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AEES is a Technical Society of IEAust The Institution of Engineers Australia and is affiliated with IAEE

1/2004

AEES Newsletter

Contents

President's Column

Happy New Year to all our members and recipients of this Newsletter. I trust 2004 will be kind to us all. It is shaping up to be a busy, and I hope noteworthy, year already. Some of you will have noted that 2004 marks 50 years since a large earthquake (M 5.5) struck Adelaide – March 1st local time to be specific. The Society is assisting locals with plans to commemorate the anniversary – a public lecture on the evening of the 1st followed by a cocktail party in a building recently upgraded seismically. No doubt, a number of press releases and hopefully follow-up interviews will be conducted to promote the occasion and, more importantly, the importance of the continuing efforts and aims of our Society and its members.

To that end, the national executive has prepared and made a submission to Engineers Australia that outlines our Society's goals for 2004 with a request for some funding to promote and implement a national Urban Search and Rescue training scheme for engineers. A list of the AEES goals for 2004 can be seen later in this newsletter. The majority of them came out of the discussions at our AGM and the open forum at the close of our Melbourne conference last November. For those that could not attend, a copy of the minutes from the 2003 AGM are also attached with this newsletter.

I would like to alert members that this year's annual technical seminar and AGM is planned for Mount Gambier, most likely in the first week of November. Please pencil this date in your diary and we will endeavor to confirm the actual dates as soon as possible. Other news that I am pleased to report at this time is that the Board of the Earthquake Engineering Research Institute in the United States has endorsed and signed a Memorandum of Understanding between EERI and our Society (AEES). It is on its way to us for our executive to assess and if consistent with our original draft, I propose to sign it and so establish our first formal commitment to international collaboration towards the common goals of our respective societies.

As for our other goals for 2004, I am informed that work is progressing and we hope to have a few more rungs on the board before our next AGM! In closing, I know all our members support me in my sending our best wishes for a full and speedy recovery to Barb Butler, who sadly injured herself during last year's conference.

Mike Griffith

Letters to Editor

Abandonment of the Draft of AS1170.4

I refer to the article in the most recent AEES Newsletter in regard to the draft AS/NZS 1170 Structural Design Actions – Part 4 Earthquake Actions and the abandonment of the current draft. If this report is correct, I am extremely disappointed by this action and believe that this decision is a retrograde step and one that may not have been fully considered. There is enormous amount of time and effort both voluntary and paid by very many dedicated people on such code committees and such work should not be abandoned without due process.

The 1993 version of AS 1170.4 has been in use for over 10 years and has reached the end of its life. All codes should be updated or rewritten to incorporate new research, understanding of design and also reflect the needs of the community and technical users for such documents. I believe it is imperative that

we move forward with a new code and that it is a worthwhile exercise in upgrading an old code.

I have considerable sympathy with current Code Committee in preparing such a document for two divergent earthquake communities as set out in the statement from the Commentary reproduced below.

> *"At the outset it needs to be acknowledged that this document is a brave attempt to harmonise the previously dramatically different approaches to the design for earthquake between Australia and New Zealand. While a brief glance at the hazard factor maps suggests that the hazard in the north of the North Island of New Zealand is of similar magnitude to that in certain areas of Australia, e.g. regions around Newcastle and Adelaide, it must be appreciated that the earthquakes and the seismicity of the two countries are different. The earthquakes influencing the design in New Zealand are inter-plate events while those in Australia are intra-plate events. Broadly speaking, while the 'magnitude' of both types can be measured on the same scale but the duration of the earthquake and likely number of incursions beyond the elastic range of a structure under each will be significantly different in Australia to New Zealand. This will be discussed in more detail later in this Commentary. It is mentioned at this stage so that users will understand the reason for the division, that occurs in a number of places throughout the Standard, between the provisions for Australia and those for New Zealand."*

Unfortunately the 1993 AS 1170.4 Code Committee made it difficult for the current code committee by producing a fairly simple and basic code. It could be argued that earthquake loads were probably on the low side and perhaps we should have increased the design requirements. Because AS 1170.4 was the first real national earthquake code, we needed to be careful not overextending the design effort required. In 1993 when the code was first produced earthquake engineering was an alien concept to most Australian engineers except that they had seen the effects of the Newcastle earthquake four years earlier in 1989.

Today there are several generations of engineers (mainly structural engineers) in Australia who have reasonable experience in earthquake design and the earthquake code. As well there is sophisticated software to assist designers. Unfortunately the engineering design community in Australia usually does not take kindly to the introduction of new codes where they are radically different from previous codes or are difficult to understand or impose significant design effort for little real gain. Such new codes can raise the wrath and ire of the design community in Australia resulting in considerable political pressure on Standard Australia.

The 1993 version of AS 1170.4 achieved a compromise between pragmatism and ideals and the code which while it added a small cost to the overall cost of building it did significantly improve the lateral resistance of buildings to earthquakes and at a level which was affordable and achievable. The problem is that all codes set only **minimum** standards and far too often these becomes the **maximum** standards at least as far as the general public, the less informed, the building regulators and others are concerned.

The current code committee need to convince structural designers in Australia of the merits of this new code and ensure that it is an easy code to use. Unfortunately in its current form the current draft is more complex than the old one, involving more design effort. It introduces a number of new design concepts and will involve significant re-education of practicing structural engineers in Australia. The design effort will be wider than before which will cause concern to practicing engineers in this era of cut price fees and PI problems. The Code committee need to focus on how they can simply the code, assist users and generally provide the background information that users will need before using the new code.

The new code also needs to be calibrated for Australian conditions using specific examples of buildings. This should cover the extent of design required and which should not be dramatically changed but recognising that the forces and design procedures for the new code are likely to be higher (but not too much higher) than the previous code.

Finally I doubt that the new code could be sensibly adopted until the materials codes were upgraded and are made available at the same time.

In conclusion I believe abandoning the current draft will be a disservice to Australia as a whole and this decision should be reconsidered by Standards Australia. What is needed is a review of the current draft in design effort and process of the new code and education of the ACB on the merits and technical aspects of why we need a new code. We do not meed an old tired and revamped existing code which we will ask ourselves in 20 years why did we do such as stupid thing.

Yours sincerely

John Woodside

Principal

F.I.E.Aust, F.A.S.C.E, M.I.C.E, M.I. Struc.E

(Former Chairman of BD2 responsible for AS 1170.4 1993)

AEES could raise public awareness of earthquakes

Dear Editor

The photo below of a plaque in a national park!about the Cadell Fault (Vic), a visible fault feature, is a good

PR idea, don't you agree?

