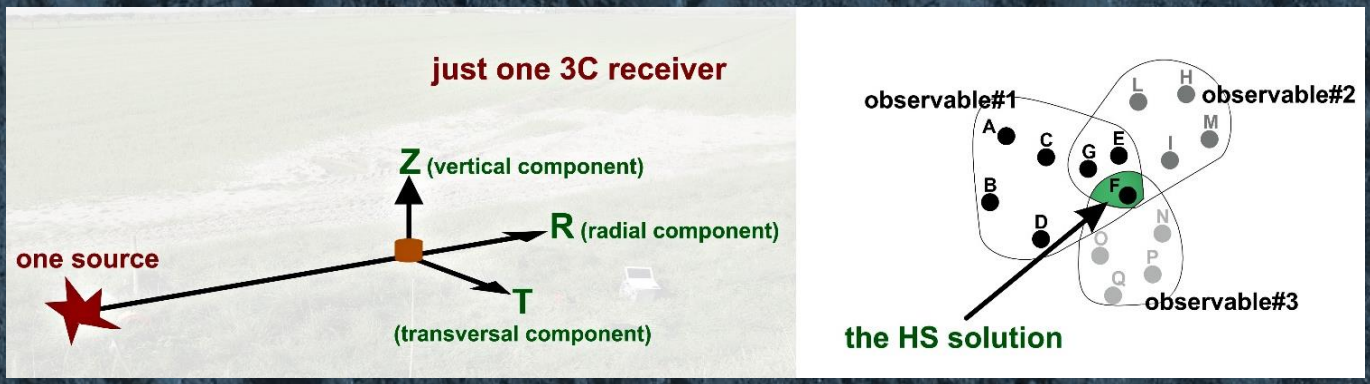
HoliSurface® - Holistic Inversion of Surface-Wave Propagation

www.holisurface.com

Robust Shear-Wave Velocity(V_S) Profiles using the Passive and the Multi-component Active Data from a Single 3-Component Geophone



Joint Inversion of the Group-Velocity Spectra (Z + R components) and HVSR [Active + Passive Data]

Automatic mapping from the GPS data included in the photo taken with your *Smartphone*

THE HOLISURFACE TECHNIQUE IS THE IMPROVEMENT OF THE CLASSICAL MFA/FTAN [MULTIPLE FILTER ANALYSIS / FREQUENCY-TIME ANALYSIS] METHODOLOGY FOR THE ANALYSIS OF THE GROUP VELOCITIES.

Levshin, A. L., V. F. Pisarenko, and G. A. Pogrebinsky, 1972, On a frequency-time analysis of oscillations: Annales de Geophysique, **28**, 211–218.

Ritzwoller, M. H., and A. L. Levshin, 2002, Estimating shallow shear velocities with marine multicomponent seismic data: Geophysics, **67**, 1991–2004.

Natale M, Nunziata C, Panza GF (2004) FTAN method for the detailed definition of Vs in urban areas. In: 13th world conference on earthquake engineering, Vancouver, BC, Canada, p 2694

THE MAIN DIFFERENCES (IMPROVEMENTS) ARE:

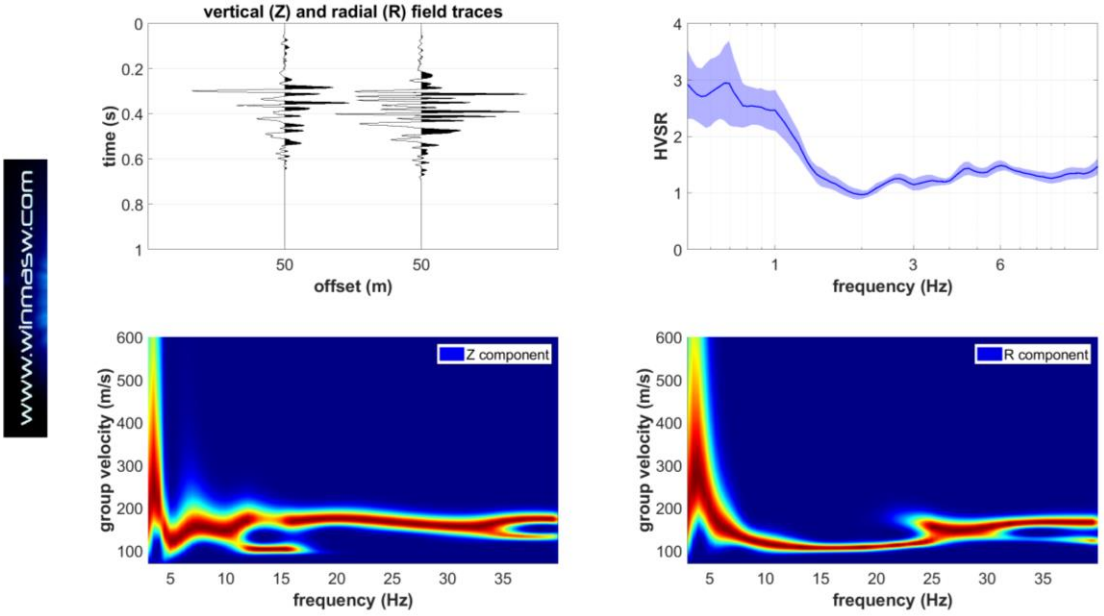
1) **WE DEAL WITH MULTI-COMPONENT DATA**
2) **DISPERSION IS ANALYSED ACCORDING TO THE FVS [FULL VELOCITY SPECTRUM] APPROACH**
3) **SINCE WITH THE SAME 3-COMPONENT GEOPHONE WE ALSO COMPUTE THE HVSR [HORIZONTAL-TO-VERTICAL SPECTRAL RATIO], WE CAN JOINTLY ANALYSE/INVERT UP TO SIX OBSERVABLES [SEE REFERENCES]**

