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Graphical representation of some recent Australian earthquake swarms

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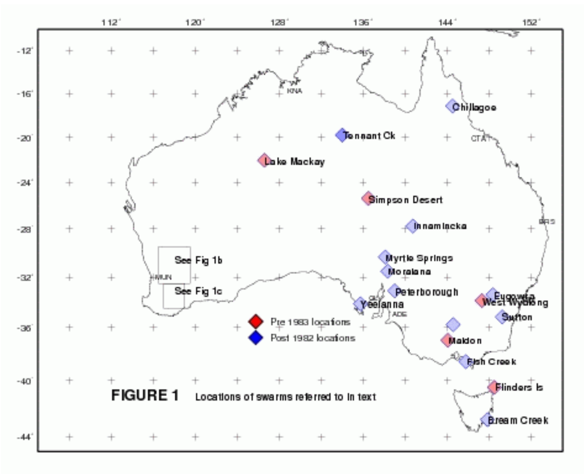
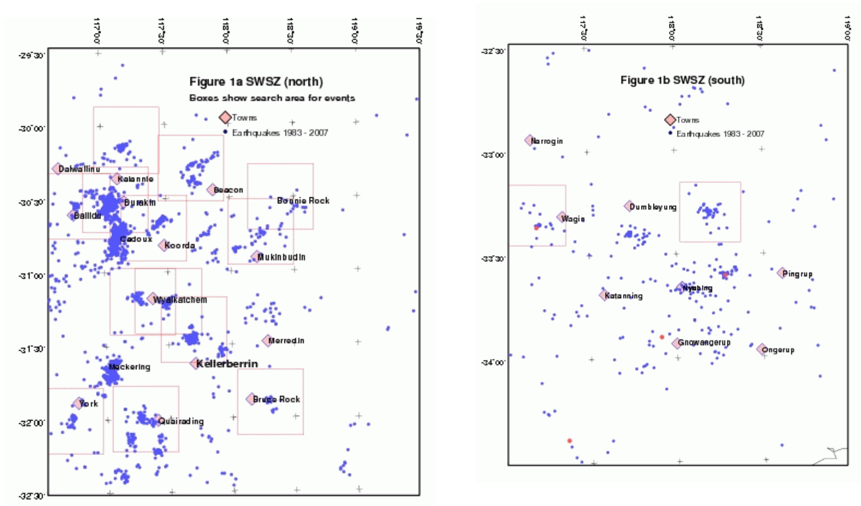


Above: Map showing locations of some of the significant Australian earthquake swarms identified between 1983 and 2007.



Above: Epicentres in the Southwest Seismic Zone (1983 – 2007) and sub-areas from which swarms have been extracted. The pattern of swarms in SWSZ (N) suggests NE trending lineaments, particularly between York and Bonnie Rock .

Earthquake swarms are found in every state – but may be preferentially found in granitic or shield environments. They are the dominant form of seismicity on Eyre Peninsula of South Australia (Love, 2004) and may be even more significant in southwest W.A.

Definition of a swarm …having a number of events within a limited volume, lasting over a period from hours to months, with the largest event well after the start of the swarm, and not having a magnitude significantly greater than the second-largest event (Gibson *et al*, 1994).

The number of catalogued events in a swarm depends heavily on the quality of the seismic network which is monitoring it. Important swarms usually result in the deployment of temporary instruments around them.

Swarms are hard to depict in map form and a graphical method has been devised to help overcome this. It shows the daily number of events over a 90 period, the distribution of magnitudes within this subset, and their aerial distribution

For earthquake risk studies, earthquake catalogues are usually "declustered" to remove "aftershocks" and this may often include swarm events. This may distort seismicity patterns – over 60% of events removed from the catalogue in southwest Western Australia (Leonard 2008). Areas of known swarm activity may need individual attention when considering seismic hazard.

LOCATION	~START	~END	Largest	2nd Largest	Comments
Nthn Tasmania	1883	1892	6.9 (26 Jan 1892)	6.8 (12 May 1885)	2000+ felt events
Simpson Desert NT	Oct 1937	Feb 1942	6.0 (Dec 1937)	5.9 (Apr 1938)	8 events >= 4.0
Lake Mackay WA	24 Mar 70	1992	6.7 (24 Mar 70)	5.7 (16 Jul 71)	13 events >= 5.0
West Wyalong	13 Mar 82	01 Dec 82	4.6 (26 Nov 82)	4.0 (24 Nov 82)	26 events >= 2.5
NSWeman WA	Feb 1984	Jan 1994	4.7 (8 Jul 87)	4.6 (14 Aug 84)	81 events
Eugowra NSW	Aug 1994	Apr 1996	4.1 (21 Aug 94)	3.1 (Sep 1994)	~ 40 events >= 2.0
Burakin WA	Sep 2001	July 2005	5.2 (28 Sep 01)	5.2 (30 Mar 2002)	~350 events >= 2.0

Table: Some important historical Australian earthquake swarms

This is a first step towards future research, allowing various seismic "episodes" to be examined in the same format. The range of magnitudes involved can be seen at a glance, as can their position within the lifetime of the swarm. In this way they may be categorized as a "swarm", "after-shock sequence" or somewhere between the two. The magnitude distribution plot helps indicate whether the sequence fits the Omori decay law for aftershocks, and estimate the magnitude level below which detection capability may be a problem. The location plot indicates whether the plot may be contaminated by surrounding events not related to the swarm being examined, and if there are potential directional features in the swarm.

