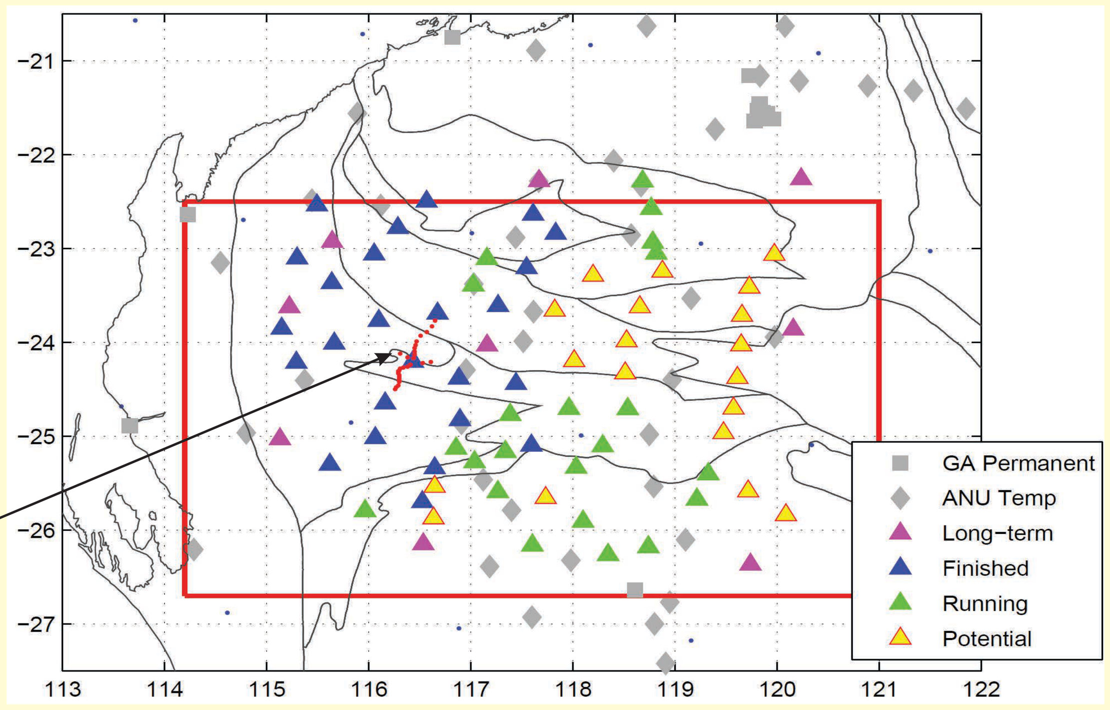
CAPRICORN OROGEN
PASSIVE SEISMIC ARRAY

The purpose of this deployment is to map/explore the lithospheric architecture of the Capricorn Orogen and the tectonic framework of its mineral systems.

An array of 36 broadband seismometers, moved over an area of 500 km by 500 km with roughly 40 km spacing (including stations from previous deployments) will complete a network of 76 sites over a period of 36 months. This should ensure enough data is collected for 3D structure imaging using body wave tomography, ambient noise surface wave tomography and P- and S-wave receiver function Common Conversion Point (CCP) stacking techniques. We aims for a 40 km lateral resolution at the surface which will degrade to about a 100 km resolution at the base of the cratonic lithosphere (200-250 km depth) due to the low frequency of the earthquake waves.

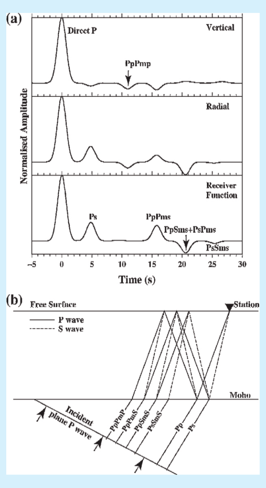
Another short term High-resolution Passive Source (HPS) array was deployed in the middle of the long term array. This focussed on the structure arose the Collier and Edmund Basins and Gascoyne Province.



