

## Supplementary Material:

# Interactions of multi-scale heterogeneity in the lithosphere: Australia

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## S1. Detection of lithospheric discontinuities

In the main paper we have presented results for the mid-lithospheric discontinuity in Central Australia exploiting stacked autocorrelograms of continuous records at a set of moderately closely spaced stations. The original picks were made visually, largely based on changes in the apparent frequency of the autocorrelogram traces. These picks can be corroborated by comparison with the variation of instantaneous frequency along the trace.

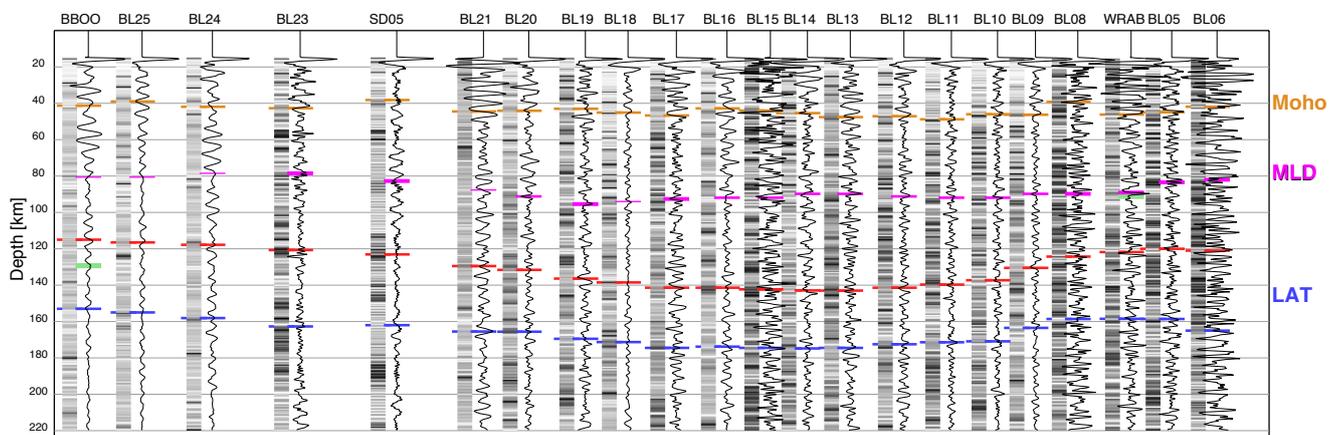


Figure S1: *P*-wave reflectivity estimates from stacked station autocorrelations for a profile of closely spaced seismic stations in central Australia projected onto the meridian 134°E. Each trace is accompanied by the envelope of instantaneous frequency, represented via grey tones, where a darker tone means higher frequency. As in Figure 9 of the main paper, the depth to the Moho and the shallow and deeper bound on the lithosphere-asthenosphere transition (LAT) are indicated. The estimates of the location of a mid-lithosphere discontinuity (MLD) are indicated and tie well to changes in the instantaneous frequency. Green markers indicate discontinuity estimates from *Sp* receiver functions (Ford et al., 2010).

We have used the three-point approximation of Barnes (1992) working with the analytic signal derived from the autocorrelogram trace. The envelope of the instantaneous frequency is displayed in Figure S1 alongside each trace in grey tone, with darker tones for higher frequency. Sharp reflection onsets appear in the instantaneous frequency as a sudden arrival of high-frequency (dark gray). Interference effects are more subtle, but are associated with a change in the character of the instantaneous frequency.

As can be seen in Figure S1, the marked estimates for the mid-lithospheric discontinuity in almost all cases are very close to a peak in instantaneous frequency. The discrepancy gives a measure of likely error in depth, which should be less than 2 km at almost all sites.

It is interesting to note that the Moho and the shallow and deep bounds on the lithosphere-asthenosphere transition (LAT), which are taken from external information, also often correspond to changes in instantaneous frequency.

## References

- Barnes, A.E. 1992. The calculation of instantaneous frequency and instantaneous bandwidth, *Geophysics*, 57, 1520–1524.
- Ford, H.A., Fischer, K.M., Abt, D.L., Rychert C.A., Elkins-Tanton, L.T., 2010. The lithosphere-asthenosphere boundary and cratonic lithospheric layering beneath Australia from Sp wave imaging, *Earth Planet. Sci. Lett.* 300, 299–310.