



ID de Contribution: 13

Type: Poster

Probing Small-scale Lunar Mantle Heterogeneities using High-frequency P-wave Scattering from Shallow Moonquakes

lundi 30 mars 2026 13:40 (20 minutes)

Small-scale heterogeneities in the lunar mantle can be detected through high-frequency scattering of seismic waves [1], but their characterization is limited by uncertainties in phase picking. In this study, we present a systematic analysis of P-wave arrival times from shallow moonquakes, using a refined picking strategy based on a detailed characterization of pre-event noise and Signal-to-Noise Ratio (SNR). These improved P-arrival time estimates allow a robust analysis of waveform distortions at high frequencies as a function of epicentral distance. We quantify the amplitude and frequency dependence of P-wave scattering and use these observations to constrain the scale and distribution of small-scale heterogeneities in the deep lunar mantle. Our results will provide new seismic constraints on the thermal state and structural state of the Moon's interior.

[1] Charalambous et al. (2025), Science, doi : 10.1126/science.adk4292

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Classification de Session: Poster

Classification de thématique: Earth and Environment