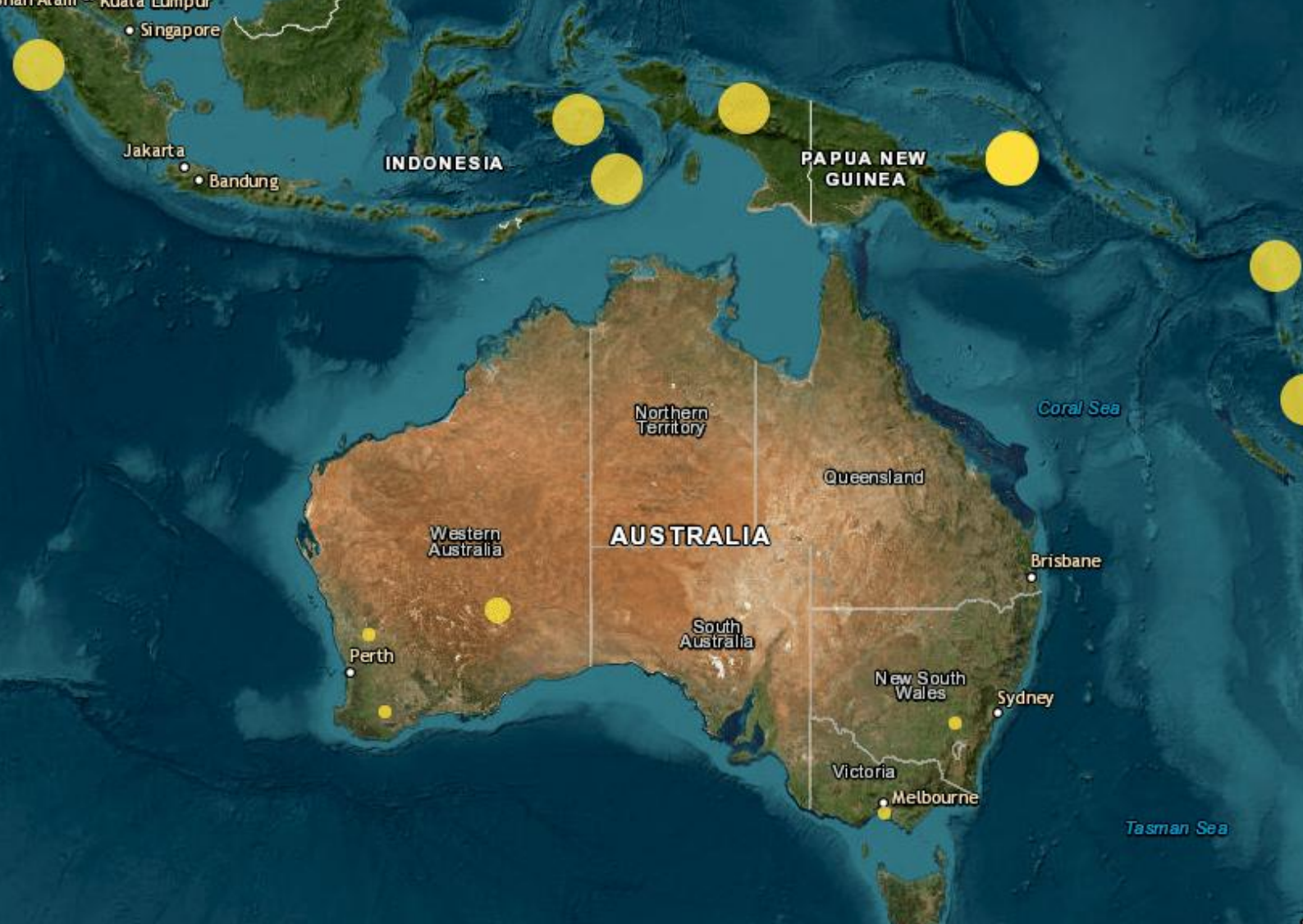

RISK FRONTIERS

Perspective on the Melbourne Earthquakes of Late May and Early June 2023

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BRIEFING NOTE 484 June 08, 2023

