

# AEES NEWSLETTER



June 2013

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## President's Report

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I have just come back from my study leave at Tianjin University, China. Tianjin University and the University of Western Australia established a joint Research Centre on Protective Structures in July 2012. I am working closely with my colleagues in Tianjin to build a protective structures lab there.



During my absence, Kevin McCue as AEES representative attended the EA meeting of the Engineering Practice Advisory Committee in Canberra (EPAC) on 14th and 15th March. Kevin reported back that Engineers Australia is undergoing transformational change. The meeting reviewed the Draft General Regulations which were later released on the 28<sup>th</sup> of May for comments. Under this new regulation, EA would like to streamline the relations between technical societies and EA. Some significant changes are: 1) Members of societies such as AEES who are non-EA members will become affiliate members of EA. The affiliate membership arrangement appears to be very straightforward, but at the moment it is not clearly stated whether there will be fees and other complications involved. I attended a teleconference on

4 Feb 2013, regarding the new EA Management Information Systems Renewal Project. EA is developing an online system to facilitate the membership renewal and to keep the members' professional and personal data. Affiliate members might also need to renew their membership and update their personal data annually. 2) Under the new regulations we will operate more closely with EA, instead of rather independently as we do now. We need to submit/inform EA on our plans at the beginning of every year. A teleconference is scheduled on 7 June for further discussions. I will attend the teleconference and seek more information and clarifications.

As many members are aware, EA will hold its first convention in November 2014 at Melbourne Convention and Exhibition Centre (MCEC). Discussions regarding the engagement strategy with technical groups/societies will start soon. According to the initial timeline, the draft program will need be finalized in mid June this year. A convention Web page will be launched and the first call for papers will be announced in mid July 2013 for the conference in 2014. It appears that we will have to start working on the conference preparation much earlier than we usually do for our annual conferences. More coordination work is also expected because our conference will form only a small part of the EA Convention. We probably need to form up a committee to look after all these matters very soon.

In my last report, I mentioned that I have sent a letter to Dr Chris Pigram, the Chief Executive Officer of Geoscience Australia, to express our concerns that the Australian seismic recordings are not kept in Australia but sent to a Database Management Centre managed by IRIS in the United States. It was suggested in the letter that GA should archive and make publicly available strong motion data not only from earthquakes in Australia, but also from large earthquakes in PNG and Indonesia that shake Australian cities. Dr. Pigram has written back to explain the current GA practices in recording and archiving strong motion data, and depending on the prioritisation of resourcing within GA's budget they would like to undertake an investigation into the feasibility of developing a discoverable archive of Australian ground motion data.

As we discussed in the last AGM, with the suggestion by an AEES past-President Bill Boyce, we will offer a scholarship up to \$3000 per year to suitably qualified postgraduate or undergraduate honours students in an Australian University, undertaking research related to earthquake engineering or seismology that is consistent with the objective of AEES. The scholarship announcement has been circulated in EA newsletters, and is also available on the AEES home page.

Sharon visited Tasmania and inspected a number of venues and sites for our annual conference and functions this year. The venue has been finalized and the conference preparation is well underway. The abstract submission has just been closed. Kevin has contacted a few people for possible supports, sponsorship, and technical tours. Sharon will work out the conference and social program based on the number of participants. I am sure it will once again be a small but very fruitful and enjoyable event. I am looking forward to seeing as many of you as possible in Tasmania in November.

Hong Hao

AEES President

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### The 2011/12 AEES Committee

President: Prof Hong Hao, UWA  
Secretary: Paul Somerville, Risk Frontiers  
Treasurer: Mark Edwards, GA  
Committee members: Helen Goldsworthy, Melb Uni  
IAEE Representative: Prof Hong Hao, UWA  
Secretariat: Sharon Anderson  
Editor: Kevin McCue, CQU  
Webmaster: Adam Pascale, ES&S

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Queensland Russell Cuthbertson, ES&S  
New South Wales (Michael Neville)  
Tasmania Angus Swindon  
ACT Mark Edwards  
South Australia David Love  
Western Australia Hong Hao  
Northern Territory tba

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## Bridge Repair in San Francisco

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Bay Bridge repair could cost \$5M-\$10M

*SMH May 9, 2013 by JASON DEAREN*

The planned repair for broken seismic safety rods on the new span of the San Francisco-Oakland Bay Bridge (Ed. damaged in the 1989 Loma Prieta earthquake) could cost between \$5 million and \$10 million, a state transportation official said Wednesday.

Officials still don't know whether the repair will be done in time for the span's scheduled Labor Day opening, but say it's still possible. A decision is expected May 29.

California Transportation Commission Executive Director Andre Boutros told a meeting of the Bay Area Toll Authority that the repair for the 32 snapped rods involves installing steel saddles.

