INTRINSIC AND SCATTERING SEISMIC ATTENUATION AT MT. ETNA AND AEOLIAN ISLANDS (ITALY) FROM THE MULTIPLE LAPSE TIME WINDOW ANALYSIS (MLTWA)

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Volcanoes are zones with high heterogeneities, identified as faults, crack dykes and magma reservoirs. Heterogeneities produce a phenomenon called scattering, which describes the energy lost by the primary wave and converted in secondary waves. Another cause of seismic waves attenuation is intrinsic absorption which transforms elastic energy into heat; quantification of both effects is crucial for understanding attenuation mechanisms and their separate estimation improves the general interpretation of the structure of volcanic regions. However, separation of both parameters is not always possible, while total attenuation (the sum of scattering and intrinsic) images are easier to obtain.

For Mt. Etna, previous estimates of both intrinsic and scattering attenuation parameters have been already calculated (i.e. Del Pezzo *et al*., 2015 and references therein) whereas, there are still no studies on attenuation of seismic waves in the Aeolian Islands region. The studies so far carried out suffer from a lack of homogeneity among approaches used, datasets and instrumental characteristics. The present availability of a high quality local earthquakes dataset, recorded in both volcanic areas by a dense and well-designed seismic network, installed starting from 2006, prompted us to re-evaluate the crustal attenuation characteristics of the regions.

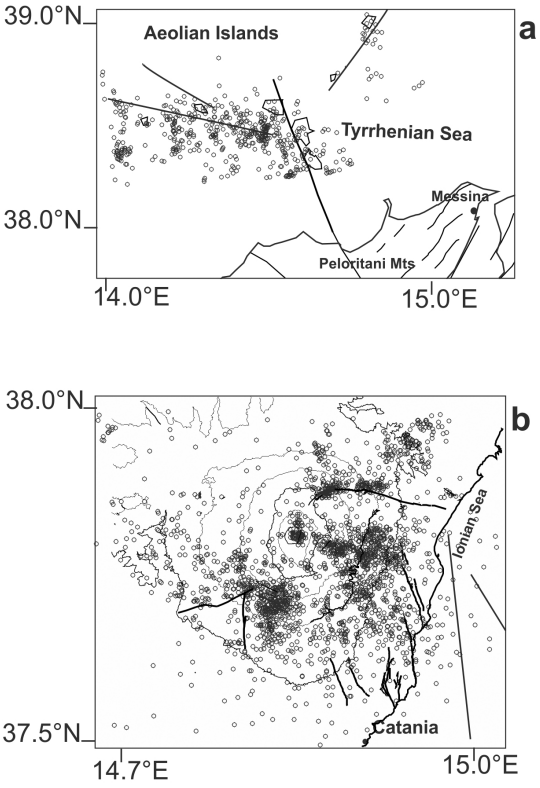

Fig. 1 - Structural map of Aeolian Island (a) and Mt. Etna (b); earthquakes selected for the present study are indicated with empty circles.

Quality factors for shear waves scattering attenuation, Q_s^{-1}, and intrinsic absorption, Q_i^{-1}, were measured by applying Multiple Lapse Time Window Analysis (MLTWA) to about 5,000 local earthquakes with magnitude 1.5≤Ml≤4.8 occurred in the period 2006-2017 (Fig.1).

MLTWA provides information on the seismic shear waves energy decay with distance and lapse time, considering estimates of the wave energy in multiple consecutive time windows (along the seismogram) as a function of the hypocentral distance. B_0, the seismic Albedo, and Le, the Extinction Length, which are related to Q_s^{-1} and Q_i^{-1}, were calculated in the frequency bands centered at 1.5, 3, 6, and 12 Hz.

We observe that at low frequency, scattering attenuation dominates over intrinsic absorption in the total attenuation of seismic energy within Mt. Etna volcanic edifice and at Aeolian Islands (Fig. 2). Moreover, the heterogeneities at the scale length corresponding to frequencies lower than 6 Hz have an

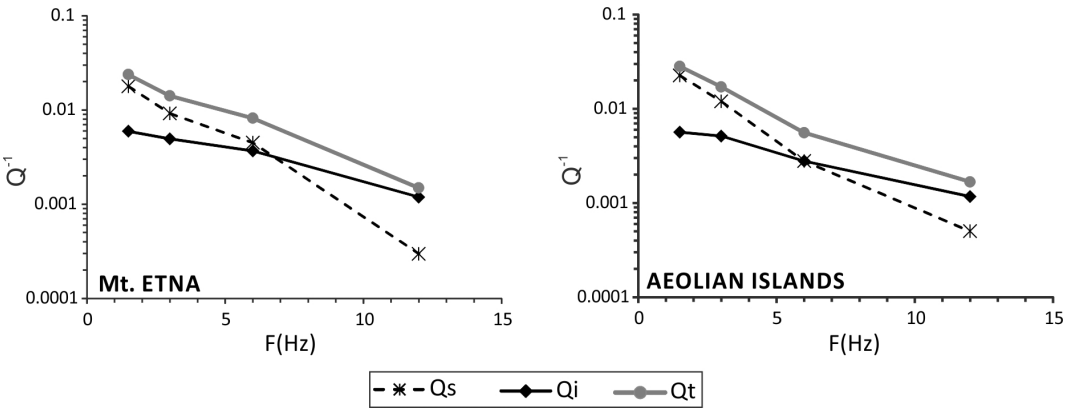

Fig. 2 - Pattern of Qi-1, Qs-1 and Qt-1 vs. frequency for each study area.

important role in determining attenuation of seismic waves in both areas. At higher frequency, intrinsic attenuation prevails over scattering.

The average Q_i, Q_s and Q_T show a strong frequency dependence, with the coefficient n ranging from ca. 0.7 to 1.9. The frequency dependence of Q_s is stronger than that of Q_i in both regions and, according to various seismologists, it can be also considered as an indirect indicator of macroscale Earth heterogeneity (Leary, 1995), being it observed when the heterogeneities responsible for scattering are of sizes comparable to the lowest frequency analysed (e.g. Mayeda *et al*., 1992; Canas *et al*., 1998; Tuvè *et al*., 2006; Giampiccolo *et al*., 2006; Mukhopadhyaya *et al*., 2010).

Similar results have been obtained in other volcanoes, such as Mt. Merapi (Wegler and Lur, 2001) and Mt. Vesuvius (Bianco *et al*., 1999; Del Pezzo *et al*., 2016).

Our findings match well with the data obtained by means of seismic tomography and confirm that both Mt. Etna and Aeolian Islands are characterized by pronounced heterogeneity, i.e. strong velocity contrasts which are able to produce high scattering of shear waves.

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