

Chapter 7

Conclusions and Further Work

7.0.4 Conclusions

A major achievement has been the first continent wide imaging of the crust based just on the cross-correlation of seismic noise between broadband stations, both portable and permanent. More than 1100 paths lie wholly within the Australian continent. The images therefore avoid the complications of surface wave tomography with regional earthquakes, or delay time tomography with distant events, where the outside structure may be mapped into the region of interest. The tomographic image from the ambient noise correlations from the inversion of the group velocities reveals the major tectonic blocks. In addition to this, the structure associated with Tasman Line at the midcrustal level is revealed, which suggests a complex structure rather than a simple boundary. The important findings are:

1. The Archaean Cratons in Western Australia give a distinct mark with fast group velocities.
2. The location of the major sedimentary basins are clearly mapped with the shorter period surface waves such as Amadeus and Officer Basins in central Australia and Fitzroy Trough at the edge of the Kimberley.
3. The transition of the structural block with large velocity contrast is accurately recovered as in the Kimberley Block.
4. The orientation of the anomalies in the transition from Precambrian to Phanerozoic Australia do not suggest a single well defined boundary as opposed to tomographic images for the mantle (150-200 km) from the surface wave tomography studies (Fishwick et al., 2005). The complex nature of the transition is supported by the receiver function results.
5. For longer period, some of the low velocity anomalies show strong correlation with the estimated crustal temperatures at depth, even though

the sediments do not extend to these depths. This suggests the significance of elevated crustal temperatures for producing slower seismic wave propagation.

The coda correlations of the teleseismic earthquakes show the potential of coda waves in imaging. The outcomes are

1. The plane wave approximation holds for the beginning P (and S) arrivals across the array, corresponding to the usual theoretical assumption.
2. The stochastic part shows arrivals with high velocity surface wave propagation in agreement with the known structure of the region.
3. The body wave component of the Green's function appears purely from the cross-correlations between the close stations with energetic excitation.

Thus it is demonstrated that it is possible to extract the surface wave and body wave components of the Green's function from the coda correlations of teleseismic earthquakes.

With spectral broadening applied to the ambient seismic noise, better estimates of the surface component of the Green's function between two stations can be recovered. The enhanced and broadened spectrum from the transfer function between stations allow us to recover the low frequency part of the propagation. The transfer function and cross-correlation estimates can be computed side by side with little extra computational cost to extract the maximum information from the noise.

It is shown that coherent signal related to the local structure can be extracted for the broadband stations located in the Australian continent by stacking seismic records. The frequency dependency and the spatial variance of the results are the supporting arguments for this conclusion. However, extensive synthetic testing is required for utilizing this new kind information efficiently.

7.0.5 Further Work

The accurate estimation of the Green's function of the Earth gained considerable importance with the recent advancements (Bostock, 2004; Campillo

& Paul, 2003; Shapiro & Campillo, 2004). Besides the traditional imaging techniques such as receiver function imaging, same datasets can be exploited in a way to recover a improved Green's function by using multiple components with coda wave interferometry type of studies. This is one of the major research goals that will be carried in the near future.

The exploitation of single station records gave promising results, which need to be continued with extensive testing for interpretation of the recovered signals.

The presented group wave tomography from the ambient noise cross-correlations was conducted only with the vertical components of the broadband stations in this study. In practice, with the three component broadband stations, nine component Green's tensor can be recovered between the two stations. A synthetic study which was conducted about recovery of multiple component Green's tensor for coda waves, was demonstrated by Paul et al. (2005).

A brief experiment for the data of TASMAL experiment was done with the cross-correlation of radial and transverse components, which gave some promising results, shown in figure 7.1. The cross-correlations of the radial-radial (R-R) and transverse-transverse (T-T) components show single sided Green's function estimates. The R-R signals is similar to the early estimated vertical-vertical component of the Green's function, shown for the same dataset in figure 4.9a. The T-T signals have high group velocities than the R-R signals with some late contamination of Rayleigh waves due to possible multiple scattering. Since Rayleigh wave excitation is dominant than the Love wave, we do not see much Love wave contribution in the R-R estimates. These extra components of the Green's function are useful to compare since they are derived from the same seismic records with similar noise excitation fields. One other approach can be to cross-correlate the horizontal components initially, and then rotate the estimates towards non great circle paths, e.g., N-S, E-W. With the extra components of the Green's tensor of the Earth, the imaging potential can be improved. This idea also coincides with the given first goal of the further work.