The saddles would be placed over the base of the seismic shock absorber that was initially intended to attach to the bridge by the rods. About 430 steel cables covered in concrete will tie down the saddles. Another repair option would have been more expensive.

Officials said they aren't taking short cuts in an attempt to get the bridge opened on schedule.

"We're dealing here with not only engineering concerns but public confidence, and public confidence has taken a beating over the last few weeks, and we are mindful of that," said Steve Heminger, executive director of the Metropolitan Transportation Commission.

Bridge officials Wednesday also sent a letter to the Federal Highway Administration requesting an independent review of the California Department of Transportation's investigation into the broken rods, and the chosen fix.

The rods connect earthquake safety devices called shear keys to the deck of the bridge and a large concrete cap. Shear keys are like big, steel shock absorbers that help control swaying during an earthquake.

The new bridge, which is replacing a span damaged during the 1989 Loma Prieta earthquake, is already years late in opening and billions of dollars over budget.

Documents released last month by the California Department of Transportation show its inspectors found structural integrity issues with some of the rods several years ago, before they were installed.

The documents were unclear about whether the problems were remedied before the rods were delivered and installed, but official later said they were. The inspectors noted that they failed elongation tests for structural integrity and said they were concerned about the quality of work by the company that galvanized them to prevent corrosion.

According to a metallurgists' investigative report released Wednesday, the steel in the broken rods was "found to be less than ideal."

The report said the hydrogen corrosion in the rods could have been discovered earlier if Caltrans had required tougher tests. The agency is developing new requirements that would require more testing in the future.

Crews also are testing bolts installed in shear keys on other parts of the bridge. So far there have been no signs of weakness, Heminger said.

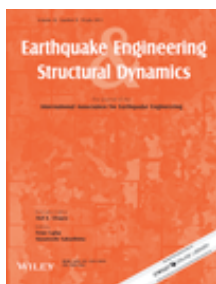
Also, bridge crews are developing further "wet tests" to address concerns that bolts might corrode in the future.

"After the wet tests we'll know whether these bolts are OK or not, and those that are not we're going to rip them out and replace them," Marwan Nader, a bridge structural engineer working on the repairs, said.

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## Earthquake Engineering & Structural Dynamics

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*Edited By: Anil K. Chopra, Peter Fajfar, Masayoshi Nakashima*

THESE EARLY VIEW ARTICLES  
ARE NOW AVAILABLE ON  
WILEY ONLINE LIBRARY

### Research Articles

Experimental study of the seismic behavior of partially concrete-filled steel bridge piers under bidirectional dynamic loading. by *Huihui Yuan, Ji Dang and Tetsuhiko Aoki*

Optimal design of an equipment isolation system with nonlinear hysteretic behavior. by *Anna Reggio and Maurizio De Angelis*

Dynamics of inelastic base-isolated structures subjected to analytical pulse ground motions. by *Michalis F. Vassiliou, Anastasios Tsiavos and Božidar Stojadinović*

SOFIE project - 3D shaking table test on a seven-storey full-scale cross-laminated building. by *Ario Ceccotti, Carmen Sandhaas, Minoru Okabe, Motoi Yasumura, Chikahiro Minowa and Naohito Kawai*

Blind modal identification of output-only structures in time-domain based on complexity pursuit. by *Yongchao Yang and Satish Nagarajaiah*

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## Report on NZSEE Conference 2013 - Wellington

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by *Gary Gibson UniMelb and ES&S*

The New Zealand Society for Earthquake Engineering annual conference is always a useful and enjoyable meeting, but the 2013 meeting was exceptional.

Rather than the normal format of three half-days (Friday afternoon, Saturday and Sunday morning) plus a Saturday afternoon excursion, this year the meeting went for three full days from April 26 to 28. It was held in the excellent Michael Fowler Centre in central Wellington.

More than 600 people attended the conference, some 50% more than normal. About five people represented Australia, fewer than normal.

The standard was set in the conference opening ceremony, when the Mayor of Wellington City, Celia Wade-Brown, gave an inspiring presentation on the role of local government in risk mitigation.

About half of the conference time was spent in single session keynote addresses, invited presentations or forum sessions. All were excellent.



*NZSEE President Stefano Pampanin (right) and immediate past-President Peter Wood, on stage at NZSEE2013.*

The keynote addresses were by Mary Comerio (UC Berkeley, USA) on *Resilience: An Engineering Challenge*, Prof Sudhir Jain (Director of IIT, India and President Elect, IAEE) on *Earthquake Engineering on the Modern World*, and Claudio Moreno (University of Padova, Italy) on *Retrofit of Heritage Buildings*.

