Seismic tomography of lunar crust and mantle:
Insight into PKT and deep moonquakes

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We determine 3-D P and S wave velocity structure of the lunar crust and mantle down to 1300 km depth by applying a seismic tomography method (Zhao, 2004) to P and S wave arrival times of shallow and deep moonquakes recorded by four Apollo seismic stations which were deployed on the lunar nearside during 1969 to 1977 (Zhao et al., 2008, 2012). Then we compared the lunar tomography with the distribution of Thorium abundance on the lunar surface. We found that the area with high-Th abundance in the Procellarum KREEP Terrane (PKT) exhibits distinct low S-wave velocity, and the low-velocity zone extends down to 300-400 km depth under PKT. This result suggests that the high abundance of radioactive heat-producing elements has resulted in high temperature in PKT, which was imaged clearly as low-velocity anomalies by seismic tomography. The thermal and compositional anomalies under PKT may extend from the surface down to 300-400 km depth in the lunar mantle, rather than just confined in the lunar crust.

Our lunar tomography results also show that most of the deep moonquakes are located in areas with average to higher velocity or at the boundary between high- and low-velocity zones, and few deep moonquakes occur in the low-velocity areas. This feature is very similar to the deep and shallow seismicity in the Earth, because many seismological and mineral-physics studies have shown that the distribution and generation of all types of earthquakes are affected or controlled by structural heterogeneities in the terrestrial crust and upper mantle (e.g., Zhao, 2004; Zhao et al., 2011). The existence of deep moonquakes and significant seismic heterogeneities in the lunar mantle suggests that the
interior of the present Moon may be still thermally and dynamically active, though not so vigorous as in the Earth’s interior (Zhao et al., 2012).

References