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Three-dimensional crustal structure of a craton rim: Preliminary results from passive seismic imaging of the eastern Albany-Fraser Orogen, Western Australia

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Western Australia consists of two Archaean cratons (Yilgarn and Pilbara) and a number of Proterozoic orogens surrounding them that attest to past continental collisions. While the former feature seismically fast crust of average thickness (around 35 km) and a usually well defined Moho overlying a thick mantle lithospheric keel, the latter have been significantly less well studied and appear to be less uniform in terms of their crustal architecture. Thicker crust and a more fuzzy Moho are two common characteristics of these belts.

The Albany-Fraser orogen, situated at the south-eastern margin of the Yilgarn craton, has been interpreted as an old suture zone from the collision of the West Australian craton (Yilgarn and Pilbara already welded together) with the Mawson craton (southern Australia and part of Antarctica today). Newer evidence, however, might point at an original rift or backarc setting of the units. It is a complex amalgam of different structures that vary significantly along its strike, featuring heavily reworked parts of the outermost Yilgarn craton as well as younger units accreted or intruded significantly later. Two major deformation stages at 1345-1260 Ma and 1214-1140 Ma have been deduced for these, the first of which has been associated with the aforementioned collision/backarc rifting itself, while the second phase is commonly interpreted as intracratonic reworking due to a major thermal event. No large-scale tectonic overprint has occurred in the region since the second deformation phase, which means that the originally emplaced units have been unusually well preserved until the present day. However, surface outcrops of rocks are very rare, so that most knowledge about extent and geometric configuration of different rock suites comes from the interpretation of magnetic and gravity data. The eastern end of the Albany-Fraser orogen, in all likelihood corresponding to the Mawson craton's westernmost edge, is hidden beneath the limestones of the Eucla Basin so that its location is currently unknown.

The aim of our experiment is to image the crustal structure of this interesting orogen, employing state-of-the-art passive seismic techniques. A seismic network consisting of 40 stations covering an area of approximately 330 × 220 km, reaching from the largely undeformed part of the Yilgarn craton in the west to the Eucla Basin in the east, has been deployed in the eastern Albany-Fraser orogen in November 2013. Continuous three-component data will be recorded for a total duration of two years, with a southward shift of the array at midterm.

We present preliminary results from the analysis of the first data batch, collected in February 2014. Phase velocity maps derived from ambient noise cross-correlation provide a first glimpse at the distribution of shear wave velocities at different depths, and 1D depth profiles of v_s have been retrieved by joint inversion of receiver functions and surface wave dispersion curves. We make use of newly developed hierarchical Bayesian inversion techniques that treat the parameterization (i.e. number of layers/grid cells and their positions and sizes) as well as the data noise level as free parameters that are also inverted for. This approach should enable us to resolve anomalies of a wide range of scales while obtaining meaningful uncertainty estimates for our results.