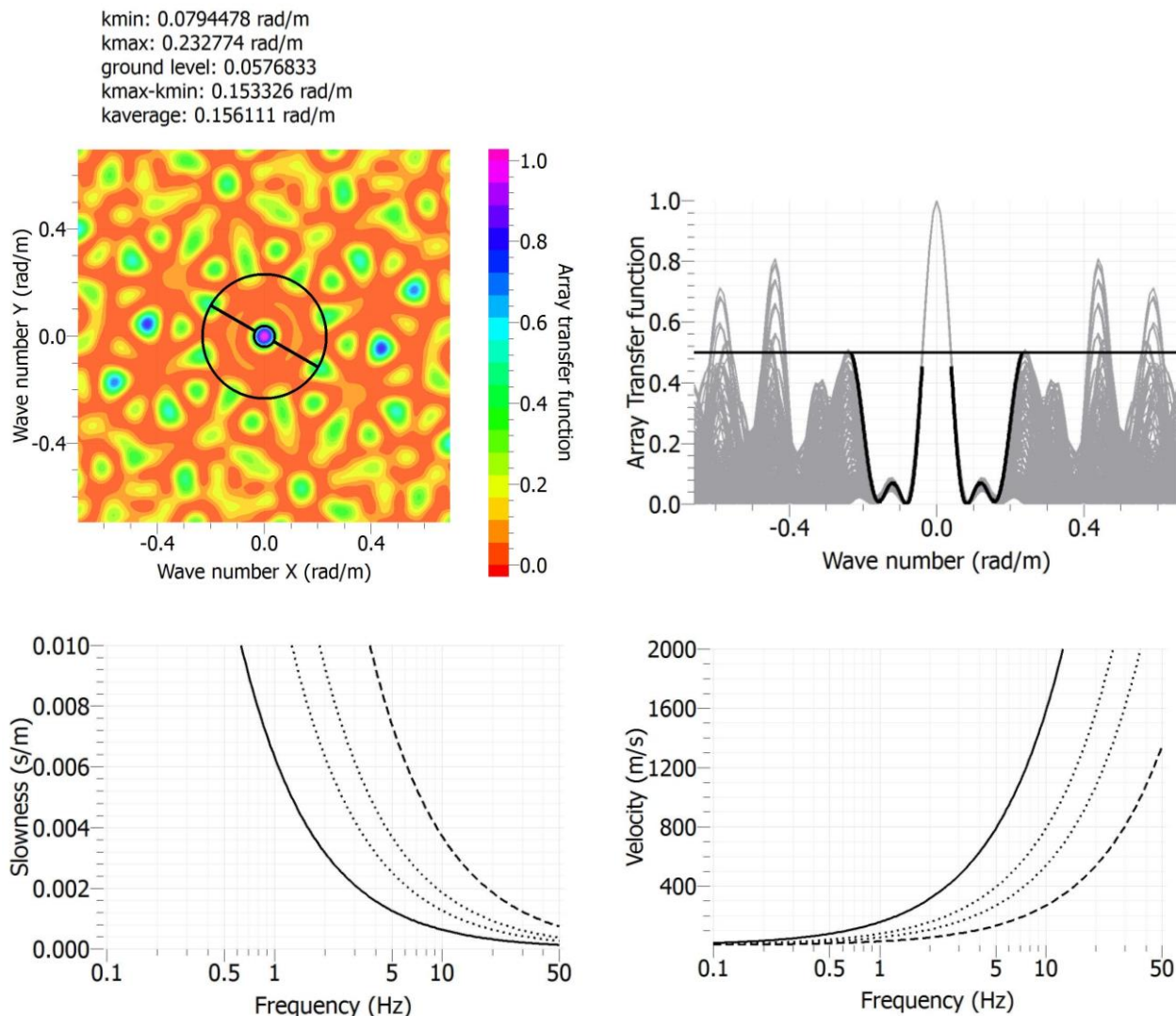


Figure 3: Theoretical Array Transfer function for the 2D array at IV-OPPE

In Figure 4, a representative H/V curve among the 9 stations of the array is reported, highlighting a first peak at 0.24 Hz and a second peak at 0.6 Hz. The analysis was performed with 120 s time windows and Konno & Ohmachi smoothing with the b coefficient set to 40. The rotated HV spectral ratios evidence consistently both the frequencies (0.24 and 0.6 Hz) showing no significant polarization effect for the peak at 0.6 Hz, whereas the first peak at 0.24 Hz shows a polarization with an azimuth around 80 degrees.