Since the magnitude 4.0 earthquake near Sunbury, about 40 km north-northwest of Melbourne on 28 May 2023 and which was followed about two minutes later by a magnitude 2.6 aftershock, there have been two smaller earthquakes in the Melbourne region, a magnitude 2.3 earthquake in Croydon, eastern Melbourne on 5 June and a magnitude 2.4 earthquake on the Mornington Peninsula on 6 June (Figure 1). These events have almost doubled the number of earthquakes that have occurred in the region shown in Figure 1 in the past seven months. The four earthquakes occurring in the last week are presumably responding to an abrupt change in stress that has occurred across the region. This stress is due primarily to the collision between the Australian Plate and the Pacific Plate along the Alpine Fault on the west coast of the south island on New Zealand (Risk Frontiers Briefing Notes 454 and 455, 2021). It is unclear how the past week's earthquakes may relate to the occurrence of future earthquakes in the Melbourne region, but it seems unlikely that they portend a larger earthquake.

It is not usually possible to associate small earthquakes with identified faults, and even large earthquakes can occur on faults that have not been identified. For example, the Mw 6.0 Woods Point earthquake of 21 September 2021 occurred on a fault that apparently does not intersect the Earth's surface and so had not been previously identified (Mousavi et al., 2023). Figure 2 shows neotectonic features, which represent potentially active faults, from the Geoscience Australia Neotectonic Features Database. The Selby earthquake is located close to the Clarkefield Scarp, which is considered to be a Possible neotectonic feature. The Mornington Peninsula earthquake is located close to the Selwyn Fault, which is considered to be a Definite neotectonic feature. The Croydon earthquake is located between the Beaumaris Monocline (Probable) and the Yarra Fault (Possible) neotectonic features.

The six earlier earthquakes in Figure 1 occurred east of Melbourne, and the largest and most northerly of them was evidently an aftershock of the Mw 6.0 Woods Point earthquake of 21 September 2021, initially known as the Mansfield earthquake. The magnitude scale is logarithmic, such that each increase of one magnitude unit corresponds to an increase in seismic energy release of a factor of 30. This indicates that the Woods Point earthquake released about 900 times as much energy as the Sunbury earthquake. While it is true that the Sunbury earthquake was the largest earthquake to have been recorded in the Melbourne region since the magnitude 4.5 earthquake near Sunbury in 1902, the ground motions in greater Melbourne caused by the Woods Point earthquake were similar to or larger than those of the Sunbury earthquake, and the Woods Point earthquake affected a much larger area, as shown in Figure 3. If we use the ordinary dictionary definition of an earthquake as a "shaking of the ground," then the Woods Point earthquake was generally felt as a stronger earthquake than the Sunbury earthquake in greater Melbourne, and it certainly would have had a much longer duration of shaking.

To put the recent Melbourne earthquakes in perspective, Figure 4 shows earthquakes that occurred in and around Australia in the past week for comparison with the earthquakes in the Melbourne region in Figure 1 during roughly the same period of time. The largest events, mostly having magnitudes of about 5, occurred on or near plate boundaries that lie to the north and east of Australia. Australia is distant from plate boundaries and has a much lower rate of earthquake activity.

