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N.Z. GEOMECHANICS NEWS

No. 34

JULY 1987

A NEWSLETTER OF THE N.Z. GEOMECHANICS SOCIETY

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Persons interested in applying for membership of the Society are invited to complete the application form at the back of this newsletter. The basic annual subscription rate is $20.00 and is supplemented according to which of the international societies, namely Soil Mechanics ($11.00), Rock Mechanics ($15.00), or Engineering Geology ($7.00) the member wishes to be affiliated. Members of the Society are required to affiliate to at least one International Society.

Editor: Yolanda Thorp
P.O. Box 6345
AUCKLAND
Phone (09) 773-410

Advertising: Dick Beetham
P.O. Box 30-368,
LOWER HUTT
Phone (04) 699-059

EDITORS NOTES

It is rare that engineering geologists have the opportunity to observe a major geological event taking place, or engineers to see their designs tested to their ultimate capacity.

The Edgecumbe earthquake which occurred in March this year provided such a case. Large ground displacements, and liquefaction of sand deposits took place. Several structures failed, but of note were the greater proportion which withstood the 6.2 magnitude earthquake with little or no damage.

The personal suffering and disruption in the lives of the Edgecumbe and adjoining communities was saddening. While being aware that this would have been multiplied many times had it not been for the present knowledge of earthquake behaviour and structural design, it must serve as a spur to further develop our knowledge in order to minimise the effects of future earthquakes. We are fortunate to have the DSIR's instrumentation at Matahina Dam in place to provide a record of the event. Surely the value of this information must emphasise the need for funds to be set aside by government bodies for recording stations and research both for earthquakes and volcanic activity. The limiting of expenditure in this field is short sighted and false economy. A brief report of the earthquake appears on page 24. Also included in this issue is a paper on the rate of tectonic movement in New Zealand.

It is perhaps appropriate that the 5th Geomechanics lecture was presented in May by Les Oborn, one of New Zealands foremost engineering geologists. His topic of the evaluation of engineering geology illustrated developments in this field. He spoke of the interdependance of the engineering and geology disciplines with the engineering geologist being the bridge. Les tossed several points to the audience, saying that proficiency in the art of engineering geology comes only after wide experience, and in the past failures have occurred where engineering geological advice has not been sought or followed. The lecture sparked lively debate on the issue of professional recognition of engineering geologists.

The need for a resolution on what form a registration for engineering geologists should take, and what body would be appropriate to administer this registration is spoken of in a challenging letter to the editor on page 17. The editor agrees with the writer that action is required as the need for professional recognition is now being expressed by many engineering geologists. However, in keeping with the intended closer co-operation and interaction between the professions perhaps this case should jointly be taken up by the Geological Society and the Geomechanics Society.

Comments on this matter and further papers relating to post Edgecumbe earthquake remedial works would be welcome for the November issue.

YOLANDA THORP
Editor - Geomechanics News

NEWS FROM THE MANAGEMENT SECRETARY

1. 1987 Management Committee

On Friday 13 February 1987 the Management Committee met in Wellington. The Committee for 1987 with the various offices held, is as follows:-

Mr A.J. Olsen	Chairman
Mr D.N. Jennings	Secretary
Mr J.H. Galloway	ISSMFE Australasian Vice President (ex office)
Mr J.P. Trudinger	IAEG " " " (" ")
Dr W.E. Bamford	ISRM " " " (" ")
Mr A.J. Bartlett	Secretary, IPENZ
Ms Y.F. Thorp	Editor, Geomechanics News
Mr R.D. Beetham	Publications Office, Wellignton Liaison
Mr N.W. Rogers	Vice Chairman IAEG, Auckland Liaison
Mr M.J. Stapleton	" " ISSMFE
Dr C.J. Graham	" " ISRM
Dr D.H. Bell	Christchurch Liaison
Mr J.W. Henderson	Dunedin Liaison
Dr R.D. Northey	IPENZ Representative
Mr J.C. Rutledge	" "

2. 1987 Annual General Meeting

This was held on Tuesday 12 May 1987 during the IPENZ conference in Christchurch. Nineteen members attended the meeting and there were twenty apologies. The Chairman's report and statement of accounts were accepted. It was noted that the Management Committee had budgeted for a net loss for the 1986/87 financial year. The Secretary reported that this loss result may be greater than budgeted because of a reversed interest charge from IPENZ of some $2500 which had been incorrectly credited to the 1986 accounts by IPENZ.

The election results for the 1987 Management Committee were confirmed (Olsen, Jennings, Thorp, Beetham, Rogers, Stapleton, Graham and Henderson).

Two nominations for life membership were proposed. Dr Roy D. Northey and Professor Peter W. Taylor were elected to life membership.

3. 1987 IPENZ Conference

Two very successful sessions were organised at the Conference in conjunction with the Earthquake Society. Four papers were presented dealing with aspects of seismic hazards. The papers were:-

'Earthquake Hazard Estimates : Where are we Going' - W.D. Smith

'The Rate of Tectonic Movement in New Zealand from Geological Evidence' - K.R. Berryman and S. Beauland

'The Evaluation of Earthquake Hazards' - I.R. Brown and G.T. Hancox

'Canterbury Research in Seismic Liquefaction' - J.B. Berrill, R.O. Davis, G. Mullenger and G. Fairless.

The papers were all well received by an audience which overfilled the E5 lecture theatre. Incorporation of features observed in the 2 March 1987 Edgecumbe earthquake added to the impact of the geological and historical aspects addressed in the sessions.

4. Geomechanics Lecture

Mr Les Oborn presented the 5th Geomechanics Lecture. Some seventy people gathered in the School of Engineering on the evening of tuesday 12 May 1987 to hear Mr Oborn 's lecture "Some Thought on the Evolution of Engineering Geology in New Zealand". A report on this lecture is presented elsewhere in this issue. Mr Oborn will also present the lecture in Dunedin, Auckland and Wellington.

5. 1988 IPENZ Conference

The 1988 IPENZ Conference will be held in New Plymouth in February 1988. The theme is energy. Please contact the Secretary if you are interested in presenting a paper to the conference. Abstracts were required to be in the hands of the Secretary by the 30 May 1987.

6. New Members

Following the February 1987 meeting the following new members are welcomed to the Society.

C.A.M.	Franks	(ISSMFE, IAEG, ISRM)
Dr McG.	Elder	(ISSMFE)
M.R.	Foley	(IAEG)
D.H.	Stapledon	(ISRM)

7. Present Membership

As at the 31 March 1987 the Society membership was 366, an increase of since 1 January 1986 (349). Present affiliations are, with 1 January 1986 figures in parentheses:

ISSMFE	(233)
ISRM	(62)
IAEG	(138)

8. 1988 ANZ Geomechanics Conference

Dr Geof Martin has agreed to present a state of the art address to the Conference on seismic aspects of geomechanics. A notice has been distributed to members calling for papers for this conference. Abstracts are required by the Conference Manager by 30 June. In addition to providing this to the Conference Manager would you please provide a copy to the Management Secretary for the information of the Management Committee.

9. Geotechnical Context in Contract Documents

The Management Committee has recently received a draft report on 'Geotechnical Context in Contract Documents' from the Australian Geomechanics Society. The report grapples with the problem of defining factual, descriptive and interpreted information and is currently being reviewed by the Management Committee. A review will be presented in the next Geomechanics News. E A Books (Australia) is in the process of publishing the report.

10. Next N.Z. Geomechanics Society Symposium

Subjects presently under consideration include;

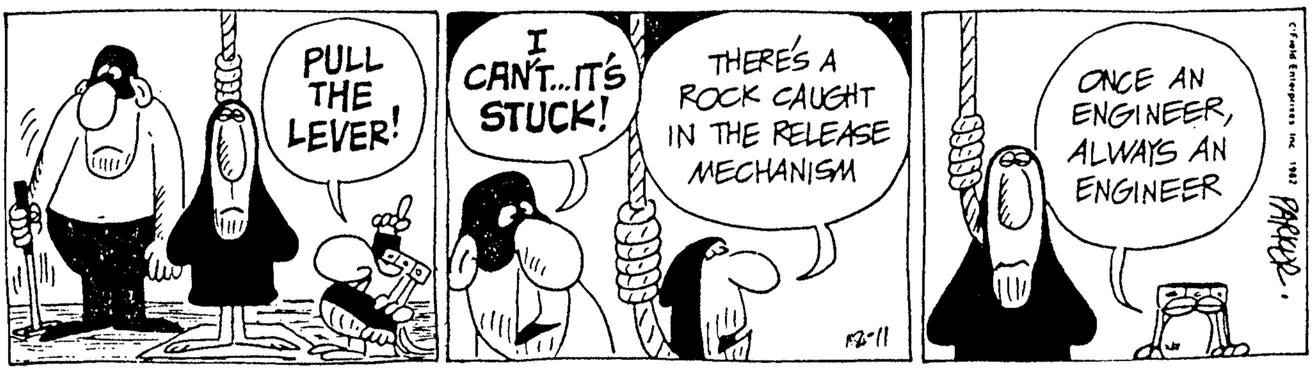
- Design of Cut Slopes
- Groundwater Geotechnical Engineering
- Waste Disposal

If you have any preference or suggestions, contact your local liaison member or the Secretary.

11. Penetration Testing of Soils

The ISSMFE Technical Committee on Penetration Testing of Soils has recently prepared draft International Reference Test Procedures for the Standard Penetration Test (SPT), the Core Penetration Test (CPT) and Dynamic Probing for discussion at Committee Meeting in August 1987. Copies can be requested from the Secretary if you are interested in providing comments.

DAVID N. JENNINGS
Management Secretary



PUBLICATIONS OF THE SOCIETY

The following publications of the Society are available:

(a) From the Secretary, IPENZ, P.O. Box 12-241, Wellington North:

- Proceedings of the Palmerston North Symposium "Geomechanics in Urban Planning", April 1981. Price $20.00

- "Stability of House Sites and foundations - Advice to Prospective House and Section Owners". (Published for the Earthquake and War Damage Commission). Price $0.50.

- Proceedings of the Third Australia-New Zealand Conference on Geomechanics, Wellington, May 1980. Price $20.00 for the three volume set to members, $30.00 to non-members.

- Proceedings of the Second Australia-New Zealand Conference on Geomechanics, Brisbane, July 1975. Price $25.00.

- Proceedings of the Wanganui Symposium "Using Geomechanics in Foundation Engineering", September 1972. Price $8.00 to members, $10.00 to non-members.

- Proceedings of the Christchurch Symposium "New Zealand Practices in Site Investigations for Building Foundations", August 1969. The last copies of a limited reprinting are available at $8.00 to members, $10.00 to non-members.

- Proceedings of the Alexandra Symposium "Engineering for Dams and Canals", November 1983. Price $40.00 to members, $50.00 to non-members.

- Copies of all back-issues of "New Zealand Geomechanics News" are available to members at a nominal price of 50cents per copy plus 50 cents post and packaging per order.

- The following back-issues of the IAEG Bulletin are available. Price $3.00 to members: volumes 15, 24, 26, 27.

(b) From Government Bookshops and the Secretary IPENZ:

- "Slope Stability in Urban Development" (DSIR Information Series No. 122). Price $2.00. (Also available from Government Bookshops).

The following publications of the Society have been sold out:

- Proceedings of the Nelson Symposium "Stability of Slopes in Natural Ground", 1974.

- Proceedings of the Wellington Workshop "Lateral Earth Pressures and Retaining Wall Design", 1974.

- Proceedings of the Hamilton Symposium "Tunnelling in New Zealand", November 1977.

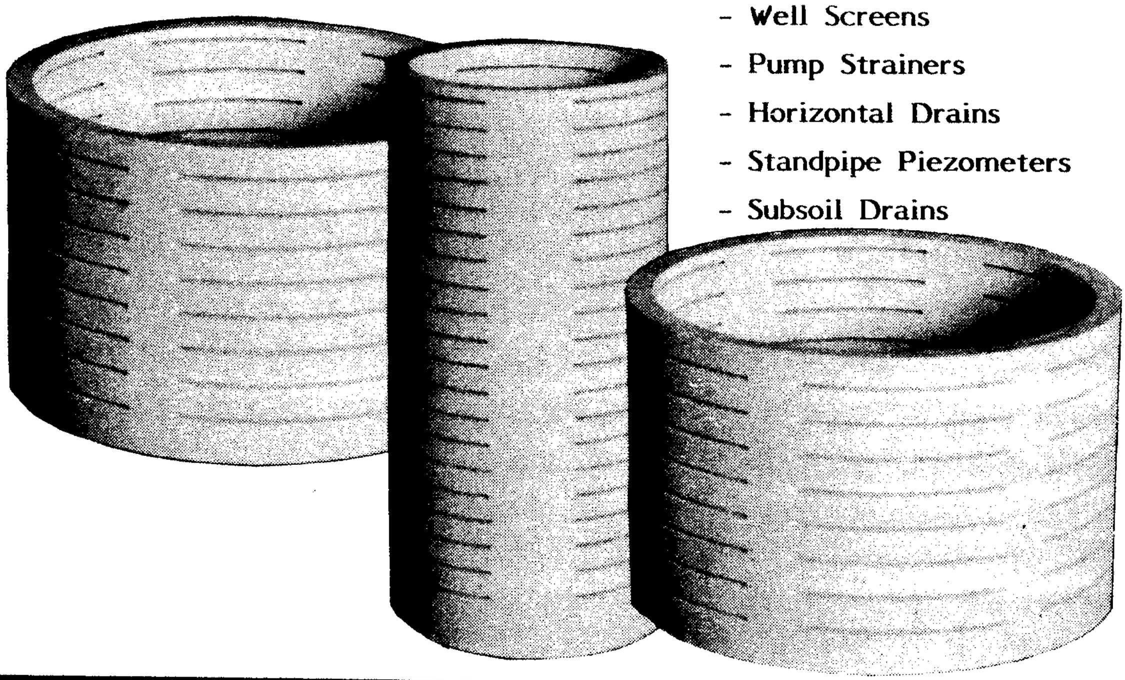
D. BEETHAM
Publications Officer

FORTHCOMING CONFERENCES

20 - 24 July 1987	- 8th Asian Regional Conference on SM & FE, Kyoto
1 - 12 August 1987	- ANZ SLIDE 87 - The Fifth International Conference and Field Workshop on Landslides
5 - 8 August 1987	- Pacific Conference on Earthquake Engineering, Rotorua
13 - 14 August 1987	- Geotechnical Engineering of Soft Soils, Mexico City
16 - 21 August 1987	- 8th Pan American Conference on SM & FE, Cartegena
19 - 21 August 1987	- 5th. Int. Conf. in Australia on FEM, Melbourne
26 - 29 August 1987	- International Congress on the Geology, Structure, Mineralization and Economics of the Pacific Rim, Queensland.
30 August - 3 September 1987	- ISRM 6th International Congress on Rock Mechanics, Montreal
31 August - 4 September 1987	- 9th European Conf. SE & FE Groundwater Effects in Geotechnical Engineering, Dublin
12 - 14 November 1987	- Symposium on Dam Safety, Rotorua
1 - 3 December 1987	- Sixth International Conference on Expansive Soils, New Delhi
19 - 22 January 1988	- Tunnelling for Water Resources and Power Projects, New Delhi
15 - 18 March 1988	- International Conference on Calcareous Sediments, Perth
20 - 24 March 1988	- First Int. Symp. on Penetration Testing ISOPT-1, Orlando, Florida
14 - 17 April 1988	- Int. Symp. on Underground Engineering, New Delhi
25 - 27 May 1988	- 3rd Int. Conf. on Application of Stress Wave Theory on Piles, Ottawa
1 - 5 June 1988	- Second International Conference on Case Histories in Geotechnical Engineering, St. Louis

June 1988	- International Congress on Tunnels and Water, Madrid
10 - 15 July 1988	- 5th International Symposium on Landslides, Lausanne
14 - 18 August 1988	- USA Spec. Conf. on Hydraulic Fill Structures
22 - 26 August 1988	- Fifth ANZ Geomechanics Conference, Sydney
19 - 23 September 1988	- IAEG Int. Symp. - Preservation and Protection of Ancient Works, Monuments and historic sites, Athens
5 - 7 June 1989	- Int. Conf. on Shaft Engineering, Harrogate, England
13 - 18 August 1989	- XII ICSMFE, Rio de Janeiro

Further details can be obtained from the Secretary.