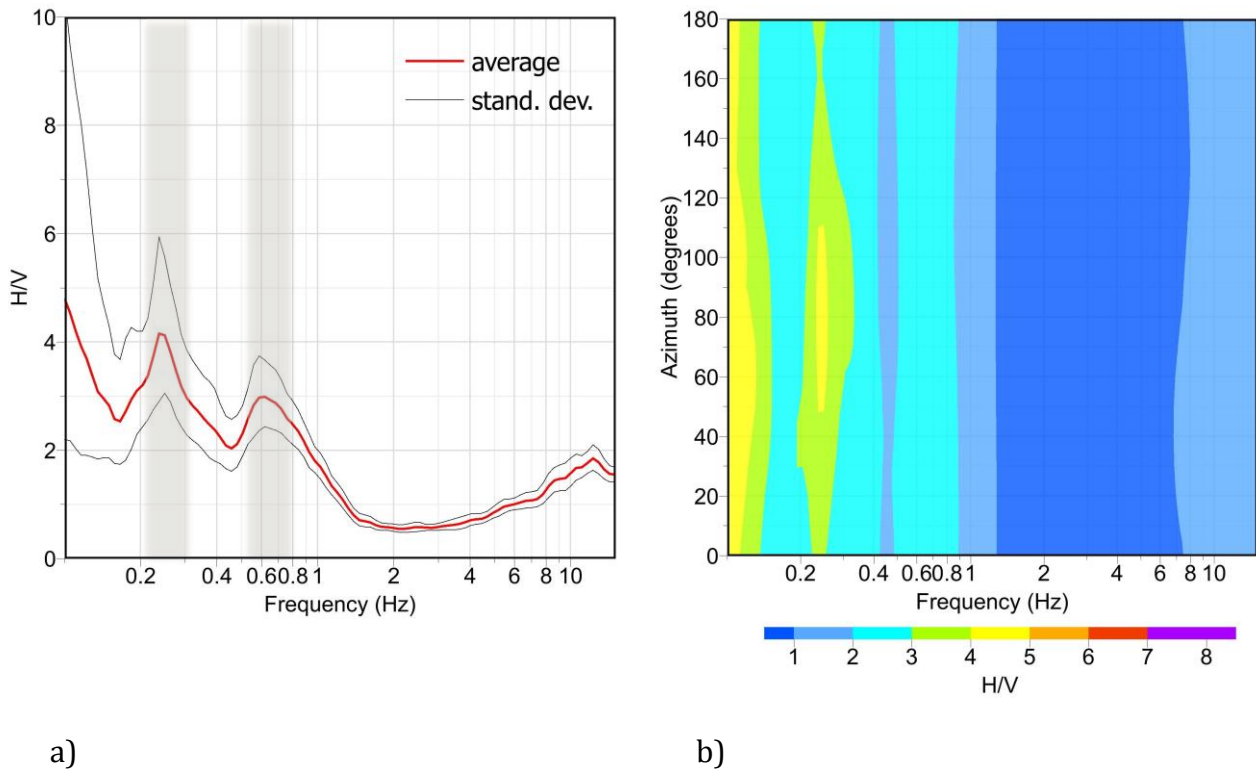
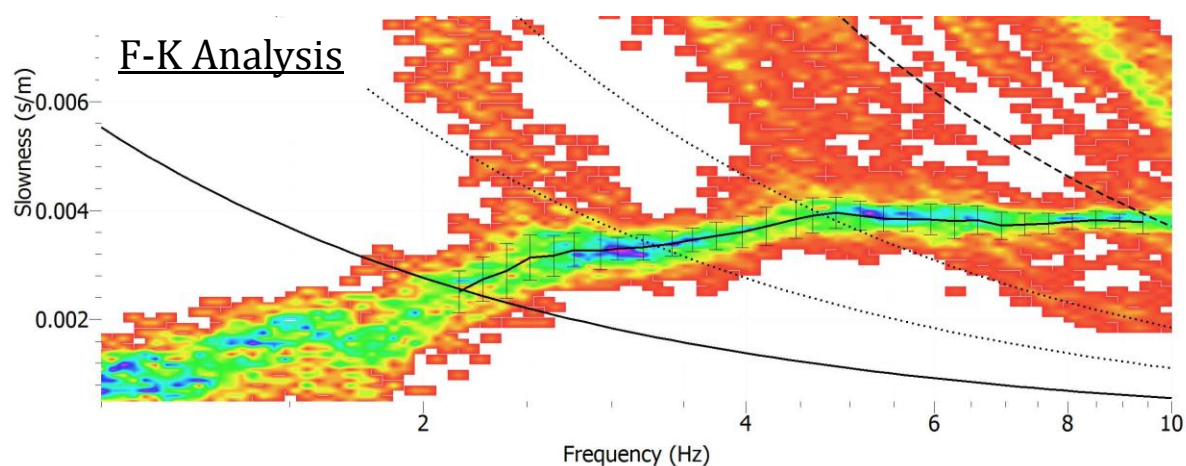
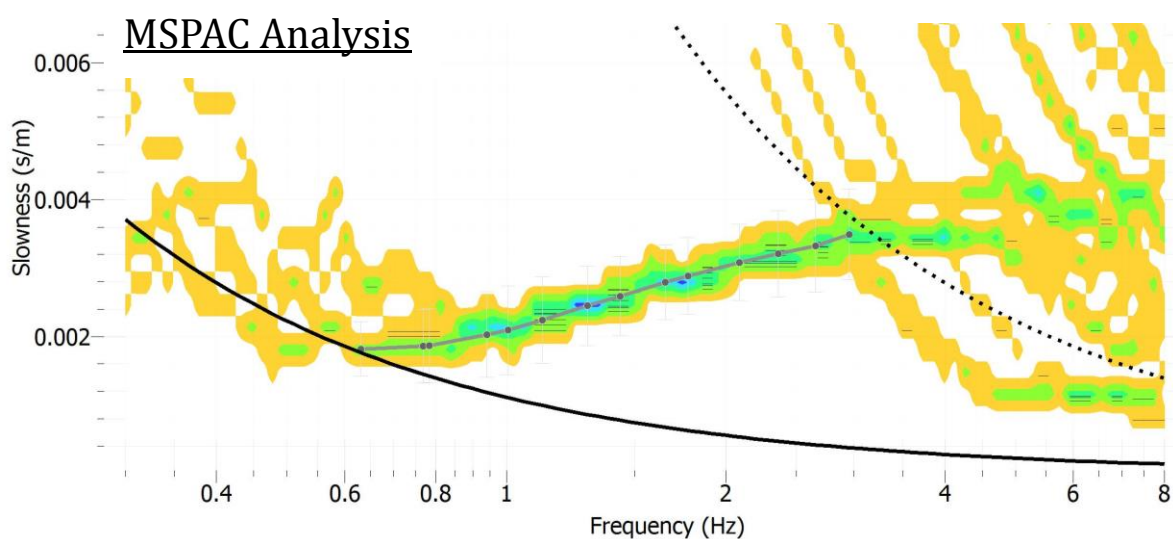