Invited presentations were by John Hare on earthquake engineering in New Zealand, Jerome Sheppard and Dave Brunson on earthquake assessment of school buildings, Kelvin Berryman on the Canterbury earthquake sequence, Russ Van Dissen on earthquake hazard about Wellington, Adrian Regnault on learning from Canterbury earthquakes to strengthen building performance, Bruce Chapman on conserving our built heritage, and Rod Cameron and Peter Kinley on a disaster rebuild model for infrastructure.

The forums held were on *Satisfying New Zealand's Appetite for Earthquake Risk*, and *Heritage Building's: What are the New Realities?*

A total of 60 specialist papers were presented in three parallel sessions, including one by our Helen Goldsworthy on displacement-based assessment.

The standard of posters was particularly good.

Saturday afternoon provided a choice of activities, including a memorable tour of the geological setting of Wellington by Russ Van Dissen, followed by visits to several buildings of earthquake significance by David Wood, Peter Holden, Gary Layfield and Alistair Cattanach.

This was an exceptional conference that showed the changes resulting from the Canterbury earthquakes. For Australians interested in any aspect of earthquakes, the short flight to New Zealand for the NZSEE conference is a very good investment.

#### Letter to Editor re NZSEE Conference

Good afternoon Kevin Good to hear from you; we missed you at the Conference.

Yes, we are receiving complementary comments on the material presented at the Conference, particularly as invited speakers were able to provide their thoughts on lessons learnt from Christchurch and how they are influencing current developments. The Government has accepted most of the recommendations from the Canterbury Earthquakes Royal Commission so real effort is being inputted into developing or amending guidelines, through to changes in legislation.

Conference presentations, particularly keynote and invited presentation are available from the Conference website

[www.confer.co.nz/nzsee/index.htm/files/NZSEE\\_2013\\_CONFERENCE\\_PROGRAMME\\_SUMMARY\\_PAPERS-2.pdf](http://www.confer.co.nz/nzsee/index.htm/files/NZSEE_2013_CONFERENCE_PROGRAMME_SUMMARY_PAPERS-2.pdf)

The presentation that are available for download are highlighted. Just click on the 'title' or 'presentation here' as appropriate to download.

Hope to see you next year in Auckland.

Best regards,

Win Clark  
Executive Officer  
NZSEE

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#### Judging the seismologists - Italy

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from Lizzy Davies *Guardian* 18 Jan 2013

The Italian judge who sentenced seven of the country's natural disasters experts to six years in jail for manslaughter in connection with statements they made before the L'Aquila earthquake of 2009 has criticised the advice they gave as "vague, generic and ineffective".

Explaining his judgment, Marco Billi, the judge who in October stunned the scientific world by handing down sentences even harsher than the prosecution had requested, said the experts had given reassuring statements in the days before the quake that might have led some residents to stay in their homes.

"The assertions made concerning the assessment of risks connected to the seismic activity in the area around L'Aquila turned out to be completely vague, generic and ineffective," Billi wrote. Three hundred and nine people died and tens of thousands were made homeless when the earthquake struck the town in the central Abruzzo region of Italy.

The six seismologists and one government official sentenced included Enzo Boschi, former president of Italy's National Institute of Geophysics and Volcanology, who on Friday rejected the judge's accusations. "I absolutely do not feel guilty," he told Ansa news agency. "Does the judge not think that, after having spent years exposing the seismic nature of Italy, I would have suddenly said that there was no risk of earthquakes in L'Aquila? It's all senseless. What reason would we have had for reassuring people? What would we have gained by it?"



In his explanation – which, under Italian law, a judge has to publish within 90 days of a sentencing, and which, in Billi's case, ran for more than 900 pages – he was at pains to say the experts had not been sentenced for failing to predict the earthquake, a task he acknowledged was impossible.

"Science is not being put on trial for not having succeeded in predicting the earthquake of April 6th 2009," he wrote. "The task of the accused ... was certainly not to predict the earthquake and indicate the month, day, hour and magnitude, but rather, more realistically, to go ahead ... with the prediction and prevention of the risk".

The experts, who were members of the National Commission for the Forecast and Prevention of Major Risks, remain free pending the appeals process.

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## Delay installing Adelaide seismograph

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Professor Milne, father of modern seismology, first proposed in 1895 that a seismograph should be established at Adelaide. It was finally ordered and delivered in 1907 but sat in the Adelaide vault for 15 months while politicians fiddled before it was inaugurated.

We are so impatient today!