Perhaps AEES members could expand on this by sending in their own pictures of a local fault that is visited the public. If they are not "plaqued", AEES could spend some of its budget to sponsor the signposting of it for the local community/ National Park/ Local Tourist agency/ Historical society/ Environmental Group - couldn't we?????

National Park photo, Victoria

Besides a photo, a suggested plaque location (sketch map) and a bit of history would help.
Cheers
Col Lynam Brisbane

AEES Executive

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Secretariat:	Barbara Butler
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Newsletter Editor	Kevin McCue

Earthquakes in Australia

Nov 2003 – Dec 2003

The following list of earthquakes was extracted from the Geoscience Australia website which uses information from ES&S and PIRSA. The three largest earthquakes had magnitudes between 4.2 and 4.8, none of which caused damage. The event near Bowral is described later in this report.

The Innaminka events are man-made. An Australian firm Geodynamics used hydraulic fracturing at a depth of about 4.3km to create a porous heat exchanger at 270^{o}C. Water pumped into the fractured rock will be converted to steam and returned to the surface to drive a generator. Dr Doone Wyborn, a former BMR, now ANU geologist, is Executive Director of the Geothermal (or hot-dry-rock) project, one of eight worldwide. (www.geodynamics.com,au).

Date	Time (UTC)	Lat S	Long E	ML	Location
Oct					
31	1214 28	13.91	138.31	3.1	G Carpentaria
Nov					
04	0252 09	21.76	129.48	2.3	L Mackay NT
04	1038 41	33.01	138.31	2.5	NE Pt Pirie SA
05	0257 01	19.88	134.14	2.0	S Tennant Ck NT
07	1352 47	36.88	145.41	2.0	S Longwood Vic
11	1919 12	33.23	138.63	2.7	SW Peterborough SA
12	1410 38	37.12	145.58	2.3	Alexandra Vic
13	1403 27	27.88	140.74	3.0	Innamincka SA
21	0850 07	34.22	135.78	3.3	Yeelanna SA
22	1836 02	31.61	138.78	**4.2**	Hawker SA
23	1132 51	19.9	134.07	2.2	Tennant Creek NT
25	1735 24	34.73	149.28	2.6	Gunning NSW
26	0439 53	34.77	149.25	3.0	Gunning NSW
26	1323 46	16.67	128.37	2.2	S of Kununurra WA
Dec					
01	0329 48	19.98	134.04	3.0	S Tennant Ck NT
01	1429 22	36.21	149.2	3.0	NE Cooma NSW
02	1400 24	27.85	140.711	3.3	Innamincka SA
03	0003 37	34.14	135.715	3.1	Yeelanna SA
04	0155 45	27.86	140.65	3.6	Innamincka SA
05	1745 38	27.78	140.63	3.7	Innamincka SA
05	2226 23	18.225	126.745	**4.8**	E Fitzroy Xing WA
07	0121 42	27.73	140.52	3.3	Innamincka SA
07	0803 03	27.74	140.55	2.7	Innamincka SA
07	1831 42	27.76	140.52	3.0	Innamincka SA
08	0709 32	27.89	140.74	2.6	Innamincka SA
08	1242 12	27.86	140.69	2.7	Innamincka SA
08	1250 07	27.88	140.71	2.5	Innamincka SA
09	0658 41	27.76	140.59	2.7	Innamincka SA
11	1019 20	34.49	150.44	**4.2**	Bowral NSW
11	1024 35	34.42	150.44	2.4	Bowral NSW
18	0731 50	29.04	144.13	3.2	Weebah NSW
21	2115 11	27.86	140.80	2.9	Innamincka SA
24	2048 30	26.70	111.59	3.8	Indian Ocean
29	1331 06	35.41	144.53	3.6	W Deniliquin NSW

AEES Conference 2003 – Melbourne

Last year's AEES conference, held at Melbourne University's new Law School, adopted the theme "Earthquake Risk Mitigation". The conference began with an enlightening keynote speech by *Mike*

Sandiford on the modelling of Australian seismicity from the perspectives of geology/neo-tectonics. Numerous eminent academics, professionals and operators were also invited to give presentations on a diversity of issues including insurance, drafting of the Standard, dam safety, urban search and rescue, and the securing of our infrastructure from acts of terrorism. This last item took the conference to a new perspective.

There was a good balance between presentations on seismology and engineering topics. Western Australia was in the spotlight in many of the presentations on seismology and risk modelling. Much attention was drawn to the behaviour of soft-storey buildings and beam-column frames in the engineering presentations. An interesting feature in this conference was the newly introduced "poster preview" session in which each poster presenter was given two minutes to present their paper orally in the theatre (before moving to the gallery). The conference was wrapped up by a brain storming session in which the future direction of the society was discussed.

The Society's AGM saw the re-election of the dedicated president and all the office bearers after another year of hard work.

Conference dinner at *Emu Bottom* (Barbara's idea) was an interesting, and desirable, switch to a country environment after spending a day surrounded by state-of-the-art facilities at the new Law school. Everybody seemed to enjoy the nice food and wine as well as the talented poetry by *Mike Turnbull*.

Conferences from previous years have set a very high standard and this put a lot of pressure on the organising committee. Hopefully, everybody agrees that it was on the whole a successful conference. We are very grateful for the support from every delegate, and particularly the post-graduates who were so helpful, keen and energetic during the entire conference.

Lastly, and not least, we must mention that this conference would not have been successful without Barbara Butler. It came as a shock to all of us when we were told on Friday morning that she had sustained serious injury the night before (shortly after alighting

from the taxi when returning home from the conference dinner). There was a moment of panic as the thought of the conference being run without Barbara. Fortunately, the rest of the conference went well and this again was attributed to Barbara who already had everything arranged so well. Let all of us wish her a speedy recovery.

Nelson Lam

(on behalf of the conference organising committee)

(Ed: Photos compliments of CQU's Mike Turnbull)

The AEES subscription year is the fiscal year. It is expensive to send each member an individual reminder that fees are due so please help us by sending your subscription for 2001/2002 to AEES if you haven't already done so (attn: Barbara Butler, Civil and Environmental Engineering Dept, Melbourne University Parkville Vic 3052) or renew through IEAust's annual subscription system by marking AEES your preferred Society. If you change address or if you know a member who is not receiving the newsletter please advise the Secretary or Barbara.