Figure 4: a) representative H/V curve and b) rotated H/V of the 9 seismic stations of the array

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, fundamental mode only (Figure 5). For the analysis, we used the GEOPSY code (<http://www.geopsy.org>).



a)



b)

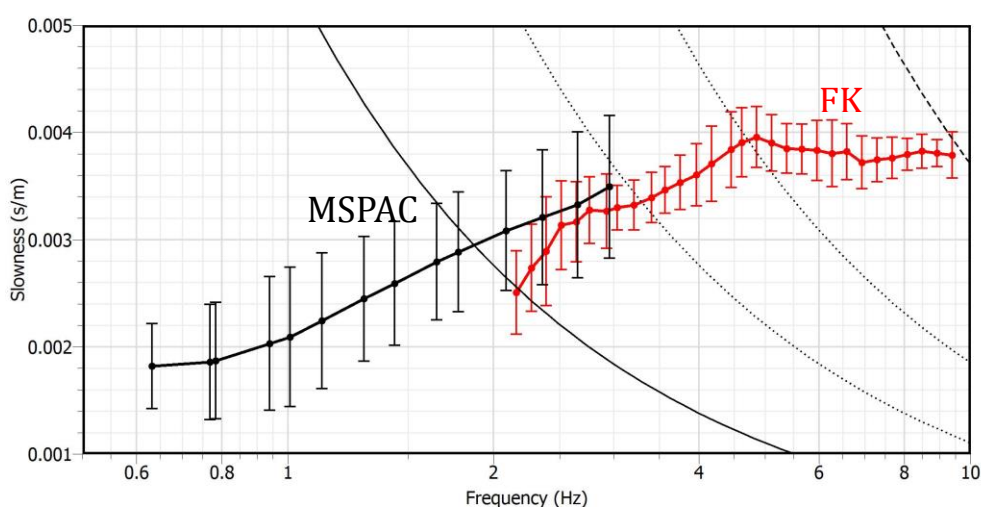
Figure 5: picked dispersion curve for the 2D array, with the FK method (a) and MSPAC method (b)