REPORT FROM AUSTRALASIAN VICE PRESIDENT ISSMFE

INTERNATIONAL SOCIETY FOR SOIL MECHANICS & FOUNDATION ENGINEERING

I recently received a complimentary copy of the proceedings of the 4th International Geotechnical Seminar held in Nanyang Technological Institute, Singapore last August. NTI is President Broms base and runs geotechnical seminars on a yearly basis.

This fourth seminar was devoted to field instrumentation and in-situ measurements and the proceedings contains 23 papers plus, as an appendix, a report on and various contributions to the third symposium.

Copies fo the proceedings are available from Applied Research Corporation, 303 Tanglin Road, Singapore 1024 (Attention Ms Doris Tan) for US$20 postage paid and seems to be good value. I was particularly interested in a paper "Field Measurements on Foundations - To Use or Not to Use" by T.H. Hanna of University of Sheffield whose main point was "think about what you hope to achieve before you decide to instrument".

I have donated my copy to Central Library, MWD on behalf of the Society. It will be available from then on interloan.

J.H.H. GALLOWAY

REPORT FROM THE ROCK MECHANICS VICE CHAIRMAN

1. ISRM COUNCIL MEETING SWEDEN AUGUST 1986

Dr Ken Mills attended this meeting as the New Zealand Geomechanics Society representative. On his return he submitted the following report.

"The I.S.R.M. council meeting was held on Sunday, August 31 at 2.00pm. It was chaired by Professor E.T. Brown, president of the I.S.R.M. and was well attended by representatives from many countries.

After a quorum was established and the minutes of the previous Council meeting were read and confirmed, a report on the activities of the Society was presented by the Secretary General Dr N.F. Grossman. He noted:

1. A 5.4% fall in the role of the society to 5800 members.

2. Some concern over the promptness of fee payments by national groups.

3. The award of the 1985 M. Rocha Medal for the best PhD thesis to P.M. Dight of Victoria, Australia.

The state of accounts was presented with the welcome news that there is to be no change to the fees for the coming year.

Dr Herget outlined progress on arrangements for the 6th International Congress in Montreal. Representatives of organising committees for other I.S.R.M. sponsored conferences addressed the meeting with progress reports and details of these conferences.

Each of the chairmen of the I.S.R.M. commissions reported progress on and in some cases completion of their commissions. Of non-technical interest is the Advisory Committee on Revision of Statutes and Bylaws chaired by Professor L. Endersbee. this committee is working by correspondence. Any problems with statutes should be relayed to one of the committee members and will be discussed in full at the time of the next council meeting.

The matter of closer co-operation with other bodies (P.C.S., I.A.E.G. and I.S.S.M.F.E.) was raised. Representatives of these bodies addressed the meeting. The feeling was that closer liaison between groups is desirable. A motion was passed that the I.S.R.M. would not sponsor any meeting during congresses of its two sister societies, I.A.E.G. and I.S.S.M.F.E., provided these two societies inform the I.S.R.M. of the dates at least 3 years in advance.

The next council meeting will be held in Montreal in 1987 to coincide with the International Congress on Rock Mechanics where consideration will be given to the election of a new president.

Dr Bamford drew attention to the 5th N.Z. Australia Geomechanics Conference to be held in Sydney.

The meeting closed at 4.24pm".

2. <u>6th INTERNATIONAL CONGRESS ON ROCK MECHANICS</u>

This conference will be held in Montreal, Canada from 30 August - 3 September 1987. A limited number of brochures and registration forms are available from the Vice Chairman (Rock Mechanics).

3. <u>MANUAL ROCHA MEDAL</u>

Dr Ken Mills has been nominated for the Manual Rocha Medal. The NZGS wish him success in this prestigious international award.

CHRIS GRAHAM
Vice-Chairman Rock Mechanics

INTERNATIONAL SYMPOSIUM ON ROCK STRESS AND ROCK STRESS MEASUREMENT

The International Symposium on Rock Stress and Rock Stress Measurement was held in Stockholm, Sweden on 1 - 3 September 1986. The 160 delegates from 24 countries listened to the presentation of 64 papers from a total of 72 contributions to the proceedings.

The opening address was presented by Professor C. Fairhurst and emphasised the need for an intergrated design strategy in rock mechanics problems, considering overall effects of interactions between stress states, geological structure, rock mass properties and excavation geometry.

In the five sessions that followed, each of the speakers had approximately 10 minutes for presentation followed by a few minutes for discussion.

On the afternoon of day 2, three technical tours were offered. These included visits to underground excavations of interest in the Stockholm area with the opportunity to see displays of laboratory and field equipment. The final address was made by Professor E.T. Brown.

I was the only delegate from New Zealand and presented two papers co-authored by Professor M.J. Pender and D. Depledge. One was in the section on application of rock stres measurements in mining, describing measurements of insitu stress made in coal seams at Huntly. the other describing the stresscell developed for, and used, at Huntly.

The papers tended to be divided into two broad groups, those associated with hydrofracturing techniques, widely used in the oil industry, and those associated with stress relief techniques, with perhaps the most interesting development, the recoverable borehole slotting technique developed at James Cook University by Dr H.F. Bock.

The conference indicated to me that:

Rock stress measurement is being widely used throughout the world as a basic input into rock mechanics problems in the civil engineering, mining and oil production industries.

The stresscell developed in new Zealand rates highly in comparison to other stress measuring instruments and attracted interest from instrument manufacturers.

Measurements of rock stress need to be carefully scrutinised and their interpretation co-ordinated with deformation measurements and general observations of geologic structure and rock behaviour.

The generous support of the Royal Society of New Zealand in assisting with travel and conference expenses is gratefully acknowledged.

K.W. MILLS

REPORT FROM AUSTRALASIAN VICE PRESIDENT IAEG

IAEG COUNCIL MEETING, BUENOS AIRES, ARGENTINA

1. Venue

The 1986 Council Meeting of the International Association of Engineering Geology (IAEG) was held in the Centro Cultural General San Martin, Sarmiento 1551, Buenos Aires, on 18 and 19 October 1986. Some items of business were also held over to 23 October to permit sub-committee consideration during the Congress, and the Council meeting in fact concluded immediately prior to the General Assembly which closed the Fifth IAEG Congress. The Council was attended by the President (Professor M. Langer), the Honorary President (Professor M. Arnould), the Secretary-General (Dr L. Primel), the Treasurer (Mr A. Peter), four Vice-Presidents (representing Asia, Australasia, North America and South America), and representatives of 22 of the IAEG's 46 National Groups.

2. Current Membership

The total IAEG membership in October 1986 stood at 4625, of whom 4410 were members of national Groups and 4010 received the Bulletin, including subscriptions by non-members the total Bulletin sales were 4300, a figure very little changed during the preceding three years. Applications were received at the Council Meeting for the affiliation of new National Groups from Ivory Coast, Morocco, Norway and Vietnam, their subsequent acceptance brings to 50 the number of affiliated national Groups. The continuing increase in members from Australia (281 as at October 1986) and New Zealand (150) means that the region now has almost 10% of the total IAEG membership, a fact that must assure the continued existence of Australasia as one of the seven regional groupings within IAEG. One matter of some concern was an accelerating decline in individual and associated members, whose combined numbers have dropped from 292 to 215 in the last four years, but no obvious solutions were forthcoming and clearly this decline is being offset by an increase in National Group membership.

3. Financial Matters

The Treasurer presented a financial statement which showed clearly that (1) the 1985 receipts barely met expenses; and (2) the 1986 budget forecast a substantial loss. It was apparent also that high bank interest from the Association's investments (in France) had principally been responsible for offsetting a loss of revenue from subscriptions, and that a dramatic increase in membership dues was essential if IAEG was to survive financially. It transpired from the subsequent discussions that there had been no change in membership dues since they were set at US$6 in 1970, and a prolonged debate then ensued which was (in my view) chacterised more by obstinacy than realism on the part of certain Council members who should have known better. Finally, the Secretariat's recommendation for a doubling of membership dues to US$12 was amended to US$9 (a 50% increase) and approved with only one abstention. I personally argued strongly for the Secretariat's recommendation, having pressed on previous occasions for a more modest but regular series of increases to offset inflation (but with no success except an undertaking from the 1985 Washington DC Council meeting that a decision would finally be made in Buenos Aires). A further pleasing outcome was a decision to review fees more often than in the past, and to appoint a Finance Committee one year before each General Assembly in order to make appropriate recommendations. The next fees' review will be at the 1989 General Assembly, which is to be held in conjunction with the International Geological Congress in Washington, DC.

4. IAEG Commissions

At the 1986 Council Meeting a number of Commissions had been disbanded, and after Buenos Aires the following remained:-

No.	Title	Chairman
1	Engineering geological mapping	H. Pahl (FRG)
2	Landslides and other mass movements	J. Hutchison (UK)
3	Engineering geological problems related to soluble rocks	A. Monjoie (Belgium)
4	Education and training in engineering geology	R. Oliverira (Portugal)
8	Engineering geology and earthquake effects	R. Cotechia (Italy)
9	Aggregates: sand, gravel and crushed stones	H. Weigers (FRG)
10	Building and ornamental stones	A. Shadmon (Israel)
11	Site investigations A. Remote sensing B. Engineering geophysics	 N. Rengers D. Price (Netherlands)
12	Soil properties as a function of their genesis	V. Osipov (USSR)
13	Minimising damages to the environment caused by mining operations	D. Voigt (FRG)
14	Underground disposal of wastes	C.O Morfeldt (Sweden)
15	The engineering geological study of the shelf and littoral zones of the seas and oceans	J. Buachidze (USSR)

Considerable discussion ensued on the role of the Commissions, in part because of the presence of only four of the Chairmen at Buenos Aires and the failure of many others to submit regular reports. It became clear that there are no guidelines as to the operation of the IAEG Commissions, that there has in the past often been no clear statement of objectives or an agreed timetable, and that the outcome has often depended on initiatives by the Chairman. On the positive side, requests for IAEG nominees on a number of ISRM and ISSMFE Commissions should lead to an avoidance of duplication by the three sister societies, and I am also satisfied that the incoming IAEG President (Dr O. White, Canada) will move to establish firm guidelines for the future operation of IAEG Commissions.

5. Publications Policy

Probably the most significant outcome of the Buenos Aires Council Meeting was the appointment of an "Ad hoc Committee on Publications" which met during the Congress, and which reported back a recommended policy in time for endorsement by the General Assembly. The ad hoc committee was chaired by Professor D.G. Price (Netherlands), and consisted of Dr Primel (Editor-in-Chief), Mr Peter (Treasurer), Professor Marinos (Greece), Professor Hawkins (UK), Mr Trudinger (Australia) and myself. The principal recommendations were

(1) That the proposed IAEG Manual be abandoned, with any completed material to be published either in the Bulletin or the proposed Monograph series.

(2) that an editing and refereeing system for the Bulletin be implemented, with an Editorial Board to be established comprising the Editor-in-Chief, the seven regional Vice-Presidents, and other nominated persons.

(3) that a series of IAEG Monographs be published, typically incorporating the findings of particular Commissions but subject to normal editorial policies.

The above proposals were accepted without modification, and a full Editorial Board is now in existence. It remains to be seen whether this new policy will be effective in raising the IAEG publications standards, and in ensuring the dissemination of Commission reports. Two new Monograph titles were in fact suggested, the first on "Pedicretes and their engineering significance" (convenor: J. Trudinger, Australia) and the second on "Rock weathering and its engineering significance" (convenor: B. Hawkins, UK). The responsibility for formulating a proposal (e.g. by way of a Commission) rests presently with each convenor.

6. Forthcoming Meetings

The following meetings were endorsed by the IAEG Council in Buenos Aires:-

(1) Beijing, 4 - 8 May 1987: The 1987 Council was scheduled to be held in conjunction with the "International Symposium on Engineering Geological Environment in Mountainous Areas", which is being organised by the Chinese National Group of IAEG.

(2) Athens, 12 - 23 September 1988: The 1988 Council will be held (subject to endorsement in Beijing) in conjunction with the "International Symposium on Engineering Geology as related to the Study, Preservation and Protection of Ancient Monuments", which is being organised by the Greek National Group.

(3) Tbilisi, USSR, 1 - 6 October 1988: After some initial concerns regarding a possible clash with the Athens symposium, it was agreed to endorse the "International Symposium on Engineering Geology of the Shelf and Continental Slope of Seas and Oceans". This will be the first formal product from IAEG Commission No. 15, and the New Zealand nominee on that working group is Dr Jarg Pettinga (Geology Department, University of Canterbury).

(4) Washington DC, June 1989: The 28th International Geological Congress will be held in Washington, and both the Council Meeting and the next General Assembly will be held in conjunction with that event. The USA National Group under Dr George Kiersch is responsible for the organisation of the engineering geology programme.

(5) Amsterdam, August 1990: The proposal by the Netherlands National Group to host the Sixth IAEG Congress was enthusiastically endorsed, and it is the intention of Dr David Price to adopt a "State-of-the-Art" format to invite General and Panel Reporters to contribute.

(6) Israel, 1991: A proposal was received from the Israeli National Group to host an "International Symposium on Engineering Geology in Desert Environments - Soil/Water Interaction", and this will be further considered at the Athens Council Meeting.

(7) Incoming Exectuve

The General Assembly on 23 October endorsed the following Executive to hold office for the period 1987 - 1990.

President	Dr O. White (Canada)
Secretary-General	Dr L. Primel (France)
Treasurer	Mr A. Peter (France)
Vice President (Africa)	Dr R. Brancart (Ivory Coast)
Vice President (Australasia)	Mr J. Trudinger (Australia)
Vice President (Asia)	Dr A. Balasubramaniam (Thailand)
Vice President (N America)	Dr G. Kiersch (USA)
Vice President (S America)	Dr N. Chiossi (Brasil)
Vice President (E Europe)	V. Osipov (USSR)
Vice President (W Europe)	R. Oliverira (Portugal)

8. Other Matters

Several matters that may be of interest to New Zealand members of IAEG are:-

(1) IUGS Urban Geology Programme: The IAEG will be participating closely in the extension of this programme to other parts of the worls, especially to South America where a preliminary co-ordinating meeting is planned for early 1987. The incoming President (Dr Owen White) has a close personal interest in this subject, and he would be most interested in any offers of assistance.

(2) ISSMFE Name Change: A proposal by ISSMFE to change its name to the "International Geotechnical Society" received quite a hostile reception from some IAEG Council members, and it is understood that both ISRM and the Secretary of the Permanent Co-ordinating Secretariat (Professor de Beer) also have expressed opposition. The Buenos Aires Council resolved to convey its strong opposition to this proposal, and also to delay the exchange of liaison members for ISSMFE commissions until the matter was resolved.

