Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PPS003-P03 Room: Convention Hall Time: May 24 17:15-18:45

Lunar interior structural heterogeneity and its relation to deep moonquakes and thorium abundance distribution

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Zhao et al. (2008) determined the first three-dimensional seismic velocity structure of the lunar interior down to 1000 km depth under the near-side of the Moon by applying seismic tomography to the moonquake arrival-time data recorded by the Apollo seismic network during 1969 to 1977. Their results show that structural heterogeneities may exist in the lunar crust and mantle, and there is a correlation between the distribution of deep moonquakes and velocity variations in the lunar lower mantle.
In this work we continue the work of Zhao et al. (2008) to determine P and S wave tomography down to 1400 km depth, because deep moonquakes occur down to 1419 km depth (Nakamura, 20 05). We applied the seismic tomography method of Zhao et al. (2008) to the Apollo arrival time data from shallow and deep moonquakes compiled by Lognonne et al. (2003) and Nakamura (200 5). The selected data set contains 221 P- and 381 S-wave arrival data.
Our results show that significant structural heterogeneities exist in the lunar interior, and more deep moonquakes are located in high S-wave velocity (Vs) areas or at the edges between the low and high Vs zones. We also attempted to compare Vs and thorium (Th) abundance distribution determined by Lawrence et al. (2000) and Jolliff et al. (2000). Our Vs images show a good correlation between the Th distribution. High-Th areas correspond to low-Vs zones, and low-Th areas correspond to high-Vs zones down to 200 km depth under the near-side of the Moon. High-Th areas may have high temperature, hence they exhibit low-Vs.

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