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

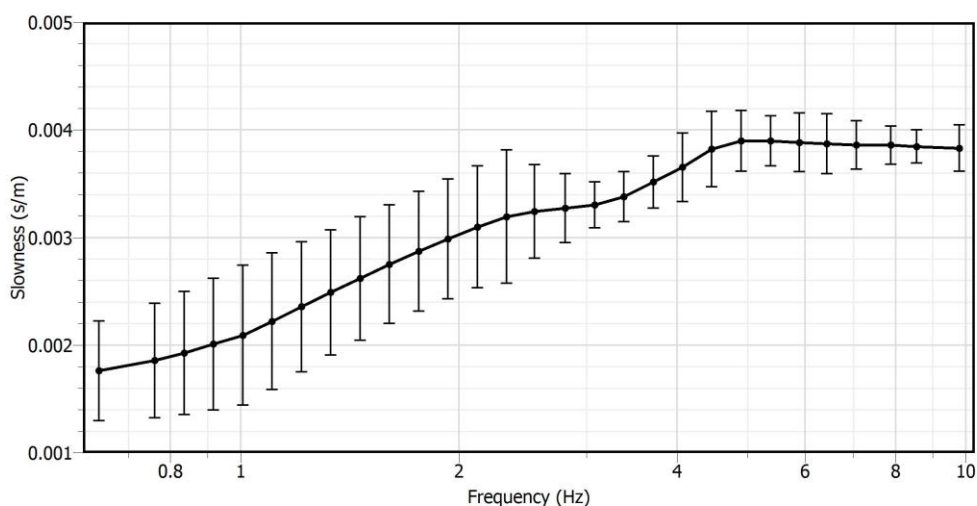


3. Vs Model

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.



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

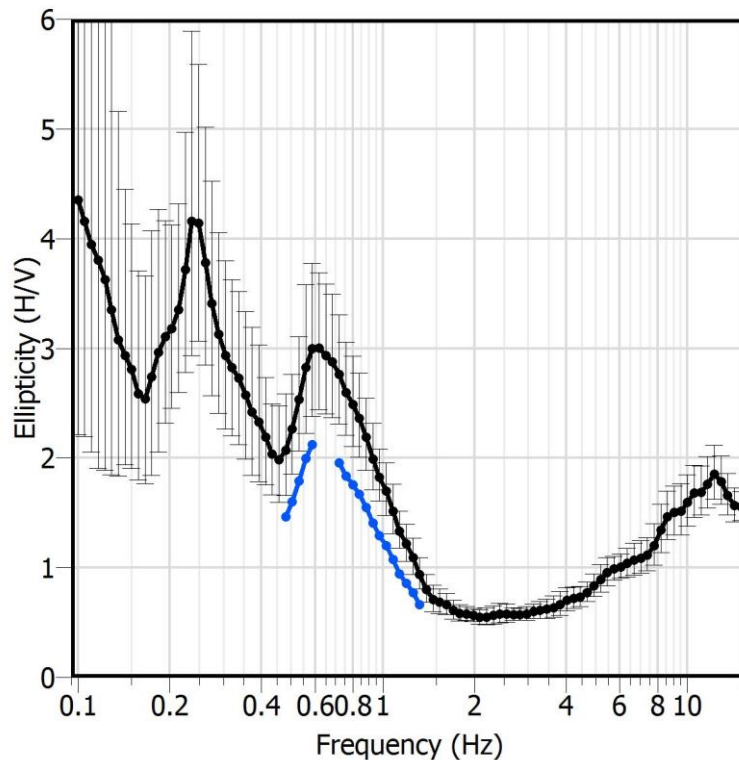


Figure 7: estimation of the ellipticity curve (blue) from the H/V curve (black).

Finally, we jointly invert the following targets:

- 1) Ellipticity curve as in Figure 7 (blue curves)
- 2) 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. The inflection at 3 Hz observed on the experimental dispersion curve is interpreted as an influence of a higher mode in the FK Analysis, therefore the modeled dispersion curve is interpreted as most accurate and the best-fit non corrected.

