

Response by Seismologists to the 1989 Newcastle Earthquake

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Abstract

The 1989 Newcastle earthquake caused the greatest level of damage and loss of life of any Australian earthquake of the twentieth century. In this the twentieth anniversary year it is important that we remember the human aspect of earthquakes. Here we describe some of the observations and actions of individual seismologists in the period immediately following the earthquake. These include how they initially found out about the earthquake, travelling to Newcastle, installing the aftershock network, interacting with the media and emergency services and ultimately creating the Joint Urban Monitoring Project (JUMP) and the Australian Earthquake Engineering Society.

1. Earthquake Felt Reports

A significant earthquake occurred near the New South Wales coast on the morning of 28th December 1989. It quickly became apparent that it had been felt over a range of at least 300 km with reports being received from parts of Sydney and urban areas to the north and south as far as Canberra. The initial estimates were that the earthquake had occurred somewhere north of Sydney.

2. Near Newcastle

Ms Zuhail Demeera, an SRC Melbourne staff member on holiday near Newcastle, felt the earthquake and phoned her office in Melbourne where Gary Gibson was on duty. He watched the seismograph until the first waves arrived at the Greenvale station which was telemetered in to the SRC office at Bundoora.

In Sydney, Vaughan Wesson was staying with his parents-in-law. He did not feel the earthquake but his brother-in-law did and immediately rang Vaughan. Vaughan then rang Gary at the SRC who confirmed that a “significant” event had occurred somewhere north of Sydney and they started organising a possible response.

3. At Jamison House BMR, Canberra

It was a quiet day at the office - morning tea time actually – with only two people on duty at the BMR seismological centre one of whom was Kevin McCue. He felt the earthquake and jumped to his feet asking the other seismologist whether he too had felt it (an ex-PNG resident familiar with ‘gurias’). Without waiting for an answer, Kevin ran along the hall to have a look at the analogue seismograph telemetered in from Kowen Forest near Queanbeyan. As he got closer he could hear the recorder pen banging backwards and forwards on the seismograph. At that time only three stations were telemetered into the centre; from Kowen Forest in the ACT, Armidale in NSW and Alice Springs in the NT, approximately 500, 280 and 2000 km from the epicenter respectively.

4. Responding

All the telephones in Jamison House started ringing at once; both from people who had felt the earthquake and from the media wanting information - but we had no information on the location or magnitude. Chaos reigned for a while until other BMR staff who had also felt the shaking walked the few hundred metres across to the centre from the main building and started taking phone calls whilst a preliminary location was performed and the earthquake size estimated. Only P wave arrivals could be read from the seismograms, the recorders being so sensitive they were saturated by the strong shaking.

Our first computer location was near Putty about 80 km west of Newcastle, but by about midday we started getting reports of damage in Newcastle. Additional seismograph data phoned or faxed in from the ANU and SRC (normally sent by post), confirmed a location closer to Newcastle. The seismograph at Mount Isa Queensland, was the nearest BMR seismograph (analogue recorders then) not saturated by the amplitude of shaking so we knew the location wasn’t well constrained. There were no seismographs

in the Newcastle area, the nearest was at Riverview College in Sydney, one of Australia's earliest seismographs established by the Jesuits in 1909.

5. Preparing for a field trip

About an hour after the earthquake we were confident that it had occurred in or near Newcastle and SRC decided that Vaughan should immediately drive up to Newcastle to scope out the situation and start selecting possible seismograph sites. It was also negotiated that Tony Corke from SRC and Kevin McCue from BMR should gather together as many portable seismographs as possible and drive up to Newcastle as soon as possible that afternoon and evening.

For those in the office, the afternoon was spent cobbling together field seismographs for installation around Newcastle to record any aftershocks or another main shock. This information would significantly help us with the first earthquake location. Tony left Melbourne by road at about 1pm and Kevin and Bill Greenwood the BMR senior technical officer left Canberra by road about 6pm in two cars. Kevin and Bill were earlier offered a lift by air to the RAAF base with the Governor General but they were not permitted to carry any equipment so the offer was declined.

6. Driving to and around Newcastle

Whilst Vaughan was driving up to Newcastle from Sydney, he found that the local ABC radio station was continuously reporting on news about the earthquake. They were reporting that many buildings had been damaged; people injured and even unconfirmed reports that some people had been killed. This put a very somber slant on everything and heightened Vaughan's desire to do whatever was required to select as many seismographs sites as possible that afternoon. He decided that it was important to set up a "home base" for operations so he selected a hotel away from the city centre to stay for at least that first night.

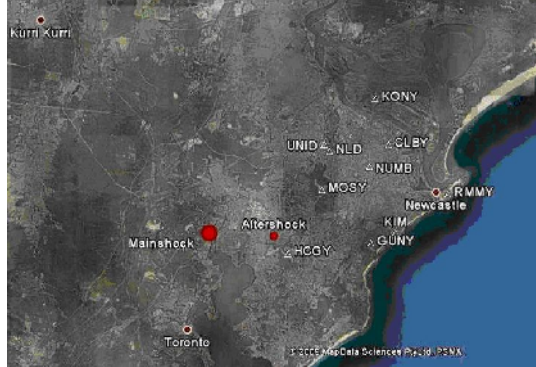
Vaughan then spent the hours until dark driving around Newcastle selecting sites centered on the CBD as this was where damage was greatest. While driving around he saw many damaged buildings, but just from driving down a street it was difficult to determine the extent of the damage. He also came across many road blocks and had discussions with some of the police manning these about contacting and interacting with the other emergency services. He also drove past the Workers Club and it was already apparent that a serious tragedy had occurred there.