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## Hazard analysis - Australian natural gas pipeline

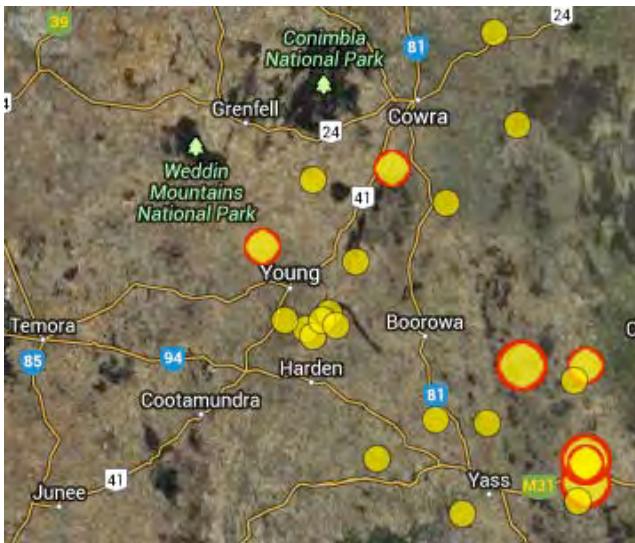
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*Ed: During a routine trawl of the web, the following report was found and the editor thought that some of the assumptions were interesting.*

<http://www.apa.com.au/media/175530/ywl%20preliminary%20hazard%20analysis.pdf>

I had to share this with you, perceptions of earthquake hazard obviously vary from person to person. The figures are available on the public record but are not in the report].

Due to the potentially hazardous nature of natural gas, NSW pipelines are classified 'potentially hazardous' by the NSW Department of Planning.



**Figure 1** Historical earthquakes within ~50km of Young NSW from 1901 to 2013, altogether 152 events with  $ML \geq 3$ .

The Department requires a Preliminary Hazard Analysis (PHA) to be prepared in accordance with the requirements of Hazardous Industry Planning Advisory Paper (HIPAP) No. 6: Guidelines for Hazard Analysis (Reference 1) and for the risk to be evaluated and compared with their risk criteria, as specified in their HIPAP No. 4: Risk Criteria for Landuse Planning.

1 Ground movement. Earthquakes account for about 5% of all historical incidents could potentially cause a failure of a pipeline due to the high forces involved. *Earthquakes are not particularly common in this area and steel pipelines have been shown to be very resistant to failure in these circumstances.*

2 The frequencies used for all below ground gas piping and for all pipelines installed as per AS2885 (Reference 5) requirements are based on incident statistics between 1988 and 1992, gathered by the European Gas Pipeline Incident Data Group (EIGPIDG).

**Figure 2** Tennant Ck NT gas pipeline, after the earthquakes on 22 January 1988 (below).



Discussion. Even though *many of the assumptions in this PHA are conservative*, the results show that the risk associated with the gas pipeline is very low. The most stringent risk criteria, as required by the NSW Department of Planning, are adhered to.

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## Letter to Editor - Scholarships

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Dear Colleague,

Please find below information about the Advanced Master Course in Structural Analysis of Existing Buildings, Monuments and Historical Constructions (call 2).

I kindly invite you to disseminate this information to anybody who could be interested in applying.

**SCHOLARSHIPS FOR THE ADVANCED MASTERS  
IN STRUCTURAL ANALYSIS OF MONUMENTS  
AND HISTORICAL CONSTRUCTIONS**

Applications for the Advanced Masters in Structural Analysis of Monuments and Historical Constructions, approved by the European Commission within the framework of the Erasmus Mundus Programme, are opened up to May 20, 2013 (call 2).

This Master Course is organized by a Consortium of leading European Universities/Research Institutions in the field, composed by University of Minho (coordinating institution, Portugal), the Technical University of Catalonia (Spain), the Czech Technical University in Prague (Czech Republic), the University of Padua (Italy) and the Institute of Theoretical and Applied Mechanics of the Czech Academy of Sciences (Czech Republic). The course combines the most recent advances in research and development with practical applications.

A significant number of scholarships, ranging from 3500 to 13000 Euro, are available to students of any nationality.

The SAHC leaflet can be downloaded at [www.msc-sahc.org/upload/docs/Leaflet\\_low.pdf](http://www.msc-sahc.org/upload/docs/Leaflet_low.pdf)

Please find full details on the MSc programme, as well as electronic application procedure, on the website [www.msc-sahc.org](http://www.msc-sahc.org)

Yours sincerely,

Paulo B. Lourenco

Course Coordinator

Editor of the International Journal of Architectural Heritage: Conservation, Analysis, and Restoration

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## Conferences

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### 3 July 2013 Quantitative Risk Assessment in Geotechnical Engineering - One Day Short Course.

Wednesday 3rd July 2013, 9am - 5pm, Romfords, Tamaki Yacht Club, Auckland

Course information: This one day short-course starts by reviewing basic probability theory and introduces the idea of treating geotechnical engineering properties as random variables. To investigate the reliability of geotechnical designs, a variety of risk assessment tools of varying complexity are at our disposal.

