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Passive seismic survey across the fault-zone of Introdacqua, central Italy: the subsurface geological structure role on the site amplification pattern

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In this work we perform a detailed passive seismic survey in proximity of a shear zone in the Introdacqua area, central Italy, around the permanent seismic station IV.INTR of the Italian seismic network RSN. This station is located on a prominent ridge (width of about 200 m, relative height of about 240 m), and is affected by a clear directional amplification between 1 and 3 Hz, with maximum amplification along N160° azimuth, as shown by HVSRs calculated using both seismic events and ambient noise recordings (CRISP database, www.crisp.ingv.it). This effect was confirmed by 11 ambient noise measurements performed nearby station IV.INTR in the framework of an agreement with the Italian Civil Protection. Since the maximum amplification occurs parallel to the topography elongation, it is not explainable through the topo-resonant model (e.g. Géli et al. 1988).

In this work, to better investigate the anomalous seismic response, as well as the areal extension of the directional effect, we implement an array of further 32 ambient noise measurement points, including a larger area around the topography. We find that the directional effect along N160° azimuth is gathered only at measurement sites close to IV.INTR, disappearing when increasing distances (over 300 m). A detailed structural geological survey suggests the presence of intensely fractured rocks produced by a fault located close to station IV.INTR, fractures strike being concentrated around N70°-80° azimuth, transversally to the directional effect. This is in agreement with several literature papers suggesting that across fault zones directional amplification is transversal to the prevailing fracture strike (e.g. Pischiutta et al., 2023, and references therein).

The Introdacqua study case suggests that anomalous amplification patterns can be found on topography as an effect of the subsurface geological structure, rather than being produced by the sole convex shape. Since topographic irregularities and rock fractures often coexist in tectonically active zones, this is a key point to interpret amplification at sites with pronounced topography. For this reason, Introdacqua was chosen as a test-site in the of the ongoing INGV-GEMME international project, whose aim is the study of the seismic site response in complex 3D geological and

morphological settings, and the deep investigation of the wave propagation by using 3D numerical modeling, to provide guidelines for future site characterization.