IN THE FOLLOWING PAGES WE REPORT A VERY SIMPLE CASE STUDY: THE JOINT INVERSION OF THE GROUP-VELOCITY SPECTRA OF THE Z (VERTICAL) AND R (RADIAL) COMPONENTS OF RAYLEIGH WAVES TOGETHER WITH THE HVSR CURVE.

BUT WITH HOLISURFACE® YOU CAN DO MUCH MORE!

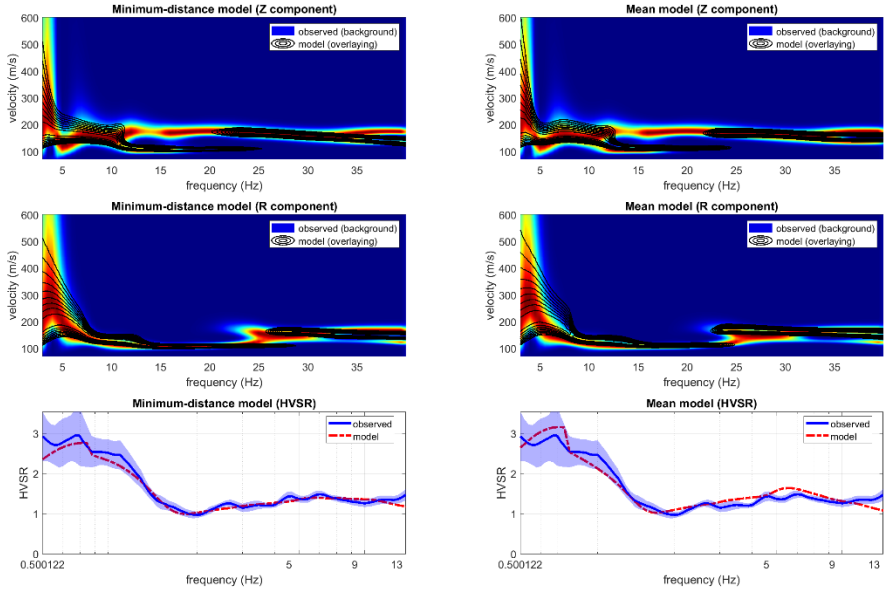
KEYWORDS: VS30, MASW, HVSR, WINMASW, HOLISURFACE, REMI, ESAC

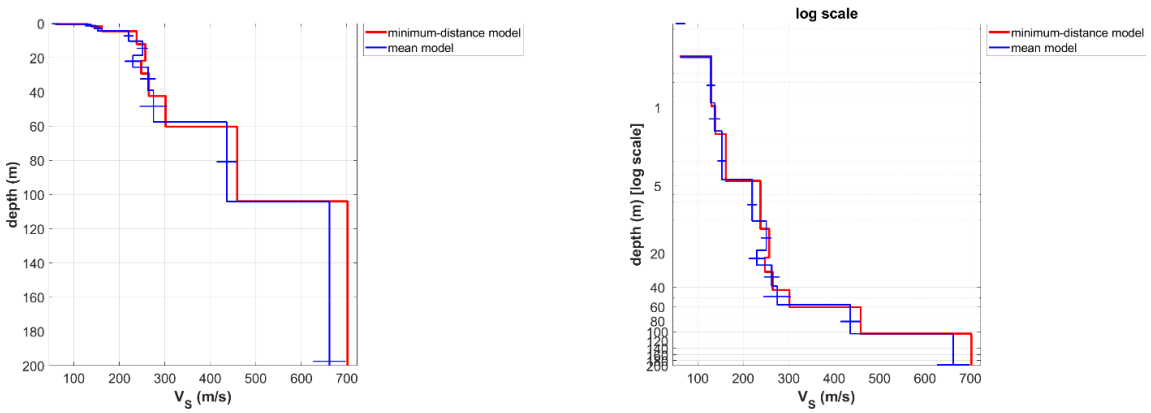
FIELD DATA: Z and R active seismic traces and HVSR curve



