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Sensitivity of ground motion parameters to local site effects for areas characterised by a thick buried low-velocity layer.

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It is well known that earthquake damage at a particular site depends on the source, the path that the waves travel through and the local geology. The latter is capable of amplifying and changing the frequency content of the incoming seismic waves. In regions of sparse or no strong ground motion records, like Malta (Central Mediterranean), ground motion simulations are used to obtain parameters for purposes of seismic design and analysis.
As an input to ground motion simulations, amplification functions related to the shallow subsurface are required. Shear-wave velocity profiles of several sites on the Maltese islands were obtained using the Horizontal-to-Vertical Spectral Ratio (H/V), the Extended Spatial Auto-Correlation (ESAC) technique and the Genetic Algorithm. The sites chosen were all characterised by a layer of Blue Clay, which can be up to 75 m thick, underlying the Upper Coralline Limestone, a fossiliferous coarse grained limestone. This situation gives rise to a velocity inversion. Available borehole data generally extends down till the top of the Blue Clay layer therefore the only way to check the validity of the modelled shear-wave velocity profile is through the thickness of the topmost layer.
Surface wave methods are characterised by uncertainties related to the measurements and the model used for interpretation. Moreover the inversion procedure is also highly non-unique. Such uncertainties are not commonly included in site response analysis. Yet, the propagation of uncertainties from the extracted dispersion curves to inversion solutions can lead to significant differences in the simulations (Boaga et al., 2011). In this study, a series of sensitivity analyses will be presented with the aim of better identifying those stratigraphic properties which can perturb the ground motion simulation results.
The stochastic one-dimensional site response analysis algorithm, Extended Source Simulation (EXSIM; Motazedian and Atkinson, 2005), was used to perform these analyses. The amplification functions were extracted using the programme SITE_AMP (Boore, 2003), which computes amplifications based on the square root of the effective seismic impedance. Sensitivity indices were obtained by changing two parameters (thickness and shear-wave velocity) of the different layers while keeping the others constant. Additional analyses were carried out by producing various profiles within specified boundaries which are able to fit the experimental data.

The analyses also show the important role that the shear-wave velocity profiles play in ground motion simulations. The results obtained highlight the importance of the correct knowledge of both the properties of the Upper Coralline Limestone and the Blue Clay, especially the Blue Clay thickness.