Comparison of attenuation and scattering of Lunar and Martian structures

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A limited number of seismic investigations have been performed on other planets and satellites. The only extraterrestrial seismic data available were those collected by the Apollo missions on the Moon and the InSight mission (Interior exploration using Seismic Investigations, Geodesy and Heat Transport) on Mars. Lunar and Martian seismograms appear to be extremely different from terrestrial ones. The seismic signals are characterized by a gradual beginning, a broad maximum and a very long decay lasting up to 20 minutes and 1 hour for Mars and the Moon respectively, compared to a few minutes on Earth. This unexpected long coda results from the low attenuation and intense scattering of highly porous and fractured regolith and megaregolith layers. This intense multiple scattering generates long ringing coda waves and makes difficult to identify direct arrivals of seismic waves such as P and S-waves. However, radiative transfer is well suited to model this process, and it can be approximated by the diffusion equation. Based on the envelope records of Mars and Moon events, the coda has been quantified by two parameters: the time arrival of the maximum of energy (t_{max}) and the decay rate of the energy, named the coda quality factor (Q_c). t_{max} quantifies the diffusion and Q_c is sensitive to attenuation. The data analysis of event 128a revealed that t_{max} and Q_c of Mars differ from those of Moon or Earth. In fact, Q_c of Mars is significantly smaller than that of the Moon and closer to the value of the Earth. This first result may imply that Mars contains more volatiles than the Moon and less than the Earth. To confirm this hypothesis, we need to separate the attenuation from the scattering by using more data which is in process.

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