[www.nzgs.org/branch/meetings\\_item.htm?id=180](http://www.nzgs.org/branch/meetings_item.htm?id=180)

**11 - 14 August 2013** 23rd International Geophysical Conference & Exhibition 2013 'Eureka Moment' (ASEG-PESA2013), which will be held in Melbourne, Victoria, Australia.

Website: [www.aseg-pesa2013.com.au](http://www.aseg-pesa2013.com.au)

**20 - 23 November 2013** the 19th NZGS Symposium "Hanging by a Thread - Lifelines, Infrastructure and Natural Disasters". Queenstown, New Zealand.

[www.nzgs13.co.nz/](http://www.nzgs13.co.nz/)

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## Canada – Magnitude 5 earthquake

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*This article has been partly extracted from the Daily Observer and National Post by Ryan Paulsen at the Daily Observer and Katrina Clarke and Allison Cross at the National Post.*

Two earthquakes shook eastern Ontario and Quebec Friday morning, rattling buildings and nerves as far away as Barrie, Toronto and Waterloo.

AEES Newsletter editor Kevin McCue recently returned from a visit to Ontario just in time “Our host reports from London, Ontario that he was busy and didn’t feel the earthquake.”

The epicenter of the magnitude 5.2 earthquake was the Shawville area (see map). The Natural Resource Canada automated reporting centre originally labelled it a 4.8 quake located in Braeside, Ontario, the NRC Earthquakes Canada web site was soon updated to show the quake centred approximately 20 km northeast of Shawville, QC. An aftershock minutes later measured magnitude 4.1.

Sounds like low-flying helicopters, noisy trucks or military exercises accompanying the shaking, awoke some and drove others out of their houses.

In Pembroke, students at Highview Public School were evacuated for approximately 30 minutes as a precaution, while students and staff at Our Lady of Sorrows in Petawawa took shelter beneath desks until the tremors subsided. No injuries and no damage to school property anywhere to be seen.

At the municipal level, staff checked infrastructure, bridges, roads, buildings and such, but there were no damage reports. Petawawa Mayor Bob Sweet reported no damage or injuries by late afternoon.

Officials at the Municipality of Shawville report that staff conducted full inspections of township infrastructure and buildings, and reported no structural damage, although some residents called in reporting minor damage to things in their own homes.

One story reported: The last time a magnitude 5 earthquake hit central Canada was in 1944 when the Ontario-New York border near Cornwall was rocked by a quake with a magnitude of 5.8, and before that, a quake hit Temiscamingue along the Ontario-Quebec border in 1935, measuring 6.1.

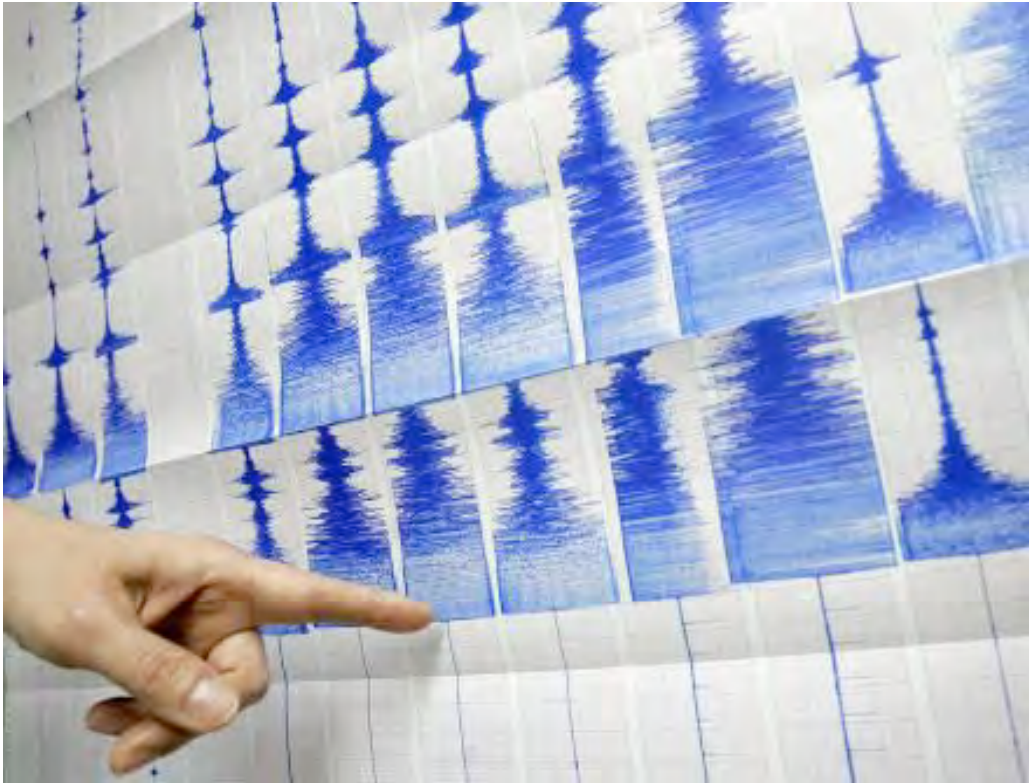
Another story reported “The area of western Quebec where Friday’s quake was centered is an area of persistent seismicity.” Cindy Ebinger, Professor of earth and environmental sciences at the University of Rochester said there had been foreshocks over the past week – smaller temblors that foreshadowed Friday’s larger event. Another quake of magnitude 5.0 occurred about 50 east of Shawville on June 23, 2010. That event was felt in western New York as well.

