Geoscience Australia's contribution to AusArray – Passive seismic imaging of Australia

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SUMMARY

Geoscience Australia (GA), as a part of the Exploring for the Future (EFTF) Programme, is aiming to create a high-resolution three-dimensional (3D) seismic model of Australia to infer physical properties of the lithosphere from depths of few meters to hundreds of kilometres. This work is based on new data collected from National Seismological Network and a new movable seismic array complimented by legacy seismological data obtained by universities. GA has deployed a movable array of 115 broadband seismic stations for one year between Mount Isa and Tennant Creek arranged in a grid pattern with interstation distance of approximately 55 kilometres in order to attain horizontal resolution of at least 20 kilometres. This dense network is reinforced by fifteen semi-permanent higher sensitivity broadband seismic stations located predominantly in the Northern Territory and Western Australia in order to increase imaging resolution within the array and within areas where the National Seismological Network has gaps. Multiple seismological methods are being combined together to obtain robust constraints on 3D lithospheric architecture. For the first time, particular attention is focused on shallow structures located at depths of less than 1 kilometre.

Key words: seismic array, Geoscience Australia, shallow structure.

INTRODUCTION

Passive seismic studies, targeting three-dimensional Earth structure, have been used in scientific research for about 30 years following the pioneering work by Aki and Lee (1976), which introduced seismic tomography. In contrast the resource exploration community commonly uses active sources to illuminate the subsurface structures due to the fast turn-around of the survey campaigns. Recently the increasing difficulty and high price of an artificial source generation forced researchers to reassess the utility of passive seismic methods for exploration purposes. The combination of lower costs, non-invasive nature and known ability of natural sources to sample deeper earth structures than active source methods for the same effort dovetails with the mineral industries UNCOVER initiative which seeks to image the near surface and entire lithosphere to enable under cover mineral exploration. Seeking to maximise the application of new techniques to industry problems Geoscience Australia is actively benchmarking the applicability of passive seismic surveys for cover-thickness estimation down to ~1 km in greenfield areas such that they can be applied away from borehole constraints.

METHOD AND RESULTS

Geoscience Australia's new fleet of passive seismic instruments consists of 135 Nanometrics Trillium Compact 120s sensors, 15 Guralp broad-band T3 post hole sensors and 150 Guralp Minimus seismic recorders. Approximately 115 seismic stations are deployed in collaboration with the Northern Territory and Queensland Geological Surveys between Tennant Creek and Mt Isa over a one-year duration to record ambient noise and seismic signal from local and regional earthquakes (Figure 1a). This array will be moved on an annual basis to maximise the national passive seismic coverage in a co-ordinated effort with AuScope and academia, which together has been badged as AusArray. During deployments stations are spaced ~55 km apart to ensure resolution of ~20 km wide features within the crust can be achieved. Following data collection multiple seismological methods will be used to image different aspects of Australia's lithosphere, starting with the velocity structure down to ~1 km. Gradually all models will be used together with seismic tomography to develop a routinely refined 3D velocity model of the Australian plate. Importantly, the AusArray effort is complimented by the Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP; Figure 1b), which seeks to constrain the resistivity structure of the Australian plate. Together, these programs mark a data infrastructure watershed moment, which will allow unprecedented insights into the deep earth architecture of the Australian plate to be developed with implications for not only the resources industry but also hazards and the environment.

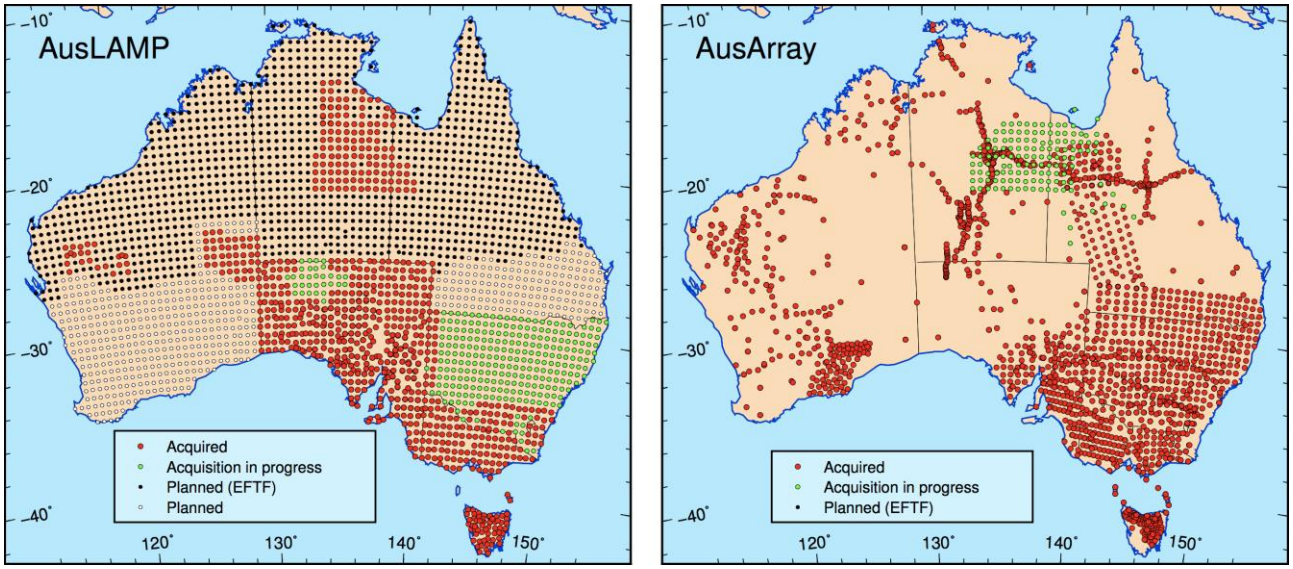

Figure 1: Map of the collaborative acquisition state of the Australian Lithospheric Architecture Magnetotelluric Project (AusLAMP) and the passive seismic AusArray project as of September 2017. EFTF = Exploring for the Future project.

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REFERENCES

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