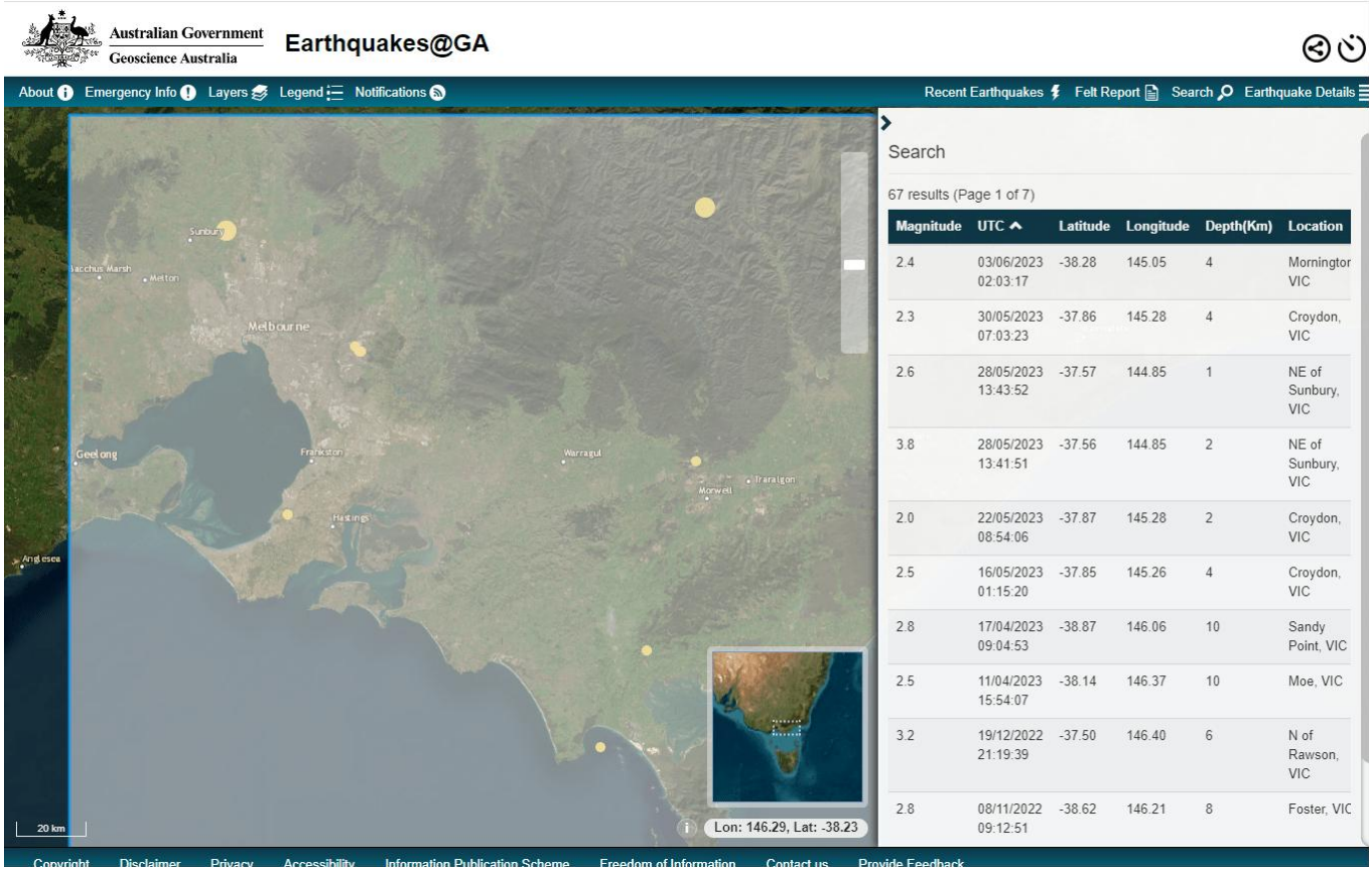

Figure 1. *The most recent ten recored earthquakes in the Melbourne region (8 November 2022 to 6 June 2023). Source: Geoscience Australia.*

