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Seismicity, Minerals, and Craton margins: The Lake Eyre Basin Seismic Deployment

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SUMMARY

The deployment of new AuScope passive seismic experiments in 2019 are transforming seismic data coverage across South Australia and Lake Eyre Basin, coinciding with additional geophysical surveys in the region such as AusLAMP. The array of 40 seismometers will eradicate a major gap (or blind spot) in the national seismic network. A range of seismic imaging techniques will be applied allowing for the nature of a suspected continental weak zone between the Gawler Craton and Lake Eyre Basin to be determined. Not only is this weak continental boundary associated with a recent surge of seismic activity, but is also home to some of the most valuable mineral resources in Australia (e.g. Olympic Dam, the world's largest uranium deposit, and the 4th largest copper deposit).

Key words: Lake Eyre, seismic array, passive seismic, craton, seismicity.

INTRODUCTION

Australia is more seismically active than most people think. Seismic hazard is considerably elevated compared to other stable continental regions and on average a large intra-plate earthquake of magnitude 6 or above occurs every 6-8 years (Johnston et al., 1994; McCue, 1990). Globally, and within Australia, such intra-plate earthquakes remain very poorly understood. Large events usually occur unexpectedly on unidentified faults, making them particularly difficult to foresee and prepare for. The distribution of intra-plate seismicity however tends to be non-random, localized both in space and in time. Such regions of intra-plate seismicity have long been associated with pre-existing zones of weakness in the continental crust, such as former ancient plate boundaries or rift zones (Johnston et al., 1994; Schulte and Mooney, 2005; Sykes, 1978).

A new AuScope funded deployment of 40 seismic stations will transform seismic data coverage across South Australia (Figure 1). A range of seismic imaging techniques are planned that will utilise data from this seismic array plus concurrent geophysical surveys such as AusLAMP. This will allow for the nature of a suspected continental weak zone between the Gawler Craton and Lake Eyre Basin to be determined. Not only is this weak continental boundary associated with a recent surge of seismic activity (Figure 2), but is also home to some of the most valuable mineral resources in Australia (e.g. Olympic Dam, the world's largest uranium deposit, and the 4th largest copper deposit).

Despite the concerns for seismic hazard and potentially high mineral prospectivity this region of central Australia remains relatively underexplored due to a thick blanket of sediments. The exact boundary of the Gawler Craton, one of the oldest continental building blocks of Australia, is poorly constrained, particularly at depth. This project will utilise the passage of seismic waves, via geophysical imaging, to see below the surface and beneath the sedimentary cover to where the important crustal boundaries, seismic zones, and mineral systems are currently hidden.

METHOD AND RESULTS

This project has been uniquely designed to investigate recent and ongoing intra-plate seismicity in central Australia and it's relationship to the make-up of the Australian continent below. This will involve a multi-component seismic investigation of the region based on the forthcoming collection of a new seismic dataset. The seismology group at ANU have deployed deployed 20 broadband seismometers and 20 short-period seismometers for AuScope in an ambitious configuration surrounding Lake Eyre (Figure 1). This will involve crossing the Simpson Desert, a feat not achieved by motorized vehicle until 1962, and will be the first such attempt to install seismometers across this vast desert.

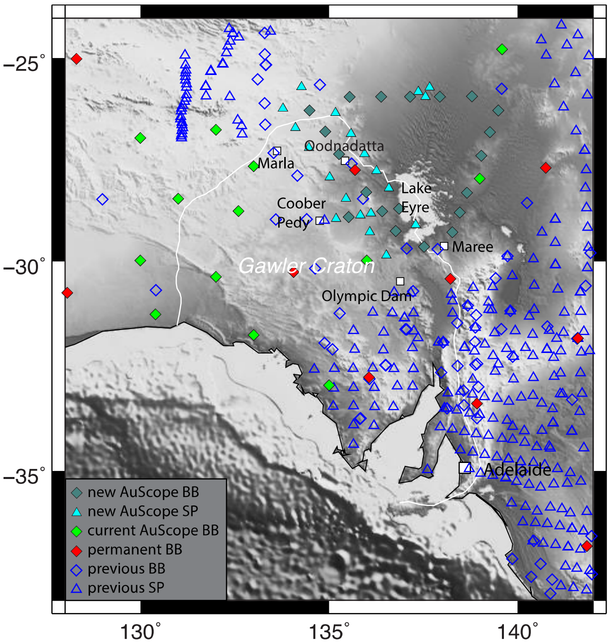

Figure 1. Map of seismic station coverage across South Australia. The forthcoming AuScope deployment (turquoise symbols) will for the first time cross the Simpson Desert and surround Lake Eyre. There will be dense coverage along the NE margin of the Gawler Craton and

zone of recent intra-plate seismicity (Figure 2). Closed symbols represent on-going or forthcoming stations to be used in this project. Open symbols are past passive seismic deployments no longer operating. Broadband (BB) sites are represented by diamonds and short period (SP) sites by triangles.

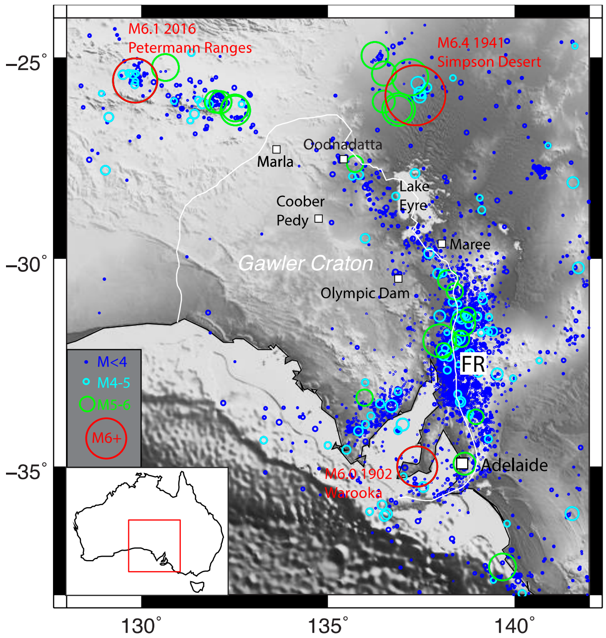

Figure 2. Map of the study region in South Australia. Intra-plate seismicity from 1900 to present (Geoscience Australia, 2018). Colour and size of the circles represents event magnitude according to the legend shown. Low-level seismic activity is common in the region (blue circles) and several large events (red circles) of magnitude 6 and above have occurred. Much of the seismicity appears to follow the inferred eastern margin of the Gawler Craton (white line, same as figure b), although curiously stops at Oodnadatta and then restarts further west. FR: Flinders Ranges. A similarity can be seen between the distribution of intra-plate seismicity and the inferred eastern margin of the Gawler Craton, one of the oldest continental building blocks of Australia. This project will seismically image the location and nature of the Gawler Craton margin at depth and investigate intriguing connections between intra-plate seismicity and the concentration of minerals.

CONCLUSIONS

This seismic deployment aims to determine the underlying cause of recent earthquake activity in central Australia. Of all the stable continents Australia is surprisingly seismically active. Intra-plate earthquakes occur relatively frequently here, but are notoriously unpredictable, placing lives and infrastructure at risk. This project offers the opportunity to utilise a new seismic experiment to improve detection of small events that may warn of a more dangerous earthquake to come and to provide sub-surface imaging of the hidden crustal boundaries and faults that are ultimately responsible.

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