MAIN RESULTS for the best (minimum distance) and mean models

HoliSurface®



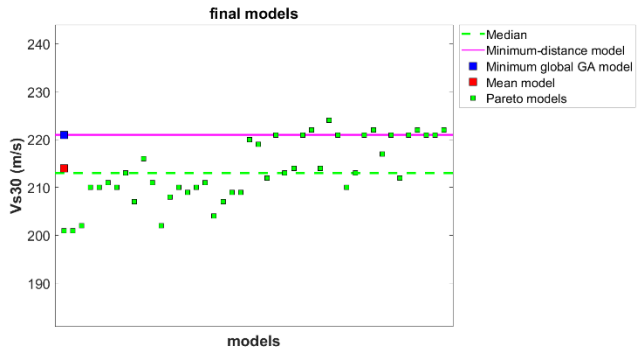


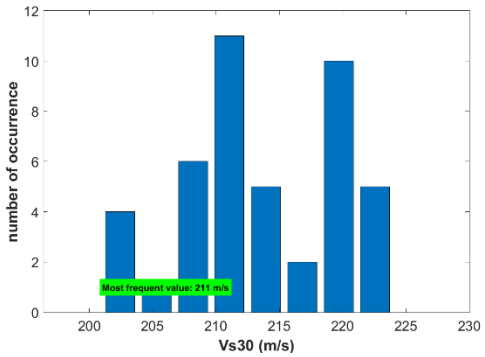
Minimum-distance (from the utopia point) model

Vs30 and VsE of the minimum-distance model (m/s): 221, 221
Shear-wave velocities (m/s): 60, 130, 139, 162, 238, 257, 248, 265, 302, 459, 702, 1142
Thicknesses (m): 0.4, 0.6, 0.8, 2.8, 7.6, 9.8, 7.3, 13.3, 17.9, 43.7, 200.4
Seismic/Dynamic Shear modulus (MPa) (approximate values): 5 29 34 47 107 126 117 134 178 435 1074 3016

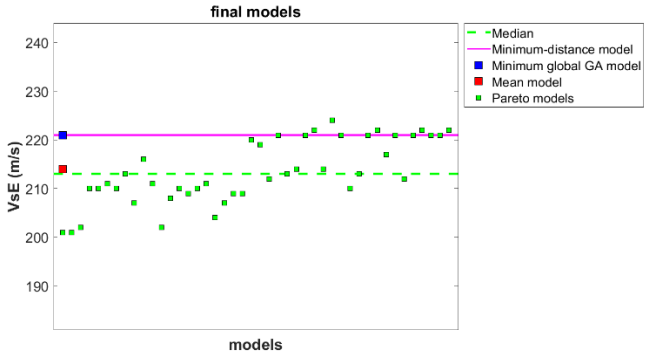
Mean model

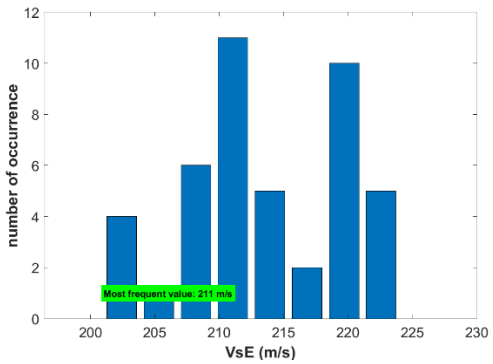
Vs30 and VsE of the mean model (m/s): 214, 214
Shear-wave velocities (m/s): 62, 129, 137, 153, 220, 251, 230, 263, 275, 436, 662, 1074
Thicknesses (m): 0.4, 0.6, 0.7, 2.8, 5.9, 8.4, 6.8, 13.7, 18.4, 46.5, 186.8
Seismic/Dynamic Shear modulus (MPa) (approximate values): 5850 28621 32574 41317 90210 119658 99217 132258 145421 389553 947921 2646359