Once Kevin got in the car he also turned on the radio which was the first time he had had the chance to listen to the news and heard with disbelief stories of damage, injuries and fatalities.

The BMR and SRC teams met up at the hotel in Ascot Park on the outskirts of Newcastle about midnight and immediately installed an analogue seismograph in the cupboard where we could lift the carpet to place the seismograph on the exposed concrete slab. We sat and watched it for half an hour expecting aftershocks but there were none. Nothing else could be done until daylight so we drove around looking for

supper and ended up with the crowd watching the recovery operations at the Workers Club for an hour and then snatched a few hours sleep.

7. The First Day



Early the next morning, we began to deploy the recorders at sites chosen by Vaughan the previous day (see the map above and photo opposite of a mosquito plagued site near the

John Hunter hospital). Late in the morning we attended a meeting, the first of several, with the Mayor and response and recovery personnel, including Inspector Cleary of the NSW Police and senior Newcastle City Council engineers. Our advice was that given our experience of previous earthquakes of this size in NSW, we would expect to have an aftershock of at least magnitude 4.5. This is small, but large enough to exacerbate the previous damage and cause additional risk for rescue personnel in those damaged buildings within a day or two of the main shock.



One of the chosen sites was in the middle of the racetrack at Broadmeadows (see photo above), distant from road traffic and public access. Somehow the media spotted us from

their helicopter and descended to land about 30 m away for an interview. We were desperate to get the equipment installed and were probably not very welcoming.



Later that night we moved to more central and salubrious quarters in Merryweather with the approval of the owners who were overseas at the time. This house had suffered considerable damage - the chimneys were dangerously sheared and the walls extensively cracked - perfect. We installed the analogue recorder in the basement and waited.

8. The next few days

The next day, after we had completed the network installation of eight digital recorders and two analogue recorders within a 15 km radius of the city centre, we relaxed for the first time over tea and coffee briefing some journalists at about 7pm. Kevin was sitting where he could see the

analogue recorder in the cellar. The phone rang. The duty officer at the Newcastle Police Station said they had just felt another shake - could we confirm that there had been an aftershock?

Nothing was visible on the recorder so Kevin reluctantly lifted the needle and spun the drum around and sure enough, around the other side of the drum was the telltale coda of a small earthquake, which turned out to be the one and only recorded aftershock.

Early Saturday morning we did the rounds to collect data from the field stations to do an earthquake location. The arrival time data had to be sent to Melbourne where Gary Gibson computed the origin time, epicentre and focal depth.

Given the damage concentration in the city centre and Hamilton, we expected the location would be under the city at shallow depth. It took some convincing to accept the location near Booleroo, some 15km SSW of the city and just outside our network at a focal depth of about 12 km. Subsequent analysis showed that this was the centre of the uncertainty ellipse of the main shock which an independent data set confirmed had a similar focal depth.



We surmised that the damage could be attributed to the foundations with parts of the city and Hamilton underlain by alluvium hydraulised from the Hunter River bed to deepen the river channel. Such materials are notorious for adding to earthquake damage by trapping and magnifying the seismic waves and for failing by slumping or liquefaction.

Over the following week we contributed to the Lord Mayor's meetings, briefed print journalists, gave TV and radio interviews and kept the instruments operating. We liaised with seismologists from New Zealand and Queensland and a group of engineers from the Institution of Engineers, Australia, which included Charles Bubb. One of the people who rang us in Newcastle was Professor Bruce Bolt from the Berkley Campus, University of California who hailed originally from northern NSW and studied seismology

at the University of NSW under Professor Bullen. He was rather busy and sent apologies for not rushing out to Newcastle. He sent his commiserations and wished us luck with our study. Bruce did later visit Newcastle and attended a meeting with the Lord Mayor and Council engineers.

9. Study Results and Newcastle Earthquake Aftermath

Our study showed that there was but a single aftershock, contrary to expectations and that its location on the rupture zone of the main shock indicated where the main earthquake occurred, under the Sydney Basin sediments in the Lachlan Fold-belt bedrock at a depth of about 12 km (Gibson et al, 1990).

The aftershock recording on one of the accelerographs of the aftershock network was later used to simulate the ground motion during the main shock (Sinadinovski et al. 1996) and contributed to the development of the 1993 update of the earthquake loading code.

The then federal Minister for Minerals and Energy the Hon Peter Morris MHR, whose portfolio included the Bureau of Mineral Resources, instructed us early in 1990 to leave a network in place to permanently monitor earthquakes in the Hunter Region.

A meeting of state and territory bureaucrats and seismologists in Canberra at BMR in early 1990 agreed to install two strong motion recorders in each major Australian city to monitor the shaking during local earthquakes. The Commonwealth Government was to provide the recorders with the states and territories to maintain them. This became the Joint Urban Monitoring Project (JUMP) which is just now being upgraded by the Commonwealth Government.

At a meeting of the Institution of Engineers Australia in Newcastle in 1990, Charles Bubb and Kevin McCue invited participants to join a new organisation dedicated to reducing the impact of earthquakes in Australia; this became the Australian Earthquake Engineering Society (www.aees.org.au) – the organisation holding this conference.

10. Acknowledgment

We would like to thank the Hughes family for making their house available as our headquarters and Tony Holley who made us comfortable there. We would also like to thank Wayne Peck of ES&S for generating the map of seismograph locations included in this paper. Finally, we would like to thank the anonymous reviewer for their valuable suggestions.

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