Australian Earthquake Engineering Society
Annual General Meeting
27th November 2003
Melbourne Law School, Carlton

Attendees: Mike Griffith, Peter McBean, David Love, Mike Turnbull, Nelson Lam, Jack Yao, Barb Butler, David Potter, Gary Gibson, Kevin McCue, John Wilson, Vagn Jensen, Cvetan Sinadinovski, Russell Cuthbertson, Bill Boyce, Vaughan Wesson, Norm Himsley, Amy Brown, Michael Neville, Dave Brundson, Glenn Potger, Wayne Peck, Trevor Dhu, Ken Dale, David Catley, Alison McArdle

Apologies: Charles Bubb, Vince Diamond, Graham Hutchinson, Col Lynam, Jim Wilson.

Correction to minutes from 2002: Accounts had been audited! (PM)

Business arising from minutes:

Joint Conference: NZSEE not interested in a joint conference as proposed, as their system is working well. They encourage AEES to consider hosting the next PCEE. Most in favour.

Web list of advertising: Will go ahead.

Web updates: Vaughan willing to do a certain amount. It is easy to add content if people send it in good order. Newsletters and conference should get to web.

Scholarships:

Dominic Dowling $2500
Huang Yao $500
Brzezniak et al $500
John Wilson will forward some guidelines for scholarship application scoring.

Workshop: Committee will pursue organising USAR workshop with IEAust funding.

Reports

Presidents report:

Agreement being developed with EERI.

IEAust is trying to resolve discrepancies in membership lists.

Scholarships

AEES is developing links with EMA, beginning in SA with recommendations for hazard custodian group of experts.

Treasurer's report:

Adjusting to more meaningful categories, particularly for explanation of conference costs.

Previous 'hire of premises' was conference dinner.

Books have been audited

Kevin McCue congratulated society on funding students and recommends that this should continue.

Editor's report:

Three Newsletters were distributed in 2003 in a joint effort with Barbara Butler. The needs is probably for less seismology and more engineering so I have agreed to stay on until the end of the year when Dr Nelson Lam will assume the role to give it a stronger engineering flavour.

Next Conference: Brisbane suggested but not supported by Qld group as their circumstances have changed. McCue suggested Mount Gambier, a non-capital as has successfully been tried by NZSEE and ANCOLD. McCue offered to be on committee. Committee to follow-up.

Election of officers:

Mike Turnbull as returning officer thanked the existing committee and announced that as the existing committee were the only nominations, and there were none from the floor, that they were re-elected.

State reps re-elected. Huang Hao to become member, then rep for WA

Any other business:

John Wilson – IAEE rep to next WCEE in Aug 2004 in Vancouver, Canada.

Prof Luis Esteva (Mexico) is the new President, and Dr Hirokazu Iemura (Japan) the new General Secretary of IAEE.

Updated list of World standards/ codes is in progress.

Gary Gibson: Next conference should have a session on low cost housing for developing countries. David Brunsdon (NZ) has agreed to give a talk.

Kevin McCue: Dept of Foreign Affairs should be approached for funding to bring people from neighbouring developing countries should this session happen.

Meeting closed in time for the Conference Dinner.

David Love

2003 Conference wrap-up notes

We need to get more email addresses on the AEES list; most members not on.

Shortage of practising engineers at conference. Need to add a half day short course module (maybe on the new standard)

Peter McBean – plenty of other good possibilities (for a course?) dynamic analysis

Richard Weller talked about a code roadshow to take the new code to State Capitals.

Helen Goldsworthy – capacity design, public safety
What is the problem? Is it bottom line only mentality?
We need the resolve to push to ideals.
She is upset / disappointed about the code.

John Wilson replied explaining why the codes were un-jointed.

Dave Brunsdon – suggested the need to endorse design that goes beyond the minimum.

Kevin McCue – expressed disappontment at loss of the Pacific solution (code)

Bill Boyce – suggesting workshop on designing for dynamic analysis, leading to capacity design approach.

Nelson Lam – Are we going to broaden to all risks?

John Wilson – We are widening with USAR course.

Boyce – There is already a risk engineering group in IEAust.

Kevin – Offering to be on organising committee (for next conference)

David Love

NEWS!

Bowral NSW Earthquake

2003 December 11, Moss Vale, NSW, ML 4.2

1019 UTC, 150.4°E, 34.5°S, normal depth [MEL]

This earthquake occurred near Bowral NSW, about 100 kilometres south of Sydney. It was reported felt strongly in Bowral where there were minor cracks caused in brickwork, and felt as far as Canberra, north of Katoomba and on the north shore, Sydney. An earthquake of this size may be felt strongly up to a

distance of about 30 kilometres, and may be felt out to distances of up to 120 kilometres.

The intensity at the epicentre is estimated to be MM 5, there was no damage to well built structures in the epicentral area, though cracking of masonry walls was reported.

At least four tiny aftershocks occurred in the few hours following the main event, and their magnitudes were between 1.7 and 2.6.

This magnitude 4.2 earthquake is the largest to have occurred in this area since a magnitude 5.6 earthquake in 1961. At that time significant damage was caused in Robertson, Moss Vale and Bowral and there were rockslides on Macquarie Pass. The Wingecarribee Dam was later built at the epicenter.

Several strong motion instruments as far as Canberra triggered during this 2003 event.

Rapid Earthquake locations in the SW Pacific region – too rapid?

GeoNet (NZ) made the following assessment of a Christmas Day earthquake:

Universal Time: *2003 Dec 25 14:21*
Latitude, Longitude: *!35.36°S, 178.17°W*
Focal Depth: *!210 km*
Magnitude: *!7.0*
480 km north-east of White Island. May have been felt throughout the North Island.

The USGS National Earthquake Information Center's preliminary assessment of the same event was:

Universal Time: *2003 Dec 25 14:21:11*
Latitude, Longitude: *!34.83S 178.43W*
Focal Depth: *10 km*
Magnitude: *!6.0*
380 km S of L'Esperance Rock, Kermadec Islands, 530 km NE of Gisborne, New Zealand.

Ed. Note the difference between magnitude and focal depth assessments, so critical for rapid response and scanario modelling. The NZ estimate could have been greatly improved with rapid access to Australian data!

Bam (SE Iran) earthquake of 26 December 2003, Mw6.5. Selected extracts from a preliminary reconnaissance report

by Dr Sassan Eshghi[1] and Dr Mehdi Zaré[2]

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1. Introduction

The Bam earthquake of December 26, 2003 (Mw6.5) occurred at 01:56:56 GMT near the city of Bam in the southeast of Iran. The earthquake happened at 5:26 am local time when most of the inhabitants were sleeping, which could be one of the causes of the great loss of life at the date of preparation of this report (29/12/2003). The official number of victims is now more than 30000, with more than 50000 people injured and about 100 000 people made homeless.