References

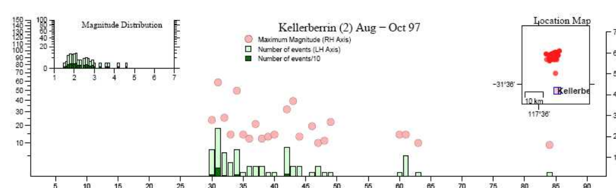
Gibson, G., Vesson, V. & Jones, T. (1994). The Eugowra NSW Earthquake Swarm of 1994. *Proc. Australian Earthquake Engineering Society, Hobart.*

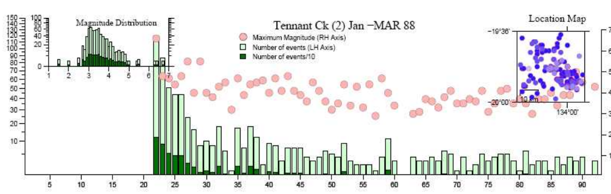
Leonard, M., (2008) 100 years of Earthquake Recording in Australia *Bull. Seismol. Soc. Am.* **98**, 1458 – 1470

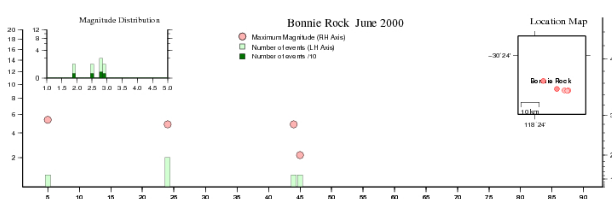
Love, D. N.L., (2004). Detailed recording of swarm activity: Yeelanna, Eyre Peninsula, South Australia. *Proc. Australian Earthquake Engineering Society, Mt. Gambier.*

DATE	LOCATION	# events	Figure #	Region	Temp Inst?
1987 Jan	Tennant Ck	41	**Fig 2.1**	NT	Yes
1987 Feb	Bream Ck Tas	27	Fig 3.1	TAS	
1987 Dec	Wyalkatchem East	13	Fig 3.2	SWWA	
1988 Jan	Tennant Ck	694	**Fig 2.2**	NT	Yes
1988 June	Bunnaloo, NSW	24	Fig 3.3	NSW	Yes
1989 July	Pingrup	5	Fig 3.4	SWWA	Yes
1989 July	Margaret River	14	Fig 3.5	SWWA	
1989 Dec	Wagin	13	Fig 3.6	SWWA	
1990 Mar	Peterborough	13	Fig 3.7	SA	
1990 Apr	Ballidu	21	Fig 3.8	SWWA	Yes
1991 Mar	Ongerup		Not plotted	SWWA	Yes
1991 Nov	Quairading	34	Fig 3.9	SWWA	Yes
1991 Apr	Bradford Hills	49	Fig 3.10	Vic	Yes
1992 July	Lake Mackay,	8	**Fig 2.3**	WA	
1992 Nov	Chillagoe	9	Fig 3.11	Qld	
1991 Nov	Moralana	63	Fig 3.12	SA	Yes
1992 Dec	Mukinbudin	13	Fig 3.13	SWWA	Yes
1994 Mar	Wyalkatchem (West)	13	Fig 3.14	SWWA	
1994 May	Kellerberrin (East)	9	Fig 3.15	SWWA	
1994 Sep	South of Nyabing	6	Not plotted	SWWA	
1994 Aug	Eugowra NSW	85	Fig 3.16	NSW	Yes
1994 Nov	York	27	Fig 3.17	SWWA	Yes
1994 Nov	Myrtle Springs	33	Fig 3.18	SA	
1995 Mar	Nyabing North	27	Fig 3.19	SWWA	
1995 May	Beacon (1)	12	Fig 3.20	SWWA	
1996 Mar	Kellerberrin (1)	137	**Fig 2.4**	SWWA	Yes
1997 Aug	Kellerberrin (2)	75	**Fig 2.5**	SWWA	
2000 Jun	Bonnie Rock	7	Fig 3.21	SWWA	
2000 Sep	Sth of Burakin	28	Fig 3.22	SWWA	
2001 Mar	Bruce Rock	13	Fig 3.24	SWWA	
2001 Sep	Burakin (1)	68	Fig 3.23	SWWA	
2001 Dec	Burakin (2)	98	**Fig 2.6**	SWWA	Yes
2002 Mar	Burakin (3)	217	**Fig 2.7**	SWWA	Yes
2001 Dec	Sutton NSW	15	Fig 3.25	NSW	Yes
2002 Sep	Fish Ck Vic	11	Fig 3.26	Vic	
2003 Oct	Yeela SA	8	Fig 3.27	SA	Yes
2003 Dec	Innamincka SA	10	Fig 3.28	SA	Yes
July 2004	Nyabing	7	Not plotted	SWWA	
2004 Nov	Koorda	22	Fig 3.29	SWWA	
2005 Sept	N of Kalie	46	Fig 3.30	SWWA	
2006 Mar	Beacon (2)	16	Fig 3.31	SWWA	

Table: swarms (1983 – 2007) which have been identified from Australian Seismological Reports and other sources and graphed in full paper (see sample plots below)







Legend for plots to the right: red circles max daily magnitude: light green -# of events per day (dk green = #/10). Magnitude distrbution plot - # of events 0.1 ML magnitude increments