https://doi.org/10.1002/2016GL070815

Australian Government
Geoscience Australia

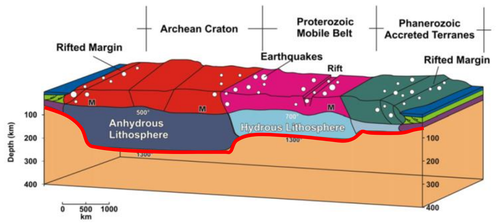
EGU2020 Sharing Geoscience Online
SM2.2 Earthquakes and active tectonics in regions of slow lithospheric deformation: towards a re-evaluation of the Stable Continental Region concept in seismic hazard assessment
D1403 | EGU2020-6279 | Abstract

Neotectonic constraint on models of strain localisation within stable continental region (SCR) crust

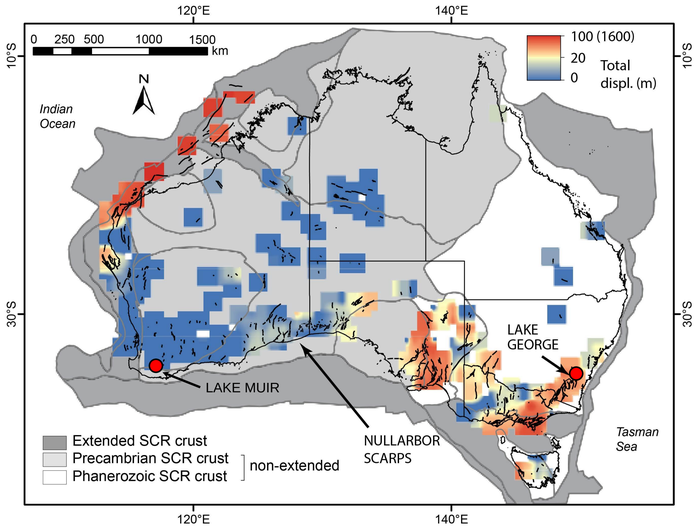
Dan Clark Geoscience Australia, GPO BOX 378 Canberra, ACT, Australia

(1) Setting and summary

- mechanisms that lead to the localisation of stable continental region (SCR) seismicity, and strain more generally, are poorly understood.
- variation in activity rate and character may relate to lateral changes in the thickness, composition and/or viscosity (thermal state) of the lithospheric mantle[1,2].
- the plate margin-centric hypothesis that the loading rate of crustal faults can been understood in terms of the strain rate of the underlying lithospheric mantle has been questioned as a space-geodetic strain signal is yet to be measured, and alternatives involving the release of elastic energy from a pre-stressed lithosphere have been proposed[3].

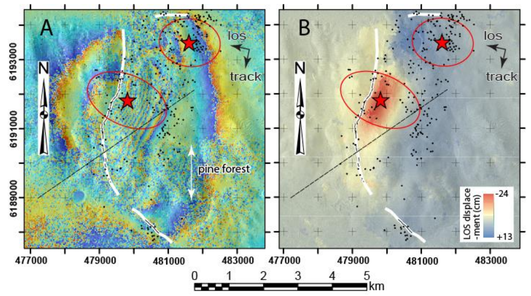


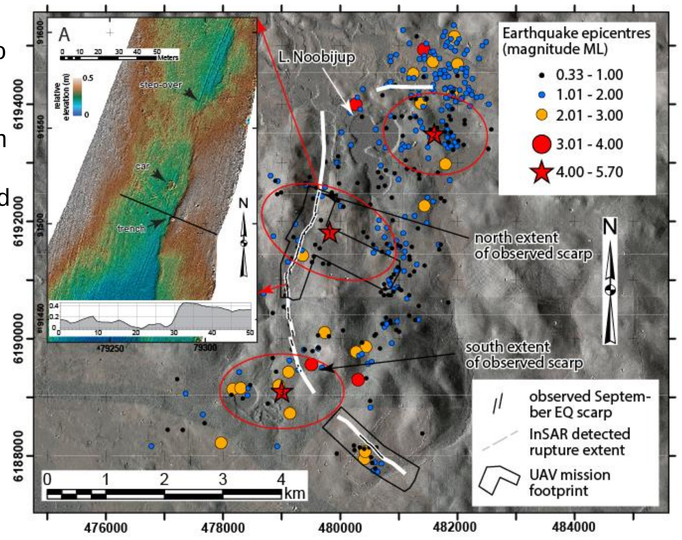
Mooney et al. (2012) EPSL 357-358, 78-83



(2) Precambrian non-extended crust (e.g. Lake Muir rupture)

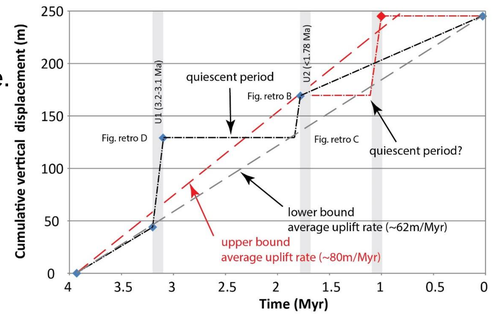
- faults in non-extended Precambrian crust are short, isolated, and show limited or no evidence for recurrence.
- the most recent 1-3 events are often all that are evident across Neogene duricrust characterised by 1-5 m/Myr bedrock erosion rates.
- Can be associated with high rates of contemporary seismicity (e.g. nine historic surface ruptures), but no associated range-building relief.
- Lake Muir: 2018 M_w 5.3 event which produced a 5km long scarp up to 0.6 m high, no evidence for a prior event in the low erosion rate landscape[6]. Reactivated Proterozoic bedrock faults and lithological contacts.