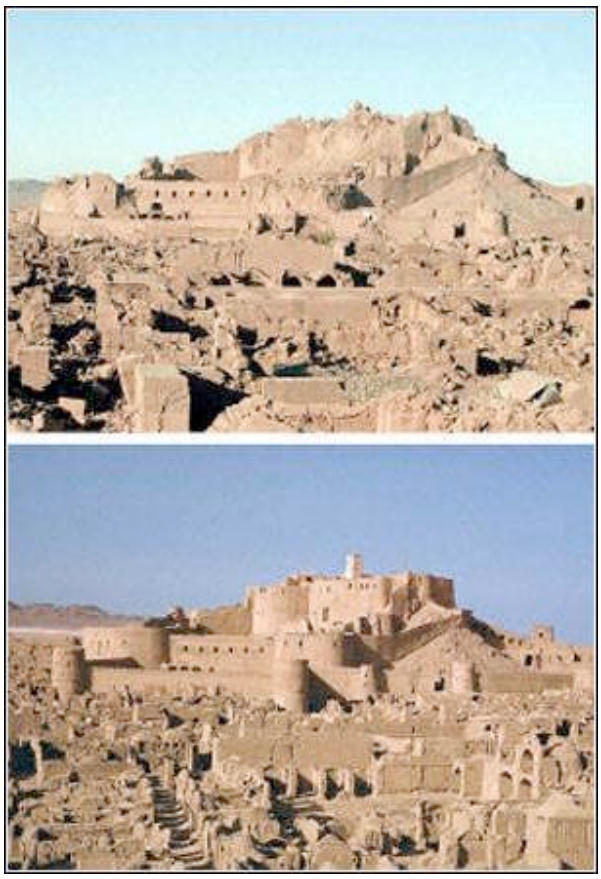

Figure 1 Arg-e-Bam Citadel after (top) and before the December 2003 earthquake (Ed. note the pre-earthquake ruins),

Kerman province is one of the largest provinces in Iran, with an area of 186 422 km^2. The population of Bam was about 100 000 at the time of the earthquake.

The city of Bam was renowned for the historical citadel of Arg-e-Bam now destroyed in the 26/12/2003 Bam earthquake (Figure-1). Arg-e Bam was the largest mud-brick complex in the world located on an igneous hill alongside the Silk Road. It has an area of some 240 000 m^2. The monument was constructed mainly from mud-brick and clay. The total area of this castle is about 6 km^2. There is no information about the exact date of its construction but according to Persian history it goes back more than 2000 years, has been repaired many times and was inhabited until 150 years ago

2. Seismotectonics of the Bam area

2.1. General features

Bam in SE Iran is in an active seismic zone though the city itself had suffered no reported major historical earthquake before the event of 26/12/2003. Towards the northwest of Bam, 3 large earthquakes (magnitudes greater than 6) occurred in the period between 1981

and 1998. The trends of the main faults (including the Bam fault) in this region are North-South and NW-SE, their intersection zones were the sources for most of the disastrous earthquakes. The Gowk fault system ruptured during the 1981, 1989 and 1998 earthquakes. In the west of the Golbaf-Sirch valley is the Lut depression, where a vertical topographic offset of more than 4000 meters has occurred. Four significant earthquakes have struck the region during recent years:

- the Golbaf earthquake of 11 June 1981, Ms6.6
- the Sirch earthquake of 28 July 1981, Ms7.0
- the South Golbaf earthquake of 20 November 1989, mb5.6 and
- the North Golbaf (Fandogha) earthquake of 14 March 1998, Mw6.6.

The Golbaf earthquake of 11/06/1981 struck the southern part of the Golbaf valley. It was associated with a fault rupture along the Gowk fault and caused 1071 fatalities. The event caused great damage in the Golbaf region.

The Sirch earthquake of 28/07/1981 occurred 49 days later and caused 877 life losses. It seems that it originated on secondary faulting along the Gowk fault (N-S trend) or was triggered by the re-activation of the Gowk fault at its intersection with the hidden continuation of the Kuhbanan fault (NW-SE trend), Such a situation might explain the major earthquakes around Sirch in 1877 and 1981 (both with magnitudes greater than 7.0).

The South Golbaf earthquake of 20/11/1989 caused 4 fatalities and 45 injured and some damages in Golbaf. Some surface faulting and folding have been related to this event.

The North Golbaf earthquake of 14/3/1998 caused 5 fatalities and 50 injuries and was associated with surface faulting (about 20km length) in northern Golbaf. The focal mechanisms of these earthquakes are compressional and strike slip mechanisms along the Gowk and Kuhbanan fault systems.

2.2. Focal mechanism

The focal mechanism of the Bam 26/12/2003 earthquake was reported as strike slip fault (NEIC Web site, December 2003, Figure-3), which fits in well with the surface evidence of right-lateral strike slip movement of the Bam fault.!

2.3. Focal Depth

The focal depth of the Bam earthquake of 26/12/2003 is estimated to be 8km (based on the S-P time on the records obtained from the mainshock.

2.4. Surface fault ruptures

The northerly trending Bam fault extends east from the vicinity of Bam (less that 1km east of Bam) south to the city of Baravat (about 10 km). Surface fissures created after the Bam earthquake were observed around the Bam fault between the cities of Bam and Baravat. Ground fissures appeared as sinkholes in the city of Baravat.

2.5. Seismic Gap

The existing records on historical seismicity indicate no major earthquake in Bam since the historical time. It seems that!the Bam earthquake of 26/12/2003 has ended a seismic gap along the Bam fault.

3. Strong Ground Motion

Strong motion was recorded on stations of the national Iranian strong motion network! (according to BHRC). The record obtained at Bam shows at PGA of 0.8g and 0.7g for the east-west horizontal and north-south horizontal components, respectively, and 0.98g for the vertical component (all non-corrected values). The preliminary observations on the strong motion record obtained at the Bam station shows a vertical directivity effect. This effect can be assigned to the Bam earthquake fault rupture, while a strong fault-normal (east-west) motion is created as well. The demolished walls and building of Bam are representative for such effects in the up-down (vertical) and east-west directions (fault-normal). The Bam residents that survived the quake explained to the reconnaissance team members that they felt strong up-down displacements during the mainshock.