John Ebel, director of the Weston Observatory at Boston College, said the same seismic area was home to a magnitude 6.2 quake in 1935. That one caused the collapse of a railroad embankment and some structural damage.

Ebel said he wouldn’t expect anything of that nature from Friday’s event. “A magnitude 5 is right at the threshold at which damage starts. There could be chimney damage, cracked plaster, things being knocked off shelves. I would not expect anything major like building collapses.”



Earthquakes generally occur where tectonic plates collide, as is the case of the San Andreas fault in California. But according to information on the website of the U.S. Geological Survey, the Western Quebec seismic zone is different. There are no plate boundaries there. Instead, the seismic zone is laced with known faults, but numerous smaller or deeply buried faults remain undetected. Even the known faults are poorly located at earthquake depths.



Accordingly, few, if any, earthquakes in the seismic zone can be linked to named faults. It is difficult to determine if a known fault is still active and could slip and cause an earthquake. As in most other areas east of the Rockies, the best guide to earthquake hazards in the Western Quebec seismic zone is the earthquakes themselves," the USGS post said.

*Ed – sounds like an Australian scenario earthquake! I thought it was also interesting they still use analogue seismograms in Canada.*

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## Geelong Vic earthquake

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**01 May 2013, 16:41 UTC, 144.5E, 38.1°S, 11km deep**

A magnitude 3.1 earthquake near Geelong at 2.41am local time was widely felt in Geelong but caused little damage. People throughout the city reported hearing a low rumble.

A garage in Grovedale ended up with multiple cracks across the floor. "There are all these cracks, it is like a road map, they are running in all directions," the property owner said. A Lovely Banks resident said the quake unnerved him. "The windows rattled (and the) whole house was shuddering. It felt like a massive truck had tipped over in front of my place. The floor moved backwards and forwards, causing me to lose my balance."

The epicentre computed by the ES&S Seismology Research Centre was in Corio Bay, about 15 km east of Geelong.

Other recent earthquakes felt in the area include a 4.5 magnitude earthquake 100km south-east of Melbourne that was felt in parts of Geelong on March 18, 2009. Residents in Belmont, Grovedale, Waurm Ponds and Jan Juc all reported feeling the quake about 4.30pm; and on March 6, Geelong was rocked by a magnitude 4.6 tremor in Gippsland.



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## Great earthquake in Russia's Far East

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Okhotsk 2003-05-24 at 05:44 UTC, Magnitude Mw8.3

The World's greatest earthquake so far in 2013 occurred at ~600km depth in Russia's Far East, causing no damage and, naturally, no tsunami.

MOSCOW (AP) – A great earthquake on Friday hit Russia's Far East with tremors felt as far away as Moscow, about 7,000 kilometers (4,400 miles) west of the epicenter.

Marina Kolomiyets, spokeswoman for Obninsk's seismic station of the Russian Academy of Sciences, told The Associated Press the epicenter was in the Sea of Okhotsk, east of the Russian coast and north of Japan. She said the quake registered 8.0 on the Richter scale.



**Figure 1.** Epicentre from the EMSC.

Emergency agencies in the Far East issued a tsunami warning for Sakhalin and the Kuril islands, but lifted it soon afterwards.

The U.S. Geological Survey quickly updated its original magnitude estimate of 8.2 to 8.3. The epicenter was in the Kuril-Kamchatka arc, one of the most seismically active regions in the world.



**Figure 2.** Focal mechanism of the earthquake from the USGS. Slip was on a vertical fault oriented NNE or a horizontal fault striking WNW. The first motion on the P-wave at Australian continental stations should be a dilatation, good chance to check the station polarities.

Russian news agencies reported that residents of Petropavlovsk-Kamchatsky on the Kamchatka peninsula in the Okhotsk Sea felt the tremors for about five minutes. Residents ran out of buildings. School children were evacuated.