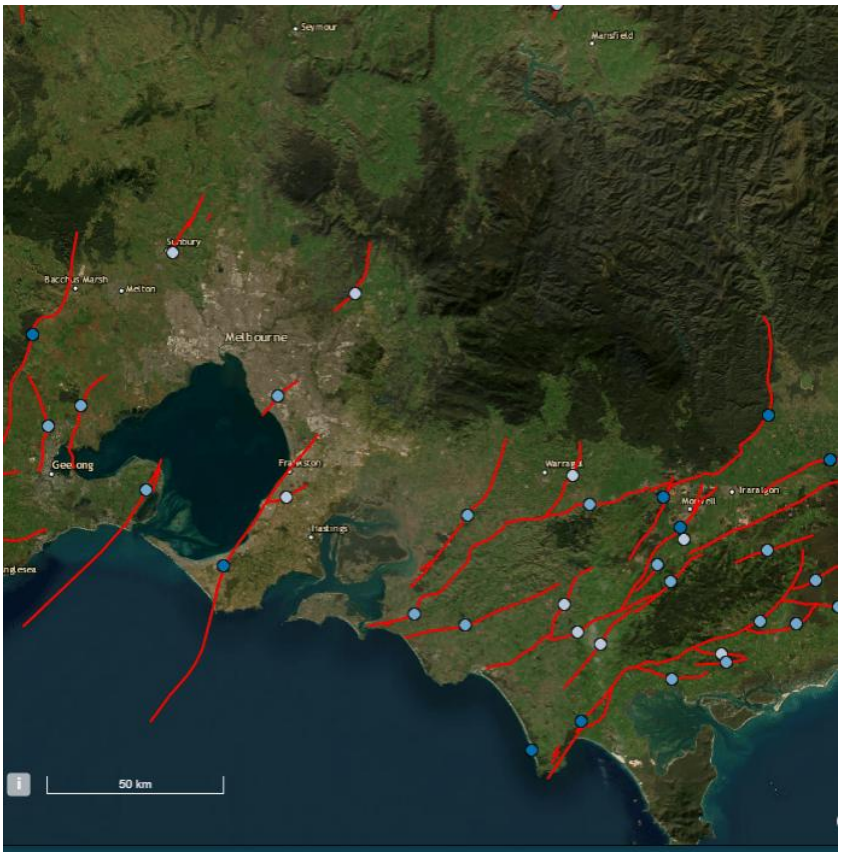

Figure 2. *Potentially active faults in the Melbourne region. Source: Geoscience Australia (2023).*

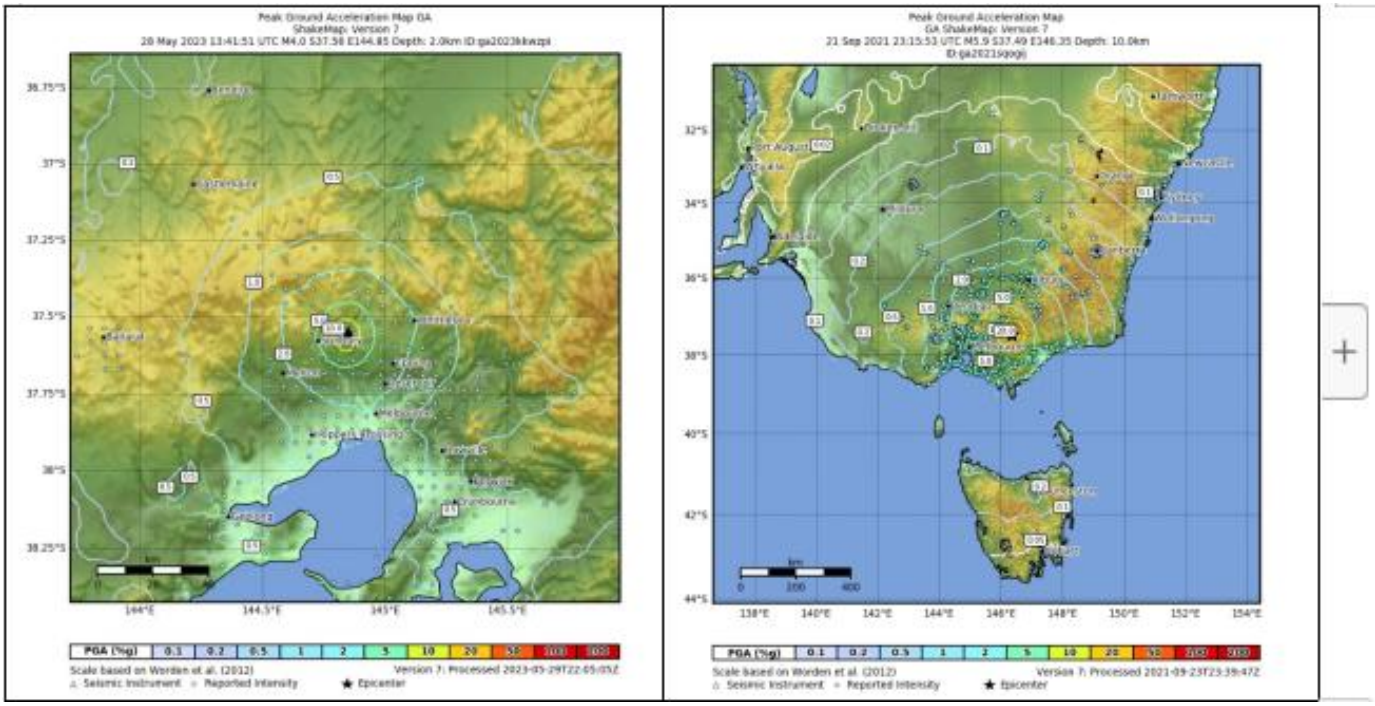

Figure 3. *Comparison of peak ground accelerations in the Melbourne region from the Sunbury (left) and Woods Point (right) earthquakes. Source: Geoscience Australia.*