4. Macroseismic intensity and the isoseismal map

The macroseismic intensity of the earthquake is estimated to be I_0=IX (EMS98 scale). The strong motions and damaging effects seems to be attenuated very fast especially in the fault-normal direction Intensities are estimated to be VIII in Baravat, VII in New-Arg (Arg-e Jadid) and the airport area and IV-V in Kerman and Mahan.

Full body scan: Imaging project offers view inside Earth

December 4, 2003
Contact: Steven Schultz, (609) 258-5729,
sschultz@princeton.edu

Results may help settle debate about how Earth sheds its internal heat.

PRINCETON, N.J. -- Like doctors taking a sonogram of a human body, Princeton geoscientists have captured images of the interior of the Earth and revealed structures that help explain how the planet changes and ages.

The scientists used tremors from earthquakes to probe the inside of the planet just as sound waves allow doctors to look inside a mother's womb. The technique, a greatly refined version of earlier efforts, produced a surprisingly sharp image and yielded the first direct measurements of giant spouts of heat, called mantle plumes, that emanate from deep within the planet.

Mantle plumes are believed to cause island chains, such as the Hawaiian Islands and Iceland, when the Earth's crust passes over the column of heat. Although accepted by most scientists, the existence of mantle

plumes has been fiercely contested by a minority of researchers in recent years.

"This is the first visual evidence that mantle plumes exist," said Raffaella Montelli, a Princeton geoscientist and the lead author of a paper published online by the journal Science on Dec. 4. "There is still a very open debate, but we are saying 'Look, here they are; you can see them.'"

Montelli, who received a Ph.D. from Princeton this year and is now a postdoctoral fellow, conducted the study in collaboration with Princeton professors Guust Nolet and Tony Dahlen as well as Guy Masters of the University of California-San Diego, Robert Engdahl of the University of Colorado and Shu-Huei Hung of National Taiwan University.

The scientists used data from more than 3,000 seismographic stations around the world. The stations monitored tremors from more than 86,000 earthquakes since 1964. The seismic waves change speed slightly when they encounter different temperatures and materials in the Earth, said Nolet. In particular, the waves slow down when they encounter warm spots where the rock is very slightly softer than in cooler spots.

"If we can find out if waves are being slowed down or speeded up, then we know whether the Earth is locally hotter or colder," Nolet said. The researchers analyzed these changes in speed and assembled their data into a three-dimensional temperature map. They immediately noticed broad columns of warm material rising out of the Earth's mantle, which is the layer nearly 2,000 miles thick just under the crust.

"We started the research without any thought of mantle plumes," said Nolet. Their goal was to improve on a century-old theory of how seismic waves travel through the Earth, taking into account how the waves interact with varying temperatures and materials. In addition to developing a better theory, the researchers selected only the highest quality data from millions of measurements that were available, Nolet said.

When the heat columns appeared in their map, the researchers compared their locations to those of suspected mantle plumes around the globe and found close correlations. They identified 32 plumes, most of which are located beneath known hot spots that had been assumed to result from plumes. A few are entirely new and were not associated with known hot spots. At the same time, some expected plumes, such as one believed to be under Yellowstone National Park, did not show up.

The results are an important step in understanding mantle plumes and also raise a host of new questions, said Princeton geophysicist Jason Morgan, who first proposed the existence of mantle plumes in 1971 and, in December, won the National Medal of Science in part for his work on the subject. The results, for example, do not show all the plumes extending from the bottom of the mantle as he and others anticipated, Morgan said. Some seem to begin in shallower parts of the mantle, he said, noting that understanding the reason for this is likely to provide valuable insights into the dynamics within the Earth. "Some plumes may be gaining strength and others may be fading. I don't know what will come of that but it will be something interesting I am sure," he said.

Montelli said she plans to continue refining the imaging technique and will repeat the analysis with a different type of seismic wave, which should yield an even sharper image of the plumes.

The research was funded by grants from the National Science Foundation and the article comes compliments of Col Lynam, Qld.

Hugh Doyle

We note with sadness the death of the last of the three eminent 20th century Australian seismologists who in 1968 published the seminal paper *Seismicity of the Australian Continent*.

Hugh Doyle was born in Sydney and in 1948 graduated with a BSc from Sydney University. He then followed a very traditional career path in BMR with a year on an Heard Island in the Antarctic and two sojourns in Papua New Guinea. He installed some of the first portable seismographs in Australia, to monitor nuclear explosions, and was the first to infer the Moho depth here. The study of the British nuclear explosions in Australia started a lifelong collaboration between Hugh, Ian Everingham and David Sutton. Hugh became a Research Fellow at the ANU in 1956 where he stayed until 1969 when he moved to UWA in Perth where amongst other things he wrote a textbook *Seismology*.

Hugh retired back to Sydney where he died at the age of 76. He is survived by a daughter and remembered for the Hugh Doyle Prize in Geophysics, awarded annually at UWA.

Progress, Promise in Space-based Earthquake Research

December 4, 2003

Nearly 10 years after Los Angeles was shaken by the devastating, magnitude 6.7 Northridge earthquake, scientists at NASA and other institutions say maturing space-based technologies, new ground-based techniques and more complex computer models are rapidly advancing our understanding of earthquakes and earthquake processes.

Dr. Andrea Donnellan, a geophysicist at NASA's Jet Propulsion Laboratory, Pasadena, Calif., says the past decade has seen substantial progress in space-based earthquake research. "We've confirmed through space observation the Earth's surface is constantly moving, periodically resulting in earthquakes, and we can measure both the seismically quiet motions before and after earthquakes, as well as the earthquakes

themselves. These technologies are allowing us to pursue lines of data and research we didn't know existed only a few years ago."

Two months before the Northridge earthquake, Donnellan and university colleagues published a paper in the journal Nature on ground deformation north of Los Angeles' San Fernando Valley. Six years of Global Positioning System (GPS) data showed the area's faults were active and building up strain, and indicated the size and style of a potential earthquake there. Following the earthquake, the data made it possible to rapidly determine where the fault ruptured and to measure how the earthquake had deformed Earth's surface.

Space-based instruments can image Earth movements to within fractions of an inch, measuring the slow buildup of deformation along faults, and mapping ground deformation after an earthquake. Two primary tools are the space-based GPS navigation system and Interferometric Synthetic Aperture Radar (InSAR). The latter compares satellite radar images of Earth taken at different times to detect ground movement.

InSAR complements surface measurements because it lets us look at whole regions in a spatial context. An InSAR mission is also a key component of EarthScope, a jointly led initiative by the National Science Foundation, NASA and the U.S. Geological Survey.