Tall buildings shook in Moscow, prompting people to evacuate buildings across the city. Tremors are rare in Moscow, the last remembered instance was in 1977, caused by the 90km deep, magnitude 7.5, Vrancea earthquake in Roumania.

Russian news agencies reported strong tremors felt across Siberia and others report it was felt in Japan.

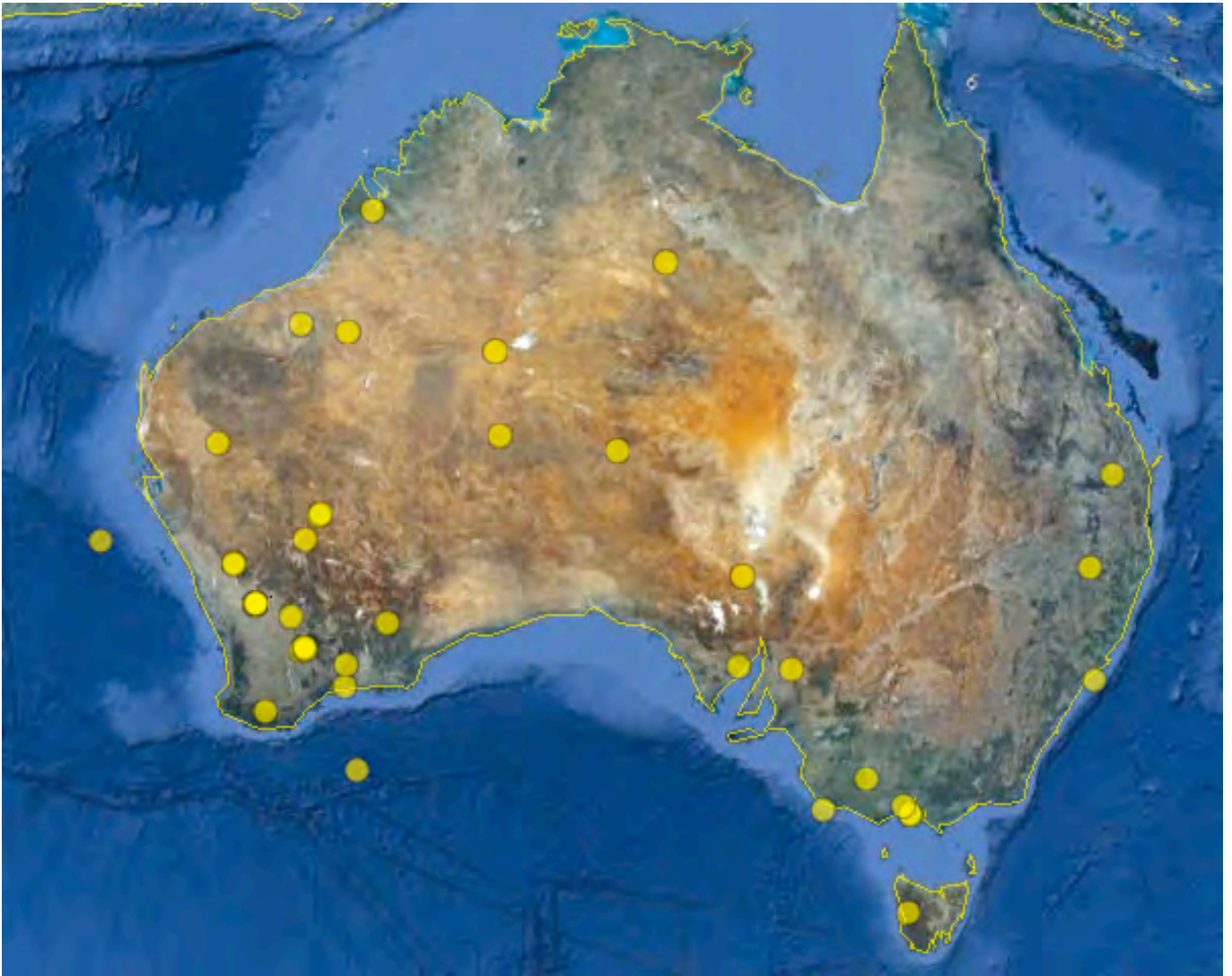
# Australian Earthquakes March to May 2013

This past quarter was very quiet in Australia earthquake-wise, the largest event only ML 3.7.

**Table:** Earthquakes in the Australian region, magnitude 2.5 or greater, located by Geoscience Australia, the ES&S Seismology Research Centre and PIRSA (the latter solutions show no seconds in time).

