Imaging the Cratonistion of Western Australia using passive seismic methods.

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A network of 83 passive seismic stations were deployed across the Capricorn Orogen of Western Australia with the aim of imaging the major trans-lithospheric structures and crustal blocks that make up the West Australian Craton (WAC). The orogen records the assembly of the WAC, first through the collision of the Archean Pilbara Craton with the Archean to Proterozoic Glenburgh Terrane during the 2215–2145 Ma Ophthalmia Orogeny, and then through the collision of this combined block with the Yilgarn Craton during the 2005–1950 Ma Glenburgh Orogeny. Subduction of oceanic crust during both orogenic events was directed beneath the Glenburgh Terrane. Despite being imaged in a recent deep crustal seismic reflection profile, the major crustal structures and sutures have been significantly reworked during subsequent Proterozoic orogenic events and are, in most part, covered by younger sedimentary basins, and so away from this seismic transect the crustal architecture is difficult to resolve. Building on this earlier seismic transect, this project which combines the newly acquired passive seismic data with gravity, magnetic and magnetotelluric data and geological mapping, aims to resolve the broader 3D and 4D structure of the orogen.

Teleseismic events were recorded over 3 years and processed for receiver functions (H-*k* analysis and common conversion point gathers) and ambient noise tomography to image the crust, and P-wave tomography to image the sub-crustal lithosphere. The H-k analysis provides an estimate of the depth to Moho beneath each station and the Vp/Vs ratio can be interpreted as a proxy for bulk crustal composition. The results show a shallower, well-defined Moho beneath the Pilbara and Yilgarn Cratons, and a deeper, fuzzy Moho beneath the structurally and magmatically reworked Glenburgh Terrane. The Vp/Vs ratio indicate that both the Archean cratons have a more felsic composition (lower Vp/Vs ratio) compared to the Glenburgh Terrane (higher Vp/Vs ratio).

The common conversion point (CCP) bins the refracted and mode converted arrival energies from each station over each sub-surface block to produce a profile/volume of velocity gradients. It images the areas between stations so has a more complete coverage of the Moho. It shows asymmetrically dipping areas of the Moho which are interpreted as the relics of Proterozoic subduction and, on the western margin, the potential for back-thrusted portions of the lower crust.

Ambient noise tomography shows the variations in S-wave speeds across the region. The Archean cratons are associated with high S-wave speeds and the edge of both the Yilgarn and Pilbara Cratons can be moderately well-defined using these data. These cratons are also defined using P-wave tomography where they are associated with a higher Vp than areas structurally and magmatically reworked during the Proterozoic. High-velocity north-dipping structures down to ~250 km depth are present along the northern Yilgarn Craton margin which likely resulted from subduction and collision during the 2005–1950 Glenburgh Orogeny. However, the Narryer Terrane which forms the oldest, and northernmost part of the Yilgarn Craton lacks all of the characteristic seismological signatures of Archean crust, the reason for which is currently unclear.

The integration of these data with other regional-scale geophysical datasets is helping to better define the 4D evolution of the orogen, which will eventually highlight the most prospective areas of the orogen for mineral exploration.