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Recent advances in understanding the characteristics of seismogenic intraplate deformation in Australia, and the potential for using global analogues

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Continental intraplate Australia can be divided according to crustal type in terms of seismogenic potential and fault characteristics. Three ‘superdomains’ are recognized, representing cratonic, non-cratonic and extended crust. In the Australian context, cratonic crust is Archaean to Proterozoic in age and has not been significantly tectonically reactivated during the Phanerozoic Eon. Non-cratonic crust includes Phanerozoic accretionary terranes and older crust significantly deformed during Phanerozoic tectonic events. Extended crust includes any crustal type that has been significantly extended during the Mesozoic and Cenozoic, and often to a lesser degree in the Paleozoic. Aulacogens and passive margins fit into this category.

Cratonic crust is characterized by the thickest lithosphere and has the lowest seismogenic potential, despite all eight documented historic surface ruptures in Australia having occurred within this category. Little strain accumulation is observed on individual faults and isolated single-rupture scarps are common. Where recurrence has been demonstrated, average slip rates of only a few metres per million years are indicated. In contrast, extended crust is associated with thinner lithosphere, better connection between faults, and strain localization on faults which can result in regional relief-building. The most active faults have accumulated several hundred metres of slip under the current crustal stress regime at rates of several tens of metres per million years. Non-cratonic crust is typically intermediate in lithospheric thickness and seismogenic character. The more active faults have accumulated tens to a couple of hundreds of metres of slip, at rates of a few to a few tens of metres per million years. Across all superdomains paleoseismological data suggest that the largest credible earthquakes are likely to exceed those experienced in historic times.

In general, the concept of large earthquake recurrence might only be meaningful in relation to individual faults in non-cratonic and extended superdomains. However, large earthquake recurrence and slip are demonstrably not evenly distributed in time. Within the limitations of the sparse paleoseismological data, temporal clustering of large events appears to be a common (perhaps ubiquitous?) characteristic. Over the last few decades, permanent and campaign GPS studies have failed to detect a tectonic deformation signal from which a strain budget could be calculated. Recent studies have used these observations, amongst others, to propose an orders of magnitude difference in the timescales of strain accumulation and seismogenic strain release in intraplate environments – i.e. clusters of large events deplete long-lived pools of lithospheric strain.

The recognition of a relationship between crustal type/lithospheric thickness and seismogenic potential in Australia provides a framework for assessing whether ergodic substitution (i.e. global analogue studies) might be warranted as a tool to better understand intraplate seismicity worldwide. Further research is required to assess how variation in crustal stress regime may influence faulting characteristics within different superdomains.