UTC Date dd/mm/yy	UTC Time	Latitude	Longitude	Depth (km)	ML	Approx. location
03/03/13	21:36:12	-32.38	119.28	1	3.4	NE of Hyden, WA.
03/03/13	13:25:24	-32.29	119.25	10	2.5	NE of Hyden, WA.
03/03/13	09:27:39	-32.41	119.05	10	2.6	NE of Hyden, WA.
03/03/13	09:26:41	-32.32	119.16	10	2.6	NE of Hyden, WA.
05/03/13	06:37:12	-30.65	117.43	4	2.7	N of Koorda, WA.
07/03/13	00:25:44	-33.05	152.06	0	2.5	Offshore Newcastle, NSW.
08/03/13	21:59:20	-21.74	122.23	10	3.4	SE of Marble Bar, WA.
11/03/13	10:32:34	-19.86	133.89	13	<b>3.7</b>	SW of Tennant Creek, NT.
15/03/13	04:40:02	-22.76	127.69	10	3.6	W of Lake Mackay, WA.
20/03/13	23:14:46	-17.63	123.37	10	3.1	SW of Derby, WA.
21/03/13	04:08:54	-25.58	127.74	10	2.9	SE of Warakurna, WA.
24/03/13	11:48:39	-27.72	111.09	10	2.9	W of Kalbarri, WA.
25/03/13	07:53	-38.65	140.70	25	3.2	South of Portland, Vic.
26/03/13	18:07:02	-33.02	120.89	15	3.0	W of Salmon Gums, WA.
27/03/13	23:35	-33.43	136.96	7	3.0	Cowell, SA.
27/03/13	14:10:13	-25.001	116.76	10	2.5	NW of Meekatharra, WA.
30/03/13	13:22:36	-37.21	142.67	11	2.8	NW of Ararat, Vic.
05/04/13	12:20	-42.1	145.5	5	3.2	Near Queenstown, TAS.
08/04/13	09:39:07	-29.19	116.77	0	2.5	E of Morawa, WA.
12/04/13	09:49:06	-21.30	120.47	20	3.3	E of Marble Bar, WA.
14/04/13	22:20:30	-38.44	144.88	9	2.8	Rye, Vic. (largest of swarm)
14/04/13	12:59:59	-38.39	144.84	6	2.5	Rye, Vic.
20/04/13	01:34:20	-28.61	119.86	18	2.6	NW of Leonora, WA.
22/04/13	21:02	-33.26	139.05	12	2.9	Near Hallett, SA.
25/04/13	12:13:45	-31.20	118.86	6	2.5	NE of Westonia, WA.
29/04/13	06:32	-42.7	148.3	5	2.6	East of Tasmania
30/04/13	08:23:14	-27.80	120.61	8	2.7	Near Leinster, WA.
01/05/13	19:41	-30.38	136.75	0	3.5	* Near Olympic Dam, SA
01/05/13	16:41	-38.1	144.5	11	3.1	Corio Bay, Vic.
02/05/13	17:27:35	-36.75	120.70	10	3.4	Offshore SE of Albany, WA.
03/05/13	17:10:31	-33.77	120.71	12	2.8	SW of Munghlinup, WA.
05/05/13	06:31:20	-27.86	120.52	0	2.7	Near Leinster, WA.
07/05/13	21:48	-26.21	132.16	5	3.3	Ernabella, SA.
13/05/13	20:44:52	-31.69	122.83	0	2.8	NE of Norseman, WA.
13/05/13	11:08	-29.2	150.8	5	3.3	Ashford, NSW.
17/05/13	15:11:06	-30.62	117.46	4	3.3	N of Koorda, WA.
20/05/13	05:14:04	-29.143	116.745	15	2.5	E of Morawa, WA.
22/05/13	15:48	-25.7	151.1	4	2.8	Mundubbera, Qld.
22/05/13	10:47:38	-34.396	117.066	0	2.6	Frankland River, WA.
24/05/13	01:51:37	-30.646	117.411	5	2.9	N of Koorda, WA.
24/05/13	01:39:36	-30.614	117.421	0	2.7	N of Koorda, WA.

\* mining induced seismic event – not strictly an earthquake



**Figure:** Epicentres of earthquakes  $M \geq 2.5$  in Australia and the region, 01 March– 31 May 2013, locations by Geoscience Australia. Some earthquakes located by the ES&S Seismology Research Centre or PIRSA and not by GA, but tabulated above, are not plotted. This may be due to the different magnitudes allotted by the different agencies, up to 0.4 in magnitude, but also because the event was outside the locatable range of the National Network.

If you have a Kelunji seismic recorder, contact the ES&S Seismology Research Centre to get your free update to download eqWave 3.2, the brilliantly user-friendly seismic waveform viewer. [seismology@esands.com](mailto:seismology@esands.com)

*The ES&S Seismology Research Centre proudly supports the AEES website and newsletter*