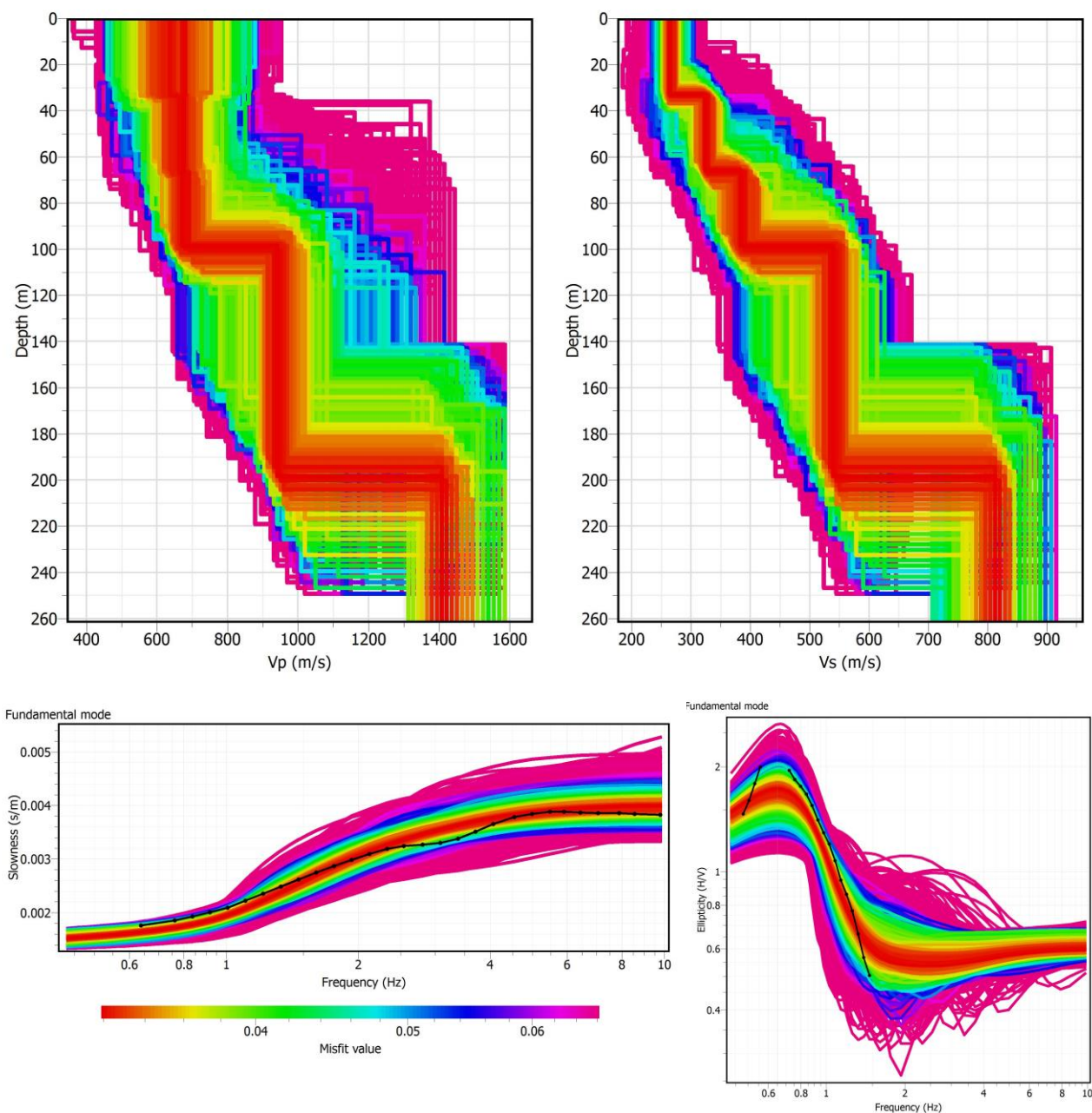


Figure 8: Inversion of the dispersion curve obtained with the 2D passive array, constrained with the H/V results.