(3) Richard Wolters Prize: This prize is to be awarded every two years to an engineering geologist less than 40 years of age who has achieved significant published work in the field, and the first award should be made at the Beijing Council Meeting.

9 Concluding Remarks

As outgoing Vice President for Australasia I feel that the IAEG is now functioning very well, and the work of the Secretariat in particular has (after some early hiccups!!) become extremely good. With the fees now resolved for the next three years budgeting should be much easier, and the moves to upgrade the publications policy were long overdue and (on paper at least) are very sound. A matter that still requires action is the functioning and reporting of the IAEG Commissions, and I am sure that Dr Owen White (the first IAEG President from North America) will give this high priority once he assumes office. Finally I can only endorse the need for continuity at Council Meetings, and I hope that New Zealand will send representatives to all future meetings, we presently have a large measure of goodwill with the Executive, and certainly much more than our "pro rata" entitlement.

DAVE BELL

REPORT FROM ENGINEERING GEOLOGY VICE-CHAIRMAN

1. IAEG PUBLICATIONS

Bulletins No. 33 and 34 have been received and distributed to those affiliated members who subscribe to the bulletin. Please notify the E.G. Vice-Chairman if you have not received your copy.

2. IAEG COUNCIL MEETINGS

Dave Bell attended both the IAEG Council meetings in Buenos Aires on October 18, 19 & 24 1986, see report on page 11 and in Beijing on May 2-3, 1987, as N.Z. Geomechanics Society representative.

The main items of interest from the Buenos Aires meeting were:

- Increase in IAEG affiliative fees US$6 to US$9 inclusive of bulletin (first increase in 16 years).
- New President of IAEG is Prof. Owen White (Canada).

- 4 new groups (Ivory Coast, Norway, Morocco & Vietnam).

We congratulate Dave on his appointment to the editorial board of IAEG Bulletin.

3. IAEG PRIZES

Dr Jarg Pettinga was nominated for the inaugural Richard Wolters Prize. This prize was initiated at the Buenos Aires Council meeting, and is to be awarded every two years to an engineering geologist less than 40 years old who will have achieved (a) significant published work(s) in the field of engineering geology. Nominations must be made by the N.Z. Geomechanics Society.

4. UPCOMING IAEG SPONSORED EVENTS

A summary of these events are given in Dave Bells report.

- N.Z. Geomechanics Society to consider hosting the 1998 IAEG Congress. Comments to the E.G. V.C. would be welcomed.

NICK ROGERS
Vice-Chairman Engineering Geology

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LOCAL GROUP ACTIVITIES

AUCKLAND GROUP ACTIVITIES

The first meeting of the year got underway on April 22 with an excellent presentation by Prof. M.J. Pender on the geotechnical aspects of the Edgecumbe Earthquake of 2 March 1987. The talk and visual presentation was very well attended.

The second meeting on May 27 was the 5th Geomechanics Lecture presented by Les Oborn on the evaluation of engineering geology in New Zealand.

At least 6 more meetings are scheduled for 1987, and an enthusiatic committee of 11 representing consultants, MWD, University, Local Authorities and the Construction/Contracting industry will ensure a successful year for local activities.

NICK ROGERS
Convenor

WELLINGTON GROUP ACTIVITIES

The following activities have been organised as part of the IPENZ Wellington Branch programme. They will be held in the Wakefield Room, 8th Floor, Wakefield House, 90 The Terrace, Wellington.

9 June, Tuesday evening 5.00 - 7.00 pm

The 5th Geomechanics Lecture by Les Oborn titled "Thoughts on the Evolution of Engineering Geology in New Zealand".

Before his retirement Les Oborn held the position of Chief Engineering Geologist with New Zealand Geological Survey, DSIR. He has been directly involved in the engineering geological investigations for most of the major power development projects in New Zealand and for many other civil engineering works. Les was responsible for the formation of the Engineering Geology Section of New Zealand Geological Survey and has taken a personal interest in seismotectonic hazard assessment.

25 June, Thursday evening session 5.00 - 7.00 pm

Subject: General Aspects of the March 2 Edgecumbe Earthquake.

Speakers:
1. Peter Wood (NZ Geological Survey) on geology, faulting and earth deformation.
2. David Dowrick (Physics and Engineering Laboratories) on strong ground motion and damage to civil engineering structures.
3. John Hunt (wellington City Council) on earthquake damage to services and housing.

29 October, Thursday evening session, 5.00 - 7.00 pm

NZSOLD & Geomechanics Society

Subject : The Performance of Matahina Dam during the March 2 Edgecumbe Earthquake and Geotechnical Aspects of the Earthquake.

Speakers:
1. Murray Gillon (MWD Power Design) on Matahina Dam.
2. Graham Ramsay (MWD Special Projects) on Geotechnical Aspects of the Earthquake.

Further local activities can be organised at quite short notice. Your local programme committee consisting of :

Ian Brown (ph. 858 603)
Graham Ramsay (ph 729 929)
Stuart Read (ph 699 059) and
Dick Beetham (ph 699 059)

would welcome suggestions for further local activities. Ian Brown has kindly offered us the use of his office seminar room for meetings and addresses.

DICK BEETHAM

LETTERS TO THE EDITOR

Madam,

THE ENGINEERING GEOLOGIST QUESTION

Les Oborn's very interesting, informative and well presented Fifth NZ Geomechanics Lecture, "Thoughts on the Evolution of Engineering Geology in NZ", among other things, surveyed the state and development of engineering geology in New Zealand. It also expressed the desire of the Engineering Geologists in this country for professional status. Following the presentation of the lecture in Auckland on May 26th there was an interesting and wide ranging discussion about the need for such recognition, the advantages and disadvantages of professional status, and how it could be achieved. No definite conclusions were reached during the discussion. Set down here are the subsequent thoughts of one of the participants.

My first point is one which I assume no one will question: the practice of geotechnical engineering is simply not possible without competent engineering geological input. This is particularly so in NZ where we have complex and exceedingly variable geological conditions. The discipline of geotechnical engineering is divided into three subdisciplines : soil mechanics, rock mechanics and engineering geology. This idea was recognised at the time the NZ Geomechanics Society was set up in the early seventies. Although one expects a geotechnical engineer to have a broad knowledge of all of these disciplines the mastery of all three is not a reasonable expectation; thus each one of us tends to specialise to a greater or lesser extent in one of the subdisciplines. Thus the practice of geotechnical engineering must be a team effort, clearly the engineering geologist must be part of this team.

My second point refers to the statistical data presented during the lecture. According to the survey made by Les Oborn in his preparation for the lecture 131 persons who regarded themselves as an engineering geologist. However, it turned out that only 59 of these 131 people were members of an IPENZ technical group, let along the Geomechanics Society. I have great difficulty in conceiving of a so-called engineering geologist who has not even bothered to seek membership in the local organisation which disseminates information about engineering geology in this country. I conclude that, the wishes of the engineering geologists aside, there is a case for some type of professional status for engineering geologists so that the definition of an engineering geologist can be settled and consideration given to who satisfy this criterion.

Now how is this to be achieved? It was explained during the discussion that in California a separate body exists to register engineering geologists. It was also pointed out that in NZ there are just not enough engineering geologists to make it feasible to set up and maintain such a separate organisation. Mention was also made of the IPENZ companion grade of membership which is for those who cannot be classed as professional engineers but whose qualifications and work mean they are closely related to professional engineering and make a vital contribution to engineering endeavour. However, Les felt that the engineering geologists were looking for more than that.

This response to the companion suggestion is unfortunate but understandable. Unwittingly IPENZ seems to have given the impression that a companion is a lesser being than an engineer. In one or two cases applicants for registration as engineers whose qualifications and experience have been deemed not to be appropriate to a professional engineer have been offered companionship. This has seemed to be second best. I would prefer that the message given is that the companion has qualifications that mean he/she is not an engineer, but that skills of a very high degree indeed, which are essential to the engineering profession, are demonstrated by that person and as recognition of this expertise and because it will be helpful to have such membership involved in and aware of IPENZ's activities a special grade of membership has been setup. I think IPENZ needs to do some public relations work to promulgate this message with a view to convincing the profession at large that the Companion grade of membership has real professional status.

IPENZ is the organisation that administers the professional examination for engineering registration. This is a confusing arrangement because the registration of a professional engineer is granted not by IPENZ but by the Engineers Registration Board, a statutory body. IPENZ happens to be a convenient organisation to perform the professional examination. If an engineer passes this professional examination IPENZ is then willing to admit that person as a member. Thus one can be a registered engineer without membership of IPENZ, but not a member of IPENZ without registration as a professional engineer. My suggestion is that the professional status of an engineering geologist be assessed by a professional examination for companion membership of IPENZ. This examination would have a very different objective from the existing professional examination but this format of the process would be similar. It seems to me that this process could be accommodated readily within existing IPENZ procedures. Just as a member of IPENZ has the letters MIPENZ after his name, I envisage that the companion would use the letters CIPENZ.

Thus the question still remains: How can professional status be achieved for engineering geologists? My current thoughts are as follows:

(i) We need to accept that the request of the engineering geologists for professional status is reasonable. Also it seems that there is a need for clarification of the term engineering geologist and the type of qualifications that are required by such professionals.

(ii) The engineering geologist makes a vital contribution to the engineering profession. Thus questions of professional status need to be decided by a body that has very close links with the engineering profession.

(iii) IPENZ currently has the grade of companion. To date the full use of the possibilities of this grade of membership seem not to have been exploited. A campaign is needed to promote this as a suitable grade of membership for the engineering geology group.

(iv) The appropriate group to persue this matter with IPENZ is the Geomechanics Society.

M.J. PENDER

Madam,

GEOMANCERS, NECROMANCERS AND WATER DIVINERS

In recent years it has been my misfortune to have had professional contact with no less than five registered engineers, variously engaged with water supplies at a significant level of responsibility, all of whom indicated that they believe in water divining. Three are engaged with major industrial complexes substantially reliant on groundwater supplies. Two were involved with catchment authorities. One of these is now employed by a major firm of consulting engineers professing expertise in water supply work. Two have used water diviners or have proposed their use to me in relation to major industrial complexes.

A certain consulting geologist might well be mortified to learn that one of his clients, or the engineer employed by this client, engaged a diviner to check the boundaries of the particular mineral deposit the consultant was evaluating. This engineer was not a mining engineer.

If a registered engineer was to engage, or even recommend the engagement, of a geomancer to site a major engineering work in a tectonically unstable area or if the engineer was to engage a necromancer to determine the timing of the next major earthquake he would either be certified insane, de-registered, or both. Rightly so. It is a pity that a similar response does not apply in the case of the users of water diviners.

Perhaps we could read a reply on the application here of professional ethics, by one of the engineering members.

ROGER DEWHURST
M.App.Sc., C.Eng., M.I.M.M., A.M.Aus.I.M.M., F.G.S.

THE NEW ZEALAND GEOMECHANICS SOCIETY AWARD

General

With minor exception, the IPENZ awards for published papers each year are for specific technical groups, and accordingly papers of geotechnical interest prepared by our members who are not IPENZ members are generally not eligible. The Management Committee has therefore decided to promote a new award specifically for our own members and the rules pertaining to this award are presented below. **Written nominations for the next award are required to be** with the Management Secretary by 31 July 1987.

The Geomechanics Society Award has been presented once before at the Society's 1986 Hamilton Symposium on Pile Foundations, to B.D. Hegan and P.J. Millar for their paper on "Investigations in Soft Rock Terrain", presented at the Symposium on Engineering for Dams and Canals at Alexandra, 1983.

Rules

1. This award may be awarded annually and shall be presented at the Society's Annual General Meeing.

2. The Award shall be made to the Society member or members producing the best published paper during the three years ending 31 July preceding the date of the Award, in any publication at the discretion of the Management Committee.

3. As to eligibility for the Award, all Society members who are authors of any paper published within the previous three years shall be eligible, provided that at least one author is a member and the paper is nominated in writing by a member during the current year.

4. Nominations for consideration as recipient of the Award shall be sought through the June issue of Geomechanics News each year.

5. The criteria for selection of the Award paper shall be merit and the degree to which the paper advances the objects of the Society.

6. The process of selection of the recipient of the Award shall be administered by the Management Committee of the Society.

7. The Award shall be a sum of money to be determined by the Management Committee for the purchase of books, plus a certificate.

8. The Award shall be known as the "New Zealand Geomechanics Society Award".

Next Award

The Management Committee are hoping that the members of the Geomechanics Society will forward nominations for the next Award to be made at the IPENZ Conference in February 1988.

DICK BEETHAM
Publications Officer

THE 1987 GEOMECHANICS LECTURE

Delivered by Les Oborn at the IPENZ Christchurch conference on May 12.

After a well attended technical groups smorgasboard dinner, the lecture was presented to a receptive audience as a highlight of the days activities. Andy Olsen, president of the Geomechanics Society, introduced Les and gave a detailed summary of his diverse and distinguished career. Les then launched into his topic, "Thoughts on the Evolution of Engineering Geology in New Zealand", holding the audiences attention with a lively delivery, his subtle humour, and a judiceous use of slides to enhance the lectures content.

The lecture commenced with a definition of engineering geology and a resume of the sciences' early beginnings overseas then in New Zealand. William Smith, a founder of modern geology, is regarded as the first engineering geologist, and he was a civil engineer who produced the first geological map. So initially it was civil engineers who took a deep interest in geology as it affected their work, and there was little significant input by geologists into civil engineering until well after the turn of the century.

In general geological input into civil projects was requested only when problems were met, although some rock strength testing was undertaken at a few early projects, such as rock jacking tests at Arapuni in 1920. Full-time engineering geologists were first appointed to the Tongariro and Upper Waitaki Power Development Projects. Also about this time, in the early 1970's, consulting geologists and geotechnical advisors began to appear, and geotechnical laboratories started carrying out specific tests on New Zealand soft rocks.

In order to determine the present status of engineering geology in New Zealand, Les had sent out a questionaire which had received quite good response. The results of this were presented as graphs, bar and pie charts showing qualifications, employment and related data. Surprisingly private consultants employ the greatest number of engineering geologists (42%), followed by Local Authorities (26%) and Government Departments (21%). In addition Les showed that there has been a very rapid growth in the number of practising engineering geologists in the last decade.

What lies ahead in the future? Is engineering geology a branch of Science or Engineering? These questions have been asked, but there is no unanimous agreement. However, Les suggested that engineering geologists will play an increasingly technical role in the future, with an increasing number having an engineering background. As the end users of engineering geology were engineers, Les felt that it was in their best interests to promote engineering geology. Perhaps some form of registration or professional association should be offered to engineering geologists under the wing of IPENZ?

Bill Fookes, retired Chief Design Engineer from the Ministry of Works, then reminised about his past associations with engineering geologists, before proposing a hearty vote of thanks to Les for his talk. This was carried by acclaimation.

Report by Dick Beetham

Note: A full text of the Geomechanics Lecture will be published in a later edition of Geomechanics News.

FIFTH AUSTRALIA-NEW ZEALAND CONFERENCE ON GEOMECHANICS

PREDICTION VERSUS PERFORMANCE

SYDNEY N.S.W. **22-26 AUGUST 1988**

THE CONFERENCE

The Conference is being organised by The Institution of Engineers, Australia and the Australian Geomechanics Society and is a regular four-yearly event which, in 1988, will be held in Sydney to coincide with the Australian Bicentennial celebration.
This call for papers seeks to attract papers within the overall theme of the Conference.
It is also proposed to hold two Case History prediction sessions at the Conference making comparisons between measured performance and that predicted by a cross-section of practitioners. At a later date, information on case histories will be distributed to interested persons to enable them to participate in a competition on predicting performance.
Expressions of interest are also sought from those wishing to attend and from organisations or individuals wishing to participate in an industry display in association with the Conference.