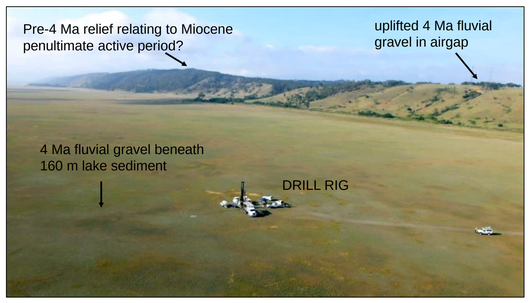


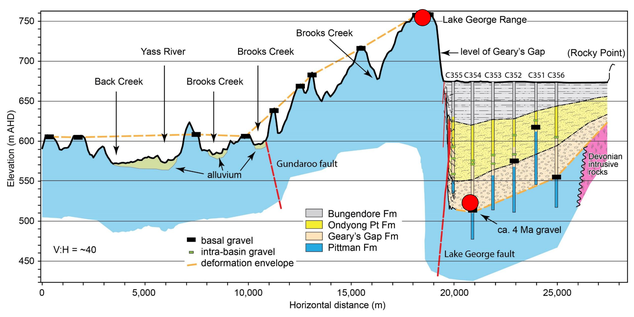


(3) Phanerozoic SCR crust (e.g. Lake George fault)

- faults in Phanerozoic accretionary crust, and extended crust, are arranged in belts, and show evidence for (often prolonged) recurrence.
- long-term fault activity proportional to relief. Highest long-term rates ~0.1 mm/a[4].
- deformation is episodic, with long periods of quiescence punctuated by brief periods of activity with slip rate up to ~1 mm/a[5].
- Lake George fault: 250 m of uplift in ~4 Myr (from displaced fluvial gravels), uplift departs from long term rate in active periods, only to return to it in quiescent periods = elastic rebound theory??

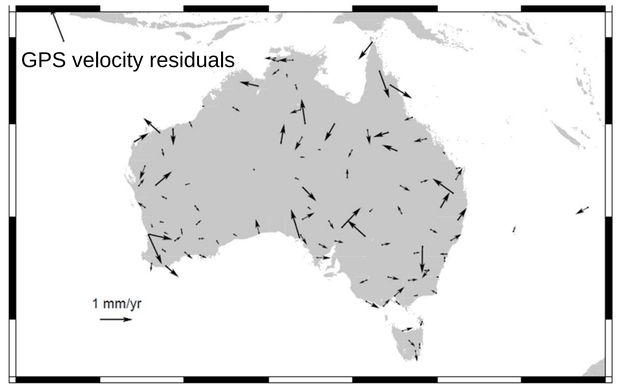






(4) Discussion

- SCR crust is not homogeneous with respect to seismogenic properties or potential.
- Variations in the distribution, cumulative neotectonic displacement, and recurrence characteristics of 'active' faults provide important constraint on models of strain localisation mechanisms within SCR, with global application.
- While 'extended', 'non-extended' (Phanerozoic/Precambrian) provides a good framework for understanding SCR seismogenic potential, global SCR analogue choice should consider more than just geological and geophysical character (e.g. extant crustal stress field character)[7].
- Question: in the absence of a GPS strain signal, what experiments can we build and test to distinguish between competing hypotheses for SCR seismicity/strain:
  - (i) Very slow tectonic strain accumulation
  - (ii) Depletion of a fossil stress pool
  - (iii) Local concentrators enhancing plate margin processes
  - (iv) Other?



References

1. Bezada & Smale, 2019 GRL, https://doi.org/10.1029/2019GL084848
2. Mooney et al., 2012 EPSL, https://doi.org/10.1016/j.epsl.2012.08.032
3. Calais et al., 2016. GRL, https://doi.org/10.1002/2016GL070815
4. Macphail et al., 2020. Aust. J. Botany, https://doi.org/10.1071/BT19076
5. Clark et al., 2012. Tectonophy,http://dx.doi.org/10.1016/j.tecto.2012.07.004
6. Clark et al., 2020. Solid Earth, https://doi.org/10.5194/se-11-691-2020
7. Whitney et al., 2018. 9th International INQUA Meeting on Paleoseismology, Active Tectonics and Archeoseismology (PATA), 25 – 27 June 2018, Possidi, Greece, 2018.

eCat#*135690*

GEOSCIENCE AUSTRALIA
APPLYING GEOSCIENCE TO AUSTRALIA'S MOST IMPORTANT CHALLENGES

For Further Information
Email: dan.clark@ga.gov.au
Ph: +61 2 6249 9606 **Web:** www.ga.gov.au