EarthScope studies the North American continent's structure and evolution, and the physical processes that control earthquakes and volcanic eruptions, according to Dr. James Whitcomb, section head for Special Projects, Earth Sciences Division, National Science Foundation, Arlington, Va.

Precise Earth surface-movement data measure strain and provide a first approximation of where earthquakes are likely to occur, notes Dr. Brad Hager, a Massachusetts Institute of Technology professor and co-author of the 1993 Nature paper. "In California, patterns of ground deformation are complicated by the complex interactions between fault systems. Interpreting this data requires computer models that can estimate how much deformation has accumulated and identify regions where strain should be released, but hasn't been."

University of California, Davis, researcher Dr. John Rundle says the complexity of earthquakes requires we study them as part of the full Earth system. "Most natural events result from interrelated Earth processes over various lengths and times. "These processes have variables that can't be readily observed, so understanding them requires computers."

NASA's QuakeSim project is developing a similar forecasting methodology. Its tools simulate earthquake processes, and manage and model the increasing quantities of data available. "We're focusing on observing and understanding earthquakes in space and time, and developing methods that use patterns of small earthquakes to forecast larger ones," Rundle explains. "New simulations of earthquakes on California's active faults are providing considerable insight, showing earthquakes tend to "cluster" in space and time due to their interactions. That is, an earthquake on one fault section can turn on or off earthquake activity on nearby fault sections, depending on the relative orientation of the faults. Simulations have led researchers to conclude that fault system geometry determines earthquake activity patterns."

A NASA/Department of Energy-funded research team reports promising results from an experiment to forecast earthquakes in southern and central California from 2000 to 2010. It uses mathematical methods to forecast likely locations of earthquakes above magnitude 5 by processing data on earthquakes of about magnitude 3 from the past decade. The high-risk regions identified in the forecast are refined from those already identified by the government as susceptible to large earthquakes. Five earthquakes greater than magnitude 5 have occurred since the research was completed, all in those high-risk regions.

Dr. Wayne Thatcher, a senior research geophysicist at the U.S. Geological Survey, Menlo Park, Calif., says as these technologies are validated they will be transferred to end users. "Such data and models improve understanding of earthquake and volcanic processes, substantially refining seismic hazard maps and resulting in more appropriate, earthquake-resistant construction codes and more targeted retrofitting strategies."

Points of contact for other organizations cited in this release are: Andy Fell, University of California, Davis, 530/752-4533; Stephanie Hannah, USGS, 206/220-4573; Deborah Halber, MIT, 617/258-9276; Cheryl Dybas, NSF, 703/292-7734.

JPL is managed for NASA by the California Institute of Technology in Pasadena and this article came compliments of Col Lynam, Qld.

2003 earthquakes - most casualties

February 24, Southern Xinjiang, China, 6.4
At least 261 people killed, 4,000 injured, 71,000 buildings collapsed, 40,119 damaged and utilities disrupted in the Bachu County area. About 38,259 livestock killed. Felt as far as Urumqui. Also felt at Almaty, Kazakhstan.

May 01, Eastern Turkey, 6.4
At least 177 people killed in the Bingol area, including 85 which were at Celtiksuyu Boarding School. At

least 521 were people injured, 718 buildings destroyed, 2,593 damaged and 1,662 livestock killed in the Bingol area. Felt strongly in much of eastern Turkey.

May 21, Northern Algeria, 6.8
At least 2,266 people killed, 10,261 injured, 150,000 homeless, more than 1,243 buildings damaged or destroyed (X) and the infrastructure was damaged in the Algiers-Boumerdes-Reghia- Thenia area. Underwater telecommunication cables were damaged. Damage estimated at 100 million U.S. dollars. A

tsunami generated with an estimated wave height of 2 m caused damage to boats off the coast of the Balearic Islands and was also recorded on the coast of Alicante, Castellon and Murcia, Spain. Felt (III) at Palma de Mallorca and Soller, Mallorca and (II) at Calvia and Mahon, Mallorca and Ibiza, Ibiza. Also felt (II) at Albacete, Alcantarilla, Alicante, Barcelona, Cartagena, Castellon, Elda, Molina de Segura, Murcia, Sagunto and Villafranca del Panades, Spain. Felt in Monaco.

December 26, Southeastern Iran, 6.6 !** Deadliest Earthquake in 2003
At least 30,000 people killed, 30,000 injured, 85% of buildings damaged or destroyed and infrastructure damaged in the Bam area. Maximum intensity IX at Bam and VIII at Baravat. Felt (V) at Kerman. Surface faulting observed on the Bam Fault between Bam and Baravat. Maximum acceleration of 0.98g recorded at Bam. A detailed report on this earthquake can be obtained from the International Institute of Earthquake Engineering and Seismology (IIEES), online at http://www.iiees.ac.ir/English/Bam_report_english.html

2003 earthquakes - largest event

Preliminary Earthquake Report
Source U.S. Geological Survey, National Earthquake Information Center, World Data Center for Seismology, Denver

Magnitude 8.3
Thursday, September 25, 2003 at 19:50:06 (UTC)
Friday, September 26, 2003 at 04:50:06 AM local time at epicenter.

Location 41.78N 143.86E
Depth 27.0 kilometers

Region HOKKAIDO, JAPAN REGION
140 km (85 miles) SSW of **Kushiro, Hokkaido,**
245 km (150 miles) NE of **Hachinohe, Honshu,**
250 km (155 miles) SSE of **Asahikawa, Hokkaido**
765 km (475 miles) NNE of **TOKYO, Japan**

Remarks
At least 589 people injured, extensive damage, landslides and power outages occurred and many roads damaged in southeastern Hokkaido. A tsunami was generated with an estimated wave height of 4.0 meters along the southeastern coast of Hokkaido. Felt strongly in much of Hokkaido. Also felt in northern and much of central Honshu as far south as Tokyo. Recorded (6L JMA) in southern Hokkaido, (5L JMA) in central Hokkaido and (4 JMA) in parts of northern and southwestern Hokkaido. Also recorded (4 JMA) in northern Honshu and (2 JMA) as far south as Shizuoka Prefecture, Honshu. Recorded (1 JMA) on Hachijo-jima, Miyaki-jima and Sadoga-shima.

Supercomputers let scientists break down problems in reverse for better quake models

Monday, December 15, 2003
By Byron Spice, Pittsburgh Post-Gazette, Eric Draper/Associated Press

The 1994 quake in Northridge, California, has never been precisely modeled by computer, partly because of a lack of information about subsurface geology of the area. An “inverse problem” form of a model could help provide that information.