Statistical assessment of the Vs30 and equivalent Vs (VsE) values for all the best (Pareto) models



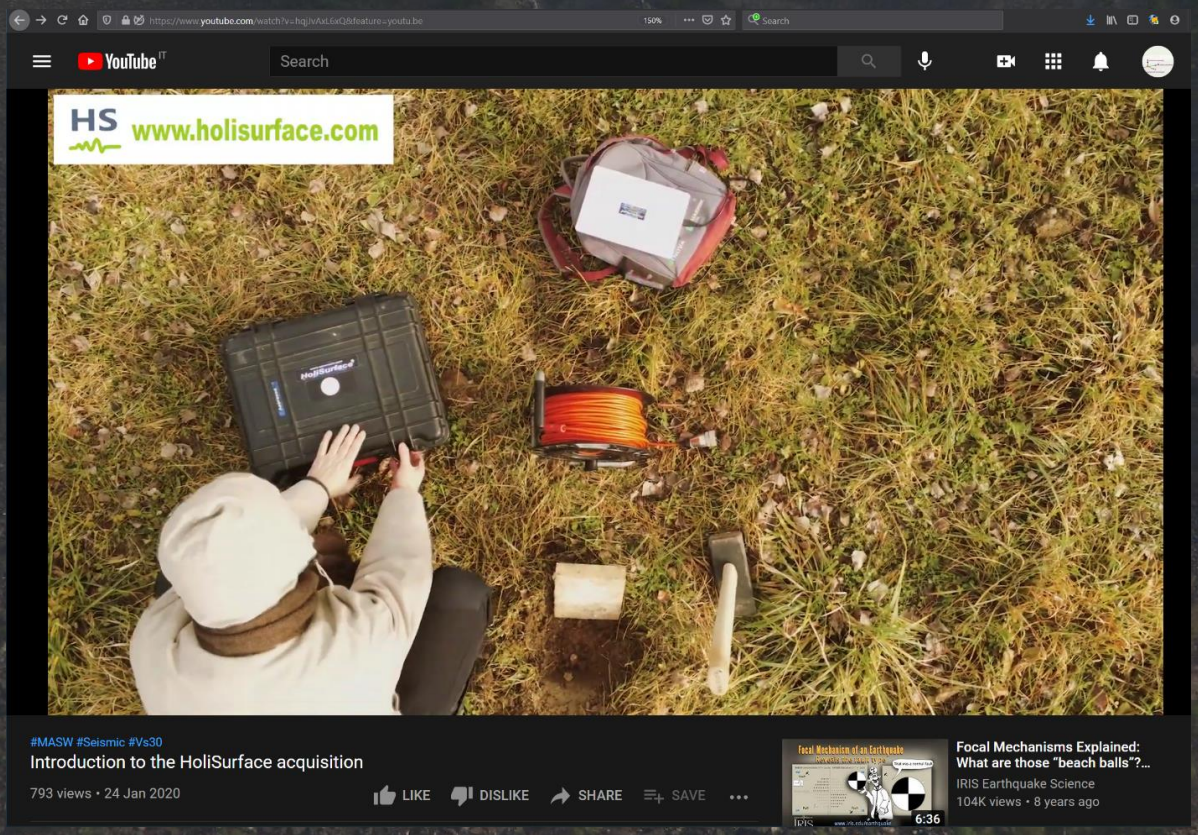


Minimum Vs30 (m/s): 201; Maximum Vs30 (m/s): 224
Minimum VsE (m/s): 201; Maximum VsE (m/s): 224

How does the HS acquisition work?

Please, have a look at the following video introduction:

https://youtu.be/hqjJvAxL6xQ



References

Multiple-peak HVSR curves: Management and statistical assessment (Dal Moro G., Panza G.F., 2022), Engineering Geology - https://doi.org/10.1016/j.enggeo.2021.106500

On the efficient acquisition and holistic analysis of Rayleigh waves: Technical aspects and two comparative case studies (Dal Moro G., Al-Arifi N., Moustafa S., 2019). Soil Dynamics and Earthquake Engineering, 125. On-line: https://www.sciencedirect.com/science/article/pii/S0267726118310613

Effective Active and Passive Seismics for the Characterization of Urban and Remote Areas: Four Channels for Seven Objective Functions (Dal Moro G., 2019). Pure and Applied Geophysics, 176, 1445-1465. Available on-line: https://rdcu.be/bbT04

