
Intraplate earthquakes - why?

David Denham

Australian Geological Survey Organisation, GPO Box 378,
Canberra ACT 2601

More than 90 per cent of the world's earthquakes take place at active plate margins, where the major plates interact at velocities of up to 100 mm/year. These zones are also host to the world's largest earthquakes, such as the 1960 Chilean and the 1964 Alaskan earthquakes. These had moment magnitudes of 9.5 and 9.2 respectively, and ruptured a total of approximately 1800 km of the earth's crust.

The tectonic models to describe these earthquakes are well known and well understood. However, earthquakes occurring away from the plate boundaries, (i.e. intraplate earthquakes) such as those in the Australian continent, are poorly understood and they do not form well defined patterns in space or time.

Nevertheless, we do know that the cause of these earthquakes is compressive stress in the crust and that most of the earthquakes are in the upper crustal basement rocks. Furthermore, these earthquakes occur close to the free surface, which cannot sustain large stresses, and therefore are unlikely to be as large as the giant events that take place at the active boundaries.

The largest known earthquake this century in Australia occurred in 1906 off the northwest coast of the continent. It had an estimated magnitude of 7.2. On land the 1941 Meeberrie earthquake which had a magnitude of approximately 7.0, appears to have been the largest. A maximum credible earthquake of magnitude 7.5 is therefore not unreasonable for calculations of earthquake risk.

This assumption is supported by studies of Recent prehistoric fault scarps. No scarp longer than 45 km has yet been found.

Table 1 shows fault scarps produced by recent earthquakes in Australia, and the magnitudes of the earthquakes. Clearly if these earthquakes had occurred in densely populated regions, there would have been considerable damage.

Table 1. Recent earthquakes that produced fault scarps

<i>Earthquake</i>	<i>Date</i>	<i>Magnitude (Ms)</i>	<i>Fault length (km)</i>	<i>Maximum surface displacement (m)</i>
Meckering WA	14 Oct 1968	6.8	37.0	2.5
Calingiri WA	10 Mar 1970	5.5	3.5	0.3
Cadoux WA	2 Jun 1979	6.0	15.0	1.3
Marryat Creek SA	30 Mar 1986	5.8	13.0	0.8
Tennant Creek NT	22 Jan 1988	6.8	35.0	2.0

Figure 1 shows the distribution of all known earthquakes with magnitude 4 or greater from 1873 until 1990. This diagram indicates that most earthquakes in the Australian region take place within the continental rather than the oceanic lithosphere, that the earthquakes occur throughout most of the continent, and are not usually associated with

major known faults, and that any seismicity patterns which may be used to forecast future earthquakes, are diffuse and somewhat ill-defined.

Although the number of damaging earthquakes has been relatively small, as the population of the continent increases there are more buildings to damage, and people to be killed, and the significance of earthquakes as a natural hazard becomes more important. Table 2 shows the most damaging earthquakes that have occurred in the second half of this century. There is clearly a significant risk to be addressed.

Table 2. Damaging Australian earthquakes, 1950-1990.

<i>Date</i>	<i>Place</i>	<i>Magnitude</i>	<i>Damage (\$A million)</i>	
			<i>A</i>	<i>B</i>
3 Jan 1954	Adelaide SA	5.4	\$8.8	\$66
22 May 1961	Robertson/Bowral NSW	5.6	\$0.5	\$3
14 Oct 1968	Meckering WA	6.8	\$5.0	\$29
10 Mar 1973	Picton NSW	5.5	\$0.5	\$2
2 Jun 1979	Cadoux WA	6.2	\$3.7	\$9
13 Feb 1985	Lithgow NSW	4.3	\$0.65	\$0.90
22 Jan 1988	Tennant Creek NT	6.8	\$1.0	\$1.20
28 Dec 1989	Newcastle NSW	5.6	\$1500	\$1600

A contemporary dollars, B 1992 dollars.

As an example of the risk, it is instructive to consider the Sydney Basin, which is home to nearly four million people. Since 1850 there have been at least eight earthquakes that have caused shaking levels of equivalent to Modified Mercalli V or greater. These are shown in Table 3.

Table 3. Maximum levels of shaking for the Sydney Basin since 1850.

<i>Earthquake</i>	<i>Date</i>	<i>Maximum intensity Modified Mercalli scale</i>
Maitland	1868	VI
Kurrajong	1919	V
Boolaroo	1925	VI
Robertson	1961	VIII
Picton	1973	VI
Appin	1981	V
Lithgow	1985	VI
Newcastle	1989	VIII

Figure 2 illustrates the areas that have experienced these levels of shaking. If the seismic activity continues at approximately the same levels as these, similar damage can be expected in the future.