Scientists have become so adept at constructing computer models of complex phenomena such as earthquakes, global climate and the human heart - and the computers they use have become so powerful - that they can run the models standing on their heads. Computationally speaking, that is.

It is what is sometimes called "the inverse problem." Rather than using the computer model to predict the future behavior of a system, as is typically done, solving the inverse problem means taking the behavior of a system and then working backward to determine what led to that behavior.

The approach already is being used in Europe to enhance the accuracy of multi-day weather forecasts. Homeland security researchers are investigating whether computer models can be used to trace back the source of a chemical weapons attack.

And researchers at Carnegie Mellon University and the Pittsburgh Supercomputing Center last month won the Gordon Bell Prize, a prestigious award for high-performance computing, for their work on earthquake simulations. Part of that work involved the inverse problem -- using the surface motion of earthquakes to determine subsurface geology.

"It's a tough problem," said Thomas Jordan, director of the **Southern California Earthquake Center**. "It's a very important problem." Not only can this inverse method tell scientists more about the geology of a region, but that geological data can subsequently be used in computer models to improve earthquake predictions.

Making the inverse problem difficult is that it requires many times more calculations than a standard, "forward" model and some additional computational tricks.

"It's not literally running the model backward," emphasized Chris Davis, an atmospheric scientist at the **National Center for Atmospheric Research** in Boulder, Colo. Though performing the meteorological version of the inverse problem might add "a half-day of forecasting skill" to a three-to-five day forecast, he noted, U.S. forecasters thus far have forgone this process because of the large amounts of computing time it requires. "If computer resources were not an issue, everybody would be doing it," Davis said.

Ever since CMU and the supercomputing center began their earthquake modeling efforts a decade ago, performing the inverse problem "was kind of a dream," said Jacobo Bielak, professor of civil and environmental engineering. But it has taken longer than expected to make that dream reality, he

acknowledged, because "we just weren't aware of how hard the forward problem would be."

Computer models attempt to translate physical phenomena into mathematical equations. Success depends not only on picking the right set of equations, but also on obtaining a large quantity of accurate information about the initial conditions of a system, be it a geologic basin or the atmosphere, and on using a computer big enough and fast enough to solve a mountain of equations within a reasonable amount of time.

Earthquake simulation was considered one of the Grand Challenges of scientific computing a decade ago by the **National Science Foundation**, which sponsored the early work in Pittsburgh. It was both an important problem and one that would strain the capabilities of the world's fastest computers.

In 1993, the researchers had access to machines capable of billions of calculations per second, recalled Omar Ghattas, a CMU engineer and one of the principals in the **Quake Project.** That was a good start, but was hardly adequate to the job. Only since the installation two years ago of Le Mieux, the supercomputing center's 3,000-processor computer capable of trillions of calculations per second, is the computing capability close to what is necessary for meaningful simulations of Los Angeles earthquakes.

"You couldn't even think of the inverse problem in the past," he added.

The Quake Project has tried to find models that explain the great variation, often within a small area, of earthquake ground motion in the L.A. basin. Following the 1994 Northridge earthquake, for instance, collapsed buildings could be found within blocks of similar buildings that stood undamaged. Much of the variation appears to be caused by differences in soil types and the underlying geological structure.

Using a number of modeling tricks and the power of LeMieux, the group now is able to perform earthquake simulations of the L.A. basin measuring 100 kilometers square and 50 kilometers deep. The model requires assessing soil and rock conditions at 10 meter intervals throughout that space.

Even so, these simulations are relevant only to the performance of buildings five stories or taller. To gauge the effects of earthquakes on homes, apartment buildings and office buildings of under than five stories, the researchers would need to simulate seismic waves at shorter wavelengths. Not only would that require a computer 10 or 20 times faster than Le Mieux, but it would require calculating ground conditions at intervals of just one meter.

Simply obtaining information about the soil and rocks at one meter intervals is a nearly impossible task, Ghattas said. But that's one reason to consider the inverse problem -- using ground motion to determine the geological conditions of the basin might be one way to obtain that data.

Jordan, of the Southern California Earthquake Center, said a number of research groups have produced earthquake models and have high confidence that the models do a good job of mimicking seismic conditions. But no one has ever been able to use a model to precisely duplicate the ground motion of the Northridge quake or other historic earthquakes. Researchers suspect the problem is that their incomplete knowledge of subsurface geology might be one reason why, he noted. A number of researchers besides the CMU team thus are pursuing the inverse problem because they hope solving it will ultimately improve the performance of all of their computer models, Jordan said.

Volkan Akcelik, a post-doctoral researcher at CMU and a member of the Quake Project, spent last summer at **Sandia National Laboratories** in Albuquerque, N.M., helping to apply these inverse techniques to the analysis of chemical terrorism.

At issue, he explained, is determining where airborne toxic chemicals might go if released in an urban area by terrorists. The hope is that by taking measurements at a number of locations, investigators could use the inverse technique to calculate the original location and concentration of the chemical. With that information in hand, Akcelik explained, it would be easier to calculate where the chemical might be spread and which areas of a city might need to be evacuated. The inverse techniques seem to work, he said -- provided that air current patterns in the area are known. Air currents ultimately might also be calculated using the inverse techniques. "We need to do more work on this," he added.

Skopje – a postscript

Following our story about the 40th anniversary of the 1963 Skopje earthquake in the last Newsletter, Dr Sinadinovski translated the mural message on the wall of the Skopje Railway Station, left in its wrecked state as a memorial to those who died.

> *Skopje experienced an unseen catastrophe, but we shall build Skopje again with the help of all our community. It will become the pride and symbol of the brotherhood and unity of Yugoslavian and world solidarity.*
>
> 27 July 1963 TITO

West Papua Earthquakes

Just a few weeks age an area in West Papua only 1000 km NNE of Darwin was struck by three earthquakes near magnitude 7. The following notes from the USGS give some idea of the effects of these earthquakes though information from this remote area is difficult to come by.

The epicentral region is south of the neck of the so-called bird's head at the western end of the island of New Guinea. The large nearly-closed deep bay to the north is Cenderawasih Bay. The area is mountainous so there were numerous landslides. To the east, more than 100 km away, is the Freeport Copper (gold) Mine

and on the south coast is a major new petroleum province. Nabire is the largest town affected, its hospital and oil tanks reportedly badly damaged. Several bridges were damaged.

