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The Mw 6.0 Northern Territory earthquake of 21 May 2016

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A magnitude 6.0 earthquake occurred early on Saturday morning, May 21, 2016, about 460 km west-southwest of Alice Springs in a region in which ancient cratonic rocks are covered by more recent sediments (Figure 1). It occurred in a sparsely inhabited region and is not known to have caused any damage or injuries. Most estimates put the depth of the hypocenter at 10 km, but one estimate puts it at 2 km. This was a once-in-a-decade event in Australia that provided an opportunity to test ground motion prediction models for Australia, which suffer from a sparsity of strong ground motion recordings, especially from large earthquakes.

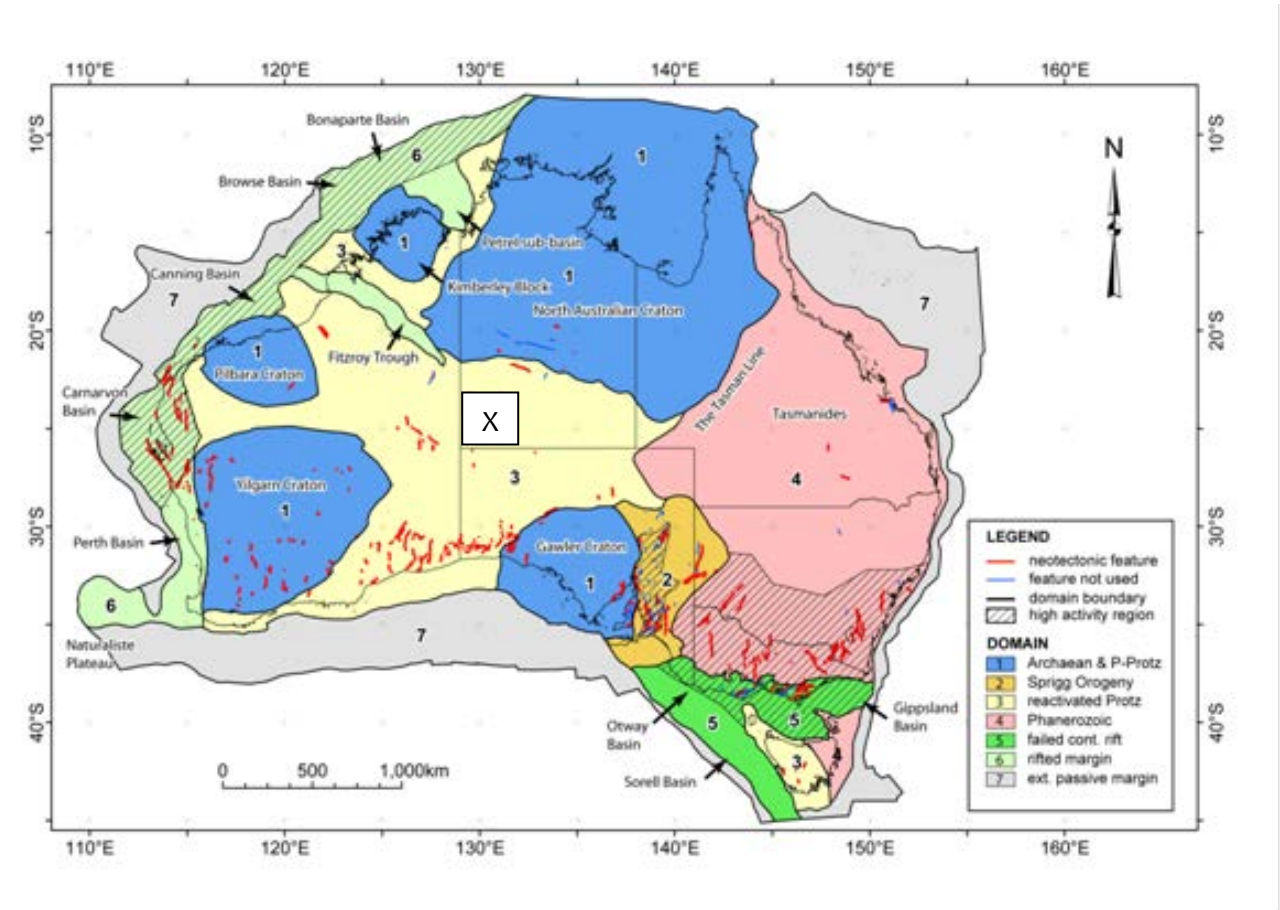

Figure 1. The location of the earthquake in the southwest corner of the Northern Territory (black cross) superimposed on a map of tectonic domains in Australia, showing the locations of cratons (blue) and cratons having sedimentary cover (yellow). Neotectonic features (potentially active faults) that have been identified to date are shown by red lines. Source: Clark et al., 2011, 2012.