LOCATION

The Hilton International Hotel, Sydney Conference & Exhibition Centre.

PAPERS

Intending authors are invited to submit titles of proposed papers together with a brief abstract of not more than 300 words outlining the contents of their papers and its relevance to the main theme of the Conference.
Papers should be in the following categories:

- ☐ Groundwater Problems
- ☐ Underground Mining and Excavation
- ☐ Stability of Soil and Rock Slopes
- ☐ Prediction of Excavation Characteristics
- ☐ Foundations on Soil
- ☐ Failures – A Yardstick for Prediction Ability
- ☐ Geotechnics of Weak and Jointed Rock
- ☐ Mining Subsidence
- ☐ Ground Stresses and Movements
- ☐ Foundations on Rock
- ☐ Geotechnical Testing
- ☐ Earthquake and Vibrations

Final papers should be restricted to 5000 words. All chosen papers will be presented at the Conference in Poster Sessions. Only keynote speakers and general reporters will be presenting their papers in open sessions.

DEADLINES

Intending authors should note the following deadlines:

Receipt of Abstract	30 June 1987
Notification of acceptance of Abstract	30 August 1987
Receipt of full text for final review	15 November 1987
Final program	April 1988

Synopses should be accompanied by a statement of the author's intention to attend the Conference.
Papers received after November 1987 will not be included in the Conference. A final program will be available in April 1988.

All enquiries should be directed:-

The Conference Manager
Fifth Australia-New Zealand Conference on Geomechanics
The Institution of Engineers, Australia
11 National Circuit
BARTON ACT 2600
Telephone: (062) 73 3633 Telex: AA62758
Telegrams: ENJOAUST CANBERRA Facsimile: (062) 73 1488

DEVELOPMENT IN PILE DRIVING

New Zealand will soon see in action the first hydraulic pile driving hammer imported into the country. The unit, a Banut 600 manufactured by Banut AB in Sweden is being imported by the Auckland Specialist piling contractor Gilberd Hadfield Pile Co.

The unit is capable of adaption to drive with either a 4, 5 or 6 tonne falling mass with drop height accuracy controlled via an electronic control box at a rate up to approximately 80 blows per minute.

The rate of blow is some three times faster than conventional piling methods which means that a very definite saving in on-site time is achieved using the Banut hydraulic hammer.

Noise is greatly reduced from that experienced by conventional pile driving equipment in that the hammer, cage and helmet are protected from direct contact with each other. Noise measurements have given a reading of 85 dB at 7m compared with the conventional hammer reading of 100 dB - a saving of 15 dB.

The height of hammer drop is controlled using the Banut hydraulic hammer so that the erratic drop height experienced with diesel or conventional hammers is removed, hence eliminating the effects of overdriving (tension cracking or other pile damage) or underdriving giving reduced pile capacities.

Banut hydraulic hammers are presently being used extensively throughout the world with the closest operating units being in Brisbane where two are in service with John Wagstaff Construction Pty Ltd.

The banut hammer is adaptable to all types of driven pile, steel, timber precast or prestressed concrete. The unit has been imported primarily to work over the Balken pile. The Balken pile is a Swedish developed piling system, the licence for which is held by Gilberd Hadfield Pile Co and is accepted worldwide for its unique qualities. The Balken Piling System is based around a high quality precast segmented concrete pile which is available in 12, 9, 6 and 3m lengths. The pile therefore is readily able to be extended to meet the ever changing founding depths. To date in New Zealand 30m is the greatest driven depth for a Balken pile but in Sweden depths to 100m have been driven.

Also available with the Banut hydraulic hammer and Balken pile to complete the Balken Piling System is the Pile Driving Analyser. The PDA uses the one dimensional wave equation to determine for every hammer blow such factors as pile bearing capacity, transferred energy, maximum tension and compressive forces, maximum impact velocity and acceleration, and pile integrity.

Driven piling has made rapid technological advances over recent years and the Banut hydraulic hammer, Balken pile and Pile Driving analyser represent the very latest developments. The existence of such plant and equipment in New Zealand has brought New Zealand into line with the constructional economies available elsewhere in the world.

J.C. YONGE
General Manager
Gilberd Hadfield Pile Co.

THE EDGECUMBE EARTHQUAKE - a brief report

M.J. PENDER

On March 2 1987, at 1.42pm an earthquake of magnitude 6.2 occurred near the town of Edgecumbe on the Rangitaiki Plains. The Seismological Observatory of the Geophysics Division of the DSIR has provisionally estimated the depth of the focus to be 10km. The approximate position of the epicentre of the main event is shown below in Fig. 2. Seismic activity in the general area during the previous week culminated in a foreshock on March 2 of Magnitude of 5.2 at 1.35pm. Four aftershocks with magnitudes in excess of 5.0 occurred later on March 2. The epicentres of some of the aftershocks were located near Kawerau.

Modified Mercalli Intensities of MM IX were reported in and around Edgecumbe. These intensity levels are consistent with previous magnitude 5 events in the region producing epicentral intensities of MM VII AND VIII.

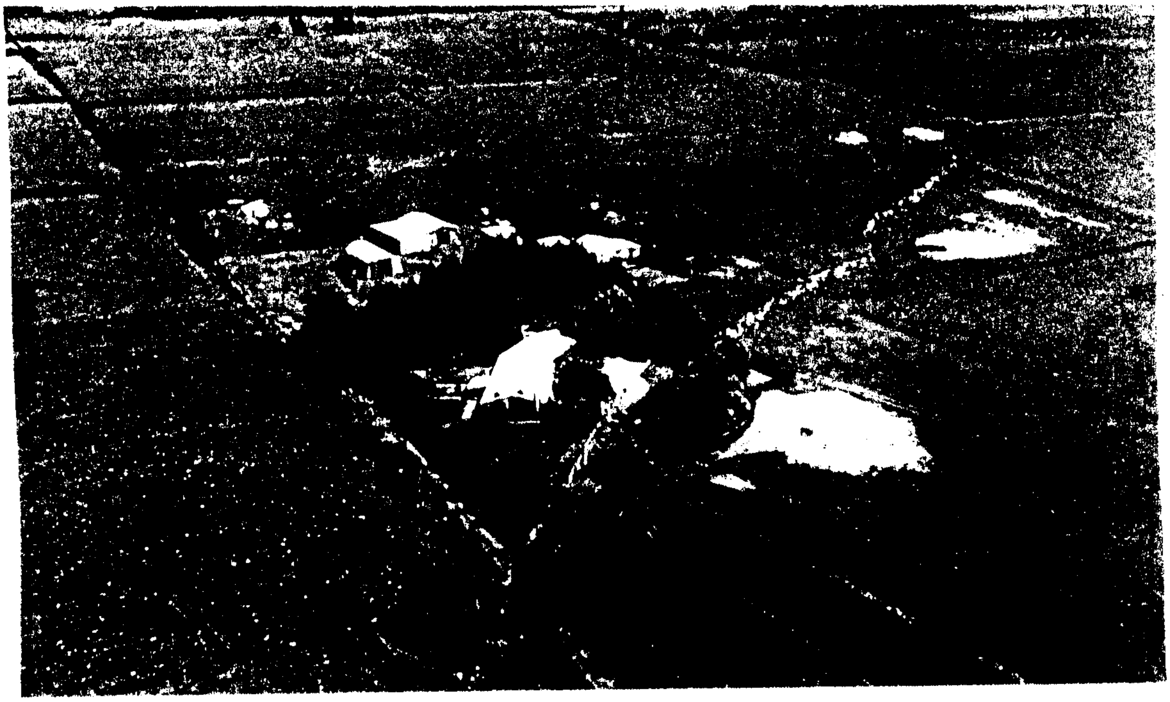

Fig. 1 Surface scarp near McCracken Rd.

The main shock produced a complex surface scarp about 6km long striking SW from near Edgecumbe. A photograph of this in the McCracken Road area is shown in Fig. 1. About 1m of extension occurred across the scarp with the area to the north-west being downthrown by about 1.5m. In addition seven other lesser surface scarps were produced. The approximate locations of these scarps is given in Fig. 2, which is a simplified map of the Rangitaiki Plains. The boundary of the plains shown on this diagram corresponds to the quaternary alluvium shown in pale yellow on the geological map of the region.

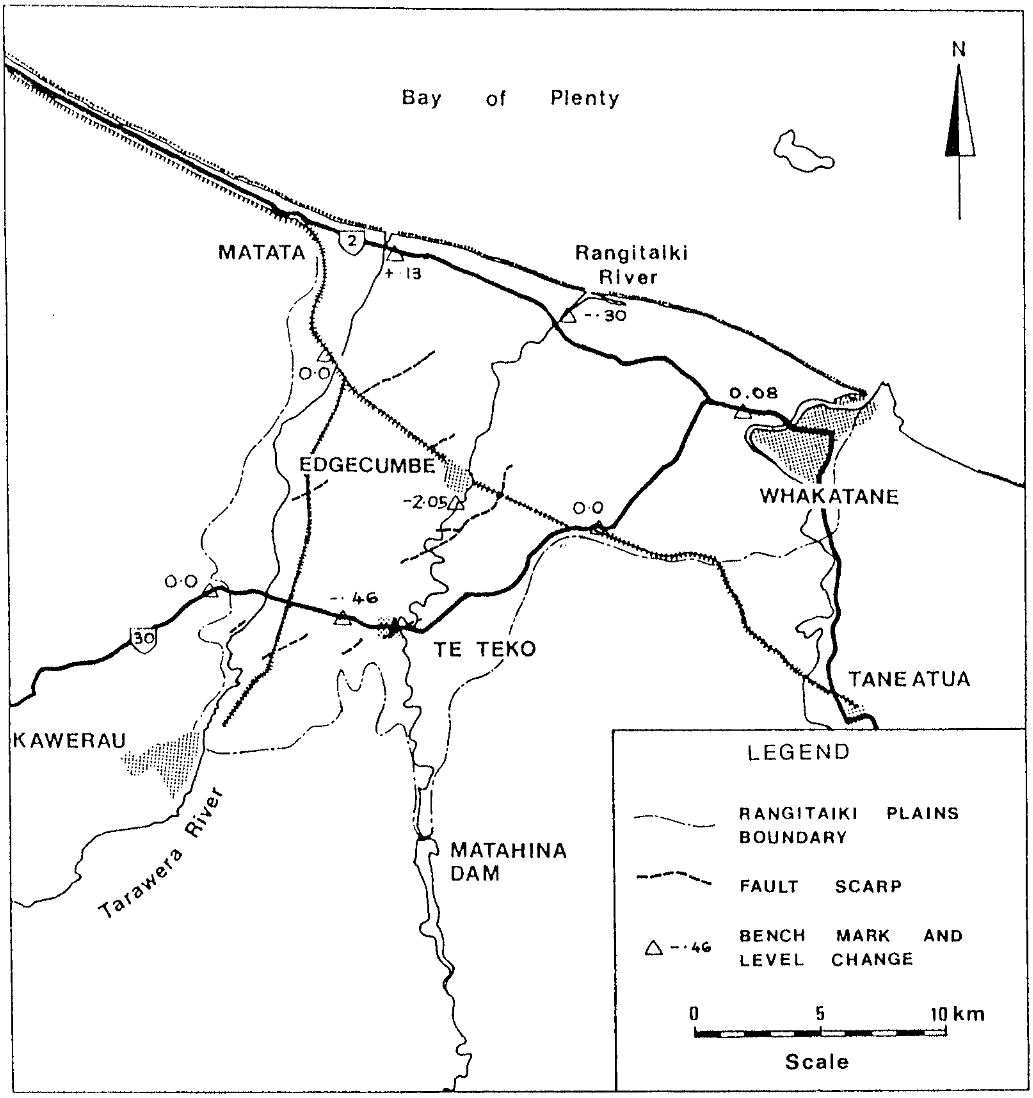

Fig. 2 Edgecumbe earthquake : principal fault scarps & level changes

Soon after the earthquake the Bay of Plenty Catchment Commission arranged for the Department of Lands and Surveys to level the main benchmarks on the plains. This has confirmed the regional subsidence. The measurements show that a maximum subsidence of 2 metres occurred just south of Edgecumbe, and subsidences of 0.4m at Te Teko and 0.3m were observed on the coast at Thornton. These level changes are summarised in Fig. 2. Associated with this subsidence was serious damage to some stretches of the stopbanks which provide flood protection from the three rivers that cross the plains.

The soil conditions on the plains consist of approximately 300 - 400m of alluvial material overlying ignimbrite. A much simplified soil profile appears in Fig. 3. This is a synthesis of a range of site investigation data from a number of sites on the plains. Groundwater level information was not available at the time of the earthquake. However, as the event occurred at the end of a dry summer period it is probable that in most locations the water table was, at least, toward the bottom of the upper loose sand layer. Even with the probable low groundwater level there was extensive evidence of liquefaction with lateral spreading adjacent to the three rivers which cross the plains. Eruptions of sand appeared at the ground surface. Particle size distributions of the ejected sand, prepared by the MWD in Hamilton, are given in Fig. 4. It is clear that these fall right into the middle of the range of potentially liquefiable sands.

0

Loose sand

N 2 to 10

3m

Medium dense to dense sand

N 10 to 42

7m

Interbedded sand, silt and peat

N 2 to > 50

14m

Marine sediments

N up 100

Fig. 3 Simplified soil profile for the Rangitaiki Plains

The most significant structure in the region is the Matahina dam. It is also the site of the strong motion instrementation which is located about 15km from the epicentre. These instruments, which are serviced by the DSIR Physics and Engineering Laboratory, gave the peak ground acceleration at the base of the dam of 0.33g and, in the upstream downstream direction, 0.43g at the crest. Processing of this strong motion data has produced a response spectrum surprisingly like the 1940 El Centro spectrum. Spectra for the base and crest of the dam are given in Fig. 5. This is the first instance of strong motion data with design level ground accelerations being recorded in NZ.

Under these accelerations the dam performed well. There were slightly increased seepage flows through the structure and slight cracking at the crest. Surveys immediately after the event showed that a downstream displacement of about 200mm had occurred at the crest. Apparently this downstream displacement is about the same as that observed on the initial filling of the lake.

There were no significant problems with the stability of natural slopes. Several roads were temporarily closed because superficial material had slumped from above. On SH 2 west of Matata low grade ignimbrite had fallen away from the top of the cliffs above the road. Residents of Kawerau noticed cracks near the crest of some of the hills behind the town. The soil profile in these areas consisted of a layer of volcanic ash, about half a metre thick, overlying a similar thickness of lapilli in the coarse sand fine gravel size range. It appeared that the lapilli layer had slumped slightly under the earthquake motion so causing the cracks. This did not appear to be a serious hazard.