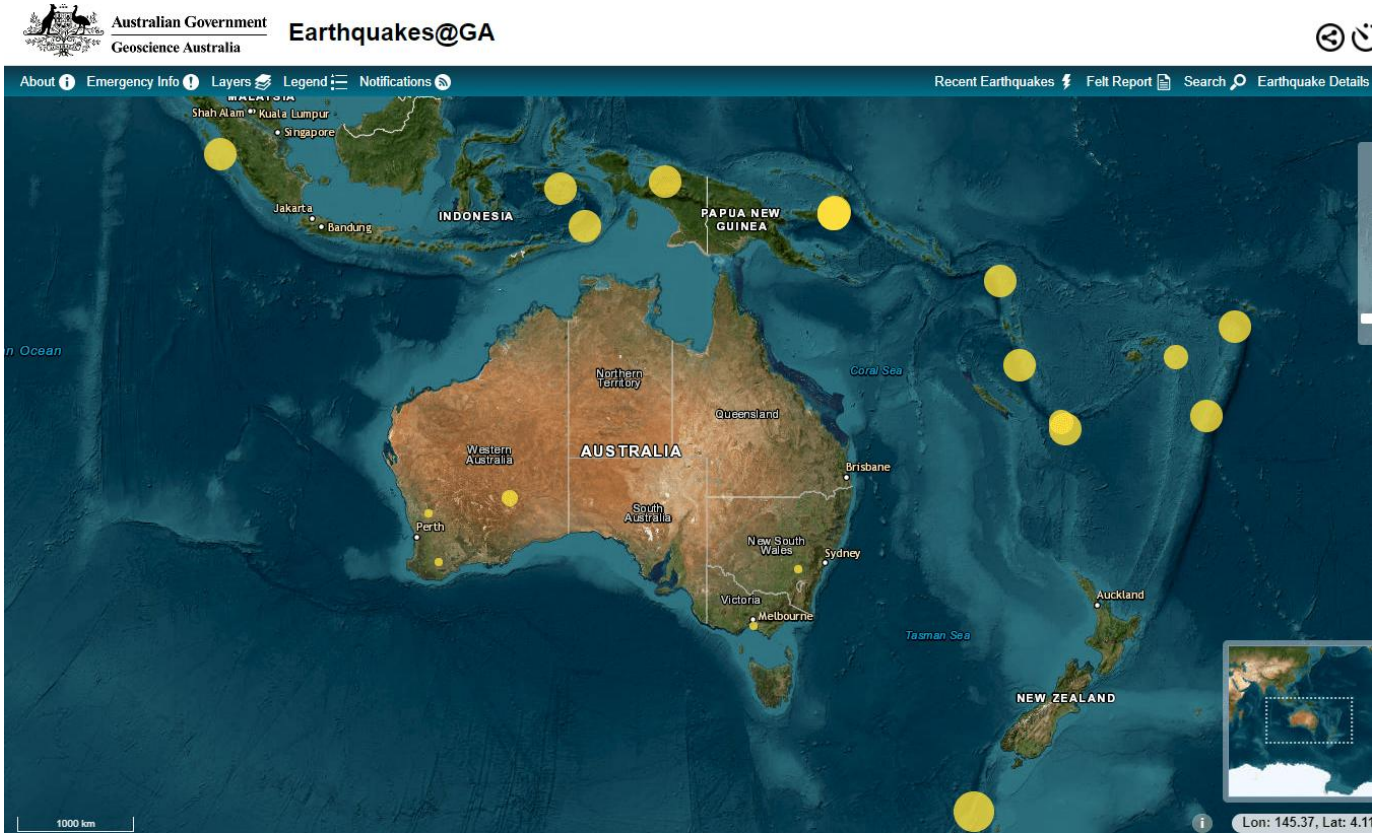

Figure 4. *Earthquakes that have occurred in and around Australia in the past week. Source: Geoscience Australia.*

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Paul is Chief Geoscientist at Risk Frontiers. He has a PhD in Geophysics, and has 45 years experience as an engineering seismologist, including 15 years with Risk Frontiers. He has had first hand experience of damaging earthquakes in California, Japan, Taiwan and New Zealand. He works on the development of QuakeAUS and QuakeNZ.