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Earth –Moon –Mars crustal attenuation properties comparison

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Following its deployement at the surface of Mars, the SEIS seismometer of the NASA-InSight mission recorded tens of high-frequency Martian seismic events (> 1Hz) which we analyzed to characterize the attenuation properties of the Martian lithosphere from an Earth-Moon-Mars comparison perspective. The Martian waveforms are generally depolarized and show P and S arrivals with a gradual beginning, a broad maximum and a very long coda decay. These characteristics are highly reminiscent of the seismic wavefield in the terrestrial oceanic lithosphere at high frequency (Po and So above 2Hz), where the stratification of the absorption was used to estimate the Asthenosphere-lithosphere boundary (Takeuchi et al., 2017). To constrain the attenuation properties on Mars, we modeled the energy envelopes of the Martian events using a multiple-scattering approach in which we considered a stratification of the velocity and the attenuation properties in the medium. We observed that a simple model composed of a highly scattered crust and a weakly inhomogeneous mantle is sufficient to explain Martian events. We found that the Martian crustal diffusivity (10^{-12} km^2/s) is similar to the estimation obtained in the lithosphere of the Atlantic Ocean (15–60 km^2/s, Hannemann et al. 2022), but higher than the Lunar crust value (2 km^2/s). The absorption attenuation results indicate that the Martian crust is globally dry $\approx 10^{-4}$ compared to the terrestrial crust $\approx 10^{-3}$. Our results suggest that the basaltic nature and the heterogeneities of the crust are the main source of the scattering in the Martian lithosphere unlike the extend of the fractures with depth observed on the Moon.

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