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

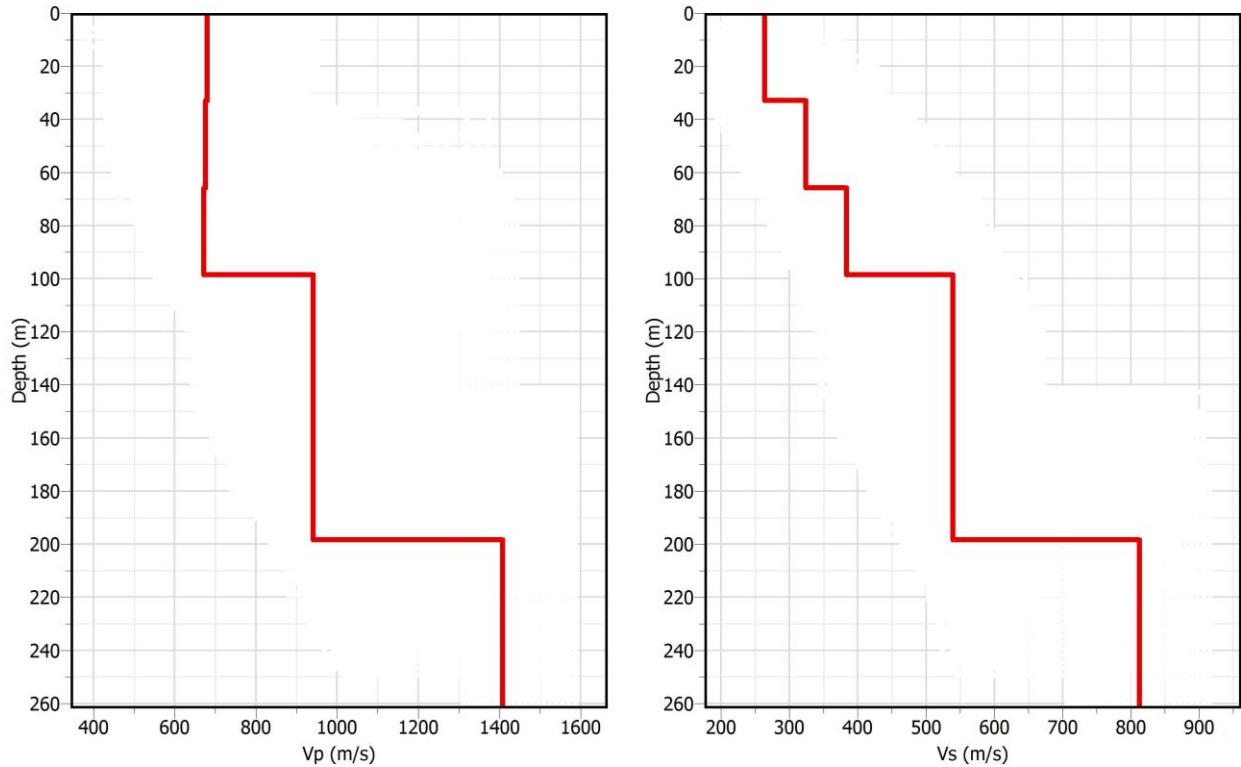


Figure 9: Best-fit model of Vp (left panel) and Vs (right panel) values

<i>From</i>	<i>To</i>	<i>Thickness (m)</i>	<i>Vs (m/s)</i>	<i>Vp (m/s)</i>
0	33	33	264	672
33	65	32	323	672
65	98	33	383	672
98	198	100	539	939
198			813	1407

Tab 1 Best-fit model



4. Conclusions

The H/V analysis for this site shows two H/V peaks at about 0.24 and 0.6 Hz respectively. The higher frequency peak at 0.6 Hz was considered for the analysis, as shown in Fig. 7 and 8, allowing to possibly relate the mentioned H/V peak with the seismic bedrock interface ($V_s > 800$ m/s; NTC 2008) at 198 m of depth. The low frequency peak at 0.24 Hz was not investigated, but it could be related to a deeper interface not reached from the obtained velocity profile.

The V_{s30} retrieved from the joint inversion of the dispersion and ellipticity curves is 264 m/s (Tab 2), therefore IV-OPPE is classified as soil class C in terms of NTC 08 seismic classification.

<i>V_{s30} (m/s)</i>	<i>Soil class</i>
264	C

Tab 2: Soil Class



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INGV contributes, within the limits of its skills, to the evaluation of seismic and volcanic hazard in the Country, according to the mode agreed in the ten-year program between INGV and DPC February 2, 2012 (Prot. INGV 2052 of 27/2/2012), and to the activities planned as part of the National Civil Protection System.

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