At present, there are three models that predict ground motion response spectra as a function of earthquake magnitude and distance in Australia. The model developed by Somerville et al. (2009) with funding from Geoscience Australia has separate models for the cratonic (older) regions of Australia, which make up most of the western part of the country (blue and yellow regions in Figure 1), and for the non-cratonic (younger) regions of Australia, including the eastern part of the country and some of its western coastal fringes including Perth (pink and green regions in Figure 1). The model developed by Trevor Allen (2012), then of Geoscience Australia, is for southeastern (non-cratonic) Australia. The model developed by Jonathan Liang and others (2008) at the University of Western Australia is for the Yilgarn Craton.

The earthquake was recorded at seismic stations in Australia. The two closest recording stations are WRKA, 162 km away, and AS01, 468 km away. Figure 2, made by Trevor Allen, compares the response spectrum of the ground motions recorded at these two closest seismic stations (wiggly black lines) with the response spectra predicted by 8 models. Of these eight models, six were developed for eastern North America, and have been used in the past to estimate earthquake ground motions in Australia. However, the predictions of these models do not match the recorded response spectra very well, especially at the more distant station. At such large distances, the models are poorly constrained by strong motion data.

The two Australia models match the data better. Trevor Allen's model (A12, orange) is for non-cratonic southeastern Australia, and so it is not surprising that it does not match these cratonic data as well as Somerville et al. (Sea09YC, green) which is the model for cratonic regions. In particular, the shape of the recorded response spectra flattens at periods longer than 1 second, which also occurs in the Somerville et al. model. In that model, this flattening is caused by the generation of higher mode surface waves by shallow earthquake faulting, and we surmise that this earthquake may have occurred at shallow depth. The Somerville et al. (2009) model was based mostly on seismological theory because of the sparsity of ground motion recordings of Australian earthquakes, so it is gratifying to see that the model fits the two recordings fairly well, suggesting that the theory we used has predictive power.

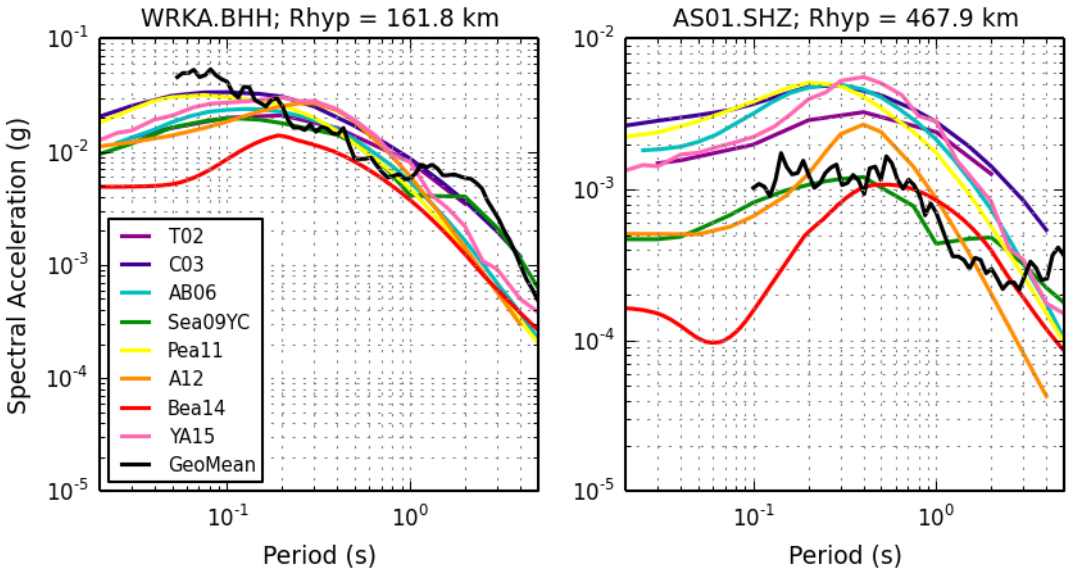

Figure 2. Comparison of response spectra of ground motions recorded at two stations (black lines) with the predictions of ground motion models. A12 (Allen et al., 2012; orange lines) and Sea09YC (Somerville et al., 2009; green lines) are the two Australian models; the others are for eastern North America. Source: Trevor Allen, personal communication)

More information on the earthquake can be found here:

http://earthquake.usgs.gov/earthquakes/eventpage/us10005iyk#shakemap

http://www.ga.gov.au/earthquakes/getQuakeDetails.do?quakeId=3821474

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