It is important that quantitative estimates of future risk are made, so that the building codes and emergency service facilities are tailored to the possible needs of the community.

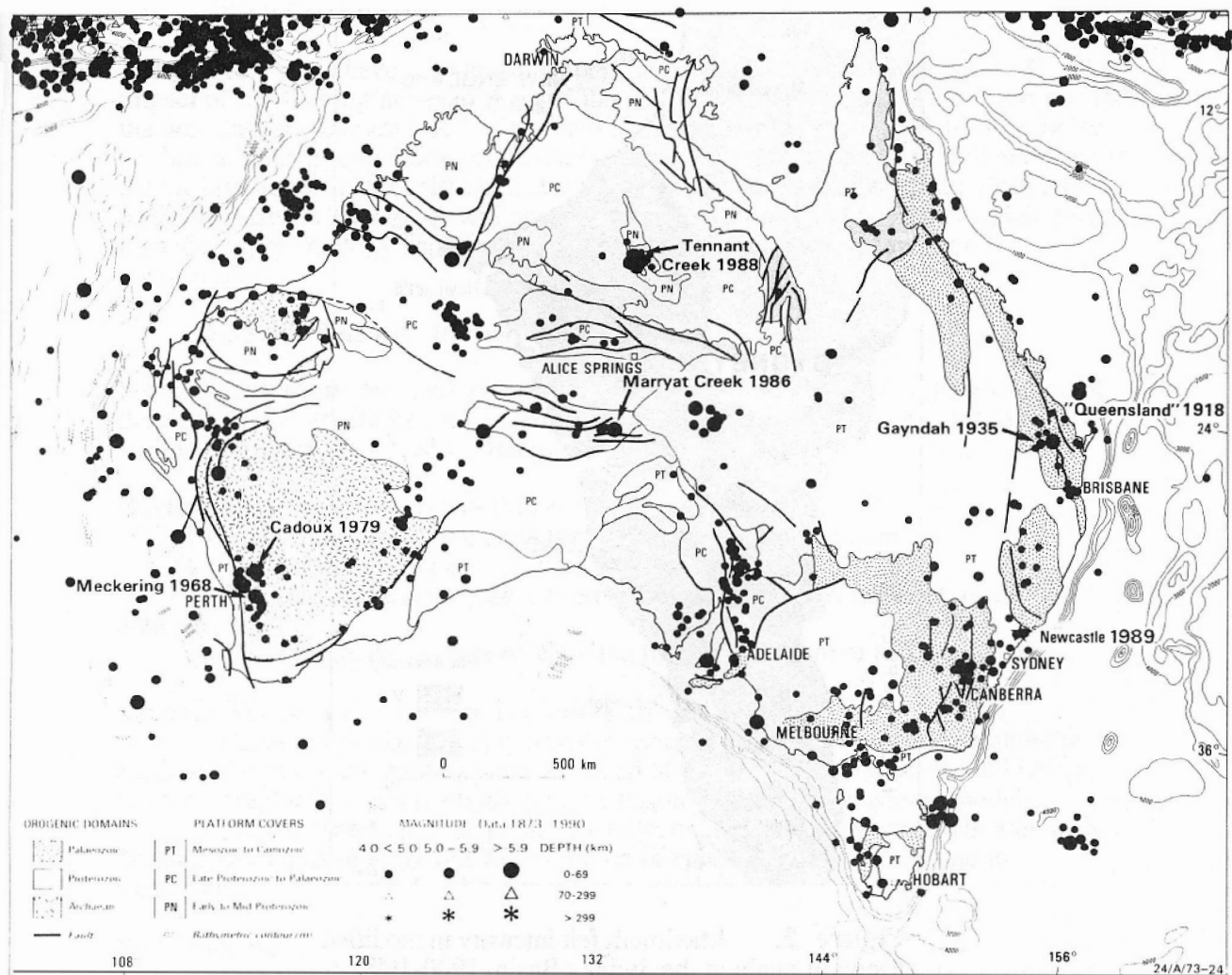


Figure 1. Distribution of known epicentres of earthquakes in the Australian region with magnitudes of 4 or greater for the period 1873-1990. The data set is complete for magnitude 6 and above from 1920 and for 5 and above from 1959. The locations of some 'significant' earthquakes are also indicated. The Cadoux, Marryat Creek, Meckering and Tennant Creek earthquakes were all associated with fault scarps (see Table 1).

MAXIMUM FELT INTENSITY 1900 - 1996

