

Detection of new moonquakes: Coherence analysis of Apollo short-period seismometer data

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The lunar internal structure is one of the pivotal factors in revealing the formation of the Earth-Moon system as well as the subsequent evolution processes. For example, the bulk chemical composition and the internal physical state can give us strong constraints on the initial thermal environment in its formation process.

To investigate the interior of planets, seismic observation is a powerful tool as demonstrated on Earth. In the Apollo missions, two types of seismometers were installed on the near side of the Moon. One is a long-period (LP) seismometer with three axial components (XYZ), which has high sensitivity below 1.2 Hz. The other is a short-period (SP) seismometer with one vertical component with higher sensitivity at above 1.2 Hz than the LP sensor (e.g., Nunn et al., 2020 for the latest review).

So far, about 13,000 seismic events were cataloged by Nakamura et al. (1981). In their catalog, 60% of events are classified as deep moonquakes or impact-induced events, which excite the energy around 1.0–2.0 Hz, whereas there are a smaller number of high-frequency events such as shallow moonquakes (28 events). This is because the catalog of Nakamura et al. (1981) mostly builds on the LP data, which are more sensitive to low-frequency events. In other words, it is expected that there are potential seismic events only observable with the SP sensor. Since increasing the number of events contributes to investigating the internal structure as well as evaluating the seismic activity of the Moon, this topic is important to deepen our understanding of the lunar environment.

In fact, for the purpose of detecting new moonquakes, Bulow et al. (2005) analyzed the LP data with a cross-correlation approach and succeeded in discovering 123 new deep moonquakes. More recently, Knapmeyer-Endrun et al. (2015) applied Hidden Markov Model to the Apollo 16 LP and SP data and found 200 novel events not listed in the previous moonquake catalog. Following these works, this study conducted a thorough search of new high-frequency events over the full observation period for Apollo 14, 15, and 16 seismic data by evaluating the similarity of frequency contents between reference moonquakes and continuous time series data (coherence analysis).

In the presentation, I will show newly detected high-frequency events and explain their characteristics.

References

- Nakamura et al. (1981), *UTIG Technical Report*, 18.
- Nunn et al. (2020), *Space Sci Rev* 216, 89.
- Bulow et al. (2005), *J. Geophys. Res.*, 110, E10003.
- Knapmeyer-Endrun et al. (2015), *J. Geophys. Res. Planets*, 120, 1620–1645.

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