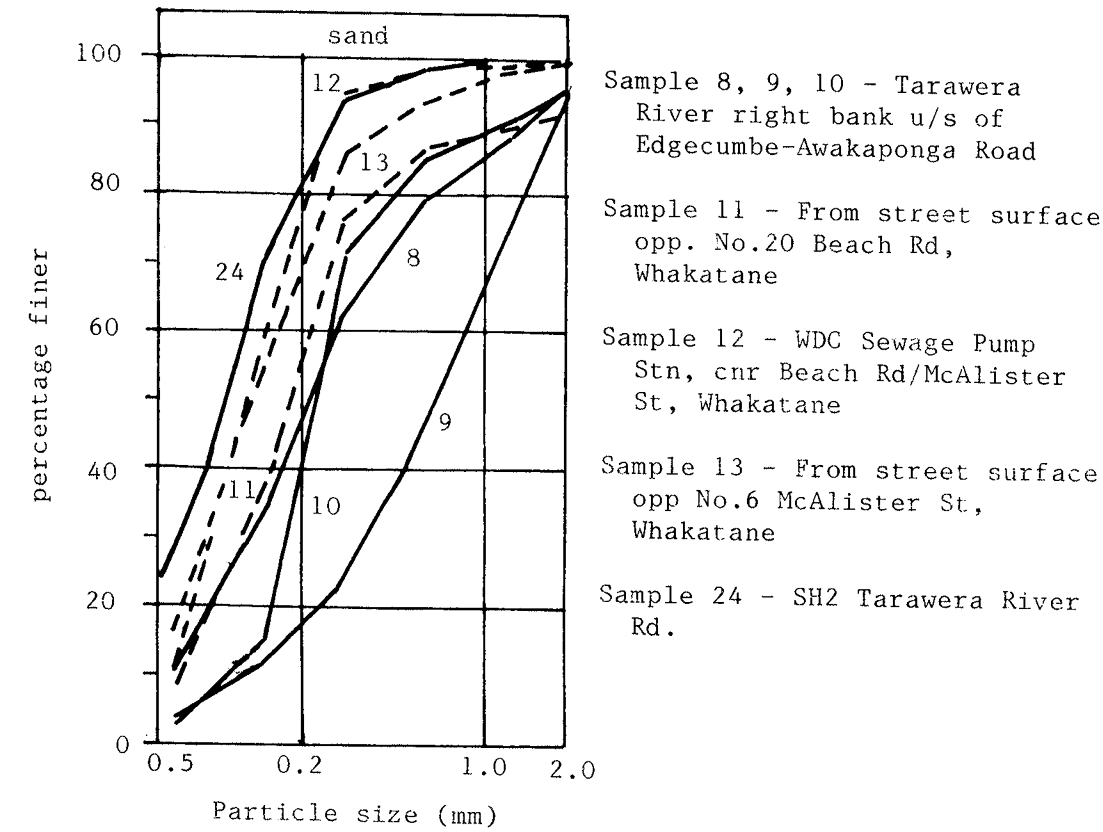

Fig. 4 Particle size distributions for ejected sand

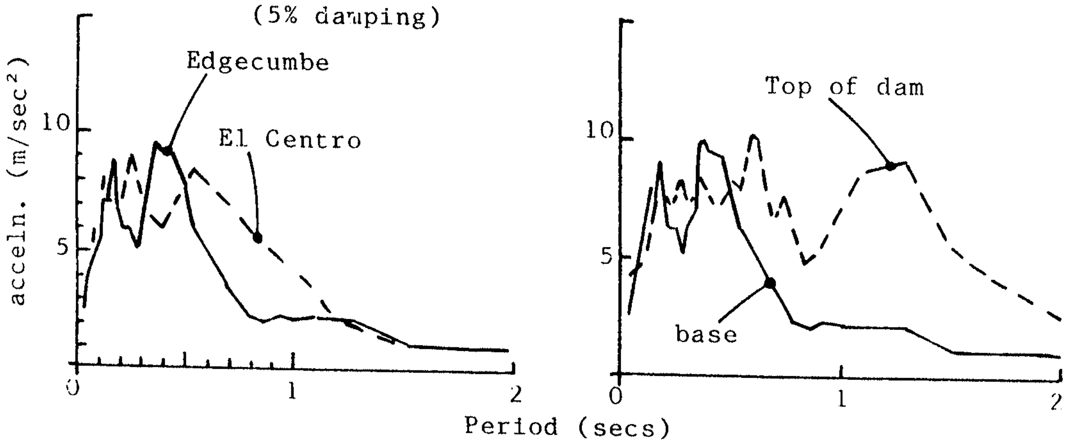

Fig. 5 Response spectra for the recorded motion at the Matahina Dam

Some wells in the area were observed to have increased flows or increased pressures whilst others had decreased flows. On one farm a well, which had water level below the ground surface before the event, had water spurting about one metre into the air just after the earthquake. This flow then subsided gradually and after three days water was just flowing from the ground surface adjacent to the well shaft. Also springs appeared at some places on the plains.

Bridge structures performed well in the earthquake. The most seriously affected being the Te Teko bridge on SH 30. This is a base isolated structure on lead rubber bearings. At the true left abutment one of the bearings had escaped from a mounting ring. However, this was speedily repaired and the MWD had the bridge open again on Wednesday morning. A pervasive problem with bridges was slumping of the approach fills. This occurred at most of the major bridges. Temporary repairs were executed with amazing speed, so that the majority of the bridges were passable again on Tuesday. At the bridge over the Tarawera river on SH 30 the tendency for the approach fills to slump caused cracking of the abutment piles at one end of the bridge, despite this the bridge remained open.

As a generalisation it can be said that more modern structures performed better than older ones during the earthquake. BRANZ did an extensive survey of the houses on the plains, they concluded that almost all the dwellings constructed in line with NZS 3604 (1978) did not suffer structural damage.

Foundation damage was not greatly apparent after the event. At the site of the dairy factory in Edgecumbe there were several examples of incompatibility between pile foundations and adjacent near surface foundations. The pile foundations tended to remain in position whilst the ground around settled and moved sideways taking the surface foundations with it. In Whakatane a sewage pumping station was damaged breaking away from pipes connected and floating upwards a few hundred millimetres. This could have been the result of liquefaction, but there is also the possibility that the lines were broken during the foreshock of magnitude 5.2 whilst the pumps continued to operate saturating the surrounding sand with water under pressure.

Underground services in Edgecumbe were seriously disrupted by the earthquake. Over 400 breaks in water supply and sewage lines had to be repaired before the state of emergency could be lifted in the town. These repairs required more than two weeks.

A more detailed reconnaissance report is under preparation by the NZ National Society for Earthquake Engineering. This has contributions from about 30 people who made a reconnaissance of damage after the earthquake. The above comments are based on the draft of this report. The Earthquake Engineering Society is holding the Pacific Earthquake Engineering Conference in August. One session of the conference program has been set aside for presentations on the earthquake.

THE RATE OF TECTONIC MOVEMENT IN NEW ZEALAND FROM GEOLOGICAL EVIDENCE

Kelvin Berryman and Sarah Beanland[1]

ABSTRACT

New Zealand straddles the boundary between the Australian and Pacific crustal plates. Relative movement across the boundary varies from 35 to 60 mm/yr. Active deformation is widespread in New Zealand and it is prudent to consider its potential hazard to long-lived or critical structures whether the rate of deformation be fast or slow. In the Axial Tectonic Belt, which extends through eastern North Island, Marlborough, Westland, and Fiordland, deformation rates and corresponding hazards are approximately ten times higher than elsewhere in New Zealand.

INTRODUCTION

New Zealand is located across one of the crustal plate boundaries of the world, and is therefore a tectonically active country. Manifestations of the Tectonism are earthquakes, volcanic activity, and active faults and folds. Almost all large magnitude (M >6.5) crustal earthquakes are associated with ground rupture on surface fault traces and the assessment of earthquake and faulting hazards can be evaluated from both seismological and geological viewpoints.

This paper seeks to review the current style and rate of tectonic activity in New Zealand from a geological viewpoint. The distribution, sense, and rate of movement of faults and folds active in the late Quaternary period (past 500,000 years) form the data base for this study.

Previous similar studies includes those of Wellman (1955), Clark et al. (1965), Lensen (1975), Suggate (1978) and Berryman (1984a, b). the understanding of deformation style within regions has not changed markedly from the study of Lensen (1975), but recent emphasis on dating of geologically young deposits and landforms disrupted by faults and folds provides an increasing capability to quantify the rates of deformation.

TECTONIC SETTING OF NEW ZEALAND

In terms of the global model of plate tectonics, New Zealand straddles the boundary between the Pacific and Australian crustal plates (Fig. 1). For a discussion on the mechanism of plates and plate boundaries in relation to New Zealand, the reader is referred to Stevens (1980).

There are three major components to the tectonic setting in New Zealand.

(i) The Kermadec-Hikurangi west dipping subduction zone extends along the east coast of New Zealand to the Chatham Rise (Fig. 1) as defined by a plunging band of seismicity (Adams and Ware 1977, Robinson 1978, Reyners 1980). Subduction related crustal thinning and extension is observed in the Havre Trough to the north of New Zealand and may persist into the central North Island as the Taupo Volcanic Zone (Cole and Lewis 1981; Walcott 1984).

[1] N.Z. Geological Survey, PO Box 30-368, Lower Hutt

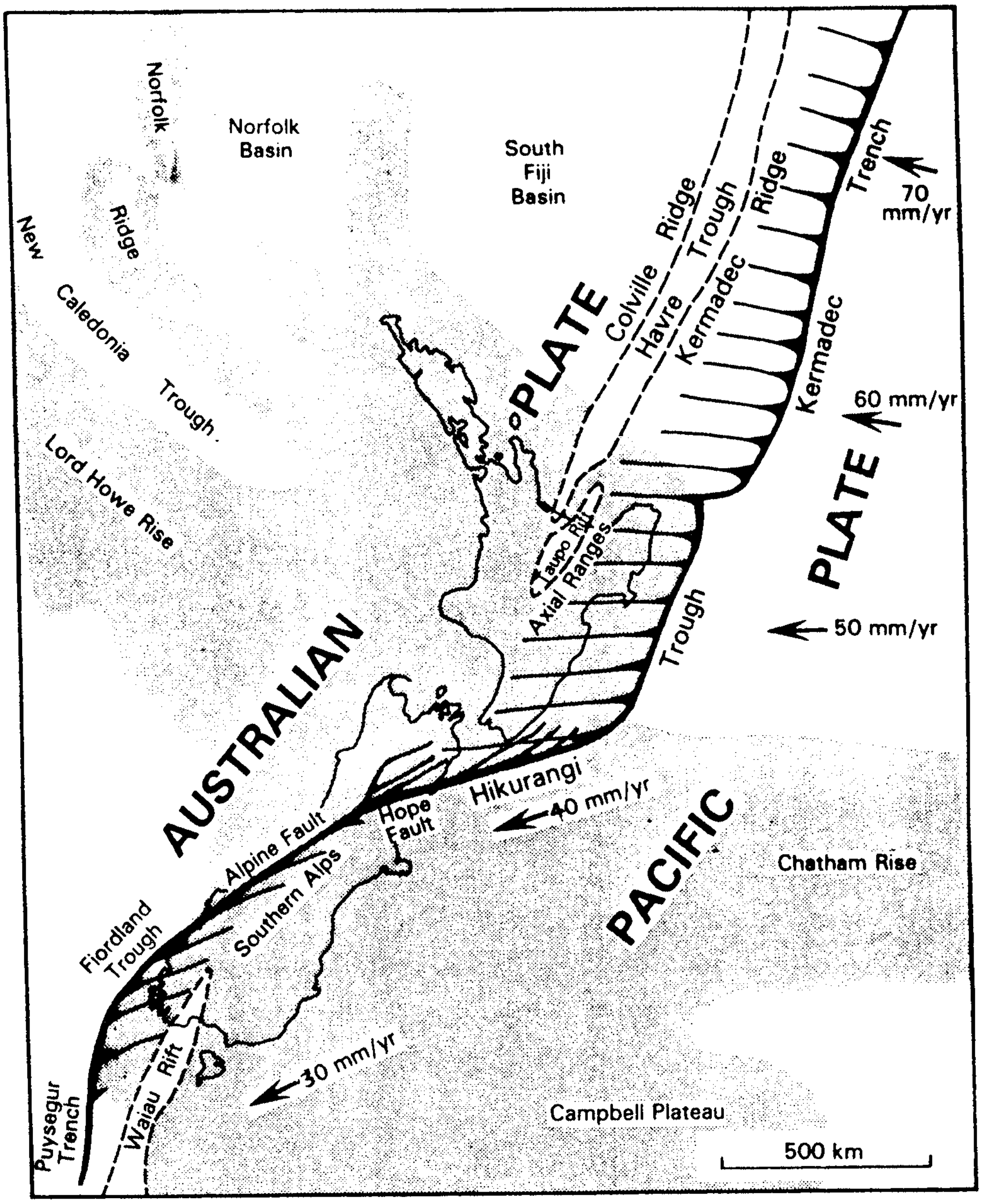

Figure 1 Major elements of the Australian-Pacific plate boundary and main topographic features in the New Zealand region. Stippling represents continental crust. Arrows show motion of the Pacific Plate relative to the Australian Plate, with lines representing direction of motion on underthrusting plate. Rates are from Walcott (1978b). After Cole and Lewis (1981).

(ii) A transform fault zone bounds the Pacific and Australian plates south of the Puysegur Trench (off Fig. 1). Near Fiodland a change in orientation of the plate boundary results in weak east dipping subduction of oceanic crust of the Australian plate beneath continental crust of the Pacific plate (Fig. 1) (Davey and Smith 1983).

(iii) Between the two opposite dipping subduction zones a transform fault system accommodates relative motion between the plates. In the southwest the arrangement is relatively simple with the Alpine Fault comprising the major element. To the northeast, in the Marlborough area, the fault system contains many branching faults.

In the New Zealand region complexities in both the subduction and transform parts of the plate boundary result, to a large extent, from the oblique relative motions of the plates (Fig. 1). Walcott (1978a) indicated that the 50 mm/yr oblique convergency in the Hawkes Bay region may resolve into 40 mm/yr contraction and 30 mm/yr strike-slip motion at the plate boundary. Within the Hikurangi subduction zone deformation structures in the overlying plate (the eastern North Island landmass and offshore continental area) appear to reflect that partitioning (Fig. 2). Near the Alpine Fault oblique plate motion of about 46 mm/yr (Walcott 1979, Table 3) may resolve into 22 mm/yr contraction and 40 mm/yr strike-slip motion.

TECTONIC PROVINCES OF NEW ZEALAND

It is possible to divide New Zealand into provinces according to the nature of tectonic deformation. Within each province a similar style of deformation is apparent and rates of activity are generally comparable.

Figure 3 shows the distribution of faults active in late Quaternary time and the generalised tectonic provinces recognised by the authors. Some of the province boundaries are sharp, for example between the Nelson-Westland region and the Axial Tectonic Belt. Other boundaries are less well defined. In some cases one region merges with another such as between the Axial Tectonic Belt and the Ranges and Basins of Otago, and in other cases tectonic activity appears to steadily diminish such as between the Canterbury-Otago-Southland Ranges and Basins and the Canterbury-Chathams Platform.

Axial Tectonic Belt

The nature of deformation structures within the Axial Tectonic Belt varies along its length but its a continuum. The belt in the southwest is composed principally of one element, the Alpine Fault[2]. Although deformation does occur outside the Axial Tectonic Belt in this part of New Zealand the majority of plate boundary deformation is concentrated in a narrow zone mostly on a Alpine Fault.

In the northeastern part of the South Island a series of strike-slip faults, commonly referred to as the Marlborough fault system, splay from the Alpine Fault to accommodate an increase in obliquity of the direction of movement of the Pacific plate relative to the boundary since about 15 million years ago.

The Hope Fault is the southernmost well developed fault, although the Porters Pass Fault and the offshore Motunau Fault may represent parts of a zone of deformation that could develop into another major strike-slip fault.

