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Seismic imaging results from a transportable array experiment in southeast Australia

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Since 1998, a program of rolling passive seismic array installations in southeast Australia has taken place with the goal of covering a significant portion of the continent at 50 km instrument spacing. To date, 14 separate arrays have been deployed resulting in the occupation of over 600 sites (now known collectively as the WOMBAT experiment). Arrays have varied in size between 20 and 70 instruments, with station spacings ranging between 15 km (Tasmania) and 50 km (mainland Australia). The majority of seismic sensors used have been 3-component short period, but a number of vertical component short period and 3-component broadband instruments have been installed as well. Deployment times have generally varied between six months and one year. Unlike USArray, WOMBAT is funded on an opportunistic basis, and array deployment, data processing and interpretation is carried out almost entirely by the seismology group at the Research School of Earth Sciences, The Australian National University.

This presentation will focus on recent seismic imaging results from WOMBAT, with a particular emphasis on 3-D traveltime tomography. To date, a variety of techniques have been applied to the recorded data, including teleseismic traveltime tomography, ambient noise tomography, and receiver function inversion. The location of southeast Australia with respect to surrounding seismogenic zones, particularly those in the vicinity of Japan, Indonesia, Fiji and New Zealand, means that teleseismic tomography is an ideal technique for imaging upper mantle velocity structure in detail. However, the use of a transportable array has the limitation that only a relatively small proportion of locations contain simultaneously recording instruments, so the joining together of numerous teleseismic datasets has the effect of filtering out long wavelength structure. Alternative approaches that we are currently testing include using a broad-scale starting model derived from regional surface wave data that takes the place of the long wavelength structure that is not constrained by the teleseismic traveltime residuals, and combining WOMBAT data together with ISC regional and global data in a joint inversion for local, regional and global structure based on irregular-grid tomography. Preliminary results using the broad-scale starting model approach appear robust, with evidence for mafic uderplating in the shallow mantle lithosphere consistent with the formation of passive margins associated with the separation of Australia and Antarctica, and the opening of the Tasman sea. At greater depths, the prominent velocity anomalies are oriented in a N-S direction, and appear to correlate well with the Palaeozoic building blocks of the Lachlan and Delamerian Orogenies. At 150 km depth, there is a general decrease in wavespeed to the southeast towards the passive margin, which probably signifies a transition from lithospheric to sub-lithospheric mantle.

Other recent work has focused on differential attenuation tomography, which appears to work well with the WOMBAT data as coherent patterns of δt^* can be observed for many events, and high resolution imaging of the 3-D P-wave velocity structure in the neighbourhood of the core-mantle boundary using PcP-P differential traveltimes. In the latter case, the subduction zones to the north and east, coupled with the large number of high density arrays, means that there is excellent path coverage in a region of the lower-most mantle that has previously not been well sampled.