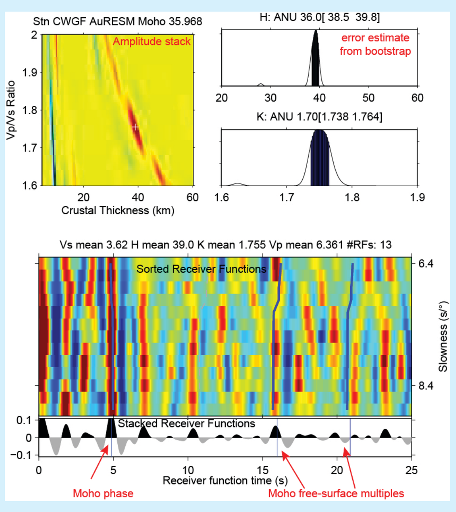
Hypotheses that will be tested
1) Distinct crustal blocks are seen within the Orogen
2) Distinct lithological differences are present in the upper crust and upper mantle
3) crustal and lithopsheric deformation along craton margins, in general, follows the wedge tectonics i.e the subduction of juvenile blocks under cratonic mantle with assiciated craton-ward dipping sutures (Snyder, 2002)

Bulk Crustal Properties

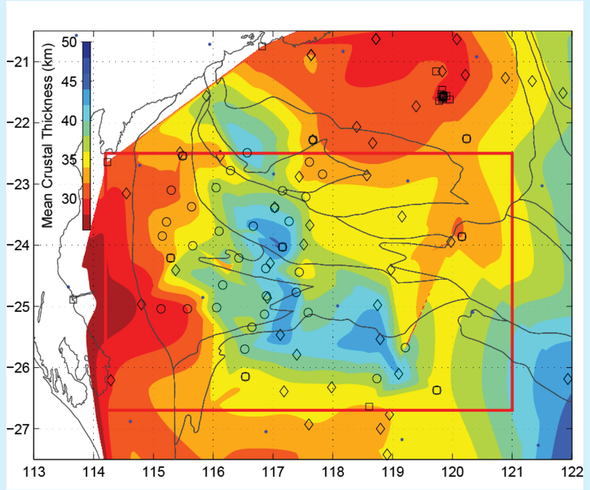
Preliminary results of the crustal structure in the Orogen are obtained from seismic receiver functions. A simple H-k stacking technique (Yuan, 2015) stacks available receiver functions for an optimum pair of bulk crustal thickness (H) and Vp/Vs ratio. The maps show bulk crustal thickness, Vp/Vs ratio (a proxy for composition) and crustal density anomalies from gravity inversions (Aitken et al, 2013). A thicker and denser crust with faster velocities is seen in the Capricorn Orogen compared to the cratons on either side. Compositionally the Orogen is complex which may indicate different terranes/deformation process during its amalgamation in the Proterozoic. The northern margin of the Yilgarn Craton shows anomalously thicker, denser and higher velocity crust at the same location as an abrupt change in crustal conductivities are observed in the MT study.



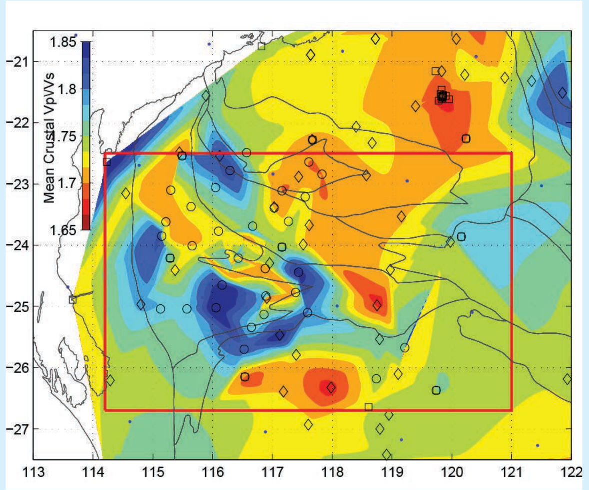
Incoming seismic phases and their normalised signal



