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Shear wave velocity inversion and its influence on seismic site response: case studies from Malta and Catania (Italy)

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The aim of this work is to study some particular geological sequences on the Maltese islands and in the city of Catania (Southern Italy). Geologically the two sites are quite different but several measurement points in both localities are characterised by sequences that represent a significant shear wave velocity inversion. The Maltese islands in the Central Mediterranean are composed of a simple 4-layer sedimentary sequence of Oligocene–Miocene limestones and clays. In particular, limestones overlying a clayey formation represent the shallower lithotypes that characterize the surficial geology in a large portion of the Maltese archipelago. On the contrary, the present geologic features of the Catania area are the result of tectonic uplift, sea level changes and lava flows originating from Etna eruptions. The area shows complex features with lateral heterogeneities at a local scale, due to the presence of volcanic and sedimentary units. In this study we make use of ambient noise recordings as well as moderate magnitude earthquakes in order to study the role of local geology on the site response in Catania. The recorded data were processed through standard and horizontal-to-vertical spectral ratios. Results of ambient noise and earthquake analysis, although showing significant differences in amplitude, are comparable in frequency. On the lava flows spectral ratios, significant amplification of the vertical component, that appear related to velocity inversion, were observed. Our findings appear linked to the complex wave-field generated by the lithologic heterogeneities existing in the area which seem to be related to alternating outcropping sediments and basaltic lavas. On the Maltese islands the main aim of this study was to identify any differences in site response, both in frequency and amplification, observed on different outcrops. All the investigated sites exhibit a clear and consistent peak in the frequency range of 1 Hz to 2 Hz. This is tentatively attributed to the presence of the buried clay formation layer everywhere below a variable thickness layer of limestone formation. The site effect induced by the clay layer has implications for the assessment of seismic risk, as well as for the validity of using Vs30 as a proxy for site class and site amplification.