Several prominent strike-slip faults in southern North Island such as the Wellington and Wairarapa Faults are probably continuations of elements of the Marlborough fault system. These strike-slip faults continue north to the Bay of Plenty.

2 Readers are referred to the 1:2 million scale late Quaternary Tectonic Map of New Zealand published by DSIR (Officers of the Geological Survey 1983) for the location of faults discussed in this section.

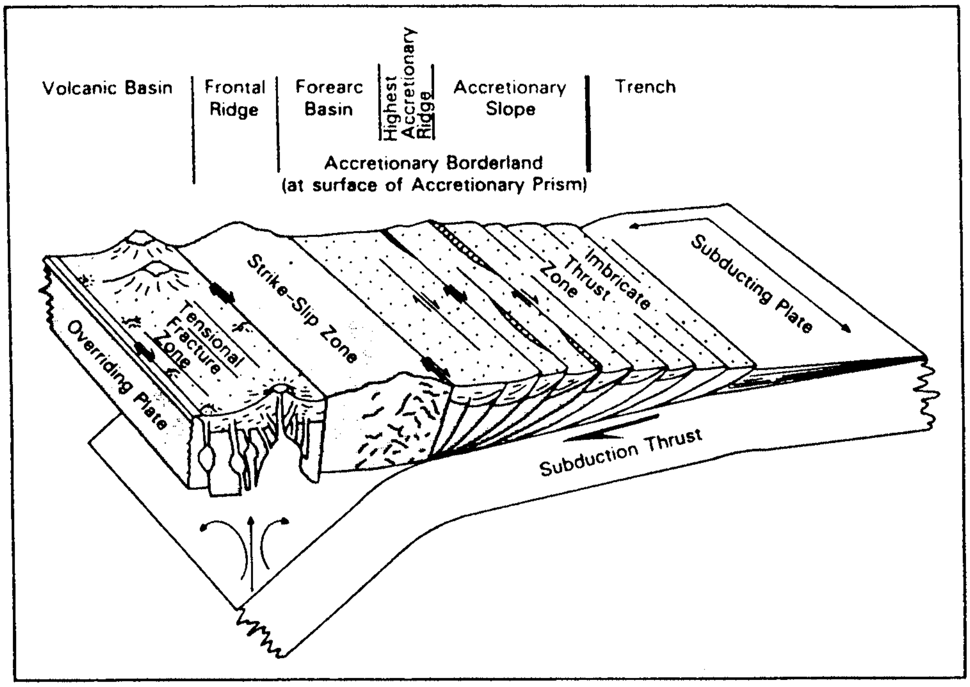

Figure 2 Diagrammatic model of the major structural elements of the Hikurangi oblique subduction zone. Stippling represents over-riding plate, denser stippling indicates pre-Cenozoic "basement" of over-riding plate. From Cole and Lewis (1981).

A minor component of the deformation in Marlborough, but rapidly increasing in importance to the northeast, is active folding associated with reverse faulting (Fig. 4). Although largely offshore, the fold belt comprising the continental borderland in eastern North Island is an important element of the Axial Tectonic Belt. Six thrust controlled ridge and basin pairs are known in a 70km transect across the borderland to the Hikurangi Trench axis off the Wairarapa coast (Lewis * Bennett 1985). Further north 14 thrust-controlled ridge and basin pairs are known.

Taupo Volcanic Zone

Cole & Lewis (1981) considered that within the last million years crustal spreading extended south from the Havre Trough into the continental margin of New Zealand and began to open the Taupo Volcanic Zone. Since that time there has been more than 2 km of subsidence consequent on spreading, the gap forming beomg largely infilled with rhyolitic pyroclastic debris. The zone is characterised by andesitic volcanoes, complex zones of normal faulting, and a high rate of occurrence of small magnitude, shallow earthquakes. Most of the faults have NNE trends although notable exceptions have northwest trends. Sissons (1979) has calculated from geodetic measurements a rate of extension of 7 ± 4 mm/yr across the TVZ in the past c.100 yrs.

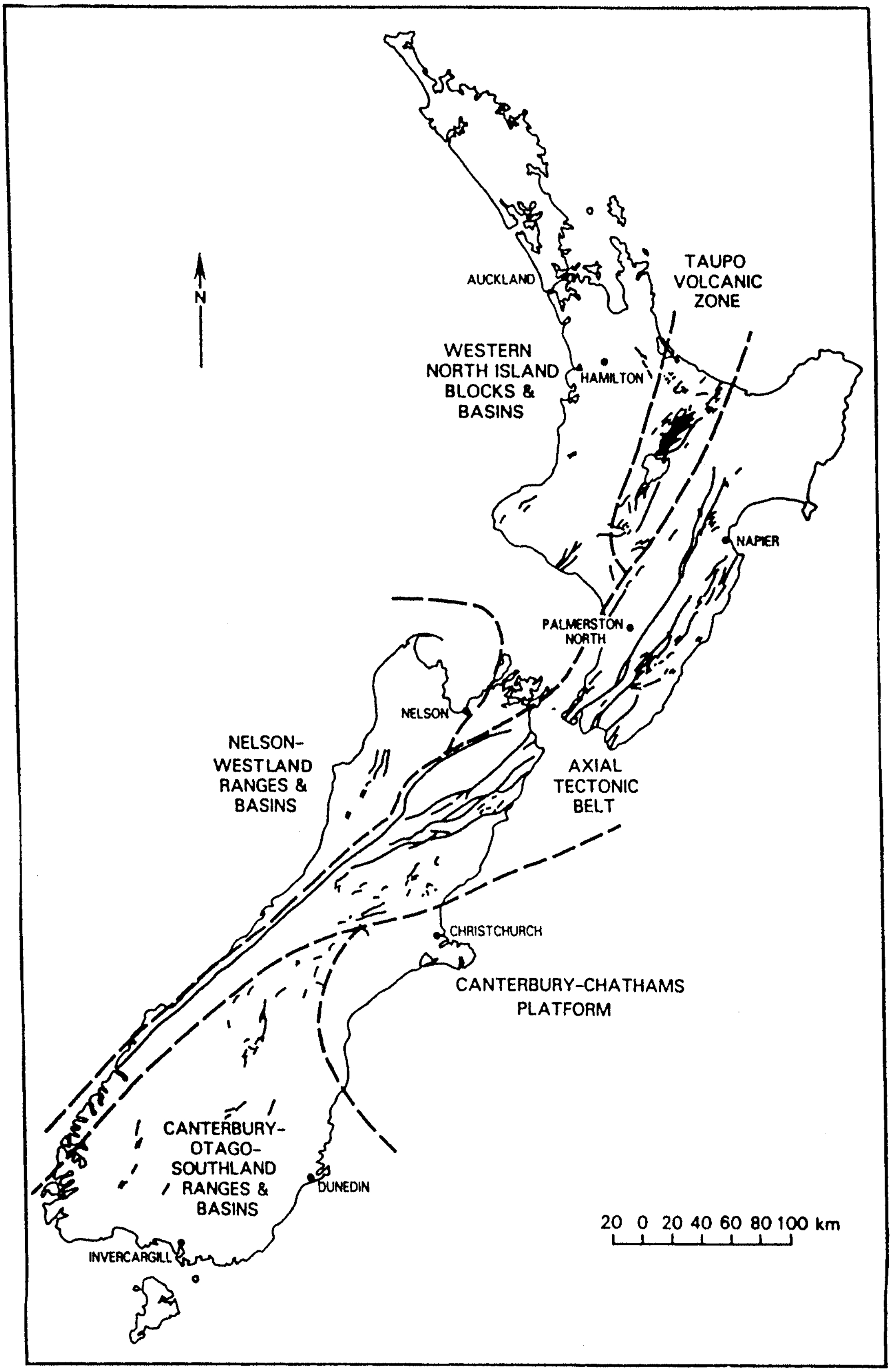

Figure 3 Late Quaternary active faults and tectonic provinces of New Zealand. Faults from Officers of the Geological Survey (1983).

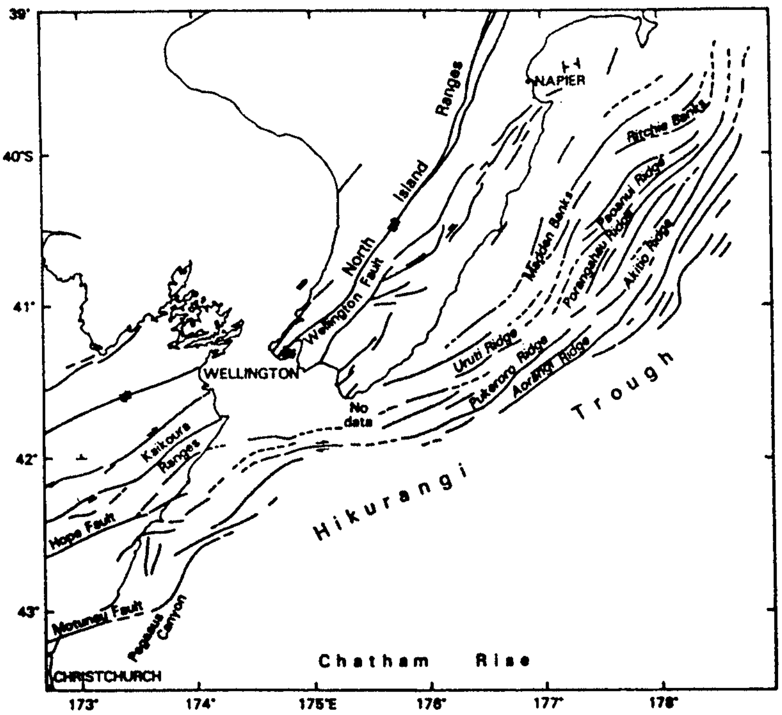

Figure 4 Map of structural trends along the Hikurangi Subduction zone from Hawke's Bay to near Christchurch. After Lewis and Bennett (1985).

Western North Island Blocks and Basins

The western North Island region is relatively stable although normal faults occur locally; the Kerepehi Fault in the Hauraki Depression, the Inglewood Fault in Taranaki, and the Nukumaru Fault zone in Wanganui are all prominent structural features. The Northland Peninsula is near stable; marine terraces show only a small amount of regional uplift. The intensity of tectonism increases steadily from noth to south, as judged by uplifted marine terraces (for example an extensive uplifted terrace sequence occurs in the Wanganui region (Pillans 1983).

Nelson-Westland Ranges and Basins

The Nelson-Westland tectonic province lies northwest of the Alpine Fault and contains approximately north-trending faults and folds that accommodate predominantly contractional strain. The faults are high angle reverse with a small left-lateral strike-slip component. Folding accounts for a major part of the deformation and may exceed faulting in importance although rates are difficult to assess. A prominent set of faults roughly parallel and a few kilometres west of the coastline have offset rocks of the New Zealand landmass down to about 2 km below sea level on the continental platform of the Lord Howe Rise (Fig. 1) during the last 20 million years (Nathan 1986). Present-day activity of this set of faults is poorly known, although the 1962 Westport earthquakes may have been related to the Cape Foulwind Fault (Adams & Le Fort 1963).

Canterbury-Chathams Platform

The Canterbury-Chathams Platform appears to be a region of general tectonic stability with minor subsidence. Pliocene to early Pleistocene (5-2 million years) terrestrial deposits occur about 600 m below present sea-level at Chertsey, about 65 km southwest of Christchurch (Suggate 1978), and the elevation and distribution of late glacial and Holocene sediments about Christchurch City also indicate slow subsidence (Suggate 1958).

No active faults are known in this region.

Canterbury-Otago-Southland Ranges and Basins

At the eastern margin of the Southern Alps a discontinuous but persistent series of low-angle, reverse faults, subparallel to the Alpine Fault, represents contractile deformation away from the plate boundary. Faults such as those near Lake Heron and Fox's Peak Range, and Ostler Fault, merge southeastward with the reverse faults bounding uplifted schist blocks of the Central Otago Ranges and Basins.

Within Central Otago a second set of faults with approximately northwest trends results in a orthogonal pattern of faulting. Few of the northwest trending set of faults are known to have late Quaternary movement.

RATES OF TECTONIC MOVEMENT

The relative importance of individual tectonic features within the overall setting of New Zealand may be understood from comparison of their rates of movement. All historical and geologically inferred fault movements in New Zealand have been episodic, occurring in association with large magnitude earthquakes. Rates of movement are generally expressed as average values in mm/yr, although it may be several hundreds or thousands of years between successive ruptures on faults or growth events of folds.

While the measurement of discrete offsets of topographic features along active faults and on active folds can be achieved very well in New Zealand, the precise dating of displaced deposits and landforms is problematical because of a lack of suitable materials. However, with increasing study of the age and distribution of volcanic airfall ashes in the North Island, and of loess deposits and fluvio-glacial river systems in the South Island, better control is being obtained.

Table 1 is a compilation of rates of movement on many active structures throughout New Zealand with the data grouped into the tectonic provinces shown in Fig. 3. Table 1 generally indicates a single value for rates of displacement on active structures. Some authors (e.g. Wellman 1985, Hull & Berryman, in press) have calculated errors on rates, but we consider that the purpose here is to indicate an approximate figure. Certainly it is unlikely that the single values for rates listed here will apply to the whole length of that structure, but it is also unlikely that the rates will vary by more than 100% along the length.

Rates of movement along the Alpine Fault in the southwest of the Axial Tectonic Belt of 30 - 45 mm/yr are in close agreement with the rate calculated from plate tectonic models (Walcott 1978b). To the northeast of the Axial Tectonic Belt rates on individual faults and folds are in the range 2 - 8 mm/yr at the few sites where data are available. The sum of displacement rates across this broader zone is comparable to the Alpine Fault rate.

Table 1 Compilation of data on rates of late Quaternary movement on faults and folds in New Zealand.

Taupo Volcanic Zone	Fault or Fold	Rate (mm/yr)	Sense of Movement	Age of Offset (yrs)	Reference
Axial Tectonic Belt	Alpine Fault - Southern alps	17	uplift	?	Wellman 1979
	- John O Groats R	45	strike-slip	14,000	Wellman 1984
	- Lake McKerrow	30	strike-slip	c.10,000	Berryman et al in prep
	- Cascade Valley	35	strike-slip	c.10,000	Berryman et al in prep
	- Central Westland	35	strike-slip	c.10,000	Nathan et al in prep
	Wairau Fault	(3.8	strike-slip	18,000	Lensen 1968
		(6.0	strike-slip	12,000	Wellman 1985
	Awatere Fault	4.0	strike-slip	16,000	Berryman 1979
	Clarence Fault	4.0	strike-slip	16,000	Berryman 1979
	Kekerengu Fault	9.0	strike-slip	?	Wellman 1985
	Hope Fault	13.0	strike-slip	?	Wellman 1985
	Porters Pass Fault	4.0	strike-slip	10,000	Berryman 1979
	Wellington Fault	7.1	strike-slip	140,000	Berryman & Wood 1983
	Wairarapa Fault	8.0	strike-slip	14,000	Lensen & Vella 1971
	Mohaka Fault - Te Hoe	3.0	strike-slip	1,800	Hull 1985a
	- Wakarara	3.0	strike-slip		Reub 1985
	Rimutaka Anticline - Cape Turakirae	4.0	uplift	6,500	Wellman 1967
	Aorangi Anticline - Cape Palliser	4.0	uplift	6,500	Wellman 1971
	Kidnappers Anticline - Cape Kidnappers	1.7	uplift	125,000	Ghani 1978
				125,000	Hull 1985b
	Lachlan Anticline - Mahia Peninsula	2.8	uplift	6,500	Berryman 1983
	Pakarae River uplift	4.0	uplift	8,000	Ota et al 1983
	East Cape Anticline - Te Araroa	2.4	uplift	125,000	Yoshikawa et al 1980
Taupo Volcanic Zone	Paeroa Fault	3.3	normal	150,000	Nairn 1976
Western North Island	Kerepehi Fault	0.5	normal	19,000	Cuthbertson 1981 •
	Inglewood Fault	0.5	normal oblique	10,000	Hull & Matsuda 1981
	Nukumaru Fault	0.2	normal	210,000	Pillans 1983
Nelson-Westland	Inangahua Fault	0.1	reverse oblique	18,000	Berryman 1980
	Lyell Fault	0.2	reverse oblique	250,000	Berryman 1980
	White Creek Fault	0.2	reverse oblique	18,000	Berryman 1980
	Waimea Fault	0.5-2.0	reverse oblique	18,000	Johnston 1983
Canterbury-Otago Southland					
	Fox's Peak Fault	1.0	reverse	c.18,000	Berryman unpub data
	Ostler Fault	1.0	reverse	14,000	Read 1984
	Nevis Fault	0.3	reverse	23,000	Beanland & Barrow-Hurlbert in prep
	NW Cardrona Fault	0.25	reverse oblique	16,000	Beanland & Barrow-Hurlbert in prep
	Dunstan Fault	1.0	reverse	c.16,000	Beanland in prep
	Akatore Fault	1.0-2.0	reverse	c.2,000	Makgill pers com 1980 Makgill & Norris 1983

Rates on individual structures outside the Axial Tectonic Belt reach about 3 mm/yr in the Taupo Volcanic Zone and are generally less than 1 mm/yr in the Western North Island, Nelson-Westland, and to the east of the Axial Tectonic Belt.