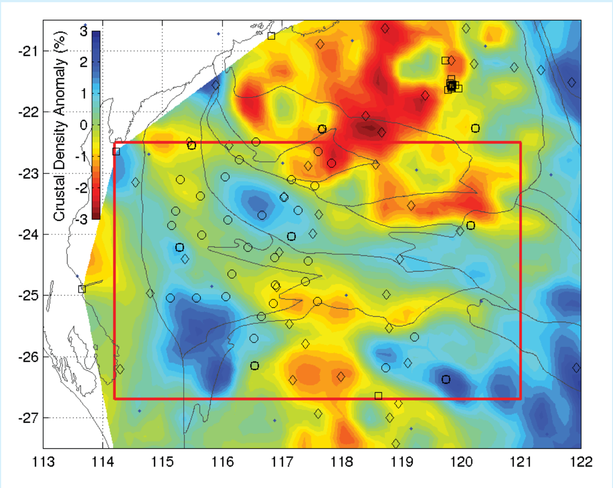
H-k processing



Bulk crustal thickness



Bulk Vp/Vs ratio

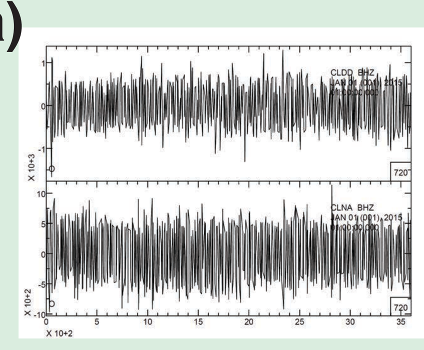


Crustal density anomaly

Ambient Noise Tomography

From ambient noise tomography we hope to obtain shear wave velocities in a 3D volume of the Orogenic crust. Waveforms for the same time period at station pairs are cross-correlated for all station pair combinations and then stacked to obtain the empirical surface wave travelling between them. Phase and group velocities are calculated for each station pair. Significant structural differences are evident in the shallow and mid-crust. The high velocity northern margin of the Yilgarn Craton is prominent as seen previously in the receiver functions and MT images.

a)



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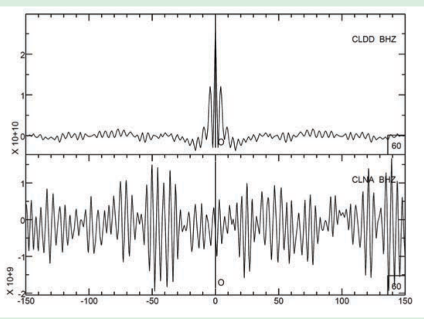

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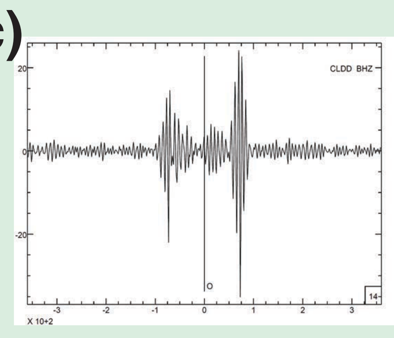

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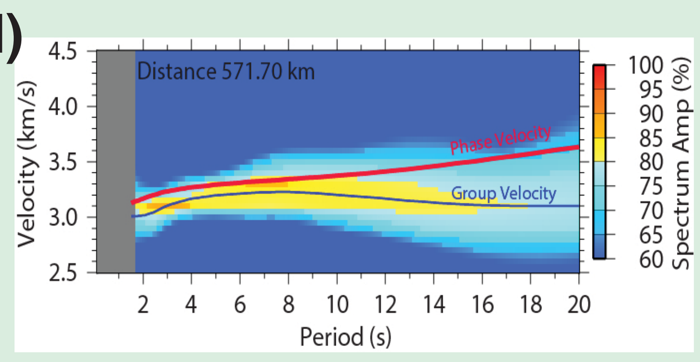

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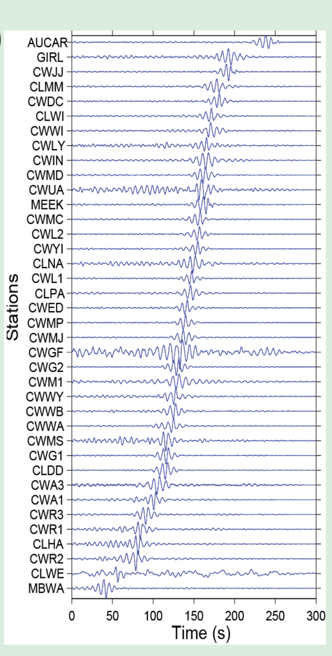

