

Recovery of Deep Moonquake Focal Mechanisms

Weber, Renee C., NASA Marshall Space Flight Center, Huntsville

Knapmeyer, Martin, DLR Institute of Planetary Research, Berlin

Deep moonquakes are clustered not only in space but also in time: their recurrence times correspond to the durations of the anomalistic and draconic months, with some clusters preferring one of the two periods, while others are active with both periods. A key constraint for the understanding of the connection between the orbital motion of the Moon and its seismic activity is the focal mechanism: the orientation of the fault surface on which failure occurs during the quake.

Due to the small aperture of the Apollo seismic network and the strong scattering of seismic waves within the lunar crust, the evaluation of P wave first motions to constrain the strike and dip of the fault planes is not feasible. Instead we evaluate the amplitude ratios of P and S waves. Seismograms are rotated into the P-SV-SH coordinate frame and amplitudes are determined as averages over short time windows after the arrival to reduce the impact of the scattering coda, which is independent of the source orientation. We allow for reversals of the fault motion, as observed for some clusters in previous studies, by taking into account the absolute amplitude only, without sign. An empirical site correction factor is applied to correct for amplitude distortions in the crust. We construct ensembles of fault plane solutions using an exhaustive grid search by accepting all orientations that reproduce the measured amplitude ratios within the observed standard deviations. Since all events of a given cluster are supposed to share the same fault plane, the combination of the individual inversion results further constrains the orientation.

We evaluate 106 events from 25 different moonquake clusters. The most active cluster A001 contributes 37 events, while others contribute 1 to 9 events per cluster. Comparison of fault orientations with the variation of the tidal stress results in preferred orientations.