While it is critical that further studies collect data for calculation of rates of movement for close determination of seismic and faulting hazards, it is not expected that the overall pattern of relative intensity of deformation across New Zealand will change.

DISCUSSION

The data presented in this paper on the rates of tectonic deformation in New Zealand are from the geologically recent past, i.e. the past few thousand to five hundred thousand years. That period is appreciably longer than that covered by the geodetic data set (c. 110 yrs), or historical seismicity data (c. 140 yrs), and it is interesting to compare the interpretations of tectonic hazards that can be derived from these separate data bases (Fig. 5).

The most significant comparison that can be made is that of the high activity rate which can be derived from both geology and geodesy in the region of the Alpine Fault in the southwest of the South Island (Fig. 5A, 5C), and the absence of large earthquakes there (Fig. 5B). As noted by others (Adams 1980, Walcott 1984, Hull & Berryman in press, Berryman et al. in prep.) this region may be a seismic gap that will be filled in the near future (50 - 100 yrs?) by rupture on the Alpine Fault and a large earthquake (M > 7?).

Table 2 Historic faulting events in New Zealand 1826 - 1983

Date	Eq. Mag.	Location	Notes	References
1826	not known	Dusky-Milford Sounds, Fiordland	Uplift of 2-3 metres reported 130 km north of Dusky Sound (about George Sound). Felt reports suggest MM8 in Dusky Sound	Taylor (1855) reported in Eiby (1968)
1848 Oct 16	7.1	On transcurrent fault(s) of NE Marlborough	Lensen (1978) indicates 6 m dextral movement on the Awatere Fault while Eiby (1980) presents evidence that movement occurred on the Wairau Fault near the present position of Blenheim. Subsidence occurred along the coast at Cloudy Bay	Lensen (1978) Eiby (1980)
1855 Jan 24	8.0	Epicentre near South Wairarapa coast on the west Wairarapa Fault	Approximately 3 m of uplift occurred on the west side of the fault and movement occurred for about 100 km northeast. Uplift of 1.5 m occurred in Wellington and the zero ioshase is roughly parallel to the west Wellington coast. Subsidence occurred in the northeast part of the South Island near Blenheim. An area of approx. 12 x 10^3 km^2 was affected by vertical tectonic movements.	Ongley (1943)
1888 Sep 1	7.3	Centred at Glynnwye on the Hope Fault	1.5 m dextral offset of a fenceline recorded by McKay may be the first reported observation of transcurrent faulting in the world. About 50 km of fault break.	McKay (1890)
1922	Perhaps M6	Several faults across the north Taupo Fault belt	Cumulative displacement approaching 4 metres was recorded over a period of 6 months in association with a swarm of earthquakes. Crustal extension of about 3 metres during the period has been derived geodetically.	Grange (1932) Sissons (1979)
1929 Mar 9	6.9	Near Arthur's Pass	Rynn (1975) reported small displacements on the western end of the Hope Fault. Damage was concentrated on Arthur's Pass; the only concentration of people in a sparsely populated region.	Rynn (1975)
1929 Jun 17	7.6	White Creek Fault, Buller	High angle reverse faulting (c. 60°) with a sinistral horizontal component occurred on White Creek Fault which had no evidence of prior displacement for at least 18,000 yrs. A total of 5.2 m of oblique slip occurred on the fault where it crosses the Buller River.	Henderson (1937) Berryman (1980)
1931 Feb 3	7.8	Central Hawkes Bay centred on Napier and Hastings	Geodetic reobservations and surface deformation suggest crustal shortening probably along a northeast striking high angle reverse fault. Maximum uplift was 2.5 m and the uplifted and tilted block was 80 km long and about 10 km wide.	Henderson (1933) Marshall (1933) Walcott (1978a)
1932 Sep 16	7.0	Wairoa, Hawkes Bay	From geodetic reobservations, about 0.5 m of dextral slip at the time of the earthquake is calculated. A 1 km long fault scarp also formed parallel to bedding on the eastern limb of the Wairoa syncline. Faulting is consistent with continued shortening across the Wairoa Syncline.	Ongley (1937) Walcott (1978a)
1968 May 24	7.1	Inangahua Buller	Regional uplift of 2.7 m (determined by precise levelling traverses) with discrete movement on the Inangahua (Glasgow) Fault of 0.4 m vertical 0.19 m sinistral. The main faulting was high angle reverse along a pre-existing fault scarp although significant and complex bedding plane slip occurred in the Tertiary rocks south of Inangahua.	Lensen & Suggate (1968) Lensen & Otway (1971) Boyes (1971)
1983 Jul	About 3.4	Kaiapo Fault, north Taupo fault belt	Associated with a localised swarm of earthquake activity 0.05 m of normal faulting occurred on the 60° northwest dipping Kaiapo Fault. The rupture was 1.2 km long and along part of the length of the Kaiapo Fault that ruptured in 1922.	Hull & Grindley (1983)

Large on-shore earthquakes have also occurred in 1863 in southern Hawkes Bay, 1881 in North Canterbury, 1893 south of Nelson, 1901 near Cheviot, North Canterbury, 1934 near the Manawatu Gorge and 1942 in the Wairarapa all of which might have been expected to have associated surface faulting. More studies are required to investigate historic active faulting in New Zealand.

Elsewhere in New Zealand there is a close correspondence between seismicity and geodetic shear strain rates, which is not surprising considering geodetic assessments include large strain associated with large historical earthquakes. Notable in this comparison is the high seismic activity and strain rate found in Buller, Nelson and Wanganui that is not seen in the longer-term geological record. Although there are many active geological structures in these regions their rate of activity is low (Table 1) which suggests the high historical rate of activity is typical in geological terms. The geological record indicates that faults in the currently aseismic Otago region have the same long-term activity rate as those in the more seismically active Buller-Nelson region.

Historic surface faulting has occurred in association with many of the large earthquakes shown in Fig. 5B (table 2). These historic faulting events confirm the style of deformation ascribed to various regions from geological studies and establish a small data set relating the amount of surface fault slip to earthquake magnitude in different tectonic provinces. These data provide an essential analogy in interpreting the geological tectonic record for future seismic hazard evaluation.

The amount of surface fault slip per event varies between regions from perhaps 8 metres on the Alpine Fault (Hull & Berryman, in press) to less than 1 metre in the Taupo Volcanic Zone (Hull & Grindley 1983; Nairn & Hull 1985). Two to five metres of slip on faults and folds in each event is common throughout the Axial Tectonic Belt and the reverse fault provinces of northwest and southeast South Island.

The amount of surface fault slip per event can be coupled with an estimate of the deformation rate to give an average recurrence interval of faulting. Within the Axial Tectonic Belt recurrence intervals are assessed at 200 - 500 years on the Alpine Fault (Adams 1980; Hull & Berryman, in press; Berryman et al., in prep) and 500 - 1500 yrs elsewhere (Berryman 1983; Hull 1985a, b; Raub 1985).

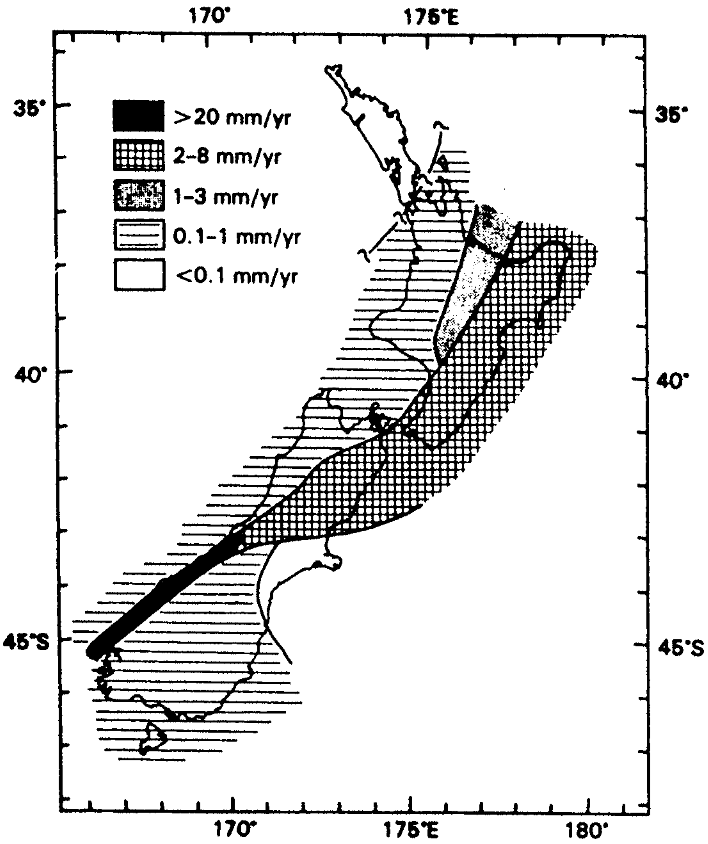

Figure 5A Slip rates on individual structures within generalised regions.

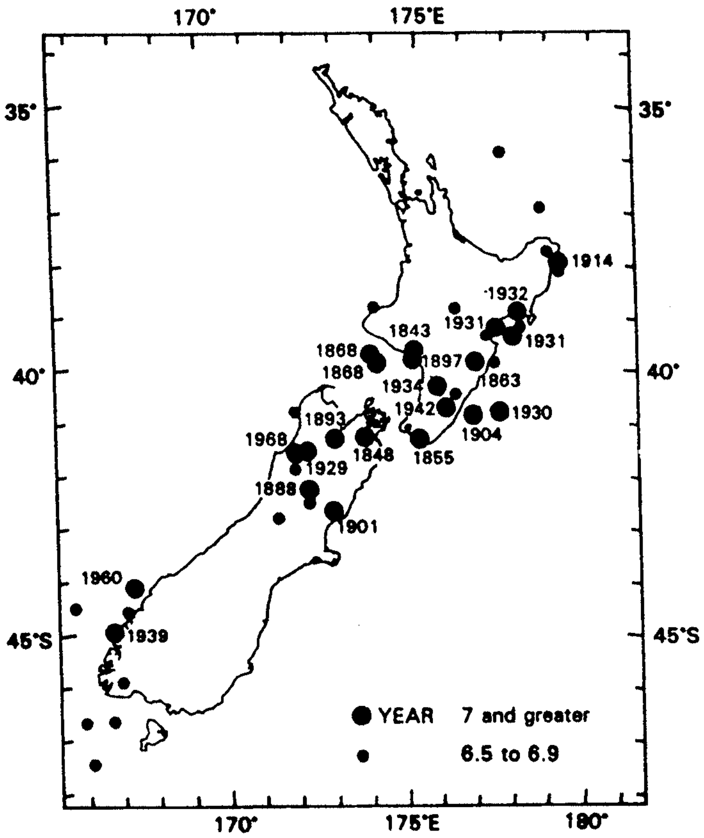

Figure 5B Epicentres of shallow earthquakes of magnitude 6.5 and greater 1840 - 1983. From Smith and Berryman (1983).

In the Taupo Volcanic Zone, faulting recurrence intervals are poorly documented although we consider they could be in the order of a few hundred years.

In the western North Island and northwest and southeast of the South Island fault activity rates are slow (generally < 1 mm/yr) and increments of fault movement are quite large (1 - 4 metres). Average recurrence intervals of faulting and therefore very long, in general several thousand to about 10,000 years.

An important conclusion from this discussion is that all three approaches (geological, geodetic and seismological) to assessing past deformation and future hazard must be considered if the hazard is to be fully appreciated. For example, along the Alpine Fault gap geological and geodetic evidence reveals a high level of hazard whereas seismological evidence does not. In contrast, in the Nelson-Westland region seismological and geodetic data define the hazard more appropriately than geological evidence. In this case it appears that the historical record represents only a geologically short term burst of activity, atypical of the long term geological rates.

As an overall assessment for New Zealand we suggest that while it is prudent to consider seismic and faulting hazards for long-lived or critical structures no matter what the deformation rate is, large earthquakes and fault rupture will occur approximately ten times more often within the Axial Tectonic Belt than outside it.

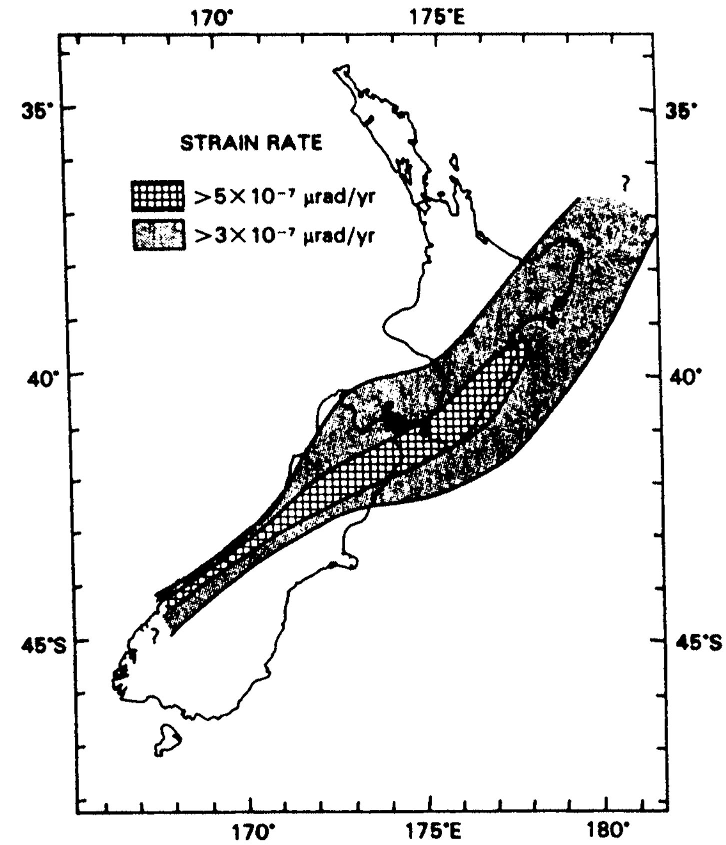

Figure 5C Geodetic shear strain rates over the past c. 100 years. From Hatherton (1984).