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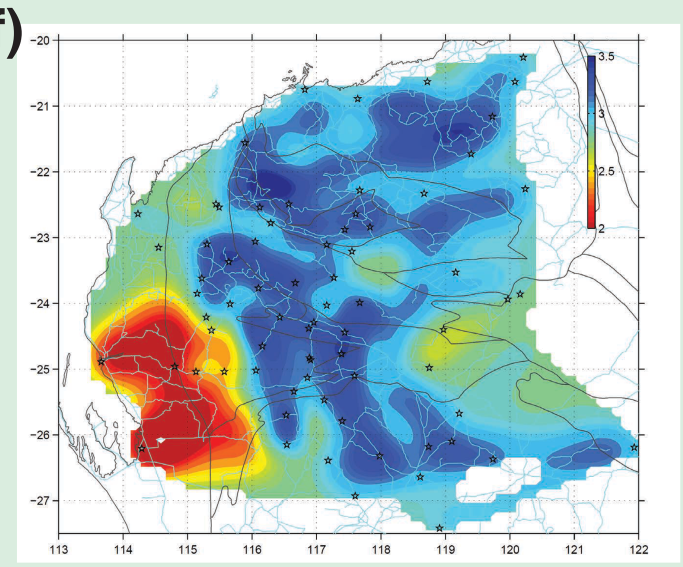
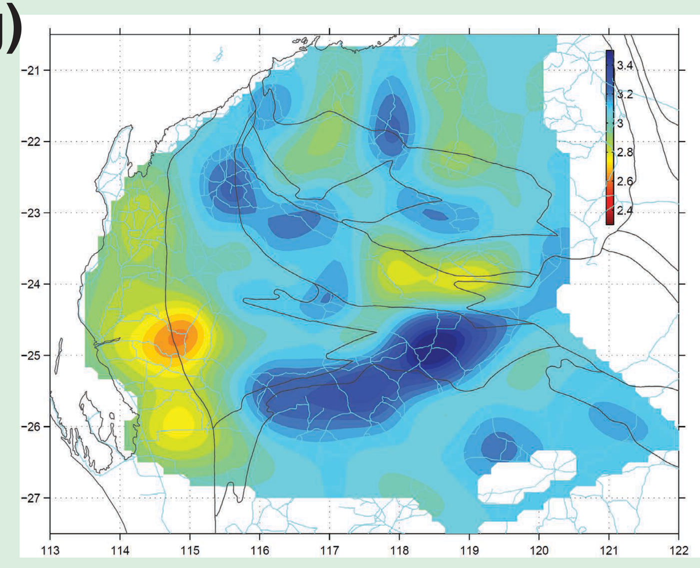


g)



