Seismic Receiver and Noise Correlation Based Studies in Australia

by

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Abstract

This thesis is directed at exploiting information in the coda of seismic phases and the ambient noise field to provide new constraints on the structure of the Australian Continent.

The exploitation of the immediate coda following the onset of P waves from a distant earthquake using radial receiver functions is now a well established method. The 40 sec interval following P contains reverberations and conversions, by deconvolving the radial component trace with the vertical components, the conversions are emphasized by canceling the part of the response that are common to both components. A member of different styles of such deconvolution, are investigated and a variant of the multitaper method is adopted for subsequent applications. The TASMAL experiment 2003-2005 spans the expected location of the transition between Precambrian and Phanerozoic Australia. The 20 portable broadband stations were exploited in receiver function studies to extract S wave crustal structure through the inversion of stacked receiver functions using the Neighbourhood Algorithm. There is no clear crustal transition associated with the presence of Tasman Line. The Precambrian Cratons tend to exhibit crustal thicknesses close to 40 km but such values are also found in some Phanerozoic sites.

The second part of the thesis is directed at the exploitation of ambient noise or seismic coda to gain information on the Green's function between seismic stations. The TASMAL experiment covered a significant fraction of the Australian continent with a simultaneous deployment of portable broadband stations. From these continuous records, it has proved possible to extract very clear Rayleigh wave signals for station separations up to 2000 km, and to demonstrate the frequency dependent variations in group velocity behaviour. The combination of the paths between the 20 stations localize such behaviour, but detailed images needed more data. The entire archive of portable broadband data recorded by RSES was mined, and combined with data from permanent stations to provide more than 1100 estimates of in-

terstation Green's functions within Australia. Group velocity analysis as function of frequency was followed by nonlinear tomography with the Fast Marching Method. The resulting images of group velocity patterns as a function frequency show pronounced regions of lowered group velocities, most of which match regions of thick sediment. The frequency dependence is not consistent with just sedimentary structure and low midcrustal velocities, most likely due to elevated temperatures, are also needed.

The surface wave portion of the interstation Green's function is the most energetic, and is normally all that seen in ambient noise studies. However, in the coda of events record at the broadband Warramunga seismic array in the Northern Territory, the P and S body wave components also emerge. The characteristics of these arrivals match those observed from nearby small earthquakes. The stacked cross-correlation is the normal approach to enhance Green's function information from ambient noise, but a broader spectral band width with the same phase response can be found by spectral division. It appears advantageous to compare both approaches and select the best result, since very little modifications to procedures are needed.

The properties of the ambient noise at a single station have been investigated in the logarithmic spectral domain and a station dependent signal can be extracted by stacking. The signal appears to be related to the local structure beneath the station, and when fully characterized may provide a new means of investigating structure.

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