REFERENCES

ADAMS, J. 1980: Paleoseismicity of the Alpine Fault seismic gap, New Zealand. **Geology 8**: 72-76.

ADAMS, R.D.; LE FORT, J.H. 1963: The Westport earthquakes, May, 1962. **New Zealand journal of geology and geophysics 6**: 487-509.

ADAMS, R.D.; WARE, D.E. 1977: Subcrustal earthquakes beneath New Zealand. Location determined with a laterally inhomogeneous velocity model. **New Zealand journal of geology and geophysics 20**: 59-83.

BEANLAND, S. in prep: Initiation and style of current tectonics in Central Otago, New Zealand.

BEANLAND, S. & BARROW-HURLBERT, S.A. in prep: the Nevis-Cardrona Fault System : late Quaternary tectonics and structural development.

BERRYMAN, K.R. 1979: Active faulting and derived PHS directions in the South Island, New Zealand. **Royal Society of New Zealand bulletin 18**: 29-34.

BERRYMAN, K.R. 1980: Late Quaternary movement on White Creek Fault, South Island, New Zealand. **New Zealand journal of geology and geophysics 23**: 93-101.

BERRYMAN, K.R. 1983: Tectonic implications of the mid-late Holocene geology of Mahia Peninsula, East Coast, North Island, New Zealand. (Abstract) International Symposium on coastal evolution in the Holocene, August 29th-31st, Tokyo, Japan.

BERRYMAN, K.R. 1984a: Active folding and faulting, in I.G. Speden; M.J. Crozier (compilers). Natural Hazards in New Zealand. **New Zealand National Commission for UNESCO**: 302-331.

BERRYMAN, K.R. 1984b: Late Quaternary tectonics in New Zealand in R.I. Walcott (ed.), An Introduction to the Recent Crustal Movements of New Zealand. **The Royal Society miscellaneous series 7**: 91-107.

BERRYMAN, K.R.; CUTTEN, H.N.C.; FELLOWS, D.L.; HULL, A.G.; SEWELL, R.J. In prep: Alpine Fault reconnaissance survey from Arawata River to Pyke River, South Westland, New Zealand.

BOYES, W.S. 1971: Horizontal and vertical crustal movement in the Inangahua earthquake of 1968. **Royal Society of New Zealand bulletin 9**: 61-72.

BROWN, I.R.; WOOD, P.R. 1983: Strain measurement across the Wellington Fault at Te Marua. Proceedings of the Third South Pacific Regional Conference on Earthquake Engineering, Wellington, New Zealand: 509-515.

CLARK, R.H.; DIBBLE, R.R.; FYFE, H.E.; LENSEN, G.J.; SUGGATE, R.P. 1965: Tectonic and earthquake risk zoning. **Transactions of the Royal Society of New Zealand 1**: 113-126.

COLE, J.W.; LEWIS, K.B. 1981: Evolution of the Taupo-Hikurangi subduction system. **Tectonophysics 72**: 1-21.

CUTHBERTSON, A.S. 1981: The Hinuera Formation in the southern Hauraki Lowland, Central North Island. Unpublished MSc thesis, Waikato University, New Zealand.

DAVEY, F.J.; SMITH, E.G.C. 1983: The tectonic setting of the Fiordland region, southwest New Zealand. **Geophysical journal of the Royal Astronomical Society 72**: 23-38.

EIBY, G.A. 1968: An annotated list of New Zealand earthquakes 1460-1965. **New Zealand journal of geology and geophysics 11**: 630-647.

EIBY, G.A. 1980: The Marlborough earthquake of 1848. **Department of Scientific and Industrial Research bulletin 225**: 81 pp.

GHANI, M.A. 1978: Late Cenozoic vertical crustal movements in the southern North Island. **New Zealand journal of geology and geophysics 21**: 117-126.

GRANGE, L.I. 1932: Taupo earthquakes 1922. Rents and faults formed during earthquake of 1922 in Taupo district. **New Zealand journal of science and technology 14**: 139-141.

HATHERTON, T. 1984: Earthquakes, in I.G. Speden; M.J. Crozier (compilers), Natural Hazards in New Zealand. **New Zealand National Commission for UNESCO**: 263-301.

HENDERSON, J. 1933: The geological aspects of the Hawke's Bay earthquakes. **Department of Scientific and Industrial Research bulletin 43.**

HENDERSON, J. 1937: The west Nelson earthquakes of 1929. **New Zealand journal of science and technology 19**: 66-143.

HULL, A.G. 1985a: Holocene displacements at the Mohaka Fault, Northern Hawke's Bay. (Abstract) Geological Society of New Zealand Christchurch Conference, December 9th-13th 1985.

HULL, A.G. 1985b: Age and deformation of Kidnappers terrace, coastal Hawke's Bay. (Abstract) Geological Society of New Zealand Conference, December 9th-13th 1985.

HULL, A.G. & BERRYMAN, K.R. in press: Holocene tectonism in the region of the Alpine Fault at Lake McKerrow, Fiordland, New Zealand. Royal Society of New Zealand bulletin 24.

HULL, A.G.; GRINDLEY, G.W. 1983: Active faulting near Taupo. **E.O.S. 65**: 51-52.

HULL, A.G.; MATSUDA, T. 1981: Late Quaternary faulting near Inglewood, North Island, New Zealand. (Abstract) Geological Society of New Zealand, Hamilton Conference, December 1981.

JOHNSTON, M.R. 1983: Geological Map of New Zealand 1:50 000 Sheet N28AC

"Motupiko". New Zealand Geological Survey, DSIR.
LENSEN, G.J. 1968: Analysis of progressive fault displacement during downcutting at the Branch River Terraces, South Island. **Geological Society of America bulletin 79**: 545-556.
LENSEN, G.J. 1975: Earth deformation studies in New Zealand. **Tectonophysics** 29: 541-551.
LENSEN, G.J. 1978: Historic tectonic earth deformation, in R.P. Suggate, G.R. Stevens, M.T. Te Punga (editors), The Geology of New Zealand. Government Printer, Wellington, New Zealand: 33-39.
LENSEN, G.J.; OTWAY, P.M. 1971: Earthshift and post-earthshift deformation associated with the May 1968 Inangahua earthquake, New Zealand. **Royal Society of New Zealand bulletin 9**: 107-116.
LENSEN, G.J.; SUGGATE R.P. 1968: Preliminary reports on the Inangahua Earthquake, New Zealand, May 1968. **Department of Scientific and Industrial Research bulletin 193**: 17-36.
LENSEN, G.J.; VELLA, P. 1971: The Waiohine River faulted terrace sequence. **Royal Society of New Zealand bulletin 9**: 177-190.
LEWIS, K.B.; BENNETT, D.J. 1985: Stress patterns on the Hikurangi margin, in K.B. Lewis (compiler), **New Zealand Oceanographic Institute field report 22**: 3-25.
MAKGILL, K.P.; NORRIS, R.J. 1983: Recent movements on the Akatore Fault, East Otago, and its relationship to regional tectonics. (Abstract) Pacific Science Association 15th Congress, Dunedin, February 1-11, 1983.
MARSHALL, P. 1933: The geological aspects of the Hawkes Bay earthquakes. **Department of Scientific and Industrial Research bulletin 43.**
MCKAY, A. 1890: On the earthquakes of September 1888, in the Amuri and Marlborough districts of the South Island. **New Zealand Geological Survey reports of geological exploration 1885-1889, 20**: 1-16.
NAIRN, I.A. 1976: Late Quaternary faulting in the Taupo Volcanic Zone. Pp. 26-33 in S. Nathan (compiler) Excursion Guide no. 55A and 55C, 25th International Geological Congress.
NAIRN, I.A. & HULL, A.G. 1985: Post-1800 years BP displacement on the Paeroa Fault Zone. **New Zealand Geological Survey Record 8**: 135-142.
NATHAN, S. and others 1986: Cretaceous and Cenozoic sedimentary basins of the West Coast region, South Island, New Zealand. New Zealand Geological Survey Basin Studies 1.
OFFICERS OF THE GEOLOGICAL SURVEY 1983: Late Quaternary tectonic map of New Zealand. New Zealand Geological Survey Miscellaneous series map 12.
ONGLEY, M. 1937: The Wairoa earthquake of 16th September 1932. 1. Field observations. **New Zealand journal of science and technology 18**: 845-851.
ONGLEY, M. 1943: Surface trace of the 1855 earthquake. **Transactions of the Royal Society of New Zealand 73**: 84-99.
OTA, Y.; YOSHIKAWA, T.; ISO, N.; IKEDA, Y.; MORIYA, I.; HULL, A.G. 1983: Holocene marine terraces in the northeastern coast of North Island, New Zealand. (Abstract) International Symposium on coastal evolution in the Holocene, August 29th-31st, Tokyo, Japan.
PILLANS, B. 1983: Upper Quaternary marine terrace chronology and deformation, South Taranaki, New Zealand. **Geology 11**: 292-297.
RAUB, M.L. 1985: The neotectonic evolution of the Wakarara area, southern Hawke's Bay. Unpublished MPhil thesis, University of Auckland, New Zealand.
READ, S.A.L. 1984: Late Quaternary deformation in the Ostler Fault Zone, Mackenzie Basin, South Island, New Zealand. (Abstract) International Symposium on Recent Crustal Movements of the Pacific Region, Wellington, New Zealand, February 1984.

REYNERS, M. 1980: A microearthquake study of the plate boundary, North Island, New Zealand. **Geophysical journal of Royal Astronomical Society 63**: 1-22.

ROBINSON, R. 1978: Seismicity within a zone of plate convergence - the Wellington region, New Zealand. **Geophysical journal of Royal Astronomical Society 55**: 693-702.

RYNN, J.M.W. 1975: Seismotectonics of the Arthur's Pass region, South Island, New Zealand, and regional variations of ts/tp. Unpublished PhD thesis, Colombia University, New York, U.S.A.

SISSONS, B.A. 1979: The horizontal kinematics of the North Island of New Zealand. Unpublished PhD thesis, Victoria University of Wellington, New Zealand.

SMITH, W.D.; Berryman, K.R. 1983: Revised estimates of earthquake hazard in New Zealand. **Bulletin of the New Zealand National Society for Earthquake Engineering 16**: 259-272.

STEVENS, G.R. 1980: New Zealand Adrift. A.H. & A.W. Reed, Wellington.

SUGGATE, R.P. 1958: Late Quaternary deposits of the Christchurch metropolitan area. **New Zealand journal of geology and geophysics 1**: 103-122.

SUGGATE, R.P. 1978: The Kaikoura Orogeny. Chapter 10 in R.P. Suggate, G.R. Stevens, M.T. Te Punga (eds) The Geology of New Zealand. Government Printer, Wellington, New Zealand. Pp 671-701.

TAYLOR, R. 1855: Te Ika a Maui, or New Zealand and its inhabitants. Wertheim and Macintosh, London.

WALCOTT, R.I. 1978a: Geodetic strains and large earthquakes in the axial tectonic belt of North Island, New Zealand. **Journal of Geoohysical Research 83(B9)**: 4419-4429.

WALCOTT, R.I. 1978b: Present tectonics and Late Cenozoic evolution of New Zealand. **Geophysocal journal of the Royal Astronomical Society 52**: 137-164.

WALCOTT, R.I. 1979: Plate motion and shear strain rates in the vicinity of the Southern Alps. **Royal Society of New Zealand bulletin 18**: 5-12.

WALCOTT, R.I. 1984: The major structural elements of New Zealand in R.I. Walcott (ed.), An Introduction to the Recent Crustal Movements of New Zealand. **The Royal Society miscellaneous series 7**: 1-6.

WELLMAN, H.W. 1955: New Zealand Quaternary tectonics. **Geologischen Rundschau 43**: 248-257.

WELLMAN, H.W. 1967: Tilted marine beach ridges at Cape Turakirae, New Zealand. **Journal of Geosciences, Osaka City University 10**: 123-129.

WELLMAN, H.W. 1971: Holocene tilting and uplift on the White Rocks Coast, Wairarapa, New Zealand. **Royal Society of New Zealand bulletin 9**: 211-215.

WELLMAN, H.W. 1979: An uplift map for the South Island of New Zealand, and a model for uplift of the Southern Alps. **Royal Society of New Zealand bulletin 18**: 13-20.

WELLMAN, H.W. 1984: The Alpine Fault, New Zealand, near Milford Sound and to the southwest. **Geological Magazine 121**: 437-441.

WELLMAN, H.W. 1985: Weathering rind ages for the central part of New Zealand. (Abstract) Geological Society of New Zealand Christchurch Conference, December 9th-13th 1985.

YOSHIKAWA, T. and others 1980: Marine terraces and tectonic deformation, northeast of North Island. **Geological Review of Japan 53**: 235-262 (Japanese with English abstract).

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MAP REVIEWS

Sheet N42/1 - Hobsonville, and Sheet N42/9 - Whitford, Geological Map of New Zealand 1:25,000 Industrial Series. Department of Scientific and Industrial Research Wellington, New Zealand. $13.20

Publication of these two maps marks the completion of the series of nine sub-sheets comprising the area covered by the 1:63360 scale sheet N42 - Auckland. It represents a milestone in the work of compiler Les Kermode, of the Auckland District Office of NZ Geological Survey, that covers a period of some twenty years since publication of the first map (Devonport).

It may not be widely known that the early maps of this series were some of the first in the context of the development of specialist geological maps for planning or engineering applications, in the English-speaking world, a fact which has received mention in overseas literature.

The new Whitford and Hobsonville sheets continue the use of the 1:25,000 photo-masaic base. This has been a popular aspect amongst users, enabling ready identification of surface features. Lithological units, as before, are distinguished on the map face by letter symbols. Compared with the colour or other in-filling of units on conventional geological maps, the use of letter symbols does not facilitate ready assessment of lithological distribution. However, it has proved quite adequate for preliminary site-specific assessments, probably their most common use.

The early maps were accompanied by legends with brief conventional formation descriptions. Tables and notes provided additional geological, geomorphological, engineering, and resource information. With the subsequent development of recommended methods of engineering geological description, the accompanying information changed accordingly. In this respect, the new Whitford and Hobsonville sheets reflect the most recent trends in such description, and contain a broad range of information.

The legends of both maps have detailed lithological and engineering geological descriptions for each unit, with accompanying tables defining the terminology used. Some classification test data are presented for engineering soils (the strength range for soft cohesive material having missed editorial scrutiny on the Hobsonville sheet). Broad strength ranges are represented on the map face by different type styles. Selected drill logs with accompanying laboratory test data are also presented on the Hobsonville sheet.

A useful inclusion is a table correlating map units with those used on previously published sheets, in recognition of the improved understanding of lithological characteristics. Also, a statement is given indicating that stratigraphic names conform with previous usage in this series, thereby sensibly avoiding involvement in recent discussions on nomenclature.

As with the previously published sheets these maps succeed in their stated objective "to help land users in general; but civil engineers, planners, and quarry operators in particular". While they may not satisfy purists, they also contain much useful regional geological information.

The completion of this map series provides a sound basis for more detailed studies in relation to land-use in New Zealand's major urban growth area. Particular aspects which warrant attention include Quaternary deposits and processes, and the geology of construction materials.

BRUCE RIDDOLLS

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