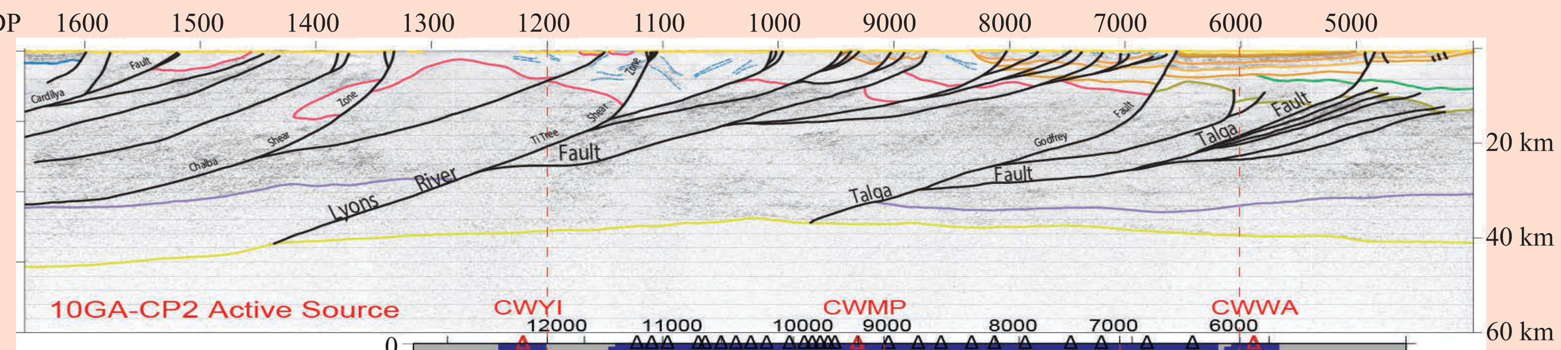
Ambient Noise Processing

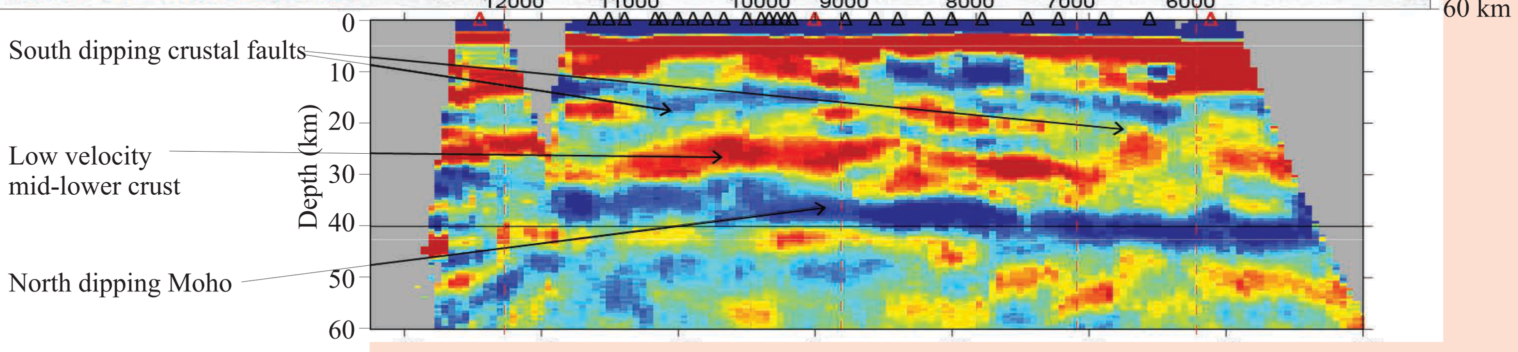
a) 10 min vertical component recordings at stations CLNA and CLDD
b) auto- and cross- correlation of a)
c) stack of over 6 months of cross-correlated waveforms
d) disperion measurements of a station pair
e) stacked correlations for all Capricorn station pairs sorted by inter-station distance
f) group velocity topographic results for the period 2.5 s (~3 km depth)
g) group velocity topographic results for the period 15 s (mid crust)

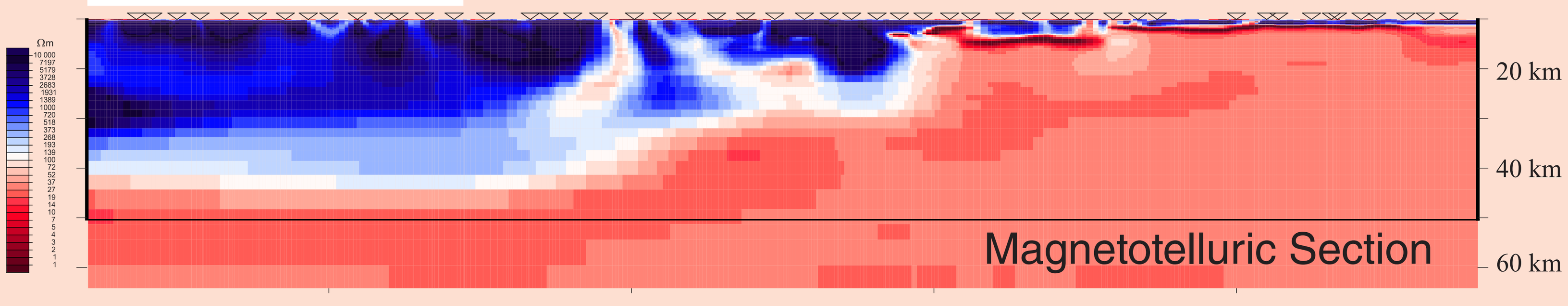
Common Conversion Point Stacking (CCP)

A receiver function CCP stack was applied to the high-resolution array to reveal crustal discontinuities. The results show good correlation with the deep seismic reflection profile shot along the same line and coincident magnetotelluric image.

The north dipping Moho and south dipping crustal faults (seen as truncated crustal regions) can be seen. A slow velocity mid-lower crust is inferred from the negative velocity gradients in the centre of the array consistent with the ambient noise observations and highly conductive mid crust as seen in the MT image.







South North

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