Improved Holistic Analysis of Rayleigh Waves for Single- and Multi-Offset Data: Joint Inversion of Rayleigh-wave Particle Motion and Vertical- and Radial-Component Velocity Spectra (Dal Moro G., Al-Arifi N., Moustafa S.R., 2017), Pure and Applied Geophysics, on-line: https://link.springer.com/content/pdf/10.1007%2Fs00024-017-1694-8.pdf

Single- and multi-component inversion of surface waves acquired by a single 3-component geophone: an illustrative case study (Dal Moro G. and Puzzilli L.M.), Acta Geodyn. Geomater., 14, 4 (188), 431-444, online: https://www.irsm.cas.cz/materialy/acta_content/2017_doi/DalMoro_AGG_2017_0024.pdf

Analysis of Rayleigh-Wave Particle Motion from Active Seismics (Dal Moro G., Al-Arifi N., Moustafa S.R., 2017) Bulletin of the Seismological Society of America (BSSA), 107, 51-62

Shear-wave velocity profiling according to three alternative approaches: a comparative case study (Dal Moro G., Keller L., Al-Arifi N., Moustafa S.R., 2016), Journal of Applied Geophysics, 134, 112-124

Four Geophones for seven possible objective functions: active and passive seismics for tricky areas (Dal Moro G.) Invited presentation and Extended Abstract for the Urban Geophysics workshop of the 22nd EAGE Near Surface Geoscience conference (4-8 September 2016 - Barcelona, Spain)

Less is more: from van der Rohe to the 4-channel system for the efficient and holistic acquisition and analysis of surface waves. An urban case study. (Dal Moro G., Moustafa S.R., Al-Arifi N., 2015). Proceedings of the GNGTS (Gruppo Nazionale Geofisica della Terra Solida - ogs.trieste.it) congress (17-19 November 2015 - Trieste, Italy)

Geophysikalische In-situ-Bestimmung der Eingangsparameter in die seismischen Standortanalysen am Beispiel des Ambassador House Opfikon (Keller L., Weber T., Dal Moro G., 2015). Proceedings of the 14th D-A-CH conference of the Swiss Society for Earthquake Engineering and Structural Dynamics, Zurich, August 21-21, SIA D0255, ISBN 978-3-03732-060-0

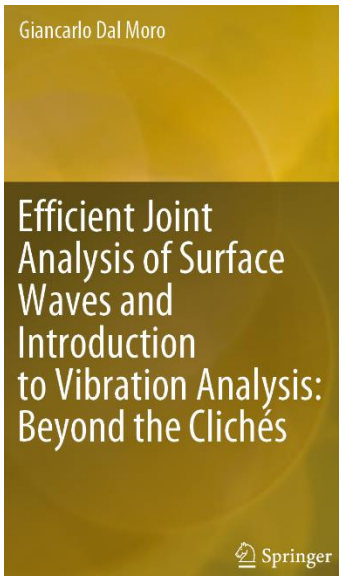
A Comprehensive Seismic Characterization via Multi-Component Analysis of Active and Passive Data (Dal Moro G., Keller L., Poggi V., 2015), First Break, 33, 45-53

Efficient acquisition and holistic analysis of Rayleigh waves (Dal Moro G., Moustafa S.R., Al-Arifi N.), Proceedings of the Near-Surface EAGE 2015 congress (Turin - Italy)

Joint Inversion of Rayleigh-Wave Dispersion and HVSR of Lunar Seismic Data from the Apollo 14 and 16 sites (Dal Moro G., 2015), ICARUS, 254, 338-349

Unconventional Optimized Surface Wave Acquisition and Analysis: Comparative Tests in a Perilagoon Area (Dal Moro G., Ponta R., Mauro R., 2015), Appl. Geophysics, 114, 158-167

Surface Wave Analysis for Near Surface Applications (Dal Moro G., 2014), Elsevier, ISBN 978-0-12-800770-9, 252pp (theory, field practice and advanced joint analysis) [see in particular paragraphs 2.2, 7.2 and case studies #2, 6, 8, 12 and 14]



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GHM method [building vibration modes]

Gaussian-filtered Horizontal Motion (GHM) plots of non-synchronous ambient microtremors for the identification of flexural and torsional modes of a building (Dal Moro G., Weber T., Keller L., 2018). Soil Dynamics and Earthquake Engineering, 112, 243-255

Influenza della modellazione degli edifici sulla determinazione della loro vulnerabilità sismica (Sancin L., Dal Moro G., Amadio C., Romanelli F., Vaccari F., 2018). Atti convegno GNGTS 2018 (gngts.ogs.trieste.it). Winner of the AGCL award 2018. Available from the following link: http://download.winmasw.com/documents/Sancin_2-2.pdf