Contribution ID: **25** Type: **Talk**

Array analyses of the seismic noise wavefield at the possible vertices of the Einstein Telescope in Sardinia (Italy)

Monday, 8 November 2021 12:00 (30 minutes)

The region surrounding the dismissed mine of Sos Enattos (Sardinia, Italy) is the Italian candidate site for hosting Einstein Telescope (ET), the next-generation gravitational wave (GW) detector. The site that will host ET must fulfill stringent requirements on seismic disturbances, particularly in the bandwidth 1-10 Hz, where the seismic noise is expected to be dominated by sources of anthropogenic origin. Here, we describe the field surveys conducted over the past year, with the specific goal of characterizing the noise wavefield at three specific locations within the area of interest. Data have been gathered using small-aperture (150-300m) seismic arrays instrumented with low-noise broad-band sensors. The first array, deployed in proximity to the Sos Enattos mine, was composed of 15 stations which operated for a 15-day-long period. The other two arrays were composed of up to 21 sensors, and were deployed in proximity of two boreholes specifically drilled for sampling the seismic wavefield at depth, and for deriving accurate 1-D velocity profiles through downhole seismic probing (see respectively the contributions by L. Naticchioni and F. Villani, this workshop). The performances of the different arrays are analysed in terms of (a) spatial coherence, (b) response functions to vertically-incident plane waves at different target frequencies, and (c) site response, evaluated through Horizontal-to-Vertical Spectral Ratios (HVSR). At all the sites, day-to-night spectral ratios indicate that anthropogenic sources are mostly associated with a wide spectral lobe spanning the 2-20 Hz frequency band. At the Sos Enattos site, superimposed to that lobe are narrow spectral peaks located within the 2-8 Hz frequency range. Results from slowness analyses indicate that those peaks are likely related to vehicle traffic along the main road running east of the mine. At the same site, the dispersive properties of surface waves are evaluated from the recordings of a mine blast, and then inverted for a 1-D shear-wave velocity (Vs) profile. Results indicate Vs spanning the 1800-2000 m/s and 2500-2700] m/s intervals at the surface and at ~200 m depth, respectively. Analysis of the noise wavefield at the other two sites yield similar results: anthropogenic sources are transient in nature, and mostly associated with the (sporadic) vehicle traffic. Rayleigh-wave phase velocities derived from the SPatial AutoCorrelation method are in the range 2500-3200 m/s over the 5-10 Hz frequency interval, consistent with the high velocities derived from refraction tomography. Overall, the data gathering has been challenged by the very low noise amplitudes at the sites, often below the sensitivity of the instruments.

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Session Classification: Sardinia Geology, Long and Short term measurements