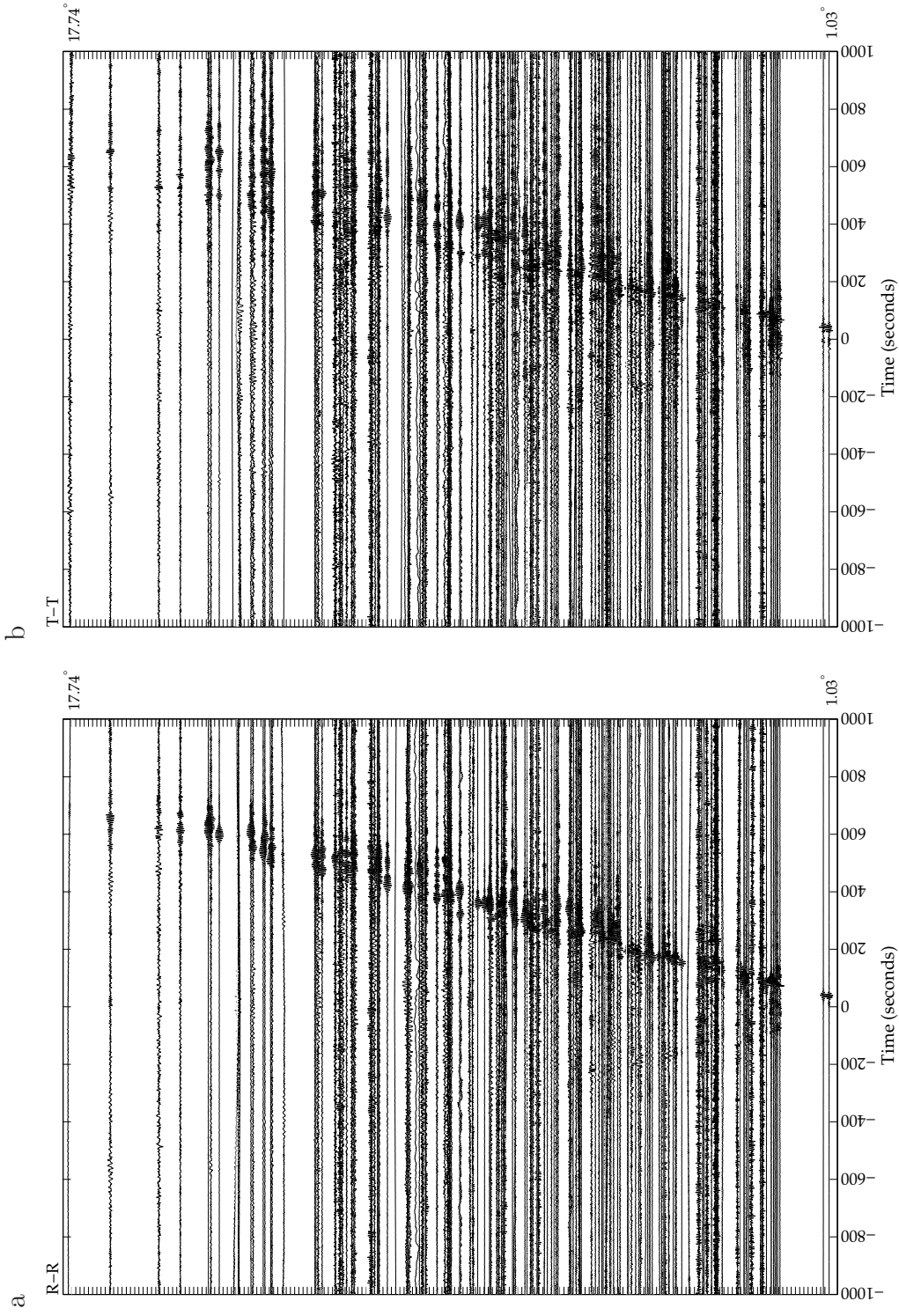


Figure 7.1: The cross-correlation of ambient noise recorded at the horizontal components of the TASMAL experiment stations. Rotation is done towards to the connecting plane between two stations. The waveforms are normalized to unity. a) Radial-Radial. b) Transverse-Transverse.

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