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Detailed teleseismic imaging of transitions in the lithosphere beneath south east Australia using data from multiple seismic arrays

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The south east Australian lithosphere comprises a complex assemblage of Palaeozoic subduction-accretion terranes and fragments of Proterozoic crust, much of which is obscured by Mesozoic and Cenozoic cover sequences of sedimentary and volcanic origin. Unsurprisingly, there is no strong consensus regarding the tectonic evolution of this region, and many fundamental questions, including the number and distribution of past subduction zones, and whether the basement beneath south east Australia is principally oceanic or continental in origin, remain unanswered. Given the profusion of large distant earthquakes from the margin of the Australian plate and beyond, teleseismic tomography is well placed to significantly contribute to the understanding of the structure and tectonic evolution of the south east Australian lithosphere. The aim of this paper is to discuss results from recent and current teleseismic experiments, reveal our plans for two future experiments in 2005 and 2006, and show how we intend to combine all available data in a single tomographic inversion.

In the last decade, seismic arrays have been deployed in several regions of south east Australia for the specific purpose of recording teleseismic arrivals. Between 1998 and 2000, the MALT project involved three separate deployments of 40 short period seismometers, at 40-50 km station spacing, spanning the southern part of the Western Lachlan Orogen (500-380 Ma), the Delamerian Orogen (520-490 Ma) and the eastern edge of the Gawler Craton ($\sim$2.5 Ga). Tomographic imaging results from the first deployment (LF98) reveals the location of the lithospheric suture between the Lachlan and Delamerian Orogens. In 1999, 28 broadband recorders were deployed in southern New South Wales and Victoria as part of the QUOLL experiment, which spanned the

northern part of the Western, Central and Eastern Lachlan Orogen.

In 2002, as part of the TIGGER project, 72 short period and broadband seismic recorders with a nominal spacing of 15 km were deployed across northern Tasmania, an island state which lies at the southern tip of south east Australia. To date, a total of 6,520 arrivals from various phases including P, pP, PP, PcP, ScP and PKiKP have been picked from five months of records. A new iterative non-linear tomographic procedure based on the fast marching method and a subspace inversion scheme has been used to construct images of the Tasmanian lithosphere. Geological inferences from these results have helped to change our perceptions about Tasmania and its previously enigmatic relationship with mainland Australia. For example, easterly dipping high velocity structures within the mantle lithosphere may represent remnants of a Late Cambrian subduction zone, and suggests that the Tyennan Orogeny in Tasmania represents the southern extension of the mainland Delamerian Orogeny. In addition, our results suggest that the lithospheric transition between the younger (Phanerozoic) and older (Neoproterozoic) Tasmanian terranes is located much further east than previously thought.

The most recent teleseismic experiment, SEAL, began in late 2004 and comprises 20 short period instruments deployed north east of MALT spanning the eastern margin of the Delamerian Orogen to the Central Lachlan Orogen. Two future experiments, EVA (2005) and SETA (2006), each involving at least a five month deployment of 40 short period seismometers in eastern Victoria and southern Tasmania respectively, will complete the high density coverage of south east Australia. The total number of instruments involved in the combined seismic array is approximately 320, which is unprecedented in the history of regional scale seismology in Australia. Our ultimate goal is to combine teleseismic data from all experiments in a single inversion for the P-wave velocity structure of the crust and upper mantle beneath south east Australia.