The area is tectonically complex with large blocks or small sub-plates jostling together in the collision zone of three major plates, the Australian, Pacific and Eurasian Plates and its on our doorstep.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY NEIC QED

FEB 05

IRIAN JAYA, INDONESIA. MW 7.0 (HRV), 6.8 (GS). ME 7.0 (GS). At least 31 people killed, 67 injured, 2678 buildings damaged or destroyed and nine bridges damaged in the epicentral area. The airport runway was damaged and power outages in the Nabire area. Felt (VI) at Nabire, (V) at Enarotali and (IV) at Manokwari. Also felt at Tembagapura.

FEB 07

024235.4 3.942S 134.987E 10G 6.2 7.5 1.1 33 266
IRIAN JAYA, INDONESIA. MW 7.3 (GS), 7.3 (HRV). ME 7.5 (GS). Casualties and damage in the epicentral area.

FEB 08

085849.1 3.679S 135.316E 10G 5.7 6.9 1.1 33 161
IRIAN JAYA, INDONESIA. MW6.7 (HRV), 6.5 (GS). ME 6.4 (GS).

The Society website/email list

Dear AEES Members,
The AEES web site is at www.aees.org.au. Any contribution from you on the following topics is most welcome:

- details of interesting recent publications
- significant research projects in earthquake
- engineering (in Australia?)
- links to other relevant Web sites

Please send me your contributions/suggestions via email.
The AEES email list is operated by the Seismology Research Centre, Melbourne.
If you would like to register please notify me at vaughan.wesson@esands.com

Vaughan Wesson

FORTHCOMING CONFERENCES

17-21 May 2004 The Joint Assembly of the Canadian Geophysical Union (CGU), American Geophysical Union (AGU), Society of Exploration Geophysicists (SEG) and Environmental and Engineering Geophysical Society (EEGS), will be held in Montreal, Canada, Session OS02: Extreme Waves (Tsunami and Rogue Waves).

August 2004 ASEG-PESA 17th Geophysical Conference. Integrated Exploration in a Changing World, Sydney. For more information, please see http://www.aseg-pesa2004.org.au

1 - 6 Aug 2004 13 WCEE Vancouver Canada. Hosted by the Canadian Association for Earthquake Engineering (Chair Don Anderson).

www.13WCEE.com

16 - 20 August 2004 Western Pacific Meeting
The 2004 Western Pacific Geophysics Meeting will take place in Hawaii. The session proposal deadline is 6 November 2003. More information will be available on the AGU web site.
www.17thagc.gsa.org.au

18 - 20 October 2004 4th International Conference on Dam Engineering Nanjing, China.

1 - 3 December 2004 The 18th Australasian Conference on the Mechanics of Structures & Materials. Perth Western Australia.

www.civil.uwa.edu.au/conferences/acmsm18/

New Books

The Seismic Wavefield Volume II by Brian L.N. Kennett, Cambridge University Press, Cambridge, UK; ISBN 0-521-00665-1; 534 pp.; 2003; $55

The first volume provides a general introduction and a development of the general theory; the second volume is primarily devoted to the interpretation of observed seismograms in terms of physical processes, which control their properties, with a strong link to the theoretical development in the first volume (extract from a review by A Zappone).

Col Lynam

STOP PRESS

Two magnitude 5+ earthquakes occurred in the Northern Territory on the evening of 11 February. According to GA seismologist Dr Cvetan Sinadinovski there were no reports that the earthquakes were felt.

The nearest previous earthquake was the magnitude 6 mainshock and extensive aftershock sequence of March 1970 near Lake MacKay in WA.

The second and larger event, magnitude 5.4, is the largest Australian earthquake since 1997.

Activities, CPD and Goals for 2004

Based on member feedback from our membership questionnaire as well as motions passed at our AGM and discussion in the closing session of our annual technical conference held in Melbourne on 27-28 November 2003, the following activities and goals for the Society in 2004 were agreed. These are listed below with the actions required to make it happen.

1. **CPD.** Implementation of a national Urban Search and Rescue (USAR) training program for Engineers, sponsored and endorsed by our Society and Engineers Australia (EA) and, crucially, endorsed by Emergency Management Australia who is the national coordinator of USAR services and activities. The national executive to approach EA for funding of $7,000 to run a national "roadshow" seminar to introduce and promote the scheme. The training scheme could conceivably be run as a user pays short course under the wing of EA's Engineering Education. Further, the executive must seek EMA endorsement of the course and subsequent certification to ensure uniform national recognition.
2. The Society will again fund at least one $2500 research scholarship for work in the area of earthquake engineering and/or seismology to honours/post-graduate students enrolled at Australian institutions.
3. **CPD.** The Society's annual Technical Conference and AGM will be held in 2004 in a regional location (Mt. Gambier, SA has been nominated) for the first time. This meeting typically attracts 50 – 100 participants every year. The national executive, with Kevin McCue in Canberra, to organise. The conference is to be budget positive without EA subsidy.
4. The Society will implement a register of members (subject to their written approval) on its website listing member professional/technical capabilities and areas of interest. A working party has been formed to draft a "database" format and collection of data.
5. Develop "Memorandum of Understanding" agreements with counterpart organisations overseas. The Earthquake Engineering Research Institute (in the USA) and the New Zealand Society of Earthquake Engineering are being targeted. Draft agreements have been developed and sent to the EERI and NZSEE for their consideration.
6. Membership to continue Standards Australia final drafting, review, promotion and implementation of the revised Australian Earthquake Loading Code, AS 1170, Part 4 , and seek a discount for AEES and EA members.
7. National executive to lobby Federal Government and its relevant arms to establish "Risk Mitigation of our National Critical Infrastructure" as a Priority Research Area. While recent attention has been on Security and Man-made hazards, the fundamental issues and strategies for "Securing Australia" are the same as for the broader Risk Mitigation theme which accounts for both Natural and Human hazards.
8. The Society will consider sponsoring individuals from developing countries from our region (i.e. southwest pacific) to attend the 2004 World Conference on Earthquake Engineering in Vancouver BC. Estimated cost, including registration, fares and living expenses could be up to $5000 per person.

Mike Griffith*

President, AEES

3 December 2003

Message to all members from Barb Butler

Thank you so much to all those AEES members who have sent messages and enquired after my health – I really have appreciated hearing from you.

Although still not able to return to the office, I am able to do a little from home – hence this Newsletter. My sincere apologies for the lateness of it – your hardworking Editor had it ready weeks ago, but I have held it up.

Please note the request from Vaughan Wesson on Page 12. It would really help if your email addresses were recorded by Vaughan. A tip: if you do not receive regular emails on all things "earthquakey" via the AEES email list, then we do not have your address.

I hope to catch up with you all at this year's conference.

Warm regards

Barb